ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR "HADEN SOLAR POWER PLANT"

PRELIMINARY STUDIES FOR ENERGY SOLAR PLANT IN HADEN, TURBAH GOVERNORATE, MAKKAH PROVINCE, IN THE KINGDOM OF SAUDI ARABIA

Prepared By

ENVIRONMENTAL CONSULTING OFFICE
مكتب علي خضير الحربي للإستشارات البيئية

February 24

Revision Status

S. No.	Revision No	Description	Prepared By	Checked By	Approved By	Date
1	00	ESIA "HADEN SOLAR POWER PLANT"	Abderrazzak ZEMZEMI	Elyes OTHMEN	Ennacer BESSGHAEIR	07/03/2022
	01	ESIA "HADEN SOLAR POWER PLANT"	Abderrazzak ZEMZEMI	Elyes OTHMEN	Ennacer BESSGHAEIR	24/03/2022
	02	ESIA "HADEN SOLAR POWER PLANT"	Abderrazzak ZEMZEMI	Elyes OTHMEN	Ennacer BESSGHAEIR	28/03/2022
	03	ESIA "HADEN SOLAR POWER PLANT"	Abderrazzak ZEMZEMI	Amer Bensaad	Ennacer BESSGHAEIR	27/02/2024

TABLE OF CONTENTS

TABLE OF CONTENTS **3**
LIST OF TABLES **18**
LIST OF FIGURES **21**
ABBREVIATIONS AND ACRONYMS **23**
1. EXECUTIVE SUMMARY 25
1.1. INTRODUCTION 25
1.2. THE ESIA PROCESS 25
1.3. PROJECT JUSTIFICATION 25
1.4. THE PROJECT DESCRIPTION 26
1.5. PROJECT PHASES 26
1.6. PROJECT BASELINE 27
1.7. STAKEHOLDER ENGAGEMENT 27
1.8. IMPACT ASSESSMENT 28
1.9. POSITIVE IMPACTS 29
1.10. POTENTIAL ADVERSE IMPACTS 29
1.11. DEVELOPMENT AND IMPLEMENTATION OF ESMP 30
2. INTRODUCTION 31
2.1. GENERAL BACKGROUND 31
2.2. STUDY OBJECTIVE 31
2.3. STUDY SCOPE 32
2.3.1. THE SCOPE OF THE STUDY 32
2.3.1.1. DEFINE THE SPATIAL AREA OF THE STUDY 32
2.3.1.2. ASSESSMENT TIME RANGE 32
2.3.1.2.1. DESIGN PHASE 32
2.3.1.2.2. CONSTRUCTION PHASE 32
2.3.1.2.3. OPERATION STAGE 33
2.3.2. ESIA METHODOLOGY 33
2.3.3. STRUCTURE OF THE ENVIRONMENTAL AND SO IMPACT ASSESSMENT STUDY 33
3. PROJECT DESCRIPTION 35
3.1. INTRODUCTION 35
3.2. PROJECT OVERVIEW 35
3.3. PROJECT JUSTIFICATION 35

3.4. Project location 35
3.5. Site Access 39
3.6. Description of Project Facilities, Components and Activities 39
3.6.1. Project key components 39
3.6.1.1. Photovoltaic Modules (PV Modules) 42
3.6.1.2. Mounting / Tracking Systems 44
3.6.1.3. Inverters 45
3.6.1.4. Transformer 47
3.6.1.5. Cabling 47
3.6.1.6. Electrical connection to SEC substation 48
3.6.2. Associated Facilities and Other Plant Infrastructure 48
3.6.2.1. Site Access and Internal Roads 48
3.6.2.2. Administration Building and Control Centre 49
3.6.2.3. Temporary Construction Laydown Area 49
3.6.2.4. Scrap yard 49
3.6.2.5. Main Substation 49
3.6.3. Project Phases and Activities 49
3.7. Land preparation and construction phase activities 50
3.7.1. Schedule 51
3.7.2. Workforce and Workers' Accommodation 51
3.7.3. Construction Activities 51
3.7.4. Construction Machinery and Equipment 52
3.8. Operation and maintenance activities 53
3.8.1. Project Lifetime 53
3.8.2. Workforce 54
3.9. Resource Requirement 54
3.9.1. Land Requirement 54
3.9.2. Water Requirement and Source 54
3.9.2.1. Water requirement in construction phase 54
3.9.2.1.1. Potable water 55
3.9.2.1.2. Water demand for dust suppression 55
3.9.2.1.3. Water demand for civil works 55
3.9.2.2. Water requirement in operation phase 55
3.9.2.2.1. Water for PV module cleaning 55

3.9.2.2.2. WATER FOR DOMESTIC USE 56
3.9.3. RAW MATERIAL REQUIREMENT 56
3.9.3.1. CONSTRUCTION PHASE 56
3.9.3.2. OPERATION AND MAINTENANCE PHASE 56
3.9.4. POWER REQUIREMENT 56
3.9.4.1. CONSTRUCTION PHASE 56
3.9.4.2. OPERATION PHASE 57
3.9.5. FIRE SAFETY AND SECURITY 57
3.9.5.1. CONSTRUCTION PHASE 57
3.9.5.2. OPERATION PHASE 57
3.10. POLLUTION STREAMS DURING CONSTRUCTION PHASE 57
3.10.1. SOLID WASTE GENERATION 57
3.10.1.1. CONSTRUCTION PHASE 57
3.10.1.2. OPERATION PHASE 58
3.10.2. AIR EMISSIONS 58
3.10.2.1. CONSTRUCTION PHASE 58
3.10.2.2. OPERATION PHASE 59
3.10.3. WASTE GENERATION 59
3.10.3.1. CONSTRUCTION PHASE 59
3.10.3.2. OPERATION PHASE 59
3.10.4. NOISE EMISSIONS 60
3.10.4.1. CONSTRUCTION PHASE 60
3.10.4.2. OPERATION PHASE 60
4. PROJECT ALTERNATIVES 61
4.1. METHODOLOGY FOR SELECTING AND EVALUATING ALTERNATIVES 61
4.2. NO-PROJECT OPTION 61
4.3. ALTERNATIVE TECHNOLOGIES 62
4.3.1. SOLAR PANEL TECHNOLOGY 62
4.3.2. TRACKER 63
4.4. ALTERNATIVE SITE SELECTION 63
4.4.1. DEFINING CRITERIA OF SITE SELECTION 63
4.4.2. PROPOSED FRAMEWORK 64
4.4.2.1. DOCUMENTARY ANALYSIS 65
4.4.2.2. FIELD SURVEY /STAKEHOLDERS ENGAGEMENT 65

4.4.2.3. WALKTHROUGH SITE VISIT 67
4.4.3. CRITERIA ANALYSIS & SITE SELECTION 69
4.4.3.1. SOCIO-ECONOMIC CRITERIA 69
4.4.3.1.1. DISTANCE TO TRANSMISSION LINES AND SUBSTATIONS 69
4.4.3.1.2. LAND CONSTRAINTS (OVERHEAD POWER LINES) 69
4.4.3.1.3. COMPLIANCE WITH SAFETY REQUIREMENTS 70
4.4.3.1.4. ELECTRIC RISK IMPACT 70
4.4.3.1.5. ACCESSIBILITY (DISTANCE TO ROADS) 71
4.4.3.1.6. LAND CONSTRAINTS (ROAD) 71
4.4.3.1.7. THE COMMUNITY INTERESTS (GRAZING ACTIVITIES) 72
4.4.3.1.8. GRAZING ZONES 72
4.4.3.1.9. POTENTIAL SOCIAL IMPACTS 74
4.4.3.2. LAND USE (RESTRICTION CRITERION) 74
4.4.3.2.1. MILITARY ZONE 74
4.4.3.2.2. LAND CONSTRAINTS (MILITARY ZONE) 75
4.4.3.2.3. ALLOCATED LAND FOR THE GOVERNMENT FUTURE PROJECTS 75
4.4.3.2.4. LAND CONSTRAINTS (GOVERNMENT PROJECTS) 76
4.4.3.3. ENVIRONMENTAL CRITERIA 76
4.4.3.3.1. BIODIVERSITY 76
4.4.3.3.2. CULTURAL HERITAGE 78
4.4.3.3.3. LAND USE 79
4.4.3.4. TECHNICAL CRITERIA 79
4.4.3.4.1. SLOPE 79
4.4.3.4.2. LOCAL CLIMATE 80
4.4.3.4.3. FLASH FLOODS RISK 80
4.4.3.4.4. WATER AVAILABILITY 81
4.4.4. THE RESTRICTED AREAS 81
4.4.5. RESULTS 84
5. POLICY, INSTITUTIONAL AND LEGAL FRAMEWORK 86
5.1. OVERVIEW 86
5.2. NATIONAL REGULATORY FRAMEWORK 86
5.2.1. THE BASIC LAW OF GOVERNANCE 86
5.2.2. PUBLIC ENVIRONMENT LAW 2001 (PEL) 86
5.2.3. GENERAL ENVIRONMENTAL REGULATIONS AND THEIR RULES FOR IMPLEMENTATION (GERRI) 87

5.2.4. GAMEP (NCEC) Environmental Standards 88
5.2.5. Environment Law, promulgated by Royal Decree No. (M/165) dated 11/19/1441 AH 89
5.2.6. Law of Antiquities, Museums and Urban Heritage promulgated by Royal Decree M/3 dated 9/1/1436 AH 91
5.2.7. The executive regulations 92
5.2.7.1. Executive Regulations for Environmental Permits for Establishment and Operation of Activities 92
5.2.7.2. The executive regulation for Environmental Inspection and Audit 95
5.2.7.3. The Executive Regulation for Control of Violations and Imposition of Penalties 97
5.2.7.4. The Executive Regulation for Prevention and Treatment of Soil Pollution 98
5.2.7.5. Executive regulations for the protection of aquatic environments from pollution 102
5.2.7.6. Standards and specifications for types of water 102
5.2.7.7. The executive regulation for Air Quality 103
5.2.7.8. The executive regulation for noise 105
5.3. International standards 106
5.3.1. International Finance Corporation (IFC) Performance Standards 106
5.3.2. Equator Principles 107
5.3.3. Project commitments with IFC Ps 110
5.3.4. Project commitments with equator principle 118
6. ENVIRONMENTAL AND SOCIAL BASELINE 125
6.1. Context 125
6.2. Baseline study methodology 125
6.3. Environment Baseline 126
6.3.1. Land Use and Land Cover 126
6.3.2. Climate and Meteorology 126
6.3.2.1. Temperatures 127
6.3.2.2. Rainfall 127
6.3.2.3. Relative humidity 128
6.3.2.4. Wind 128
6.3.3. Topography and slopes 132
6.3.3.1. Topography 132
6.3.3.2. Slopes 133
6.3.4. Geology 134
6.3.4.1. Precambrian layered rocks 136
6.3.4.2. Plutonic rocks 136

6.3.5. Soil 139
6.3.5.1. Soil type 139
6.3.5.2. Soil analysis 139
6.3.5.2.1. Soil samples locations 139
6.3.5.2.2. Soil analysis results 141
6.3.6. Hydrology 142
6.3.6.1. Hydrological study context 142
6.3.6.2. Methodology of hydrological study 142
6.3.6.2.1. Contribution basins delimitation 143
6.3.6.2.2. Maximum flows estimation and chosen return period 146
6.3.6.2.3. Hydraulic modelling and Flooding risk analysis 146
6.3.6.3. Conclusion 153
6.3.7. Groundwater 153
6.3.8. Historical and cultural heritage 155
6.3.9. Ambient air quality 163
6.3.9.1. Measurement methods 163
.6.3.9.2 Methodology for Locating Air Measurements 163
6.3.9.3. quality of results 163
6.3.9.4. Equipment 164
6.3.9.5. Methodology adopted 164
6.3.9.5.1. Methodology for using AQMS for Outdoor Air Quality measurements. 164
6.3.9.5.2. Monitoring and Data Collection 165
6.3.9.5.3. Data Acquisition 165
6.3.9.5.4. Data Validation and Reporting 165
6.3.9.5.5. Air Quality Limit Values 165
6.3.9.5.6. Calibration 165
6.3.9.6. Results for air quality analysis 166
6.3.10. Ambient noise 167
6.3.10.1. Methodology of noise monitoring 167
6.3.10.2. Results of noise measurement 169
6.4. Ecology and Biodiversity Baseline 170
6.4.1. Introduction 170
6.4.2. Project Site boundaries identification 170

6.4.3. OBJECTIVE 171
6.4.4. METHODOLOGY 171
6.4.4.1. DESKTOP REVIEW 171
6.4.4.2. FIELD SURVEY 172
6.4.5. RESULTS 172
6.4.5.1. HABITATS AND FLORA 172
6.4.5.1.1. DESKTOP REVIEW 172
6.4.5.1.2. FIELD SURVEY 173
6.4.5.2. BIRDS 175
6.4.5.2.1. DESK REVIEW 175
6.4.5.2.2. FIELD SURVEY 176
6.4.5.3. MAMMALS AND REPTILES 177
6.4.5.3.1. DESKTOP REVIEW 177
6.4.5.3.2. FIELD SURVEY 179
6.4.5.4. AREAS OF CONSERVATION IMPORTANCE 180
6.5. SOCIO-ECONOMIC ENVIRONMENT 182
6.5.1. ADMINISTRATIVE BOUNDARIES 182
6.5.2. THE REGIONAL PLAN FOR MAKKAH REGION 182
6.5.3. MOVEMENT INFRASTRUCTURE 183
6.5.4. DEMOGRAPHIC BACKGROUND 185
6.5.5. GROSS DOMESTIC PRODUCT 186
6.6. SENSITIVE RECEPTORS 187
6.6.1. ENVIRONMENT SENSITIVE RECEPTORS 187
6.6.2. ECOLOGICAL SENSITIVE RECEPTORS 187
6.6.3. SOCIOECONOMIC SENSITIVE RECEPTORS 188
7. IMPACT ASSESSMENT 189
7.1. INTRODUCTION 189
7.2. IMPACT ASSESSMENT METHODOLOGICAL APPROACH 189
7.3. PROJECT AREA OF INFLUENCE (AOI) 189
7.4. IDENTIFICATION AND CHARACTERIZATION OF IMPACTS 190
7.5. EVALUATION OF IMPACTS 191
7.5.1. MAGNITUDE OF IMPACT 192
7.5.2. SENSITIVITY OF RECEPTORS 193
7.5.3. ASSESSMENT OF IMPACT SIGNIFICANCE 195

7.5.3.1. Mitigation Potential and Residual Impacts 196
7.5.4. Residual Impact Assessment 197
7.5.5. Cumulative Impacts 197
7.5.6. Management and Monitoring 197
7.6. Impact Assessment Criteria 197
7.6.1. Assessment Criteria for Impact on land Use 198
7.6.2. Assessment Criteria for Impact on Topography and Drainage 199
7.6.3. Assessment Criteria for Impact on soil contamination 200
7.6.4. Assessment criteria for Impact on soil erosion and compaction 201
7.6.5. Assessment Criteria for Impact on surface water resources consumption 202
7.6.6. Assessment Criteria for Impact on ground water resources consumption 203
7.6.7. Assessment Criteria for Impact on surface Water quality 204
7.6.8. Assessment criteria for impact on groundwater quality 205
7.6.9. Assessment Criteria for Impact on Air Quality 206
7.6.10. Assessment Criteria for Impact on Ambient Noise 207
7.6.11. Assessment Criteria for landscape and visual impact 209
7.6.12. Assessment criteria for traffic and transport 210
7.6.13. Assessment Criteria for Socio-economic Impacts 210
7.6.14. Assessment Criteria for Ecological Impacts 211
7.6.14.1. Interactions with the project 211
7.6.14.2. Assessment Criteria 212
7.6.15. Assessment Criteria for Impact on archaeology and cultural heritage 213
7.6.16. Assessment Criteria for Impact landscape and visual 215
7.7. Impact Assessment in Construction Phase 216
7.7.1. Impact on Land Use 216
7.7.1.1. Impact source 216
7.7.1.2. Receptor sensitivity 216
7.7.1.3. Impact assessment 217
7.7.2. Impact on topography and drainage 218
7.7.2.1. Impact source 218
7.7.2.2. Receptor sensitivity 218
7.7.2.3. Impact assessment 218
7.7.3. Impact on soil contamination 219
7.7.3.1. Impact source 219

7.7.3.1.1. SOIL CONTAMINATION DUE TO WASTE GENERATION 219
7.7.3.1.2. SOIL CONTAMINATION DUE TO LEAKS AND SPILLS 219
7.7.3.2. RECEPTOR SENSITIVITY 220
7.7.3.3. IMPACT ASSESSMENT 220
7.7.4. IMPACT ON SOIL COMPACTION 221
7.7.4.1. IMPACT SOURCE 221
7.7.4.2. RECEPTOR SENSITIVITY 221
7.7.4.3. IMPACT ASSESSMENT 221
7.7.5. IMPACT ON SURFACE WATER AVAILABILITY 222
7.7.5.1. IMPACTS SOURCES 222
7.7.5.2. RECEPTOR SENSITIVITY 222
7.7.5.3. IMPACT ASSESSMENT 222
7.7.6. IMPACT ON GROUNDWATER AVAILABILITY 223
7.7.6.1. IMPACT SOURCE 223
7.7.6.2. RECEPTOR SENSITIVITY 223
7.7.6.3. IMPACT ASSESSMENT 224
7.7.7. IMPACT ON SURFACE WATER QUALITY 224
7.7.7.1. IMPACT SOURCE 224
7.7.7.1.1. CONTAMINATION OF SURFACE WATER BY WASTEWATER 224
7.7.7.1.2. CONTAMINATION OF SURFACE WATER BY SPILLS/LEAKS 224
7.7.7.1.3. CONTAMINATION BY LOAD OF SEDIMENTS 225
7.7.7.2. RECEPTOR 225
7.7.7.3. IMPACT MAGNITUDE ASSESSMENT 225
7.7.8. IMPACT ON GROUNDWATER QUALITY 225
7.7.8.1. SOURCE OF IMPACTS 225
7.7.8.2. RECEPTOR SENSITIVITY 226
7.7.8.3. IMPACT ASSESSMENT 226
7.7.9. IMPACT ON AIR QUALITY 226
7.7.9.1. SOURCE OF IMPACT 226
7.7.9.1.1. DUST FROM CONSTRUCTION ACTIVITIES 227
7.7.9.1.2. EXHAUST EMISSIONS DURING CONSTRUCTION ACTIVITIES 227
7.7.9.1.3. ODOURS 228
7.7.9.2. RECEPTOR 228
7.7.9.3. IMPACT ASSESSMENT 228

7.7.9.3.1. IMPACTS OF DUST FROM CONSTRUCTION ACTIVITIES 228
7.7.9.3.2. IMPACTS OF FUGITIVE EMISSIONS 229
7.7.9.3.3. IMPACTS OF ODOURS 230
7.7.10. IMPACT ON AMBIENT NOISE 230
7.7.10.1. SOURCES OF IMPACT 230
7.7.10.2. RECEPTOR SENSITIVITY 232
7.7.10.3. IMPACT ASSESSMENT 232
7.7.11. IMPACT ON TRAFFIC AND TRANSPORT 233
7.7.11.1. SOURCE OF IMPACT 233
7.7.11.2. RECEPTOR 233
7.7.11.3. IMPACT ASSESSMENT 233
7.7.12. IMPACTS ON ECOLOGY AND BIODIVERSITY 234
7.7.13. IMPACT ON OCCUPATIONAL HEALTH AND SAFETY 235
7.7.13.1. IMPACT SOURCE 235
7.7.13.2. RECEPTOR SENSITIVITY 236
7.7.13.3. IMPACT ASSESSMENT 236
7.7.13.3.1. SAFETY RISKS 236
7.7.13.3.2. HEALTH RISKS 236
7.7.14. SOCIO-ECONOMIC IMPACTS 237
7.7.14.1. IMPACT ON COMMUNITY HEALTH AND SAFETY 237
7.7.14.2. IMPACT ON EMPLOYMENT OPPORTUNITIES 238
7.7.14.2.1. SOURCE 238
7.7.14.2.2. RECEPTOR 239
7.7.14.2.3. IMPACT ASSESSMENT 239
7.7.14.3. IMPACTS FROM MIGRANT WORKERS 239
7.7.14.3.1. SOCIAL IMPACTS OF MIGRANT WORKERS 239
7.7.14.3.2. COMMUNITY HEALTH IMPACTS FROM MIGRANT WORKERS 239
7.7.15. IMPACT ON ARCHAEOLOGY AND CULTURAL HERITAGE 240
7.8. IMPACT ASSESSMENT IN OPERATION AND MAINTENANCE PHASE 240
7.8.1. IMPACT ON LAND AND SOIL ENVIRONMENT 241
7.8.1.1. SOURCES OF IMPACT 241
7.8.1.2. RECEPTOR 241
7.8.1.3. IMPACT ASSESSMENT 241
7.8.1.3.1. IMPACT ON LAND DUE TO IMPROPER WASTE DISPOSAL 241

7.8.1.3.2. Soil Contamination due to Leaks/Spills 242
7.8.2. Waste Generation 243
7.8.2.1. Sources 243
7.8.2.2. Receptor 243
7.8.2.3. Impact Assessment 243
7.8.3. Impact on Water Resources Quantity and Quality 244
7.8.3.1. Sources of Impact 244
7.8.3.2. Receptor 244
7.8.3.3. Impact Assessment 245
7.8.3.3.1. Water Availability 245
7.8.3.3.2. Impact on Water Quality 245
7.8.4. Impact on Air Quality 246
7.8.4.1. Sources of Impact 246
7.8.4.2. Receptor 246
7.8.4.3. Impact Assessment 246
7.8.5. Impact on Ambient Noise Levels 247
7.8.5.1. Sources of Impact 247
7.8.5.2. Receptor 247
7.8.5.3. Impact Assessment 247
7.8.6. Impact on Ecology and biodiversity 248
7.8.7. Landscape and Visual Impact 249
7.8.7.1. Sources of Impact 249
7.8.7.2. Receptor 249
7.8.7.3. Impact Assessment 249
7.8.8. Occupational Health and Safety 250
7.8.8.1. Sources of Impact 250
7.8.8.2. Receptor 250
7.8.8.3. Impact Assessment 250
7.8.9. Traffic and Transport 252
7.8.9.1. Sources of Impact 252
7.8.9.2. Receptor 252
7.8.9.3. Impact Assessment 252
7.8.10. Impact on Climate Change 253
7.8.11. Impact on Employment 253

7.9. Impact Assessment in Decommissioning Phase 254
7.9.1. Impact on Soil Environment 254
7.9.2. Impact on Water Environment 255
7.9.3. Impact on Air Quality 255
7.9.4. Impact on Ambient Noise 256
7.9.5. impact on occupational health and safety 257
7.9.5.1. Impact source 257
7.9.5.2. Receptor sensitivity 257
7.9.5.3. Impact assessment 257
7.9.5.3.1. Safety Risks 258
7.9.5.3.2. Health Risks 258
7.9.6. Impact on Employment and community 259
7.10. Cumulative Impact Assessment 260
7.11. Summary of potential impacts 260
8. MITIGATION MEASURES 265
8.1. Identification and description of mitigation measures 265
8.2. Mitigation measures in construction phase 269
8.2.1. mitigation measures for impact on land use 269
8.2.2. mitigation measures for land use for topography and drainage 270
8.2.3. mitigation measures for soil contamination 270
8.2.3.1. Leaks and spills 270
8.2.3.2. Soil contamination by waste generated 271
8.2.4. mitigation measures for soil erosion and compaction 272
8.2.5. mitigation measures for surface water sources consumption 272
8.2.6. mitigation measures for groundwater sources 273
8.2.7. mitigation measures for surface water quality 273
8.2.7.1. wastewater/oil leaks and spills 273
8.2.7.2. Sediment load 274
8.2.8. mitigation measures for groundwater quality 274
8.2.9. mitigation measures for air quality 275
8.2.9.1. dust elimination 275
8.2.9.2. Fugitive emission 276
8.2.10. mitigation measures for ambient noise 278
8.2.11. Traffic and transport 279

8.2.12. MITIGATION MEASURES FOR SOCIO-ECONOMIC IMPACTS 280
8.2.12.1. MITIGATION MEASURES FOR COMMUNITY HEALTH AND SAFETY 280
8.2.12.1.1. EMPLOYMENT OPPORTUNITIES MEASURES 281
8.2.12.2. MITIGATIONS MEASURES FOR IMPACTS FROM MIGRANT WORKERS 281
8.2.13. MITIGATION MEASURES FOR OCCUPATIONAL HEALTH AND SAFETY 282
8.2.14. MITIGATION MEASURES FOR ECOLOGICAL AND BIODIVERSITY IMPACTS 283
8.3. MITIGATION MEASURES IN OPERATION AND MAINTENANCE PHASE 284
8.3.1. MITIGATION MEASURES FOR LAND AND SOIL ENVIRONMENT 284
8.3.1.1. MITIGATION FOR IMPACT ON LAND DUE TO IMPROPER WASTE DISPOSAL 284
8.3.1.2. MITIGATION FOR IMPACT ON SOIL CONTAMINATION DUE TO LEAKS/SPILLS 284
8.3.2. MITIGATION MEASURES FOR WASTE GENERATION 285
8.3.3. MITIGATION MEASURES FOR WATER RESOURCES AND QUALITY 286
8.3.3.1. MITIGATIONS MEASURES FOR WATER AVAILABILITY 286
8.3.3.2. MITIGATION MEASURES FOR IMPACT ON WATER QUALITY 286
8.3.4. MITIGATIONS MEASURES FOR IMPACT ON AIR QUALITY 287
8.3.5. MITIGATION MEASURES FOR IMPACT ON AMBIENT NOISE LEVELS 287
8.3.6. MITIGATION MEASURES FOR IMPACT ON ECOLOGY AND BIODIVERSITY 287
8.3.7. MITIGATION MEASURES FOR VISUAL IMPACT 288
8.3.8. MITIGATIONS MEASURES FOR IMPACT ON OCCUPATIONAL HEALTH AND SAFETY 289
8.3.9. MITIGATIONS MEASURES FOR IMPACT TRAFFIC AND TRANSPORT 290
8.4. MITIGATION MEASURES IN DECOMMISSIONING PHASE 290
8.4.1. MITIGATIONS MEASURES FOR IMPACT ON SOIL ENVIRONMENT 290
8.4.2. MITIGATIONS MEASURES FOR IMPACT ON WATER ENVIRONMENT 290
8.4.3. MITIGATIONS MEASURES FOR IMPACT ON AIR QUALITY 291
8.4.4. MITIGATION MEASURES FOR IMPACT ON AMBIENT NOISE 292
8.4.5. IMPACT ON ECONOMY AND EMPLOYMENT 292
8.4.6. MITIGATIONS MEASURES FOR IMPACTS ON OCCUPATIONAL HEALTH AND SAFETY 293
9. STAKEHOLDER ENGAGEMENT PLAN 294
9.1. OVERVIEW 294
9.2. STAKEHOLDER IDENTIFICATION AND ANALYSIS 294
9.2.1. IDENTIFIED STAKEHOLDERS 294
9.2.1.1. AFFECTED STAKEHOLDERS 295
9.2.1.2. INTEREST BASED STAKEHOLDERS 295
9.3. PROPOSED STAKEHOLDER ENGAGEMENT ACTIVITIES 297

9.3.1. PROPOSED ENGAGEMENT ACTIVITIES 297
9.3.2. ENGAGEMENT METHODS 297
9.3.2.1. STAKEHOLDER ENGAGEMENT DURING THE DESIGN PHASE 298
9.3.2.2. STAKEHOLDER ENGAGEMENT DURING PRE-CONSTRUCTION PHASE 302
9.3.2.3. STAKEHOLDER ENGAGEMENT DURING CONSTRUCTION PHASE 306
9.3.2.4. STAKEHOLDER ENGAGEMENT DURING OPERATION 310
9.4. GRIEVANCE MECHANISM 314
9.4.1. SCOPE OF GRIEVANCE MECHANISM 314
9.4.2. STEPS IN MANAGING GRIEVANCE MECHANISM 315
9.4.2.1. PUBLICIZING GRIEVANCE MANAGEMENT PROCEDURES 315
9.4.2.2. RECEIVING GRIEVANCE 316
9.4.2.3. REVIEWING AND INVESTIGATING GRIEVANCES 316
9.4.2.4. GRIEVANCE RESOLUTION OPTIONS AND RESPONSES 317
9.4.2.5. GRIEVANCE MECHANISM IN CONSTRUCTION PHASE 317
9.4.2.6. GRIEVANCE MECHANISM IN OPERATIONAL PHASE 318
9.5. MONITORING AND REPORTING PROCESS 318
9.5.1. PERIODIC MONITORING 318
9.5.2. REPORTING 319
9.5.3. INTERNAL RESOURCES 319
9.5.3.1. PROJECT MANAGEMENT SPECIALIST 319
9.5.3.2. ENVIRONMENTAL AND SOCIAL MANAGER 320
9.5.4. EXTERNAL RESOURCES 320
10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 321
10.1. TRAINING OF PERSONNEL & CONTRACTORS 321
10.2. MONITORING 322
10.3. DOCUMENTATION & RECORD KEEPING 322
10.4. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) 324
11. CONCLUSION 337
11.1. ALTERNATIVE TECHNOLOGY USED 337
11.2. ENVIRONMENTAL AND SOCIAL IMPACTS GENERATED 337
11.3. THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 338
11.4. STAKEHOLDERS AND THEIR ROLES 338
APPENDIX A. TERRESTRIAL ECOLOGY SURVEY 340
APPENDIX B. SOIL ANALYSIS 341

APPENDIX C. AIR QUALITY ASSESSMENT.....361

LIST OF TABLES

TABLE 1 : SUMMARY OF IMPACT ASSESSMENT FINDINGS 28
TABLE 2 : COORDINATES OF THE PROJECT AND LIMITS 36
TABLE 3 : PROJECT PHASE AND KEY ACTIVITIES 49
TABLE 4 : ESTIMATION OF CONSTRUCTION MACHINERY AND EQUIPMENT USED IN PEAK TIME 53
TABLE 5 : WATER DEMAND FOR PV PANEL CLEANING WHEN FULLY OPERATION (WET CLEANING ONLY SCENARIO) 56
TABLE 6 : IDENTIFIED CRITERIA AND FACTORS 63
TABLE 7 : THE CONSULTATION OF LOCAL AUTHORITIES 65
TABLE 8: GRAPHICAL MAPPING FOR DECISION 82
TABLE 9 : GAMEP ENVIRONMENTAL STANDARDS 88
TABLE 10 : STANDARDS FOR PROTECTING SOIL FROM POLLUTION 98
TABLE 11 : AIR QUALITY STANDARDS FOR BASIC POLLUTANTS CONTAINED IN ANNEX 1 OF THE EXECUTIVE REGULATIONS FOR AIR QUALITY OF THE CURRENT ENVIRONMENTAL LAW 104
TABLE 12 : NOISE LIMITS NEAR ROADS AREA 105
TABLE 13 : PERMISSIBLE NOISE LIMITS EXCEPTIONS 105
TABLE 14 : MEASUREMENT NOISE LEVELS FOR RESIDENTIAL AND COMMERCIAL AREAS 106
TABLE 15 :CORRECTIVE LIMITS FOR PERMITTED NOISE LEVELS AT CONSTRUCTION SITE 106
TABLE 16 : IFC PERFORMANCE STANDARDS 110
TABLE 17 :TEMPERATURES IN MAKKAH AL-MUKARRMAH PROVINCE 127
TABLE 18 : RAINFALL IN MAKKAH AL-MUKARRMAH PROVINCE 127
TABLE 19 : RELATIVE HUMIDITY IN MAKKAH AL-MUKARRMAH PROVINCE 128
TABLE 20: SOIL SAMPLES LOCATION COORDINATES 140
TABLE 21 : SOIL ANALYSIS RESULTS- SAMPLE NO. 1 141
TABLE 22 : BASINS AND MAXIMUM FLOWS 146
TABLE 23 : COMBINED HAZARD CURVES-VULNERABILITY THRESHOLDS CLASSIFICATION LIMITS, AUSTRALIAN DISASTER RESILIENCE HANDBOOK 150
TABLE 24: THE ESTIMATED GROUNDWATER RESERVES IN SAUDI ARABIA TO A DEPTH OF 300 METERS BELOW GROUND LEVEL IN MM3 155
TABLE 25 : WORLD HERITAGE TENTATIVE LIST BY UNESCO 156
TABLE 26 : WORLD HERITAGE LIST BY UNESCO 160
TABLE 27 : EQUIPMENT USED FOR MEASURING AIR QUALITY 164
TABLE 28 : COORDINATES OF AIR QUALITY MEASUREMENT POINTS 165
TABLE 29: AIR QUALITY MEASUREMENT RESULTS IN POINT 1 167
TABLE 30 : NOISE MEASUREMENT POINTS COORDINATES 168
TABLE 31 : NOISE INTENSITY IN MEASUREMENT POINTS IN THE SITE 169
TABLE 32 : FLORA SPECIES RECORDED ON SITE 174
TABLE 33 : MIGRATORY SOARING BIRD SPECIES AND GLOBALLY THREATENED SPECIES THAT THE PROJECT SITE OVERLAPS WITH THEIR DISTRIBUTION RANGE 176
TABLE 34 : REPTILE SPECIES THAT THE PROJECT SITE OVERLAPS WITH THEIR DISTRIBUTION RANGE 177
TABLE 35: MAMMAL SPECIES THAT COULD BE PRESENT THE PROJECT SITE 178
TABLE 36 : POPULATION DISTRIBUTION 186
TABLE 37 : IMPACT CHARACTERIZATION CRITERIA 191
TABLE 38 : IMPACT SIGNIFICANCE MATRIX 195
TABLE 39 : INTERACTIONS IDENTIFIED THAT ARE LIKELY TO RESULT IN SIGNIFICANT IMPACTS 198
TABLE 40 : SENSITIVITY ASSESSMENT CRITERIA FOR LAND USE 199
TABLE 41 : CRITERIA FOR MAGNITUDE OF IMPACT ON LAND USE 199
TABLE 42 : SENSITIVITY ASSESSMENT CRITERIA FOR TOPOGRAPHY AND DRAINAGE 199

TABLE 43 : CRITERIA FOR IMPACT MAGNITUDE ON TOPOGRAPHY AND DRAINAGE 200
TABLE 44 : SENSITIVITY ASSESSMENT CRITERIA FOR SOIL CONTAMINATION 200
TABLE 45 : CRITERIA FOR IMPACT MAGNITUDE ON TOPOGRAPHY AND DRAINAGE 201
TABLE 46 : SENSITIVITY ASSESSMENT CRITERIA FOR SOIL EROSION AND COMPACTION 201
TABLE 47: CRITERIA FOR IMPACT MAGNITUDE ON SOIL EROSION AND COMPACTION 201
TABLE 48 : SENSITIVITY ASSESSMENT CRITERIA FOR SURFACE WATER RESOURCES 202
TABLE 49 : CRITERIA FOR IMPACT MAGNITUDE ON SURFACE WATER RESOURCES 202
TABLE 50 : SENSITIVITY ASSESSMENT CRITERIA FOR GROUND WATER RESOURCES CONSUMPTION 203
TABLE 51 : CRITERIA FOR IMPACT MAGNITUDE ON GROUND WATER RESOURCES CONSUMPTION 203
TABLE 52 : SENSITIVITY ASSESSMENT CRITERIA FOR SURFACE WATER QUALITY 204
TABLE 53 : CRITERIA FOR IMPACT MAGNITUDE ON SURFACE WATER QUALITY 204
TABLE 54 : SENSITIVITY ASSESSMENT CRITERIA FOR GROUNDWATER QUALITY 205
TABLE 55 : CRITERIA FOR IMPACT MAGNITUDE ON GROUNDWATER QUALITY 205
TABLE 56 : SENSITIVITY CRITERIA FOR AIR QUALITY 206
TABLE 57 : CRITERIA FOR IMPACT MAGNITUDE ON AIR QUALITY 206
TABLE 58 : MEASUREMENT NOISE LEVELS FOR RESIDENTIAL AND COMMERCIAL AREAS 207
TABLE 59 :CORRECTIVE LIMITS FOR PERMITTED NOISE LEVELS AT CONSTRUCTION SITE 207
TABLE 60 : NOISE EMISSION CRITERIA 208
TABLE 61 : SENSITIVITY CRITERIA FOR AMBIENT NOISE 208
TABLE 62 : CRITERIA FOR IMPACT MAGNITUDE ON AMBIENT NOISE 208
TABLE 63: SENSITIVITY ASSESSMENT CRITERIA FOR LANDSCAPE AND VISUAL 209
TABLE 64 : CRITERIA FOR MAGNITUDE ASSESSMENT OF IMPACT ON LANDSCAPE AND VISUAL 209
TABLE 65 : RECEPTOR SENSITIVITY FOR TRAFFIC AND TRANSPORT 210
TABLE 66 : IMPACT MAGNITUDE FOR TRAFFIC AND TRANSPORT 210
TABLE 67 : RECEPTOR SENSITIVITY FOR LOCAL COMMUNITIES 211
TABLE 68 : IMPACT MAGNITUDE FOR LOCAL COMMUNITIES 211
TABLE 69 : IDENTIFIED INTERACTIONS THAT ARE LIKELY TO RESULT IN SIGNIFICANT IMPACTS 211
TABLE 70 : HABITAT-IMPACT ASSESSMENT CRITERIA 212
TABLE 71 : SPECIES-IMPACT ASSESSMENT CRITERIA 213
TABLE 72 : SENSITIVITY CRITERIA FOR ARCHAEOLOGY AND CULTURAL HERITAGE 214
TABLE 73 : CRITERIA FOR IMPACT MAGNITUDE ON AMBIENT NOISE 214
TABLE 74 : SENSITIVITY ASSESSMENT CRITERIA FOR LANDSCAPE AND VISUAL 215
TABLE 75 : CRITERIA FOR MAGNITUDE ASSESSMENT OF IMPACT ON LANDSCAPE AND VISUAL 215
TABLE 76: SUMMARY OF IMPACT ON LAND USE DURING CONSTRUCTION PHASE 218
TABLE 77: SUMMARY OF IMPACT ON TOPOGRAPHY AND DRAINAGE DURING CONSTRUCTION PHASE 219
TABLE 78: SUMMARY OF IMPACT ON SOIL CONTAMINATION DURING CONSTRUCTION PHASE 220
TABLE 79: SUMMARY OF IMPACT ON SOIL COMPACTION DURING CONSTRUCTION PHASE 222
TABLE 80: SUMMARY OF IMPACT ON SURFACE WATER AVAILABILITY DURING CONSTRUCTION PHASE 223
TABLE 81: SUMMARY OF IMPACT ON GROUND WATER AVAILABILITY DURING CONSTRUCTION PHASE 224
TABLE 82: SUMMARY OF IMPACT ON SURFACE WATER QUALITY DURING CONSTRUCTION PHASE 225
TABLE 83: SUMMARY OF IMPACT ON GROUNDWATER QUALITY DURING CONSTRUCTION PHASE 226
TABLE 84: SUMMARY OF IMPACT OF DUST ON AIR QUALITY DURING CONSTRUCTION PHASE 229
TABLE 85: SUMMARY OF IMPACT OF DUST ON AIR QUALITY DURING CONSTRUCTION PHASE 229
TABLE 86: SUMMARY OF IMPACT OF DUST ON AIR QUALITY DURING CONSTRUCTION PHASE 230
TABLE 87 : NOISE EMISSION LEVELS FOR SOME CONTRUCTION MACHINERY 231
TABLE 88: SUMMARY OF IMPACT ON AMBIENT NOISE DURING CONSTRUCTION PHASE 232
TABLE 89: SUMMARY OF IMPACT ON TRAFFIC AND TRANSPORT DURING CONSTRUCTION PHASE 234
TABLE 90: SUMMARY OF IMPACT ON ECOLOGY AND BIODIVERSITY DURING CONSTRUCTION PHASE 235

TABLE 91: SUMMARY OF IMPACT ON OCCUPATIONAL HEALTH AND SAFETY DURING CONSTRUCTION PHASE 237
TABLE 92: SUMMARY OF IMPACT ON COMMUNITY HEALTH AND SAFETY DURING CONSTRUCTION PHASE 238
TABLE 93: SUMMARY OF IMPACT OF MIGRANT WORKERS DURING CONSTRUCTION PHASE 240
TABLE 94: SUMMARY OF IMPACT OF IMPROPER WASTE DISPOSAL DURING OPERATION PHASE 242
TABLE 95: SUMMARY OF IMPACT ON SOIL CONTAMINATION BY SPILLS AND LEAKS DURING OPERATION PHASE 242
TABLE 96: SUMMARY OF IMPACT OF WASTE GENERATION DURING OPERATION PHASE 244
TABLE 97: SUMMARY OF IMPACT ON WATER AVAILABILITY DURING OPERATION PHASE 245
TABLE 98: SUMMARY OF IMPACT ON WATER QUALITY DURING OPERATION PHASE 246
TABLE 99: SUMMARY OF IMPACT ON AIR QUALITY DURING OPERATION AND MAINTENANCE PHASE 247
TABLE 100: SUMMARY OF IMPACT ON AMBIENT NOISE DURING OPERATION AND MAINTENANCE PHASE 248
TABLE 101: SUMMARY OF IMPACT ON ECOLOGY AND BIODIVERSITY DURING OPERATION PHASE 248
TABLE 102: SUMMARY OF IMPACT LANDSCAPE AND VISUAL DURING OPERATION AND MAINTENANCE PHASE 250
TABLE 103: SUMMARY OF IMPACT ON OCCUPATIONAL HEALTH AND SAFETY DURING OPERATION PHASE 252
TABLE 104: SUMMARY OF IMPACT ON TRAFFIC AND TRANSPORT DURING OPERATION PHASE 252
TABLE 105: SUMMARY OF IMPACT SOIL ENVIRONMENT DURING DECOMMISSIONING PHASE 255
TABLE 106: SUMMARY OF IMPACT SOIL ENVIRONMENT DURING DECOMMISSIONING PHASE 255
TABLE 107: SUMMARY OF IMPACT ON AIR QUALITY DURING DECOMMISSIONING PHASE 256
TABLE 108: SUMMARY OF IMPACT ON AMBIENT NOISE DURING DECOMMISSIONING PHASE 257
TABLE 109: SUMMARY OF IMPACT ON OCCUPATIONAL HEALTH AND SAFETY DURING DECOMMISSIONING PHASE 259
TABLE 110: SUMMARY OF IMPACT ON EMPLOYMENT AND COMMUNITY DURING DECOMMISSIONING PHASE 259
TABLE 111: SUMMARY OF THE PROJECT IMPACTS 261
TABLE 112 : MITIGATION HIERARCHY IN THE DESIGN OF THE INFRASTRUCTURE 265
TABLE 113 : IDENTIFIED POTENTIALLY AFFECTED STAKEHOLDERS 295
TABLE 114 : IDENTIFIED INTEREST-BASED STAKEHOLDERS 296
TABLE 115 : PROPOSED STAKEHOLDER ENGAGEMENT ACTIVITIES (DESIGN PHASE) 299
TABLE 116 : PROPOSED STAKEHOLDER ENGAGEMENT ACTIVITIES PRE-CONSTRUCTION PHASE 303
TABLE 117 : PROPOSED STAKEHOLDER ENGAGEMENT ACTIVITIES DURING CONSTRUCTION PHASE 307
TABLE 118 : PROPOSED STAKEHOLDER ENGAGEMENT ACTIVITIES DURING OPERATIONAL PHASE 311
TABLE 119 : GRIEVANCE REGISTER 316
TABLE 120 : ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN 325

LIST OF FIGURES

FIGURE 1 : PHOTOS FROM THE SITE OF THE PROPOSED PROJECT 38
FIGURE 2: PROJECT LOCATION 38
FIGURE 3 : HADEN SOLAR PLANT SITE ACCESS 39
FIGURE 4 : A MODEL OF THE SOLAR POWER PLANT CONNECTION WITH HADEN NETWORK 41
FIGURE 5 : HADEN SOLAR POWER PLANT LAYOUT 43
FIGURE 6 : SINGLE AXIS TRACKER SYSTEM IN COMBINATION WITH BI-FACIAL MODULES 44
FIGURE 7 : GRAPHICAL DIAGRAM SHOWING TRACKING SYSTEM 45
FIGURE 8 : PRINCIPLE OF STRING INVERTER 46
FIGURE 9 : PRINCIPLE OF ELECTRIC CIRCUIT OF AN INVERTER 47
FIGURE 10 : THE ELECTRIC CIRCUIT OF TRANSFORMER 47
FIGURE 11 : DIAGRAM OF THE INTEGRATION OF CRITERIA 64
FIGURE 12 : PROPOSED FRAMEWORK IN SITE SELECTION 65
FIGURE 13 : PHOTOGRAPHIC DATABASE. A PHOTOGRAPHIC RECORD OF THE SITE (CREATE A DIGITIZED PHOTOGRAPHIC RECORD OF EACH ZONE VISITED FROM THE HADEN SITE) 68
FIGURE 14 :HADEN SITE 68
FIGURE 15 : OVERHEAD POWER LINES & HADEN SITE 70
FIGURE 16 : LAND CONSTRAINTS (OVERHEAD POWER LINES) 71
FIGURE 17 : LAND CONSTRAINTS (ROAD) 72
FIGURE 18: GRAZING ZONES 73
FIGURE 19 : LAND CONSTRAINTS (GRAZING ZONES) 74
FIGURE 20 : LAND CONSTRAINTS (MILITARY ZONE) 75
FIGURE 21 : LAND CONSTRAINTS (FUTURE GOVERNMENT PROJECTS) 76
FIGURE 22 : HIGH DENSE VEGETATION AREA 77
FIGURE 23 : LAND CONSTRAINTS (VEGETATION COVER) 78
FIGURE 24 : LAND CONSTRAINTS (CULTURAL HERITAGE) 78
FIGURE 25 : THE PREVAILING WIND DIRECTION 79
FIGURE 26 : LAND CONSTRAINTS (SLOPE) 80
FIGURE 27 : HADEN AND ITS LOWER RISK AREAS 81
FIGURE 28 : LOWER RISK FLASH FLOOD AREA 81
FIGURE 29: SITE ALTERNATIVES PROPOSAL 84
FIGURE 30 : SELECTED SITES 85
FIGURE 31 : NCEC EIA FLOW PROCESS 95
FIGURE 32 : WIND ROSES BY MONTH FOR HADEN SOLAR PLANT (OBTAINED FROM TAEIF METEOROLOGICAL STATION: OETF, LATITUDE: 21.48342, LONGITUDE: 40.54433, ELEVATION [M]: 1449) 131
FIGURE 33 : YEARLY WIND ROSE FOR HADEN SOLAR PLANT (OBTAINED FROM TAEIF METEOROLOGICAL STATION: OETF, LATITUDE: 21.48342, LONGITUDE: 40.54433, ELEVATION [M]: 1449) 132
FIGURE 34 :DIGITAL TERRAIN MODEL FOR THE PROJECT SITE 133
FIGURE 35 : PROJECT SITE SLOPES 134
FIGURE 36 : PROJECT SITE GEOLOGY- GENERAL OVERVIEW 136
FIGURE 37 : PROJECT SITE GEOLOGY-DETAILED OVERVIEW 138
FIGURE 38 : SOIL IS PROJECT SITE 139
FIGURE 39 : SOIL SAMPLES LOCATION 140
FIGURE 40 : DIGITAL TERRAIN MODEL 144
FIGURE 41 : IDENTIFIED HYDROLOGICAL BASINS WITH RUNOFF STEAMS. 145
FIGURE 42 : MAXIMUM DEPTH REACHED DUE TO AN INTENSITY OF PRECIPITATION ASSOCIATED WITH A RETURN PERIOD TR=100 YEARS 147

FIGURE 43 : MAXIMUM VELOCITY REACHED DUE TO AN INTENSITY OF PRECIPITATION ASSOCIATED WITH A TR= 100 YEAR..... 148
FIGURE 44: COMBINED HAZARD CURVES-VULNERABILITY THRESHOLDS CLASSIFICATION LIMITS, AUSTRALIAN DISASTER RESILIENCE HANDBOOK..... 151
FIGURE 45 : CLASSIFICATION FLOOD HAZARD (DXV) FOR THE TR= 100 YEARS. 152
FIGURE 46: THE EXTENSION OF THE OUTCROP AREAS OF PRINCIPLE AND SECONDARY AQUIFERS..... 154
FIGURE 47 : POINTS OF NOISE MEASUREMENT LOCATION 168
FIGURE 48 : PROJECT SITE BOUNDARIES AND LOCATION 170
FIGURE 49: LOCATION OF THE PROJECT SITE IN THE DESERTS AND SPARSELY VEGETATED AREA (GHAZANFAR & FISHER, 1998) (LEFT), AND THE LOCATION OF PROJECT SITE IN THE RED SEA-ARABIAN DESERT SHRUBLANDS ECOREGION (OLSON ET AL, 2001) (RIGHT). 173
FIGURE 50: FLORA SPECIES RECORDED ON SITE: *CLUTIA LANCEOLATA* (TOP LEFT) *VACHELLIA TORTILIS* (TOP RIGHT), *INDIGOFERA SPINOSA* (BOTTOM LEFT) AND *CALOTROPIS PROCERA* (BOTTOM RIGHT) 174
FIGURE 51: AVIFAUNA SPECIES RECORDED ON SITE 176
FIGURE 52 : LOCATIONS OF NOMADIC SETTLEMENTS AND LIVESTOCK ENCLOSURES AT THE PROJECT SITE AREAS OF CONSERVATION IMPORTANCE..... 181
FIGURE 53 : ADMINISTRATIVE BOUNDARIES 182
FIGURE 54 : DEVELOPMENT SECTORS ACCORDING TO THE REGIONAL PLAN FOR THE MAKKAH REGION, VISION 1460H (2038) ... 183
FIGURE 55 : DEVELOPMENT CORRIDORS ACCORDING TO THE REGIONAL PLAN OF THE MAKKAH REGION, VISION 1460H (2038).. 184
FIGURE 56 : ACCESS AND CONNECTIVITY IN THE MAKKAH REGION 185
FIGURE 57 : POPULATION DISTRIBUTION IN THE GOVERNORATES ACCORDING TO 2010 CENSUS. 186
FIGURE 58 : REGIONAL GROSS DOMESTIC PRODUCT AND ECONOMIC SECTOR CONTRIBUTION 187

ABBREVIATIONS AND ACRONYMS

Acronym	Description
AC	Alternating Current
AH	Anno Hegirae
AHEC	Ali Harbi Environmental Consulting Office
AIS	Air Insulated Switchgear
AoI	Area of Influence
AQMS	Air Quality Monitoring Station
CCTV	Closed-circuit Television
dB	decibel
DC	Direct Current
DG	Diesel Generator
ECRA	Water & Electricity Regulatory Authority
EHV	Extra High Voltage
EIA	Environmental Impact Assessment
EMMP	Environmental Management & Monitoring Plan
EP	Equator Principle
EPFI	Equator Principles Financial Institution
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental & Social Management Plan
ESMS	Environmental and Social Management Plan
GAMEP	General Authority For Meteorology an Environment Protection
GBIF	Global Biodiversity Information Facility
GERRI	3.2.3 General Environmental Regulations and their Rules for Implementation
GHG	Greenhouse Gases
GIS	Gas Insulated Substation
HCIS	High Commission For Industrial Security
HV	High Voltage
IFC	International Finance Corporation
IUCN	International Union for Conservation Of Nature
kV	kilo-Volt
kVA	kilo Volt-Ampere
LC	Least Concern
MEWA	Minitry of Environment, Water and Agriculture
MoE	Ministry of Energy
MoU	Memorandatum of Understanding
MV	Medium Voltage
MW	Mega-Watt
MWp	Megawatt peak
NCEC	National Center For Environmental Compliance
NFPA	National Fire Protection Authority
NREP	National Renewable Energy Program,
O&M	Operation and Maintenance

PMS	Project Management Specialist
PPE	Personnel Protection Equipment
PV	Photovoltaic
RCC	Reinforced Cement Concrete
SCADA	Supervisory Control And Data Acquisition
SEC	Saudi Electricity Company
SEP	Stakeholder Engagement Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
WWTP	Wastewater Treatment Plant

1. EXECUTIVE SUMMARY

1.1. Introduction

The Kingdom of Saudi Arabia set out the national Vision 2030 that aims to accelerate efforts toward attaining sustainable development goals. In the framework of this Vision, the "National Renewable Energy Program (NREP)" has been launched. This ambitious program aims to ensure renewable energy growth in the Kingdom and offer sustainable alternatives to liquid fossil energy.

In this context, the Ministry of Energy (MoE) proposes to develop a Photovoltaic Solar Plant in Haden in the Turubah Governorate. The Proposed Development will have a generation capacity up to 2000 MW.

The construction of the project will take approximately 24 months, and the operation and maintenance during the service life will last a minimum of 30 years. The power from the Project will be injected into the Saudi Electric Company via substation constructed into the Plant site.

This is the Environmental and Social Impact Assessment (ESIA) report for the construction and operation for the planned up to 2000-megawatt (MW Alternating current) solar photovoltaic (PV) plant.

1.2. The ESIA Process

The key process elements of an ESIA generally consist of (i) initial screening of the project and scoping of the assessment process; (ii) examination of alternatives; (iii) stakeholder identification (focusing on those directly affected) and gathering of environmental and social baseline data; (iv) impact identification, prediction, and analysis; (v) generation of mitigation or management measures and actions; (vi) significance of impacts and evaluation of residual impacts; and (vii) documentation of the assessment process.

The ESIA has been developed in line with the International Finance Corporation (IFC) Performance Standards (PS) as well as the NCEC regulations.

1.3. Project Justification

The solar power plant will provide new alternatives for energy and reduce the Kingdom's dependence on traditional energy source represented by petroleum. The project achieves several of strategic goals emanating from the Kingdom of Saudi Arabia's 2030 vision and the global will, including, but not limited to:

- Reducing carbon emissions resulting from the consumption of fossil fuels.
- Preserving the national natural resources.
- Relying on an inexhaustible source of energy, which is the sun.
- Reducing the cost of producing electricity.

- Supporting global efforts to reduce emissions that cause climate change and global warming.
- Diversifying the sources of Saudi national income by relying on new and clean energy sources.

1.4. The Project description

The Project comprises of a solar PV plant with a maximum capacity of 2000 MW on an area of 60 km² in Haden, in Governorate of Turubah – Makkah Pronvince. It is adjacent to Haden Road which runs north-west – south -east joining Turubah city to Makkah–Riyadh highway. It is approximately located 63 km to the North-west of Turubah city and 40 km south to the city of Ateef.

The solar plant will connect to the grid of Saudi Electricity Company via the constructed substation in the site.

The PV solar technology chosen for this Project consists of the following main components:

- bifacial PV cell: The PV cell is the device that generates electricity when exposed to solar radiation.
- PV module: The PV module is the set of interconnected photovoltaic cells encapsulated between a transparent front (usually glass) and a backing support material then mounted in an aluminium frame.
- Mounting structures: Multiple PV modules are bolted onto a mounting structure which tracks the suns progress across the sky in an east to west direction.
- PV array: The PV array is the complete power generating plant consisting of multiple PV modules wired in series and in parallel.
- Inverter: The inverter converts the Direct Current (DC) to Alternative Current (AC)
- Substation: The substation receives all power from the inverters via underground cables and provides protection and control equipment required to safely manage the plant and to ensure grid code compliance regulations.
- Transformer: The transformer steps up the AC power from the inverters (typically at 33 kV) to match the grid voltage (expected to be 110 kV).
- Stores, offices and control building.
- Access tracks and fencing.

1.5. Project Phases

The Project will be completed in three phases:

- Construction.
- Operational.
- decommissioning.

Site preparation and construction will involve the clearance of topsoil, installation of fencing and levelling of the site and preliminary earthworks. The site will be marked out, safety and security fencing installed, an access road will be constructed, and internal site access tracks will be constructed. It is anticipated that there will be approximately an average 800 workers, a maximum of 1500 at the Project site during the 24 months construction phase of the 2000 MW power plant.

The solar PV power plant will be operated on a 24 hour, 7 days a week basis with 60 on site workers. Key operational activities will include:

- cleaning of the modules
- management and irrigation on green spaces planted inside the plant
- maintenance of all Project Components
- site security monitoring.

The proposed Project is expected to operate for at least 25 years.

1.6. Project Baseline

The Project Site is located on a flat sandy plain. The landscape is natural and does not feature any prominent human interventions, except for scattered nomadic settlements. Concurrently, high levels of grazing can be observed across the Project Site.

Vegetation cover is limited to groups of perennial shrubs/trees. Some parts of the Project Site are completely devoid of any vegetation cover while in others, dense vegetation is covering the area. The eastern part of the Project Site has the highest density of vegetation mainly composed of small trees of *Calotropis procera* and shrubs of *Clutia lanceolate*. No indications of animal presence, apart domestic animals, were observed at the Project Site.

Based on the above, below are some considerations to be taken during the different phases of the development of the project:

- Construction at the areas of the highest vegetation cover should be avoided as much as possible. Removal of trees and any perennial shrubs should also be avoided.
- Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

1.7. Stakeholder Engagement

Extensive stakeholder engagement has been undertaken as part of the ESIA. Through this action all relevant stakeholders have been engaged and their feedback gathered. Chapter 9 describes the stakeholder engagement undertaken to date.

1.8. Impact Assessment

The ESIA identified both potential positive and adverse impacts, as illustrated in the table below. The table summarizes the potential impacts of the Project phases (construction operation and decommissioning) before and after mitigation measures. Mitigation measures that are included in this Report become set project commitments, which will be implemented by EPC Contractor as part of the Environmental and Social Management Plan (ESMP).

Table 1 : Summary of Impact Assessment Findings

Potential Impact	Significance (Pre-mitigation)	Residual significance (Post-Mitigation)
Construction Phase		
Impact on Land Use	Minor	Negligible
Impact on topography and drainage	Minor	Negligible
Impact on soil contamination		
· Soil contamination due to waste generation	Minor	Negligible
· Soil contamination due to leaks /spills	Minor	Negligible
Impact on soil erosion and compaction	Minor	Negligible
Impact on surface water availability	Moderate	minor
Impact on ground water availability	Negligible	negligible
Impact on surface water quality		
· Contamination by wastewater	Minor	Negligible
· Contamination by spills /leaks	minor	Negligible
· Contamination by loads sediments	minor	Negligible
Impact on groundwater quality	Minor	Negligible
Impact on air quality		
Dust from construction	Moderate	Minor
Exhaust/fugitive emission	Minor	Negligeable
Odors	Minor	Negligible
Impact on ambient noise	minor	Negligible
Impact on traffic and transport	Moderate	minor
Impacts on ecology and biodiversity	minor	Negligible
Impact on occupational health and safety	Moderate	Minor
Socio-economic impacts		
Impact on community health and safety	Minor	Negligible
Impact on employment	Positive	Positive
Impacts from migrants workers (social impacts, spreading of infectious disease..)	Minor	Negligible
Archeology and cultural heritage	No Impact	No impact
Operation and Maintenance Phase		
Impact on Land and Soil Environment		
Soil contamination due to accidental spills leaks	Moderate	Minor

Potential Impact	Significance (Pre-mitigation)	Residual significance (Post-Mitigation)
Waste generation	Moderate	minor
Impacts on water quality and quantity		
Water availability	moderate	Minor
Water quality	minor	negligeable
Air quality	minor	Negligible
Impact on Ambient Noise Levels	minor	negligible
Impact on Ecology and biodiversity	minor	Negligible
Landscape and Visual Impact	minor	Negligible
Occupational Health and Safety	Moderate	Minor
Traffic and transport	Negligible	Negligible
Impact on climate change	Positive	Positive
Impact on employment	positive	Positive
Decommissioning phase		
Impact on soil environment	minor	minor
Impact on Water Environment	minor	negligible
Impact on air quality	Negligible	Negligible
Impact on ambient noise	minor	negligible
Impact on employment and community	Minor	negligible
Impact on occupational health and safety	Moderate	Minor

1.9. Positive Impacts

Positive impacts are associated with economy and livelihoods, through the need of approximately 1500 jobs during construction and 120 jobs during the operation and maintenance of the power plant . There will be job training and capacity development opportunities.

1.10. Potential Adverse Impacts

Due to the nature of a solar plant, its construction and operation, the majority of the potential environmental and social impacts occur during the construction phase. As described in the table above there were several potential impacts from routine Project activities of major or moderate significance. All of these potential impacts have been addressed through mitigation and management measures of the ESIA report, and the potential impacts have been reduced to minor or negligible significance.

There is always the potential for unplanned events such as spills and traffic accidents. These have been identified and preventative measures will be put in place to reduce the likelihood of these occurring.

1.11. Development and Implementation of ESMP

An ESMP has been developed to specify the standards and controls required to manage and monitor the environmental and social impacts. To achieve this, the ESMP Framework identifies potential adverse impacts from the planned activities and outlines mitigation measures required to reduce the likely negative impacts on the biophysical and social environment. The ESMP actions, contained in this report are legally binding on authorization of the ESIA and ESMP by the NCEC.

In summary, the proposed Project will benefit the local economy through job creation and upskilling of the local workforce as well as generation of additional electricity for the country which will contribute to implement the NREP program. Whilst adverse impacts have been identified, there are no potential impacts, which cannot be managed and outweigh the positive impacts of the Project and the objective of the Project in developing renewable energy sources in the Kingdom of Saudi Arabia. Finally, those adverse impacts that have been identified in the ESIA have been minimized through the implementation of the ESMP, which is based on the approach of continual improvement following international best practice.

Positive impacts will be enhanced and maximized through the ESMP by the EPC Contractor commitment to ongoing engagement with the community and key stakeholders and an open and transparent dialogue and hiring process throughout the life cycle of the Project. On the basis of this ESIA Report it is recommended that the Project continue as planned.

2. INTRODUCTION

2.1. General background

The Kingdom of Saudi Arabia set out the national Vision 2030 that aims to accelerate efforts toward attaining sustainable development goals. In the framework of this Vision, the "National Renewable Energy Program (NREP)" has been launched. This ambitious program aims to ensure renewable energy growth in the Kingdom and offer sustainable alternatives to liquid fossil energy.

It is the responsibility of the Ministry of Energy (MoE) to oversee the implementation of the (NREP) through the development and implementation of renewable energy initiatives and projects, to develop renewable energy policies and strategies for the Kingdom in cooperation and integration with the energy ecosystem, and work on business development and market studies to ensure optimal use of this kind of energy and maximize its economic and social returns.

In this context, the Ministry of Energy (MoE) proposes to develop a Photovoltaic Solar Plant in Haden, Governorate of Turubah in Makkah-Al-Mukarramah Province. The Proposed Development will have a generation capacity up to 2000 MW.

Through these investment programs, the Ministry of Energy is working to diversify the national energy mix used in electricity production, increasing the share of natural gas and renewable energy sources to approximately 50% by 2030 while reducing the use of liquid fuel.

2.2. Study objective

The Ministry of Energy (MoE) has assigned TYPSA to provide technical assistance to complete the preliminary studies of a PV solar plant project as a part of the National Renewable Energy Program (NREP) in Haden in Governorate of Turubah, Makkah-Al-Mukarramah Province, Kingdom of Saudi Arabia.

TYPSA has commissioned AH Environmental Consulting Office as a sub-contractor to carry out the ESIA study on the Proposed Development. ESIA Study will be prepared by AH Environmental Consulting Office in accordance with the relevant national and international environmental laws and regulations.

The ESIA study describes the main features of the proposed development, discusses the environmental and social baseline within which it is commissioned, identifies its potential adverse and beneficial impacts, together with appropriate management, mitigation and monitoring measures and recommend an Environmental and Social Management Plan (ESMP).

This study has been produced in accordance with the international standards required by International Finance Corporation (IFC) as the project may require financing from such

international bank. In addition, in line with the IFC requirements, the ESIA study also addresses Saudi legislative requirements relating to environmental impacts assessment and environmental protection which have been presented in the applicable reference framework below.

2.3. Study scope

2.3.1. The scope of the study

2.3.1.1. Define the spatial area of the study

The study area covered by the ESIA generally represents the area that is exposed to potential impact of the project. This area may experience significant impacts due to the project itself or in combination with other impacts resulting from other projects.

The study area covered by the project ESIA generally includes the area of disruption that the project may cause. This includes impact assessment on several environmental and social parameters (such as infrastructure, socio-economic parameters, health and safety and community security, etc.). each parameter is treated separately.

2.3.1.2. Assessment time range

The project will be developed in three successive phases as mentioned below:

- Design phase
- Construction phase
- Operation phase

It is important to note that the ESIA study does not cover facilities in connection with the project, or the works being undertaken to construct or operate such facilities. The facilities concerned by ten ESIA include only the solar power plant.

2.3.1.2.1. Design phase

This stage of the project includes proper engineering planning and design and adherence to best building practices so that negative project impacts can be dealt with at an early stage.

2.3.1.2.2. Construction phase

This phase includes construction works on the site, which will be undertaken by a contractor. It includes transporting the project components to the site as well as preparing the site for installation of solar panels, foundations, internal roads, buildings, etc.

2.3.1.2.3. Operation stage

This phase includes works to be performed by the contractor and project operator which is expected to include the normal day-to-day operations of the solar power plant operation and routine maintenance.

2.3.2. ESIA Methodology

The study methodology was designed in order to achieve the requirements of the National Center for Environmental Compliance (NCEC) and IFC guidelines in the preparation of environmental and Social Impact assessment studies. The study methodology included doing the following works:

- Office work: It includes a study of similar projects, and some geographical, demographic and historical characteristics of the site.
- Site visits and conducting of a comprehensive survey, including topography of the site, roads and transportation infrastructures, population and socio-economic life.
- A study of the current state of the environment, including air quality monitoring, dust, and noise levels, and taking samples of soil and water.
- Studying the project components and the project phases that will be followed.
- Studying the project technical characteristics.
- Assessment of the project environmental impacts (positive and negative) on the environment, social and economic life and biodiversity.
- Several alternatives, recommendations, and procedures have been prepared that will reduce the impact of the project to an acceptable extent, during the phases of operation, maintenance, and project decommissioning
- Preparation of an environmental management plan in order to ensure compliance with the environmental standards required for the construction and operation phase, and the implementation of recommendations prepared for this purpose.

2.3.3. Structure of the Environmental and So Impact Assessment Study

The report of the Environmental Impact Assessment Study will be prepared in accordance with the requirements of the environmental assessment in the Kingdom of Saudi Arabia and the best practices required by the National Center for Environmental Compliance. In order to present the ESIA in a logical format, it has been divided into several sections:

- Section one: presents an executive summary of the ESIA, including the main outcomes and conclusions.
- The second section: consists of the main text of the ESIA, with identification of mitigation, management and control measures and follows the general structure:
    1. an introduction

2. Project Description
3. The institutional and organizational framework of the study
4. Description of the surrounding environment
5. Impact identification, analysis, and evaluation
6. plans
7. Conclusion

The Saudi General Environmental Protection Regulation obliges the project owner/developer to prepare an environmental impact assessment study for the project and take approval for construction and operation. Thus, this study comes in response to the requirements of the Saudi environmental system and the executive regulations. At the international level, the United Nations Agenda 21 states in many of its chapters the importance of studying the impact on the environment to reduce environmental degradation and before that, the Rio de Janeiro Declaration, which states that "Governments must subject any project that is likely to cause damages to the environment to an Environmental Impact Assessment".

This study aims to achieve the following detailed objectives:

- Assessment of the environmental impacts of the project.
- Improve the social impact of the project.
- Determine the capacity of the project environment to support additional environmental impacts.
- Looking for the procedures that would mitigate the negative environmental impacts of the project.
- Studying the available alternatives that contribute to mitigating of the environmental impacts of the project.
- Determining the degree of compliance with the requirements of the National Center for Environmental Compliance and international standards.
- Preparing recommendations that would reduce the project impacts on the environment during the operation phase.
- Putting the necessary information and studies in the hands of the decision maker in order to build plans and programs.

3. PROJECT DESCRIPTION

3.1. Introduction

This section provides a description of the project in terms of location, facilities and associated project infrastructure and activities during the project lifecycle and facilitates an identification of the potential impacts on resources and receptors that could result from project activities during the planning, construction, operation and decommissioning stages.

3.2. Project overview

The project consists of a photovoltaic solar power plant with a production capacity up to 2000 megawatts of alternating current (AC). The solar plant will use bifacial panels technology. The project site cover almost 60 km^2 area and is located approximately 135 km west the Holy City of Makkah.

3.3. Project justification

The solar power plant will provide new alternatives for energy and reduce the Kingdom's dependence on traditional energy source represented by petroleum. The plant will also contribute to distributing electric power to multiple areas such as residential and commercial projects. The project achieves several of strategic goals emanating from the Kingdom of Saudi Arabia's 2030 vision and the global will, including, but not limited to:

- ✓ Reducing carbon emissions resulting from the consumption of fossil fuels.
- ✓ Preserving the national natural resources.
- ✓ Relying on an inexhaustible source of energy, which is the sun.
- ✓ Reducing the cost of producing electricity.
- ✓ Supporting global efforts to reduce emissions that cause climate change and global warming.
- ✓ Diversifying the sources of Saudi national income by relying on new and clean energy sources.

3.4. Project location

The proposed project site is located 135 km southeast of the Holy City of Makkah and about 680 km west of the capital, Riyadh.

The proposed site for the development of Haden Solar plant is located in Turbah Governate. Turbah is one of the governorates of the Makkah province in the Kingdom of Saudi Arabia. Turbah is located south of the mountain of Haden ("Jebel Haden"), to the southeast of Makkah Al Mukarramah. The mountain of Haden (Side of Haden) is a larva region located about 100 km East of Taif and about 200 km East of Makkah-Al-Mukarramah. The mountain is about 1400 m in height. The area where the project will be located in Haden is an open plateau of about 1100 m height. The site is about 50 km south of the city Ateef and 100 km from the Mahazat as-Sayd Protected Area. The project, which

consists of a photovoltaic solar power plant, is located in Turbah Governorate, specifically at latitude 21.53823° and longitude 41.12672°, the project cover 60 square kilometres as shown in the maps below.

Table 2 : Coordinates of the project and limits

Project	Latitude (Centre)	Longitude (Centre)
Solar Power Plant Haden	21.53823°	41.12672°

Limits		
Point	**LONGITUDE**	**LATITUDE**
01	41,1822	21,5848
02	41,1188	21,5856
03	41,1127	21,5762
04	41,1014	21,5159
05	41,1388	21,5033
06	41,1555	21,5021
07	41,1576	21,5055
08	41,1579	21,5230
09	41,1671	21,5229
10	41,1822	21,5483

N21.54841° E41.14777° @9/10/2021, 11h31:18AM

N21.53850° E41.12733°@9/10/2021, 11h28:34AM

Figure 1 : Photos from the site of the proposed project

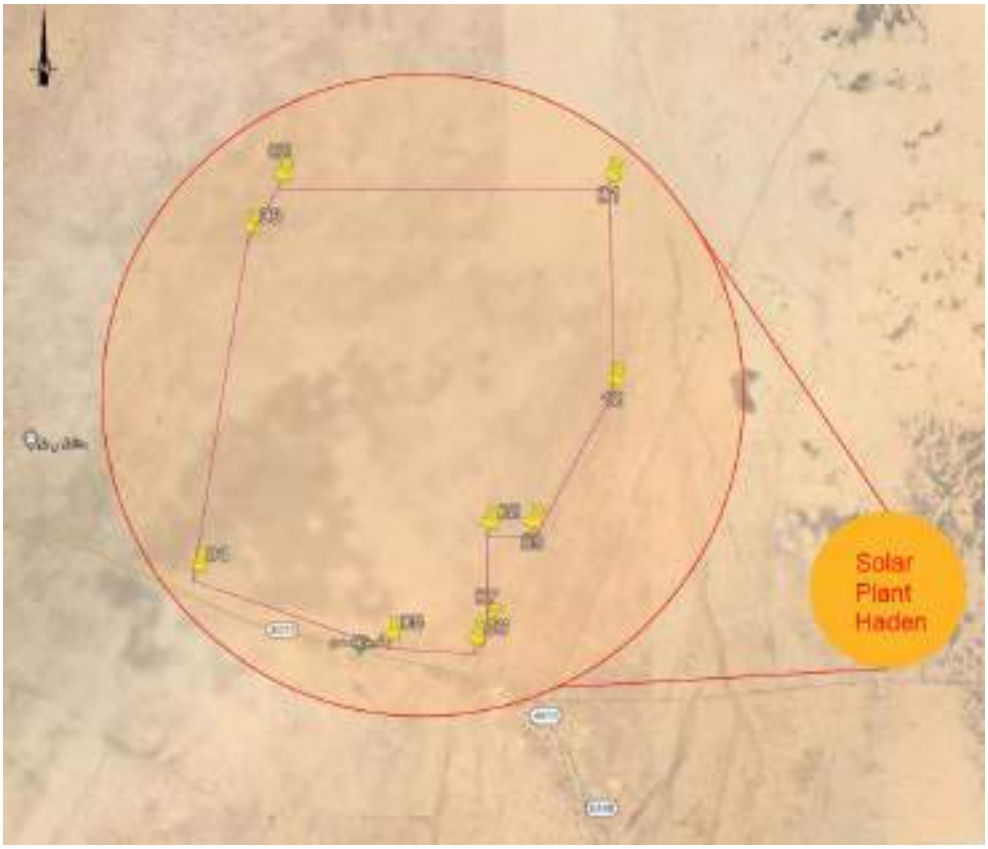


Figure 2: Project location

3.5. Site Access

Vehicle access to the site during construction and operation phases of the Project will be via access points on the adjacent Haden Road (numbered 80) which runs North-west – South-east along the western edge of the Project. This road links Turbah city to Riyadh - Makkah Highway. The figure below shows the principal roads that will be used to access the site.

Figure 3 : Haden Solar Plant Site access

3.6. Description of Project Facilities, Components and Activities

3.6.1. Project key components

The main components of the PV Solar plant include:

- PV modules
- Mounting / Tracking Structures
- DC/AC current inverters
- Cabling
- Transformers
- Substations
- Energy Transmission Lines
- Supervisory Control and Data Acquisition (SCADA) System
- Associated infrastructure and utilities, including:
  - ✓ Site security, including fencing and CCTV
  - ✓ Buildings, including onsite substation, connection building, control building, guard cabin, and spare parts storage.
  - ✓ Access road and internal road network

- ✓ Stormwater infrastructure and drainage system
- ✓ Water supply infrastructure.

The main components of a utility scale grid connected solar PV power plant and their general arrangements are shown the below figure.

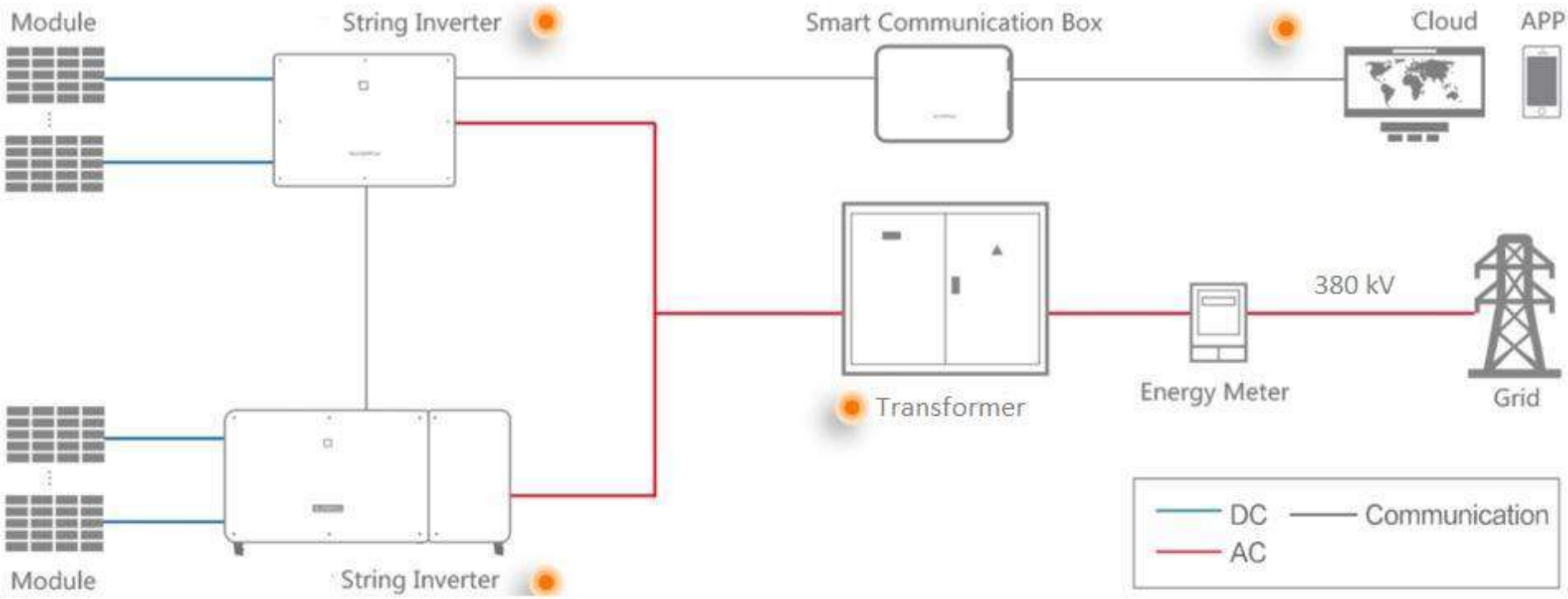


Figure 4 : A model of the Solar Power Plant connection with Haden Network

3.6.1.1. Photovoltaic Modules (PV Modules)

PV modules convert solar radiation directly into electricity through the photovoltaic effect in a silent and clean process that requires no moving parts. The PV effect is a semiconductor effect whereby solar radiation falling onto the semiconductor PV cells generates electron movement. The output from a solar PV cell is DC electricity. A PV power plant contains many cells connected together in modules and many modules connected together in strings to produce the required DC power output.

Bifacial half-cell type modules at maximum 1,500 V system voltage (Direct Current) will be used for the Project. Bifacial solar panels have solar cells that could absorb light from both the front and the back side which allows capturing sunlight that is reflected from the ground as well as from the front of the panel.

The estimation of the energy yield was made using the photovoltaic system of the proposed site taking into account the bifacial solar photovoltaic modules. The 60 km² area is for Solar panel. Bifacial modules achieve a better collar-electric conversion performance at similar project size and more production at a barely higher installation cost.

A maximum total of 5.468.400 PV modules will be installed at Haden PV Solar Plant with an estimated maximum capacity of 2000 MW. The figure shows the layout of solar modules that will be installed.

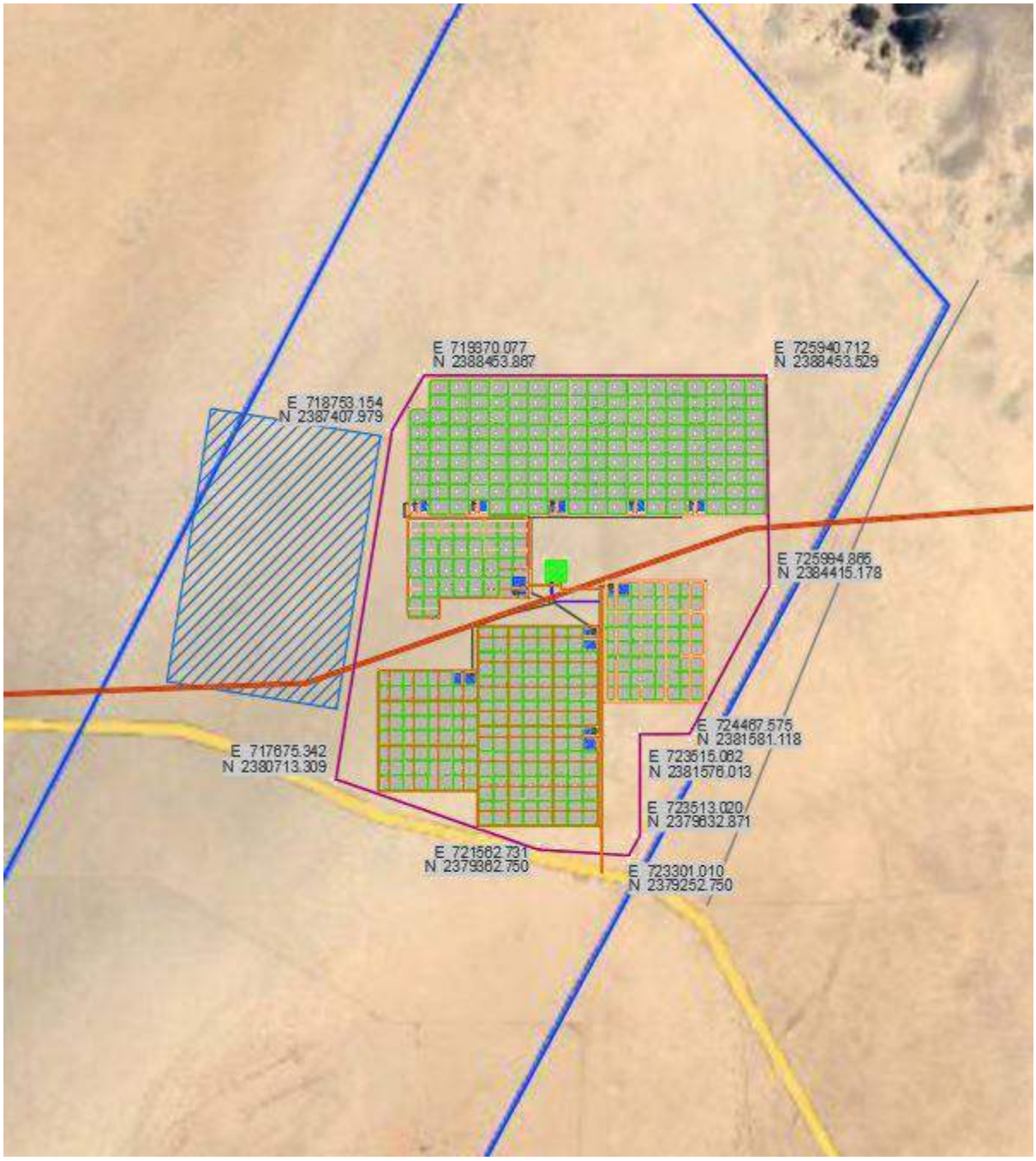


Figure 5 : Haden Solar Power Plant layout

3.6.1.2. Mounting / Tracking Systems

Module mounting (or tracking) systems allow PV modules to be securely attached to the ground at a fixed tilt angle, or on sun-tracking frames; modules for the solar plant will be mounted on a tracking system.

East-west single axis horizontal trackers will be used for the Project. Trackers will be driven by an electric motor and a control unit to follow the course of the sun during the day and will allow modules to tilt angle to an angle of between 50° or 60°. The whole tracker structure will be made of galvanized steel to resist corrosion with a design life of more than 25 years. The below figures present a single axis tracker system with bi-facial modules and shows how trackers allow modules to tilt angle throughout the day.

Figure 6 : Single Axis Tracker System in Combination with Bi-facial Modules

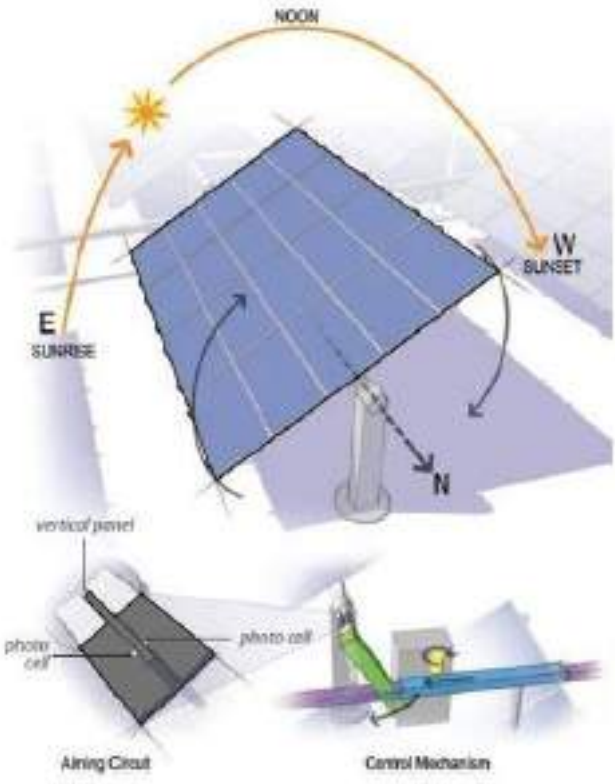


Figure 7 : Graphical Diagram Showing Tracking System

3.6.1.3. Inverters

A solar inverter or PV inverter is a type of electrical converter which converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. The inverter can also implement a variety of functions to increase the productivity of the power unit by increasing voltages, monitoring performance, recording data, providing protection and disconnecting in the event of problems in the network or in order to connect with the photovoltaic units.

Only two types of inverters can be used for large PV solar plants: central or string inverters. third type which is microinverters cannot be considered in large PV projects.

Central inverters centralize the power produced by the plant and are extremely large, converting up to 3 megawatts each. Each power block at the plant will have one or two central inverters.

String inverters use a distributed rather than centralized architecture, with a small inverter for smaller sections, up to 300 kW, of the array. They manage much less power than a central inverter, but the advantage is that should an inverter fail, only the power from one

small section is lost as opposed to an entire power block. Also, the maintenance is much simpler. Each power block at a solar PV plant consists of 10 string inverters.

At this preliminary stage, the inverter selection has no relevant impact either on the size of the PV plant or production. This must be decided by the Contractor as the inverter design has a major impact not only on the initial cost of a solar PV project, but on its long-term operating costs and performance.

PV Plant design based on string inverters as they have some advantages as:

- No single point of failure in the overall system (some power loss if a string goes down)
- Easier to service

The figures below present the principle and how string inverter works.

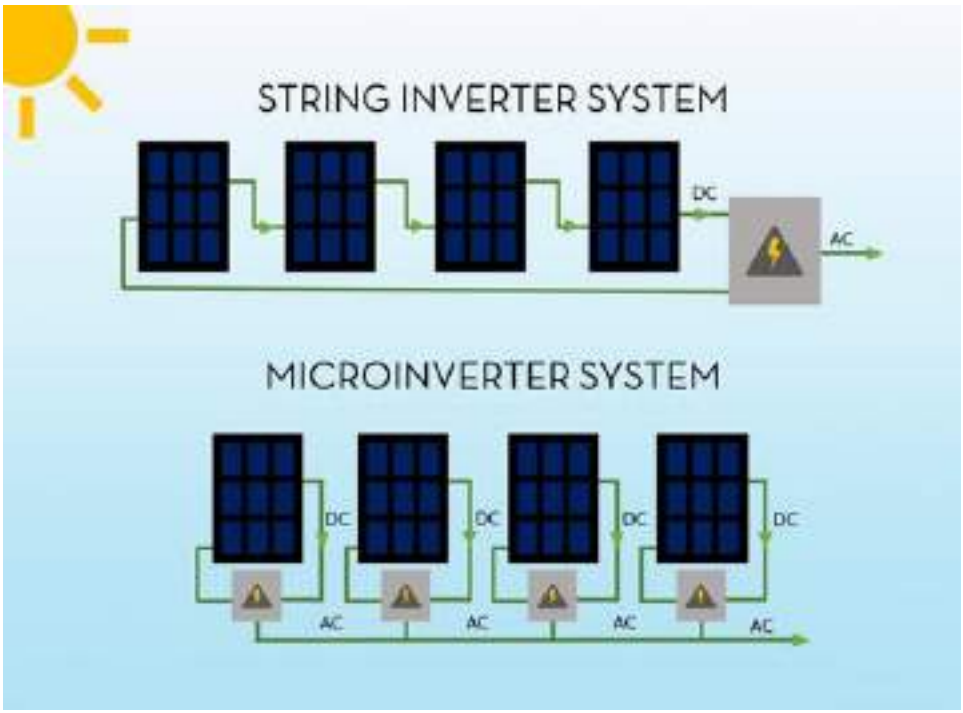


Figure 8 : Principle of string inverter

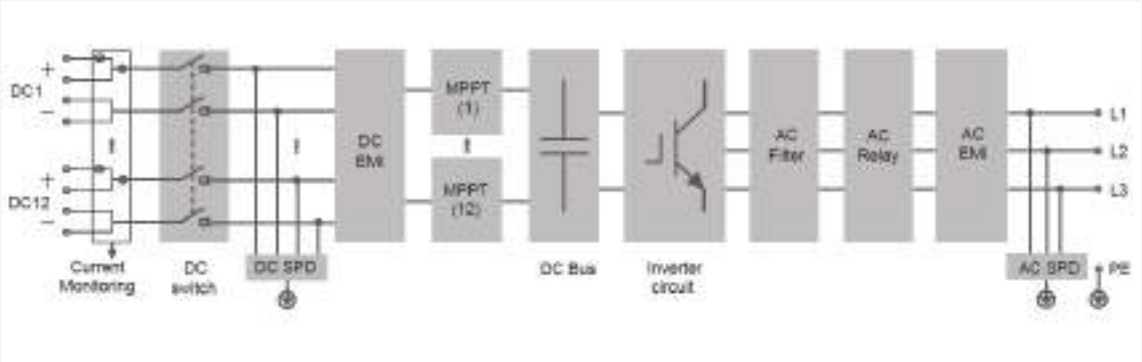


Figure 9 : Principle of electric circuit of an inverter

It is predicted to use in total 9300 string inverters with a rating 225 kVA at 40ºC.

3.6.1.4. Transformer

Transformers are an essential component in the production and distribution of solar energy. Transformers are electrical devices that convert voltage to different levels. Since PV modules and insulators typically operate at low voltage, transformers are required to convert the voltage to a level suitable for distribution corresponding to the grid voltage.

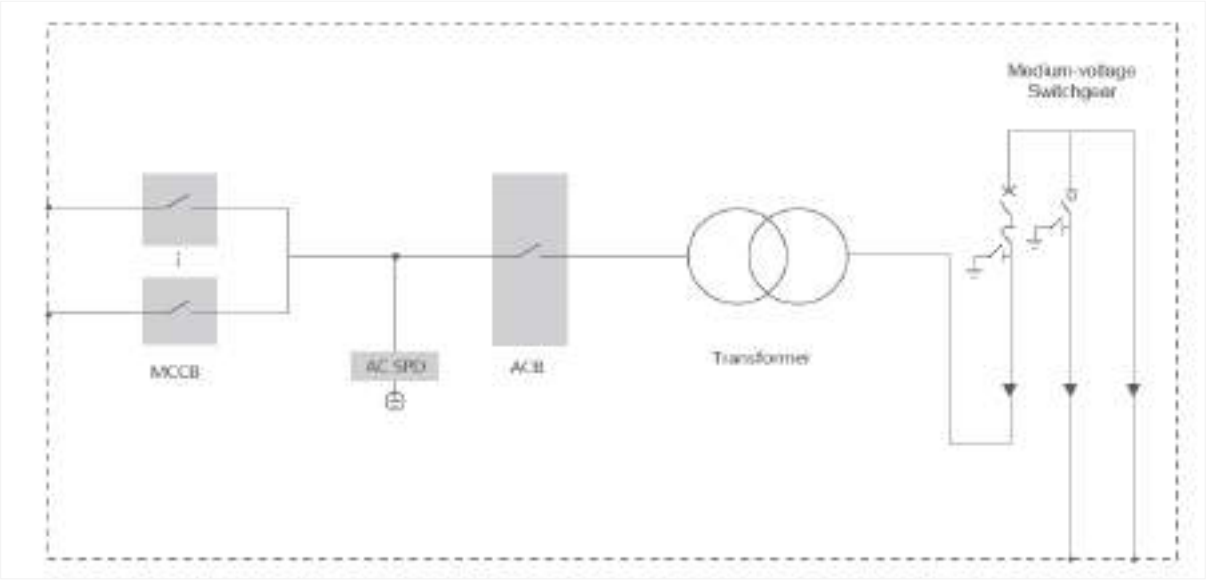


Figure 10 : The electric circuit of transformer

3.6.1.5. Cabling

The PV arrays will be connected via cables that run either under the PV arrays or underground (at a depth of approximately 1 m) to the combiner boxes. Combiner boxes collects the DC power generated by multiple arrays to larger cabling in order to transmit the power more efficiently up to the Medium Voltage (MV) Power Units.

3.6.1.6. Electrical connection to SEC substation

The interconnecting to the National Grid substation (SEC substation), will be located inside the boundaries of the solar plant. The location of the substation, considering the standard required surface (400 x 400 m), will be based on the optimal technical an economic condition, including topography and geotechnics.

The proposed access roads from the existing road will be selected to reduce the distance to the SEC substation.

At medium voltage, the photovoltaic plant will primarily generate at 33 kV (output voltage of the MV inverter-transformers). Due to the high capacity and extension of the plant, the voltage level of that energy produced will be elevated through an internal HV (110 kV) network to limit the transmission losses. The power plant will be designed in blocks of 150-200 MW, with a 33/110 kV step-up substation for the evacuation (5-6 blocks/substations per power plant foreseen).

The step-up internal substations shall be Indoor Gas insulated GIS (Gas-insulated high-voltage switchgear) type for the MV side, one power transformer 33/110 kV (final capacity to be defined at further steps and case by case) and one line/transformer bay outdoor, air insulated AIS for the HV. The interconnection line of the block will run to the 110 kV gantry of the SEC substation where the solar project limits will be located.

Then, SEC substation will be 110/380 kV, indoor GIS type for both voltage levels, as per SEC standards and with the required autotransformers. The design, construction and commissioning of the SEC substation from the 110 kV interconnection gantries and the 380 kV overhead lines to other electrical nodes at North and South of the site and between new two substations will be made by SEC and so, it is out of the PV project.

3.6.2. Associated Facilities and Other Plant Infrastructure

Many associated facilities and other plant infrastructure are necessary to carry out the project in the right way. These facilities and infrastructures are described below:

3.6.2.1. Site Access and Internal Roads

There will one access point to the Site. The access point to the site has been designed from road 44100 at the south limits of the PV plant.. Access road is running North-South up to the SEC substation that will have an separate access. Limited by the SEC substation, the total length of the access road from the access point to the substation is approximated to 8 km. its width is fixed to 10 m.

Internal access roads will be built during land preparation for each phase. There will be internal access roads and a ring road surrounding the Project Site. Construction of internal

roads is carried out phase by phase with a ring road. Internal roads will be in linear form running between PV Modules. Ring road will be col-mixed asphalt to minimise dust generation and internal roads will be chip sealed. Further details such as length and width of these roads etc. are not available at this stage.

3.6.2.2. Administration Building and Control Centre

There will be an administrative building, control centre, dining hall and warehouses within the administrative building area.

3.6.2.3. Temporary Construction Laydown Area

A construction laydown area would be set up. This area would be used for laydown of materials, staging of traffic to avoid congestion, and for the temporary concrete batch plant.

3.6.2.4. Scrap yard

A scrap yard will be present within the site. The scrap yard will consist of discarded panels and other hardware components such as wood/steel, oil barrels, wires/cables and domestic components.

3.6.2.5. Main Substation

Power from the 2000 MW solar power plant will be evacuated to 380/110 kV substation within the project site which will be developed and operated by SEC.

3.6.3. Project Phases and Activities

The proposed project plant is currently at initial stages of planning. The activities for the project can be divided into the following phases/stages.

- Planning phase.
- Construction phase.
- Operation and maintenance phase; and
- Decommissioning phase.

The key activities for the above are as showcased in table below.

Table 3 : Project Phase and Key activities

Phase No	Project phase	Key activities
1	Planning	• Identification of land area and site; • Site surveys as topographic, geo-technical investigations, solar radiation and yield study, electrical grid studies, etc.; • Obtaining all necessary approvals/clearances; and • Design and finalization of contractors.
2	Construction	• Contractor mobilisation;

Phase No	Project phase	Key activities
		• Site Preparation including fencing, clearing of bushes, pit filling, levelling and grading; • Construction of site office and internal roads; • Construction of temporary storage facilities; • Foundation laying for ground mounted structures; • Storage of PV modules delivery and their installation; • Laying of internal electrical connections; • Construction of substation and office buildings; • Installation of inverter and transformers; • Excavation foundation and erection of transmission line towers; and stringing of transmission lines.
3	Operation and Maintenance	• Monthly cleaning of PV modules; • Control of vegetation, weeds, bushes etc. within the site and those immediately surrounding it; • Routine inspection of all PV modules and associated structures , cables, transformers, inverters, mounting structures etc.; • Operation and maintenance of ancillary facilities such as power substation. • Inspection and maintenance of transmission lines; and • Inspection and maintenance of internal pathways and access roads.
4	Decommissioning	• The average life span of the solar modules is minimum 25 years; • At the end of this life cycle, the solar modules will either be revamped or replaced, or disposed as per the then applicable legislation; • If decommissioned, all components including foundations and internal roads of the project will be removed and the site will be restored to its preconstruction state; • The concrete pedestals of the ground mounted structure foundations will be demolished and removed from the sub-surface.

3.7. Land preparation and construction phase activities

Land preparation and construction activities as well as schedule, workforce and relevant construction machinery equipment are described below.

3.7.1. Schedule

Land preparation, construction and test phase are estimated to last a minimum of 24 months for the 2000 MW solar power plant.

3.7.2. Workforce and Workers' Accommodation

Approximately 1500 labours are estimated to be deployed in the peak construction phase for the foundation structural work, fencing, cleaning and erection of mounting structure. The contractor workforce will comprise of both skilled and unskilled labours.

Where possible workforce will be sourced from nearest communities during the project construction phase. Non-local workforce, including unskilled workforce, administrative staff and engineers, will be accommodated at the Camp within the construction laydown area.

3.7.3. Construction Activities

The construction phase activities will include the following key activities

- Land clearing for site preparation and access roads.
- Excavation and filling.
- Transportation of supply equipment, components and materials.
- Construction of foundations, involving excavations and placement of concrete.
- On-site assembly of tracker systems and installation of PV modules.
- Installation of electrical connection systems, including cabling.
- Construction of offices and warehouses.
- Construction of Substations and Electrical Transmission Lines.
- Testing, commissioning and connection to the grid.

Land preparation works will include removal of topsoil, excavations and construction of access roads and backfilling/site levelling where required. Firstly, topsoil will be removed to a depth of 0.1 m then excavation will be carried out.

Given that the total area covered by the plant is 60 km^2, then the total volume of the soil that will be excavated land preparation is estimated to 3 million m^3. All of excavation material will be used for backfilling while 20% of it will be used for levelling on site.

All materials, equipment, and components, such as PV panels, inverters, transformers, ETL towers etc. will be transported to Site via road along the southern boundary of the site and will provide access to the Project.

Contractor responsible for engineering and material supply, will manage the project logistics, including all material transportation and installation works for PV Solar plant Project.

3.7.4. Construction Machinery and Equipment

Typical list of machinery and equipment to be used for construction activities is provided in the below table Electricity required during the construction phase will be supplied from on-site diesel generators. The table below considers that ae 2000 MW is executed in a single phase.

Table 4 : Estimation of Construction Machinery and Equipment used in peak time

Machinery / Equipment	Estimated Maximum Number during Peak Time
Excavator	10
Grader	4
Vibratory Roller	6
Water Sprinkler	5
Loader	4
Backhoe loader	2
Truck	40
Dozer	4
Tractor	5
Crane	5
Diesel generators	5
Mobile Fuel Tanker	2
Lowbed	2
Pick-up Truck	5
Bus	5
Light tower	8
Manitou	15
Rock Machine	2
Colon Pile Driver	8

3.8. Operation and maintenance activities

3.8.1. Project Lifetime

The design lifetime of PV Panels is generally 25 years, but in practice panels should last longer with proper maintenance. The whole tracker structure should be made of galvanised steel or any other resisting to corrosion material with a lifetime of over 30 years.

The Project operation phase will require routine (preventive) maintenance throughout the operation phase to ensure extended system lifetime, as well as compliance with manufacturer warranty and ensure efficiency in energy production.

Routine maintenance activities include regular cleaning of panels (considering the climatic conditions of the region frequent periods may be required) and maintenance of electrical components, control equipment and access roads. Wet cleaning for PV panel cleaning could be applied and working on options for water source nearby for this purpose.

3.8.2. Workforce

The maximum number of personnel during peak construction time is estimated to be 320 personnel. All non-local project staff including technical and administrative staff will be accommodated at the Camp Site that will be installed on site.

For the operation of the PV plant, the number of 150 personnel is estimated (focusing on number employed in similar projects) to be employed. Non-local operation personnel will be accommodated in project site.

During the operation phase, approximately 20 - 30 employees/technicians of SEC/ O&M contractor would be deployed at site. Apart from these, there will be 3-5 staff who will be engaged in housekeeping and approximately 15 are envisaged to be employed as security guards during O&M stage. These figures will be confirmed upon finalization of project components.

3.9. Resource Requirement

3.9.1. Land Requirement

The total land requirement for the 2000 MW solar power project is estimated to be approximately 60 km^2. Breakdown of land requirement for each component (Installation of solar modules, Site office, Inverter room, Temporary labor camp, Stock yard and Transmission line) in details are not available this stage.

The project does not involve any private agricultural land, any restricted, protected area or private property.

According to the available information and interviews with the official authorities in the Haden region, there are no current or future projects, and no restrictions or constraints on the site.

3.9.2. Water Requirement and Source

3.9.2.1. Water requirement in construction phase

During the project construction phase, water is required for preparing RCC foundations (Reinforced Cement Concrete (RCC)) for module mounting structures, building control room and security rooms, and domestic purpose such as drinking and washing by the construction workers and staff. Water is also used for dust suppression.

3.9.2.1.1. Potable water

General Authority for Statics in The Kingdom has reported in 2017 that has reported that average daily water consumption per capita ranges between 102 L per day per capita (in Jazan) and 381 L per day per capita (in Eastern region). For the project we can take the average value of 240 L per day per capita. Accordingly, maximum daily water demand is estimated to be 300 m^3 for 1500 workers during the peak construction.

Drinking water can be purchased as bottled water from the nearest market. water for other domestic purposes will be brought to Project Site by Tankers. No other source is known yet at this stage.

3.9.2.1.2. Water demand for dust suppression

According to the up-to-date information gathered from other similar projects, daily water demand for dust suppression varies between 40-500 m^3 during dry periods. If we take the average value of 450 m^3/day. The monthly water demand for dust elimination will be 13500 m^3/month.

Water supply for dust elimination will be assured by tankers brought to the site.

3.9.2.1.3. Water demand for civil works

The total quantity of concrete estimated for civil works in the project is 250 m^3. The water Considering the value of 150 L of water per cubic meter of concrete. The total water demand for the project is estimated to 40 m^3.

To this demand, it is added approximately 1000 m^3 per month for other miscellaneous civil works.

Water will be brought to project site by tankers.

3.9.2.2. Water requirement in operation phase

3.9.2.2.1. Water for PV module cleaning

During operation and maintenance phase. Water is used is used in cleaning of panel (wet cleaning). The cleanness of panels significantly influences their performances to produce electric power.

Research made on relationship between cleanness and performance in desert climate had shown that, the PV panel, which kept dusty for 20 days, produced 5% less power. Power losses of 7% and 13% were observed for 30 days and 90 days of dusted panels, respectively. Many researchers proposed cleaning of PV modules between 8 to 35 days based on their

geographical location, energy wasted due to soiling, and cost associated with cleaning. A module cleaning frequency of, at least, 10 times a year is recommended.

Considering a specific water demand for cleaning of 3.86 m^3/MWp. The water demand to clean the modules is given by the Table below:

Table 5 : Water Demand for PV Panel Cleaning when Fully Operation (Wet Cleaning Only Scenario)

Project information	Unit	value
Project capacity	MWp	2600
Specific water consumption	m3/MWp	4
Water demand per cleaning	m3	10400
Cleaning times per year	1/year	10
Yearly water consumption	m3/year	104000

3.9.2.2.2. Water for domestic use

Water will be required for domestic purposes by the operations staff and workers. The daily water demand for the 100 personnel working on site is 15 m^3/day. Considering a rejection rate of 80% the daily domestic wastewater flow rate will be estimated to 12 m^3/day.

3.9.3. Raw Material Requirement

3.9.3.1. Construction phase

The major raw materials required for the construction phase are fencing material, construction materials like cement, sand, aggregate that will be sourced from local areas. Solar modules for the project along with associated structures will imported. The quantity of steel needed for the reinforced concrete is estimated to 120 MT and the amount of concrete is 100 m^3.

3.9.3.2. Operation and Maintenance phase

There will not be major requirement of raw materials during operation except for maintenance purpose excepted consumable spares.

3.9.4. Power Requirement

3.9.4.1. Construction Phase

Power requirement during the construction phase will be met through Diesel Generators (DG). It is estimated that 5 D.G. sets of capacity 35 kVA each will be used during

construction phase. The exact number of DG sets to be used, as well as the quantity of fuel, could not be ascertained as the Project is in the planning stages.

3.9.4.2. Operation Phase

Based on initial assessment, power requirement during daytime would be met through auxiliary generation. During the night-time power requirement would be met through SEC electricity supply.

DG sets would also be kept at the control room for emergency power backup.

3.9.5. Fire Safety and Security

3.9.5.1. Construction Phase

Appropriate firefighting system and equipment shall be provided throughout the construction period.

The fire extinguishers will be placed at all strategic locations such as site office, storage yard, near construction area, welding area, etc. Besides this, emergency contact numbers shall also be displayed onsite.

3.9.5.2. Operation Phase

It is understood that suitable fire protection, fighting systems, portable fire extinguishers, fire buckets and automatic fire detection system will be made available at the entire PV array area, inverter stations, main control room and switchyard. The aforesaid systems and equipment will conform to National Fire Protection Authority (NFPA), fire safety standards and local fire authority requirements. Firefighting arrangements for electrical utilities like transformers etc. will be in accordance with Saudi firefighting standards in electrical facilities and National Fire Protection Association (NFPA) 70 and 15 requirements

3.10. Pollution Streams during Construction Phase

Pollution streams during construction phase will include air emissions, wastewater generation and solid waste generation

3.10.1. Solid Waste Generation

3.10.1.1. Construction Phase

The key solid wastes that are expected to be generated during construction phase are as follows:

- Domestic waste from temporary site office; hazardous waste such as waste oil, lubricants, oil contaminated rags; electronic waste like broken PV module etc…

- As a means of best practice, hazardous wastes will be stored onsite at separate designated covered area provided with impervious flooring and secondary containment. The storage containers/bins/drum will be clearly marked and identified for their hazards. Before completion of 90 days, hazardous waste materials will be sent to an authorized vendor for eventual disposal at the Common Hazardous, Waste Treatment, Storage and Disposal Facility.
- Hazardous waste authorized vendor is yet to be identified as the Project is in the planning phase.
- The broken solar panels, batteries (dry type or wet type), electronics if any, will be sent back to the vendor as part of buyback arrangement.
- Domestic solid waste will be disposed with the help of authorized vendor at authorized disposal ground.
- The transformer oil drums will be disposed through an authorized hazardous waste recycler.
- All non-recyclables waste will be collected and disposed of by the contractor at designated landfill sites.

3.10.1.2. Operation Phase

During operation phase waste generated from the project will include

- domestic waste at site office, scrap materials like scrap tools, damaged PPEs etc…
- Hazardous waste like waste oil, lubricants, used transformer oil; damaged batteries…
- damaged PV modules etc.

Following measure will be adopted for disposal of solid waste:

- The hazardous wastes will be stored temporarily onsite at separate designated covered area provided with impervious flooring and secondary containment and will be disposed in accordance with Hazardous and Other wastes.
- The broken solar panels, batteries (dry type or wet type), electronics if any, will be sent back to the vendor as part of buyback arrangement.
- Domestic solid waste generated form the site office will be disposed at disposal site of the nearest municipality.

3.10.2. Air Emissions

3.10.2.1. Construction Phase

There will be impact on air quality due to onsite construction activities. The likely emissions from construction activities would include the following:

- Fugitive emissions from site clearing, material handling, transportation, piling, use of construction machinery, etc…
- Fugitive dust emissions from unpaved roads.
- Vehicular emissions from increased traffic volume from vehicles used for transport of construction material, transportation of PV modules and accessories.
- Exhaust emissions from operation of diesel generators.

To control air emission during construction phase from operation of D.G. sets, adequate stack height as per national standards will be provided to ascertain regulatory compliance. Fugitive dust emission arising from various activities such as piling, transportation of material (loading and unloading), vehicular movement (on unpaved roads) will be minimized through sprinkling of water and maintaining vehicular speed to 10-15 km/hr. Vehicular emission will be controlled through proper maintenance of vehicles.

3.10.2.2. Operation Phase

Under normal operating conditions there would be no gaseous emissions from the operating areas.

However, there is a likelihood of gaseous and fugitive dust emissions, in smaller concentrations, owing to the operating of maintenance vehicles. As a means of best practice and adherence to national regulations, well maintained vehicles will be used for operation and maintenance purposes.

3.10.3. Waste Generation

3.10.3.1. Construction Phase

Liquid effluents generated during the construction phase will include domestic sewage from temporary site office. As part of the site preparation stage, a drainage and sewerage system will be constructed for the site office. The sewerage system will consist of soak pits for the collection of wastewater from the kitchen and washing areas and Office facility. Sewage from the toilets will go into lined septic tanks. Sewage disposal trucks will be used to periodically remove the sludge/sewage from the site.

3.10.3.2. Operation Phase

The operational phase will have negligible wastewater generation at site office. Septic tank and soak pits will be provided at the site office for disposal of sewage.

3.10.4. Noise Emissions

3.10.4.1. Construction Phase

During the construction phase noise will be generated primarily during the daytime. Noise will be generated from pilling, moving vehicles as well as construction equipment and machineries, including the DG sets utilized for power. Since there are no settlements in the near vicinity of the construction site, the receptors of noise pollution will be only the construction workers. As a control measure it will be ensured that noise emission from the vehicles and equipment's shall not exceed 91 dB(A). DG sets will be provided with acoustic enclosures and workers near noise generating machines will be provided with earplugs as safeguard against high noise hazards.

3.10.4.2. Operation Phase

Under normal operations, none of the activities of solar power plant will generate noise. Any activities generating from maintenance work will be restricted to daytime only.

4. PROJECT ALTERNATIVES

4.1. Methodology for selecting and evaluating alternatives

This step aims to describe the proposed alternatives for the project and determine the most appropriate and least impactful on the environment. This step includes a study and analysis of many technical aspects of the project, including the location and design of the project and the technology used in the operation process. The alternatives evaluation methodology is based on making a comparison between the various proposed alternatives for the project and comparing the following aspects:

- Proposed project site alternatives,
- Economic feasibility and associated costs,
- The pros and cons of each alternative,
- Financial efficiency, including costs, environmental management,
- The degree of impact on the environmental, economic and social aspects,
- Technology used and possible project designs,
- Consistency and not conflict with future development plans in the region,
- Possible build and run processes,
- Consumption of natural resources, especially energy and water,
- Administrative, legal and technical difficulties associated with the implementation of each alternative,
- Risks related to the implementation of each alternative.

Various alternatives will be studied, with the aim of eliminating or reducing the impact to an acceptable degree. All available alternatives will be presented and include:

- No-project alternative
- Technology alternatives.
- Site alternatives.

4.2. No-project Option

The no-project alternative represents the option of not undertaking the proposed activity or any of its alternatives. It provides the baseline against which the predicted impacts and risks can be assessed. Although the no-project alternative would not result in any environmental impacts on the site or surrounding area, it would also not bring any positive impact to the local area in terms of socio-economic benefits, job creation and skills development. The local area will not benefit from economic benefits associated with the Saudi Arabia's NREP and investment in socio-economic development.

The no-project alternative will not contribute to the Saudi Arabia's long-term strategy of diversifying energy mix and will not reduce the Kingdom's dependence on oil and gas and its greenhouse gas emissions as part of the Paris Agreement. It will also reduce chances to create jobs and limit economic development in the region, and then opposes Vision 2030's goals.

Although the predicted negative impacts of the proposed activities (e.g. vegetation clearance, disturbance of habitat, noise and dust generation, etc) would not occur on the proposed site, the no-project alternative may result in other and less environmentally friendly land uses to be developed on the site.

Based on the evaluation of the no-project alternative, it seems most likely that the overall positive impacts of the proposed activities would outweigh negative impacts if the proposed mitigation measures and management actions are implemented. The project would help to diversify the local economy and result in significant positive economic spin-offs primarily because of the expenditure injection and jobs associated with it. Risks and negative impacts would primarily arise at a local scale and site level and will be managed and controlled if the recommendations made are well followed.

4.3. Alternative Technologies

4.3.1. Solar Panel Technology

PV modules are the basic building blocks of solar PV systems. Modules consist of solar cells which convert solar radiations (sunlight) into DC electricity. The individual crystalline solar cells are connected in a module in series and are hermetically sealed to survive in extreme temperature and weather conditions and ensure optimum performance. The PV module frame would be generally made up of anodized aluminium.

Bifacial solar panels operate with the same principle of solar photovoltaic but can produce solar power from both sides of the panel. Whereas traditional monofacial panels are opaque from rear side, bifacial modules expose both the front and backside of the solar cells to radiation. When bifacial modules are installed on a ground, it absorbs the solar radiation reflected from the ground, called as "albedo", which results in increase of electrical output from the solar panel.

Few important aspects of energy simulation with bi-facial type solar panel are described below:

- Rear shading losses – The loss of power due to obstruction or shading of incident radiation on the rear side of the solar panel.
- The proportion of the incident light or radiation that is reflected by Earth's surface.

4.3.2. Tracker

Also, the latest state of the art for large PV power plants is to uses those modules mounted on ground-mounted tracking structures. To maximize the site for annual and seasonal energy production, the tracking mechanism follow the sun daily from east to west (Northern hemisphere).

4.4. Alternative Site selection

4.4.1. Defining criteria of site selection

In this section we aim to identify all those spatial factors considered for optimal site selection to delimit the best area for Haden PV power plant.

In the planning process, we identified two types of criteria: evaluation criteria that will be used in the site suitability analysis and constraints that will be used to eliminate the unsuitable areas. One of the most important steps in site selection analysis is identifying factors or criteria used to evaluate suitable locations. Evaluation criteria involve factors that directly affect the performance of the solar power plant and the cost of solar project.

In this methodology, the selected criteria were extracted from expert opinions and after reviewing the previous research studies conducted in this field, especially the ones that consider Saudi Arabia as the study area. The criteria included socio-economic, environmental and technical.

The methodology will ensure that the defined criteria are not only based on the socio-economic, environmental, and technical principles but also meet the legal and regulatory framework.

Table 6 : Identified criteria and factors

identified criteria		Factors
1	Socio-economic	Accessibility
		Community Interest
		Slope
		Proximity to electric transmission
2	Environmental	Used land
		Protected Area
		Flora & Fauna
3	Technical	Climate
		Water access
		Land use

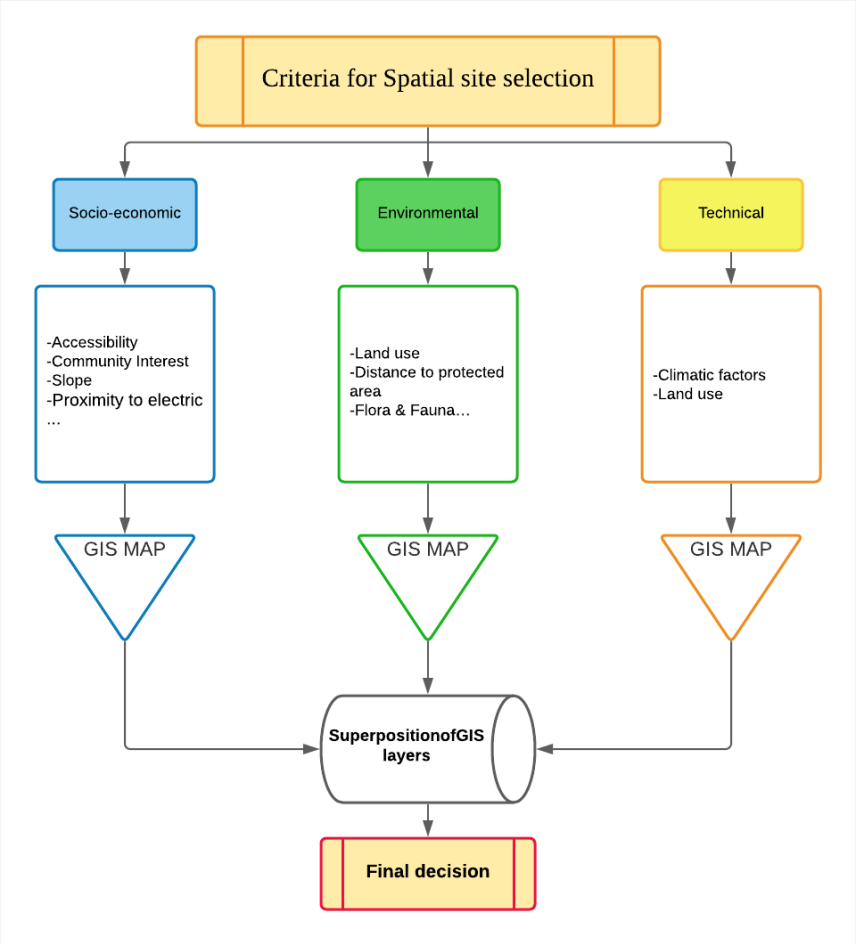


Figure 11 : Diagram of the integration of criteria

4.4.2. Proposed Framework

Since site selection is a crucial stage and depends on different criteria, a combination of GIS maps was applied to perform the site suitability analysis. The steps are discussed below according to the proposed framework as shown in Figure below.

The proposed framework is as follows:

1. Data collection, which includes the data collection process according to the required criteria.
2. Spatial analysis, which includes the spatial analysis involving GIS.
3. Visualization, which consists of the final results of the methodology, represented by suitability maps.
4. A field surveys and local administration interviews.

Figure 12 : Proposed framework in site selection

4.4.2.1. Documentary analysis

This study applied the documentary analysis along with field surveys to identify the key factors for optimal siting of PV power plant. The real situations, impacts, and issues in term of spatial factors (among others) were compiled and designed as spatial database applicable to implement with the Geographic Information System (GIS). Furthermore, factors identified during field and desktop work were assessed and ranked with respect to their relevance. Then, they are used to exclude areas where undesirable impacts are likely to impair the optimal yield of the power plant.

4.4.2.2. Field survey /Stakeholders Engagement

The schedule of investigations includes a set of visits to the locations of relevant authorities for inquiring about envisaged projects and plans about the proposed area. The visits were in part conducted through the period from 9 through 12 September 2021.

Table 7 : The consultation of local authorities

Contact/consultation	Action / Contact/consultation details	Achieved or expected outputs
Ministry of Transport and Logistic Services	Consulting the requirements published on the official website (in the event of available)	Current and future projects for the benefit of Haden Road, including the developments, expansion and protection facilities against flashfloods. Requirements related to the setback distances on both sides of the road

Contact/consultation	Action / Contact/consultation details	Achieved or expected outputs
Ministry of Environment, Water and Agriculture	Action: The Ministry of Energy to communicate with the relevant ministry	The water resources in the project area Historical data for rainfall and flashfloods in the project area Environmental or water projects in an area proposed for the solar plant or in its close vicinity
Civil Defense	Action: The Ministry of Energy to communicate with the relevant ministry	Data on civil defense interventions in the project area to protect against the dangers of flashfloods
Municipalities Riyadh Municipality Agency for Regional Municipal Affairs General Administration of Studies and Designs Urbanism agency General Department of Urban Planning	The mayor of Turbah was contacted on 08/02/1443 AH to consult the municipal projects in the proposed area for the development of the solar power plant in Haden	Awaiting the official response from the concerned municipalities (Turbah) in order to deliver the GIS system for the study site, which includes all plans for existing and future projects. There is no municipal project in the study area and the site does not fall within the urban intervention area of the municipality The presence of a military area in the south of the plot, and an official report was sent to the Taif Municipality for this purpose
Ministry of Defense	Action: The Ministry of Energy to communicate with the relevant ministry	Land ownership limits for the military base south of the proposed site Requirements regarding return distances / Buffer zone Requirements regarding the safety of activities inside the military facility and not being affected by the establishment of the station Statutory licenses to implement the project
Ministry of Interior	Action: The Ministry of Energy to communicate with the relevant ministry	Consult if any future road security facilities are envisaged in Haden road

4.4.2.3. Walkthrough site visit

The purpose of the walkover survey is to highlight any immediately apparent geological, ecological, topographical or other issues which may present constraints to the Haden site, such as; the presence of protected species, contamination, site obstructions, access problems, water sources, trees, site boundaries and so on.

It incorporates additional information gathered from local authorities, local residents and people who work in the vicinity of the site. It should identify any areas where further and potentially more detailed surveys may be necessary.

- ✓ Direct inspection of the Haden site and the surrounding area was carried out in conjunction with the desk study.
- ✓ A photographic record of the site to help in the reporting of the walkover survey.
- ✓ photographs showing points of interest or concern (e.g., areas vegetation), facilities projects...

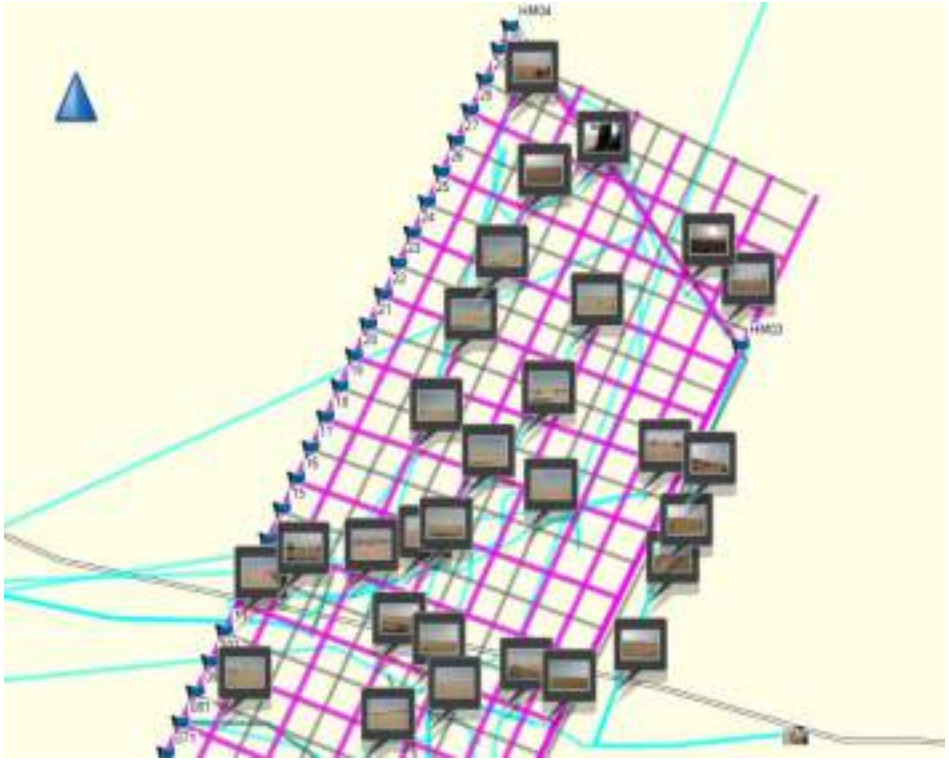


Figure 13 : Photographic Database. A photographic record of the site (Create a digitized photographic record of each zone visited from the Haden site)

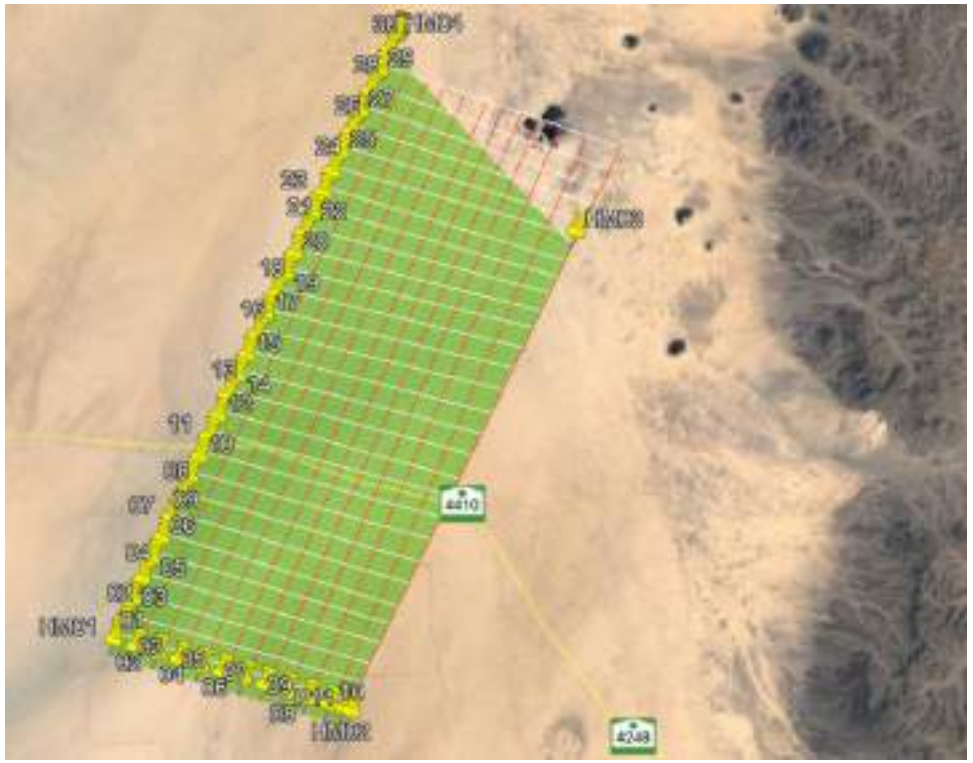


Figure 14 :Haden Site

4.4.3. Criteria Analysis & Site Selection

In general, the process of site selection must consider the environmental/technical/socio-economical constraints of the Haden site and the impacts it may have on the cost of the electricity generated; Low grid capacity or insufficient area to install modules.

A Geographical Information System (GIS) mapping tool can be used to assist the site selection process by assessing multiple constraints and determining the total area of suitable land available for solar PV project development.

4.4.3.1. Socio-Economic criteria

The area Accessibility (distance to roads), slope, community interest and elevation are among the socio-economic criteria selected for the Haden site selection. The proximity of power plants to urban and industrial areas plays a crucial role in the viability of Solar Power Plant because the transmission and distribution cost of generated electricity and the network losses has a direct relation with the distance to the consumers.

On the other hand, accessibility to the transport network minimizes the operational costs of Solar Power Plant, because proximity to the roads will reduce the transportation costs of power plant. To reduce wasting energy from the electrical grid, it is necessary to build power stations near the residential areas and transmission lines.

4.4.3.1.1. Distance to transmission lines and substations

Availability of Existing Grid is an advantage to evacuate the generated power from the plant, a viable transmission line is needed.

When the power plant is close to transmission lines, it helps to minimize the loss of power in the transmission, as well as avoiding the high cost of installing new lines. It is necessary to build a substation near the Solar Power Plant.

4.4.3.1.2. Land Constraints (Overhead Power Lines)

A 30 kV overhead powerline crosses the initial development area form South-West towards North-east in the diagonal direction with respect to the area shape with a crossed distance of 14.6 km. Thus, the development area with lower risk proposed initially is divided into two zones.

Figure 15 : Overhead Power Lines & Haden site

4.4.3.1.3. Compliance with safety requirements

The siting proposals should take into consideration the compliance with the right-of-way and approach limits required by safety best practices and working regulations. As well, adequate clearances under power lines during construction and operation/maintenance phases should guaranteed. Since the high voltage lines already exist, it is required when choosing the final site alternative for the construction of the solar power plant to leave a band along these lines as an area under which it is forbidden to work at any stage in the life cycle of the project

4.4.3.1.4. Electric risk impact

The risks associated with the high voltage power lines pertains to the rights of way (RoW) group. In the project case, they should be classified as high-impact factor regarding the solar plant siting process. As the process uses exclusion strategy to reduce the initial zone into a suitable area less extended, the following mapping is provided as an indication. General arrangement layout should be developed with precise approach distances from Saudi electricity company.

Figure 16 : Land Constraints (Overhead Power Lines)

4.4.3.1.5. Accessibility (distance to roads)

Site closeness to the road is an important aspect of plant development. It has a direct impact on the final plant development cost and Maintenance. Constructing an access road to the site would be costly. Hence, Easy accessibility to the road should be considered an important criterion.

In this criterion, proximity to roads is required in order to avoid additional costs for building new roads and infrastructures in order to provide transportation for power plant installation.

4.4.3.1.6. Land Constraints (Road)

The Haden Road crosses the initial development area from the West to the east in the diagonal direction with a crossed length of 12 km. Thus, the development area with lower risk proposed within the reference document is divided into two zones.

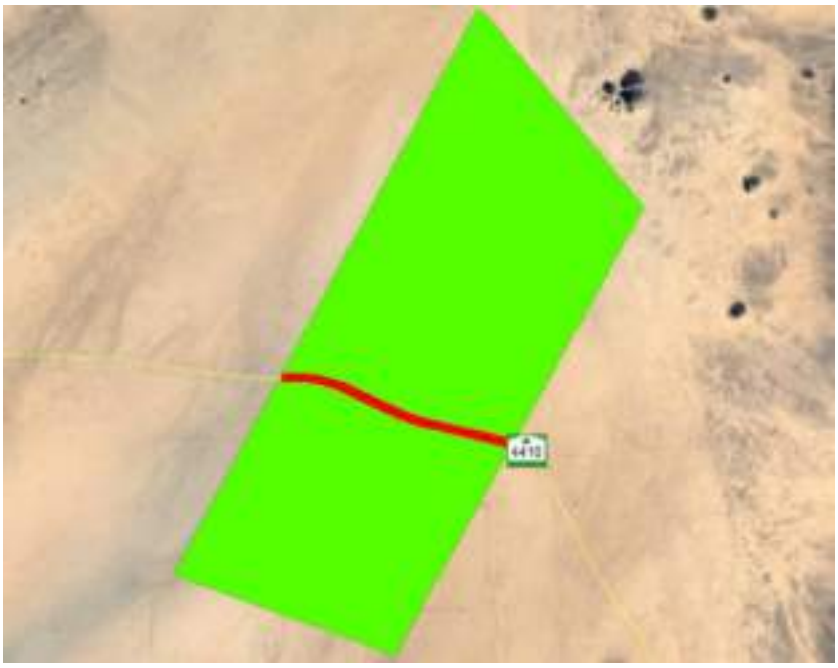


Figure 17 : Land Constraints (Road)

4.4.3.1.7. The community interests (grazing activities)

During the visit to the Haden site, it was observed that there are separate groups of dwellings of what appear to be human groups practicing grazing activity inside and outside the vicinity of the study area.

4.4.3.1.8. Grazing zones

Since the visit was conducted at the end of the summer season and the beginning of autumn, it was noticeable that most of the houses were completely deserted. Since there is no evidence that these dwellings remain deserted all the time, an in-depth study is necessary to know the state of occupancy of these human settlements in the remaining seasons when more favorable conditions are available.

Figure 18: grazing zones

The dwellings identified by aerial imagery Mapbox inside the project are generally medium size scattered individual settlements and distributed in linear pattern northward the high voltage power line. In eastern central zones, no settlements were identified. The count of dwelling is hard to perform due satellite resolution limitations. However, a couple of tens of dwellings were identified, variously mid-size and large size.

The groups' main concentrations are localized nearby the pathway of the power lines. The rationale for such distribution pattern may be to benefit from the easy accessibility offered by the dirt roads constructed during the erection of the power lines. It was also interesting to see there are signs of activities practiced inside the proposed area like irrigated farming and not exclusively herbing. The potential presence of water resources should be useful for the future plant maintenance operations (cleaning of the solar panels).

Figure 19 : Land constraints (Grazing zones)

4.4.3.1.9. Potential social impacts

Regarding the potential impact of the implementation of the solar energy project within the proposed limits, it does not appear that there have profound impacts that may affect the continuation of the grazing activities when associated areas are excluded. Indeed, the pastoral areas themselves do not represent the largest part inside the project boundaries.

However, as the event that these areas need to be evacuated is likely to happen, the socio-economic issue may arise. For the solar plant siting purposes, the issue may be less significant in the event of land alternatives availability for the project development. In any case, social and economic aspects deserve more detailed investigations. Focusing only special distributions based on satellite images is not enough to inform the site selection process.

4.4.3.2. Land use (restriction criterion)

4.4.3.2.1. Military zone

During the Haden site visit, a military zone was observed in the southern region. A restricted military area is an area under military jurisdiction where special security measures are used to prevent unauthorized entry. This zone is dedicated for military training it is used for live firing.

The presence of military warning signs in the southern area. On a concrete floor sign, there is a reference to land ownership from the Ministry of Defense and Aviation which is the old designation of the Ministry of Defense now.

An earth dike along Haden Road two kilometers southwards as if it were a setback distance from the military base. In order to exploit this band of land for solar farm development, it may be necessary to resort to special authorizations.

4.4.3.2.2. Land Constraints (Military zone)

This parameter is important in selecting a site for Solar Power plant, the military area restricts the deployment of the plant between the military fence and Haden Road.

Figure 20 : Land Constraints (Military zone)

4.4.3.2.3. Allocated land for the government future projects

The Haden site includes government lands allocated to future government projects. Indeed, the land is owned by government sectors for:

- Municipal wastewater treatment plant.
- Landfill project.
- A third project not yet specified during the visit.

During the Haden site visit, excavation works can be seen in the western border inside the initial area proposed for the solar plant.

4.4.3.2.4. Land Constraints (Government projects)

The area allocated for the three government projects is approximately 54.7 km² of which 35.6 km² is included in the proposed area for the project. The nearby wastewater treatment plant (WTP) and landfill facility westwards the future power plant may cause environmental issues.

This parameter is important in selecting a site for Solar Power plant, Restriction map contains area allocated for government project.

Figure 21 : Land Constraints (future government projects)

4.4.3.3. Environmental criteria

Since the present study aims to preserve environmental resources and reduce damage to the environment, it excludes the protected areas and sensitive plant species from the selected sites for Solar Power Plant. The land use and biodiversity map were prepared and entered into GIS environment using satellite images.

4.4.3.3.1. Biodiversity

The ecological features reported about the area of Haden project are detailed in the appendix. Although the ecological values of the proposal site should be investigated at a high level, the current stage (the siting process) of the project does not require such in-depth investigations. Indeed, the ecosystem components are not specific to the site project

at local level. The same ecological features were observed everywhere over a couple of thousands of square kilometers in the surrounding areas. No endangered species

Inside the project area boundaries during the site visit, the ecological features are worthy of some comments:

- Flora: trees, shrubs and perennial herbs species are typical of arid climate conditions. The site contains an important number of these species. The area of the land with a high vegetation density does not exceed 2% of the total area of the land proposed for the establishment of the solar farm.
- A clear discrepancy can be seen in the distribution of these species over the site's land. However, the dominant feature is the weak density of vegetation cover. The weak density of the vegetation cover can be explained by the climatic conditions at the time of the visit where perennial herbs are quasi-absent.

There are sharp contrasts between the seasons of the year, as the team of experts had aerial photographs of the site in what appeared to be the spring season, when the dense vegetation cover dominates most of the site. The areas of weak density in both photographs were unchanged. Red-hatched surface represents high-density vegetative cover. The areal imagery from Mapbox seems to be taken during spring season. however, Google earth shows less vegetative cover. The imagery took place in December 2020.

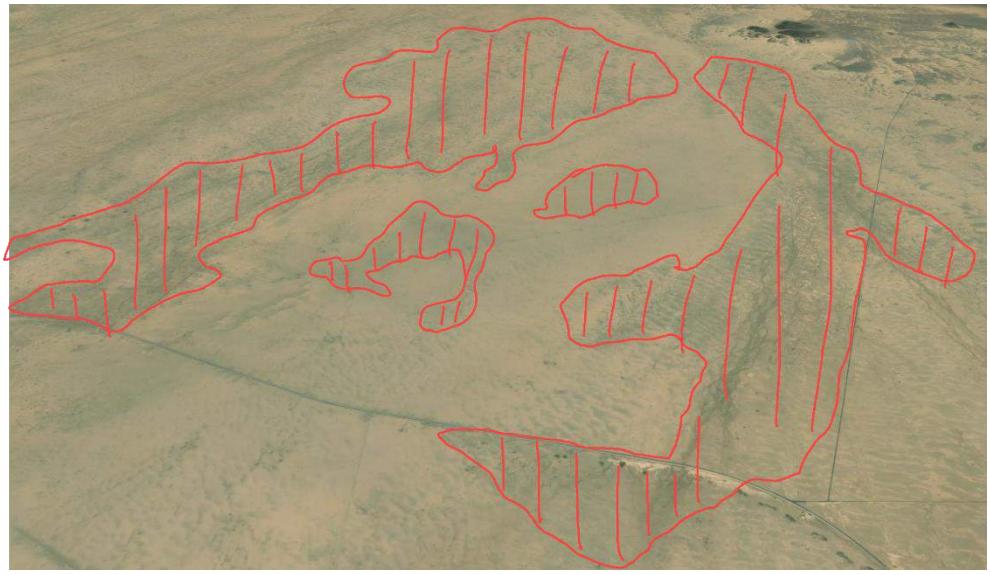


Figure 22 : high dense vegetation area

The areas where moderate to high vegetation cover was identified with Google Earth imagery in the figure below.

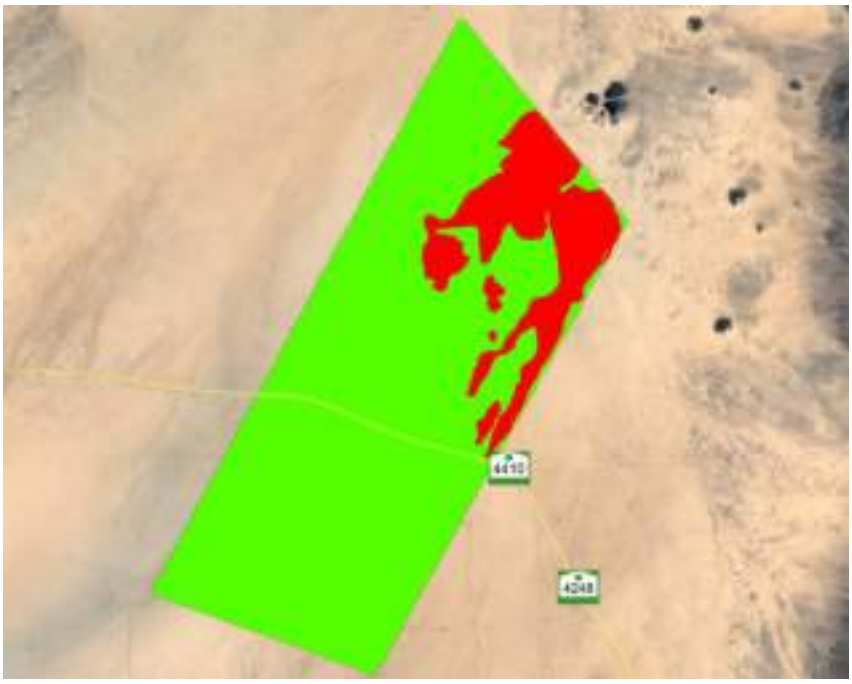


Figure 23 : Land Constraints (Vegetation cover)

4.4.3.3.2. Cultural Heritage

No evidence of cultural/archaeological artefacts, objects or structures have been identified within the site during the site visits. No structures bearing cultural, historical, religious, or spiritual significance are located in the site or in the adjacent areas.

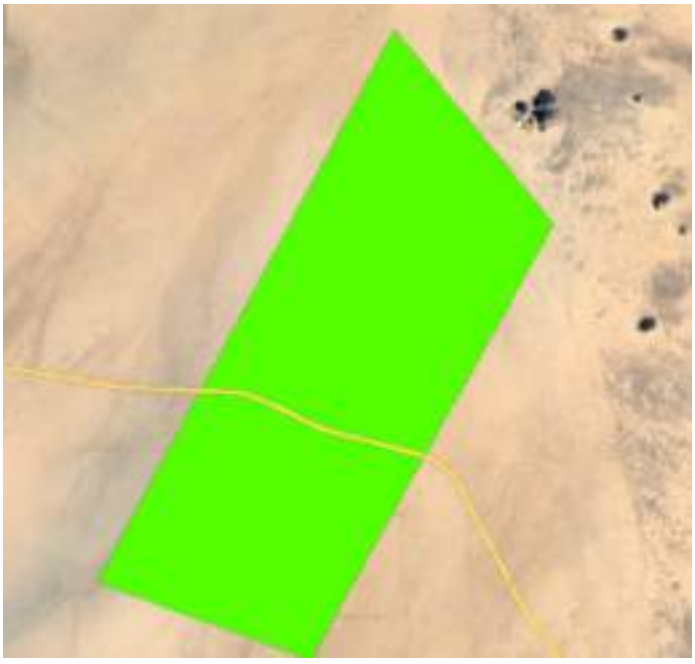


Figure 24 : Land Constraints (Cultural heritage)

4.4.3.3.3. Land use

The nearby wastewater treatment plant (WTP) and landfill facility westwards the future power plant may cause environmental issues. Then, it is worth thinking about the disturbances that will happen when WTP is operating and emitting odors and other nuisances to the power plant operators. Wind blowing predominately from west to east may worsen the situation. The plant siting should include a wind data analysis to inform designer on wind regimes in the project site. As well, a documentary analysis about the third project (the closer to the power plant) which is not specified up to end of the expert team visit should be carried out. The figure below depicts wind W-E direction as of 25 September 2021. The zone (left in the figure) in light red should not be a first-order alternative. Only other constraints predominates unless the facilities in the west executed with technology that drastically reduce their impacts on the neighboring.

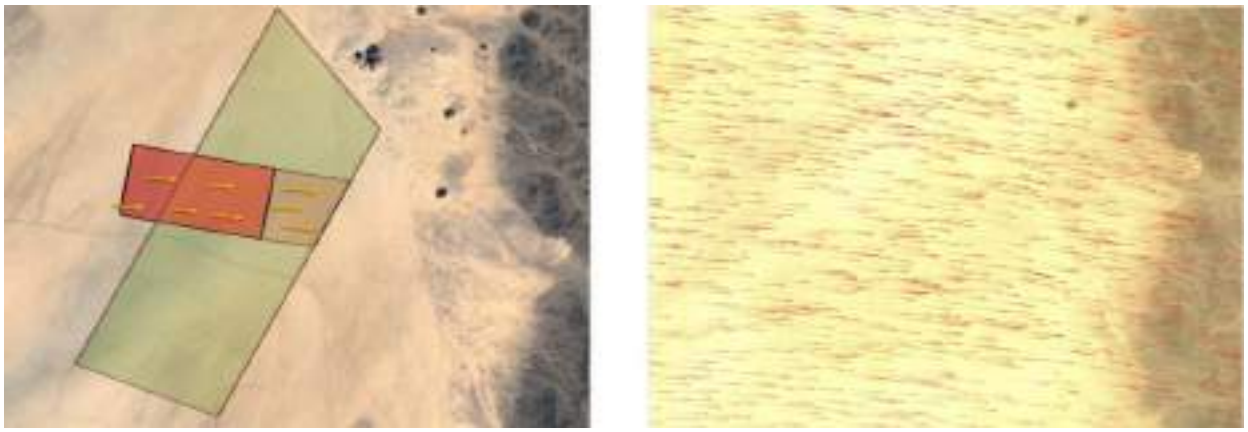


Figure 25 : the prevailing wind direction

4.4.3.4. Technical Criteria

4.4.3.4.1. Slope

Slope and elevation are technical criteria. Slope shows the gradient of land surface, which can be an important factor in civil issues relevant to construction and deployment of solar plant.

The topography of Haden is a basically flat area and limited slopes. Only few spots, probably dunes or mounds are detected.

The most complex area was found at the eastern side. This analysis shows those areas marked predominantly in green will only require minimum earthworks and ground leveling in Haden and the red area is considered as less favorable for Solar power plant projects although still, technically feasible.

Figure 26 : Land Constraints (Slope)

4.4.3.4.2. Local Climate

It is important to analyze the local climate of the proposed site. Condition of the weather has direct impact on the Solar Power Plant performance at any particular location.

4.4.3.4.3. Flash floods risk

In Haden, potential runoffs coming from the hills located to the east of the site present the greatest hydrological risk. These hills are only a few kilometers away and have altitudes of over 1400m, 250m above the elevations found in the site. If a strong flood came to occur, the eastern part of this site would be that most at risk.

To the south of Haden, there are also hills that present similar risks. The water catchment areas to the south are very extensive and can accumulate large water flows as they approach the plant. They are also notably higher which means the higher precipitation levels and faster water speeds can be expected.

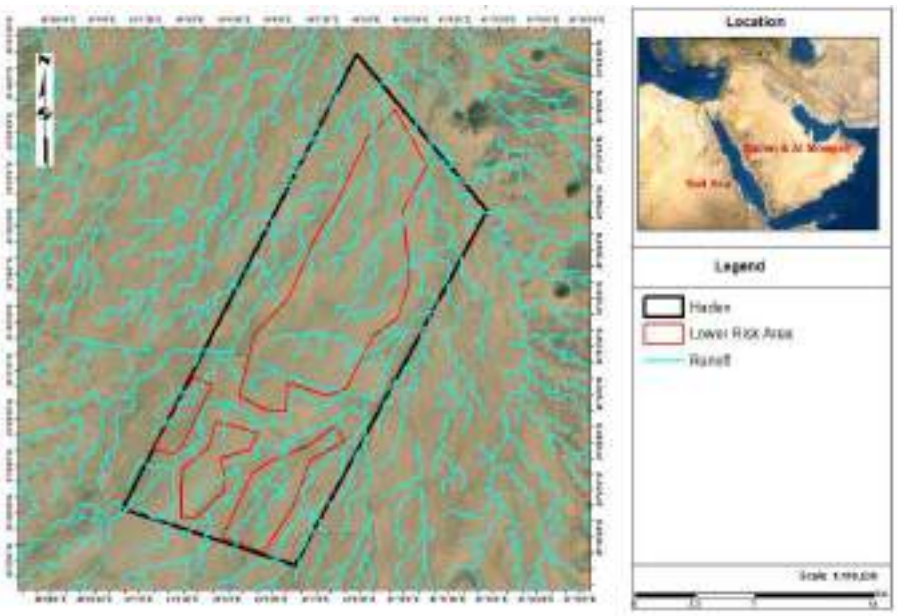


Figure 27 : Haden and its Lower Risk Areas

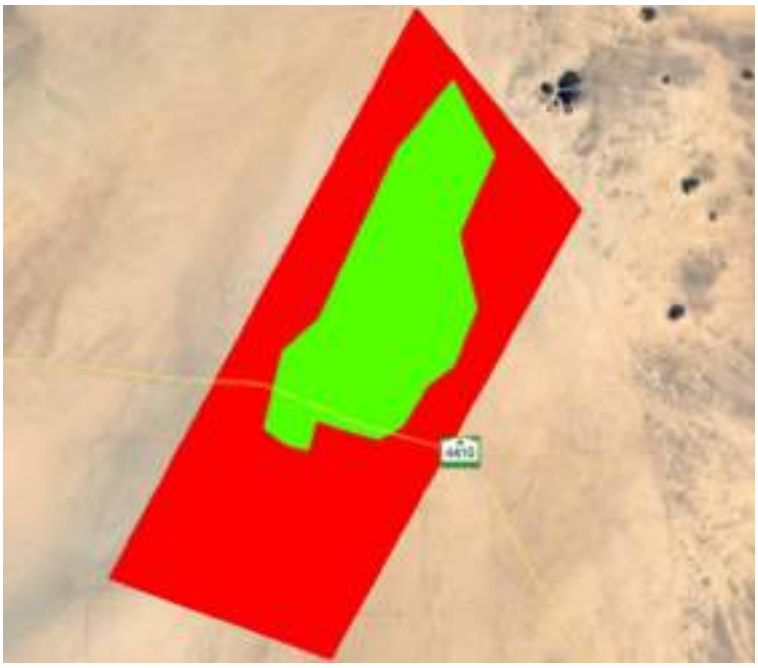


Figure 28 : Lower Risk Flash flood area

4.4.3.4.4. Water Availability

There is a high possibility of module soiling due to dusty weather. Hence clean low mineral water is needed for module cleaning.

4.4.4. The Restricted Areas

A graphical mapping of decisions made during the site selection process are presented as follows:

Table 8: graphical mapping for decision

Factors	Map restriction
Overhead Power Lines	
The Road	
Grazing zones	
Military Zone	

Factors	Map restriction
Government projects	
Biodiversity	To discuss: This restricted area falls on the selected 60 km2 area.
Slope	
Lower Risk Flash flood area	

Factors	Map restriction
Cultural heritage	

4.4.5. Results

The final output of the site selection process performed and illustrated above is obtained by superposition maps. Two alternatives are generated with or without taking into account the zone between Haden Road and the military northern fence.

The site layouts may be established inside light or dark green zones or more conservatively in dark green zones. Some proposals for the power plant layout development are provided.

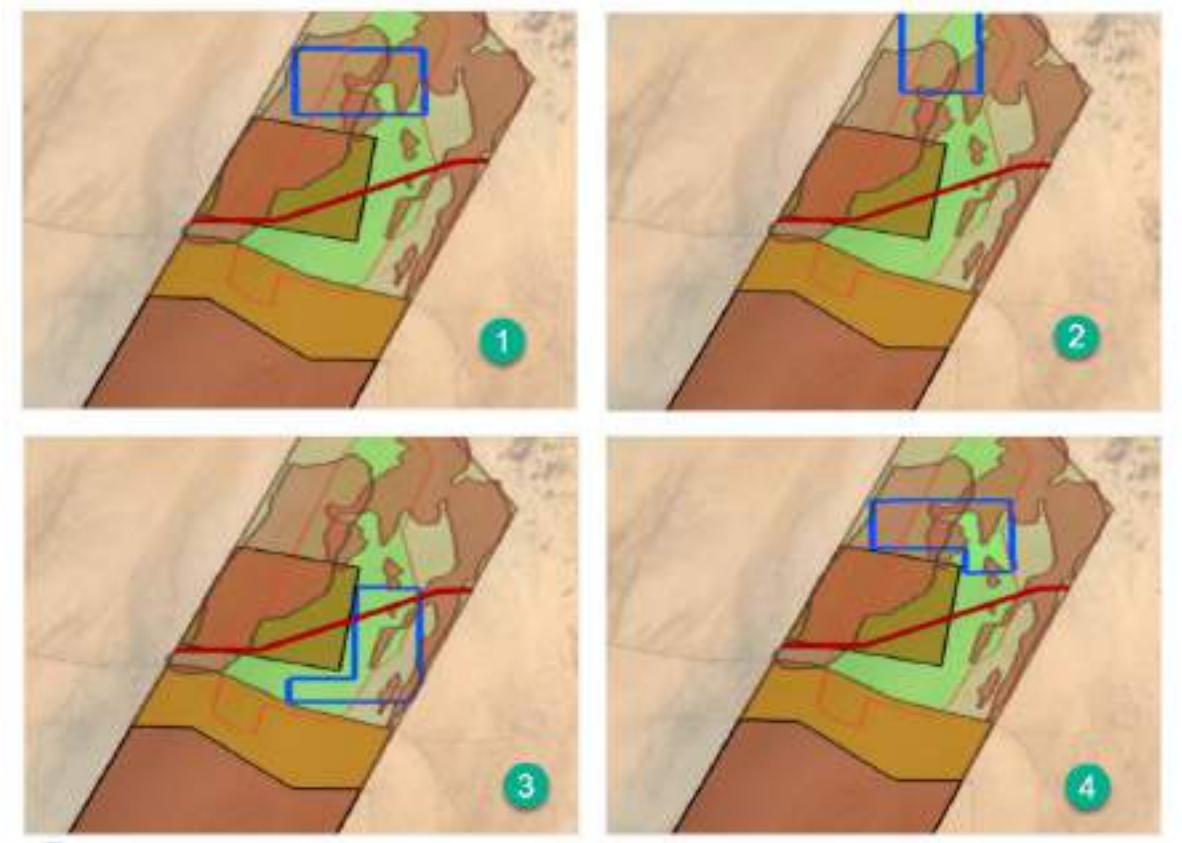


Figure 29: Site alternatives proposal

The mapped alternatives without constraints displayed are provided in the figure below. Because of the high number of constraints, the site alternatives are not so numerous. Some moderate impact constraints have to be left apart. Nevertheless, for the remaining constraints and respective retained alternatives, more detailed investigations should be planned for further design development stages. It is worthy to note that the alternatives maps are build based on satellite imagery and one site visit. In this meaning, the provided maps should take as informative for the next design planning in terms of needs for deeper assessment of constraints.

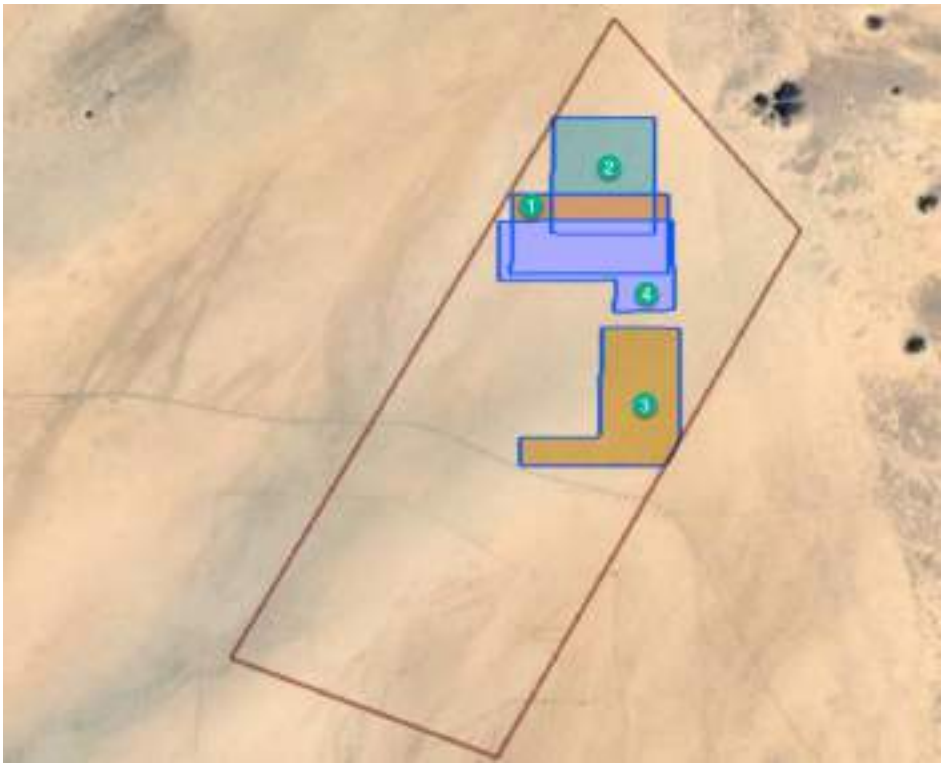


Figure 30 : Selected sites

5. POLICY, INSTITUTIONAL AND LEGAL FRAMEWORK

5.1. Overview

this section explains the legislative basis for the proposed project outlined in the ESIA Report and outlines the following information:

- National environmental law & regulation
- IFC / EP requirements

It provides a summary of the environmental legislative framework relevant to the Kingdom of Saudi Arabia. The legislation, guidelines and standards relevant to the development are used as a basis for screening and evaluating the development's impacts. These guidelines and standards are presented as a summary. The full and most recent legislation will be consulted prior to undertaking the assessment and the implementation of any mitigation or monitoring plans.

The main environmental regulator with responsibility for the terrestrial environmental management of Kingdom of Saudi Arabia's (KSA) is the Ministry of Environment, Water and Agriculture (MEWA).

The National Center for Environmental Compliance (NCEC) is concerned with preserving and protecting the environment, preserving its resources, and preserving it from deterioration, by providing high-quality services that contribute to raising the level of compliance with environmental regulations and standards.

5.2. National regulatory framework

The KSA Law on Environment Impact Assessment and law supporting regulations defines the legal requirements for the EIA procedure.

The first comprehensive Saudi Arabian national environmental legislation was enacted on September 24, 2001, in the form of the General Environmental Regulation, Council of Ministers Resolution No. 193. It entered into force on October 31, 2002, and its implementation rules were published on September 30, 2003.

5.2.1. The Basic Law of Governance

The Basic Law (Royal Decree No. A/90) is commonly referred to as the Constitution of Saudi Arabia. Article 32 of the Basic Law states: "The State works for the preservation, protection and improvement of the environment and for the prevention of pollution".

5.2.2. Public Environment Law 2001 (PEL)

The Public Environmental Law (PEL) was enacted by Royal Decree No.M/34 dated 28/7/1422 H (corresponding to 16 October 2001) and established the general regulatory framework for the development and enforcement of environmental rules and regulations

in the Kingdom of Saudi Arabia. Under this law the General Authority for Meteorology and Environment protection (GAMEP), previously the Presidency of Meteorology & Environment (PME) has been assigned with the responsibility for the development and enforcement of environmental rules and regulations.

The GAMEP is therefore responsible for:

- Conducting environmental studies.
- Documenting and publishing the results of any environmental studies.
- Preparing, issuing and reviewing relevant environmental standards.
- Ensuring compliance with relevant environmental standards.
- Working in conjunction with other governmental agencies, establishing plans to deal with environmental disasters.
- Promoting general awareness for the protection of the environment.
- Environmental monitoring.
- Updating of environmental standards.

5.2.3. General Environmental Regulations and their Rules for Implementation (GERRI)

The General Environmental Regulations and Rules for Implementation were enacted in October 2001 and under this law GAMEP is responsible for issuing consent for projects to ensure compliance with the Public Environment Law and implementing regulations. Under this regulation, any licensing authority must ensure that an ESIA is prepared for any project that may have a negative environmental impact.

In respect to the completion of environmental assessments, particular reference should be made to the GERRI (2001) articles presented in Table below.

Owners of "projects", which are defined as utilities and facilities which may have an effect on the environment, are required to comply with existing and future environmental specifications, standards, measurements and guidelines as promulgated by the General Authority for Meteorology and Environment Protection (GAMEP) previously the Presidency of Meteorology & Environment (PME) and set out in the appendices of the Implementing Rules. Moreover, prior to the setting up of a project, an environmental impact assessment study must be completed and approved by GAMEP.

The detail of the legislation is contained in the appendices of the Implementing Rules, as follows:

- **Appendix 1:** Environmental Protection Standards.
- **Appendix 2:** Fundamentals and Standards for the Assessment of Environmental Effects of Industrial and Development Projects.

- **Appendix 3:** Guide to Environmental Accreditation Procedures.
- **Appendix 4:** Hazardous Waste Control Rules and Procedures.
- **Appendix 5:** National Contingency Plan for Combatting Marine Pollution by Oil and other Harmful Substances in Emergency Cases.
- **Appendix 6:** All Types of Violations and Penalties.

5.2.4. GAMEP (NCEC) Environmental Standards

The GERRI were enacted in October 2001, and Appendix 1 of GERRI outlines the Environmental Protection Standards relevant to facilities in the Kingdom of Saudi Arabia. The GAMEP (2001) General Environmental Protection Standards for New Facilities (Article 7) are outlined as:

- All new major facilities as well as major modifications to existing facilities shall be designed, operated and maintained so as to avoid exceedances of the ambient environmental standards as promulgated for the Kingdom of Saudi Arabia at the time of approval of the design.
- Each new major facility or major modification of an existing facility shall incorporate the best available technology for control of pollutant discharges and for the disposal of wastes resulting from the operation of the facility.
- All new facilities and modifications of an existing facility shall be designed and operated so as to avoid the discharge of any toxic substance, whether specifically regulated or not, in sufficient quantities to be harmful to public health.

In 2012, the GAMEP developed several draft supplementary Environmental Standards revising in part the General Standards for the Environment issued by the GAMEP in Appendix 1 to the GERRI. These Standards are listed in Table below.

Table 9 : GAMEP Environmental Standards

GAMEP Environmental Standard (GAMEP-ES)	Topic
	Material Recovery & Recycling
	Mobile Source Emissions
	Noise
	Air Emissions for Stationary Sources
	Prevention of Major Accidents
	Storage and Material Reclamation Facilities Design and Operation
	Thermal Treatment and Incineration Design and Operation

GAMEP Environmental Standard (GAMEP-ES)	Topic
	Waste Acceptance Criteria
	Waste Classification
	Drinking Water Quality
	Biological Treatment Design and Operation
	Waste Control
	Waste Handling and Storage
	Waste Training
	Waste Transportation
	Landfill Design
	Industrial and Municipal Wastewater Discharges
	Best Practicable Environmental Option for Waste Disposal
	Ambient Air Quality
	Ambient Water Quality

5.2.5. Environment Law, promulgated by Royal Decree No. (M/165) dated 11/19/1441 AH

The first comprehensive Saudi Arabian National Environmental legislation was enacted on 2001 in the form of the General Environmental Regulation. It entered into force on 2002, and its Implementing Rules were published on 2003. The Environment Law, promulgated by Royal Decree No. (M/165) dated 19 Dhu al-Qadah1441 AH (corresponding to 10 July 2020) entered into force on January 2021, superseding the 2001 Regulation.

Under the General Environmental Regulation, the Presidency of Meteorology and Environment (the PME), was charged with the general supervision of environmental affairs in Saudi Arabia and had the responsibility of granting environmental permits. In 2019, the PME's functions and responsibilities were transferred to four Centres for the environment sector development: The National Centre for Environmental Compliance (NCEC), the National Centre for Vegetation Cover and Combating Desertification, the National Centre for Wildlife and the National Centre for Meteorology. **The Ministry of Agriculture was renamed to the Ministry of Environment, Water and Agriculture (MEWA) in 2016, and now handles responsibilities related to environmental sustainability as well**.

The current Environment Law has granted the National Centre for Monitoring Environmental Compliance with full powers to assume the responsibility of protecting the environment in the Kingdom of Saudi Arabia and to issue environmental standards and guidelines, including environmental legislation and standards for various industrial and construction activities. This Law consisting of 49 articles divided into 9 Chapters aims at protecting the environment, its development and sustainability, adherence to environmental principles, and the regulation of the environment sector and related activities and services.

According to Article 8 of the Environmental Law, both the authorized person and the licensee who engage in activities that may emit emissions or pollutants, or that may affect the environment; commit to the following environmental requirements, controls, procedures, and standards; determined by the regulations:

- Take the necessary actions and measures when approaching the environmental standards exceedance as specified by the regulations.
- Develop programs and devices to monitor, measure and control the quality of environmental media, in accordance with the regulations.
- Provide the competent authority - on a regular basis - with data and reports related to emissions or pollutants emanating from its activities; To review and conform them, and to identify violations of standards, and requirements, in accordance with what is specified by the regulations.
- Provide the competent authority with an environmental audit study, as determined by the regulations.
- Rehabilitate environmental environments degraded as a result of the exercise of its activities, as determined by the regulations.

Finally, the Environment Law, after its entry into force, cancels the following Regulations, among others:

- Regulation of Saudi Wildlife Authority, issued by Royal Decree No. (M/22) dated 12/09/1406 AH
- Regulation of Trade in Endangered Wildlife and their products, issued by Royal Decree No. (M/9) dated 03/06/1421 AH
- General Regulations for the Environment, issued by Royal Decree No. (M/34) dated 28/07/1422 AH (GERRI 2001). [*NOTE: As an exception to sub-paragraph of GERRI, the provisions relating to waste contained in the General Environmental Regulation - issued by Royal Decree No. (M/34) dated 7/28/1422 AH - continue until the issuance of its provisions and work accordingly*].

- Law of Protected Areas for Wildlife, issued by Royal Decree No. (M/66) dated 19/10/1436 AH

The Environmental Law is implemented through **Executive Regulations** in different areas including:

- Environmental Inspection and Audit.
- Ozone-depleting Substances and Carbon Compounds.
- Environmental Permits for Establishment and Operation of Activities.
- Environmental Rehabilitation for Degraded Sites and Remediation of Polluted Sites
- Prevention and Treatment of Soil Pollution
- Air Quality
- Control of Violations and Imposition of Penalties
- Noise
- Environmental Services Providers
- Protection of Aquatic Environments from Pollution
- Trade in Wildlife and their Products and Derivates

5.2.6. Law of Antiquities, Museums and Urban Heritage promulgated by Royal Decree M/3 dated 9/1/1436 AH

This law states in Article 9 that:

- Archaeological and urban heritage sites shall be preserved when carrying out projects for planning, expansion, or improvement of urban or rural areas. In addition, easement rights shall be taken into consideration, including designation of construction-free areas, in coordination with the Ministry of Municipal and Rural Affairs. Planning projects, in which, or in the vicinity of which, there are archaeological and urban heritage sites, may not be adopted without the approval of SCTA (Saudi Commission for Tourism and Antiquities).

- Licenses for construction or renovation in areas adjacent to archaeological and urban heritage sites may not be issued without SCTA's agreement

In Article 24 it is stated:

1. Activities may not be carried out within the limits of archaeological and urban heritage sites without the prior approval of SCTA:

a) Whole or partial demolition.

b) Utility, communication, and road works, as well as any activity or process that may change the physical appearance of the archaeological and urban heritage sites, or buildings thereon, or disturb their archaeological layers.

c) new construction or landscaping projects.

2. SCTA shall respond within 60 days from the date of receipt of the application for performing any of the activities set out in paragraph 1 of this Article.

3. Activities set out in paragraph 1 of this Article shall be subject to SCTA's control.

4. SCTA shall, in coordination with the Ministry of Interior and the Ministry of Municipal and Rural Affairs, develop technical and procedural mechanisms for dealing with any dilapidated heritage buildings.

5.2.7. The executive regulations

These Executive Regulations are approved by Ministerial Decision of the Minister of Environment, Water and Agriculture and based on Article 48 of the Environmental Law and Cabinet Resolution No. (729) dated 16/ 11/1441 AH. The following is a brief description of the Regulations that are mainly applicable to the project:

5.2.7.1. Executive Regulations for Environmental Permits for Establishment and Operation of Activities

According to the Executive Regulations for Environmental Permits for Establishment and Operation of Activities, the provisions of this Regulations shall apply to all persons who own or operate any activity that has an environmental impact (new or existing) within the territory of the Kingdom including establishment, modification, addition, expansion or closure.

The National Centre for Environmental Compliance is entrusted with the following tasks:

- Issuing technical standards and controls related to environmental impact assessment studies in coordination with the competent environmental centres.
- Receiving and reviewing environmental classification forms and environmental impact assessment studies and issuing relevant decisions.
- Issuing up-to-date indicative lists to classify the various activities in accordance with the provisions of the regulation.
- Defining and approving the rules, conditions and controls related to environmental permits and licenses.
- Carrying out field visits to the sites required to be authorized, when needed.
- Monitor the implementation of the environmental management plan during all phases of any environmentally authorized activity.
- Request and review self-monitoring reports during construction and operation processes.
- Issuing and renewing environmental permits and licenses and collecting the fees specified for them.

- Monitoring and supervising the implementation of the requirements of environmental permits and licenses.
- Inspection, monitoring and detection of violations of these Regulations; Coordination with the competent authority at the Ministry of Interior when needed with regard to the work of arresting violators.
- Coordination with other national environmental centres whenever the activity or studies presented are related to the competencies or powers of these centres.
- Coordination with laboratories, scientific and research centres and experts whenever the need arises when reviewing environmental impact assessment studies.
- Ensure that all environmental impact assessment studies, analyses, tests and environmental measurements contained in these studies are provided by a service provider licensed by the Centre.

The NCEC categorizes or revises the classification of activities according to environmental impacts into categories specified in this regulation as follows:

- Type and volume of activity.
- Energy used.
- Activity depletion of natural resources.
- Land uses.
- Sensitive receptors in areas surrounding the activity.
- The characteristics of environmental impacts, including:
- The nature of the effects (negative or positive, direct or indirect, cumulative…etc).
- The range of the effects.
- Duration of effects.
- The ability of effects to be reversible and return to normal before effects.
- The possibility of effects.
- Level/level of impacts (global - regional - local).

The head of the Centre shall issue updated indicative lists to classify the various activities in accordance with the provisions of the regulations.

Activities are classified into three categories according to the environmental impacts resulting from them and accordingly, their need to conduct an environmental impact assessment study or not. This classification shall be as follows:

- First category: Activities that are expected to cause minimal impacts on the environment that do not exceed the limits of the activity site.
- Second category: Activities that are expected to cause moderate impacts on the environment through the different phases of the activity and these effects can be

reduced and controlled and they do not significantly exceed the limits of the activity site.

- Third category: Activities that are expected to cause significant environmental and social impacts. These impacts exceed the boundaries of the activity site and may negatively affect the sustainability of sensitive areas and receptors.

Referring to the Environment Law, promulgated by Royal Decree No. (M/165) dated 19 Dhu al-Qadah1441 AH (corresponding to 10 July 2020) and based on NCEC decision the PV solar plant of Haden project is classified as a Category Three which calls for a comprehensive environmental impact assessment.

An environmental permit will be required before starting any construction or modification of the activity and to operate before operating or practicing any activity.

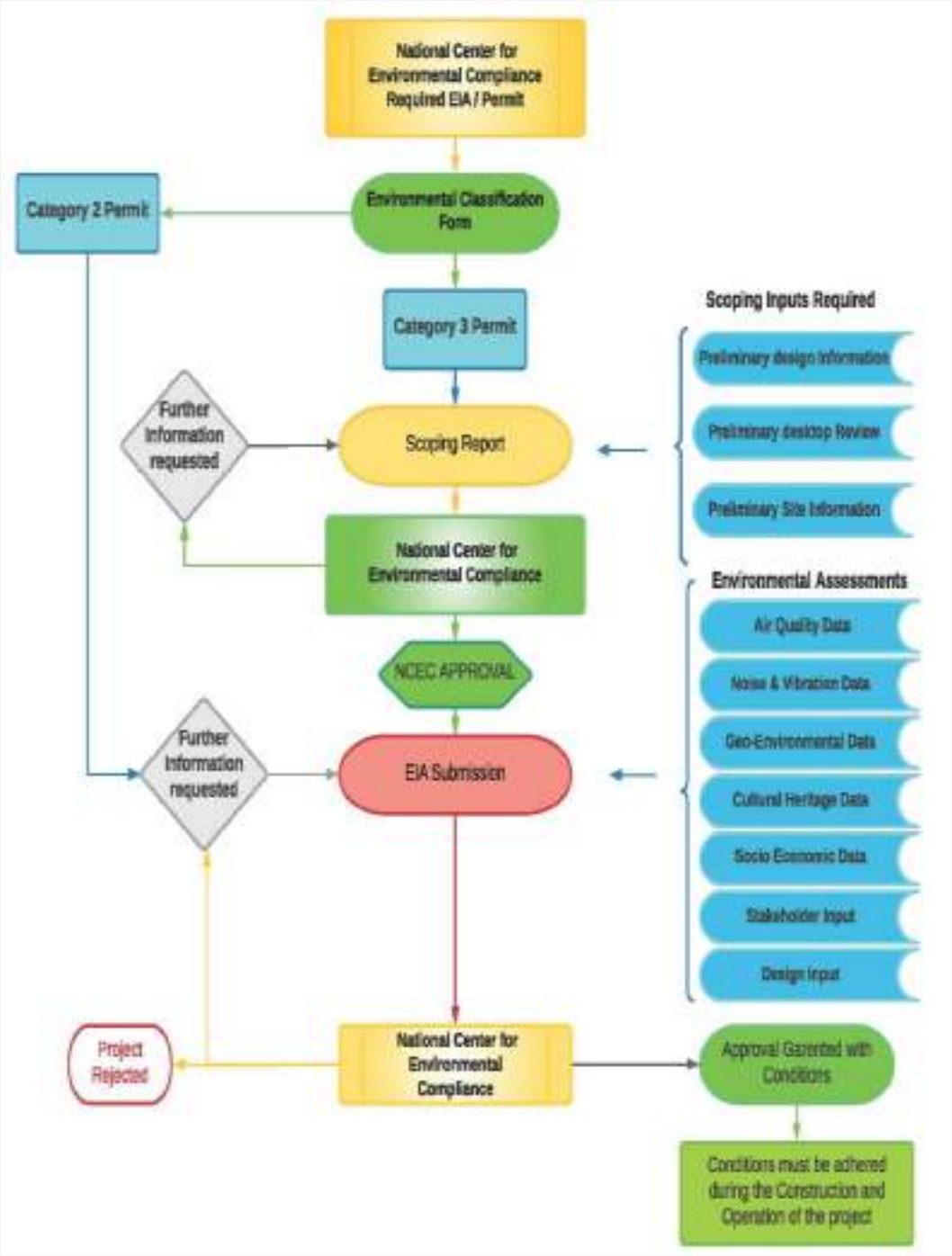


Figure 31 : NCEC EIA Flow process

5.2.7.2. The executive regulation for Environmental Inspection and Audit

According to the Executive Regulations for Environmental inspection and audit, the provisions of this Regulations shall apply to all persons who own or operate any activity that has an environmental impact (new or existing) within the territory of the Kingdom including establishment, modification, addition, expansion or closure.

The National Centre for Environmental Compliance is entrusted with the following tasks:

- Preparing the methodology for environmental inspection for different activities based on the international best practices
- Prepare and implement an annual environmental inspection plan
- Inspect, control and penalties
- Inspection, Control and Detecting violations of the environmental law or executive regulations and coordinating with the competent authority at the Ministry of Interior when needed with regard to security monitoring work and arresting violators
- Reviewing people's environmental self-inspection reports and ensuring environmental compliance and the effectiveness of approved self-inspection programs
- Preparing requirements and controls related to environmental audit studies
- Reviewing reports of environmental audit studies and issuing relevant decisions
- Follow up the commitment of people to implement what is stipulated in the environmental self-inspection reports, environmental audit study reports, and action plans to implement corrective measures
- Issuance of environmental compliance certificates
- Coordination with other national environmental Center when needed with regard to inspection work whenever the submitted reports and plans are related to the competencies or powers of these Center.

Environmental inspection are classified into 5 categories. This classification shall be as follows:

1- Periodic inspection: It is carried out in accordance with the annual plans for environmental inspection in order to verify compliance with the rules and regulations and requirements of licenses and permits.
2- Environmental emergency inspection: It is carried out after the occurrence of any emergency to ensure that all corrective and precautionary measures have been taken.
3- Inspection to verify the validity of reports and data: It is carried out to verify the correctness of the information provided through reports and data submitted to the center
4- Inspection upon receiving environmental complaints or communications: Execution is carried out after receiving complaints or reports to the center and based on what the center decides that the complaints or communications require inspection.

5- Inspection in partnership with the relevant authorities: In the event of the formation of committees from several specialized bodies working to study any cases related to the environment sector, emergency or environmental disaster related to all participating parties, or at the request of the supervisory authority.

The center conducts the inspection by sending specialized inspectors to:

- review records and data and keep copies of them
- Take pictures for documentation
- Carry out any operations required for inspection/examination/measurement/or testing
- Take samples of materials / soil / water.
- Ensure that the environmental management plan is implemented
- Detecting violations and taking action
- Document the results of the inspection process and providing companies with a copy of it to take the necessary corrective measures

Environmental auditing

According to the Executive Regulations for Environmental inspection and audit, both the authorized person and the licensee who engage in activities that may emit emissions or pollutants, or that may affect the environment; commit to provide the competent authority with an environmental audit study, as determined by the regulations in case of renew the environmental permit to construct or to operate or if required from the center.

5.2.7.3. The Executive Regulation for Control of Violations and Imposition of Penalties

This regulation sets out the method and procedures for detecting violations of environmental law and regulations, investigating, and proving them by the inspectors. They may request assistance and support from the security authorities when needed.

Anyone who violates the obligations of law or regulations, as indicated in the penalties tables attached to the regulations, shall be punished.

The violator must remove the consequences of the violation and rehabilitate the environment in accordance with the requirements and standards set by the competent authority (Violations are seized by writing a seizure report that includes information on the location, date, details, time of seizure, the names of the violators, their nationalities, and their identification numbers, …etc.)

5.2.7.4. The Executive Regulation for Prevention and Treatment of Soil Pollution

The Executive Regulations for Prevention and Treatment of Soil Pollution establish the provisions related to soil and its protection from pollution Including preventive measures to prevent pollution and treat soil after pollution. They include "Standards for protecting soil from pollution" in its Annex (1). The table included in Annex 1 is shown below:

Table 10 : Standards for protecting soil from pollution

Parameter	Unit	Value
PH	PH Unit	8,5
Cyanide (free)	mg/kg	8
Fluoride	mg/kg	2,000
Sulphur (elemental)	mg/kg	500
Metals		
Antimoney	mg/kg	40
Arsenic (inorganic)	mg/kg	26
Barium (non-barite)	mg/kg	2,000
Barite - Barium	mg/kg	140,00
Beryllium	mg/kg	8
Boron (Standard Phase extract)	mg/kg	5
Cadmium	mg/kg	22
Chromium (Hexavelent)	mg/kg	1,4
Chromium (Total)	mg/kg	87
Cobalt	mg/kg	300
Copper	mg/kg	91
Lead	mg/kg	600
Mercury (Inorganic)	mg/kg	50
Molybdenum	mg/kg	40
Nickel	mg/kg	89
Selenium	mg/kg	2,9
Silver	mg/kg	40
Thallium	mg/kg	1
Tin	mg/kg	300
Uranium	mg/kg	300
Vanadium	mg/kg	130
Zinc	mg/kg	360
Organic		
Benzene (C6H6)	mg/kg	0,046

Parameter	Unit	Value
Toluene (C7H8)	mg/kg	0,52
Ethylebenzene	mg/kg	0,073
Xylenes	mg/kg	0,99
Styrene	mg/kg	0,68
F1 (C6 to C10)	mg/kg	640
F2 (C10 to C16)	mg/kg	520
F3 (C16 to C24)	mg/kg	4,300
F4 (C24 to C50)	mg/kg	10,000
Acenapthene (C12H10)	mg/kg	0,32
Anthracene (C14H10)	mg/kg	0,0046
Fluoranthene (C16H10)	mg/kg	0,032
Fluorene (C13H10)	mg/kg	0,29
Naphthalene (C10,H8)	mg/kg	0,014
Phenanthrene (C14H10)	mg/kg	0,051
Pyrene (C16H10)	mg/kg	0,034
Carcinogenic (PAHs	mg/kg	1
Benz[a]anthracene (C18H12)	mg/kg	0,07
Benxo[b+j]fluoranthene	mg/kg	
Benzo[k]fluoranthene (C20H12)	mg/kg	
Benxo [a]payrene (C20H12)	mg/kg	0,7
Chrysense (C18H12)	mg/kg	
Vinyl chloride (C2H3Cl)	mg/kg	0,014
1,1-Dichloroethene (C2H3,Cl2)	mg/kg	0,15
Trichloroethene (Trichloethylene, TCE)	mg/kg	0,054
Tetrachloroethene (C2Cl4)	mg/kg	0,26
1,2-Dichloroethane (C2H4Cl2)	mg/kg	0,15
Dichloromethane (Methylene chloride)(CH2Cl2)	mg/kg	0,1
Trichloromethane (Chloroform)(CHCL3)	mg/kg	0,0029
Tetrachloromethane (Carbon tetrachloride)(CCl4)	mg/kg	0,027
Dibromochloromethane (CHBr2Cl)	mg/kg	0,91
Chlorobenzene (C6H5Cl)	mg/kg	0,61
1,2-Dichlorobenzene (C6H4Cl2)	mg/kg	0,097
1,4-Dichlorobenzene (C6H4Cl2)	mg/kg	0,051
1,2,3-Trichlorobenzene (C6H3Cl3)	mg/kg	0,26
1,2,4-Trichlorobenzene (C6H3Cl3)	mg/kg	0,78
1,3,5-Trichlorobenzene (C6H3Cl3)	mg/kg	1,9
1,2,3,4-Tetrachlorobenzene (C6H2Cl4)	mg/kg	0,042

Parameter	Unit	Value
1,2,3,5-Tetrachlorobenzene (C6H2,Cl4)	mg/kg	0,37
1,2,4,5-Tetrachlorobenzene (C6H2Cl4)	mg/kg	0,19
Pentrachlorobenzene (C6HCl5)	mg/kg	3,7
Hexachlorobenzene (C4Cl2)	mg/kg	3,6
2,4-Dichloropheneol (C6H4Cl2O)	mg/kg	0,0029
2,4,6-Trichlorophenol (C6H2Cl3OH)	mg/kg	0,19
2,3,4,6-Tetrachlorophenol (C6H3Cl4O)	mg/kg	0,039
Pentachlorphenol (C6HCl5O)	mg/kg	0,024
Dioxins & Furans	mg/kg	0,000004
Polychlorinated biphenyl (PCBs)	mg/kg	33
Aldicarb (C7H14N2O2S)	mg/kg	0,041
Aldrin (Cl2H8Cl6)	mg/kg	5,9
Atrazine and metabolites	mg/kg	0,0077
Azniphos-methyl (C10PN3H12S2O3)	mg/kg	0,41
Bendiocarb (C11H13NO4)	mg/kg	0,14
Bromacil (C9H13BrN2O2)	mg/kg	0,009
Bromoxynil (C7H3Br2NO)	mg/kg	0,044
Carbaryl (C12H11NO2)	mg/kg	1,9
Carbofuran (Cl2H15NO3)	mg/kg	0,68
Chlorothalonil (C8Cl4N2)	mg/kg	0,0084
Chlorpyrifos (C9H11Cl3NO3PS)	mg/kg	49
Cyanazine (C9H13ClN6)	mg/kg	0.12
2,4-Dichlorophenoxyacetic acid (C8H6Cl2O3)	mg/kg	0.43
Dichlorodiphenyltrichloroethane (C14H9Cl5)	mg/kg	12
Diazinon (C12H21N2O3PS)	mg/kg	2,2
Dicamba (C8H6Cl2O3)	mg/kg	0,5
Dichlofop-methyl (C16H14Cl2O4)	mg/kg	2
Dieldrin (C12H8Cl6O)	mg/kg	0,59
Dimethoate (C5H12NO3PS2)	mg/kg	0,0058
Dinoseb (C10H12N2O5)	mg/kg	2,7
Diquat (C12H12Br2N2)	mg/kg	11
Diuron (C9H10Cl2N2O)	mg/kg	1,9
Endosulfan (C9H6Cl6O3S)	mg/kg	0,0013
Endrin (C13H8Cl6O)	mg/kg	2,4
Glyphosate (C3H8NO5P)	mg/kg	0,054
Heptachlor epoxide (C10H5Cl7O)	mg/kg	0,039
Lindane (C6H6Cl6)	mg/kg	0,31

Parameter	Unit	Value
Linuron (C9H10Cl2N2O2)	mg/kg	0,051
Malathion (C10H19O6PS2)	mg/kg	0,82
MCPA	mg/kg	0,42
Methoxychlor (C16H15Cl3O2)	mg/kg	0,046
Metolachlor (C15H22ClNO2)	mg/kg	0,048
Metribuzin (C8H14N4OS)	mg/kg	0,024
Paraquat (as dichloride)	mg/kg	1,1
Parathion (C10H14NO5PS)	mg/kg	7,2
Phorate (C7H17O2PS3)	mg/kg	0,075
Picloram (C6H3Cl3N2O2)	mg/kg	0,024
Simazine (C7H12ClN5)	mg/kg	0,033
Tebuthiuron (C9H16N4OS)	mg/kg	0,6
Terbufos (C9H21O2PS3)	mg/kg	0,08
Toxaphene (C10H8Cl8)	mg/kg	3,3
Triallate (C10H16Cl3NOS)	mg/kg	0,0077
Trifluarin (CC13H16F3N3O4)	mg/kg	0,038
Aniline (C6H5NH2)	mg/kg	0,36
Bis (2-ethyl-hexyl)phathalate (C24H38O4)	mg/kg	34
Dibutyl phthalate (C16H22O4)	mg/kg	0,54
Dichlorobenzidine	mg/kg	4,2
Diethanolamine (C4H11NO2)	mg/kg	2
Diethylene glycol (C4H10O3)	mg/kg	10
Diisopropanolamine (C6H15NO2)	mg/kg	14
Ethylene Glycol (C2H6O2)	mg/kg	60
Hexachlorobutadiene (C4Cl6)	mg/kg	0,036
Methanol CH3OH	mg/kg	37
Methylmethacrylate (C5H8O2)	mg/kg	1,3
Monoethanolamine (C2H7NO)	mg/kg	20
Methyl tert-butyl ether (MTBE)	mg/kg	0,044
Nonylphenol + ethoxylates	mg/kg	14
Phenol)C6H6O)	mg/kg	0,0028
Sulfolane ((CH2)4SO2)	mg/kg	0,18
Triethylene glycol (C6H14O4)	mg/kg	100
Radionuclides		
Uranium -238 Series (all progeny)	Bq/kg	0,3
Uranium - 238 (238U, 234Th, 234mPa, 234U)	Bq/kg	10
Thorium-230	Bq/kg	10

Parameter	Unit	Value
Radium -226(in equilibrium with its progeny)	Bq/kg	0,3
Lead-210 (in equilibrium with 210 Bi and 210 Po)	Bq/kg	0,3
Thorium-232 Series (all progeny)	Bq/kg	0,3
Thorium-232	Bq/kg	10
Radium-228 (in equilibrium with 228AC)	Bq/kg	0,3
Thorium-228 (in equilibrium with its progeny)	Bq/kg	0,3
Potassium-40	Bq/kg	17

5.2.7.5. Executive regulations for the protection of aquatic environments from pollution

The Ministry of Environment, Water and Agriculture announced the start of implementing the executive regulations for the protection of aquatic environments from pollution in all regions of the Kingdom, based on the environment system issued by Royal Decree No. (M/165) dated 11/19/1441 AH.

The ministry explained that the regulation applies to all persons and activities related to aquatic environments and aims to define the scope of the work of the National Center for Controlling Environmental Compliance with regard to protecting aquatic environments from pollution, by proposing standards, controls and requirements, and preparing and implementing plans aimed at reducing pollution of aquatic environments.

Mitigating its effects, proposing programs, studies and research related to aquatic environments, periodic monitoring and evaluation of environmental indicators, determining the procedures and measures to be taken when people approach exceeding standards related to aquatic environments, approving rules and requirements related to licenses or permits for environmental works or activities that have environmental impacts, and issuing Permits and licenses, collecting the financial compensation, organizing various activities for environmental guidance, in addition to inspection and control of violations, imposing penalties, and coordinating with the concerned authorities to enforce the regulation.

The Executive Regulations for the protection of aquatic environments from pollution establish the provisions related to water (coastal waters, Surface water and underground water) and its protection from pollution Including preventive measures to prevent pollution. They include "Ambient water quality standards" in its Annex (1).

5.2.7.6. Standards and specifications for types of water

This standard stems from the water law issued by Royal Decree No. (M/159) dated 11/11/1441 AH, and from its objectives related to this regulation are the following:

1- Ensuring the provision of safe, clean, reliable, high quality and competitive water supplies at reasonable competitive prices, achieving justice among consumers, with each person having access to water to meet his needs.
2- Enhancing the participation of the private sector in the activities subject to the law and promoting effective governance.
3- Every person has access to clean, safe, water that conforms to the approved specifications; to satisfy his natural needs, based on justice; In accordance with approved standards, plans and programs.

The standards establish the provisions related to required effluent quality for restricted and unrestricted use. This includes the following:

- Standards for the quality of unbottled drinking water
- Non-potable water quality standards
- Treated wastewater quality standards
- Commercial wastewater quality standards- to municipal collection systems
- Sludge standards

5.2.7.7. The executive regulation for Air Quality

The Executive Regulations for Air Quality establish the provisions related to air quality and its protection from pollution. They include "Air Quality Standards for Basic Pollutants" in its Annex (1) and "Air Quality Standards for Hazardous Pollutants" in its Annex (2), excluding accidents and natural conditions such as dust storms, forest fires, volcanoes, etc. and cases decided by the Centre related to accidents and internal disasters. Table included in Annex 1 is shown below:

Table 11 : Air Quality Standards for Basic Pollutants contained in Annex 1 of the Executive Regulations for Air Quality of the current Environmental Law

Pollutant	Measurement micrograms/m^3 (µg.m-3) *[1]	Permissible transgressions	Average time
Carbon Monoxide CO	40,000	Once a year	hour
	10,000	Twice a month	8 hours
Nitrogen dioxide NO_2	200	24 per year	hour
	100	-	annual
Sulphur dioxide SO_2	441	24 per year	hour
	217	3 per year	24 hours
	65	-	annual
Ozone O_3[2]	157	25 days annually, averaged over 3 years	8 hours
suspended particles (<10 µm) PM_{10}[3]	340	12 per year	24 hours
	50	-	annual
suspended particles (<2.5 µm) $PM_{2.5}$[4]	35	12 per year	24 hours
	15	-	annual
Lead in suspended particles Pb (in TSP)	0.15	Average over 3 months with no irregularities	3 months

The table above provides the relevant values for each important air quality parameter for the executive air quality regulation 2020. The executive air quality regulation 2020 are straightforward and apply to all circumstances. However, the IFC standards require a

[1] Values are based on a standard temperature of 25°C and a pressure of 1 atmosphere.

[2] To calculate the 8-hour ozone value and to assign it to the appropriate day, the following rule is applied: The maximum daily concentration for 8 hours must be determined by checking the running averages for 8 hours, calculated from the hourly data and updated hourly. Each average 8 hours calculated is assigned to the day it expires, meaning that the first calculation period for any day will be the period from 5 pm on the previous day to 1 am of the day. The last calculation period for any day is from 4 after noon to 12 o'clock at night.

[3,4] Calculation of excesses: The contributions from natural sources can be assessed by measurements, modelling, and remote sensing. These contributions are subtracted from the air quality monitoring results, thus calculating exceedances.

certain level of interpretation due to various 'interim' and 'guideline' values being specified rather than fixed limits. The WHO guidelines provide interim targets for countries that still have very high levels of air pollution to encourage the gradual cutting down of emissions.

5.2.7.8. The executive regulation for noise

The provisions of the Noise Executive Regulations shall apply to all persons in residential, commercial, industrial, and environmentally sensitive areas, roadsides, and construction sites; It does not include indoor noise.

Emissions from the different operating areas of the project must comply with the standards of operational noise as described in the environmental standards of noise allowed in proximity of roads.

Table 12 : Noise limits near roads area

Evening time (dB)	Daytime (dB)
65	70

The table below shows the exceptions to the application of the permissible noise limits. The National Center for Environmental Compliance also specifies any other exceptions it deems appropriate.

Table 13 : permissible noise limits exceptions

Notes	Exceptions
all the time	Prayer call
all the time	military activities
all the time	Airports, commercial and private aircraft, including helicopters
all the time	Railways
During operational activities	commercial port activities
during festivals	Festivals
Subject to the evaluation of the center	Major disruptions, emergencies or closures
Subject to a permit as specified by the regulations	Excesses allowed by the center

The provisions of the Executive Regulations for Noise shall apply to all persons in residential, commercial, industrial, and environmentally sensitive areas, roadsides, and construction sites, not including indoor noise. Article 4 contains the Measurements of Noise Levels for residential and commercial areas, including the following categories:

a. includes low-density residential areas in addition to iconic areas, including tourist attractions and recreational parks, and areas around hospitals, schools and homes for the elderly, nurseries, and environmentally sensitive areas
b. Includes residential areas of medium density
c. Includes high-density residential areas and areas that include a mixture of residential and commercial activities
d. Includes commercial areas, including warehouses and financial centres.

It is not permitted to exceed the noise levels established for residential and commercial areas, except with the permission of the NCEC, which are shown in the next table:

Table 14 : Measurement noise levels for residential and commercial areas

Category	Daytime $L_{Aeq,T}$ (dB)	Night-time $L_{Aeq,T}$ (dB)
A	50	40
B	55	45
C	60	50
D	65	55

Article 7 sets the limits for permitted noise levels at construction sites so that the noise level standards set out in this Regulation are allowed to be exceeded during construction works from 7 am to 6 pm, as indicated in the following table:

Table 15 :Corrective limits for permitted noise levels at construction site

Duration of the construction activities	Correction of permitted noise limits LAeq, T (dB)
Up to 2.5 hours	10
2.5 to 8 hours	5
Above 8 hours	0

5.3. International standards

5.3.1. International Finance Corporation (IFC) Performance Standards

Given that the project is likely to attract private sector finance, it is assumed that an ESIA would need to assess the environmental impacts in accordance with the International Finance Corporation (IFC) Performance Standards. For projects located in non-OECD countries (as is the case for KSA), the ESIA should refer to the IFC Performance Standards and IFC Environmental Health and Safety Guidelines, which provide general and sector specific guidance.

All IFC projects or projects where IFC Performance Standards (updated 2012) are adhered to must meet with the following Performance Standards on Environmental and Social Sustainability:

- **Performance Standard 1**: Assessment and Management of Environmental and Social Risks and Impacts.
- **Performance Standard 2**: Labour and Working Conditions.
- **Performance Standard 3**: Resource Efficiency and Pollution Prevention.
- **Performance Standard 4**: Community Health, Safety and Security.
- **Performance Standard 5**: Land Acquisition and Involuntary Resettlement.
- **Performance Standard 6**: Biodiversity Conservation and Sustainable Management of Living Natural Resources.
- **Performance Standard 7**: Indigenous Peoples; and
- **Performance Standard 8**: Cultural Heritage.

In addition to meeting the requirements under the Performance Standards, projects must also comply with applicable national laws, including those laws implementing host country obligations under international law.

The IFC has prepared a series of Environmental Health and Safety Guidelines, which provide general and sector specific guidance. These documents provide details of the required levels and considerations when undertaking an ESIA for a project. The following would specifically be referred to as part of the preparation of an ESIA for the project:

- IFC General EHS Guidelines (2007);
- IFC EHS Guidelines for Tourism and Hospitality Development (2007);
- IFC EHS Guidelines for Electric Transmission and Distribution
- IFC EHS Guidelines for Waste Management Facilities
- IFC EHS Guidelines for Water and Sanitation

On applying these Guidelines, the IFC expect that when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance level protects human health and the environment.

5.3.2. Equator Principles

In October 2002, the IFC convened a meeting of banks in London to discuss environmental and social issues in project finance. It was decided to try to develop a

banking industry framework for addressing environmental and social risks in project financing. This led to the drafting of the Equator Principles. On June 4th, 2003, 10 banks from seven countries signed up to the Equator Principles, a voluntary set of guidelines for assessing and managing environmental and social risks in project financing. To date, in excess of 60 financial institutions operating in more than 100 countries worldwide have adopted the Equator Principles. As a result, the Equator Principles have become the industry standard for addressing environmental and social issues. During March to May 2006, the Equator Principles Financial Institutions (EPFIs) engaged in a substantive review of the Equator Principles. The revised principles became effective from July 6th, 2006, although have recently been superseded by a third revision on 4th June 2013. This revision is referred to as 'Equator Principles III' (EP III).

The EPs are updated periodically. The latest iteration, EP4, was released on 18 November 2019. It came into effect for all EPFIs on 1 October 2020. This revision is referred to as 'Equator Principles 4 (EP 4).

EP 4 ensures a strengthened framework for both social and environmental aspects and will result in benefits for Equator Principles Financial Institutions e.g. improved transparency in reporting, and focus on emerging social and environmental concerns.

The key points to note are as follows:

- The Equator Principles apply to all new project financing that has a total capital cost of $10 million or more across all industry sectors (the previous threshold was $50 million);
- For projects with potentially significant social and environmental impacts (Category A and B), the borrower must complete and disclose a Social and Environmental Assessment (EIA) (previously called an Environmental and Social Impact Assessment). The EIA must now comprise a detailed assessment of social and environmental impacts including labor, health and safety; and
- In the context of the project, the EIA report must address the relevant potential impacts and risks.

The Equator Principles is a risk framework for identifying, assessing and managing environmental and social risks in project finance transactions. This framework is based on the IFC Performance Standards and the World Bank Group EHS Guidelines. Equator Principles Financial Institutions (EPFIs) have adopted the Equator Principles in order to ensure that the Projects financed are developed in a manner that is socially responsible and reflects sound environmental management practices. The principles comprise a set of ten broad principles that are underpinned by the environmental and social policies, standards and guidance of the IFC. The Equator Principles are as follows:

- Principle 1: Review and Categorization.
- Principle 2: Environmental and Social Assessment.
- Principle 3: Applicable Environmental and Social Standards.
- Principle 4: Environmental and Social Management System and Action Plan.
- Principle 5: Stakeholder Engagement.
- Principle 6: Grievance Mechanism.
- Principle 7: Independent Review.
- Principle 8: Covenants.
- Principle 9: Independent Monitoring and Reporting; and
- Principle 10: Reporting and Transparency.

When a Project is proposed for financing, the EPFI is required to categorize the Project based on the magnitude of its potential risks and impacts. This screening is undertaken using the following categorization scheme of the IFC:

- **Category A**: Projects with potential significant adverse environmental social risks and/or impacts that are diverse, irreversible, or unprecedented.
- **Category B**: Projects with potential limited adverse environmental social risks and/or impacts that are few, generally site-specific, largely reversible and readily addressed through mitigation measures; and
- **Category C**: Project with minimal or no adverse environmental and social risks and/or impacts

PV Solar plant Project is considered to be a **Category A** project.

5.3.3. Project commitments with IFC Ps

This ESIA report has been conducted in accordance with the requirements of the NCEC as well as the IFC Performance Standards as far as practicable (See Tables below).

Table 16 : IFC Performance Standards

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
Performance Standard 1	Assessment and Management of Social and Environmental Risks and Impacts. Requirements: Environmental and Social Management System (ESMS): a methodological approach to managing environmental and social risk and impacts in a structure way on an ongoing basis. The ESMS will incorporate: (i) policy; (ii) identification of risks and impacts; (iii) management programmes; (iv) organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (vii) monitoring and review. Objectives: • To identify and evaluate environmental and social risks and impacts of the project. • To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and	The first comprehensive Saudi Arabian National Environmental legislation was enacted in 2001 in the form of the General Environmental Regulation. It entered into force on 2002, and its Implementing Rules were published on 2003. The Environment Law, promulgated by Royal Decree No. (M/165) dated 19 Dhu al-Qadah1441 AH (corresponding to 10 July 2020) entered into force on January 2021, superseding the 2001 Regulation. Under this regulation, any licensing authority must ensure that an ESIA is prepared for any project that may have a negative environmental impact.	The following documents demonstrate adherence to this Performance Standard: • Environmental and Social Impact Assessment (ESIA); • Environmental Monitoring Management Plan (EMMP); • and ESIA Socio- economic Chapter. • Emergency Response Plan (EERP); (in construction phase) • Stakeholder Engagement Plant (SEP) EPC Contractor will establish an ESMS relevant to the Project and support any ongoing management and reporting as required. EPC Contractor will use the ESMS to manage the implementation of the actions necessary to meet the applicable requirements of all Performance Standard.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	impacts to workers, Affected Communities, and the environment. • To promote improved environmental and social performance of clients through the effective use of management systems. • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.		
Performance Standard 2	Labor and Working Conditions Requirements are outlined for: Working Conditions and Management of Worker Relationship; Protecting the Work Force; Occupational Health and Safety; Workers Engaged by Third Parties; Supply Chain. Objectives: • To promote the fair treatment, non-discrimination, and equal opportunity of workers.	Royal Decree No. M/51 Labor Law (2005) is the principal legislation defining the Occupational Health and Safety rights of all workers within Saudi Arabia. The law seeks to provide the guiding principles for workers' rights in terms of pay, welfare, working hours and conditions and access to healthcare. The most relevant chapters and articles relating to Health and Safety are detailed below.	The ESIA identify and assesses potential impacts that the proposed project could pose on workers' health and conditions as well as proposing measures to manage and monitor them.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	• To establish, maintain, and improve the worker-management relationship. • To promote compliance with national employment and labour laws. • To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain. • To promote safe and healthy working conditions, and the health of workers. • To avoid the use of forced labour.	Part VI – Work conditions and circumstances provides the regulations for pay, working hours, leave and rest periods. • Chapter 2 (Articles 98 – 100) set out the guidelines for working hours, which seeks to ensure that workers do not work more than 8 hours a day (40 hours per week), either through regular working patterns, or through averaging across a three week period for shift workers. Working hours are reduced for the period of Ramadan. • Chapter 3 (Articles 101 - 108) define the daily and weekly resting periods for all workers, including the provision of time for prayer, minimum rest times, and meals. • Chapter 4 (Articles 109 - 118) provide the relevant guidance for the provision of annual and sick leave, including the regulations for remuneration. • Part VIII - Protection against occupational hazards, major industrial accidents and work injuries, and health and social services, is the principal section related to the protection of the health of workers. • Chapter 1 (Articles 121 – 126) define the general level requirements on employers to protect workers from occupational hazards.	

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
		• Chapter 2 (Articles 127 – 131) define the employers responsibilities for the prevention of major accidents. • Chapter 3 (Articles 132 – 141) define the rights of employees in the event of work injury or workplace induce disease, including remuneration. • Chapter 4 (Articles 142 - 148) define the employers duties to provide health and social facilities for workers, including the provision of first aid facilities, access to medical supplies, and welfare facilities including prayer rooms. In particular article (147) states:	
Performance Standard 3	Resource Efficiency and Pollution Prevention Requirements are outlined for: Resource Efficiency (Greenhouse Gases and Water Consumption); and Pollution Prevention (General, Hazardous Materials Management and Pesticide Use and Management) Objectives: • To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote more sustainable use of resources, including energy and water. • To reduce project related GHG emissions.	• Law of Preservation of Water Resources • Law of the National Commission for Wildlife Conservation and Development • Environmental Law • Forest and Pasture Law The Regulations aim to achieve the following: • Preserve, protect and develop the environment and prevent its pollution. • Protect public health from activities and acts that harm the environment.	The ESIA documents how potential impacts on human health and the environment were identified and assessed. The ESIA specifically identifies and describes the assessment of the key strategic and technological alternatives that have been considered for the Project, and the integration of best available techniques (BAT) principles within the facility design in order to minimize significant impacts.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
		• Conserve and develop natural resources and rationalize their use. • Include environmental planning as an integral part of overall development planning in all industrial, agricultural, architectural and other fields; and • Raise awareness in environmental issues and strengthen individual and collective feelings of responsibility for preserving and improving the environment and encouraging national voluntary efforts in this field.	
Performance Standard 4	Community Health, Safety and Security Objectives: • To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non- routine circumstances. • To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights	health law of 1423 AH Article Three: The kingdom works to provide health care and is concerned with the public health of the community in a way that ensures living in a healthy environment, and this includes in particular the following: 1 - The safety and suitability of drinking water. 2 - Safety and purification of sewage. 3- Safety of food handled.	The ESIA identify and assesses potential impacts that the proposed Project could pose on workers and community's health as well as proposing measures to manage and monitor them.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	principles and in a manner that avoids or minimizes risks to the Affected Communities.	4- Safety of medicines, drugs and medical supplies in circulation, and monitoring of their use. 5- Protecting society from the effects of the dangers of drugs and intoxicants. 6- Protecting the country from epidemics. 7- Protecting the environment from the dangers of all kinds of pollution. 8- Setting health requirements for the use of public places. 9 - Spreading health awareness among the population.	
Performance Standard 5	Land Acquisition and Involuntary Resettlement. • To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. • To avoid forced eviction. • To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost4 and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.	Law of Eminent Domain and Temporary Taking of Property Article 2 : The agency owning the project shall prior to initiating the expropriation proceeding verify that the site designated for the project has no state-owned real property sufficient for constructing the project.	The MoE has been allocated the Government land for the Project. The ESIA identifies and addresses potential impacts resulting from changes to access to the land upon which the Project is to be built. Due to the nature of the Project site location and land ownership, no assessment of resettlement is required as part of the ESIA.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	♦ To improve, or restore, the livelihoods and standards of living of displaced persons. ♦ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure5 at resettlement sites.		
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources. Objectives: • To protect and conserve biodiversity. • To maintain the benefits from ecosystem services. • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.	The National Biodiversity Strategy for the Kingdom of Saudi Arabia A sectoral document aiming at introducing the conservation and sustainable use of biodiversity into the national planning process; providing the basic information and a significant contribution to the Convention on Biological Diversity ratified by Saudi Arabia. Because the Strategy covers many issues, its effective implementation requires a high level of political support as well as coordination between government, non-governmental organization, and the private sectors.	The ESIA documents how potential impacts biodiversity and living natural resources were identified and assessed. the ESIA specifically identifies the existing ecological status of the site and describes the assessment of potential impacts to the biodiversity, habitats, and ecosystem services as a result of the Project as well as proposing mitigation measures to manage and monitor them.
Performance Standard 7	• Indigenous Peoples. • Objectives : • To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples.	Statute of Human Rights Commission Under this regulation, a body called (the Human Rights Commission) is established directly linked to the Prime Minister and aims to protect and promote human rights in accordance with international human rights standards in all fields, raise awareness of them, and contribute to ensuring the implementation of this in light of the	the ESIA describes the assessment of potential impacts that the proposed Project could pose to indigenous peoples that may inhabit the region. The baseline assessment identifies no indigenous peoples occupying the land, but notes expatriate herders are found tending livestock.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	• To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. • To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. • To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life cycle. • To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. • To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.	provisions of Islamic Sharia. It is the governmental body competent to express opinion and advice on human rights issues.	
Performance Standard 8	Cultural Heritage. Objectives: • To protect cultural heritage from the adverse impacts of project activities and support its preservation.	Law of Antiquities All immovable and movable antiquities located in the Kingdom, or in the marine areas under its sovereignty or legal jurisdiction, are considered public property	the ESIA describes the assessment of potential impacts that the proposed Project could pose to cultural or archaeological heritage as a result of the Project.

IFC Performance Standards		Local regulation requirement	OBSERVATION /RESOLUTION
	• To promote the equitable sharing of benefits from the use of cultural heritage.	of the state, with the exception of the following: 1 - Fixed antiquities whose owners prove their ownership before the competent authorities. 2- Movable antiquities registered by their owners with the Authority. 3- Movable antiquities that the Authority does not deem necessary to register. Anyone who owns a movable antiquity shall submit it to the Authority for registration within two years from the date this system comes into force.	

5.3.4. Project commitments with equator principle

Equator Principles		Observation	Responsibility
Principle 1	Review and Categorization Categorization of the project based on the magnitude of its potential risks and impacts in accordance with the environmental and social screening criteria of the International Finance Corporation (IFC). The categories are:	Classification of the project under the environmental law is confirmed by the NCEC, although following the ESIA classification forms, the Project is considered to be a Third Category. It is anticipated that the Equator Principle Financial Institutions (EPFIs) will categorize the project as a Category A project.	MoE obtain the classification of the project under the environmental law and confirmed by NCEC.

Equator Principles		Observation	Responsibility
	Category A – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented; **Category B –** Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures2; and **Category C –** Projects with minimal or no adverse environmental and social risks and/or impacts.		
Principle 2	Environmental and Social Assessment Assessment process to address to the EPFI's satisfaction, the relevant environmental and social risks and impacts of the proposed Project. The Assessment Documentation should also propose measures to minimise, mitigate and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project.	The **ESIA Scoping Report** identified the relevant environmental and social risks and impacts of the proposed Project. Informed by the ESIA Scoping Report, the **ESIA** was completed to assess all aspects of the project including utilities and infrastructure.	MoE assigns a subcontractor to prepare an ESIA report.

Equator Principles		Observation	Responsibility
	For Category A projects the Assessment Documentation includes an Environmental Impact Assessment (ESIA).		
Principle 3	Applicable Environmental and Social Standards Compliance with host country legislation / permits is required to be addressed in the first instance, For Projects located in Non-Designated Countries, the assessment is required to evaluate compliance with the respective IFC Performance Standards and World Bank Group EHS Guidelines. For Projects located in Designated Countries, the relevant host country laws, regulations and permits apply.	Saudi Arabia is a Non-Designated Country; therefore, the assessment process outlined in this ESIA evaluates compliance with the IFC Performance Standards and EHS Guidelines. Where NCEC Regulations are more stringent however, these have been applied.	ESIA will be submitted to NCEC in order to obtain the required permit and to be in compliance with KSA regulation.
Principle 4	Environmental and Social Management System and Action Plan An ESMS to be developed and maintained by the Client for all Category A and B Projects. An Environmental and Social Management Plan is also required to address issues raised in the	EPC contractor will establish and maintain an ESMS. this ESIA report includes an **Environmental Management & Monitoring Plan (EMMP)** developed to address and manage the environmental aspects and impacts related to the construction, commissioning, and	An ESMS will be prepared and continue to be developed by EPC contractor for the life of the Project.

Equator Principles		Observation	Responsibility
	Assessment and incorporate actions required to comply with the applicable standards.	operation of the Project. The EMMP is considered appropriate as an ESMP. It is anticipated that all applicable standards will have been met to the satisfaction of the EPFI. However, if it is deemed necessary by the EPFI to prepare an Action Plan (AP) to address any gaps identified, EPC Contractor will work with the EPFI to resolve this.	
Principle 5	Stakeholder and Engagement For all Category A and Category B Projects, effective stakeholder engagement must be demonstrated as an on-going process in a structured and culturally appropriate manner with affected communities and where appropriate other stakeholders. For projects with environmental or social risks and adverse impacts, disclosure should occur early in the Assessment process, in any event before the Project construction commences, and on an ongoing basis.	The Stakeholder Engagement Plan (SEP) outlines the approach to be taken in supporting the communications and engagement objectives, processes and deliverables required to support successful delivery of the project. It also identifies the range of people and organizations that may be regarded as stakeholders in the Project and describes the strategy to be used for engaging with these stakeholders in a culturally appropriate manner. The SEP will be prepared and continue to be developed by EPC contractor for the life of the Project.	The SEP will be prepared and continue to be developed by EPC Contractor for the life of the Project.

Equator Principles		Observation	Responsibility
Principle 6	Grievance Mechanism For all Category A and, as appropriate, Category B Projects, the client will, as part of the ESMS, establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.	The Stakeholder Engagement Plan (SEP) provides an Action Plan which initiates a grievance mechanism for use during the life of the Project. This will be developed further and maintained by EPC Contractor during all phases of the Project.	The Grievance Mechanism will be prepared and continue to be developed by EPC Contractor for the life of the Project.
	Independent Review For all Category A and, as appropriate, Category B Projects, an independent Environmental and Social Consultant not directly associated with the client will carry out an Independent Review of the Assessment Documentation including the ESMP, ESMS and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance.	An Independent Technical (ENVIRONMENT) Advisor will be appointed to the project. The EPFI to advise if further Independent Reviewers are appropriate for the (Category A) Project.	EPC contractor will assign the expert as an Independent Reviewer.
Principle 8	Covenants The client will covenant in the financing documentation: to comply with all relevant host country environmental and	The ESIA will provide the initial documentation to demonstrate compliance with the appropriate regulations as well as commitments related to the outline plans	EPC Contractor will establish and maintain an ESMS relevant to the Project and support any on-going management and reporting as required by the EPFI.

Equator Principles		Observation	Responsibility
	social laws; regulations and permits to comply with the ESMP and AP (where applicable), to provide periodic reports to the EPFI demonstrating compliance, and to decommission facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.	developed for environmental management and decommissioning/closure.	
Principle 9	Independent Monitoring and Reporting To assess Project compliance with the Equator Principles and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFIs will for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFIs.	The EPFI to determine the appropriate requirements for independent monitoring and reporting for the (Category A) Project.	EPC Contractor will assign the expert to verify its monitoring information which would be shared with the EPFIs.
Principle 10	Reporting and Transparency For all Category A and, as appropriate, Category B Projects.	EPC Contractor may disclose the Assessment Documentation (e.g. Executive Summary of the ESIA) online for this Category A Project.	EPC Contractor responsibility

Equator Principles		Observation	Responsibility
	• The client will ensure that, at a minimum, as summary of the ESIA is accessible and available online • The client will publicly report GHG emission levels during the operational phase for Projects emitting over 100,000 tons of CO2 equivalent annually. • The EPFI will encourage the client to share commercially non-sensitive Project-specific biodiversity data with the Global Biodiversity Information Facility13 (GBIF) and relevant national and global data repositories, using formats and conditions to enable such data to be accessed and re-used in future decisions and research applications.	The Project is not expected to emit more than 100,000 tonnes of CO2 equivalent annually; therefore, annually reporting of such emissions will not be required.	

6. ENVIRONMENTAL AND SOCIAL BASELINE

This section presents environment, ecological and socio-economic baseline of the study area for the proposed 2000-megatwatt solar power project in Haden, in Governorate of Turbah, Makkah Province.

6.1. Context

Baseline refers to the physical, biological, cultural and human conditions that will prevail in the absence of the project, including interactions amongst them. Establishing baseline helps in understanding the prevailing environmental, ecological and socio-economic status of the study area. It provides requisite information of the biophysical and social environment for decision makers to take appropriate measures regarding the project.

Establishing baseline provides the background environmental and social conditions for prediction of the future environmental characteristics of the area before setting up of the project. It also helps in environmental and social management planning and provides a basis to finalize a strategy for minimizing any potential impact due on surrounding environment due to setting up of the project.

This section establishes the baseline environmental, ecological and socio-economic status of the proposed solar power site and surrounding area to provide a context within which the impacts of the proposed solar power project are to be assessed.

6.2. Baseline study methodology

An AH environment consultant office, comprising of environment, biodiversity, hydrology, and social experts undertook multiple site visits to understand the site setting, environmental and social sensitivities, baseline data collection and to identify the relevant local stakeholders. The activities undertaken during the site visits has been summarized below:

- Identification of key social and environmental risks/receptors in the study area.
- Understanding of prevailing community engagement processes.
- Understanding aspects of community health and safety, if any, linked to the proposed Project.
- Understanding land-based impacts, livelihood impacts, cultural heritage issues.
- Understanding significance of impacts on biodiversity and natural resource management; and
- Consultations with the local communities and focused group discussions in the vicinity to understand their views and concerns of the Project.

Environmental baseline data was collected through primary monitoring and surveys of the study area. Secondary information through literature surveys was also collected for the study area of the Project.

The primary baseline study undertaken by an accredited laboratory included the following.

- Ambient air quality monitoring at 3 locations within the study area.
- Ambient noise quality monitoring at 3 locations within the study area.
- Soil quality covering different land uses at 10 locations: and

The details of environmental and social baseline conditions in the study area are provided below in this section.

6.3. Environment Baseline

Environmental baseline data was collected through available literature and studies related to the project area and site surveys. baseline data collection involved identifying and collecting available published material and documents containing information on various environmental aspects like soil, geology, hydrology, drainage, ecology etc.

A brief description of the existing physical environment within the project site is detailed in the sections below.

6.3.1. Land Use and Land Cover

Land use/ cover inventories are an essential component in land resource evaluation and environmental studies due to the changing nature of land use patterns in the AoI. Based on site visits and observations from maps and satellite images it is understood that there is no current land use of the project site.

6.3.2. Climate and Meteorology

The project site is located 200 km from the Red Sea, 1000 km from the Arabian Gulf, and 1000 km from the Gulf of Aden. This area belongs to Governorate of Turbah which belongs in turn to Makkah al Mukarramah province.

The climate of Makkah-Al-Mukarramah Province is characterized by a desert climate in the east and a marine climate in the west, with long hot summers and short mild winters. The distribution of weather elements in Makkah Al-Mukarramah is generally due to the areas of altitude and latitude of convergence and horizontal divergence in the atmosphere, the marine or continental origin of the prevailing air masses, the seasonal shift in the region's pressure and the wind regime. The local convective system, which results from daytime surface heating, causes variation in the annual distribution of weather elements.

6.3.2.1. Temperatures

Temperature in Makkah-Al-Mukarramah province varies slightly during an entire year. the hottest period is April to October, the coldest period is from November to March.

The temperature of Makkah-Al-Mukarramah is fairly representative of the plain strip of land at the eastern coast of Red Sea with continental plain at the observatory and marine climates at Jeddah having hot long summers and warm short winters. The mean monthly temperature of Makkah-Al-Mukarramah is 31.6˚C and the maximum mean monthly temperature is about 36.4˚C and minimum of 24.8 ˚C. The area has moderate temperature in winter, when the mean monthly temperature drops to 26.9˚C (December to March) and hot in summers, when it rises up to or above 35 degrees Celsius (April to October). The highest mean monthly temperature of the area is above 36˚C from June to September with a maximum of 43˚C in July and minimum of 29˚C in July to September, respectively and being hottest months of the Observatory. The lowest mean monthly temperature of 24.8˚C with 30.7˚C maximum and 19˚C minimum temperature recorded in January and constitutes as a coldest month of the area (see table).

Table 17 :Temperatures in Makkah Al-Mukarrmah province

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Medium temperature (°C)	24.8	25.8	28.3	31.7	35	36.4	36	36.3	36	33.2	29.4	26.4
Max temperature (°C)	30.7	32.1	35.1	38.7	42.1	43.9	43	42.8	42.9	40.2	35.5	32.3
Min temperature (°C)	19	19.5	21.5	24.7	27.8	28.9	30	29.7	29	26.2	23.2	20.5

6.3.2.2. Rainfall

The climate in Makkah-Al-Mukarramah province is called a desert climate. There is virtually no rainfall all year long in this region. The Köppen-Geiger climate classification is BWh. In a year, the total rainfall is 130 mm, most of which falls on a few days or even occurs on one day each year between October and May. Most of the precipitation falls in January, averaging 43 mm. The driest month is June. There is 0 mm of precipitation in June.

The month with the highest number of rainy days is January (3.87 days). The month with the lowest number of rainy days is July (0.10 days).

Table 18 : Rainfall in Makkah Al-Mukarrmah province

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (mm)	13.2	9.1	3.1	11.6	3.9	1	3.9	9.8	14.6	6.2	7.5	5.5

Number of rainy days	4	1	1	2	2	0	0	1	1	2	2	2

6.3.2.3. Relative humidity

The month with the highest relative humidity is December (59 %). The month with the lowest relative humidity is June (32.4 %)

Table 19 : Relative humidity in Makkah Al-Mukarrmah province

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Relative Humidity (%)	57.9	54.3	48	42.7	36.4	32.4	34	39.4	44.8	49.9	57.3	59

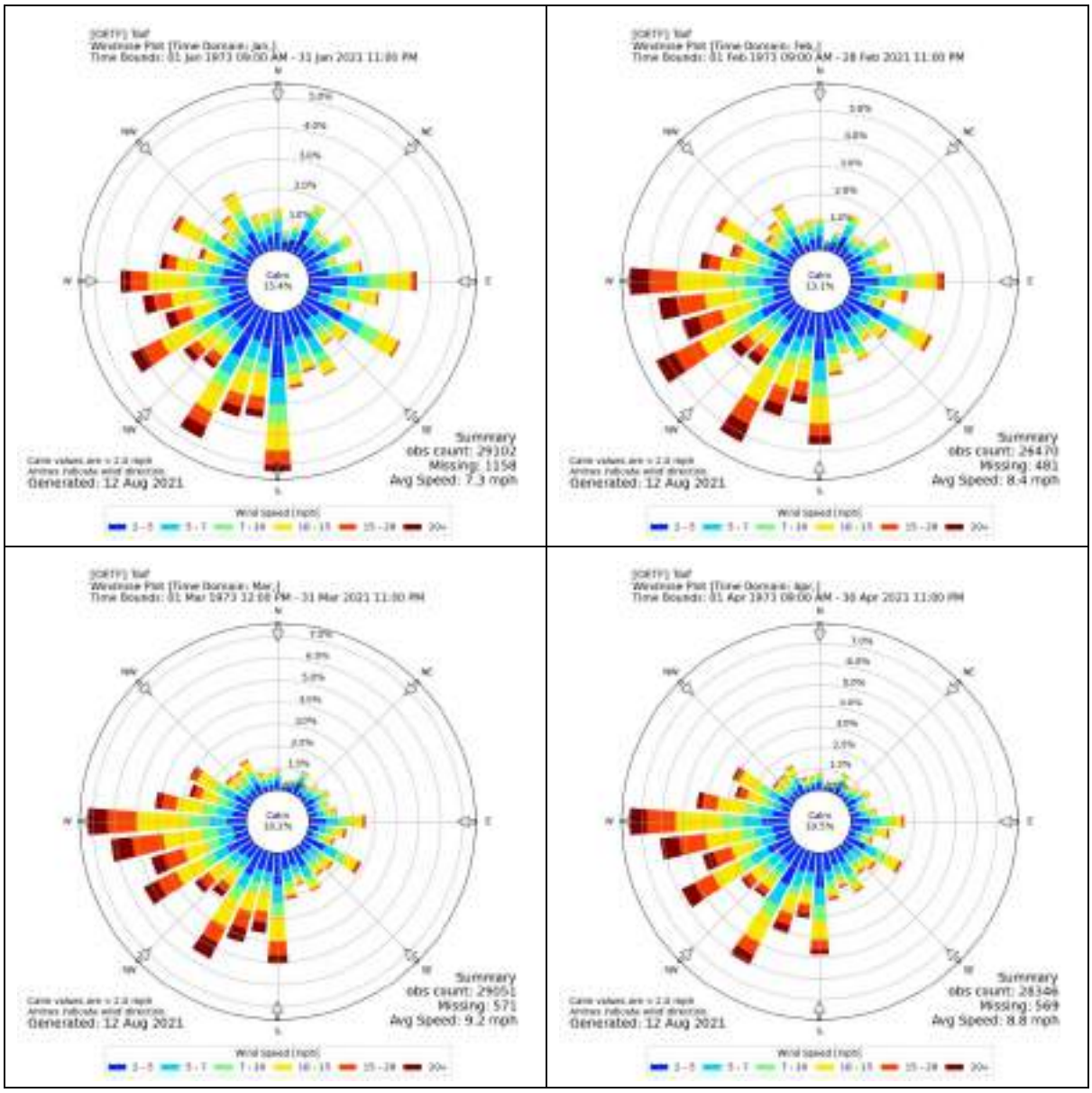
6.3.2.4. Wind

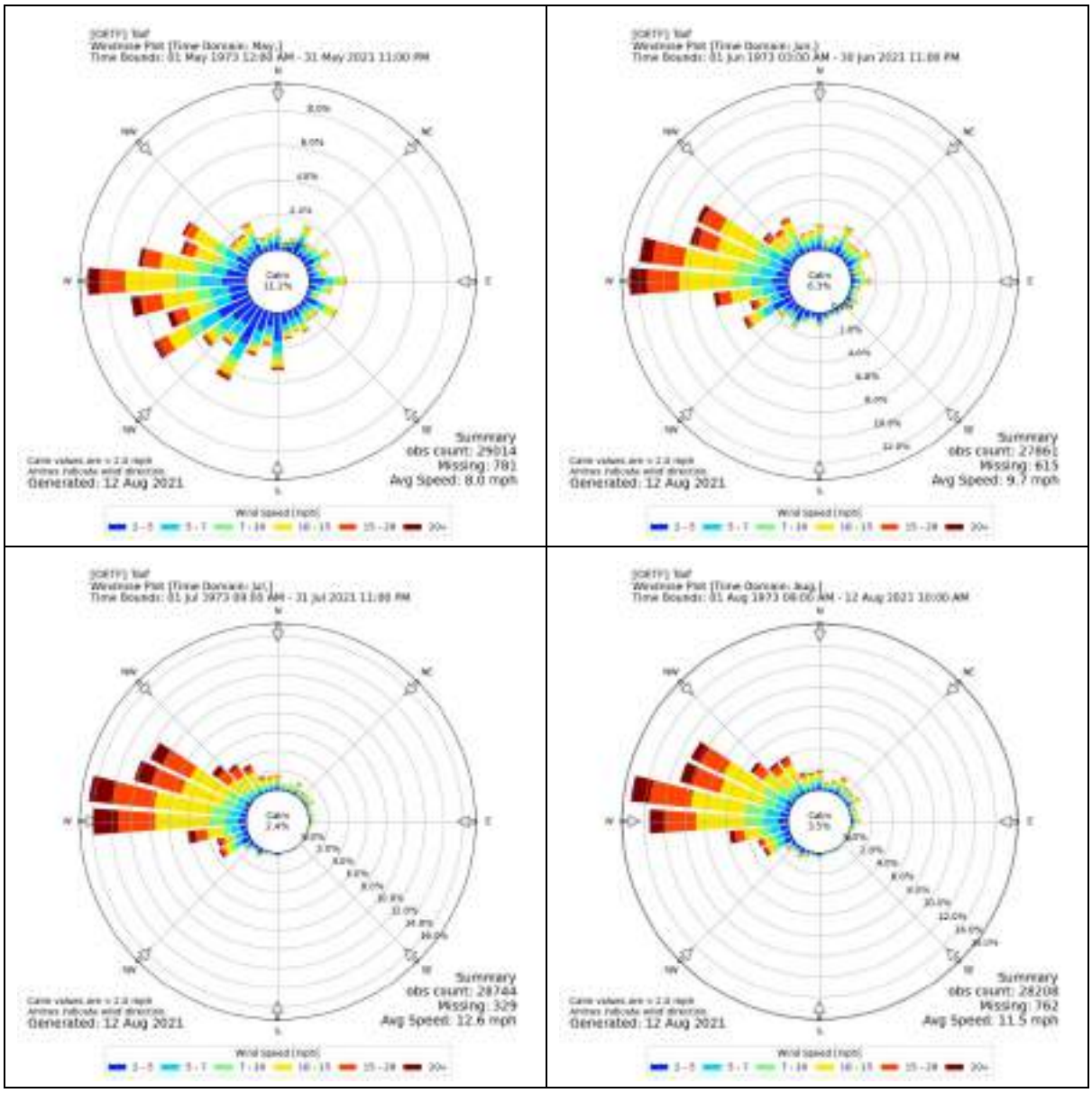
The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. In this section, we adopted the wind data obtained from the Taeif meteorological station.

The average hourly wind speed in Taeif experiences mild seasonal variation over the course of the year.

The windier part of the year lasts for 2.3 months, from June to August, with average wind speeds of more than 3.5 meters per second. The windiest month of the year in Taeif is July, with an average hourly wind speed of 4.1 meters per second.

The calmer time of year lasts for 9.7 months, from August to June. The calmest month of the year in Taeif is September, with an average hourly wind speed of 3.0 meters per second. The wind rose obtained from Taeif station is given by the table below.


Summary
obs count: 29102
Missing: 1158
Avg Speed: 7.3 mph
Generated: 12 Aug 2021
Summary
obs count: 2947
Missing: 481
Avg Speed: 8.4 mph
Generated: 12 Aug 2021
Summary
obs count: 29051
Missing: 571
Avg Speed: 9.2 mph
Generated: 12 Aug 2021
Summary
obs count: 28346
Missing: 569
Avg Speed: 8.8 mph
Generated: 12 Aug 2021


Summary
obs count: 29014
Missing: 781
Avg Speed: 8.0 mph
Generated: 12 Aug 2021
Summary
obs count: 27861
Missing: 615
Avg Speed: 9.7 mph
Generated: 12 Aug 2021
Summary
obs count: 28744
Missing: 329
Avg Speed: 12.6 mph
Generated: 12 Aug 2021
Summary
obs count: 28208
Missing: 762
Avg Speed: 11.5 mph
Generated: 12 Aug 2021

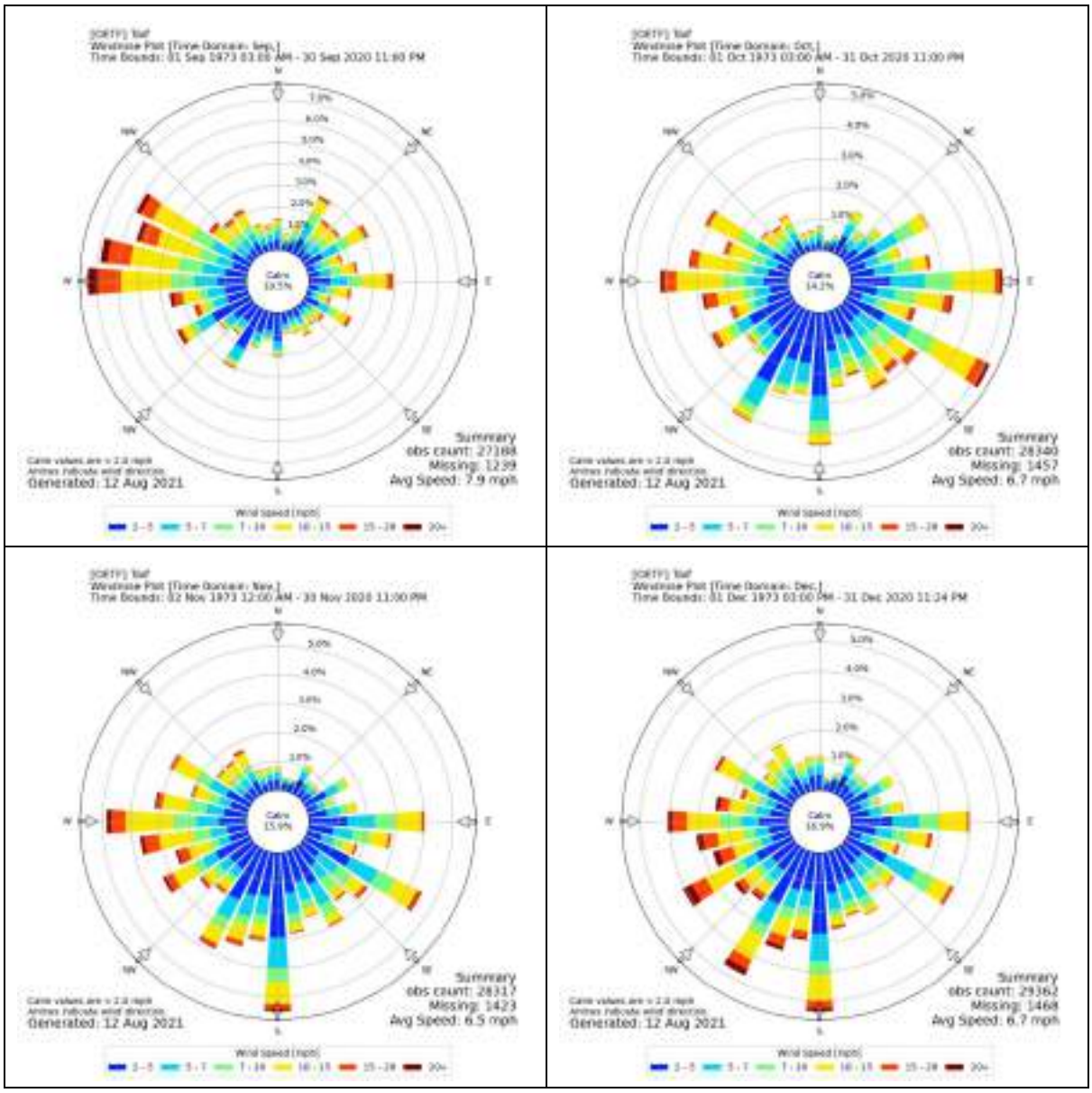


Figure 32 : Wind Roses by Month for Haden Solar plant (obtained from Taeif meteorological station: OETF, Latitude: 21.48342, Longitude: 40.54433, Elevation [m]: 1449)

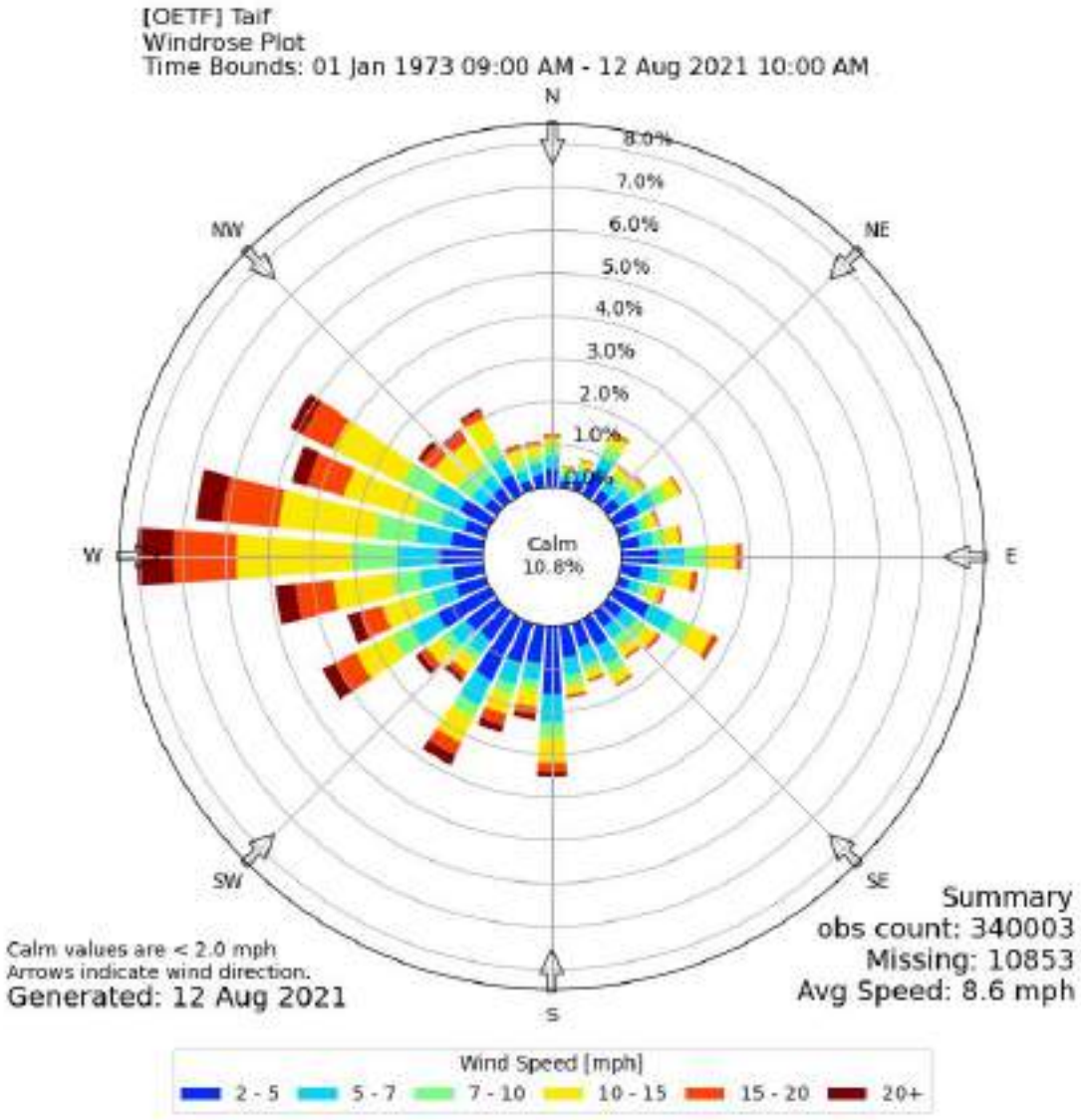


Figure 33 : yearly wind rose for Haden Solar plant (obtained from Taeif meteorological station: OETF, Latitude: 21.48342, Longitude: 40.54433, Elevation [m]: 1449)

6.3.3. Topography and slopes

6.3.3.1. Topography

The site of Haden has an average height of around 1170 m above sea level. The highest point is at an altitude of 1210 m in the South-west while the lowest point is 1150 m at the north-east border. The map below shows a slight global south-west – North-East slope of 0.1%.

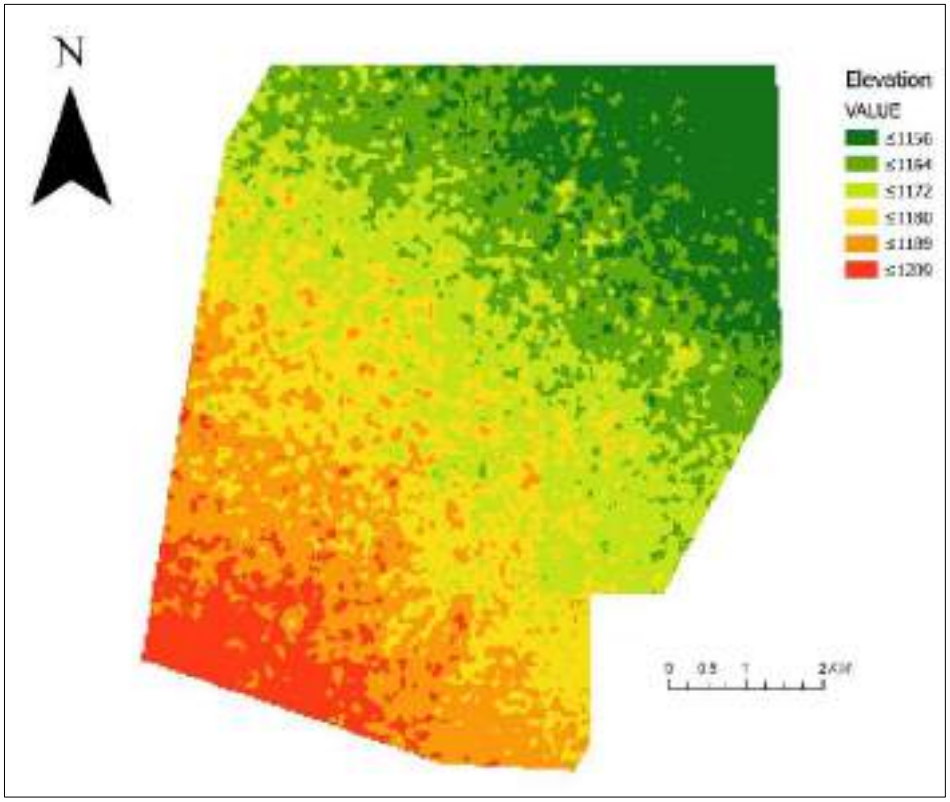


Figure 34 :Digital terrain model for the project site

6.3.3.2. Slopes

The maps show a basically flat area and limited slopes. Only few spots (in red), probably dunes or mounds are detected.

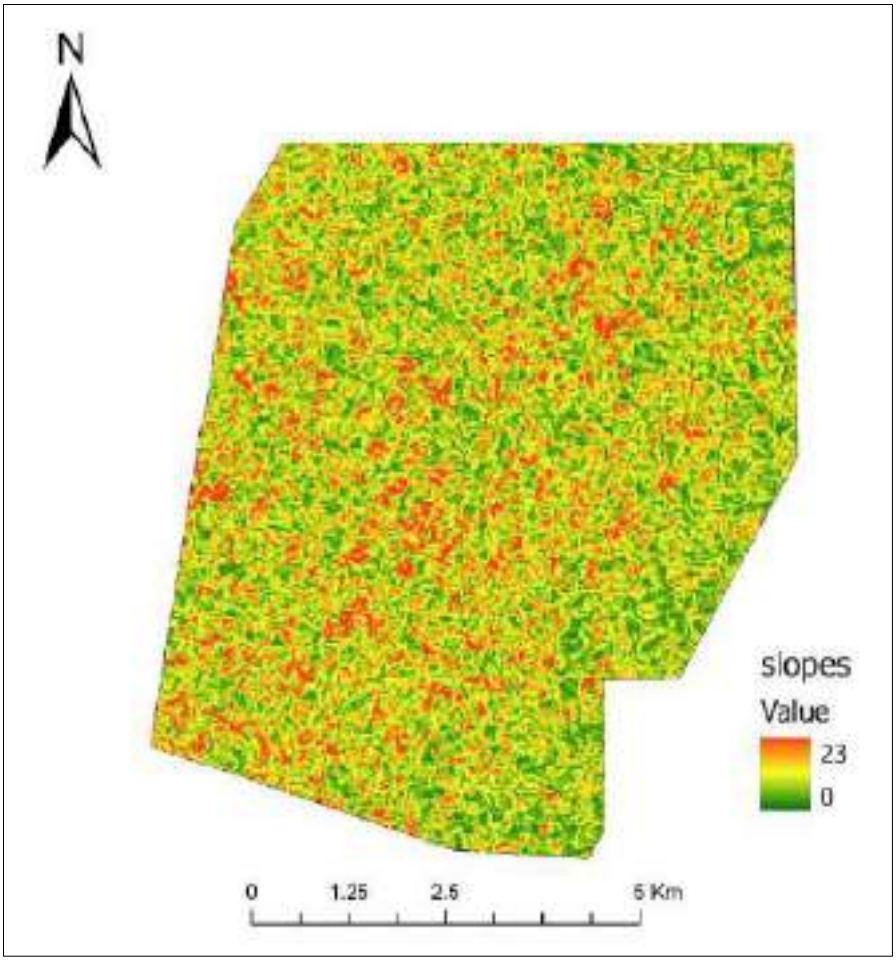


Figure 35 : Project site slopes

6.3.4. Geology

The initial phase of rifting of the Arabian Plate from the African Plate began as a wide zone of continental-crust extension manifested by basin and range topography. Freshwater lakes, northwest-trending marine gulfs, and alkali olivine basalt flows occupied these basins. Extensive dike swarms intruded parallel to the proto-Red Sea and marked the first phase of new mafic crust formed by volcanic processes. After a hiatus in volcanic activity, counter-clockwise rotation of the Arabian Plate during middle Miocene time changed the stress pattern in the plate and a second phase of extrusion of alkali olivine basalt commenced along north-trending fractures. This stress pattern continues to influence Holocene volcanism.

The western margin of the Arabian Peninsula is covered by approximately 180,000 km2 of Cenozoic to Recent basalt flows and related volcanic rocks. The volcanic fields stretch from Yemen to northern Syria and are comprised dominantly of alkali olivine basalts and hawaiites that were erupted onto Neoproterozoic crust of the Arabian-Nubian shield.

Volcanism started in the late Oligocene to early Miocene, slightly earlier than the main stage of continental extension that has subsequently produced the Red Sea Rift.

Western Arabia lies within the low-latitude desert of north Africa and the Middle East, the core being the Arabian segment of the African Shield. The core of complex basement rocks accounts for about one-third of the Arabian Peninsula.

The project area is geologically part of the so-called Arabian Shield, located in the western sector of the peninsula.

A region of Precambrian crystalline rocks lies along the northeast flank of the Red Sea, with two long prongs extending northwest and southeast for a total of 1,800 km. These basement rocks of the Arabian Shield are well exposed on the uplands, scarp mountains, and coastal pediments where the Phanerozoic cover rocks have been stripped as a result of Paleozoic epeirogeny and Tertiary ramping.

The outcrops of the shield rocks are of the Late Proterozoic or Infra-cambrian epochs. The rocks are divided into six lithostratigraphic sequences, two plutonic suites, and an ophiolitic suite. The mafic and ultramafic volcanic and plutonic rocks of the ophiolitic suite everywhere were emplaced tectonically and are probably of different ages in different places. Some ophiolite is highly deformed and altered to serpentinite in fault zones that mostly define sutures between different tectonic blocks or terranes within the shield.

Three of the lithostratigraphic sequences consist of mafic to silicic volcanic rocks and volcanic-derived clastic rocks which, with their subvolcanic plutonic rocks of a dioritic suite, probably formed in oceanic island arcs during convergent plate tectonism. Most of the layered rocks are andesitic, but they range from basalt to dacite and in places contain intercalated pillow basalt, marble, chert, and carbonaceous or graphitic schist. Most of the plutonic rocks of the dioritic suite are dioritic, but they range from gabbro to trondhjemite and rarely contain potassium feldspar.

Two other lithostratigraphic sequences with an associated plutonic granitic suite are the products of two mountain-building episodes during which the primary crust was greatly thickened and converted into craton. The two sequences, including largely the Ablah (Al Ays) and Murdama (Shammar) Groups, consist of abundant sedimentary rocks, commonly arkosic, that are the erosional products of the orogenic mountains. They are several thousand meters thick. Less abundant calc-alkalic to alkalic volcanic rocks, commonly dacitic and rhyolitic, are intercalated with the sedimentary rocks.

The meta-andesite in the foothills east of Jeddah, where it is intruded by the Mecca Granodiorite, was described as andesite and andesite porphyry metamorphosed to the greenschist facies. In many places it is schistose, but it includes some diabase, gray slate, conglomerate, dacite, and marble.

6.3.4.1. Precambrian layered rocks

Baish-Bahah Group. The presumed lowermost and oldest rocks originally described in the Arabian Shield were metadiorite, metagabbro, and amphibolite. These rocks consist of two units: (1) basalt and andesitic basalt containing local pillow structure, with interbedded marine volcaniclastic and sedimentary wacke and (2) carbonaceous and graphitic schists, and minor marble and chert, all metamorphosed to the greenschist facies.

The Jeddah Group consists of a lower volcanic formation, the Qirshah Andesite, and an upper clastic, predominately immature arkosic and volcaniclastic wacke, the Khutnah Formation.

Ablah Formation is the name of a belt of sedimentary rocks exposed in a graben extending south-southwest from Jabal Rafa. The basal polymict conglomerate, quartzitic wacke, red sandstone, stromatolitic limestone, arkose, and purple shale rest nonconformably on Jeddah Group metavolcanic and plutonic rocks. They are folded into a series of asymmetric anticlines and dip predominantly to the east.

6.3.4.2. Plutonic rocks

The plutonic rocks of the Saudi Arabian Shield are divided into an older, pretectonic dioritic suite and a younger, syntectonic and posttectonic, mostly granitic suite which includes an early layered gabbroic phase.

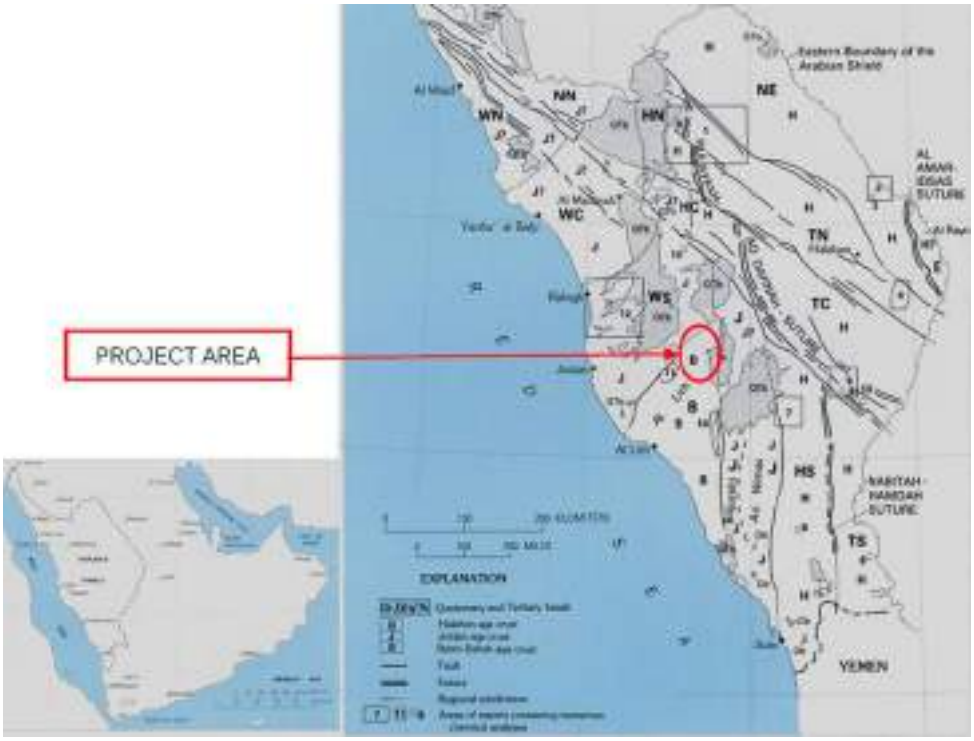


Figure 36 : Project site geology- general overview

The geological conditions of the site consist, on the surface, of gravels of rock fragments, mostly basaltic and sands. They seem to be related to piedmont type deposits, developed over the lithological substrate or bedrock or over alluvial materials themselves located over the rock substrate.

The bedrock substrate may consist of lava flows from nearby harrats, in the Precambrian substrate underlying the Sahl Rakbah alluvial deposit, or more likely in sedimentary materials of the Usfan Formation, given the proximity of extensive outcrops of this unit to the planned site of the solar plant.

The Usfan Formation consists of conglomerates, sandstones, siltstones, mudstones, and ironstones arranged in upward coarsening and fining cycles of intermittent depositional environments ranging from fluvial coastal plain to shallow marine. In the middle of this siliciclastic Tertiary series, carbonate rocks appear, in a sequence that show a pronounced lateral and vertical changes from predominantly dolostones in the west to mixed dolostones and limestones in the east. The carbonate sequence begins by yellow dolomitic lime mudstones and fine crystalline dolomite which indicate the formation of dolomite by late depositional to early diagenetic recrystallization of precursor Fe and Mg lime mud.

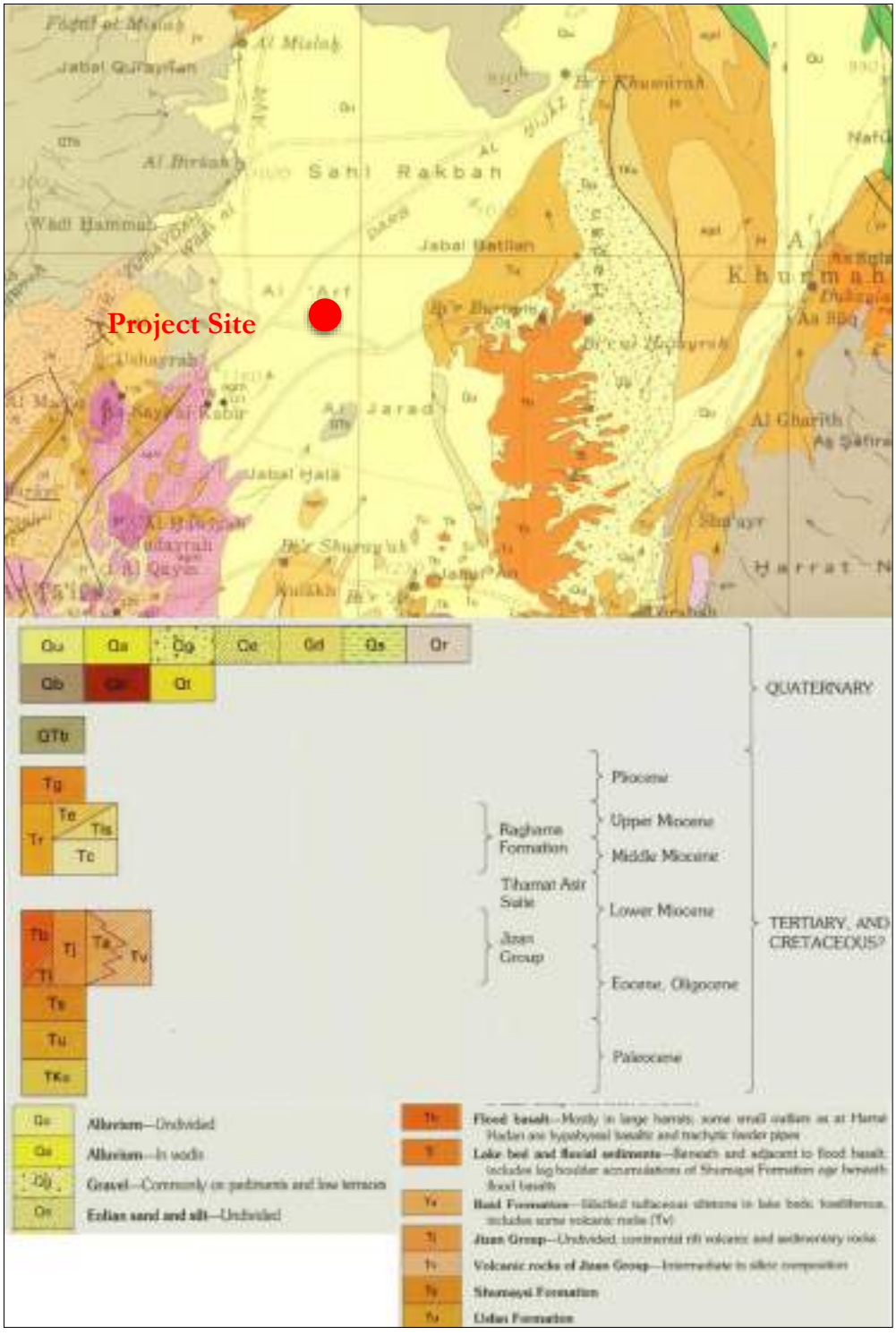


Figure 37 : Project site geology-detailed overview

6.3.5. Soil

6.3.5.1. Soil type

The soils on site are classified as very poorly developed semidesert soils, often sands and gravels. In Site, they are frequently non-existent, and vegetation largely develops on the expanses of broken rock, as shown in Figure, other than where weathered rock material and winter rainfall are washed into surface depressions. Even within the wadis, the infrequent but sporadic flows expose rock bedding planes that are washed clean of weathered detritus each rainy season, leaving little opportunity for soil development.

Figure 38 : Soil is project site

6.3.5.2. Soil analysis

6.3.5.2.1. Soil samples locations

To characterize the soil in place, an accredited laboratory was designated to withdraw and analyse ten (10) soil samples from the site.

Location of sampling was fixed to cover at the extent possible the site and represent its soil, as shown in the following figure.

Figure 39 : soil samples location

The coordinates of picked samples are showing in the following table

Table 20: Soil samples location coordinates

No. Point	Longitude (°)	Latitude(°)
1	41.16625572	22.31766
2	41.16613233	22.31809
3	41.14773123	22.33543
4	41.1468303	22.32401
5	41.14615327	22.30058
6	41.13110394	22.30041
7	41.1317869	22.29999
8	41.13110815	22.28104
9	41.11416111	22.28096
10	41.11348488	22.28121

6.3.5.2.2. Soil analysis results

Results of Soil analysis sample no. 1 are presented by the following table

Table 21 : soil analysis results- sample no. 1

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	……	8.32	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	726	n/a
Chloride	EPA 9212	0.01	µg/g	102	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	18.3	n/a
Magnesium	EPA 3050	0.01	µg/g	25.8	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	16.2	n/a
Calcium	EPA 3050	0.01	µg/g	28.9	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.15	n/a
Iron	EPA 3050	0.01	µg/g	0.51	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.03	63
Zinc	EPA 3050	0.01	µg/g	0.24	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.6	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd] pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.012
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.014
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Based on the results of the analysis of the previous sample, it was found that soil quality was conform and did not exceed the permissible limits of to the National Center for the Control of Environmental Compliance.

6.3.6. Hydrology

The studied site of Haden is in the region of Makkah. Within this region, the sites are situated to the east of the Hijaz Mountain Range, northeast of the city of Taif. This situates the sites in the interior watershed. This area is quite flat, with higher elevations in the South-west that cause the water flow to go east and north-east. The sites in question are near two hydrologic depressions so hydraulic considerations are of great importance in order to evaluate the risk of flooding.

6.3.6.1. Hydrological study context

To well evaluate this risk of flooding, a hydrological study was performed. This study provides the most suitable location for the implementation of the PV power plant and define the proper design requirements.

This hydrological study indicates the points that are more vulnerable to flood hazard and should preferably be avoided.

6.3.6.2. Methodology of hydrological study

The plant's preliminary studies include a hydrological assessment of the area to provide the most suitable location and define the proper design requirements for the implementation of the PV plant.

To assess the risk of flooding maximum flows at in contribution basin are determined by applying the American Rational Method recommended by "Highway Design Manual KSA". the Return Periods involved in the hydrological estimation are 5, 10, 25, 50, 100 and 200 years.

6.3.6.2.1. Contribution basins delimitation

The delimitation of the hydrographic basins in the project area was performed by using the NASA Aster-type Digital Terrain Model, 29x29 pixels. The basin configuration obtained is presented by the figure below.

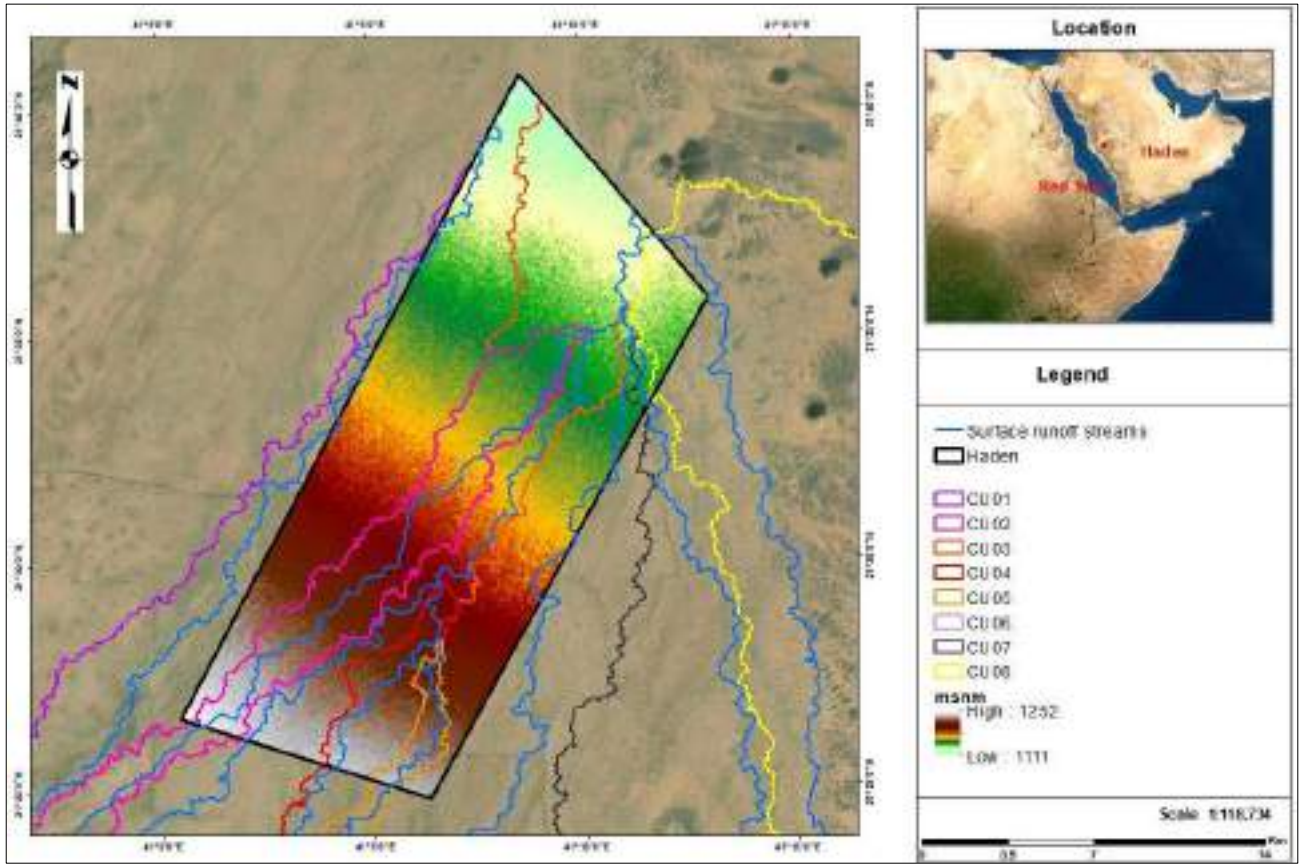


Figure 40 : Digital Terrain Model

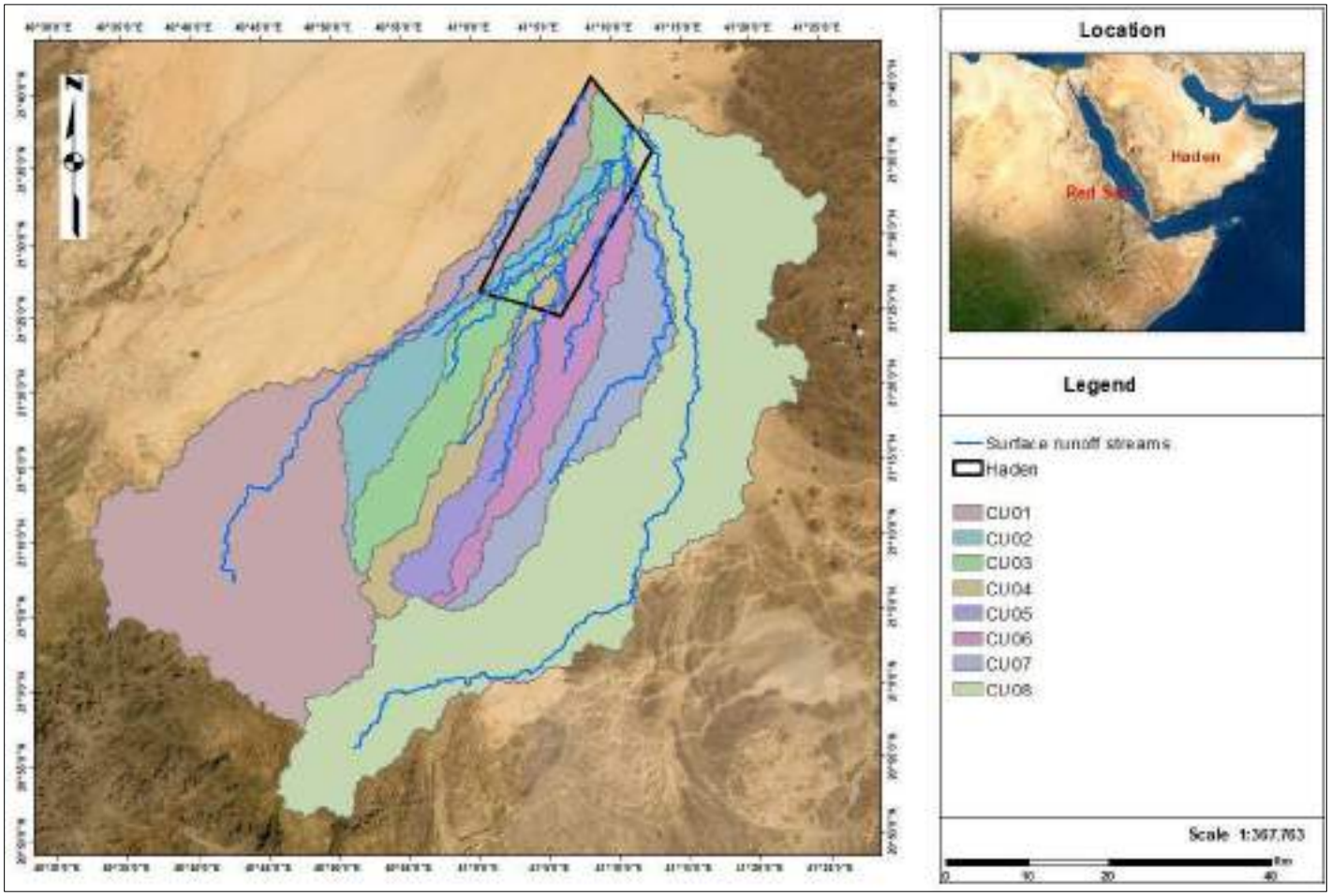


Figure 41 : Identified Hydrological basins with Runoff steams.

The size of water basins, demarcated by the topography, is the main factor that determines the water flow that can be expected. Larger basins will collect water from larger catchment areas, and this will result in higher water runoff flows. Basins CU02, CU03, CU07 and CU06 (see map above) are the main water catchment areas that will affect the project's site. high water flows are expected in the water runoff streams from these basins.

6.3.6.2.2. Maximum flows estimation and chosen return period

The rational method has been used to determine the water flow for various return periods. These return periods show various levels of risk depending for rainfall events of varying frequency and intensity. However **only the 100-year return period (Tr 100) will be used** when determining areas subjected to flood risk, as his will be the return period employed in the project.

Table 22 : Basins and maximum flows

ID	Q Tr 5 (m^3/s)	Q Tr 10 (m^3/s)	Q Tr 25 (m^3/s)	Q Tr 50 (m^3/s)	Q Tr 100 (m^3/s)	Q Tr 200 (m^3/s)
CU01	172.6	203.9	254.0	300.0	**354.3**	418.4
CU02	54.7	64.5	80.4	95.0	**112.2**	132.5
CU03	55.0	64.9	80.9	95.5	**112.8**	133.2
CU04	39.7	46.8	58.3	68.9	**81.4**	96.1
CU05	40.2	47.4	59.1	69.8	**82.5**	97.4
CU06	57.7	68.1	84.9	100.3	**118.4**	139.8
CU07	55.0	64.9	80.9	95.5	**112.8**	133.2
CU08	209.9	247.9	308.8	364.7	**430.7**	508.7

6.3.6.2.3. Hydraulic modelling and Flooding risk analysis

Flood Analysis is used to develop localized flooding scenarios and visualize the impact of flooding on the future PV plant. The results of the analysis will be used to find the most suitable areas and develop mitigation strategies. Only the return period of 100-year is considered.

6.3.6.2.3.1. Hydraulic modelling results

Surface water flooding occurs when intense rainfall can't be absorbed by the ground or drained away through drainage infrastructure. The results of the hydraulic modelling of the scenario of 100-year return period is presented by Figure 22 and Figure 23 below. These figures show the flood hazard risk.

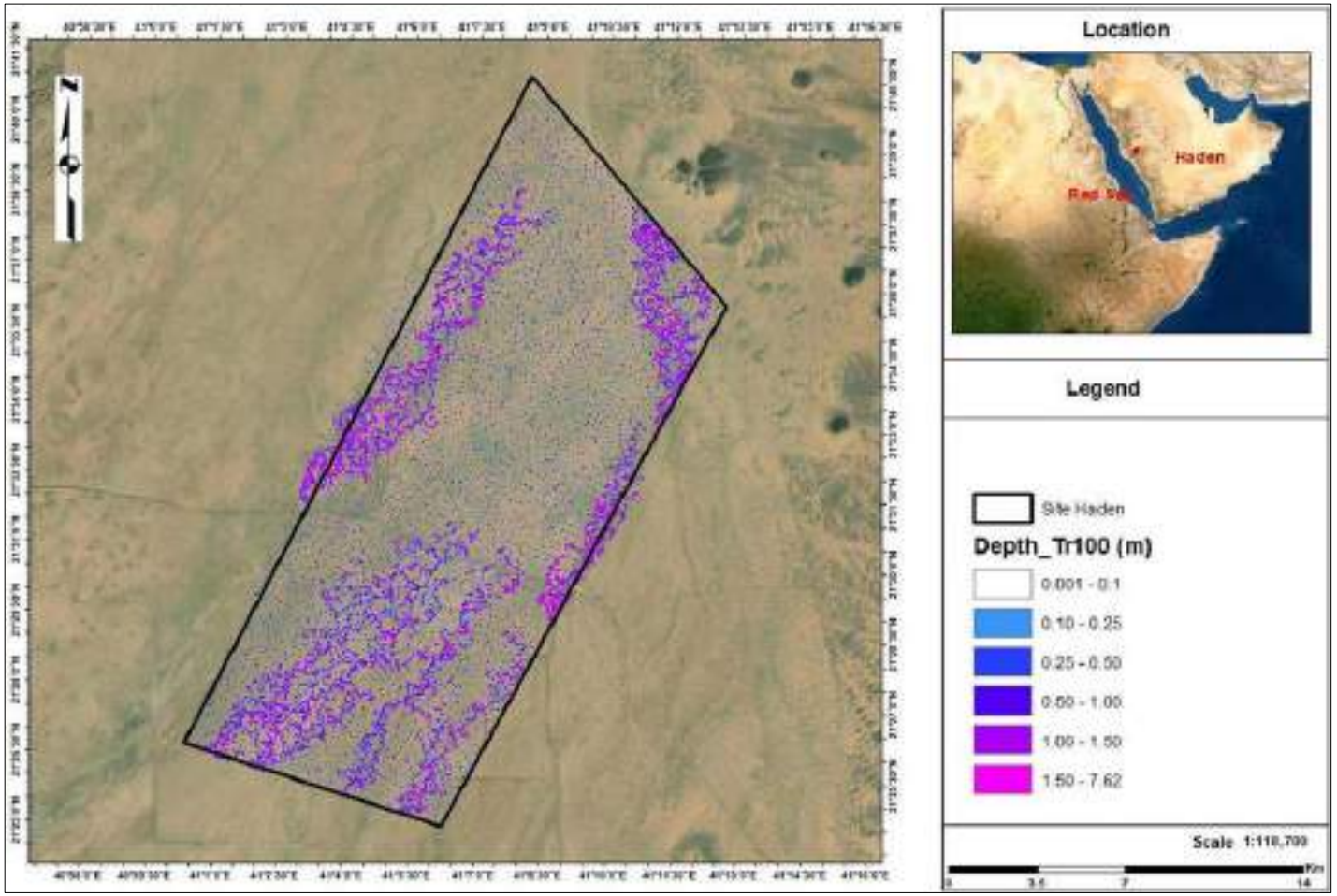


Figure 42 : Maximum depth reached due to an intensity of precipitation associated with a return period Tr=100 years

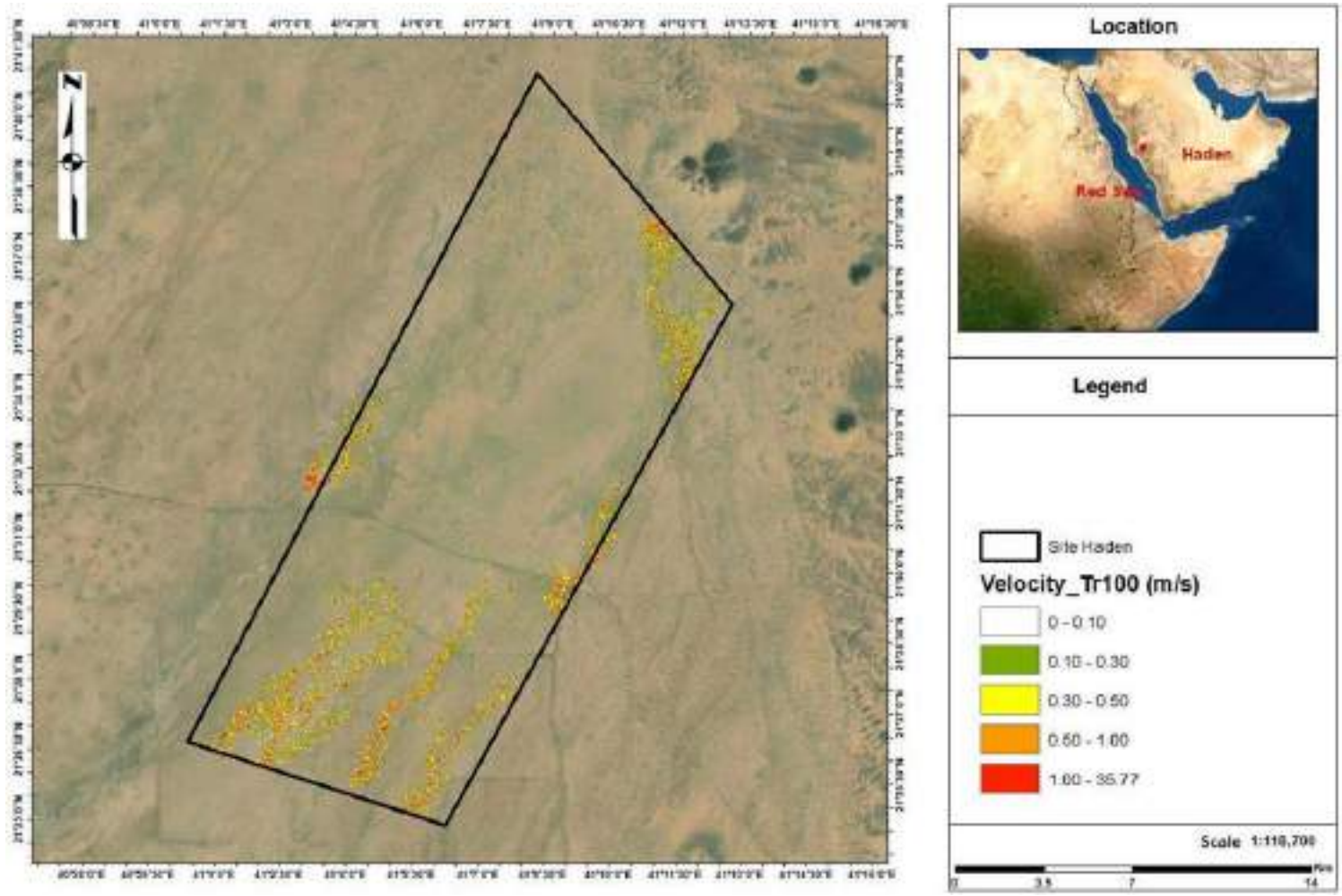


Figure 43 : Maximum velocity reached due to an intensity of precipitation associated with a Tr= 100 year

In general, flood levels below 25 cm will not originate hardly any surface runoff. These low flood levels can be simply considered as puddles and, since there is not enough slope to drain them, the runoff is low or non- existent. Therefore, these conditions pose a very low risk, and the excesses are expected to infiltrate into the soil.

Flood levels between 25 and 50 cm will present low risk of flooding, especially in permeable terrains like those found in most of the site.

Flood levels above 50 cm are also found on site. These levels of flooding pose a medium-high risk as they can cause instability in structures. It is advisable to take structural measures to prevent or mitigate these levels of flooding, or alternatively, avoid altogether these areas.

The Western part of the site shows higher impact due to the runoff from the basins CU01. So due to the configuration of the terrain and the magnitudes of its flows, the flooding levels depths of up to 0.50 meters and velocities 1 m/s. In the South, the higher surface runoff comes from the CU02, CU03, CU04 and CU05 basins and in the Eastern part of the site there are high depths and speeds from the basin CU06, CU07 and CU08.

In general, the computed speeds are below 0.50 m /s. However, there are areas where the magnitude of the velocities could be greater than 1 m/s. This magnitude could cause erosion and sediment drag so; these areas should be avoided.

6.3.6.2.3.2. Flood hazard analysis

When quantifying and classifying flood hazard, the relative hazard degree and the underlying flood behavior (e.g., depth, speed, combined depth, and speed combined) must be considered. If the site is small and flood behavior is relatively uniform, a simplified method can be used to quantify the flood behavior on the floodplain. In these cases, a single point value of D × V is appropriate. However, in sites where there is significant variability in the flood behavior across the floodplain, like the studied Haden site, a map of flood hazard assessing the spatial variability is more appropriate.

Once the flood hazard has been quantified and the timing aspects of flood hazard understood, the potential damage flood flows present can be indexed against vulnerability curves linked to meaningful hazard thresholds.

When interpreting flood hazard from model outputs, some underlying assumptions of the model approach and the effects this might have on flood hazard quantification must be considered. The modelling approach, model scale and resolution, and the associated level of topographic detail incorporated in a model, may all influence flood hazard estimates.

The flood hazard values may be used for development planning, and there is a variety of guidance in the literature. The guidance showed by Australian Disaster Resilience

Handbook can be used as a general classification of flood hazard on a floodplain, see Figure 44 and Table 23 below.

The combined flood hazard curves presented in Figure 24 set hazard thresholds that serve as benchmark to understand the hazard level in each circumstance. These combined curves are divided into hazard classifications that relate to specific vulnerability thresholds.

Table 23 : Combined Hazard Curves-Vulnerability Thresholds Classification Limits, Australian Disaster Resilience Handbook

Hazard Vulnerability Classification	Classification limit (D x V) m^2/s	Limiting still water depth (D) m	Limiting Velocity (V) m/s	Level
H1	≤ 0.3	0.3	2.0	Low
H2	≤ 0.6	0.5	2.0	Medium-Low
H3	≤ 1.0	2.0	2.0	Intermediate
H4	≤ 4.0	4.0	4.0	High
H5	> 4.0	-	-	Very High

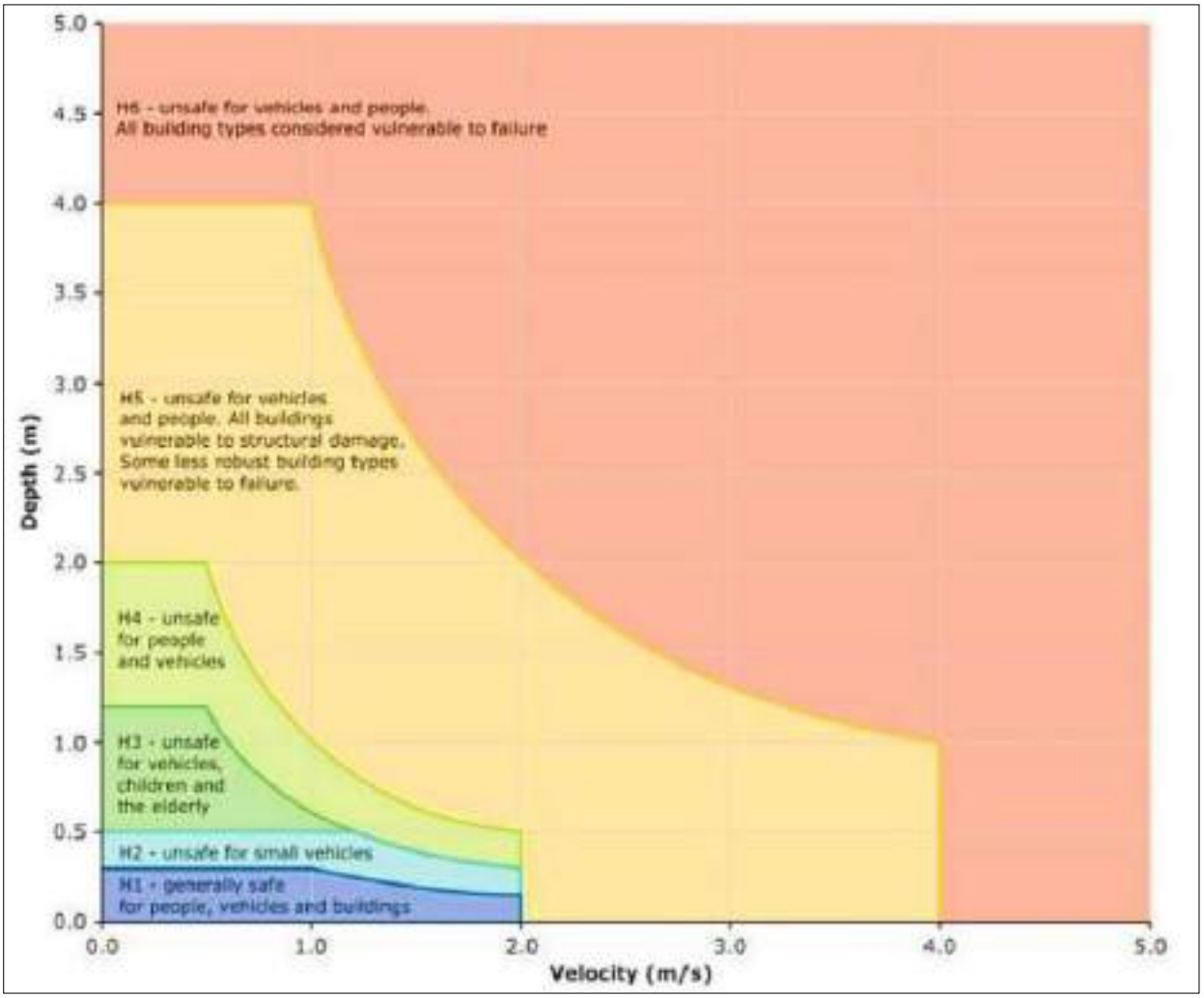


Figure 44: Combined Hazard Curves-Vulnerability Thresholds Classification Limits, Australian Disaster Resilience Handbook

Considering the return period of 100-years, an estimation of the flooding hazard was achieved by multiplying the maximum flood depths and velocities observed at this period. Figure 25 shows that for most of the area where the infrastructure will be implemented it has a low risk (H1), while, for the area of the main surface runoff streams belonging to the basins CU01 and CU08 have a higher level of hazard H4 and H5. However, the other basins come to present levels H4 and H5.

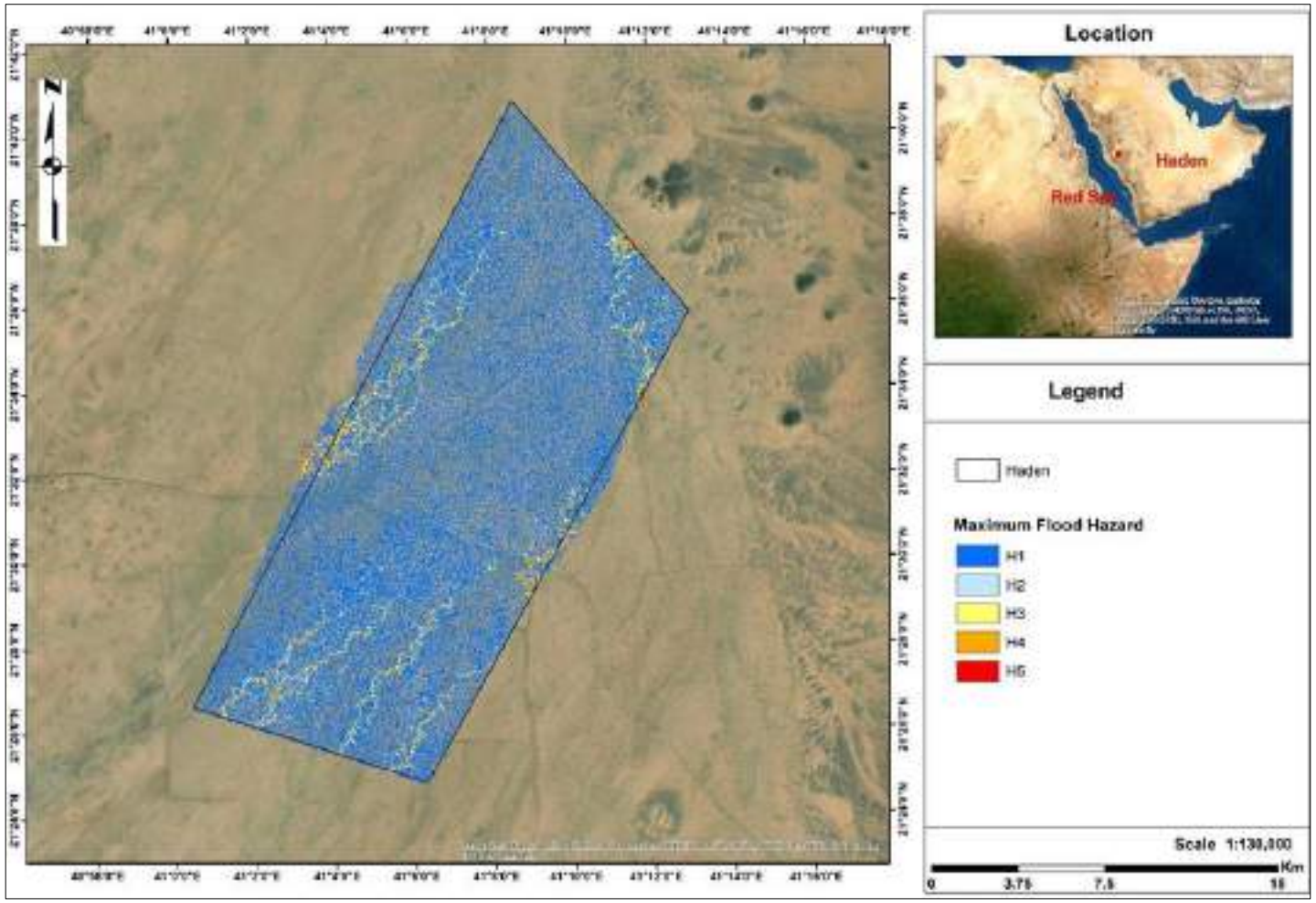


Figure 45 : Classification Flood Hazard (DxV) for the Tr= 100 years.

6.3.6.3. Conclusion

The hydrological model shows that areas subjected to flood hazard risk are mainly located the southern half of the site and all the perimeter of the northern half. Surface runoff streams resulting from basins CU02, CU03, CU04 and CU05 cause the flood hazard risks in the southern half of the developing site. In the northern limits, surface runoff streams resulting from basins CU01, CU06, CU07 and CU09 generate high risk flood hazard areas. All these are relatively small areas, but they are less adequate for the development of any power plant as the basins that drain into these surface runoff streams very large, resulting in potential deep levels of water and high water-speeds. However, moving to the central areas of the site and a short distance away of these surface runoff streams, the level of flood hazard risk rapidly drops to very low levels.

6.3.7. Groundwater

Groundwater in Saudi Arabia is found almost entirely in the many thick, highly permeable aquifers of large sedimentary basins to the north, east, and groundwater occurs in the fractured, Precambrian crystalline rocks of the Arabian Shield, which is more significant in providing extensive, higher, relatively impermeable areas for surface runoff, and localised, shallow wadi underflow. While the major aquifers in the north of the country consist of multiple, Lower Palaeozoic arenaceous permeable formations with interdigitated impermeable argillaceous strata, those in the eastern part include both karstified Tertiary carbonates and Mesozoic to basal Palaeozoic arenaceous formations. To the south of the Arabian Shelf, a single thick basal Lower Palaeozoic sandstone formation constitutes a high yield aquifer. Groundwater is stored in more than 20- layered principal and secondary aquifers of different geological ages (Figure 38) (Ministry of Agriculture and Water - MAW 1984). The Arabian Shelf includes the deep sedimentary aquifers, which are formed mostly of limestone and sandstone that overlay the basement rock formation known as the Arabian Shield and covers about two thirds of Saudi Arabia or 1,485,000 km2 (Ministry of Agriculture and Water 1984). These aquifers crop out in the western parts of the Shelf and extend towards the eastern parts. The total thickness varies between a few hundred to more than 5,000 m (Ministry of Agriculture and Water 1984). The principal aquifers are: Saq, Wajid, Tabuk, Minjur, Dhruma, Biyadh, Wasia, Dammam, Umm Er Radhuma and Neogene. The secondary aquifers are: AlJauf, Al-Khuf, Al-Jilh, the Upper Jurassic, Sakaka, the Lower Cretaceous, Aruma, Basalts and Wadi Sediments (Figure 3). Apart from the last two, groundwater resources stored in these aquifers are non-renewable. The groundwater quality varies between sites and among aquifers (Table 22). The isotopic analyses showed that the fossil groundwater in the above aquifers is 10,000–32,000 years old. Large volumes of groundwater are stored in the sedimentary aquifers (King Fahd University of Petroleum and Minerals, Research Institute 1988). The estimated groundwater reserves to a depth of 300 meters below ground surface is about 2,185 km3, with a total annual recharge of 2,762

Mm3 based on several hydrogeological studies as given in King Fahd University of Petroleum and Minerals and Research Institute (1988) (Table 22). Renewable groundwater resources are mainly stored in the shallow alluvial aquifers and within Basalts, which extend mostly in the south-western parts of Saudi Arabia with varying thickness and width (MAW 1990). These aquifers store about 84,000 Mm3, with an average annual recharge of 1,196 Mm3 (British Arabian Advisory Company - BAAC 1980). The total national groundwater reserves in the shallow and deep aquifers to a depth of 300 m below ground surface is about 2,259 km3. These volumes of renewable and non-renewable groundwater resources represent a dependable source for different purposes, including irrigation in the Kingdom, if properly managed.

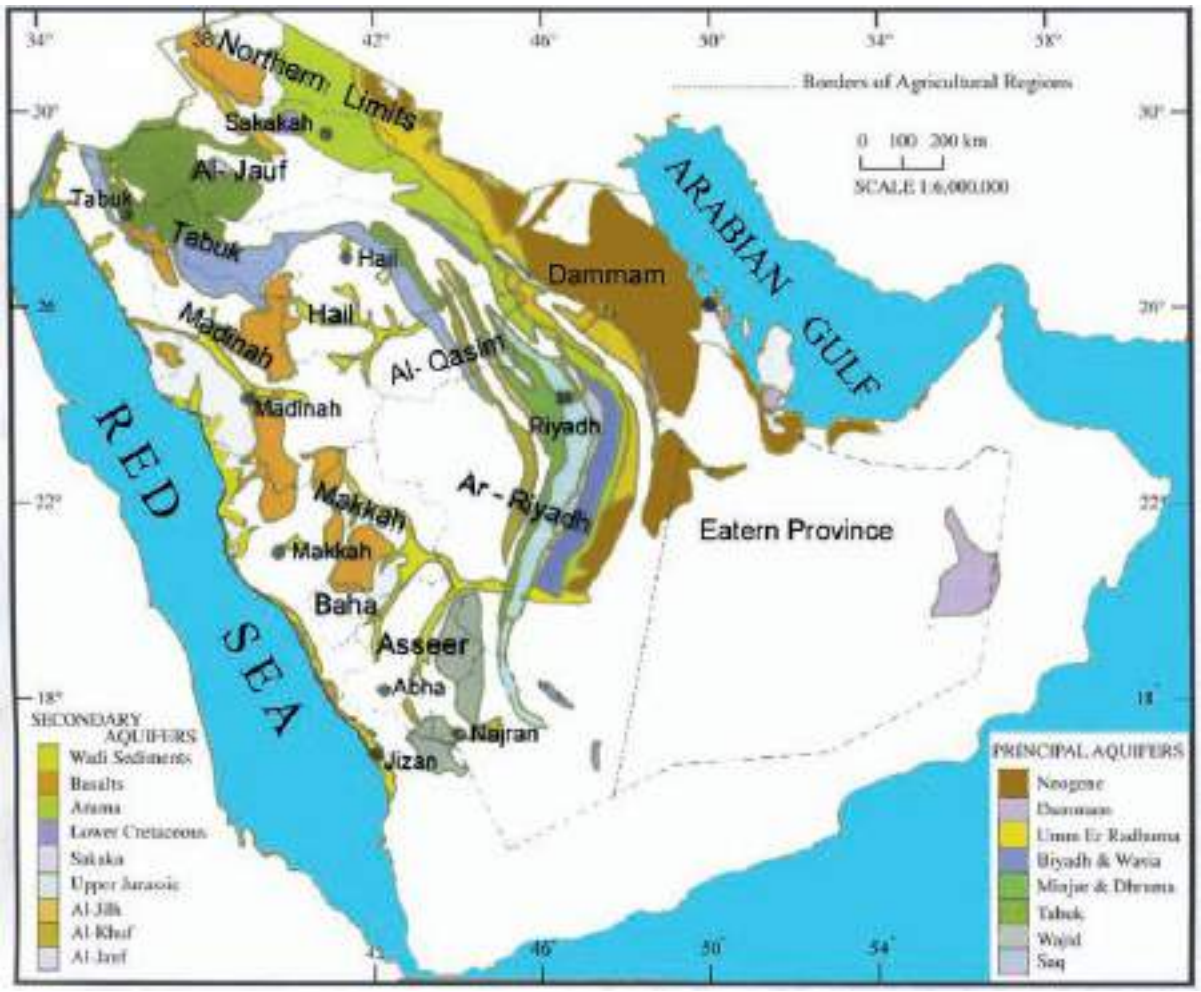


Figure 46: The extension of the outcrop areas of principle and secondary aquifers

Table 24: The estimated groundwater reserves in Saudi Arabia to a depth of 300 meters below ground level in Mm3

Aquifer	Reserve (Mm^3)	Recharge (Mm^3)	Total dissolved solids (ppm)
Saq	290,000	310	300–3,000
Tabuk	210,000	455	250–2,500
Wajid	220,000	104	500–1,200
Minjur- Dhruma	180,000	80	1,100–20,000
Wasia- Biyadh	590,000	480	900–10,000
Umm Er Radhuma	190,000	406	2,000–5,000
Dammam	45,000	200	2,600–6,000
Khuf & Tuwal	30,000	132	3,800–6,000
Aruma	85,000	80	1,600–3,000
Jauf & Sakaka	100,000	95	400–5,000
Jilh	115,000	60	3,800–5,000
Neogene	130,000	360	2,400–4,000
Total	2,185,000	2,762	

6.3.8. Historical and cultural heritage

As for the cultural heritage limitations, the project site is far from the historical and cultural sites in the Kingdom, where the UNESCO World Heritage List was reviewed to confirm, with the analysis of both the places currently included in the World Heritage List and the places with nominations for examination by the World Heritage Committee as well as the Tentative List, in order to Consider any site of cultural or natural interest. The World Heritage List in Saudi Arabia is shown in the below table.

Table 25 : World Heritage Tentative List by UNESCO

Picture	The name	the site	Registration	the number	Type
	Zubaydah's (The pilgrimage route from Kufa to Mecca)	Northern Border District Hail region Qassim region Medina area Makkah Region	2015	6025	cultural
	Hejaz Railway	Tabuk Medina area	2015	6026	cultural
	Shami Hajj Road	Tabuk Medina Makkah Region	2015	6027	cultural

Picture	The name	the site	Registration	the number	Type
	Egyptian pilgrimage route	Tabuk Medina Makkah Region	2015	6028	cultural
	The ancient village of Al-Faw	Riyadh region	2015	6029	cultural
	Rijal Almaa Heritage Village	Asir region	2015	6030	cultural

Picture	The name	the site	Registration	the number	Type
	Dhi Ain Heritage Village	Al Baha area	2015	6031	cultural
	The historical oasis of Dumat Al-Jandal (Al-Dir` neighborhood in Dumat Al-Jandal)	Al-Jawf region	2015	6034	cultural
	Uruq Bani Maarid Reserve	Najran Province Riyadh region	2019	6369	natural

Picture	The name	the site	Registration	the number	Type
	Farasan Islands Reserve	Jazan region, the south-eastern part of the F	2019	6370	natural

Table 26 : World Heritage List by UNESCO

Picture	Name	Registration year	Site	Notes	Number	Type
	Al Hajar (Madain Saleh)	2008	Medina area 26°47'1"N 37°57'18"E	It was one of the cities of the Nabataean kingdom. The mission is in the north of the Arabian Peninsula and the stone is the name of Thamud homes. The site includes huge tombs, dating back to the first century BC. It also includes about 50 inscriptions dating back to that period, and a number of cave drawings.	1293	cultural
	At-Turaif neighborhood in Diriyah	2010	Riyadh region 24°44'3"N 46°34'21"E	Its dwellings are distributed on the banks of Wadi Hanifa And its tributaries, and its ancient wall is surrounded by its fortifications and mud towers, and Diriyah was the first capital of the Al Saud family.	1329	cultural
	Historic Jeddah	2014	Makkah Region 21°29'N 39°12'E	Historic Jeddah (Al-Balad) is located in the center of the city of Jeddah and includes a number of monuments and archaeological and heritage buildings, such as the Jeddah wall and its historical lanes, as well as a number of historical mosques.	1361	cultural

Picture	Name	Registration year	Site	Notes	Number	Type
	Rock arts in the Hail region(mealAnd Shuwaimis)	2015	Hail region 28°00'N 40°54'E	Rock art in the Hail region includes drawings of Jabal Umm SinmanIn Jubbet Warrat and Al-Manjour in Shuwaymis. Jabal Umm Sinman was a lake at an earlier time, and its inhabitants left many inscriptions about their lives. As for Rat and Al-Manjour, they were two valleys, and the inscriptions in them show drawings of humans and animals dating back ten thousand years.	1472	cultural
	Al-Ahsa Oasis	2018	Eastern Region 25°24'7"N 49°37'50"E	The oasis is located in Al-Ahsa Governorate. More than a million and a half palm trees grow there, and it is the largest palm oasis surrounded by sand in the world. Extensive agricultural works are held next to it, due to the abundance of water and fresh springs. The site includes several landmarks, namely: Jawathi Mosque, Ibrahim Palace, Sahoud Palace, Muhairis Palace, Abu Jalal Palace, Al-Aqeer Port, Qara Mountain, Al-Qaysaria Market.	1563	cultural

Picture	Name	Registration year	Site	Notes	Number	Type
	cultural fever area	2021	Najran Province		1619	cultural

These sites are listed above to demonstrate that are far away from the project site. the project site is located out of influence of these monuments, and it doesn't have any interference with them nor with their buffer zones.

6.3.9. Ambient air quality

6.3.9.1. Measurement methods

AH Environmental Consultancy has engaged an accredited laboratory to undertake to air quality measurements for the Environmental Monitoring for Haden PV solar plant Project. The laboratory team moved to make the required measurements, namely (Air Quality Measurements), the most recent devices approved by the NCEC were used.

The project site was visited by the work team on in order to assess the air quality in the work environment at the site and the surrounding environment to determine the extent of the impact of works inside the site on the environment surrounding the project. The standard methods approved by NCEC were followed.

6.3.9.2. Methodology for Locating Air Measurements

The measurement methodology for air samples inside the site is based on the selection of suitable sites for air sampling to be representative, expressive and accurate representation of the site, taking into account the direction of the wind for each point selected, to determine the effects resulting in the site and the role of wind in transferring emissions from surrounding facilities to the site environment.

6.3.9.3. quality of results

the engaged accredited laboratory follows an accurate and high-quality system in conducting its environmental measurements. The measuring devices are calibrated according to a periodic preprepared program. The measurements obtained by these devices are compared to measurements obtained by of other accredited laboratories to evaluate the accuracy of the results.

The accredited laboratory follows (ISO 17025/2008) system for laboratory quality. The readings, calculation of averages and the standard deviation rate are taken and compared to the quality scheme of each device to identify the systematic error and evaluate the random error and reduce each of them by comparing the results of the devices with the results of other accredited parameters to evaluate the accuracy of the results.

6.3.9.4. Equipment

The characteristic of the devices used for assessing the air quality is given by then following table.

Table 27 : Equipment used for measuring air quality

Items	Description	Specification
Particle Modules PM	Monitor method	Continuously, automatically and real-time
	Working principle	Light scattering technique
	Measurement data	PM2.5, PM10
	Measuring range	0 10mg/m3
	Response time	60s
	Measuring time	1min(Standard measurement time)
	Minimum detection limit	0.001 mg/m3
	Instrument parallelism	10%
	Data validity	＞75%
	Dehumidification	With the automatic dehumidification function module
	Alarm function	With high concentration alarm function, the platform can configure the alarm threshold
Gas modules	Monitor method	Continuously, automatically and real-time
	Working principle	High precision Electrochemical sensor
	Gas monitor	SO2,H2S, NO2, CO, O3
	Sulfur Dioxide SO2	Measuring range: 0 -2000ppb Resolution: 1ppb / Response time: ＜45s
	Sulfur Dioxide H2S	Measuring range: 0 -2000ppb Resolution: 0.1ppm / Response time: ＜45s
	Ozone O3	Measuring range: 0 -20000ppb Resolution: 5ppb / Response time: ＜45s
	Carbon Monoxide CO	Measuring range: 0 200ppm Resolution: 0.1ppm / Response time: ＜45s
Meteorological parameters	Temperature: Measuring range: -40 60 , Precision: 0.3 (20)	
	Humidity: Measuring range: 0 -100%RH, Precision: 2%(5%RH 95%RH, 25)	
	Wind direction: Measuring range: 0 360°, Precision: 5°	
	Wind speed: Measuring range: 0 30m/s, Precision: 0.3m/s	
	Barometric pressure: Measuring range: 30 110Kpa, Precision: 2.5pa	

6.3.9.5. Methodology adopted

6.3.9.5.1. Methodology for using AQMS for Outdoor Air Quality measurements.

The AQMS Air Quality Monitoring Station can measure outdoor air pollutants in real-time, quickly and accurately. It can be customized for different application demand. The following parameters can be measured:

- the Gas type Ozone(O_3),

- Nitrogen Dioxide (NO_2),
- Sulfur Dioxide (SO_2), Carbon Monoxide (CO),
- Particulate matter PM $_{2.5}$ and PM_{10}.

6.3.9.5.2. Monitoring and Data Collection

The location coordinates of the indoor air quality monitoring stations are as shown in the table below. The station location and siting were chosen by AH environmental consultancy and were intended to provide indoor air quality data for the site.

Table 28 : Coordinates of air quality measurement points

Point	Latitude	longitude
P1	41.16769772°	21.54851683°
P2	41.14237078°	21.52884385°
P3	41.11042168°	21.51658093°

6.3.9.5.3. Data Acquisition

Data acquisition was performed by using a Personal Computer based data logger situated at AQMS in monitoring sites. Data were saved every hour (hourly average). The data were backed up and downloaded every day and were subjected to a rigorous program of quality check.

6.3.9.5.4. Data Validation and Reporting

The accredited laboratory maintains distinct databases containing non-validated and validated data respectively. The validated database is created by duplicating the non-validated database and then flagging data affected by instrument faults, calibrations and other maintenance activities. Invalid data is removed with the support of valid reason (e.g., supported by maintenance notes, calibration sheets etc. as documented in exception tables). Validation is performed by a trained data analyst. All data is checked and reviewed by the laboratory's head section. Graphs and reports are generated based on the validated hourly data and daily data.

6.3.9.5.5. Air Quality Limit Values

Air quality data of Air Quality Monitoring Station have been compared with the NCEC 2014 indoor air standards.

6.3.9.5.6. Calibration

Multipoint calibration of the instruments monitoring gaseous pollutants was conducted before installation at both locations successively. The instruments were calibrated in full accordance with the manufacturer's recommendations and conform to the requirements of United States Environment Protection Agency SEPA. Calibrations were performed at

the monitoring site by allowing the analyzer to sample a gaseous standard containing a known pollutant concentration.

6.3.9.6. Results for air quality analysis

The results of sample 1 are shown in tables below. it was found that there are no diffractions in any of parameters measured, of the standards of the General Authority for Meteorology and the NCEC.

Table 29: air quality measurement results in point 1

Time	Temperature (°C)	Humidity (%)	Wind direction (o)	Wind speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOX (µg/m3)	O3 (µg/m3)	H2S (µg/m3)
7:00	16.2	56	376.3	6.776	16.9371	62.176	84.21463	20.748	0.433245
8:00	19.44	45.92	389.9	7.711	11.73629	53.5456	69.625	24.624	0.70975
9:00	22.68	36.96	308.5	8.371	8.064741	48.0008	59.925	30.21	0.80563
10:00	24.84	30.24	5.65	9.009	7.136091	46.9336	57.82088	29.526	0.953275
11:00	27	24.64	5.65	7.854	5.619009	28.9768	36.93538	32.718	1.3481
12:00	28.08	24.64	123.2	5.049	3.120141	15.834	20.23125	27.018	2.757145
13:00	28.08	22.4	335.6	3.696	8.618241	49.9844	62.62088	20.064	0.302345
14:00	29.16	23.52	323.2	2.959	13.75755	68.15	87.41875	20.064	0.246075
15:00	28.08	24.64	343.5	2.497	15.56356	63.394	84.12713	17.67	0.232645
16:00	28.08	26.88	331.1	2.024	19.81936	68.1268	93.55	9.918	0.306595
17:00	27	30.24	339	1.848	22.73864	71.4676	100.1209	7.752	0.368305
18:00	24.84	35.84	319.8	2.838	27.08866	73.7064	106.9584	12.312	0.396355
19:00	23.76	40.32	282.5	2.277	31.05135	84.2508	122.3375	9.234	0.41888
20:00	21.6	40.32	211.3	1.199	13.97686	31.378	48.01663	15.276	0.1751
21:00	21.6	42.56	167.2	1.595	8.5977	24.6732	35.32288	16.986	0.393125
22:00	20.52	45.92	145.8	1.914	14.36431	30.4848	47.44375	12.54	0.388025
23:00	19.44	47.04	171.8	3.146	24.55486	62.5704	92.38338	6.612	0.403495
0:00	18.36	49.28	154.8	2.574	19.97114	42.0384	65.58963	8.436	0.48365
1:00	18.36	50.4	123.2	1.991	12.05806	31.6796	46.38963	7.866	0.57817
2:00	18.36	50.4	131.1	2.497	22.6074	46.8988	73.51038	4.56	0.431545
3:00	17.28	51.52	133.3	2.618	29.3232	65.3544	100.2229	5.358	0.31195
4:00	16.2	53.76	111.9	1.98	23.91526	62.7676	91.94375	6.954	0.343655
5:00	15.12	54.88	131.1	1.672	21.16424	70.412	97.38125	7.866	0.386155

6.3.10. Ambient noise

6.3.10.1. Methodology of noise monitoring

Baseline environmental noise measurements were conducted at three (03) locations in the project site as required by the contract. the three points have been set to cover the project area to the extent possible (see figure below).

Measures were undertaken by the device "Cirrus Optimus sound level meters instrument (CK: 1720 kit)" which is approved by the NCEC Control and compliant with the requirements of the Environmental Protection Agency (EPA).

The microphone was placed on a tripod, at a height of 1.5 m above ground level under free-field conditions.

The attended survey collected continuously sound level data during one half an hour to one hour on morning, and on late evening as required by the NCEC to gain a realistic understanding of baseline sound on the development site.

As the project site is located far from any human settlement and only adjacent roads will be impacted by the noise. The noise level limits adopted are those dictated by NCEC standards for noise levels in proximity of roads (see table 12)

Table 30 : Noise measurement points coordinates

Point	Longitude (°)	Latitude (°)
P1	21.54733869	41.16813836
P2	21.52726846	41.13831618
P3	21.51543115	41.11104989

Figure 47 : Points of noise measurement location

6.3.10.2. Results of noise measurement

The results of measures are given by the following table.

Table 31 : Noise intensity in measurement points in the site

Time	Time	LAeq	LAFMax	LA10	LA90	NCEC LIMIT
NM1	**07:00- 08:00 AM (Day time)**	43.5	57.5	44.5	38.9	**70**
	19:30 -20:30 PM (Evening)	51.2	60.5	44.2	38.2	**65**
NM2	**07:30- 08:30 AM (Day time)**	41.8	57.3	47	41.1	**70**
	20:00 -20:30 PM (Evening)	50.2	62.2	45.8	38	**65**
NM3	**08:00- 08:30 AM (Day time)**	45.6	56.6	48.8	40.8	**70**
	20:30 -21:00 PM (Evening)	52	61.7	46.1	39.9	**65**

From the results shown above, it was found that the noise intensity values at the points in the site did not exceed the permissible limits according to the executive regulations of the NCEC nor the IFC guidelines.

6.4. Ecology and Biodiversity Baseline

6.4.1. Introduction

A biodiversity assessment was carried out for Haden PV solar plant site (henceforth referred to as 'the Project Site) to characterize the ecological features and identify any biodiversity elements that require special consideration during the development stages of the project.

6.4.2. Project Site boundaries identification

The Project Site has a surface area of approximately 60 Km² and is located roughly around 80 Km east of the city of Taif, see the figure 49 below.

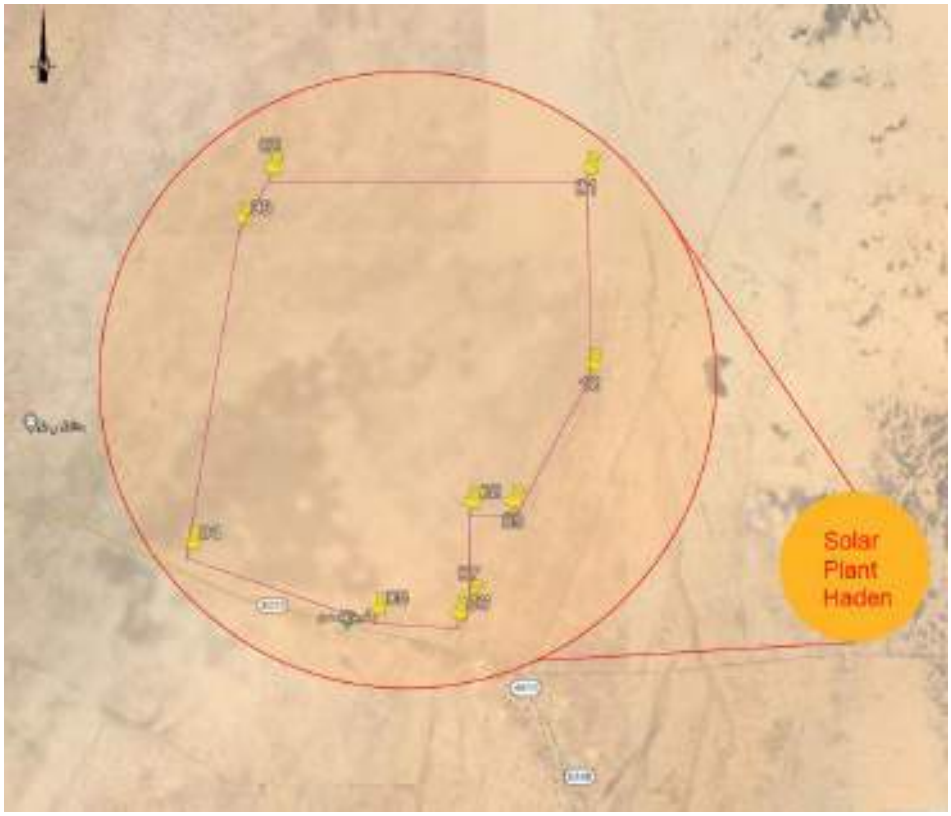


Figure 48 : Project Site boundaries and location

6.4.3. Objective

The ecological walkover survey was undertaken at the Project Site in order to document ecological features (flora, fauna, and habitat/landscape).

Items recorded during the survey included the following:

- Landscape features.
- Flora species.
- Fauna species, including avifauna, and any relevant signs.
- Land use features (human settlements, domestic animals, agricultures etc.).

6.4.4. Methodology

The biodiversity assessment would cover general ecology, biogeography, and habitats in addition to flora (annual and perennial) and fauna (mammals, herpetofauna, avifauna and macro-invertebrates). The assessment aims to identify any ecologically sensitive areas in the study area and its surroundings, including Key Biodiversity Areas (KBAs), which include Important Bird Areas (IBAs).

Based on the results of the assessment, potential impacts of the project on all biodiversity will be analyzed outlining those potential impacts at the various development stages of the project. Following up on the potential impacts, mitigation and monitoring measures will be provided.

The assessment methods of the Project Site are divided into two main parts; a comprehensive literature review and field survey.

6.4.4.1. Desktop Review

The Desktop Review is based on previous studies, data, surveys, and records available in published scientific papers, books, and journals on biodiversity recorded within the study region in general. It is important to note that since the available literature on the Project site and its vicinity is relatively limited, the literature reviewed will include a wide spectrum of references including international references that have a wider focus than the area of the Project.

As part of the desktop assessment, habitat mapping and assessment was undertaken in order to identify any areas of conservation sensitivity present. Integrated Biodiversity Assessment Tool (IBAT) will be referred to in order to identify all sites of biodiversity importance (Key Biodiversity Areas) and Protected Areas. In compliance with IFC's PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, the review of IBAT will identify the need to undertake a Critical Habitat Assessment (CHA). As defined by PS6, critical habitats are 'areas with high biodiversity value, including (i) habitat of significant *importance to Critically Endangered and/or Endangered11 species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally*

significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

Based on this, it is crucial to undertake this desktop exercise at an early stage of the assessment in order to identify if there is a need to carry out a Critical Habitat Assessment or not at the Project Site. Also, on the habitat level, priority ecoregions of global conservation will be identified if present at the project areas according to Olson et al (2003).

6.4.4.2. Field Survey

A comprehensive walkover field survey was undertaken at the Project site, Including field observation.

The site was examined carefully for the presence of active animals, animal signs and tracts, active burrows, remains or any other vital signs that indicate the activity of animals. In addition, the site was surveyed for occurring plant species, which was noted and recorded to include number of species, coverage per species, etc. Routes of inspection was spread out across the project area to provide a comprehensive representation. Additionally, any areas that were identified as areas of special interest were visited and their biodiversity was recorded. Finally, any accidental records of any species at the project Site were added into the list of species recorded.

Items recorded during the survey will include the following:

- Landscape features.
- Flora species.
- Fauna species, including avifauna, and any relevant signs.
- Land use features (human settlements, domestic animals, agricultures etc.).

6.4.5. Results

6.4.5.1. Habitats and Flora

6.4.5.1.1. Desktop Review

The Project Site is part of the Southwest Arabian Escarpment Shrublands and Woodlands Ecoregion (Olson et al, 2001), which is part of the Desert and Xeric Shrublands Biome under the Afrotropic Realm (Figure 30 (right)). From a biogeographical perspective, the Project Site has its vegetation type described as 'Scarcely vegetated dunes and sandy gravel plains', as part of the Deserts and other scarcely vegetated areas of the Arabian Peninsula (Ghazanfar & Fisher, 1998) (Figure 30 (left)).

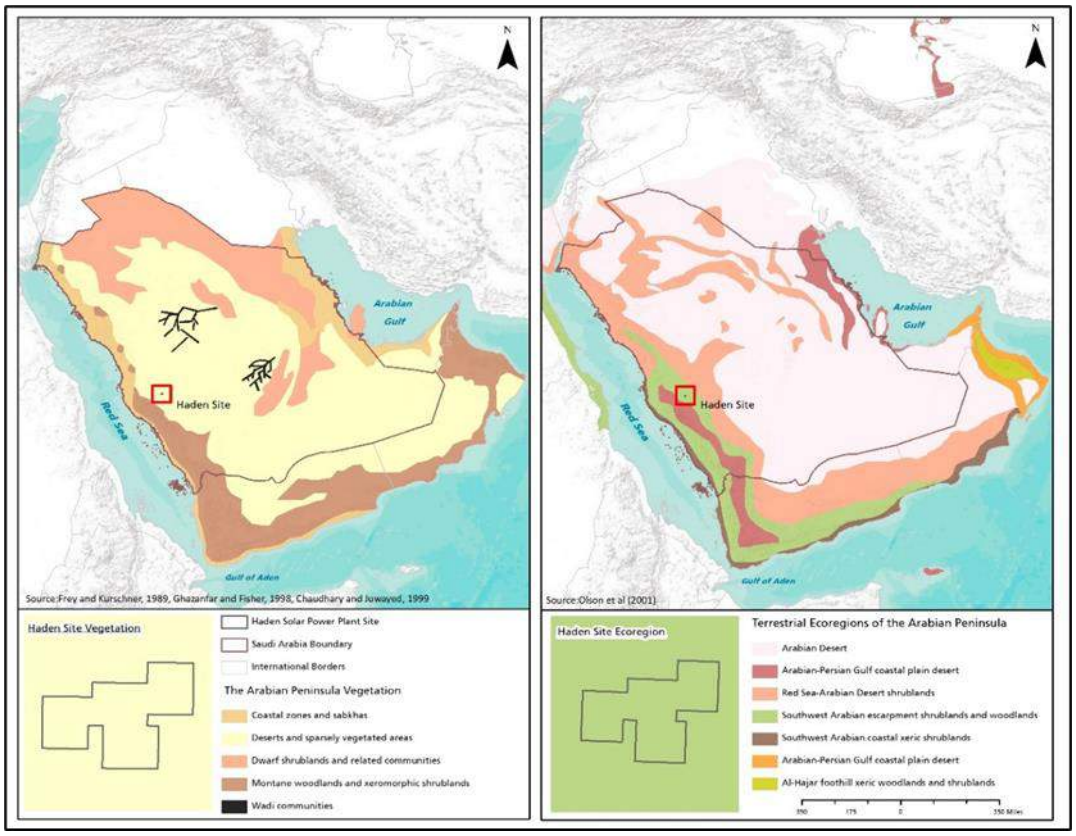


Figure 49: Location of the Project Site in the Deserts and Sparsely vegetated Area (Ghazanfar & Fisher, 1998) (left), and the location of Project Site in the Red Sea-Arabian Desert Shrublands Ecoregion (Olson et al, 2001) (right).

6.4.5.1.2. Field Survey

Based on the field survey, the Project Site is located in a sandy/gravel plain ranging in elevation between 1155 m and 1186 m asl. Generally, the area can be divided into two conspicuous parts; the western part with scarce vegetation and mainly sandy substrate and the eastern part that has a relatively high density of perennial species making it almost inaccessible with a vehicle in some part.

Annual species were recorded across the Project Site were limited to grass species *Stipagrostis plumosa*, while perennial plant species recorded were limited to five species, see Table 32 and Figure 51. Vachellia tortilis was very scarcely recorded along with *Citrullus colocynthis* and Indigofera spinosa, while the highest coverage, including the western part of the Project Site was dominated by *Clutia lanceolata* and *Calotropis procera.*

Table 32 : Flora Species Recorded on Site

Family	Name	Type	DAFOR	Endemism / Status	IUCN Threatened Species Status (2022)
Apocynaceae	*Calotropis procera*	Shrub	A	Native	Not Evaluated (NE)
Cucurbitaceae	*Citrullus colocynthis*	Shrub	R	Native	Not Evaluated (NE)
Fabaceae	*Vachellia tortilis*	Shrub	R	Native	Least Concern (LC)
Fabaceae	*Indigofera spinosa*	Shrub	R	Native	Not Evaluated (NE)
Graminae	*Stipagrostis plumosa*	Grass	R	Native	Not Evaluated (NE)
Peraceae	*Clutia lanceolata*	Shrub	A	Native	Not Evaluated (NE)

Figure 50: Flora Species Recorded on Site: *Clutia lanceolata* (top left) *Vachellia tortilis* (top right), *Indigofera spinosa* (bottom left) and *Calotropis procera* (bottom right)

6.4.5.2. Birds

6.4.5.2.1. Desk Review

Based on the desktop review, the Project Site does not overlap with any Important Bird Areas (IBAs).

According to BirdLife International Sensitivity Mapping Tool for Migratory Soaring Birds (BirdLife, 2022), it shows that the Project Site does not potentially indicate a high level of migration. No satellite-tracked bird is documented to pass over the Project Site. On the other hand, nine species of Migratory Soaring Birds have the Project Site overlapping with their distribution range, in addition to another non-MSB globally threatened species bringing the overall number of species into ten see Table 29.

Table 33 : Migratory Soaring Bird Species and Globally Threatened Species that the Project Site overlaps with their Distribution Range

Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)	IUCN Red List Status for Breeding Birds of Arabia (2015)
Griffon Vulture	*Gyps fulvus*	Extant (Resident)	Least Concern	Endangered
Egyptian Vulture	*Neophron percnopterus*	Extant (Resident)	Endangered	Vulnerable
Steppe Eagle	*Aquila nipalensis*	Extant (Non-breeding)	Endangered	Not Applicable
Eastern Imperial Eagle	*Aquila heliacal*	Extant (Non-breeding)	Vulnerable	Not Applicable
Greater Spotted Eagle	*Clanga clanga*	Extant (non-breeding / passage)	Vulnerable	Not Applicable
Shikra	*Accipiter badius*	Extant (Resident)	Least Concern	Least Concern
Saker Falcon	*Falco cherrug*	Extant (passage)	Endangered	Critically Endangered
Common Kestrel	*Falco tinnunculus*	Extant (Resident)	Least Concern	Least Concern
Great White Pelican	*Pelecanus onocrotalus*	Extant (passage)	Least Concern	Not Applicable
Asian Houbara	*Chlamydotis macqueenii*	Extant (Non-breeding)	Vulnerable	Critically Endangered

6.4.5.2.2. Field Survey

Incidental observations were limited to four species out of which a single species is globally evaluated as Near Threatened: Pallid Harrier *Circus macrourus*. Other avifaunal species of conservation importance that could be recorded at the Project Site are listed in the below table.

Figure 51: Avifauna Species Recorded on Site

Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)	IUCN Red List Status for Breeding Birds of Arabia (2015)
Pallid Harrier	*Circus macrourus*	Extant (Passage)	Near Threatened	Not Applicable
Eurasian Collared-dove	*Streptopelia decaocto*	Extant (Resident)	Least Concern	Least Concern
Great Grey Shrike	*Lanius excubitor*	Extant (Resident)	Least Concern	Least Concern
Brown-necked Raven	*Corvus ruficollis*	Extant (Resident)	Least Concern	Least Concern

6.4.5.3. Mammals and Reptiles

6.4.5.3.1. Desktop Review

A list was compiled for all reptile and mammal species that the Project Site is located inside their distribution range. For reptiles, in total, the Project Site is located inside the distribution range of 18 reptile species. None of which are evaluated as globally threatened. No burrows of the species were noticed at the Project Site., see Table 30. As for mammals, 23 species out of the 24 species are evaluated as Least Concern while a single species is recorded as Near Threatened; Striped Hyaena Hyaena hyaena, see Table 31. Due to its large home range and since the Project Site has several nomadic settlements and surrounded by several main road, it is believed that the species would not be using the Project Site and its vicinity extensively.

Table 34 : Reptile Species that the Project Site overlaps with their Distribution Range

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Reptilia	Squamata	Lacertidae	Hadramaut Sand Lizard	*Mesalina adramitana*	Extant (Resident)	Least Concern
Reptilia	Squamata	Lacertidae	-	*Mesalina brevirostris*	Extant (Resident)	Least Concern
Reptilia	Squamata	Lacertidae	Bosk's Fringe-toed Lizard	*Acanthodactylus boskianus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Varanidae	Desert Monitor	*Varanus griseus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Phyllodactylidae	-	*Ptyodactylus hasselquistii*	Extant (Resident)	Least Concern
Reptilia	Squamata	Gekkonidae	Middle Eastern Short-fingered Gecko	*Stenodactylus doriae*	Extant (Resident)	Least Concern
Reptilia	Squamata	Scincidae	Common Skink	*Scincus scincus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Psammophiidae	Hooded Malpolon	*Rhagerhis moilensis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Psammophiidae	Afro-Asian Sand Snake	*Psammophis schokari*	Extant (Resident)	Least Concern
Reptilia	Squamata	Atractaspididae	Mole Viper	*Atractaspis engaddensis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Viperidae	Arabian Horned Viper	*Cerastes gasperettii*	Extant (Resident)	Least Concern

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Reptilia	Squamata	Viperidae	Palestine Saw-scaled Viper	*Echis coloratus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Leptotyphlopidae	Beaked Thread Snake	*Myriopholis macrorhyncha*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Common Leaf-nosed Snake	*Lytorhynchus diadema*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Braid Snake	*Platyceps rhodorachis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Arabian Cat Snake	*Telescopus dhara*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Diadem Snake	*Spalerosophis diadema*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Elegant Racer	*Platyceps elegantissimus*	Extant (Resident)	Least Concern

Table 35: Mammal Species that could be present the Project Site

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Mammalia	Carnivora	Felidae	Sand Cat	*Felis margarita*	Possibly Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Red Fox	*Vulpes vulpes*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Blanford's Fox	*Vulpes cana*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Rüppell's Fox	*Vulpes rueppellii*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Grey Wolf	*Canis lupus*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Hyaenidae	Striped Hyaena	*Hyaena hyaena*	Extant (Resident)	Near Threatened
Mammalia	Carnivora	Mustelidae	Honey Badger	*Mellivora capensis*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Viverridae	Common Genet	*Genetta genetta*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Herpestidae	White-tailed Mongoose	*Ichneumia albicauda*	Extant (Resident)	Least Concern
Mammalia	Hyracoidea	Procaviidae	Rock Hyrax	*Procavia capensis*	Extant (Resident)	Least Concern
Mammalia	Eulipotyphla	Soricidae	Lesser Shrew	*Crocidura suaveolens*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Vespertilionidae	Sind Serotine Bat	*Rhyneptesicus nasutus*	Extant (Resident)	Least Concern

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Mammalia	Chiroptera	Vespertilionidae	Kuhls Pipistrelle	*Pipistrellus kuhlii*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Hipposediridae	Geoffroy's Trident Leaf-nosed Bat	*Asellia tridens*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Rhinopomatidae	Lesser Mouse-tailed Bat	*Rhinopoma hardwickii*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Rhinopomatidae	Egyptian Mouse-tailed Bat	*Rhinopoma cystops*	Extant (Resident)	Least Concern
Mammalia	Eulipotyphla	Erinaceidae	Desert Hedgehog	*Paraechinus aethiopicus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Dipodidae	Lesser Egyptian Jerboa	*Jaculus jaculus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Pygmy Gerbil	*Gerbillus henleyi*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Dwarf Gerbil	*Gerbillus nanus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Sundevall's Jird	*Meriones crassus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Arabian Spiny Mouse	*Acomys dimidiatus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Golden Spiny Mouse	*Acomys russatus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Fat Sand Rat	*Psammomys obesus*	Extant (Resident)	Least Concern

6.4.5.3.2. Field Survey

No live mammals or reptiles and/or burrows were recorded throughout the survey. On the other hand, livestock (sheep and camels) and shepherd dogs were recorded all over the Project Site along with several nomadic settlements and livestock enclosures, see Figure 34. Indications of intense levels of grazing were observed across the vegetation at the Project Site.

6.4.5.4. Areas of Conservation Importance

The Project Site does not overlap with any areas of nature conservation importance. The closest area to the Project Site is a Key Biodiversity Area called National Wildlife Research Centre and Environs, which is located around 55 km southwest of the Project Site. The KBA is around 40 km2 and is a fenced captive-breeding center. No protected areas are located near the Project Site.

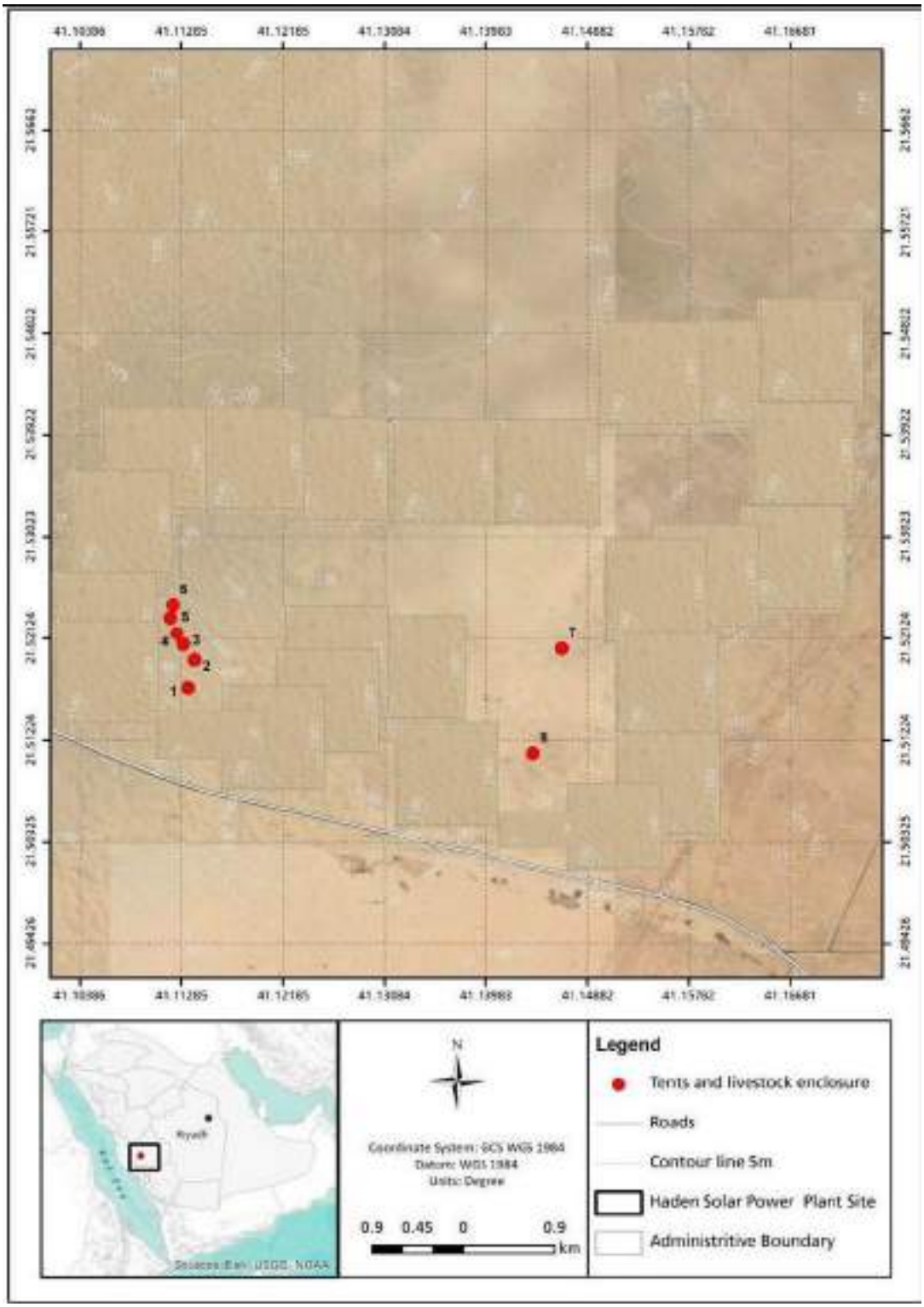


Figure 52 : Locations of nomadic settlements and livestock enclosures at the Project Site Areas of Conservation Importance

6.5. Socio-economic Environment

6.5.1. Administrative Boundaries

The external boundaries of the Makkah Mukkaramah Province were revised in 2016, when the number of governorates increased from 12 to 17. The 17 governorates, ordered by population from largest to smallest, are: Jeddah, Makkah, Taif, Qunfudah, Bahra, Al Jamoom, Rabigh, Laith, Al Ardhiyat, Maysan, Khulais, Adhaam, Raniyah, Turbah, Khurmah, Al Mowyah, and Al Kamil.

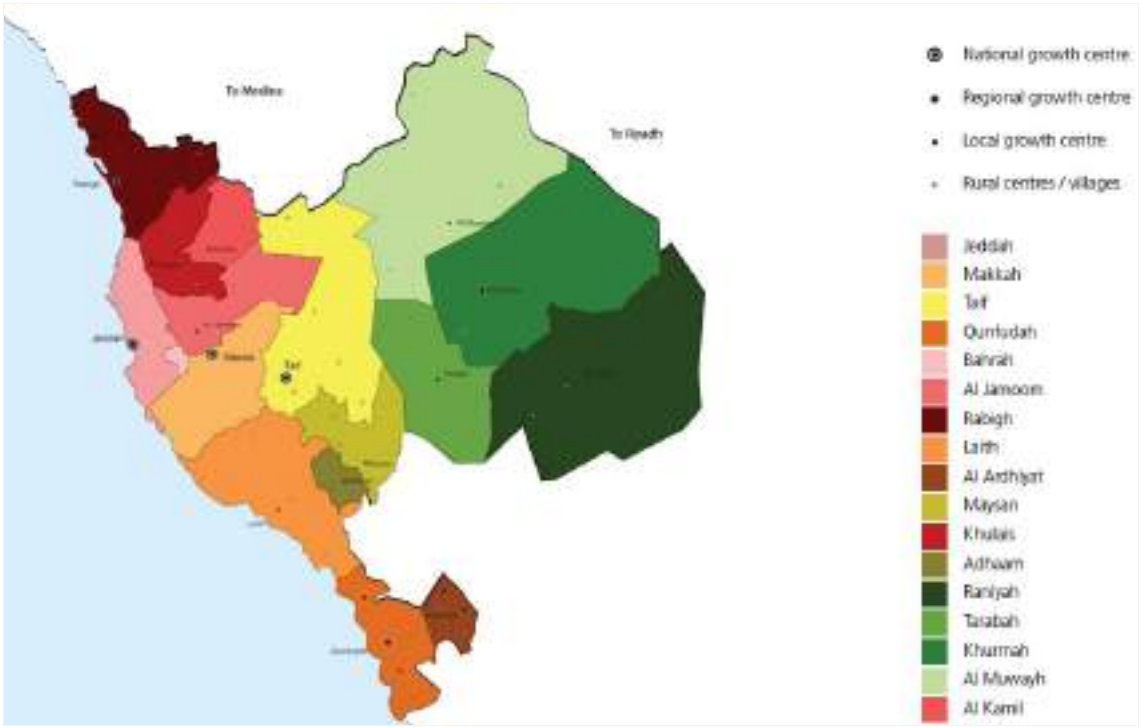


Figure 53 : Administrative boundaries

6.5.2. The Regional Plan for Makkah Region

The existing plan of the Makkah Region for the year 1460H, divides the region into the main development planning sectors and development corridors, as the maps display.

The first sector is the Northwestern coastal development corridor. The main economic activities include industrial, mining, and offshore activities, as minerals are abundant in the region. The second development sector features the pillars of the current economic activities in the Makkah Region (including Makkah, Jeddah, and parts of Al-Jamoom area), having the highest population density in the region.

The third development sector is the Southwestern coastal corridor, primarily represented by maritime and related activities. The fourth development sector, represented in the western and southwestern parts, which includes the study area, considers grazing the main source in the area. The fourth sector also enjoys wide coverage of basic services, such as

sewage networks, water supply networks, highways, and road infrastructure in the region. Agricultural and industrial activities are absent in the region.

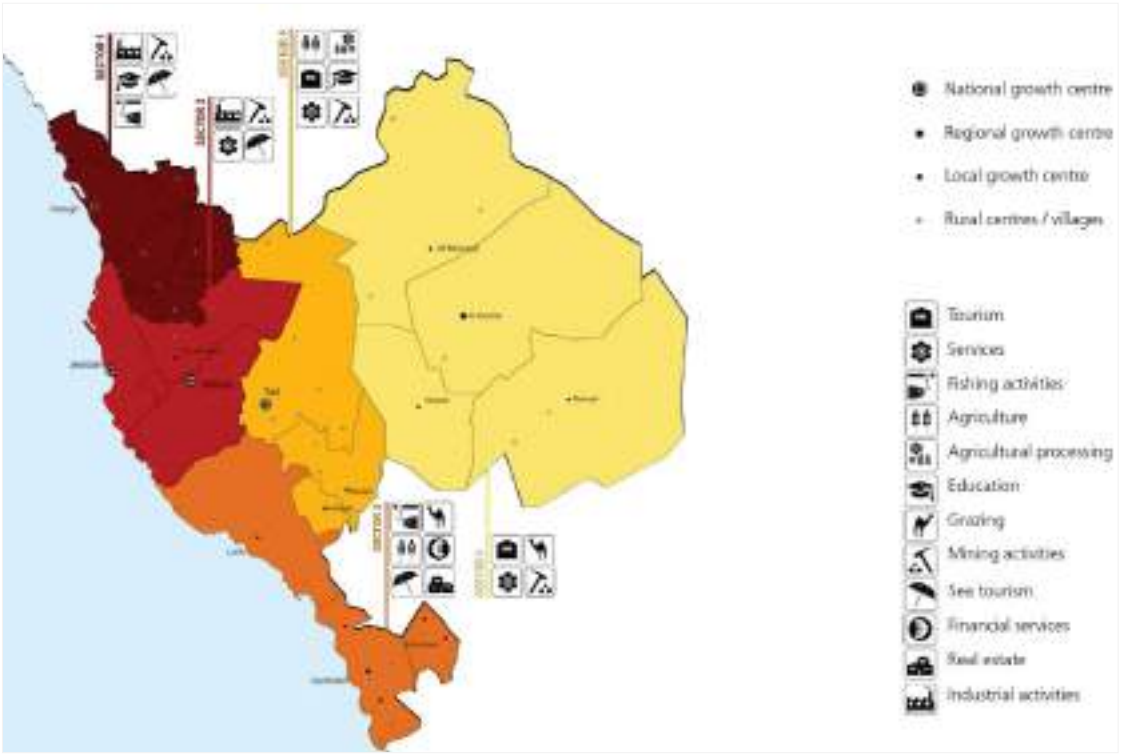


Figure 54 : Development sectors according to the Regional Plan for the Makkah Region, Vision 1460H (2038)

6.5.3. Movement Infrastructure

Although the region is considered well serviced with roads in comparison with other regions, the Regional Plan adopted the idea of developing a link between various parts of the region and establishing a road network characterized by a well-structure road hierarchy, including the upgrading of desert roads linking villages and urban centers. According to our drivability analysis, about 95% of the population resides within 15-minute drive time from the major urban centers with more than 80% of the total population living in the three major cities (and their peri-urban region).

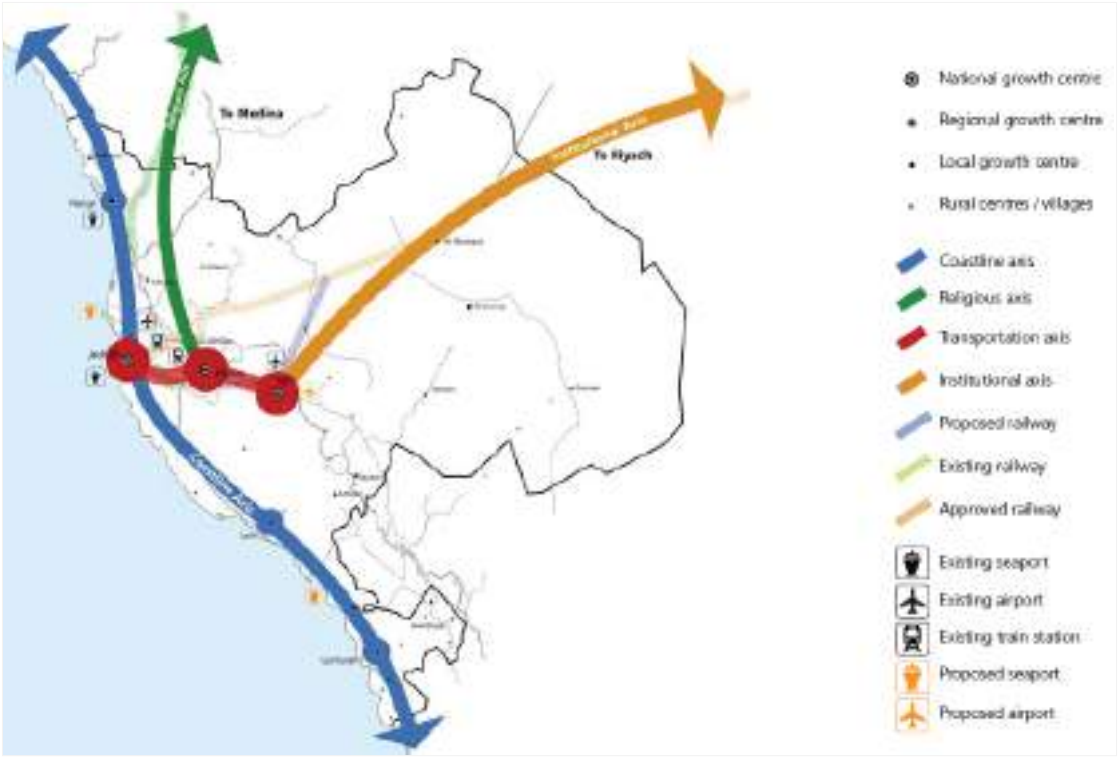


Figure 55 : Development corridors according to the Regional plan of the Makkah Region, Vision 1460H (2038)

In addition to the development sectors identified by the Regional Plan for Makkah, four strong functional / thematic axes have been identified:

- The religious axis between Makkah and Madinah;
- The coastline axis connecting Jeddah with other regional
- growth centers along the coastline, supported by a major highway;
- The institutional axis directly connecting Taif to Riyadh; and
- The Jeddah-Makkah-Taif Corridor.

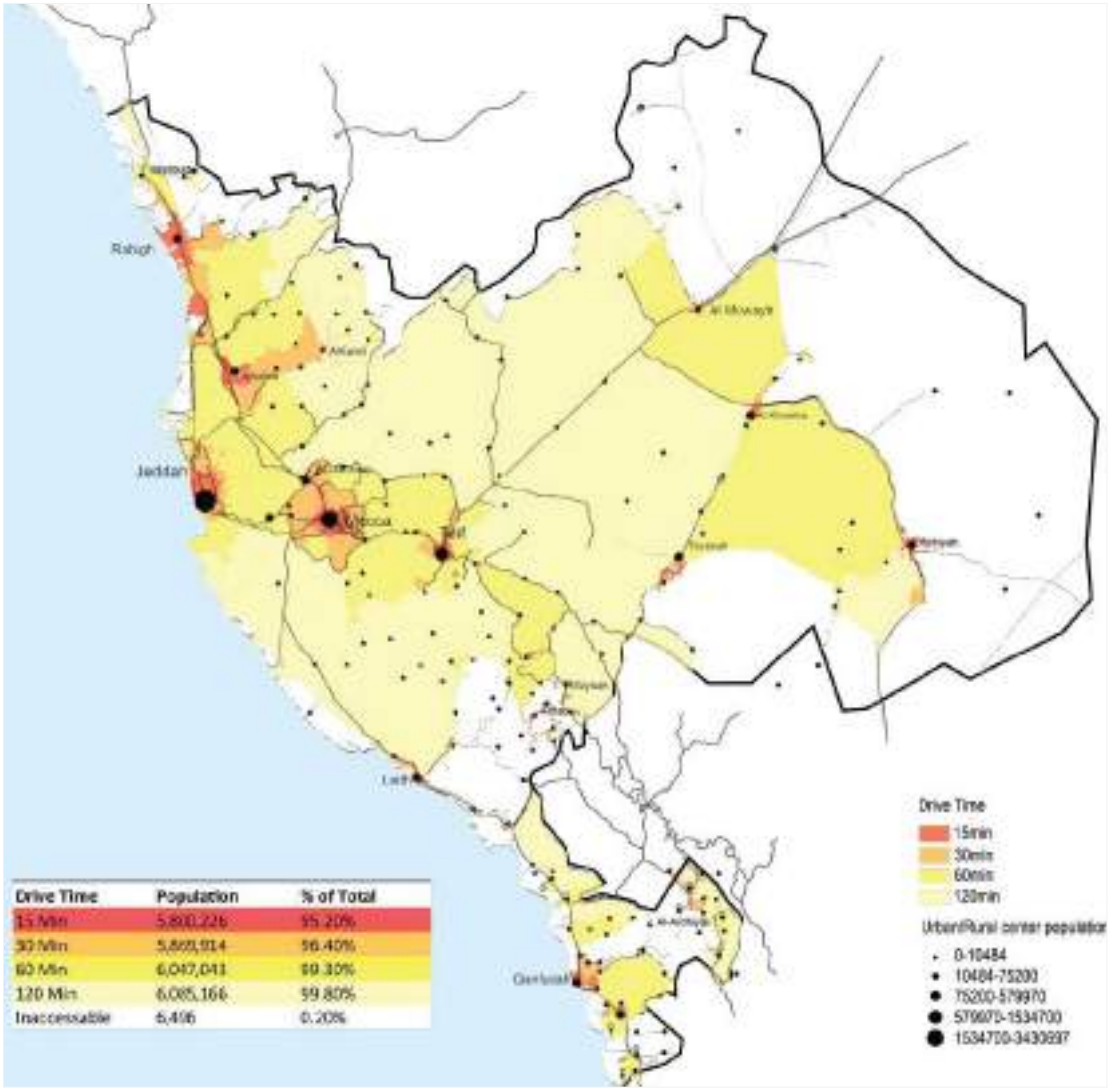


Figure 56 : Access and connectivity in the Makkah Region

6.5.4. Demographic background

The Makkah Region is the most populated region in KSA, hosting more than a quarter of the population of the Kingdom. It has a population of 6,915,006, (according to the 2010 Census). Jeddah Governorate has the most significant share of the total population of the region at 50.3%, followed by Makkah with 24.2%, and by the third largest city, Taif, with 14.1%. The number of Saudi population in the region is estimated to be 4.55 million and 3,340 non-Saudis, which is one of the highest ratios in the Kingdom.

Table 36 : Population distribution

administrative area	Saudis			Non-Saudis			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Mekkah Region	2085813	2030252	4116065	1828412	970529	2798941	3914225	3000781	6915006

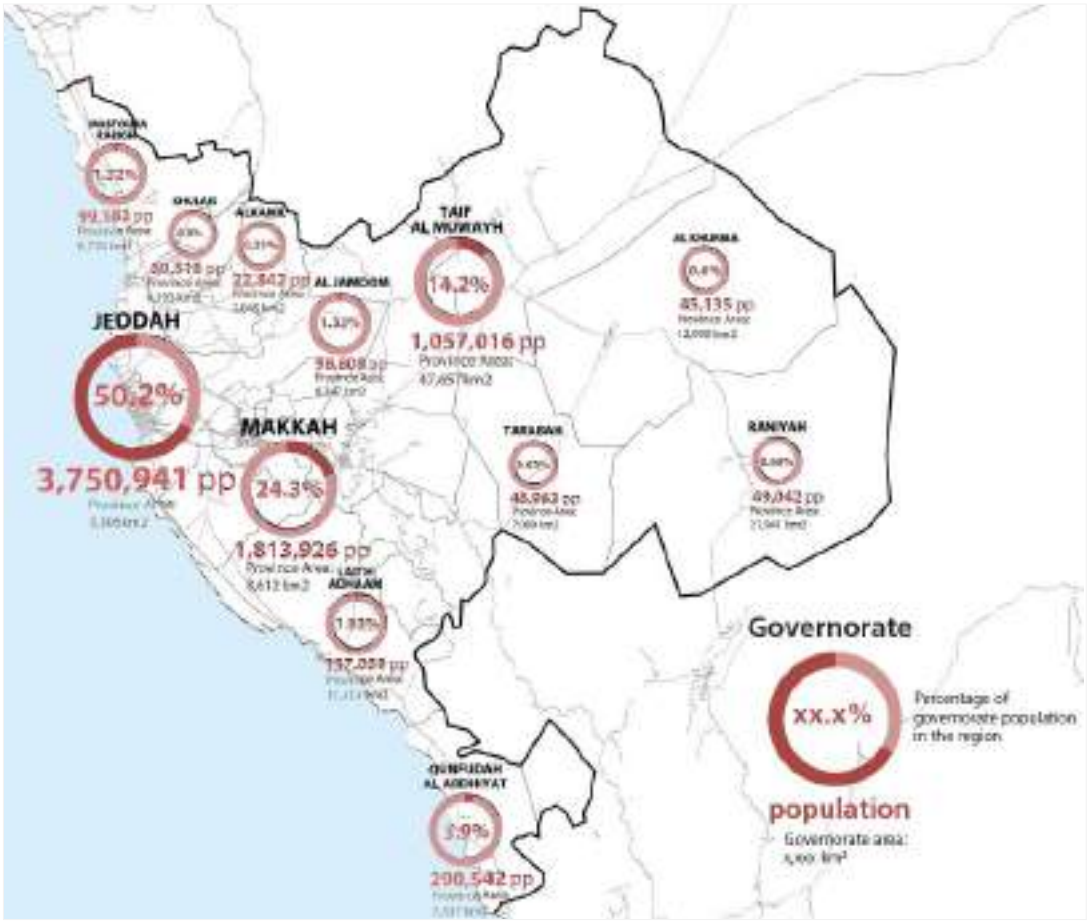


Figure 57 : Population distribution in the governorates according to 2010 Census.

6.5.5. Gross Domestic Product

The Gross Domestic Product (GDP) of the Makkah Region (2012) was 288 billion Riyals, representing 10.9% of the GDP of the Kingdom, and 20.8% of the GDP of the Kingdom excluding crude oil and gas. The average annual growth rate of the GDP for the region was 30% during the 2009-2012 triennium. Real estate and financial services sector ranked first in terms of contribution to the region's GDP with 18%, followed by industry with 16.9%, trade with 16.7%, transport and communications with 9.5%, building and construction with 6.7%, and personal and community services sector with 3.3%.

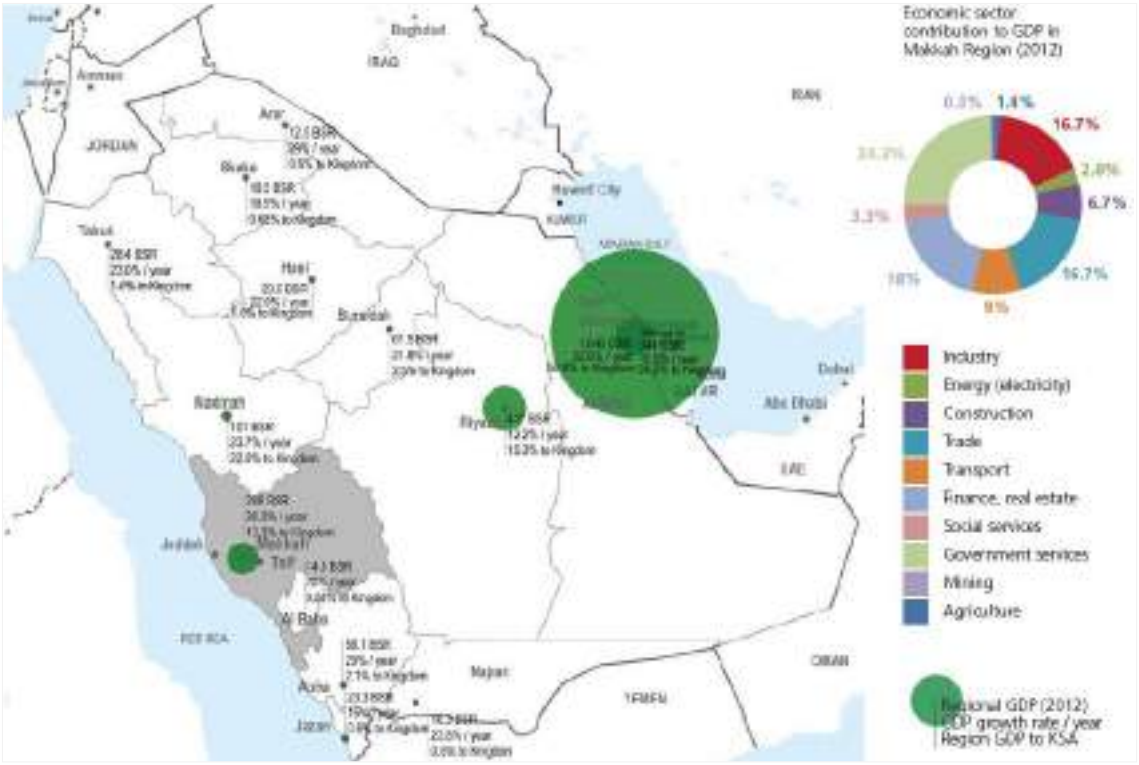


Figure 58 : Regional Gross Domestic Product and economic sector contribution

6.6. Sensitive receptors

6.6.1. Environment sensitive receptors

Sensitive areas are defined as the areas located near the Project and where occupants are more susceptible to the exposure of pollutants, chemicals, traffic, noise, and vibration as a result of the project construction and operation. Sensitive receptors include schools, universities, hospitals, housings, mosques, libraries, parks, Government buildings, cemeteries, museum, investigation centres, etc.

No sensitive receptors such mentioned above was identified close to the project site except some seasonal shepherds/herders and temporary settlements whom main activity is grazing. The nearest city which is Ateef is far from the site 39 km.

It is also important to mention the presence of military area in the south of the selected site at 20 km far.

6.6.2. Ecological sensitive receptors

The Project Site is located on a flat sandy plain partially covered in gravel. The landscape is natural and does not feature any prominent human interventions.

During the ecology survey vegetation cover was evaluated as limited to groups of perennial shrubs/trees. Some parts of the Project Site are completely devoid of any vegetation cover while in others, sparse vegetation was observed.

The project site itself is evaluated to have a minor ecological value.

6.6.3. Socioeconomic sensitive receptors

Potential receptors relevant to the Socio-Economic impact assessment include:

- Farmers, seasonal herders, and recreational users within the site boundary and which utilize the wider landscape. The sensitivity of these receptors is valued as moderate on account their transient nature or limited likelihood of being occupied by vulnerable groups for extended periods.
- Local communities including settlements adjacent to the development site and along the route of potential transportation routes. The sensitivity of these receptors is valued as moderate and working age members of the community most likely to be affected and settlements on transport routes will not be receptors of impacts for extended periods.
- Local utility infrastructure and providers. The sensitivity of these receptors is valued as low on account of the ability to adapt and respond to change

7. IMPACT ASSESSMENT

7.1. Introduction

This section assesses the manner in which the Project will interact with elements of the physical, ecological or social environment to produce impacts to resources/ receptors. It has been organized as per the operational and decommissioning phases of the project life cycle to understand the risks and impacts associated with each phase.

7.2. Impact assessment methodological approach

The methodological approach used for the assessment of the potential environmental and socio-economic impacts associated with the construction and operation of the proposed Project and associated facilities and indicates how the relevant mitigation measures to be adopted for avoiding, reducing or compensating such impacts will be considered as part of the impact assessment process.

Impact identification and assessment starts with scoping. Once identified, potential impacts need to be assessed in order to enable a judgement of their significance that allows for the prioritization of the mitigation/enhancement and management measures. Potential Project impacts are assessed in relation to environmental and biological resources as well as socio-economic resources (community, individuals, and social, economic, and cultural assets) within the Project Area of Influence (AoI).

The principal ESIA steps comprise the following:

- ***Impact prediction***: to determine what could potentially happen to resources or receptors because of the Project and its associated activities – potential impacts are identified during the ESIA scoping phase.
- ***Impact evaluation***: to evaluate the significance of the predicted impacts by considering their magnitude and likelihood of occurrence, and the sensitivity, value and/or importance of the affected resource or receptor.
- ***Mitigation and enhancement***: to identify appropriate and justified measures to mitigate negative impacts and enhance positive impacts.
- ***Residual impact evaluation***: to evaluate the significance of impacts assuming effective implementation of identified mitigation and enhancement measures.

7.3. Project area of Influence (AOI)

According to the IFC Performance Standard 1 "where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence (AoI)", which is defined as to encompass the following (IFC, 2012):

- The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors)

and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.

- Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly affected by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

The Project AOI consists of the environmental and social aspects within the Project Site, if they exist and receptors within the 500m corridor along the project access roads and Electrical Transfer lines that will potentially be affected by the Project activities and operations and cumulative impacts of nearby other existing plants/facilities.

7.4. Identification and characterization of impacts

An 'impact' is any change to a resource or receptor caused by the presence of a project component or by a project- related activity. Impacts can be negative or positive and are defined in terms of their characteristics, including the impact's type (direct, indirect, induced, cumulative) and the impact's spatial and temporal features (i.e. extent, duration, scale and frequency).

Types of impacts are described as below:

- **Direct**: applies to an impact which can be clearly and directly attributed to a particular environmental or social parameter (e.g. dust generation directly affects air quality).
- **Indirect**: applies to impacts which may be associated with or subsequent to a particular impact on a certain environmental or social parameter (e.g. high levels of dust could entail nuisance and health effects to workers on site).
- **Induced**: applies to impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project.
- **Cumulative**: applies to impacts that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect.

Impact characteristics are defined in the below table.

Table 37 : Impact Characterization Criteria

Duration	Short-term: impacts with relatively short duration with respect to the whole duration of the project (e.g. limited to five-year period).	Long-term: impacts whose effects last longer than a period of five years, but limited to within the project lifetime.	Permanent: impacts that cause a permanent change in the baseline conditions and therefore also evaluated as irreversible
Extent	Local: impact affecting the environment or communities within the Project AoI.	Regional: impact affecting a wider area or socio- economic asset of importance going beyond the communities in the Project Area of Influence.	National: impact extending to the national level, or affecting assets of national importance.
Frequency	One-off/ Occasional: impacts that occur once only or occasionally.	Intermittent: impacts that occur periodically or repeatedly.	Continuous: impacts that happen continuously
Intensity/Impact scale	**Low**: limited impacts not causing any change or causing change hardly distinguishable from background conditions	**Medium**: impacts causing change, but not affecting the core structures/functions of the resource/receptor	**High**: impacts causing evident changes of core structures/functions of the resource/receptor
Likelihood	Unlikely: The event is unlikely but may occur at some time during normal operating conditions	Possible: The event is likely to occur at some time during normal operating conditions.	Likely: The event will occur during normal operating conditions (i.e. it is essentially inevitable).

7.5. Evaluation of Impacts

A consistent approach to the assessment of impacts will be followed to enable environmental and social (E&S) impacts to be broadly compared across the ESIA. A set of generic criteria are used to determine impact significance and are applied across the various environmental and social parameters.

Environmental and social impacts are quantified as much as possible. For cases where quantification is not possible/applicable, a qualitative assessment is conducted using professional judgement, experience and available knowledge, and including the consideration of stakeholder views. Where there are limitations to the data, and/or uncertainties, these are recorded in the relevant sections, along with any assumptions made during the assessment.

In order to determine the significance of each impact, two overall factors are considered:

- Magnitude and nature of impacts
- The importance and/or sensitivity of the environmental and social receiving parameter, as determined during the assessment of baseline conditions.

7.5.1. Magnitude of Impact

Once impacts are characterized as per table, they are assigned a 'magnitude' which is typically a function of some combination (depending on the subject receptor) of the following characteristics:

- Duration
- Extent
- Frequency
- Scale.

Magnitude is a continuum from small to large, along which evaluation requires professional judgement and experience. Each impact is evaluated on a case-by-case basis and the rationale for each determination is noted. Magnitude designations for negative effects are ***negligible, small, medium*** and ***large***. The magnitude designations themselves are universally consistent, but the definition for the designations varies by issue. In the case of a positive impact, no magnitude designation is assigned as it is considered sufficient for the purpose of the impact assessment to indicate that the Project is expected to result in a positive impact.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is used. In addition, the likelihood factor is also considered, together with other impact characteristics, when assigning a magnitude designation while likelihood is considered either possible or likely for impacts from a planned activity.

For biophysical impacts, the semi-quantitative definitions for the spatial and temporal dimension of the magnitude of impacts used in this assessment are provided as follows:

Negligible Magnitude Impact results in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes are regarded as having no impact and characterized as having a negligible magnitude.

Low Magnitude Impact affects a specific area, system, aspect (physical), group of localized individuals within a population (biological) and at sufficient magnitude to result in a small increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) over a short time period (one plant/animal generation or less, but does not affect other trophic levels or the population itself), and localized area.

Moderate Magnitude Impact affects a portion of an area, system, aspect (physical), population or species (biological) and at sufficient magnitude to cause a measurable numerical increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) and may bring about

a change in abundance and/or distribution over one or more plant/animal generations, but does not threaten the integrity of that population or any population dependent on it (physical and biological). A moderate magnitude impact may also affect the ecological functioning of a site, habitat or ecosystem but without adversely affecting its overall integrity. The area affected may be local or regional.

High Magnitude Impact affects an entire area, system (physical), aspect, population or species (biological) and at sufficient magnitude to cause a significant measurable numerical increase in measured concentrations or levels (to be compared with legislated or international limits and standards specific to the receptors) (physical) or a decline in abundance and/ or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations (physical and biological). A high magnitude impact may also adversely affect the integrity of a site, habitat or ecosystem.

For socioeconomic impacts, the magnitude considers the perspective of those affected by taking into account the likely perceived importance of the impact, the ability of people to manage and adapt to change and the extent to which a human receptor gains or loses access to, or control over socio-economic resources resulting in a positive or negative effect on their well-being. The quantitative elements are included into the assessment through the designation and consideration of scale and extent of the impact.

7.5.2. Sensitivity of Receptors

In addition to characterizing the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity of the receptor. There are ranges of factors to be considered when defining the sensitivity of the receptor, which may be physical, biological, cultural or human. Where the receptor is physical (for example, a water body) its current quality, sensitivity to change, and importance (on a local, national and international scale) are considered. Where the receptor is biological or cultural (i.e. the marine environment or a coral reef), its importance (local, regional, national or international) and sensitivity to the specific type of impact are considered. Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. As in the case of magnitude, the sensitivity designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity of receptor is low, medium and high.

For ecological impacts, sensitivity is assigned as negligible, low, medium or high based on the conservation importance of habitats and species. For socio-economic impacts, the degree of sensitivity of a receptor is defined as the level of resilience (or capacity to cope) with sudden social and economic changes. Criteria for deciding on the value or sensitivity of biological and socioeconomic receptors are presented as follows:

Negligible: A resource/receptor that has no or very low importance and rarity. The value of the resource/receptor is easily replaceable, or the resource/receptor is commonplace in the context of the assessment scope.

Low: A resource/receptor that has a high capacity to resist change. Recovery/regeneration is spontaneous upon cessation of Project activities. The value of the resource/receptor is considered low or easily replaceable or the resource/receptor is commonplace in the context of the assessment scope.

For ecological receptors, not protected or listed as common / abundant, or not critical to other ecosystem functions (e.g. key prey species to other species). For social receptors, those affected are able to adapt with relative ease and maintain pre-impact status.

Medium: A resource/receptor that has a moderate capacity to resist change. Recovery may require some intervention measures and/or time after cessation of project activities. A resource/receptor that is important locally or regionally in the context of the assessment scope.

For ecological receptors, not protected or listed but may be a species common globally but rare in Turkey with little resilience to ecosystem changes, important to ecosystem functions, or one under threat or population decline. For social receptors, those able to adapt with some difficulty and maintain pre-impact status but only with a degree of support.

High: A resource/receptor with limited or no capacity to resist change and is vulnerable. Recovery will require a long time or may not be possible (permanent loss). A resource/receptor that is important nationally or globally in the context of the assessment scope.

For ecological receptors, specifically protected under national legislation and/or international conventions. Listed as rare, threatened or endangered. For social receptors, those affected will not be able to adapt to changes and continue to maintain pre-impact status.

7.5.3. Assessment of Impact Significance

In order to assess the significance of an impact, the sensitivity of the receiving environmental or social parameter is considered in association with the magnitude of the impact, according to the matrix shown in Table below.

Table 38 : Impact Significance Matrix

Receptor Sensitivity	Impact Magnitude			
	Negligible	Small	Medium	Large
Low	Negligible	Negligible	Minor	Moderate
Medium	Negligible	Minor	Moderate	Major
High	Negligible	Moderate	Major	Critical

While the above matrix provides a framework for the determination of significance and enables comparison across environmental and social parameters, a degree of professional judgement is required, and some parameter-specific factors considered in making a determination of impact significance.

Additional guidance to the degrees of significance in the ESIA is provided below. Positive impacts provide resources or receptors, most often people, with positive benefits. Note that positive impacts are defined, but not rated for significance.

- **Negligible significance**: The impact is hardly distinguishable from background conditions and expected development in a no-project situation or the predicted effect is deemed 'imperceptible' or is indistinguishable from natural background variations.
- **Low significance**: a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.
- **Medium significance**: has an impact magnitude that is within applicable standards but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.
- **High significance**: an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of impact assessment is to get to a position where the Project does not have any

major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP[5] has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

7.5.3.1. Mitigation Potential and Residual Impacts

A key objective of an ESIA is to identify and define socially, environmentally and technically acceptable and cost- effective mitigations measures to avoid, reduce, remedy or compensate for potential negative impacts, and to enhance potential environmental and social benefits.

Impacts with negligible and low significance usually do not require any additional mitigation measure. This means that these impacts are within acceptable limits because:

- they are very unlikely to happen; and/or
- the sensitivity of receiving environment is very low; and /or
- project designs have installed sufficient control mechanisms.

For ***negligible*** and ***low significance,*** impacts should inherent control measures fail, the implementation of additional control measures should ensure impacts remain acceptable.

Impacts with ***medium significance***, deemed as significant impacts, require additional mitigation measures to reduce the impacts at acceptable levels. These impacts can be minimized in order to reach negligible or low levels that are also deemed as acceptable level of impacts (using effective control measures).

Impact with ***high significance*** generally require imperative mitigation to reduce the significance to lower levels before proceeding with the Project.

Positive impacts should be subject to enhancement measures where possible.

The approach followed to define mitigation measures is based on a typical hierarchy of decisions and measures. The priority is to first apply mitigation measures to the source of the impact (i.e. to avoid or reduce the magnitude of the impact from the associated Project activity); and then to address the resultant effect

[5] ALARP, which stands for "as low as reasonably practicable" is a principle that aims to reduce residual risk while not incurring unrealistic costs or effort.

to the resource/receptor via abatement or compensatory measures or offsets (i.e. to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

7.5.4. Residual Impact Assessment

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

7.5.5. Cumulative Impacts

Cumulative impacts result from combination of an impact from the Project with an impact from another activity / project. How the impacts and effects are assessed is strongly influenced by the status of the other activities (e.g. already in existence, approved or proposed) and how much data is available to characterize the magnitude of their impacts.

The approach for assessing cumulative impacts is to screen potential interactions with other projects based on:

- Projects that are already in existence and are operating.
- Projects that are approved but not yet built or operating.
- Projects that are a realistic proposition but are not yet built.

There is no project in the vicinity of the proposed PV solar plant site. Therefore, there will not be cumulative impacts assessment.

7.5.6. Management and Monitoring

The final stage in the IA Process is the definition of the basic management and monitoring measures that are needed to identify whether: a) impacts or their associated Project components remain in conformance with applicable standards/ guidelines; and b) mitigation measures are effectively addressing impacts and compensatory measures and offsets are reducing effects to the extent predicted. This is covered in section 8 under Environmental and Social Management Plan (ESMP).

7.6. Impact Assessment Criteria

For the purpose of this assessment the following sections define the criteria against which the impacts associated with the 2000 MW PV solar plant proposed project have been assessed. The impact assessment criteria are general criteria and not specifically associated with the project. Interactions that are likely to lead to significant impacts, as identified during the scoping exercise and baseline conditions are presented in table.

Table 39 : Interactions identified that are likely to result in significant impacts

Resource/Receptor	Potentially Significant Impacts
Land Use	• Permanent changes in land use due to installation of PV Modules, Central Monitoring Station, Switching Yard, access roads. • Temporary changes in land use due to temporary site office and material storage yard.
Topography and drainage	• Alteration of topography and micro drainage channel due to construction of project site approach road.
Soil Environment	• Decrease of soil quality due to loss of vegetation cover; • Soil erosion during monsoon season and windy periods; • Sedimentation into nearby water bodies due to soil erosion and run-off; • Storage and handling of hazardous materials (e.g., fuel and lubricant) and waste generated from operation of construction equipment and machinery and their maintenance may lead to soil contamination due to leaks/ spillage; and • Impact on soil and land environment due to improper management of domestic solid waste generated.
Ambient Air Quality	• Fugitive dust emissions due to movement of machinery and vehicles; • Fugitive emission due to operation of pile drivers; and • Air emissions due to operations of DG sets and machinery.
Water Environment	• Usage of ground water for construction activities and cleaning of PV modules; • Surface and ground water contamination due to improper disposal of sewage at site; and • Surface and ground water contamination due to spillage of oil, lubricant and hazardous waste.
Ambient Noise Quality	• Noise generation due to movement of vehicles and machineries; • Noise generation due to operation of pile drivers; and • Noise generation due to operation of DG set.
Occupational Health and Safety	• Occupational health hazards due to dust and noise pollution; • Safety risk due to wrong handling of construction machinery, working at heights; and • Exposure of workers to electromagnetic field (EMF) while working in proximity to charged electric power lines during operation and maintenance.

7.6.1. Assessment Criteria for Impact on land Use

For the purpose of assessment of impacts on land use of the area, following project activities, leading to an alteration in land use of the area during construction phase, were considered:

- ✓ Strengthening of access roads and construction of internal access roads.
- ✓ Installation of PV modules.

- ✓ Establishment and operation of temporary structures such as temporary site office (porta cabin) and store yard.

For the assessment of land use, the sensitivity and magnitude criteria outline in tables below have been used respectively.

Table 40 : Sensitivity Assessment Criteria for Land Use

Land Use Sensitivity	Criteria
Low	• Land use not of relevant use by Community • Negligible visual change.
Medium	• Land use of local use by communities e.g. grazing, agriculture, but no major dependence • Visual Change but common feature
High	• Land use of regional importance. Change would impact Land use classification of the area. • Land use of major dependence of local people for agriculture, livestock grazing, settlement etc. • Visual Change aesthetically affecting locals.

Table 41 : Criteria for Magnitude of Impact on Land Use

Impact Magnitude	Criteria for land use
Negligible	An imperceptible, barely or rarely perceptible change in land use characteristics. The change may be short term.
Small	Subtle changes in land use character over a wide area of a more noticeable change either over a restricted area or infrequently perceived. The change may be short term to long term and is reversible.
Medium	A noticeable change in land use character, frequently perceived or continuous and over a wide area; or a clearly evident change over a restricted area that may be infrequently perceived. The change may be medium to long term and may not be reversible.
Large	A clearly evident, frequently perceived and continuous change in land use characteristics affecting an extensive area. The change may be long term and would not be reversible.

7.6.2. Assessment Criteria for Impact on Topography and Drainage

For the purpose of assessment of impacts on topography and drainage of the area, sensitivity and magnitude criteria have been outlined in tables below.

Table 42 : Sensitivity Assessment Criteria for Topography and drainage

Topography and Drainage Sensitivity	Criteria
Low	Flat topography
Medium	Undulating topography
High	Hilly area

Table 43 : Criteria for Impact Magnitude on Topography and Drainage

Impact Magnitude	Criteria for topography and drainage
Negligible	An imperceptible, barely or rarely perceptible change in topographical characteristics. The change may be short term.
Small	A subtle change in topography character over a wide area of a more noticeable change either over a restricted area or infrequently perceived. The change may be short term to long term and is reversible.
Medium	A noticeable change in topographic character, frequently perceived or continuous and over a wide area; or a clearly evident change over a restricted area that may be infrequently perceived. The change may be medium to long term and may not be reversible.
Large	A clearly evident, frequently perceived and continuous change in topographic characteristics affecting an extensive area. The change may be long term and would not be reversible.

7.6.3. Assessment Criteria for Impact on soil contamination

For the assessment of impacts on soil contamination, the sensitivity and magnitude criteria is as outlines in tables below.

Table 44 : Sensitivity Assessment Criteria for Soil contamination

Soil contamination sensitivity	Criteria
Low	The soil quality does not support diverse habitat or populations and/or supports habitat or population of low quality
Medium	The soil quality supports diverse habitat or population of flora and fauna and supports habitats commonly available in the study area
High	The soil quality supports economically important or biologically unique species or provides essential habitat for such species.

Table 45 : Criteria for Impact Magnitude on Topography and Drainage

Impact magnitude	Criteria for soil contamination
Negligible	Well within standards
Small	Well within standards
Medium	Exceeds Target Value but well within Interventional Value
Large	Exceeds Interventional Value and needs intervention.

7.6.4. Assessment criteria for Impact on soil erosion and compaction

For the assessment of impacts on soil erosion and compaction, the sensitivity and magnitude criteria are as outlines in tables below.

Table 46 : Sensitivity Assessment Criteria for Soil erosion and compaction

Soil erosion and compaction sensitivity	Criteria
Low	The soil quality has little or no role in provisioning of services as agricultural/grazing uses for the local community.
Medium	The soil has local importance in terms of provisioning services as agricultural services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality i.e. ready availability across the study area.
High	The soil is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional level for provisioning services

Table 47: Criteria for Impact Magnitude on soil erosion and compaction

Magnitude Criteria	Soil compaction and erosion
Negligible	• Qualitative No perceptible or readily measurable change from baseline conditions • Scale- Localized area as Particular activity areas • Time-Short duration (few days) or one time as temporary
Small	• Perceptible change from baseline conditions but likely to easily revert back to earlier stage with mitigation • Scale- Project site, activity areas and immediate vicinity not impacting any sensitive receptor

Magnitude Criteria	Soil compaction and erosion
	• Short term- Only during particular activities or phase of the project lifecycle as civil works or construction phase (few months)
Medium	• Clearly evident (e.g. perceptible and readily • measurable) change from baseline conditions and/or likely take time to revert back to earlier stage with mitigation • Scale- Project site, activity areas and immediate vicinity impacting sensitive receptor/s • Long term- Spread across several phases of the project lifecycle (few years)
Large	• Major (e.g. order of magnitu e) change in comparison to baseline conditions and/or likely difficult or may not to revert back to earlier stage with mitigation • Scale- Regional or international. • Permanent change

7.6.5. Assessment Criteria for Impact on surface water resources consumption

For the assessment of the project impact due to the consumption of surface water sources during the project activities, the sensitivity criteria and magnitude criteria are outlined in tables have been used.

Table 48 : Sensitivity Assessment Criteria for Surface water Resources

Surface water sensitivity	Criteria
Low	The surface water resource has little or no role in terms of provisioning services as agricultural water source, other domestic uses as washing, bathing, industrial use and waterways for the local community
Medium	The surface water resources have local importance in terms of provisioning services but there is ample capacity and / or adequate opportunity for alternative sources of comparable quality.
High	The surface water resources are wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or transboundary watershed level for provisioning services

Table 49 : Criteria for Impact Magnitude on Surface Water Resources

Impact magnitude	Surface water consumption
Negligible	There is likely to be negligible (less than 1% of lean season flow) or no consumption of surface water by the Project at any time
Small	The Project will consume surface water, but the amounts abstracted are likely to be relatively small in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)
Medium	The Project will consume surface water, and the amounts abstracted are likely to be significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)
Large	The Project will consume surface water, and the amounts abstracted are likely to be very significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation)

7.6.6. Assessment Criteria for Impact on ground water resources consumption

For the assessment of the project impact due to the consumption of ground water resources during the project activities, the sensitivity criteria and magnitude criteria are outlined in tables below have been used.

Table 50 : Sensitivity Assessment Criteria for Ground water Resources consumption

Ground water consumption sensitivity	Contributing criteria (ground water)
Low	The groundwater resource is not currently abstracted and used in the vicinity of the Project, but is of sufficient quality and yield to be used for that purpose in the future (and there is a reasonable potential for future use).
Medium	The groundwater resource is an important water supply, and is currently used, but there is capacity and / or adequate opportunity for alternative sources of comparable quality.
High	The groundwater resource is wholly relied upon locally, with no suitable technically or economically feasible alternatives, or is important at a regional or national level for water supply or contribution to groundwater dependent ecosystems (e.g. transboundary rivers).

Table 51 : Criteria for Impact Magnitude on Ground water resources consumption

Impact magnitude	Criteria for ground water consumption
Negligible	There is likely to be negligible or no abstraction, use of or discharge to the groundwater by the Project at any time.
Small	The Project will consume groundwater or deliver discharge to groundwater, but the amounts abstracted / discharged are likely to be relatively small in comparison to the resource available at the time of use (i.e., taking into account seasonal fluctuation).

Impact magnitude	Criteria for ground water consumption
Medium	The Project will consume groundwater or discharge to groundwater, and the amounts abstracted / discharged are likely to be significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation).
Large	The Project will consume groundwater or discharge to groundwater, and the amounts abstracted / discharged are likely to be very significant in comparison to the resource available at the time of use (i.e. taking into account seasonal fluctuation).

7.6.7. Assessment Criteria for Impact on surface Water quality

For the assessment of the project impact on surface water quality due to contamination from accidental spilling of fuel, lubricant and hazardous waste. …Etc. during the project activities, the sensitivity criteria and magnitude criteria are outlined in tables below have been used.

Table 52 : Sensitivity Assessment Criteria for surface water quality

Surface water quality sensitivity	Criteria
Low	The water resource does not support diverse aquatic habitat or populations or supports aquatic habitat or population that is of low quality.
Medium	The water resource supports diverse populations of flora and / or fauna but available in the surface water bodies in the region.
High	The water resource supports economically important or biologically unique aquatic species or provides essential habitat for such species.

Table 53 : Criteria for Impact Magnitude on surface water quality

Impact magnitude	Criteria for surface water quality
Negligible	Discharges are expected to be well within statutory limits
Small	Discharges are expected to be within statutory limits
Medium	Occasional breach(es) of statutory discharge limits (limited periods) expected
Large	Repeated breaches of statutory discharge limits (over extended periods) expected

7.6.8. Assessment criteria for impact on groundwater quality

For the assessment of the project impact on groundwater quality due to contamination from accidental spilling and infiltration of fuel, lubricant or burial of hazardous waste. …Etc. during the project activities, the sensitivity criteria and magnitude criteria are outlined in tables below have been used.

Table 54 : Sensitivity Assessment Criteria for groundwater quality

groundwater quality receptor sensitivity	Criteria
Low	The groundwater source does not support diverse aquatic habitat or populations or supports aquatic habitat or population that is of low quality.
Medium	The groundwater source supports diverse populations of flora and / or fauna but available in the surface water bodies in the region.
High	The groundwater source supports economically important or biologically unique aquatic species or provides essential habitat for such species.

Table 55 : Criteria for Impact Magnitude on groundwater quality

Magnitude Criteria	Water quality (ground water)
Negligible	Abstractions from or discharge to aquifer(s) are unlikely to cause water quality issues
Small	Groundwater quality be within ambient levels or allowable criteria or may exceed for 1-2 parameters which is common occurrence due to geological regime of the area. Abstraction or discharge to aquifer(s) may cause small but local changes in water quality in the aquifer system. These can be considered potential short-term localized effects on groundwater quality which is likely to return to equilibrium conditions within a short (months) timeframe.
Medium	Groundwater quality exceeds ambient levels or allowable criteria for key parameters. Abstraction or discharge to aquifer(s) are expected to cause potential localized effects on groundwater quality which are likely to be fairly long lasting and / or give rise to indirect ecological and / or socio-economic impacts.

Large	Groundwater quality exceeds ambient levels or allowable criteria. Abstractions or discharge to aquifer(s) are expected to cause potentially severe effects on groundwater quality which are likely to be long-lasting (e.g. years or permanent) and / or give rise to indirect ecological and / or socio- economic impacts.

7.6.9. Assessment Criteria for Impact on Air Quality

The assessment with respect to air quality of the study area has been done for the following project activities:

- Fugitive emissions from site clearing, excavation work, material handling etc.;
- Fugitive emission from traffic movement.
- Exhaust emission from operation of machineries like pile drivers, vehicles; and
- Point source emission from diesel generator.

The sensitivity criteria and impact magnitude criteria has been provided in tables below.

Table 56 : Sensitivity criteria for air quality

Sensitivity Criteria	Contributing Criteria	
	Human Receptors	**Ecological Receptors**
Low	Locations where human exposure is transient.	No
Medium	Few Receptors (settlements) within 500 m of the project site	Nationally designated sites.
High	Densely populated receptors(settlements) within 500 m of project site	Internationally designated sites.

Table 57 : Criteria for Impact Magnitude on Air Quality

Magnitude Criteria	Air Quality
Negligible	• Soil type with large grain size (e.g. sand); and/or No emissions/dust generation due to Project across all phases • Existing ambient air quality of the area is well below the Prescribed NCEC limits
Small	• Soil type with large grain size (e.g. sand); and/or Limited emissions/dust generations for short duration • Existing ambient air quality of the area is well below the Prescribed NCEC limits.
Medium	• Moderately dusty soil type (e.g. silt); and/or Dust generation and emissions from Projects for long duration • Existing ambient air quality of the area is within the Prescribed NCEC limits.

Large	• Potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size); and Significant process emissions from Project for the entire Project cycle. • Existing ambient air quality of the area is exceeding the Prescribed NCEC limits

7.6.10. Assessment Criteria for Impact on Ambient Noise

The assessment with respect to ambient noise quality of the study area has been done for the following project activities:

- Construction activities including site preparation, piling work, access road widening, construction of ancillary facilities.
- Transportation of construction materials, machinery and personnel.
- Operation of DG sets; and
- Demolition activities during decommissioning phase.

The ambient noise levels have been assessed with respect to NCEC Rules and IFC – WHO Guidelines as shown in tables below.

Table 58 : Measurement noise levels for residential and commercial areas

Category	Daytime $L_{Aeq,}$ T (dB)	Night-time $L_{Aeq,}$ T (dB)
A	50	40
B	55	45
C	60	50
D	65	55

Article 7 sets the limits for permitted noise levels at construction sites so that the noise level standards set out in this Regulation are allowed to be exceeded during construction works from 7 am to 6 pm, as indicated in the following table:

Table 59 :Corrective limits for permitted noise levels at construction site

Duration of the construction activities	Correction of permitted noise limits LAeq, T (dB)
Up to 2.5 hours	10
2.5 to 8 hours	5
Above 8 hours	0

Table 60 : Noise emission criteria

Location	Noise Level Limit (dB(A))	
	Daytime (07:00 – 22:00 hrs)	Night-time (22:00 – 07:00 hrs)
Industrial; commercial	70	70
Residential; institutional; educational	55	45

Source: Guidelines values are for noise levels measured out of doors. Source: Guidelines for Community Noise, World Health Organisation (WHO), 1999.

The above standards have been utilized to create a sensitivity criterion for ambient noise and criteria for impact magnitude for assessment of impact to ambient noise.

Table 61 : Sensitivity criteria for ambient noise

Sensitivity Criteria	Contributing Criteria	
	Human Receptors	**Ecological Receptors**
Low	Industrial Use	Locally designated sites; and/or areas of specific ecological interest, not subject to statutory protection (for example, as defined by the project ecology team).
Medium	Residential and Recreational place	Nationally designated sites.
High	Educational/ Religious/ Medical Facilities	Internationally designated sites.

Table 62 : Criteria for impact magnitude on ambient noise

Magnitude criteria	Noise quality
Negligible	Predicted noise levels are at or less than 3 dB (A) above the relevant limits / thresholds. Short term exposure (Few hours in a day and not continuous)
Small	Predicted noise levels are 3 to less than 5 dB(A) above the relevant limits / thresholds.
Medium	Predicted noise levels are between 5 and 10 dB (A) above the relevant limits / thresholds. Medium Term Exposure (1 to 6 months)
Large	Predicted noise levels are more than 10 dB (A) above the relevant limits / thresholds. Long term exposure (> 6 months)

7.6.11. Assessment Criteria for landscape and visual impact

For the purpose of assessment of impacts on landscape and visual aspect of the area, sensitivity and magnitude criteria have been outlined in tables below.

Table 63: Sensitivity Assessment Criteria for landscape and visual

Landscape and visual Sensitivity	Criteria
High	Important landscape or landscape resources of particularly distinctive character of high importance, sensitive to relatively small changes.
Medium	Landscape or landscape resources of moderately valued landscape characteristics reasonably to tolerant to change.
Low	Landscape or landscape resources of relatively unimportant landscape characteristics largely tolerant to change.

Table 64 : Criteria for magnitude Assessment of Impact on landscape and visual

Magnitude	Criteria
Large	A substantial / obvious change to the landscape due to total loss of, or change to, elements, features or characteristics of the landscape. Would cause a landscape to be permanently changed and its quality diminished. Change is likely to cause a direct adverse permanent or long term (more than 10 years) impact on the value of the receptor.
Moderate	Discernible changes in the landscape due to partial loss of, or change to the elements, features or characteristics of the landscape. May be partly mitigated. The change would be out of scale with the landscape, and at odds with the local pattern and landform and will leave an adverse impact on a landscape of recognized quality. Change is likely to impact adversely the integrity/value of the receptor but recovery is predicted in the medium term (5-10 years).
Small	Minor loss or alteration to one or more key landscape elements, features, or characteristics, or the introduction of elements that may be visible but may not be uncharacteristic within the existing landscape. Change is likely to adversely impact the integrity/value of the receptor but recovery is expected in the short term (0-4 years).
Negligible	Almost imperceptible or no change in the view as there is little or no loss of / or change to the elements, features or characteristics of the landscape. The existing landscape quality is maintained but be slightly at odds to the scale, landform, and pattern of the landscape.

7.6.12. Assessment criteria for traffic and transport

For the purpose of assessment of impacts on traffic and transport of the area, receptor sensitivity and impact magnitude criteria have been outlined in tables below.

Table 65 : Receptor Sensitivity for traffic and transport

Sensitivity	Description
High	Receptors of greatest sensitivity to changes in traffic flow, would include: People whose livelihood depends upon unrestricted movement within their environment including commercial drivers and companies who employ them, local residents, schools and colleges. Accident hotspots would also be considered.
Medium	Traffic flow sensitive receptors would include: People who pass through the area habitually, but whose livelihood is not wholly dependent on free access. Would also typically include: congested junctions, community services, parks, businesses with roadside frontage, and recreation facilities.
Low	Receptors with some sensitivity to changes in traffic flow: People who occasionally use the road network. Would also typically include: public open spaces, nature conservation areas, listed buildings, tourist attractions, residential roads with adequate footway provision and places of worship.

Table 66 : Impact Magnitude for traffic and transport

Magnitude	Description
Major	The proposals could result in an appreciable change in terms of length and/or duration to the present traffic routes or schedules or activities, which may result in hardship.
Moderate	The proposals could result in changes to the existing traffic routes or activities such that some delays or rescheduling could be required, which cause inconvenience.
Minor	The proposals could occasionally cause a minor modification to routes, or a very slight delay in present schedules, or on activities in the short-term.
Negligible	No effect on movement of road traffic above normal level.

7.6.13. Assessment Criteria for Socio-economic Impacts

For the assessment of social impacts, the sensitivity and magnitude criteria outlined in tables have been used.

The social impacts associated with the operations and decommissioning stages have been assessed qualitatively and, in some cases, quantitatively (subject to availability of data), using professional judgement and based on experience from similar projects.

Table 67 : Receptor Sensitivity for Local Communities

Sensitivity	Criteria of assessment
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project.
Medium	Some but few areas of vulnerability; but still retaining an ability to at least in part adapt to change brought by the Project.
Low	Minimal vulnerability: consequently, with a high ability to adapt to changes brought by the Project and opportunities associated with it.

Table 68 : Impact Magnitude for Local Communities

Category	Extent / Duration / Scale / Frequency
Large	Change dominates over baseline conditions. Affects the majority of the area or population in the area of influence and/or persists over many years. The impact may be experienced over a regional or national area.
Medium	Clearly evident difference from baseline conditions. Tendency is that impact affects a substantial area or number of people and/or is of medium duration. Frequency may be occasional, and impact may potentially be regional in scale.
Small	Perceptible difference from baseline conditions. Tendency is that impact is local, rare and affects a small proportion of receptors and is of a short duration.
Negligible	Change remains within the range commonly experienced within the household or community.

7.6.14. Assessment Criteria for Ecological Impacts

7.6.14.1. Interactions with the project

Interactions that are likely to lead to significant impacts on ecology and biodiversity in the study area are listed in the following table and will be focus of the impact assessment.

Table 69 : Identified interactions that are likely to result in significant impacts

S. No	Potential Impacts	Causes for Impacts
1.	Clearance of vegetation for construction of access roads, ancillary facilities	• Loss of scrub habitat that may be used by species spilling over from the forest habitats located northeast and northwest of the site; and • Loss of foraging resources, shelter and shade for resident fauna.
2.	Electrocution risk from increase transmission line laying in the region	• Roosting on solar panels places avifauna in close proximity to wiring and other electrical components of the solar module.

S. No	Potential Impacts	Causes for Impacts
3.	Disturbance and displacement of species due to noise, light, anthropogenic movement and traffic	• Increased movement of people and vehicles can increase the stress levels of fauna that causes them to spend an increased amount of time in alert mode instead of foraging, nesting, socializing or mating; and • Noise, light and uncovered waste can attract or repel fauna to or from the solar site.
4.	Mortality as a result of worker influx and increased hunting, trapping and poaching of wildlife	• The Project site is located near sensitive ecological areas and therefore an influx of workers to the area can result in increased human-wildlife conflicts.
5.	Loss of resources and barrier to movement	• Project compound has to be fenced off and therefore fauna cannot access the resources that were formerly located in the Project site; • The fenced project site acts as a barrier for animals to move along the large expanse of scrub land present at the Project site; • Solar panels mimic the reflection of water bodies that may attract avifauna that could collide with the panels; • Heat related issues on roosting avifauna that could be impacted by the reflection of the panels onto their bodies; and • Steel components of solar modules can injure faunal species that have wandered into the Project compound.

7.6.14.2. Assessment Criteria

The sensitivity of ecological receptors is defined by determining the significance of effects on species and habitats separately. The significance tables for species and habitats are given in tables below.

Table 70 : Habitat-Impact Assessment Criteria

Habitat Sensitivity/ Value	
Negligible	Habitats with negligible interest for biodiversity.
Low	Habitats with no, or only a local designation / recognition, habitats of significance for species listed as of Least Concern (*LC*) on IUCN Red List of Threatened Species, habitats which are common and widespread within the region, or with low conservation interest based on expert opinion.

Habitat Sensitivity/ Value	
Medium	Habitats within nationally designated or recognized areas, habitats of significant importance to globally Vulnerable (VU) Near Threatened (NT), or Data Deficient (DD) species, habitats of significant importance for nationally restricted range species, habitats supporting nationally significant concentrations of migratory species and / or congregatory species, and low value habitats used by species of medium value.
High	Habitats within internationally designated or recognised areas; habitats of significant importance to globally Critically Endangered (CR) or Endangered (EN) species, habitats of significant importance to endemic and/or globally restricted-range species, habitats supporting globally significant concentrations of migratory species and / or congregatory species, highly threatened and/or unique ecosystems, areas associated with key evolutionary species, and low or medium value habitats used by high value species.

Table 71 : Species-Impact Assessment Criteria

Baseline Species Sensitivity/ Value	
Negligible	Species with no specific value or importance attached to them.
Low	Species and sub-species of LC on the IUCN Red List, or not meeting criteria for medium or high value.
Medium	Species on IUCN Red List as VU, NT, or DD, species protected under national legislation, nationally restricted range species, nationally important numbers of migratory, or congregatory species, species not meeting criteria for high value, and species vital to the survival of a medium value species.
High	Species on IUCN Red List as CR, or EN. Species having a globally restricted range (i.e. plants endemic to a site, or found globally at fewer than 10 sites, fauna having a distribution range (or globally breeding range for bird species) less than 50,000 km^2), internationally important numbers of migratory, or congregatory species, key evolutionary species, and species vital to the survival of a high value species.

7.6.15. Assessment Criteria for Impact on archaeology and cultural heritage

For the assessment of the project impact on archaeology and cultural heritage, the sensitivity criteria and magnitude criteria are as outlined in tables below have been used.

Table 72 : Sensitivity criteria for archaeology and cultural heritage

Sensitivity / Value	Criteria
High	Sites of international significance: World Heritage Sites National Monuments Protected Structures of international and national importance Designed landscapes and gardens of national importance Architectural Conservation Areas Undesignated archaeological, architectural and/ or cultural heritage sites.
Medium	Recorded Monuments Protected Structures of regional importance Building and Garden Survey Newly identified archaeological sites, confirmed through archaeological investigation or research Undesignated archaeological, architectural and/or cultural heritage sites.
Low	Sites listed for which there are no upstanding remains. Undesignated archaeological, architectural and/or cultural heritage sites. Undisturbed greenfield areas and riverine environs, which have an inherent archaeological potential.
Negligible	Assets with very little or no surviving archaeological architectural and cultural heritage interest.

Table 73 : Criteria for impact magnitude on ambient noise

Impact Magnitude	Criteria
High	These impacts arise where an archaeological, architectural and cultural heritage asset is completely and irreversibly destroyed by a proposed development. A change such that the value of the asset is totally altered or destroyed, leading to a complete loss of character, integrity and data about the site.
Medium	An impact which, by its magnitude, duration or intensity alters an important / significant aspect of the environment. An impact like this would be where an archaeological, architectural and cultural heritage asset would be impacted upon leading to a significant loss of character, integrity and data about the site. Or an impact which by its magnitude results in the partial loss of a historic structure (including fabric loss or alteration) or grounds including the part removal of buildings or features or part removal of demesne land (e.g. severance, visual intrusion or degradation of setting and amenity). A permanent positive impact that enhances or restores the character and / or setting of a cultural heritage site or upstanding archaeological and architectural heritage site in a clearly noticeable manner.

Impact Magnitude	Criteria
Low	A low impact arises where a change to the site is proposed which though noticeable is not such that the archaeological, architectural and cultural heritage character / integrity of the site is significantly compromised, and where there is no significant loss of data about the site. A positive impact that results in partial enhancement of the character and / or setting of a cultural heritage site, upstanding archaeological architectural heritage site in the medium to long-term.
Negligible	An impact which causes very minor changes in the character of the environment and does not directly impact an archaeological, architectural and cultural heritage asset, or affect the appreciation or significance of the asset. There would be very minor changes to the character and integrity of the asset and no loss of data about the site.

7.6.16. Assessment Criteria for Impact landscape and visual

For the purpose of assessment of impacts on landscape and visual aspect of the area, sensitivity and magnitude criteria have been outlined in tables below.

Table 74 : Sensitivity Assessment Criteria for landscape and visual

Landscape and visual Sensitivity	Criteria
High	Important landscape or landscape resources of particularly distinctive character of high importance, sensitive to relatively small changes.
Medium	Landscape or landscape resources of moderately valued landscape characteristics reasonably to tolerant to change.
Low	Landscape or landscape resources of relatively unimportant landscape characteristics largely tolerant to change.

Table 75 : Criteria for magnitude Assessment of Impact on landscape and visual

Magnitude	Criteria
Large	A substantial / obvious change to the landscape due to total loss of, or change to, elements, features or characteristics of the landscape. Would cause a landscape to be permanently changed and its quality diminished. Change is likely to cause a direct adverse permanent or long term (more than 10 years) impact on the value of the receptor.
Moderate	Discernible changes in the landscape due to partial loss of, or change to the elements, features or characteristics of the landscape. May be partly mitigated. The change would be out of scale with the landscape, and at odds with the local pattern and landform and will leave an adverse impact on a landscape of

Magnitude	Criteria
	recognized quality. Change is likely to impact adversely the integrity/value of the receptor but recovery is predicted in the medium term (5-10 years).
Small	Minor loss or alteration to one or more key landscape elements, features, or characteristics, or the introduction of elements that may be visible but may not be uncharacteristic within the existing landscape. Change is likely to adversely impact the integrity/value of the receptor but recovery is expected in the short term (0-4 years).
Negligible	Almost imperceptible or no change in the view as there is little or no loss of / or change to the elements, features or characteristics of the landscape. The existing landscape quality is maintained but be slightly at odds to the scale, landform, and pattern of the landscape.

7.7. Impact Assessment in Construction Phase

7.7.1. Impact on Land Use

7.7.1.1. Impact source

For the purpose of assessment of impacts on land use of the area, following Project activities leading to change in land use of the area during construction phase were considered:

- Construction/ upgradation of access roads (internal).
- Establishment and operation of temporary structures such as temporary site office (portable cabin) and store yard.
- Vehicular movement for carrying out the plant component and construction materials.
- Movement of construction equipment like cranes, excavators, dumpers, trucks.
- Establishment of PV modules and associated transformer yard; and
- Construction of Central Monitoring Station, Switching Yard.
- Erection of PV panels as well as associated transformer yard and permanent site office.

7.7.1.2. Receptor sensitivity

The proposed Project site is located in a rural setup with no industrial or anthropogenic activities. According to the available information and interviews with the official authorities in the Haden region, there are no current or future projects planned in this zone, and no restrictions or constraints on the project area.

In the pre-construction phase, permanent change will occur to the land use where the project boundaries are established, to prepare for the next phases (construction and operations). In the construction phase, temporary land use changes will occur at contractor facilities and labour camps, material storage areas and there will be a long-term change of the land use where the Solar panels and substation will be located. Receptor sensitivity is envisaged to be **low** considering that the proposed site land has no really current use excepted some scattered area for grazing and will change to industrial use.

7.7.1.3. Impact assessment

The establishment of the solar plant will contribute for the energy growing demand on the region for a long term (30 years). Changes in land use are also envisaged for material store yard and temporary site office. However, those changes in land use will take place only during the construction period (24 months). Further, the project will require to develop an access road which will be used as the main access road to the project site. magnitude of the impact has been assessed to be **medium to small**. The overall impact significance will therefore be **minor**.

Table 76: summary of impact on land use during construction phase

Impact	Changes in Land use during construction					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	Limited to PV panels footprint and construction areas and associated facilities					
Impact frequency	During construction phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **minor.**					

7.7.2. Impact on topography and drainage

7.7.2.1. Impact source

Construction activities will include pre-construction site clearance and grading prior to the installation of operational infrastructure, excavation works for panels supporting structures and creating internal of access roads. These works will induce modification of some natural micro drainage natural channels.

7.7.2.2. Receptor sensitivity

The project area exhibits flat and uniform topography with no major undulations. There are no water bodies that pass though the proposed project site. Typically, solar power projects do not undertake levelling of topography and since the proposed project, along with the access road, is mostly on a flat terrain. the receptor sensitivity has been assessed to be **low**.

7.7.2.3. Impact assessment

Thanks to non-undulating topography, study area does not exhibit presence of micro drainage channels. Though the solar power project does not require levelling of land, construction of access road for the project purpose could potentially alter topography but the chances of that are miniscule. Therefore, the impact magnitude has therefore been assessed as **small to medium**.

construction activities are not anticipated to be extensive, and this impact is assessed as being of **minor significance.**

Table 77: summary of impact on topography and drainage during construction phase

Impact	Changes on topography and site drainage					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	construction areas and associated facilities					
Impact frequency	During construction phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible	Small		**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **minor.**					

7.7.3. Impact on soil contamination

7.7.3.1. Impact source

Municipal and hazardous waste, wastewater and spills and leaks of oils and fuels and many other chemicals may contribute to soil pollution if not managed properly during the construction phase. on site during construction phase.

7.7.3.1.1. Soil contamination due to waste generation

General construction waste generated onsite will comprise of concrete, steel cuttings/filings, packaging materials, wood, glass, plastic and other metals.

Municipal solid wastes consisting of food waste, plastic, glass, aluminium cans and wastepaper will also be generated by the construction workforce at canteen facility/ labor camp. This waste will contaminate soil if not handled properly.

A small proportion of the waste generated during construction phase will be hazardous.This waste includes waste fuel, greases, broken modules, paints for solar PV and switchyard structures, chemicals and waste oil containing rags which if not managed properly, may lead to contamination of soil

7.7.3.1.2. Soil contamination due to leaks and spills

The project will involve the use of paints for solar PV plant and switchyard structures during construction which if not handled and used properly, may lead to contamination of soil.

Improper disposal of hydraulic fluids, diesel, lubricating oils and other used oils can also result in contamination of soil. Improper storage of construction material can also result in the unwanted dispersal of contaminants into adjoining areas.

Spills could have a long-term impact on soil quality but are expected to be localized in nature. Spill control measures such as the storage and handling of chemicals and fuel in concreted areas will be implemented to minimize impacts in the event of a spill.

The soil in the Project area is not contaminated as there is no anthropogenic activity in the project area.

Diesel storage will be provided at batching plant onsite during construction phase. Wastewater will be storage tank to be disposed in proper place. Other materials such as oil, greases, paints, and solvents will be stored in drums in storage area and having restricted access. improper handling of chemical/fuel storage, lubrifaction oils and wastewater may lead to spills and leaks and then to soil contamination.

Soil contamination during the construction phase may result from leaks and spills of oil, lubricants, or fuel from heavy equipment. Leaks and spills may occur also during preventive and corrective maintenance operations of construction machinery and vehicles. Such spills could have a long-term impact on soil quality but are expected to be localized in nature.

7.7.3.2. Receptor sensitivity

Situated in a barren territory, the soil in the Project area is not contaminated as there is no anthropogenic activity. Receptor sensitivity is assessed to be **low**.

7.7.3.3. Impact assessment

The potential of the soil contamination of the brought material is normally known. Once the nature of soil is known, sufficient controls will be implemented to ensure that any impacts to existing soil contamination will be **medium to small**. The overall impact significance will be assessed as **minor.**

Table 78: summary of impact on soil contamination during construction phase

Impact	Changes on soil contamination				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	construction areas and associated facilities				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **minor.**				

7.7.4. Impact on soil compaction

7.7.4.1. Impact source

The project will undertake the soil compaction activity to ensure soil stability during the establishment of storage areas, labour camp, access road, installation of batching plant, establishment of substation, control building… etc. During construction activities, there would be compaction of soil in the Project area during movement of vehicles/ construction machinery and work force movement. In addition, laying of electrical wires during erection of internal electrical lines will also lead to the compaction soil to certain extent. No adverse impact on the soil in the surrounding area is anticipated.

The soil compaction would lead to impact on the soil physical properties such as reduction in pore spaces, water infiltration rate, and soil strength…etc.

Usage of the existing roads with minor strengthening by vehicles will be encouraged. The usage of existing roads by vehicles and minimal access road construction will reduce the impact from soil compaction in the area.

However, in order to minimize such impacts, appropriate soil erosion control measures would be undertaken by Developers of Modules and associated structure to appease the chances of soil erosion.

The site clearance, excavation for foundation and access road construction will largely affect the top layers of the soil. Loss of topsoil quality would have an impact on the vegetation cover grow in the land but the effects can be reversed over time. Further, site clearance will be restricted only in the project site. Potential grazing land close to the project site will not be disturbed.

7.7.4.2. Receptor sensitivity

The receptor sensitivity has been assessed as **low** because of the absence of any anthropogenic activity in the site or any agricultural activity to be a likely a source of livelihood area.

7.7.4.3. Impact assessment

As the soil compaction will be restricted within the project boundary and its extent is expected to be limited to the impact significant due to the soil compact is considered as **medium** to **small.**

The impact magnitude therefore has been assessed to be **minor**.

Table 79: summary of impact on soil compaction during construction phase

Impact	Impact on soil texture and compaction						
Impact Nature	**Negative**		Positive			Neutral	
Impact Type	**Direct**		Indirect			Induced	
Impact Duration	Temporary		Short-term	**Long-term**		Permanent	
Impact Extent	**Local**		Regional			International	
Impact Scale	construction areas and associated facilities						
Impact frequency	During construction phase						
Impact Likelihood	unlikely		Possible			**Likely**	
Impact Magnitude	Negligible			Small		**Medium**	Large
Receptor Sensitivity	**Low**		Medium			High	
Impact Significance	Negligible	**Minor**		Moderate		Major	
	Significance of impact is considered **minor.**						

7.7.5. Impact on surface water availability

7.7.5.1. Impacts sources

The potential sources of impact on surface water resources are as follows:

- Surface water abstraction for construction work and domestic purposes.
- Earthworks in the project area may increase the erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources.
- Sewage will generate from the construction workforce (toilets and washing facilities) and from drainage from cooking activities.
- Liquid effluents will also arise from washing of construction equipment and vehicles.
- Inappropriate storage of construction waste, material storage that leading to water quality impacts from runoff entering the water resources close to project area.

7.7.5.2. Receptor sensitivity

There is no surface water resource identified in the footprint of the project area. The water demand for civil works, dust control cleaning of PV panels and for sanitary needs will be brought to the project site by tankers. Using water tankers filled from nearby surface water bodies will affect the surface water resources availability in the region. The scarcity of water in the region will accentuate this water stress condition. Therefore, sensitivity of surface water resources will be assessed as **medium** to **high**.

7.7.5.3. Impact assessment

During the construction phase, the primary water use requirement will be for dust control. However, water may also be required to moisture condition the soils for proper compaction of internal roads and foundations within the site premises. Temporary ablution

facilities will be required during construction (i.e. portable toilets). Water will be required for foundation work and domestic requirement of workers. Water will be brought by tankers to the site. No water source in vicinity will solicited to meet the total demand of the project in construction phase. However, The Project obtains its water from closest surface water bodies available in the region that are available year-round for the population and can put on stress the water requirement for the region.

Considering that the construction phase will last only 24 months, the impact magnitude can be assessed as **small.** Then the impact significance can be classified as **moderate.**

Table 80: summary of impact on surface water availability during construction phase

Impact	Impact on surface water availably				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	construction area and settlements around the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	Low	Medium		**High**	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **minor.**				

7.7.6. Impact on groundwater availability

7.7.6.1. Impact source

Water is a prime requirement for the execution of civil works, especially with regard to preparation of raw materials like concrete etc. for civil works associated with the Project (i.e. PV panel foundation casting, construction of proposed site office, control room). approximately **22** m3/day of water will be required for civil works during the construction. Approximately **290** m3/day of water will be required for dust suppression activities. Tankers water through authorized vendors will be the main source of water (by tankers) for construction activity while bottled water will be used for drinking purpose.

According to geotechnical campaign, it is noticed that no shallow groundwater was found until the depth of 10 m. construction of borewells within the site to cater to the domestic water requirement or civil works or dust control is not proposed

7.7.6.2. Receptor sensitivity

Since groundwater resources will not be utilized for the project activities, the receptor sensitivity is assessed to be **low**.

7.7.6.3. Impact assessment

construction phase of the Project will last for a short period of time (24 months). Using groundwater by construction of borewell during this period of time seems to have a **negligible** to **small** impact if it were existing. But bringing water by tankers seems to be the therefore the most economical solution for the project. The significance of impact on groundwater resource is then assessed as **negligeable**.

Table 81: summary of impact on ground water availability during construction phase

Impact	Groundwater availability				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area and settlements around the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	**Negligible**	Small		Medium	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	**Negligible**	Minor	Moderate	Major	
	Significance of impact is considered **negligible.**				

7.7.7. Impact on surface water quality

7.7.7.1. Impact source

7.7.7.1.1. Contamination of surface water by wastewater

As the construction camp will be set up in the project premises and sanitary facilities including toilets and showers will be provided for the use of the construction workforce both on-site and at the worker's accommodation. Such liquid effluent streams are likely to be high in organic matter, suspended solids, bacteria, and other pollutants. Septic tanks will be provided to treat sanitary wastewater. Surface water quality might be contaminated due to the accidental spills/leaks at the storage areas. A small volume of wastewater from the washing of equipment and machinery may also be generated. This wastewater may contain concentrations of suspended solids and traces of hydrocarbon. The contractor will be responsible for ensuring that any wastewater discharges meet the standards stipulated by the Executive Regulations of Law of Treated Sewage Water and its Reuse by the MOWA/IFC EHS guidelines 2007.

7.7.7.1.2. Contamination of surface water by spills/leaks

Surface water can be contaminated due to accidental spills/leaks of oil, greases, fuel from construction machinery or storage facilities of these materials. It can be also contaminated

by solvents paints and other chemicals products if not handled properly. Even there is no surface water identified in the footprint of the project, the risk of contamination exists and concerns the surface water source of the region by carrying these pollutants by runoff and wind erosion

7.7.7.1.3. Contamination by load of sediments

Soil compaction and vegetation clearance may increase the intensity and volume of surface water runoff as a result drainage lines within the site will be impacted by the increase of sediment load that will be dumped in the nearest water surface

7.7.7.2. Receptor

Scarcity of surface water in the region gives the source a great importance for the neighboring population and doesn't have any alternative. The sensitivity of the receptor can then be assessed as **medium**.

7.7.7.3. Impact magnitude assessment

Potential impacts are expected to be short-term, and extent will be localized. Therefore, the impact on surface water from wastewater discharges, sediments loading or leaks and spills for hazardous waste during construction is assessed to be **minor**.

Table 82: summary of impact on surface water quality during construction phase

Impact	Surface water contamination by wastewater/leakage and spills /sediments load				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area and settlements around the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.7.8. Impact on groundwater quality

7.7.8.1. Source of impacts

Topsoil clearance and soil compaction may increase the intensity and volume of surface water runoff as a result of a decrease in water infiltration recharging the groundwater.

Improper disposal of sewage and wastewater from a labour camp and construction debris can contaminate the groundwater resources in the area. The hydrogeology of the project

area could potentially be affected if any leaked hydrocarbons permeate into the sub-surface and

through cracks in the bedrock geology come into contact with the groundwater. Groundwater contamination during the construction phase may occur from unplanned events such as leaks and spills of oil, lubricants, fuel from heavy equipment, chemicals and improper handling of sewage. The risk of contamination is enhanced by nature of the soil which is characterized by a high rate of percolation.

7.7.8.2. Receptor sensitivity

Since there is no utilization of groundwater in the footprint of the project. And the potential contamination of groundwater from improper handling of fuel, waste and liquid effluents is a long-term process, then receptor sensitivity is assessed to be low. direct impacts to groundwater quality from construction, proper handling of fuel, waste and liquid effluents, the impact to groundwater from spills and leaks is assessed to be **medium**.

7.7.8.3. Impact assessment

Contamination of groundwater is unlikely to happen in a short-term procedure due to depth of groundwater. Then the direct impact magnitude on groundwater contamination is assessed to be **small** to **negligible**. Then, the impact significance will be **minor**.

Table 83: summary of impact on groundwater quality during construction phase

Impact	groundwater contamination				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	construction area				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.7.9. impact on air quality

7.7.9.1. source of impact

The main impacts associated with construction activities will be:

- **Dust Generation**: Resulting from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy

conditions, construction of approach road, construction of PV module foundation, construction of building, loading and unloading equipment, dust generated from stockpiles of waste, topsoil handling and moving excavated material and transporting wastes on vehicles.

- **Exhaust Emissions**: Exhaust emissions of SO2, NOx, CO, CO2, PM2.5 an PM10 will be attributed predominantly to the construction of the plant, DG set operation and road vehicles such as movement of trucks and vehicles during construction work.
- **Odors**: resulting principally from handling of sewage and wastewater.

7.7.9.1.1. Dust from Construction Activities

The presence of dust can be a nuisance to site users, including construction workers and other nearby receptors. The levels of dust at the site are expected to be variable and dependent on the time of year, the intensity of the activity and the prevailing winds. During the construction phase, dust will be generated from increased vehicle and heavy machinery movements, from trucks driving on unpaved roads and from activities that cause disturbance of the soil.

Dust becomes airborne due to the action of winds on material stockpiles and other dusty surfaces, or when thrown up by mechanical action, for example, the movement of tires on a dusty road or activities such as excavating. The quantity of dust released during construction depends on a number of factors, including:

- the type of construction activities occurring.
- the area of exposed materials.
- the moisture and silt content of the materials.
- distances travelled on unpaved surfaces; and
- the mitigation measures employed.

The key construction activities likely to result in increased dust levels are site cleaning, excavation work, cutting and levelling work, movement of trucks transporting solar infrastructure to the site, water transportation, movement of construction vehicles along dusty roads, clearance of vegetation, trenching, burial of cables and screwing/ piling support poles of structures into the ground. Dust emissions are exacerbated by dry weather and high wind speeds. The impact of dust also depends on the wind direction and the relative locations of dust sources and receptors.

The site workers will be affected by construction dust as well as the people living near the site of the approach road.

7.7.9.1.2. Exhaust emissions during construction activities

In addition to dust generation, construction vehicles and other construction equipment will generate exhaust emissions. Heavy equipment such as bulldozers, excavators, dump

trucks, and compactors will be used onsite. Emissions from this equipment and from diesel generator sets used to generate power will cause impacts to ambient air quality. It is not anticipated that large volumes of exhaust emissions will be generated during the construction phase of the solar PV plant facility.

The implementation of the good site practices, such as the regular maintenance of vehicles and equipment, using cleaner fuels and switching off vehicles when not in use will be used to reduce exhaust emissions from the operation of the diesel-powered construction equipment and therefore, minimize adverse air quality impacts.

7.7.9.1.3. Odours

There is the potential for release of associated odour to the immediate surrounding areas associated with inappropriate containment and coverage associated with wastewater holding/septic tanks. Any such impacts are likely to be temporary and limited to the immediate surrounding area.

Such impacts may only occur at the local construction camp or laydown area, which as any receptor is less sensitive to changes in air quality. All receptors will be located at greater distances from the construction camp by which point odor is not expected to be discernible.

7.7.9.2. Receptor

There is potential that the construction workforce for the project may be impacted by the impacts stated above (as a result of construction) and as a result of existing air emission sources. The risks from site generated air emissions (i.e. dust and vehicle/equipment emissions) can be managed via a robust CEMP and associated air quality management plan.

However, the risk to the workforce is considered to be low. This low risk is not further considered in the potential impacts section, but monitoring recommendations are included herein, as a precautionary approach to protect the workforce.

For population in the footprint of the project site, there is no settlement adjacent to the project site in the ray of at 500 m. the only population exposed to dust are workers on site. Receptor's sensitivity is assessed as **low**.

7.7.9.3. Impact assessment

7.7.9.3.1. Impacts of dust from construction activities

It is noticed that no settlement is located more within 500 m far from the project site. Traffic movement for carrying out construction materials and infrastructure of PV will generate dust to the local resident due to the presence of household close to the access roads.

On the basis of soil nature (silty sand according to geotechnical analysis), the magnitude of the impact associated with the emission of dust during construction activities is predicted to be **small to medium**.

The impact significance is assessed as **moderate.**

Table 84: summary of impact of dust on air quality during construction phase

Impact	Impact of dust on air quality					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	construction area					
Impact frequency	During construction phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.7.9.3.2. Impacts of fugitive emissions

The air quality impacts associated with the vehicular and equipment emissions during construction activities are assessed to be of low potential significance. This implies the effects to be of localized nature and temporary which indicates that any deterioration in air quality at project location is unlikely to be significant and is expected to be transient. The impact magnitude due to the fugitive emissions from the vehicles and construction machinery is assessed to be **small to medium.** Thus, impact is significantly **minor.**

Table 85: summary of impact of dust on air quality during construction phase

Impact	Impact of fugitive emissions on air quality					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	construction area					
Impact frequency	During construction phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.7.9.3.3. Impacts of odours

Odours will be generated from wastewater holding/septic tanks, portable toilets. odors smelling will be limited in time and space during construction phase. Then impact magnitude of odours will be assessed **small to medium**. Thus, the impact is significantly **minor**.

Table 86: summary of impact of dust on air quality during construction phase

Impact	Impact of odors on air quality						
Impact Nature	**Negative**		Positive			Neutral	
Impact Type	**Direct**		Indirect			Induced	
Impact Duration	Temporary	**Short-term**		Long-term		Permanent	
Impact Extent	**Local**		Regional			International	
Impact Scale	construction area						
Impact frequency	During construction phase						
Impact Likelihood	unlikely		Possible			**Likely**	
Impact Magnitude	Negligible			Small	**Medium**		Large
Receptor Sensitivity	**Low**		Medium			High	
Impact Significance	Negligible	**Minor**		Moderate		Major	
	Significance of impact is considered **Minor.**						

7.7.10. Impact on ambient noise

The proposed solar and wind energy facility will be located in an area with a rural character which is fairly remote. Increased noise levels are directly linked with various activities associated with the construction phase.

7.7.10.1. Sources of Impact

Following project activities were considered for the purpose of impact assessment on ambient noise levels during the construction phase:

- Construction activities including site preparation, construction of PV modules foundation, operation of earthmoving and excavation equipment, building, and substation construction.
- Transportation of PV module, PV module mounting structure and components, construction material, construction machinery, and personnel.
- Operation DG sets;
- Operation of batching plant.
- Digging of trenches to accommodate underground power cables.

The equipment likely required to complete the above tasks will typically include Excavator, Graders, bulldozers, dump trucks, vibrating roller, wheel loader, rock breaker, flatbed trucks, concrete trucks, cranes, forklifts and various four-wheel drive and service vehicles.

Typical noise emissions for plant and equipment likely to be deployed in Haden PV solar Plant are listed in Table below.

Excessive noise, particularly when experienced continuously, outside normal working hours and on rest days, can be a nuisance to workers. In extreme cases, it may become a health hazard.

Table 87 : Noise Emission Levels for some contruction machinery

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Air Compressor	81
Backhoe	80
Ballast Equalizer	82
Ballast Tamper	83
Compactor	82
Concrete Mixer	85
Concrete Pump	82
Concrete Vibrator	76
Crane Derrick	88
Crane Mobile	83
Dozer	85
Generator	81
Grader	85
Impact Wrench	85
Jack Hammer	88
Loader	85
Paver	89
Pile Driver (Impact)	101
Pile Driver (Sonic)	96
Pneumatic Tool	85
Pump	76
Rail Saw	90
Rock Drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike Driver	77
Tie Cutter	84
Tie Handler	80

Equipment	Typical Noise Level (dBA) 50 ft from Source*
Tie Inserter	85
Truck	88

7.7.10.2. Receptor sensitivity

Since there is no settlement within the boundary of 500 m far from The Project site. The few households and camps located within the 200m of the access roads, will be temporary affected by the movement of the vehicle, trucks... etc. holding construction materials and water. The sensitivity can be defined as **low**.

7.7.10.3. Impact assessment

A significant source of noise during the construction phase is additional traffic to and from the project site as well as traffic on the site. The use of borrow pits and a concrete batching plant will significantly reduce heavy traffic vehicle movement to and from the site.

Construction traffic is expected to be generated throughout the entire construction period; however, the volume and type of traffic generated will depend on construction activities being conducted which will vary during the construction period. Movement of traffic during night hours can also disturb the local community in both sides of access road.

As there is no population within the 100 m around the project site and the noise nuisance will be limited to the traffic movement for population near to access roads and workers onsite. The impact of noise can be assessed as **small to medium**.

Table 88: summary of impact on ambient noise during construction phase

Impact	Impact on ambient noise					
Impact Nature	**Negative**		Positive		Neutral	
Impact Type	**Direct**		Indirect		Induced	
Impact Duration	Temporary	**Short-term**		Long-term	Permanent	
Impact Extent	**Local**		Regional		International	
Impact Scale	construction area					
Impact frequency	During construction phase					
Impact Likelihood	unlikely		Possible		**Likely**	
Impact Magnitude	Negligible		Small		**Medium**	Large
Receptor Sensitivity	**Low**		Medium		High	
Impact Significance	Negligible	**Minor**		Moderate	Major	
	Significance of impact is considered **Minor.**					

7.7.11. Impact on traffic and transport

7.7.11.1. Source of impact

The construction phase shall involve transportation of construction materials, solar PV modules, equipment and mounting structures. The existing roads/paths leading to the project site are not suitable for carrying construction and plant material; therefore, a new access road will be constructed. The access road plan will be finalized during the detail design stage.

Some of construction workforce will travel on a daily basis to the site over the arterial road; the highway Riyadh – Mekkah-Al-Mukarramah and will, therefore, have an impact on local traffic and transportation.

It's anticipated that traffic levels will increase during construction phase due to transportation of construction materials, PV Panels, water and other equipment. The traffic augmentation will be remarkable especially on roads leading to the project site especially the High Riyadh Mekkah-al-Mukarramah.

The volume of traffic will vary over the course of construction depending on the phases of construction and the demand for materials, water, removals, and construction personnel on site. The main factors that will affect the number of vehicles on the roads will be related to manpower needs, material usage and waste generation.

7.7.11.2. Receptor

As mentioned in project description all project construction materials, equipment, water, PV panels will be transported to the site via ground route via principally the Highway Riyadh – Mekkah-al-Mukarramah and road joining turbah city to this highway. Traffic level through the localities (Radhouen , Ateef,..etc) situated along this road will be affected due to the additional traffic movement occasioned by the transit of heavy vehicles and other type vehicles. The receptors exposed to impacts from construction phase movements and personnel are the existing users of the road as well as nearby residents of these localities. This roadway and local users are the main receptors considered in this assessment. This road is certainly used by the local people and people from the eastern regions to go to attend pilgrimage and other purposes. The receptor sensitivity is assessed to be **medium**.

7.7.11.3. Impact assessment

The construction activities will require transportation of construction material, PV module, PV module mounting structure and construction material to the site. The project construction activities will lead to additional traffic and increased risk of traffic-related accidents and injuries to the community and to workers. Such impacts arise almost entirely during the construction period. The increase in traffic due to the project is, however, going to be marginal. Transportation of construction material in open trucks /tippers can also

lead to dust generation along the route. Excess traffic on the road will create discomfort for locals due to increment in noise level and fugitive dust and gaseous pollution expected to exhaust from the vehicles. The impact magnitude due to the traffic movement is assessed as **small** to **medium**. Thus, impact significance is assessed as **moderate**.

Table 89: summary of impact on traffic and transport during construction phase

Impact	Impact on traffic and transport				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area / settlements in vicinity of the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	**Medium**		High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Minor.**				

7.7.12. Impacts on ecology and biodiversity

It is anticipated that during the construction phase site preparation activities will take place (such as excavations, levelling, land clearing activities, etc.) for the various Project components. Such activities are expected to cause a major disturbance and removal of the semi-natural vegetation present at the project site, including the grasses and the trees. Such activities could also cause regular disturbance to the other wildlife species inhabiting the Project Site. Other impacts on the biodiversity of the site could be caused by improper management of the site, which could include improper conduct and housekeeping practices by workers (i.e., hunting of animals, discharge of hazardous waste to land, etc.).

As discussed in the results above, generally the Project Site is generally arid with very low vegetation cover and wildlife species presence, except for the southwestern part that has a high vegetation cover of arboreal species. As mentioned earlier, no threatened flora/fauna species or sensitive habitats have been observed within the Project Site and all recorded floral and faunal species are considered to be of least concern. The literature review also has not identified any globally threatened species. No burrows were observed at the Project Site.

In addition, the Project site is not located within any area of nature conservation concern such as protected areas and/or Key Biodiversity Areas (KBAs), including Important Bird and Biodiversity Areas (IBAs). However, the closest area to the Project Site is the National Wildlife Research Centre and Environs, which is a KBA located around 55km southwest of the Project Site. The KBA is around 40km2 and is a fenced captive-breeding center. No protected areas are located near the Project Site.

Given all of the above, the potential impacts on biodiversity created during the construction phase would of a long-term duration as they would result in a permanent change in the natural biodiversity of the site. Such impacts are considered of negative nature and of a low magnitude given that the change in the natural biodiversity of the site will be noticeable in limited individual footprints. However, as the site is considered of low ecological significance, the receiving environmental is determined to be of a low sensitivity.

Given all of the above, such an impact is considered to be of minor of **minor** significance.

Table 90: summary of impact on ecology and biodiversity during construction phase

Impact	Impact on ecology and biodiversity				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area / settlements in vicinity of the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.7.13. impact on occupational health and safety

The development of the proposed Solar PV energy facility will involve a range of activities that could potentially be unsafe to workers and the local community without mitigation measures. Examples of such activities include excavation for solar PV support structure foundations, use of drills for cutting, working at heights, trenching, etc. Such activities require the use and operation of heavy-duty earth moving equipment, machinery and vehicles.

7.7.13.1. Impact source

The sources of impact on the health and safety of the Project construction workforce are listed below.

- Accidents and injuries associated with the operation of heavy machinery and other construction activities; and
- Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions of air, water pollution and noise generation from construction activities as well as from storage and handling of waste, particularly hazardous waste.
- Loading and unloading activities of the construction materials

- Working at height, working with rotating machinery and falling objects

7.7.13.2. Receptor sensitivity

The receptors of the impacts on occupational health and safety include the workers, both regular and contractual working on the project. The construction workforce is estimated 800 workers as average (1500 at peak times) during construction phase (24 months) will be exposed to occupational health and safety impacts arising from construction activities of solar PV plant. Sensitivity of receptor is assessed as **medium**.

7.7.13.3. Impact assessment

The construction activities include site preparation, infrastructure utilities installation and building structures. Loading and unloading operation of the construction material may cause an injury if not handled properly. During construction works, physical injury results due to road accidents, construction accidents, and other occupational hazards. Overexertion injuries and illness are potentially the most common health hazards associated with construction activities. Further, there is potential for slips and fall on the same elevation associated with poor housekeeping, such as excessive waste debris, loose construction material, liquid spills and uncontrolled use of electrical cords and ropes on the ground which results in injuries and time loss during construction.

Hazards associated with fall of construction material or tools, as well as the collapse of constructed slabs, walls and roofs can result in injury to head, eyes, and extremities. Transportation and movement of vehicles are associated with road accidents and related hazards, which can lead to injuries and fatalities.

Therefore, there will be potential impacts on worker's health and safety due to exposure to risks through construction activities that lead to accidents causing injuries and death. The most frequent risks cause of accidental death and injury are:

7.7.13.3.1. Safety Risks

- Tripping due to uneven surfaces, obstacles, trailing cables;
- Falling during working at height due to fall from fragile surfaces, roof edges, and ladders;
- Fire due to hot works, smoking, failure in electrical installations;
- Mobile plant and vehicles; and
- Electrical shocks.

7.7.13.3.2. Health Risks

- Manual handling and musculoskeletal disorders: typical construction activities that can cause injury such as lifting, lowering, pushing, pulling and carrying

- Hand-arm vibration: people work with hand-held or hand-guided power- tools and machines, such as concrete breakers, pokers and compactors, sanders, grinders and disc cutters, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns.
- Temporary or permanent hearing loss which usually comes from noise generated from machinery used for excavation or piling work and from compressors and concrete mixers etc.
- Heat stress and working at high temperatures.

These risks could create long-term impacts to the health and safety of the construction workforce and therefore the impact magnitude is assessed to be **medium** without advanced mitigation measures. So, the impact significance on occupational health and safety during construction phase has been assessed as **Moderate** without taking mitigation measures.

Table 91: summary of impact on occupational health and safety during construction phase

Impact	Impact on occupational health and safety				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	construction area				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.7.14. socio-economic impacts

7.7.14.1. impact on community health and safety

As per IFC EHS guidelines (2007), the occupational and community health and safety hazards during the construction, operation, and decommissioning of solar power projects are generally similar to those of most large infrastructure projects if fact:

- During construction phase, various project components such as transmission cable laying, switchgear, internal road network and porta cabin construction will require land clearing, levelling, excavation and grading activities. Vehicle movement will also take place. This will result in an increased level of dust and particulate matter emissions, as well as high traffic load, which in turn will directly and temporarily impact the local community. If improperly managed, there is a risk of nuisance and health effects.

- The construction of solar PV power plant activities will generate different types of solid and liquid wastes and hazardous that should be managed properly otherwise:

  ✓ Improper disposal of these wastes can lead to littering in the construction site and surrounding areas. Hazardous wastes such as waste oil, lubricants, hydraulic oil etc. can cause contamination of soil and water bodies if adequate precautions for management and handling are not undertaken.
  ✓ Improper disposal of solid waste from the labor camps at the site and lack of proper sanitation facility for labor can lead to unhygienic conditions due to open defecation and spread of diseases in the area. It can also lead to the discontent of the local community and result in conflicts with the labor engaged at the site.
  ✓ Taking the distribution of impact as within the site, duration as short, the impact can be considered as **"minor"**

Table 92: summary of impact on community health and safety during construction phase

Impact	Impact on community health and safety				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area / settlements around the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	**Moderate**	Major	
	Significance of impact is considered **Minor.**				

7.7.14.2. Impact on employment opportunities

7.7.14.2.1. Source

The project is likely to create a range of avenues for direct and indirect employment opportunities:

- The requirement for around 800 labors as average in the construction phase can spur local labor contracting activities as well as avenues of unskilled labor;
- Self-employment options for individuals possessing vocational or technical training skills like electricians, welders, fitters etc, which are likely to be sourced locally.
- Contracting opportunities for locals possessing tractors, trucks or other vehicles which would be needed during construction phase for material and personal transportation.

7.7.14.2.2. Receptor

Local population living near to the project site will be benefited.

7.7.14.2.3. Impact Assessment

The construction phase activities of the project including construction of access road, civil works, foundation activities, site clearance and security will involve skilled, semi-skilled and unskilled workers including technicians, electricians, welders, mechanics…etc., who are likely to be recruited from the local community.

Furthermore, the community will be benefited from the project in terms of the cars, trucks, heavy machinery drivers hired by the project. The project is also likely to create a number of indirect economic opportunities in terms hiring tractors, trucks…. etc. As the project development will generate the employment opportunity so it is assessed as the **positive** impact.

7.7.14.3. Impacts from Migrant Workers

The entire construction phase for the Project is scheduled to be undertaken under in 24 months The approximate working population for both civil and mechanical work is expected to be around 800 persons as average. This will require labor of unskilled, semi-skilled, skilled and highly skilled nature. However, it is envisaged that outsourced personnel will comprise mostly of skilled laborer and workers.

The Construction Contractor will be responsible for the construction of temporary labor camps and provide the workers with water supply, electricity, sanitary facilities, medical aid and other basic amenities. It is assumed that the camps would be constructed in-situ. Following impacts are envisaged due to influx of migrant workers.

7.7.14.3.1. Social Impacts of Migrant Workers

Due to the migrant worker influx in the project area the following impact may arise:

- Frequent movement of vehicles may increase accidents.
- Sharp increase in daily wage rates for labor, impacting the availability of other working activities; and
- On the contrary, there could be an enhancement of local skills and skill sets through interaction of local unskilled or semi-skilled laborers with the skilled migrant workers.

7.7.14.3.2. Community Health Impacts from Migrant Workers

As the project worker will live in the temporary construction camp and surrounding area in a rental basis. The following health risk may be brought out due to the migrant worker:

- Spread of communicable diseases, especially infectious diseases, which accompany many major constructions.
- Poor health infrastructure in the Project area may worsen the spread of any disease.
- Lack of hygiene and adequate sanitation facilities would create health ailments related to food poisoning or diseases.

As most of the unskilled worker will be recruited from the local community therefore migrant worker will less. So, the impact due to the labor influx during the construction phase on community people has been assessed as **minor** without taking mitigation measures.

Table 93: summary of impact of migrant workers during construction phase

Impact	Impact on community of migrant workers				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	**Long-term**	Permanent	
Impact Extent	Local	**Regional**		International	
Impact Scale	construction area / settlements around the project				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	**Moderate**	Major	
	Significance of impact is considered **Minor.**				

7.7.15. impact on archaeology and cultural heritage

The site does not contain any archaeological monuments or sites as per the last site visits and walkover. No impact is envisaged both during construction and operation phase.

7.8. Impact Assessment in Operation and Maintenance Phase

Due to increased activities and efficient operational systems, there will be some impacts on the environmental setup in the project area, which are discussed hereunder. In order to achieve sustainability of the development works, it is necessary to ensure the effectiveness of mitigation measures even after construction, as some adverse environmental impacts may result from the operation of the project facilities. Therefore, in order to reap the full environmental benefits of the project activities and ensure environmental enhancement, it would be necessary to implement a good monitoring plan for these activities.

7.8.1. Impact on Land and Soil Environment

7.8.1.1. Sources of Impact

The following activities will lead to an impact on soil quality:

- Monitoring of solar PV operation
- Routine maintenance activities at PV module
- Material Handling and Storage.
- Hazardous and Non-Hazardous Materials and Waste Management during maintenance activity

7.8.1.2. Receptor

The operational phase of the project will have limited impacts on the soil in form of waste generation and soil contamination due to accidental spillages/leakage. Receptor sensitivity is assessed as **medium**.

7.8.1.3. Impact Assessment

7.8.1.3.1. Impact on Land due to Improper Waste Disposal

During operation phase, the waste generated from the project will include domestic solid waste at SCADA building and substation, and hazardous waste like waste oil and lubricants and oil containing jute and rags will be generated during maintenance activities. Operation of solar photovoltaic panels for power generation will not have a direct impact on soil. However, the water as may use for washing activities may contaminate the soil if the chemical is used for washing. The quantity of hazardous waste generated will be much lesser quantity than during the construction stage. The PV module will be set on a tracking system and gear oil/hydraulic oil shall be required for this system. Waste oil/grease from operation and maintenance of tracking system maybe generated. Maintenance of solar panel their change may produce solid waste as used panels, glass wastepaper wood packing cartons, plastics if this waste is not handled properly, it would be scattered all about the project site. The impact has been assessed as **moderate**.

Table 94: summary of impact of improper waste disposal during operation phase

Impact	Impact of improper waste disposal				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site / settlements around the project				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible		Small	**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.8.1.3.2. Soil Contamination due to Leaks/Spills

There are chances of spillage of oil during maintenance work such as lubricating oils from, hydraulic systems of tracking system, transformers, utilities machinery and vehicles on site. The accidental spillages at oil/lubricants and hazardous waste storage areas may cause contamination of soil and groundwater. The probability of the impact is only during the maintenance and therefore occasional. In case of accidental spillage, the impacts will be confined to the maintenance area and storage area. The impact on soil due to leaks/spills has medium intensity with low probability and assessed as **moderate** significance without mitigation measures.

Table 95: summary of impact on soil contamination by spills and leaks during operation phase

Impact	Impact of improper waste disposal				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible		Small	**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.8.2. Waste Generation

7.8.2.1. Sources

- Wastes likely to be generated during routine operations are dielectric fluids, clearing agents and solvents etc.
- Repair and maintenance of underground cables and associated utilities will lead to generation of hazardous wastes as used oils.
- Wastewater from PV module cleaning.
- Hazardous waste generated from operation and maintenance of PV solar plants is limited to small quantities of waste oil from use of lubricant oil and transformer oil;
- The defunct / damaged photovoltaic cells will also be generated.
- Domestic wastewater and solid waste

7.8.2.2. Receptor

Improper disposal and maintenance of waste may lead to contamination of soil, surface and groundwater environment, which could result in indirect impacts to humans, flora, and fauna. Receptor sensitivity is medium.

7.8.2.3. Impact Assessment

Once the plant is commissioned there will be limited waste generation, however different hazardous and non-hazardous waste will be generated from PV module cleaning, used oil from substation, broken PV module. These wastes typically would be put in containers, characterized and metallic, possibly stored briefly, and transported by a licensed hauler to an appropriate permitted off-site disposal facility as a standard practice.

Hazardous waste generated from operation and maintenance of PV panels is limited to small quantities of waste oil from the use of lubricant oil for tracking system and transformer oil. Improper disposal of hazardous waste can lead to contamination of soil and groundwater, which could result in indirect impacts to humans, flora, and fauna.

Operations and maintenance of the PV power panel are not expected to require hazardous materials to be present and used on Site or to generate hazardous waste. PV panels, array enclosures, and inverter/transformer enclosures will not produce waste during operation. The PV panels contain micron-sized metallic residue which is classified as hazardous waste.

Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer. This reduces the risk of the metallic debris impacting on human health or the environment.

The PV panels will possibly be cleaned twice a month to remove dust accumulated on the surfaces of the modules during the operational phase of the project. Some of thos cleaing could be done with water. The water used for cleaning will not contain any harmful chemicals or additives and will not be heated. Therefore, the water is not regarded as wastewater and the water will be allowed to percolate into the soil. As the impact magnitude is **medium** from waste and effluent generation from operation phase the significance of impact assessed as **moderate**.

Table 96: summary of impact of waste generation during operation phase

Impact	Impact of waste generation					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent		
Impact Extent	**Local**	**Regional**		International		
Impact Scale	PV solar plant site /settlements around the project site					
Impact frequency	During operation and maintenance phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	Low	**Medium**		High		
Impact Significance	Negligible	Minor	**Moderate**	Major		
	Significance of impact is considered **Moderate.**					

7.8.3. Impact on Water Resources Quantity and Quality

7.8.3.1. Sources of Impact

The impacts of the proposed project on water environment are assessed with respect to following:

- Water use for PV module cleaning.
- Water Consumption for domestic use.
- Possibility of groundwater level reduction due to compacted soil and covered by PV module.
- Surface water pollution due to the surface runoff from the project site
- Surface and groundwater pollution due to the accidental leakage and spills of oil

7.8.3.2. Receptor

Surface water from the localities close to the project and groundwater might be polluted. Water resources from localities around may face shortage due to quantities of water for PV module cleaning. Receptor sensitivity might be assessed as **low to medium**.

7.8.3.3. Impact Assessment

7.8.3.3.1. Water Availability

During the operation phase, the water requirement will be for domestic as well for cleaning of modules. Although most of the cleaning operations will be dry, some of the operations could require from some water. The operation phase water requirement of the project will be approximately 120.000 m3 per year for module cleaning. Module cleaning needs to be carried out periodically (10 times per year) to remove dust, bird dropping etc. During operation of the whole project, approximately 120 persons will work on the project site, and they will consume approximately 250-liter water per person per day (according to statics in KSA). The water has to be provided by tankers. There is both surface and ground water source to meet up the water requirement during operation to be provided from the close localities. As there is water scarcity of water in the region, availability of water in the project site would be a major problem sensitivity of This situation will put more stress on water availability in close localities receptor is assessed to be high. Impact magnitude will be assessed **small** to **medium** considering the nature of non-water consuming of such facilities. Therefore, impact significance due to water consumption and availability during operation phase has been assessed as **minor to moderate.**

Table 97: summary of impact on water availability during operation phase

Impact	Impact of on water availability				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site /settlements around the project site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible		Small	**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.8.3.3.2. Impact on Water Quality

Rare Run-off from the plant site may carry waste oil from plant area to the nearest drainage system. Due to proposed hard standing areas (lay down areas, building foundations, compacted gravel roads), compacted soil (rows between arrays) and PV panels covering large parts of the Site, possible recharge to groundwater from rainfall is expected to be reduced on the site. Sewage would be generated from substation and Control/SCADA

building, and this will be of negligible quantity. Based on the above possibility of impact, the impact has been assessed as **minor** to **negligeable** due to the plant operation.

Table 98: summary of impact on water quality during operation phase

Impact	Impact of on water quality				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site /settlements around the project site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible		**Small**	Medium	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.8.4. Impact on Air Quality

7.8.4.1. Sources of Impact

The impacts of the proposed project on air quality are assessed with respect to following:

- Maintenance of vehicles and machinery used in the site.
- Transportation during operation and maintenance of the power plant

7.8.4.2. Receptor

As the project is a renewable and clean energy development project, the operation will be largely free from air emissions. The only limited vehicle will move through the access road and within the project site for maintenance activities so dust and emission will be generated. There are no major settlements close to the project site. Thus, receptor sensitivity is assessed to be **low.**

7.8.4.3. Impact Assessment

No emissions are expected to be released during the operation phase, due to the fact that solar PV plants do not release greenhouse gases or any toxic pollutants during their operation as solar power plants do not involve combustion processes. Dust will be generated during the movement of the vehicle during maintenance of power plant which is very limited scale. Limited exhaust will be emitted from the vehicle during the operation phase. impact magnitude is then assessed to be **small** to **medium**. The impact significance

of dust and emissions generated during the operation phase is considered as **minor** to **negligible.**

Table 99: summary of impact on air quality during Operation and maintenance phase

Impact	Impact on air quality					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	Short-term	**Long-term**	Permanent		
Impact Extent	**Local**	**Regional**		International		
Impact Scale	PV solar plant site /settlements around the project site					
Impact frequency	During operation and maintenance phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.8.5. Impact on Ambient Noise Levels

7.8.5.1. Sources of Impact

Noise will be generated from the following activities during operation phase:

- Vehicular movement
- Noise from inverters and transformers
- Repair and Maintenance Works of solar panels

7.8.5.2. Receptor

No major noise will be generated from the solar power plant. And there is no close settlement to the plant. People living along the access roads and traffic will not feel discomfort from traffic level as in construction phase. intensity of movement of vehicle from and to the project will be extended in time and not felt by settlement. So, the receptor sensitivity will be assessed as **low** during the operation and maintenance phase.

7.8.5.3. Impact Assessment

During the operation phase of the project, the limited vehicle will move on the access road and within the project site for maintenance activities as a result dust generation and exhaust emission will be a negligible amount. Noise emission will be limited as well. Impact significance is assessed to be **minor to negligible**.

Table 100: summary of impact on ambient noise during Operation and maintenance phase

Impact	Impact ambient noise				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site /settlements around the project site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.8.6. Impact on Ecology and biodiversity

The only impacts anticipated during the operation phase are related to improper management of the site as discussed earlier. This could include improper conduct and housekeeping practices by workers (i.e., hunting of animals, discharge of hazardous waste to land, etc.).

The potential impacts on biodiversity would of a long-term duration throughout the operation phase of the Project. Such impacts are of negative nature and of a low magnitude. However, as the site is considered of low ecological significance, the receiving environmental is determined to be of a low sensitivity. Given all of the above, such an impact is considered to be of **minor** significance

Table 101: summary of impact on ecology and biodiversity during operation phase

Impact	Impact on ecology and biodiversity			
Impact Nature	**Negative**	Positive		Neutral
Impact Type	**Direct**	Indirect		Induced
Impact Duration	Temporary	Short-term	**Long-term**	Permanent
Impact Extent	**Local**	**Regional**		International
Impact Scale	PV solar plant			
Impact frequency	During operation and maintenance phase			

Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible		Small	**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.8.7. Landscape and Visual Impact

7.8.7.1. Sources of Impact

As total of maximum 5,468,400 modules will be set up in the proposed project area when considering a 2000 MW solar power plant. The original landscape is highly modified as it will be covered by the panels so the presence of a large area of PV panels is expected to constitute a risk for glare. Besides this, lighting in the power plant area and building structure also sources of visual impact. The reflection from the PV panels may create a limited visual impact to passing people and animals.

7.8.7.2. Receptor

The landscape of the project area is fallow land with a poor vegetation cover far from settlements. Installation of PV power plant will modify its original landscape.

Reflection from the solar panels may affect passing people around. Sensitivity of receptors is assessed to be **low**.

7.8.7.3. Impact Assessment

The visual impacts will be perceived by two types of receptors, namely:

- Receptors located at a fixed point, i.e. dwellings on the Site and surrounding areas; and
- Receptors who will temporarily come into contact with the solar PV facility, such as passing people around the area.

The closest settlements located almost 62 km to the south and 40 km to the north for respectively Turbah city and Ateef from project boundary. The PV module will be bifacial and provided by sun tracking system. glare could be felt in very short time by passing people coming from both sides eastern and western as the plant is close to the highway Mekkah – Riyadh.

PV panel will not cause any visual impact on the settlement area. Only the road user will be affected due to the glare from the PV power plant. so, the visual impact due to the solar power plant considering without mitigation measures has been assessed as **minor** to **negligible**.

Table 102: summary of impact landscape and visual during Operation and maintenance phase

Impact	Impact on land scape and visual				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	**Regional**		International	
Impact Scale	PV solar plant site /settlements around the project site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.8.8. Occupational Health and Safety

7.8.8.1. Sources of Impact

There are many hazards associated with a solar PV power plant if sufficient precautions are not taken during the operation stages. The impact origins are in the following sectors:

- Leaching of materials from broken or fire damaged PV modules
- Vehicle accidents, replacement of components/parts
- Emergency Fire Hazard
- Electrocution of workers
- Electromagnetic radiation from PV modules
- Working at height for PV modules replacement or maintenance

7.8.8.2. Receptor

The main receptors are workers of the power plant and nearby passing people who are living close to the project site. Receptor sensitivity is assessed as **medium.**

7.8.8.3. Impact Assessment

Leaching of materials from broken or fire damaged PV modules: the potential for chemical releases appears to be small since the chemicals are present in the sealed PV modules when completed installations of photovoltaic systems for power generation. Releases are likely to occur only due to fires or other unusual accidents. Cadmium could be a potential concern in this setting with thin-film technologies, as would arsenic and zinc to a lesser extent. Other chemicals that have inhalation toxicity factors are present only during the manufacturing process. Solar PV modules may contain heavy metals like lead, mercury, cadmium, chromium, polybrominated biphenyls (PBBs), or brominated diphenyl

ethers (PBDEs) etc. Leaching of metals from the installed modules is not likely to be a concern, as documented in a study by Steinberger (1998). Leaching from small cells used in electronic devices is also unlikely to be a concern, given the small amounts of chemicals present and the sealed nature of the devices.

Vehicle accidents, replacement of components/parts: The potential occupational safety and health risks include injuries to workers from routine monitoring and maintenance activities (vehicle accidents, replacement of components/parts, etc.) and emergencies such as equipment malfunction, fires, etc.

Emergency Fire Hazard: Since this is a solar PV power plant, the plant has always some risks of fire hazards. Electrical equipment is the main source of a potential fire hazard. In the event of fire catching a solar module, it is theoretically possible for hazardous fumes to be released and inhalation of these fumes could pose a risk to human health. However, researchers do not generally believe these risks to be substantial given the short- duration of fires and the relatively high melting point of the materials present in the solar modules. Moreover, the risk of fire at ground-mounted solar installations is remote because of the precautions are taken during site preparation including the removal of fuels and the lack of burnable materials mostly glass and aluminium contained in a solar panel.

Electrocution of Workers: Risk of electrocution of workers during performing duties in a power plant is always present. Faulty electrical equipment, electric short circuits, exposed electrical wires may be the chief sources of electrocution. Damaged PV modules with exposed high voltage conductor also present high risk of electrocution.

Electromagnetic radiation from PV modules: The strength of electromagnetic fields produced by photovoltaic systems do not approach levels considered harmful to human health established by the International Commission on Non-Ionizing Radiation Protection. Moreover, the small electromagnetic fields produced by photovoltaic systems rapidly diminish with distance and would be indistinguishable from normal background levels within several yards.

Working at height for maintenance: Periodic maintenance will be required for proper functioning of PV panels and tracking system. Maintenance worker may fall down from the height during the maintenance work. Beside this, there is a possibility of electrocution during the maintenance work PV panels and tracking system.

As the abovementioned impact may happen during the operation phase but the probability of the impact occurrence is **Medium**. The impact may cause serious damage if the proper mitigation measures do not take properly. So, the impact on health and safety during operation phase has been assessed as **minor to moderate**.

Table 103: summary of impact on occupational health and safety during operation phase

Impact	Impact on occupational health and safety				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	PV solar plant site				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	**Minor**	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.8.9. Traffic and Transport

7.8.9.1. Sources of Impact

During the operation phase, only limited person will be involved with the power plant. Minimum transportation will be required for maintenance of the power plant.

7.8.9.2. Receptor

Limited traffic will be run on the access Road. Receptor sensitivity is then **low**

7.8.9.3. Impact Assessment

A limited number of people will be employed permanently at the power plant during the operation phase of the Solar PV power facility and these employees will reside in on-site accommodation. Infrequent deliveries of replacement parts may be made during the lifespan of the solar PV power facility. Traffic impacts associated with the operation of the facility will be minimal and therefore traffic impacts associated with the operation are not considered any further. The impact due to the traffic movement during operation phase will be **negligible**.

Table 104: summary of impact on traffic and transport during operation phase

Impact	Impact on traffic and transport				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	Short-term	**Long-term**	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	PV solar plant site /settlements around the project				
Impact frequency	During operation and maintenance phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	**Small**		Medium	Large
Receptor Sensitivity	**Low**	Medium		High	

Impact Significance	Negligible	Minor	Moderate	Major
	Significance of impact is considered **Negligible.**			

7.8.10. Impact on Climate Change

The project is based on the power generation through Solar PV Technology. The Solar PV technology is environment-friendly in terms of GHGs emission. Levels of carbon dioxide (CO2) and other greenhouse gases (GHG) in the atmosphere have increased dramatically in the past few decades. Solar energy is a Renewable resource available with the great potential to significantly reduce GHG emissions. The technology of electricity generation from Solar PV Plant is environment friendly as it does not use any fossil fuel. It thereby reduces the greenhouse gas emissions associated with fossil fuel-based electricity generation system. The availability and reliability of solar power depend largely on current and future climate conditions, which may vary in the context of climate change.

The comparison of the GHGs emission caused by solar power plant with the GHGs emission that would have been caused by fossil fuel burned to make the same amount of electricity has been made. Thus, the purpose of the project activity is to generate power from zero emissions Solar PV power project and thereby reduce the emissions associated with the grid.

The proposed power plant is based on Photovoltaic technology which generates electricity using solar energy which depends upon solar flux in the area. It is defined by the Global Horizontal Irradiance (GHI) of the area, wherein shortwave radiations received by the surface at a high temperature get absorbed and individual electrons in bonds move into a higher energy level. This absorption of energy does not cause any change in temperature of the area. It is also very well understood that there can be an increase in temperature, which will be confined only to the site.

Climate change is a burning issue now a day. The project will help in reduction of GHG emission with the use of environment-friendly technology of power generation. So, it would be a long-term beneficial impact of the project.

7.8.11. Impact on Employment

The operation and maintenance phase activities of the project including maintenance and cleaning of PV solar modules. Maintenance of structures and tracking system and replacement PV modules, Irrigation of green spaces, cleaning of service building ..etc. will involve skilled, semi-skilled and unskilled workers, who are likely to be recruited from the local community.

The project is also likely to create a number of indirect economic opportunities in terms hiring tractors, trucks…. etc. As the project development will generate the employment opportunity so it is assessed as the **positive** impact.

7.9. Impact Assessment in Decommissioning Phase

7.9.1. Impact on Soil Environment

The decommissioning activities will cause following impacts on soil:

- Soil compaction due to the increased vehicular and workforce movement, dismantling and storage of plant components on the adjacent land, removal of internal electric lines/ poles etc.
- Waste will be generated in form of dismantled plant components and demolition debris from plant foundations, storage yard and substation complex. Electric components such as transformers, insulators, wires will be generated. The waste will be mainly of inert nature.
- Depending on the type used, photovoltaic cells may contain toxic substances such as gallium arsenide, copper-indium-gallium-diselenide and cadmium telluride. If any solar panel is damaged during the dismantling of the facility, these toxins are likely to spill and leach into the soil and contaminate it.

Soil contamination during decommissioning phase may occur due to leakage from machinery and transportation vehicles and during collection of remaining oil/ lubricants in the plant.

Receptor sensitivity, based upon the context presented above, is assessed to be **low**.

Removal of grounded structures and demolition during decommissioning phase may affect the top layers of the soil and loss of topsoil quality but the effects can be reversed over time. Also, as the plant is spread over an area of 60 km2, number of labors required during the decommissioning phase is assumed to be large. Hence, generation of domestic waste will be a lot, especially at the labor camps. Thus, the Impact magnitude has been assessed to be **medium**.

The overall impact significance is assessed to be **minor.**

Table 105: summary of impact soil environment during decommissioning phase

Impact	Impact on soil environment					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	PV solar plant site					
Impact frequency	During decommissioning phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.9.2. Impact on Water Environment

Water during the decommissioning phase will be consumed by laborers and will be required for civil work. The water demand could be met through procurement of water tankers. Potential contamination of groundwater /surface water resources resulting from improper management of sewage and accidental spills/leaks at the storage areas is **low**.

The overall impact significance is assessed to be **minor.**

Table 106: summary of impact soil environment during decommissioning phase

Impact	Impact on water environment					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	PV solar plant site					
Impact frequency	During decommissioning phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		Small	**Medium**	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.9.3. Impact on Air Quality

Air quality will largely get impacted from the following sources during the decommissioning phase:

- Fugitive dust emissions from site excavation work, to remove structure and restore the land to its original state.
- Vehicular emissions due to traffic movement on site and on access roads.

- Exhaust emissions from heavy machineries
- The solar panels if not handled or disposed of properly during the decommissioning phase, any toxic substances contained within them are likely to escape into the surrounding air creating serious environmental and public health risks.

The biggest source of emissions in the decommissioning phase is the fugitive dust emissions from demolition activities. the impact magnitude has been assessed as **small.**

The impact significance for air quality in the decommissioning phase is assessed as **negligible.**

Table 107: summary of impact on air quality during decommissioning phase

Impact	Impact on traffic and transport					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	PV solar plant site /settlements around the project					
Impact frequency	During operation and maintenance phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		**Small**	Medium	Large	
Receptor Sensitivity	**Low**	Medium		High		
Impact Significance	**Negligible**	Minor	Moderate	Major		
	Significance of impact is considered **Negligible.**					

7.9.4. Impact on Ambient Noise

During decommissioning phase of the project, noise will generate from movement of vehicles carrying dismantled structure and equipment.

There are three other solar projects and a grid substation located within 5 km radius of the project site along with three village. The area is would then be an Industrial area and therefore the receptor sensitivity is assessed to be **low to medium.**

Impact magnitude is considered to be **small** considering the decommissioning period to last for small duration.

The overall impact significance is envisaged to be **negligible to minor.**

Table 108: summary of impact on ambient noise during decommissioning phase

Impact	Impact on ambient noise					
Impact Nature	**Negative**	Positive		Neutral		
Impact Type	**Direct**	Indirect		Induced		
Impact Duration	Temporary	**Short-term**	Long-term	Permanent		
Impact Extent	**Local**	Regional		International		
Impact Scale	PV solar plant site					
Impact frequency	During decommissioning phase					
Impact Likelihood	unlikely	Possible		**Likely**		
Impact Magnitude	Negligible		**Small**	Medium	Large	
Receptor Sensitivity	Low	**Medium**		High		
Impact Significance	Negligible	**Minor**	Moderate	Major		
	Significance of impact is considered **Minor.**					

7.9.5. impact on occupational health and safety

The decommissioning of the Solar PV plant will involve a range of activities that could potentially be unsafe to workers without mitigation measures.

7.9.5.1. Impact source

The sources of impact on the health and safety of the Project construction workforce are listed below.

- Accidents and injuries associated with the operation of heavy machinery and other construction activities; and
- Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions of air, water pollution and noise generation from decommissioning as well as from storage and handling of waste, particularly hazardous waste.
- Loading activities of dismantled materials
- Working at height, working with rotating machinery and falling objects

7.9.5.2. Receptor sensitivity

Workers will be exposed to occupational health and safety impacts arising from dismantling of solar PV plant. The decommissioning phase will last a short period of time

Sensitivity of receptor is assessed as **medium**.

7.9.5.3. Impact assessment

During dismantling works, physical injury maybe results from working with rotary machines, loading dismantled objects, and other occupational hazards. Overexertion injuries and illness are potentially the most common health hazards associated with

construction activities. Further, there is potential for slips and fall on the same elevation associated with poor housekeeping, such as excessive waste debris, loose construction material, liquid spills and uncontrolled use of electrical cords and ropes on the ground which results in injuries and time loss during construction.

Hazards associated with fall of dismantled objects or tools, as well as the collapse of constructed slabs, walls and roofs can result in injury to head, eyes, and extremities. Transportation of dismantled structures and object and movement of vehicles are associated with road accidents and related hazards, which can lead to injuries and fatalities.

Therefore, there will be potential impacts on worker's health and safety due to exposure to risks through dismantling activities that lead to accidents causing injuries and death. The most frequent risks cause of accidental death and injury are:

7.9.5.3.1. Safety Risks

- Tripping due to uneven surfaces, obstacles, trailing cables.
- Falling during working at height due to fall from fragile surfaces, roof edges, and ladders.
- Fire due to hot works, smoking, failure in electrical installations.
- Mobile plant and vehicles; and
- Electrical shocks.

7.9.5.3.2. Health Risks

- Manual handling and musculoskeletal disorders: typical dismanteling activities that can cause injury such as lifting, lowering, pushing, pulling and carrying.
- Hand-arm vibration: people work with hand-held or hand-guided power- tools and machines, such as concrete breakers, grinders and disc cutters, hammer drills, chipping hammers, chainsaws, scrabbles and needle guns.
- Temporary or permanent hearing loss which usually comes from noise generated from machinery used for cutting and dismantling structures and from compressors etc.
- Heat stress and working at high temperatures.

These risks could create long-term impacts to the health and safety of the dismantling workforce and therefore the impact magnitude is assessed to be **medium** without mitigation measures. So, the impact significance on occupational health and safety during decommissioning phase has been assessed as **Moderate** without taking mitigation measures.

Table 109: summary of impact on occupational health and safety during decommissioning phase

Impact	Impact on occupational health and safety				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	PV solar plant				
Impact frequency	During construction phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	Low	**Medium**		High	
Impact Significance	Negligible	Minor	**Moderate**	Major	
	Significance of impact is considered **Moderate.**				

7.9.6. Impact on Employment and community

The major social impacts associated with the decommissioning phase are linked to the loss of jobs and associated income and issues results from this situation when workers asked to leave. This has implications for the households who are directly affected, including their families. However, the impacts are likely to be limited due to relatively small number of permanent employees (mainly security guards) who will be affected. Other associated impacts would be that improper disposal of construction waste and debris from deconstruction of storage area, etc. will lead to contamination of soil and discontentment with the immediate surrounding settlements. The receptor sensitivity is assessed to be **low**.

Impact magnitude is considered to be **small to medium** considering the decommissioning period to last for small duration.

The overall impact significance is envisaged to be **Minor.**

Table 110: summary of impact on employment and community during decommissioning phase

Impact	Impact on employment and community				
Impact Nature	**Negative**	Positive		Neutral	
Impact Type	**Direct**	Indirect		Induced	
Impact Duration	Temporary	**Short-term**	Long-term	Permanent	
Impact Extent	**Local**	Regional		International	
Impact Scale	PV solar plant site /settlement around site project				
Impact frequency	During decommissioning phase				
Impact Likelihood	unlikely	Possible		**Likely**	
Impact Magnitude	Negligible	Small		**Medium**	Large
Receptor Sensitivity	**Low**	Medium		High	
Impact Significance	Negligible	**Minor**	Moderate	Major	
	Significance of impact is considered **Minor.**				

7.10. Cumulative Impact Assessment

During site visit it was observed that the project falls in an area with no other project or existing facilities that could interfere with the PV solar plant project. Then no cumulative impacts could be mentioned.

7.11. Summary of potential impacts

The impacts identified in this chapter in each project phase are recapitulated in the following table.

Table 111: summary of the project impacts

Potential Impact	Impact nature	Impact type	Impact duration	Impact extent	Impact frequency	Impact likelihood	Receptor sensitivity	Impact magnitude	Impact Significance
A- CONSTRUCTION PHASE									
Impact on Land Use	Negative	direct	Long - term	local	Construction phase	Likely	low	medium	Minor
Impact on topography and drainage	Negative	direct	Long term	local	Construction phase	Likely	low	medium	Minor
Impact on soil contamination									
· Soil contamination due to waste generation	Negative	direct	Long-term	Local/regional	Construction phase	Likely	low	medium	Minor
· Soil contamination due to leaks /spills	Negative	direct	Long - term	local	Construction phase	Likely	low	medium	Minor
Impact on soil erosion and compaction	Negative	direct	Long - term	local	Construction phase	Likely	low	Medium	Minor
Impact on surface water availability	Negative	direct	Short - term	regional	Construction phase	Likely	high	small	Moderate
Impact on ground water availability	Negative	direct	Short - term	Local/regional	Construction phase	Likely	low	Negligible	Negligible
Impact on surface water quality									
· Contamination by wastewater	Negative	direct	Long-term	local	Construction phase	Likely	Medium	small	Minor
· Contamination by spills /leaks	Negative	direct	Long-term	local	Construction phase	Likely	Medium	small	minor
· Contamination by loads sediments	Negative	direct	Long-term	regional	Construction phase	Likely	Medium	small	minor

Potential Impact	Impact nature	Impact type	Impact duration	Impact extent	Impact frequency	Impact likelihood	Receptor sensitivity	Impact magnitude	Impact Significance
Impact on groundwater quality	Negative	direct	Long-term	Local/regional	Construction phase	Likely	Medium	small	Minor
Impact on air quality									
Dust from construction	Negative	direct	Short - term	local	Construction phase	Likely	low	Medium	Minor
Exhaust/fugitive emission	Negative	direct	Short-term	local	Construction phase	Likely	low	Medium	Minor
Odors	Negative	direct	Short - term	local	Construction phase	Likely	low	Medium	Minor
Impact on ambient noise	Negative	direct	Short - term	local	Construction phase	Likely	low	Medium	minor
Impact on traffic and transport	Negative	direct	Short - term	regional	Construction phase	Likely	Medium	Medium	Moderate
Impacts on ecology and biodiversity	Negative	direct	Short - term	local	Construction phase	Likely	Low	Medium	minor
Impact on occupational health and safety	Negative	direct	Short - term	local	Construction phase	Likely	Medium	Medium	Moderate
Socio-economic impacts									
Impact on community health and safety	Negative	direct	Long-term	regional	Construction phase	Likely	Medium	small	Minor
Impact on employment	Positive	direct	Short - term	regional	Construction phase	Likely	--	--	Positive
Impacts from migrant workers (social impacts, spreading of infectious disease.)	Negative	direct	Short-term	regional	Construction phase	Likely	Medium	small	Minor

Potential Impact	Impact nature	Impact type	Impact duration	Impact extent	Impact frequency	Impact likelihood	Receptor sensitivity	Impact magnitude	Impact Significance
Archeology and cultural heritage	No impact								No Impact
B- OPERATIONAL AND MAINTENANCE PHASE									
Impact on Land and Soil Environment									
Improper waste disposal	Negative	Direct	Long-term	Local/regional	Operation phase	likely	medium	Medium	Moderate
Soil contamination due to accidental spills leaks	negative	Direct	Long-term	local	operation phase	Likely	medium	Medium	Moderate
Waste generation	Negative	Direct	Long-term	Local/regional	operation phase	Likely	medium	Medium	Moderate
Impacts on water quality and quantity									
Water availability	Negative	Direct	Long-term	regional	operation phase	Likely	medium	medium	moderate
Water quality	Negative	Direct	Long - term	Local/regional	operation phase	Likely	Medium	small	minor
Air quality	Negative	Direct	Long - term	local	operation phase	Likely	Low	medium	minor
Impact on Ambient Noise Levels	Negative	Direct	Long-term	local	operation phase	Likely	Low	medium	minor
Impact on Ecology and biodiversity	Negative	Direct	Long-term	local	operation phase	Likely	Low	medium	minor
Landscape and Visual Impact	Negative	Direct	Long-term	Local/regional	operation phase	Likely	Low	medium	minor
Occupational Health and Safety	Negative	Direct	Long-term	local	operation phase	Likely	Medium	medium	Moderate
Traffic and transport	Negative	Direct	Long-term	regional	operation phase	Likely	Low	small	Negligible
Impact on climate change	Positive	Direct	Long-term	regional	operation phase	Likely	--		Positive

Potential Impact	Impact nature	Impact type	Impact duration	Impact extent	Impact frequency	Impact likelihood	Receptor sensitivity	Impact magnitude	Impact Significance
Impact on employment	Positive	Direct	Long-term	regional	operation phase	Likely	--		positive
C- DECOMMISIONING PHASE									
Impact on soil environment	Negative	Direct	Short-term	Local/regional	Decommissioning phase	Likely	low	Medium	minor
Impact on Water Environment	Negative	Direct	Short-term	Local/regional	Decommissioning phase	Likely	low	Medium	minor
Impact on air quality	Negative	Direct	Short-term	local	Decommissioning phase	Likely	low	Small	Negligible
Impact on ambient noise	Negative	Direct	Short-term	local	Decommissioning phase	Likely	Medium	small	minor
Impact on employment and community	Negative	Direct	Short-term	regional	Decommissioning phase	Likely	Medium	Small	Minor
Impact on occupational health and safety	Negative	Direct	Short-term	local	Decommissioning phase	Likely	Medium	Medium	Moderate

8. MITIGATION MEASURES

8.1. Identification and description of mitigation measures

Preventive measures are more effective when applied at an early stage of project (planning).

During first stages, the environmental component has a key factor in the design of the elements of a project. Sustainable design can enable to avoid risks and impacts, reducing costs and improving benefits.

The overall objective of the environmental infrastructure design criteria has been to ensure that the project will be developed in an environmentally sound and sustainable manner ensuing that all negative effects are mitigated as best as practical and positive impacts are enhanced.

Mitigation hierarchy has been considered during the design of the infrastructure: Avoid, Minimize / Reduce, Mitigate, and Compensate; that is:

- Anticipate and avoid risks and impacts.
- Where avoidance is not possible, minimize or reduce risks and impacts to acceptable levels.
- Once risks and impacts have been minimized or reduced, mitigate such risks and impacts.
- Compensate where significant impacts occur.

Table 112 : Mitigation hierarchy in the design of the infrastructure

Preference Order	Mitigation Hierarchy
1	Avoid
2	Minimize/Reduce
3	Mitigate
4	Compensate

Since the first stage of the project, the following measures have been considered to avoid, to reduce or to mitigate impacts foreseen:

Land Use and Local People

- Minimize land take as far as possible.
- Construction camps and ancillary facilities have been located at areas which are acceptable from environment, cultural and social point of view.

Design for Prevention and Minimization

- Provisions to preserve the operation of current facilities in enough quantity. Coordination with the utility company. Preliminary study of Existing Utilities and Urban Networks data collection and analysis.

- Ensure that the Project and all associate activities will cause the least environmental/ cultural/ social impacts:
- Minimize loss of trees/vegetation.
- Protect trees by fencing during construction phase (marking out and individual protection).
- Provision of adequate and timely tree transplanting and replacement.
- Minimize noise impacts to sensitive receptors.
- Minimize impacts on landscape and restoration of altered areas.
- Reuse (if suitable) of excavation spoils.
- Identification of a suitable disposal location. Selection of authorized landfill for spoils. Designation of suitable transport routes and schedule for spoil truck movements to minimize traffic disruption/congestions.
- Mitigation measures for avoiding traffic congestion and access problems in Road Transport

Water Conservation

- Ensure maximum water efficiency.
- Stormwater stored and reuse
- Grey water recycling and reuse network.
- Protect water quality.
- Avoid habitats emergency for insects

Energy Efficiency and Renewable Energy

- Energy Efficiency in Buildings to achieve the goal of reducing carbon footprint and electricity cost.
- Material planning for efficient maintenance in Buildings and Energy Saving, reducing the consumption of energy during operation. Increase maintenance efficiency by zoning the Buildings.
- Proper ventilation in Buildings avoiding greenhouse effect.

Noise

- Fulfilment of legal framework and standards.
- Noise Control Plan.
- Good construction practices about noise mitigation measures will reduce significant noise levels:
- During construction phase, the contractor shall employ only approved vehicles and machinery. All the vehicles and machinery must work properly avoiding

malfunctioning that may increase noise levels. Equipment will be serviced regularly and operated as per manufacturer's specifications.

- Night works should be avoided to reduce noise nuisance.
- Truck drivers and equipment operators shall minimize the use of horns.
- All construction equipment and vehicles shall be well maintained and shall be fitted with appropriate noise suppression equipment consistent with applicable national noise standards.
- Standard sound reduction devices such as silencers or mufflers will be installed on construction equipment.
- Whenever possible, completely enclose noisy equipment which can reduce noise level by 15-25 dB(A) and restrict the use of noisy equipment.
- Speed limits will be imposed on construction vehicles to minimize noise emission.
- If some works & activities generate high noise levels in sensitive areas, the contractor shall install temporary barriers.

Air Quality

- Dust Control Plan
- Good construction practices about air quality mitigation will reduce significant impacts:
- To reduce air pollutant emissions from point and mobile sources during construction, it will be used cleaner fuels such as ultra low sulphur fuels. The construction contractor will also ensure that fuels will be burned more efficiently by using machinery and vehicles according to manufacturer's specifications. In addition, a preventive and regular maintenance program will be undertaken by the construction contractor to ensure that machinery and vehicles are in good condition throughout the duration of the project construction and meet national emission standards.
- Burning of wastes generated at the construction sites shall be strictly prohibited. No bonfires.
- Dust generating materials stockpiled and transported by road vehicles will be covered with suitable sheets or dampens with water to prevent dispersal of particulates.
- Paving or regular dampening with water on haul roads.
- Setting appropriate speed limits onsite.
- Provision of wheel washing bay at project site exits to prevent materials offsite.

Waste and Wastewater

- Waste and Wastewater Management Plan.

- The waste during construction phase will be managed in a manner that will be safe and without risks to the health of workers, the community, or the environment.
- Consideration of sustainable options such as renewable, reusable or recyclable materials and implementation of waste management options integrating international best practices will reduce waste generation thereby minimizing the load on existing waste disposal facilities. In addition, waste will be segregated at source to readily facilitate sorting of waste when transferred to a designated central waste holding area or directly to a waste recycling plant, to ensure recycling and reuse of materials.
- Regarding wastes generated during construction, the mitigation measures for the prevention, mitigation and remediation of any significant adverse environmental impact will be:
- Measures provided for in the law and other regulations, standards and deadlines for their enforcement.
- Measures to reduce the amount of waste generated and minimize the resources needed to do the job.
- Measures that can contribute to the prevention or mitigation of harmful environmental effects. Prevention is financially advantageous as it reduces the purchase of construction materials and obviates the need to remove wastes from site. Purchase of cleaning materials that will minimize damage to the environment.
- Plans and technical environmental protection solutions (recycling, treatment and disposal of waste substances and other).
- Measures that will be undertaken in case of accident.
- Impacts from hazardous materials will be managed through appropriate management system including disposal through approved environmental service providers to transport and dispose of the hazardous wastes.
- Emergency Action Plan to potential situations of risk.
- Treatment of contaminated water before discharge in accordance with wastewater standards. Discharge permit.

Landscape Integration and Visual Impact

- The design for the buildings shall adopt universal design principles, including improved facilities for woman, the elderly persons with disabilities. All the detail architectural designs in Buildings shall be prepared in accordance with local design. Appropriate color treatment of the buildings shall be used to help the structures fit in with the landscape. The facades on the structures shall be designed to be sensitive to the local landscape character. Materials aesthetically pleasant and Harmony with surrounded environments.

- Use of environmentally friendly materials
- Structures will be designed in a manner sensitive to the local landscape character within the area including the use of neutral colors and materials.
- Only lighting the areas that are required and directing lighting away from visual receptors.
- Planting, as part of mitigation measures, will increase the ability of the landscape to accommodate development. Different criteria will be used to select the most suitable species to achieve a balanced and sustainable plantation scheme. The selected species will have the purpose of contributing for the integration of the new buildings and structures with the surrounding environment using shapes and color contrasts to create enjoyable spaces with a strong local identity.

The Project will include these considerations about landscape mitigation measures during construction phase:

- Minimization of working areas as much as possible.
- All earthworks design shall minimal visual impact. The finished surfaces of earthworks shall be protected against erosion.
- Careful consideration of the form and finish of structures so they fit in with existing landscape.
- Disposal of excavated unacceptable material shall be minimized, where possible.
- Restriction of stockpiling heights. Stockpile areas will be fenced.
- Dust control.
- Tidy storage of materials and machinery.
- Making good all work sites at the end of the construction period.
- Appropriate storage and reuse of topsoil for final landscaping.

8.2. Mitigation measures in construction phase

8.2.1. mitigation measures for impact on land use

The actual area of land use impact would be limited to some grazing lands in immediate vicinity of the solar plant. The overall impact on land use is considered negligible, however the following mitigation measures should be implemented:

- the After-construction work, any land taken for a temporary basis for storage of material will be restored to their original form.
- Existing roads widened and developed for access to the project site with the exception of a small connection from the Mekkah-Riyadh highway to the plant site.
- Construction activities should be restricted to designated area.
- The land use in and around permanent project facilities should not be disturbed.

- The construction activities will be restricted within the boundary of the proposed plant and will not alter the land use of the adjacent areas.
- Proponent should take tree plantation program whereas possible in the plant boundary or along the access roadside.
- Waste should not be allowed to litter in and around the project area.
- On completion of construction activities, land used for temporary facilities will be restored to the extent possible.
- The land should be restored back to the original state to the extent possible after completion of the life cycle of the project and in case there are plans not to continue further at the site.

The impact on land use will have a high intensity within the project site for a permanent duration which will result in an overall minor impact without mitigation. with proper implementation of suggested mitigation measures, the overall impact will be **negligible**.

8.2.2. mitigation measures for land use for topography and drainage

The following measure should be implemented to mitigate the change topography and drainage pattern:

- The EPC contractor will be instructed to avoid any unnecessary changes in the topography.
- Detail hydrology study should be carried out.
- Appropriate number of cross drainage channels should be provided during access road construction to maintain flow in existing natural channels.
- Keep all natural channels to the extent possible at their original state.
- Design structures considering the natural functioning of the of drainage channels.

The impact on the topography and drainage pattern will have medium intensity with locally extent for a long duration which will result in an overall minor to medium impact without mitigation. However, with proper implementation of suggested mitigation the impact will be reduced to **negligible**.

8.2.3. mitigation measures for soil contamination

The following mitigation measures will be taken to mitigate soil contamination.

8.2.3.1. Leaks and spills

The following measure will be implemented to mitigate the Soil contamination by leaks and spills.

- Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area.

- Sewage generated from the project site will be treated and disposed of through septic tank and soak pits;
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.
- Construction vehicles and equipment will be serviced regularly
- The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals;
- Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system;
- A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination.
- Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively; and
- The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events

8.2.3.2. Soil contamination by waste generated

The following measure will be implemented to mitigate/avoid soil contamination by waste generation:

- The construction contractors will have control over the amount and types of waste (hazardous and non- hazardous) produced at the site. Workers will be strictly instructed about random disposal of any waste generated from the construction activity;
- Construction contractor should ensure that no unauthorized dumping of used oil and other hazardous wastes is undertaken from the site;
- Municipal domestic waste generated at site to be segregated onsite;
- Ensure hazardous waste containers are properly labelled and stored onsite provided with an impervious surface, shed and secondary containment system;
- Ensure routinely disposal of hazardous waste through approved vendors and records are properly documented;
- Construction contractor should ensure daily collection and periodic (weekly) disposal of construction waste generated debris, concrete, metal cuttings wastes, waste/used oil etc.;
- Ensure hazardous waste is properly labeled, stored onsite at a location provided with impervious surface, shed and secondary containment system and;
- The municipal waste from the labor camp will only be routed through proper collection and handover to the local municipal body for further disposal. The

hazardous wastes will be temporarily stored in labeled drums on the impervious surface at designated area onsite and will be disposed of through approved vendors.

The impact on soil contamination due to waste generation, spills and leaks will have a medium intensity within the project site for a short duration which will result in an overall minor impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **negligible.**

8.2.4. mitigation measures for soil erosion and compaction

The following measure will be implemented to mitigate the Soil Compaction and Erosion:

- The area to be cleared must be clearly demarcated and this footprint strictly maintained.
- Soil conservation measures will be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas.
- Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds;
- Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint;
- It is recommended to grow turf grass beneath solar panels to avoid soil erosion
- Construction vehicles will remain on designated and prepared compacted gravel roads;

The impact on topsoil compaction and erosion will have a medium intensity within the project site for a short duration, which will result in an overall minor impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be ***negligible***.

8.2.5. mitigation measures for surface water sources consumption

The following mitigation measures will be implemented to mitigate the impact on availability of surface water:

- Construction labor deputed onsite to be sensitized about water conservation and encouraged for optimal use of water.
- Regular inspection for identification of water leakages and preventing wastage of water from water supply tankers is necessary for efficient utilization of water.
- It should be ensured that water supply for the Project to be procured from approved suppliers and the approval copy of the same to be maintained to ensure the right source;
- Blending of low-quality water with fresh water for construction uses to ensure efficient use of natural resource.
- Recycling/reusing to the extent possible

- Use to extent possible wet technology for cleaning equipment to optimize the consumption of water
- Implement, if possible, a system to treat and reuse the wastewater

After implementation of the mitigation measures the magnitude of impact on surface water availability is assessed to be **minor**.

8.2.6. mitigation measures for groundwater sources

as noted above there will be no groundwater use during the project. The impact on the consumption of this resources is negligible. Thus, no mitigation measures will be implemented.

8.2.7. mitigation measures for surface water quality

8.2.7.1. wastewater/oil leaks and spills

The following measure will be implemented to mitigate the wastewater /oil spills leaks discharge:

- Fuel, oil and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material.
- Refueling will be carried out in designated areas using strict protocols.
- Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a bound landfill site.
- Project staff will not be permitted to utilize any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing.
- Construction vehicles and equipment will be serviced regularly at off-site location.
- Ensure that all construction plant and equipment is maintained in a good state of repair with minimal leaks.
- Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal.
- Oil and grease separator shall be used for wastewater generated from cleaning activities.
- Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce;
- Workers will be trained in the use of designated areas/bins for waste disposal and encouraged to use toilets.
- Septic tanks will be provided to treat sanitary wastewater
- Use of licensed contractors for management and disposal of waste and sludge and
- All sewage and liquid effluent will be treated to meet the standards specified by the MEWA regulations and IFC guidelines EHS 2007

8.2.7.2. Sediment load

The following measure will be implemented to mitigate the sediment content in the water body:

- The drainage pattern of the site will not be altered and the natural slope of the site will be maintained;
- Special care needs to be taken during the road construction to maintaining the standard slop as the soil cannot wash out in the water body. As well as need proper compaction of the road structure.
- Cover all slopes of the road by first growing grass.
- Adequate arrangement for stormwater management during construction period will be made to avoid sediment runoff from the site.
- Stormwater flow should be directed to the existing channels / Wadi with silt trap to avoid sedimentation of the canals or the receiving water body.

The impact on surface water quality will have low intensity with short-term duration which will result in an overall **minor** impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **negligible.**

8.2.8. mitigation measures for groundwater quality

The following measure will be implemented to mitigate the ground water by leaks and spills

- Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area.
- Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of.
- Construction vehicles and equipment will be serviced regularly
- The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.
- Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system.
- A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination.
- Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively.
- The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events.

Impact significance will be assessed as **negligible** after implementation of the mitigation measures.

8.2.9. mitigation measures for air quality

8.2.9.1. dust elimination

To reduce dust impacts, the following measures will be put in place:

- Implementation of a regular watering and sprinkling dust suppression regime, during the dry season.
- Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent the escape of dust during loading and transfer from Site.
- No stockpiles will be maintained outside, and maximum Possible distance between the stockpiles and receptors will be maintained.
- Covering and/or watering of all stockpiles of dusty materials such as excavated spoils to avoid fugitive dust emissions.
- During construction, the approach road will be kept clean, free from mud and slurry;
- Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site.
- Speed of vehicles on site and approach road will be limited to 15-20 km/hr which will help in minimizing fugitive dust emission due to vehicle movement
- Idling of vehicles and equipment will be prevented and
- Waste from construction will not be burned.
- Concrete, sand and aggregates shall be stored as far from sensitive receptors as possible and screened/shielded if they are located within 100m of sensitive receptor.
- The distance from receptors to dust emission sources (stockpiles etc) shall be maximized, with consideration of prevailing wind direction.
- Dusty materials shall be removed from construction sites as soon as possible.
- Transport of contaminated soil (if any) shall also be carried out with tight fitting covered trucks or closed containers.
- Loaded trucks to or from the work site area shall avoid heavily travelling through residential roads in the localities around.
- Traffic management measures shall reduce congestion: Planning of driving construction vehicles outside of the construction area during rush hour traffic.
- Implementation of a Dust Control Plan: The construction contractor shall draw up a Dust Control Plan in accordance with Air National Standards. The construction contractor:
  - ✓ Shall instigate effective dust suppression measures as may be necessary to avoid creating dust nuisance arising as a result of the Works on site.
  - ✓ Shall clearly identify proposed dust control measures intended to be implemented in detail as a part of a general method statement to be issued.

- ✓ Shall ensure that all temporary construction shall be such that it will not allow the infiltration of any biological or chemical pollutants into the works.
- ✓ The Dust Control Plan shall provide details of mitigation measures, specific location and schedule where such measures will be implemented to minimize impacts to sensitive receptors due to construction works, sourcing and transport of construction materials, and other project-related activities.
- ✓ The construction contractor shall designate a person or several persons to monitor the Dust Control Plan, with authority to order additional sprinkling when needed to avoid dust problems around the construction site and on external roadways. This monitoring includes weekends and holidays when there is no work on the construction site.
- ✓ The Dust Control Plan Report shall have at least the following content:

1.DUST CONTROL PLAN

1.1. Purpose

1.2. Air Standards and other National Legislation. Acceptable levels.

1.3. Time for completion

1.4. Quality assurance

1.5. Site working conditions

1.6. Local conditions

1.7. Material Support

2.SCOPE OF THE WORK

2.1. Measures to minimize dust and other emissions

2.2. Measures to monitor dust and other emissions

3.DELIVERABLES

Appendix: Monitoring Control Points.

The impact due to dust generation will have medium intensity with locally extent for a short-term duration which will result in an overall **minor impact** without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **negligible**.

8.2.9.2. Fugitive emission

Exhaust emissions will be minimized by following mitigation measures:

- ✓ The movement of construction vehicles will be minimized, and a 20 km/hr speed limit will be enforced in the project site as well as approach road;

- ✓ Vehicles traveling on gravel roads will not exceed a speed of 30 km/hr;All diesel-powered equipment will be regularly maintained and idling time reduced to minimize emissions;
- ✓ Low sulfur diesel (S<O.5%) will be used in diesel-powered equipment in collaboration with best management practices;
- ✓ Vehicle/equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use);
- ✓ Vehicle/equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced; and
- ✓ Implementation of an Engine **Emission Management Program:** According to Mobile Source Emissions Standard (The Executive Regulations for Air Quality NCEC-MEWA 2020), the owner or operator of a large site or facility (the construction contractor) must develop an internal management program. Large sites are those that have 5 or more engines, equipment and/or vehicles that have the potential to be operational at the same time. This engine emission management program shall include the following:
  - A list of all applicable engines
  - Engine maintenance procedures
  - Procedures to ensure best available environmental technology are used where economically feasible
  - Potential hazards and emergency response procedures.
  - It is the responsibility of the site owner or his designated site manager to ensure the implementation and maintenance of the engine emission management program.
  - All engine emission management program documentation shall be organized carefully and made available to the Competent Agency when required.
  - Failure to submit internal management program documentation to the Competent Agency, within a 30 day period, will be deemed as a failure to comply with Mobile Source Emissions Standard of the Executive Regulations for Air Quality NCEC-MEWA 2020
  - Solid waste burning in the project site is strictly prohibited
  - The impact of exhaust emission will have high intensity with locally extent for a short-term duration which will result in an overall minor impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **negligible.**

8.2.10. mitigation measures for ambient noise

The following mitigation measures will be implemented to minimize potential noise impacts during the construction phase in all periods:

- The contractor should ensure that all construction equipment and vehicle is fitted with silencers (where possible).
- The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work (this is a requirement of OSHA 2007).
- The contractor should undertake additional post development noise monitoring in accordance with National and International noise standards.
- Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum disturbance to receptors.
- Developer shall instruct their Safety Officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum.
- Only limited construction activities shall be carried out during night-time.
- Restrict the night-time vehicle movement through the access road.
- Adopt the vehicle speed limit in the access road
- It is also to be ensured that no village road will be utilized for movement of equipment except the designated access road.
- The number of equipment operating simultaneously should be reduced as far as practicable.
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable.
- All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary.
- Rubber padding/noise isolators will be used for construction equipment
- Temporary noise barriers shall be provided surrounding the high noise generating construction equipment.
- The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels.
- Construction vehicles and machinery will be well maintained and not kept idling when not in use.

The impact of noise will have low intensity with locally extent for a short-term duration which will result in an overall **minor** impact without mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **negligible.**

8.2.11. Traffic and transport

The following mitigation measures will be taken to mitigate the traffic and transportation impact:

- The contractor should ensure that all PV module and mounting structure components are transported in appropriate vehicles that adhere to the axle load limits.
- Only trained drivers with valid license shall be recruited by the construction contractor.
- Training programs shall be conducted at regular intervals for all the drivers for raising awareness about road safety and adopting best transport and traffic safety procedures once in every month.
- Additionally, speed limits for all construction related vehicles shall be adhered to at all times to prevent damage to roads and other infrastructure
- Mitigation measures such as emphasizing on safety amongst drivers, adopting limits for the trip duration and arranging driver roster to avoid overtiredness and avoiding dangerous routes and times of day to reduce the risk of the accident shall also be implemented.
- High visibility colors should be used during the transportation of PV panels to the project site.
- Regular maintenance of vehicles and use of manufacturer approved parts should be adopted to minimize potentially serious accidents caused by equipment malfunction or premature failure.
- The villagers will be made aware of the schedule prior to the movement of trucks and transportation of power plant equipment in the project area.
- Collaboration with local communities and responsible authorities to improve signage, visibility, and awareness of traffic and pedestrian safety.
- Notify the governing body and local area responsible person prior to start the construction work and put adequate signage around the construction area on both way and instruct the driver for carefully driving in close to the sensitive area;
- Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents.
- The existing earthen road should keep functional as the local people can use the road;
- Movement of the project traffic should be limited to the planned route only and;

The traffic movement in the settlement areas should be limited for the daytime only

The impact due to traffic and transport will have medium intensity with a local extent for a short duration which will result in an overall **minor** to **negligible** impact without

mitigation. However, with proper implementation of suggested mitigation, the impact will be reduced to **negligible**.

8.2.12. mitigation measures for socio-economic impacts

8.2.12.1. mitigation measures for community health and safety

The mitigation measures that will be implemented during the construction phase to attenuate impact on community health and safety are:

a) for traffic

- The truck drivers carrying construction machinery and materials will be instructed to drive within speed limits with careful consideration for villages traffic in vicinity.
- Movement of heavy equipment and construction materials will be regulated during peak hours (09:00 AM to 06:00 PM).
- Proper route of movement of project vehicles will be identified.
- Depute traffic escorts as and when required near project site and major settlements to guide movement of project vehicles.
- Keep limited speed of project vehicles near settlements and within the project site.
- Provide necessary training to the drivers for speed restrictions and on do's and don'ts.

b) For waste management and disposal

- The excavated areas will be properly fenced for safety and sign boards in local languages will be put up;
- No hazardous waste or any waste be stored within the site for long periods of time and be in contact with the soil.
- The quantity of domestic waste generated daily from the labor camps will be small and limited as most of the workers will be hired locally. However, the construction contractor shall ensure that the camp sites provided at the site have adequate waste disposal facilities. Arrangements for collection of garbage in dustbins and daily disposal to the nearest dump site shall be made. Provision of toilets for workers shall be made at the campsites in order to maintain hygienic and clean surroundings.
- Effort should be made to use the locally available labor for unskilled work purpose.
- Construction contractor will be followed the 3R policy to manage the solid waste management.
- Nearby municipality may also be contracted for regular disposal of the labor camp waste.
- Washing and bathing areas will be provided with a proper drainage system so that wastewater is not accumulated in the campsites. Disposal of sewage shall be made through a septic tank – soak pit arrangement.

- Used or waste oil generated from generators and construction machinery and equipment will be stored on a paved surface in a secure location at the project site. Appropriate secondary containment capable of containing the 110 percent of the largest tank is to be provided.
- The waste oil, which is characterized as hazardous will be sold to authorized vendors at frequent intervals.
- Empty fuel containers will also be stored at a secured area designated for scrap and sold to authorized vendors. All packaging material will also be collected at the storage area and sold to scrap dealers.
- Construction debris and excavated material will be stored in a confined area to prevent spread by wind or water.
- The construction debris will be used for backfilling of excavated areas and for foundation works at site.

The overall impact on community health and safety with the implementation of suggested mitigation measures, will be **negligible**.

8.2.12.1.1. Employment opportunities measures

The project is recommended to have the following mitigation measures in place:

- The local community is preferred by the project for the requirement of skilled, semiskilled and unskilled workers to the extent possible.
- The sourcing of local labor wherever possible should be made obligatory for the sub- contractors and in all major procurement activities.
- Preference should be given to the vulnerable population.
- The EPC Contractor/ and the MoE/MEWA will establish a mechanism to audit subcontractors and suppliers with respect to compliance of utilizing local labor and resources.

8.2.12.2. Mitigations measures for impacts from migrant workers

Potential impacts during construction period include impact due to the influx of migrants and associated health related risk to the community. These impacts are expected to be low and with the implementation of the following mitigation measures the potential impact due influx of migrant workers will be further minimized.

- Engage as many locally available unskilled, semi-skilled and skilled human resources as practically possible to avoid large scale in migration of labor force.
- Provision of infrastructure and amenities for migrant labor in construction camp to avoid dependence on limited local resources.

- Adequate sanitation facility at labor camps to maintain hygiene and minimize spread of diseases.
- Creating awareness about local tradition and culture among outside migrant and encouraging respect for same.
- Providing awareness training regarding infectious diseases among the migrant population.
- Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area.
- Avoid unnecessary movement of vehicles through near settlement areas to avoid disturbance and traffic safety related issues.

The impact due to influx of migrant worker will have medium intensity with a local spread for a short duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures the overall impact will be **negligible**.

8.2.13. Mitigation measures for occupational health and safety

Following measures will be taken to minimize the health impact during construction phase:

- The workers (both regular and contractual) on the project will be provided with training on the Health and Safety policy in place, and their role in the site and refresher courses will be provided throughout the life of the project.
- Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work activities.
- Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional.
- The contractor should ensure that no person is engaged in driving or operating construction machinery unless he is sufficiently competent and reliable, possess the knowledge of risks involved in the operation and is medically examined periodically.
- Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project.
- Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures;
- Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries;
- Safety sign should also be marked at appropriate places.
- It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls.

- Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for the attention of everyone at the site.
- Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also be carried out.
- Dropping/lowering of construction material or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas.

The health and safety impact will have high intensity with a local spread for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact significance after will be **negligeable to minor**.

8.2.14. mitigation measures for ecological and biodiversity impacts

The following identifies the additional studies and mitigation measures to be applied by the EPC Contractor during the construction phase and which include:

- Should as part of the Project any fencing be erected, it must be ensured that it allows for the natural movement of small faunal species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30 cm).
- One major modification that could take place at the project site is the removal of the. trees. The trees are believed to be of significance for the biodiversity elements at the Project Site especially the birds. Therefore, the minimum number of trees should be removed from the project site in order to achieve the minimal impact possible on the biodiversity at the Project Site. The trees removed should be replaced by other trees to be planted in the vicinity of the project site in order to act as an offset for the removed trees and as a new refuge for the species affected.
- Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following:
- Prohibit hunting at any time and under any condition by construction workers onsite.
- Ensure proper storage, collection, and disposal of waste streams generated.
- Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

- Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.

Following the implementation of these mitigation measures, the significance of the residual impact is categorized as **negligible** significant.

As per monitoring and reporting requirements during construction phase the EPC Contractor should inspect the works at all times.

8.3. Mitigation measures in operation and maintenance phase

8.3.1. Mitigation measures for Land and Soil Environment

8.3.1.1. Mitigation for Impact on Land due to Improper Waste Disposal

The following mitigation measures will be taken to manage the waste:

- The waste generated during operation phase will be disposed of through approved vendors.
- The hazardous wastes will be stored onsite at separate designated covered area provided with impervious flooring and send for disposal to nearest designated dumping site.
- During the operation phase, the quantity of municipal waste and hazardous waste generated is less and probability of the hazardous waste generation is only during maintenance and therefore occasional. The waste generated would be routed through proper collection and containment.
- The water for cleaning purpose of the solar PV modules remove dust from it is likely to get evaporate or absorbed by the vegetation and soil underneath the solar panel;
- The Operator/Contractor should make a MoU (Memorandum of Understanding) with the local municipality to collect the daily domestic for disposing of in the designated dumping site.

The impact on soil environment due to waste generation will have medium intensity with a local spread for a long duration which will result in an overall **moderate** impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **minor**.

8.3.1.2. Mitigation for impact on Soil Contamination due to Leaks/Spills

The following mitigation measures will be taken for controlling the leaks/spills of liquid effluent.

- Ensure oil/ lubricants are stored on impervious floor in the storage area having secondary containment.
- Use of spill control kits to contain and clean small spills and leaks during O&M activities; and

- The guidelines and procedures shall be prepared and followed for immediate clean- up actions following any spillages.

The impact on soil environment due to spills/leaks of liquid effluent will have medium intensity with a local spread for a long duration which will result in an overall moderate impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **minor.**

8.3.2. Mitigation measures for waste Generation

- The separate designated area should be earmarked for storage of hazardous waste like waste oil, transformer oil. These wastes shall be given to the MoE approved recyclers.
- Operation waste management will be governed by an Environmental Management Plan (EMP) and will incorporate reduction, recycling, and reuse principles.
- Material Safety Data Sheets for all applicable materials present on Site will be readily available to on-site personnel.
- All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers.
- Solid wastes will be segregated to facilitate reuse and recycling of specific materials.
- All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal.
- First of all, inspection of PV modules for defects that can appear in the form of burn marks, discoloration, or broken glass is to be undertaken. An authorized person will walk the site to confirm that there are no broken modules (shattered glass) and broken modules should not be sprayed with water.
- Broken or damaged solar panels are required to be immediately shifted to a designated area in a scrap yard to avoid any type of land contamination. A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims.
- Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer.
- Use the soak pit and septic tank in the office building and guard room for sewage.

The impact of waste and effluent from the operation of the project will have medium intensity with locally extent for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **minor to negligeable**.

8.3.3. Mitigation measures for Water Resources and Quality

8.3.3.1. Mitigations measures for Water Availability

The following measure will be implemented to mitigate the water consumption:

- variability and projected changes in demand in the Project area;
- Periodical training should provide to workers for best utilization of water.
- Bore-wells could be established, if deep aquifer is available is after requisite permission from the regulatory authority. Meters should be installed at the bore-wells to monitor the abstraction of water; this option proposed should be studied and assessed in advance.
- Wastage of water during cleaning of panels should be avoided; otherwise opt for dry cleaning technology. It would save considerably water.
- Drinking water demand should be met by bottle potable water purchased
- The wastewater emanating from cleaning operations shall be used for the irrigation of green spaces in project area. Wastewater reused should be in compliance with the Saudi regulations on wastewater reuse. and excess water shall be discharged after settling of the sediment.
- Appropriate drainage network should be planned in the project site.

The impact due to water abstraction from water sources from the neighbouring localities will have medium intensity with locally extent for a long duration which will result in an overall medium - moderate impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **minor**.

8.3.3.2. Mitigation measures for Impact on Water Quality

- The drainage and sewerage system will be provided for the collection and treatment of wastewater at SCADA building/ CMS and substation areas by establishing a sceptic tank or portable Wastewater Treatment plant (WWTP). This Alternative (WWTP) could allow to reuse the treated wastewater in compliance with Saudi Regulations for Wastewater treatment and reuse and it could save water. The better choice between the two alternatives should be the object of a technical and economic study
- No wastewater discharge on open land will be practiced.
- The plant site should be provided with adequate drainage facility to drain-off the rainy water and prevent any waterlogging at site or in the surroundings.
- No careless attitude in the handling of hazardous waste and oil should be tolerated during plant operation. If any oil spilled out accidentally, it should be cleaned and stored appropriately.

- Fuel, oil and used oil storage areas will be contained in bunds of 110% capacity of the stored material.

The impact due to water abstraction from River and ground will have low intensity with locally extent for a long duration which will result in an overall low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **negligible**.

8.3.4. Mitigations measures for Impact on Air Quality

- Vehicles traveling on gravel roads should not exceed a speed of 30 km/hr.
- Regular water spray is required on unpaved road as the dust not move during heavy wind;
- Use clean fuel in vehicle as the exhaust emission will be low

The Implementation of these mitigation measure will lead to an overall **negligible** impact.

8.3.5. Mitigation measures for Impact on Ambient Noise Levels

- Periodic maintenance of machinery and vehicles used on the site.
- Inverters and transformers should be well maintained and provided by noise reduction system.(noise barriers, sound absorbing noise barriers ..)
- Periodic monitoring of noise near to the sources of generation, like transformers, to ensure compliance with design specification;

with proper implementation of suggested mitigation measures, the overall impact will be very **negligible**.

8.3.6. Mitigation measures for impact on Ecology and biodiversity

The following identifies the mitigation measures to be applied by the Project Operator during the operation phase and which include:

- Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following:
- Prohibit hunting at any time and under any condition by workers onsite.
- Ensure proper storage, collection, and disposal of waste streams.
- Restrict activities to allocated areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

Following the implementation of these mitigation measures, the significance of the residual impact is categorized as **negligible**.

As per monitoring and reporting requirements during operation phase the Project Operator should inspect the works at all times.

8.3.7. Mitigation measures for Visual Impact

- The solar panels will be installed at a low height and will be kept closer to the ground so that it does not prop out of the general landscape of the area.
- The panels will be arranged in a systematic manner which will give an aesthetic sense to it.
- The proposed solar PV power project would include a boundary wall around the perimeter of the project to further obscure the peripheral view of the project and any indirect reflection. Impacts from glare would be minor.
- All cables and power lines will be located underground as far as possible.
- The substation, gatehouses and maintenance and storage buildings will be grouped as far as possible to avoid the scatter of buildings in the open landscape.
- The design of the buildings will be compatible in scale and form with the building style of the region.
- All yards and storage areas to be enclosed by masonry walls or screens.
- The color of the solar array and structures, such as the supports and the rear of the panels, will be carefully selected, and to be in the light grey or white colors, to minimize visibility and avoid reflectivity.
- External lighting will be confined to the substations and maintenance areas. Lights will be low-level and fitted with reflectors to avoid light spillage.
- Signages related to the enterprise are to be discrete and confined to the entrance gates. No other corporate or advertising signage, particularly billboards or flags, to be permitted.
- All lighting will be kept to a minimum within the requirements of safety and efficiency.
- Where such lighting is deemed necessary, low-level lighting, which is shielded to reduce light spillage and pollution, will be used.
- No naked light sources will be directly visible from a distance. Only reflected light will be visible from outside the Site.
- External lighting will use down-lighters shielded in such a way as to minimize light spillage and pollution beyond the extent of the area that needs to be lit.
- Security and perimeter lighting will also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles are to be avoided.
- Warning signs at appropriate distances indicating solar power plant location should be placed to alert road users.

The visual impact will have medium intensity with a local spread for a long duration which will result in an overall Medium Low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **negligible**.

8.3.8. Mitigations measures for impact on Occupational Health and Safety

The following mitigation measures will be taken to minimize the health impact during operation phase:

- Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears.
- Adequate training regarding health and safety will be provided to the workers.
- A health, safety, and environment (HSE) management system will be developed, rolled out and implemented. This system which will be reviewed annually or after a major accident or incident
- The switchyard building will be provided with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire.
- Safety incidents will be recorded and monitored with an aim that numbers are never significant, and gradually reduce.
- Workers at site handling broken solar panels shall be provided with adequate PPEs (safety gear, goggles, and gloves).
- The workers at the site are also on regular basis shall be appraised about the potential health risks associated with the handling of solar panels.
- Ensure use of safety belt and need for safety net as required;
- All work at height to be undertaken during daytime with sufficient sunlight except emergency (with proper illumination arrangement);
- Fixtures shall be installed on tower components to facilitate the use of fall protection systems;
- Only workers trained in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment shall be engaged for work at height;
- Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. Adequate training regarding health and safety will be provided to the workers;
- Access to areas containing exposed electrical equipment (such as transformers) shall be fenced and locked. Warning signs shall be posted at hazardous locations;
- Firefighting equipment such as fire extinguishers and sand buckets shall be provided at appropriate locations;
- Workers involved in electric operations shall be provided with Protective Equipment such as rubber gloves etc;

- Employees involved in electrical works shall be trained in and familiar with the safety- related work practices, safety procedures, and other safety requirements that pertain to their respective job assignments.
- First aid box/ arrangement to be ensured

The impact on health and safety from the operation of the project will have medium intensity with locally extent for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact will be **minor**.

8.3.9. Mitigations measures for impact Traffic and Transport

During operation, if abnormal loads are required for maintenance, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimize the impact of other road users.

Unnecessary travels outside the plant should be avoided at the extent possible. The impact significance is assessed as **negligible**.

8.4. Mitigation measures in decommissioning phase

8.4.1. Mitigations measures for impact on Soil Environment

Following mitigation measures are proposed to reduce the impacts of solar plant decommissioning activities on soil environment:

- The decommissioning of the solar plant will be carried out in a planned manner.
- During decommissioning phase, the quantity of waste generated will be high. The waste will be routed through proper collection, storage and disposal. The waste will be evaluated for its recycling/ reuse/ scrap value and disposed accordingly.
- The vehicular movement during decommissioning activities should be restricted to the designated route path;
- The demolition/ dismantling waste should not be left over in the project area and to be collected and stored at designated area only for further segregation and disposal.

The significance of impacts due to waste generation and soil contamination after implementation of mitigation measures will be **negligible**.

8.4.2. Mitigations measures for Impact on Water Environment

To mitigate the impact on water environment and protect the water from contamination the following measures should be implemented:

- The provisions of septic tank and soak pits will be provided onsite for treatment and disposal of sewage, thereby minimizing the impacts of wastewater discharge.

Planning of toilets, soak pits and septic tanks, waste collection areas should be away from natural drainage channels.

- Use of licensed contractors for management and disposal of waste and sludge;
- Spill/ leakage clearance plan to be adopted for immediate cleaning of spills and leakages.
- Water tankers with proper permissions will be utilized for water sourcing.
- Ensure proper cover and stacking of loose construction material to prevent surface runoff and contamination of receiving water body;
- Laborers will be given training towards proactive use of designated areas/bins for waste disposal and encouraged for use of toilets. Any random disposal of sewage shall be strictly restricted.
- Construction labor deputed onsite to be sensitized about water conservation and encouraged for optimal use of water.
- Regular inspection for identification of water leakages and preventing wastage of water from water supply tankers.
- Recycling/reusing to the extent possible.

The residual impact significance is envisaged to be **negligible** upon application mitigation measures.

8.4.3. Mitigations measures for impact on Air Quality

Good air quality should be preserved in decommissioning phase by applying the following mitigations measures:

- Emissions from the emergency DG set and other stationary machines will be controlled by ensuring that the engines are always properly tuned and maintained.
- Minimize stockpiling by coordinating excavations, spreading and restoring land activities.
- Speed of vehicles on site will be limited to 10-15 km/hr which will help in minimizing fugitive dust emissions due to vehicular movement
- A dust management plan should be applied
- Idling of vehicles and equipment will be prevented.
- Burning of any waste material shall be prevented.
- Laborers shall be provided with natural gas connection to prevent burning of fuel wood for cooking or heating purposes.
- Work shall be ceased or phased down if excess fugitive dust is observed. Source of dust shall be investigated, and proper suppression measures ensured.
- Proper maintenance of engines and use of vehicles well maintained shall be ensured.
- Panel solar should be handled properly to do not be damaged on site

The significance of residual impact will be **negligible** after implementing mitigation measures because of the fugitive dust emissions anticipated during demolition activities.

8.4.4. Mitigation measures for impact on Ambient Noise

Non-Noisy ambient environment within the project site should be guaranteed in decommissioning phase by implementing the following mitigations measures

- Normal working hours of the contractor to be defined (preferable 8 am to 6pm). If work needs to be undertaken outside these hours, it should be limited to activities which do not generate noise.
- Only well-maintained equipment should be operated on-site;
- If it is noticed that any particular equipment is generating too much noise then lubricating moving parts, tightening loose parts and replacing worn out components should be carried out to bring down the noise and placing such machinery far away from the households as possible.
- Machinery and equipment that may be in intermittent use should be shut down or throttled down during non-work periods; and
- Minimal use of vehicle horns and heavy engine breaking in the area needs to be encouraged.

Significance of residual impact is assessed to be negligible upon incorporation of the above-mentioned mitigation measures.

8.4.5. Impact on Economy and Employment

The decommissioning phase will require removal of machinery, workers and other temporary structures. The mitigation measures for decommissioning shall include the following:

- O&M Contractor should ensure that retrenchment packages are provided for all staff who stand to lose their jobs when the plant is decommissioned.
- The contractor shall inform the workers about the duration of work;
- Reduction of worker will be done phase wise and corresponding to completion of each activity; and
- All waste generated from demobilization shall be collected and disposed of at the nearest municipal disposal site.

Significance of residual impact is assessed to be **negligible** upon incorporation of the above-mentioned mitigation measures.

8.4.6. Mitigations measures for impacts on occupational health and safety

Following measures will be taken to minimize the health impact during decommissioning phase:

- The workers of decommissioning phase will be provided with training on the Health and Safety policy in place, and their role in the site and refresher courses will be provided throughout the life of the project.
- Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional.
- The contractor should ensure that no person is engaged in driving or operating dismantling machinery unless he is sufficiently competent and reliable, possess the knowledge of risks involved in the operation and is medically examined periodically.
- Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project.
- Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures;
- Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries;
- Safety sign should also be marked at appropriate places.
- It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls.
- Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for the attention of everyone at the site.
- Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also be carried out.
- Dropping/lowering dismantled objects or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas.

The health and safety impact will have high intensity with a local spread for a long duration which will result in an overall medium-low impact without mitigation. However, with proper implementation of suggested mitigation measures, the overall impact significance after will be **minor to moderate**.

9. STAKEHOLDER ENGAGEMENT PLAN

9.1. Overview

Stakeholder engagement can be described as the systematic method to understand and involve stakeholders and their concerns in project activities and decision-making processes. It identifies the appropriate approach to be used for consultation and information disclosure.

The Stakeholder Engagement Plan (SEP) for Haden Solar Power Plant has been prepared to guide stakeholder engagement for the project. The Stakeholders included to this plan include persons or groups that may be directly or indirectly affected by the project, as well as those that may have interest in the project and/or those that may influence the projects outcome either positively or negatively. These stakeholders may change over time and as such this plan will need to be updated as and when new stakeholders are identified, or the circumstances of stakeholders evolve.

The SEP has been prepared according to applicable IFC Performance Standards on "Social and Environmental Assessment and Management Systems" (first performance standard), as well as Equator Principle 5: Stakeholder Engagement and Equator Principle 6: Grievance Mechanism.

the SEP cannot be considered definitive for the lifetime of the project. As such, the SEP will evolve over time as the project progresses and will be updated as necessary to include any relevant changes.

It should be recognized that the SEP is a living document and will be utilized throughout the lifecycle of the project to guide the necessary engagement with identified stakeholders at the various project phases.

9.2. Stakeholder identification and analysis

The first step in the process of Stakeholder Engagement Plan is stakeholder identification– determining who your project stakeholders are, and their key groupings and sub-groupings. This section of the SEP identifies the key stakeholder groups and analyses how they may be affected by the project, at the respective project stages.

9.2.1. Identified stakeholders

The stakeholders of the project are classified in two categories:

- Affected Stakeholders, i.e. the people or institutions that may potentially be affected by one or more of the potential impacts of the project.
- Interest Based Stakeholders, which potentially include public agencies concerned with any of the project activities, national and international non-governmental organizations and the interested part of the civil society.

The table below outlines the identified stakeholders and their interest in the project. This list is not exhaustive and may be completed especially during public consultation Where applicable this SEP will include differentiated measures to allow the effective participation of those identified as disadvantaged or vulnerable stakeholders.

9.2.1.1. Affected stakeholders

The Affected or Impacted stakeholders are individuals or group of people that can be potentially affected by the projects' environmental and social impacts either directly or indirectly. Identified stakeholders that can potentially be directly impacted by the Project are listed in the table below.

Table 113 : Identified Potentially Affected Stakeholders

Stakeholders	Relation with the project
Sheepherders / Camel herders	Project Affected People – Need to be resettled from the site.
Turbah Municipality	Solar power plant on the territory
Ministry of Interior	Security restrictions that must be considered
Ministry of defence	Neighbouring / Security restrictions that must be considered
Ministry of National Guard	Neighbouring / Security restrictions that must be considered
National Center for Vegetation Cover	Biodiversity protection / Environmental restrictions
The National Centre for Wildlife	Biodiversity protection / Environmental restrictions
General Authority of Civil Aviation	The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)

9.2.1.2. Interest Based Stakeholders

It is important to also include in your stakeholder analysis those groups or organizations that are not adversely affected, but whose interests determine them as stakeholders. Interest-based stakeholders are groups or organizations that are not adversely affected by the project but whose interests determine them as stakeholders. The identified interest-based stakeholders for the project are presented in the table below.

Table 114 : Identified Interest-Based Stakeholders

Stakeholders	Relation with the project
Ministry of Municipal, Rural Affairs and Housing: • Taif Amanah • Trubah Municipality. • General Administration of Studies and Designs. • Construction Agency. • General Department of Urban Planning. • Provincial Planning Department.	Solar power plant on the territory (Master plan, Current and future plans to residential or commercial extension near the project area) / Municipal Permit
Minister of Environment, Water and Agriculture	Plans for future protected area expansion / Predicted future Protected zone
• National Center For Vegetation Cover	Plans for future area (Agriculture / vegetation / parks)
• National Center for Environmental Compliance	Environmental Permit to Construct / Environmental Permit to Operate
• Water & Electricity Regulatory Authority (WERA)	ECRA - License / permit to practice the activities
Saudi Electricity Company	Neighbouring / Future projects: Substation, Network Grid. Supporting the company's efforts by providing renewable energy sources
The Ministry of Transport and Logistic Services	Transport and traffic organization
Transport General Authority	Neighbouring / Transport and traffic organization
Saudi Railway Company (SAR)	Current and future plans for the railways around the project site
Ministry of Tourism (Branch of Ministry of Tourism in Taif)	The project could impact tourism activities
The Ministry of Culture	Interest in the development of the project. Interest may include potential environmental and social risks related to the project construction.
Heritage Commission	Heritage and historical features around the project site
Ministry of Labor and Social Development	Employment
Minister of Commerce and Investment	The project will impact commercial and industrial development
The Ministry of Communications and Information Technology	Future projects: telecommunications networks, relay towers, broadcasting stations, and landline telephone lines at the project site
The Communications and Information Technology Commission	Future projects of the Commission close to the project site
Ministry of Defense	The project is close to a military area. It is important to see if there is any proposed development of the military area in the future.
Saudi Authority for Industrial Cities and Technology Zones	Industrial projects close to the project / Industrial Permit
High Commission for Industrial Security	HCIS permit

The list of permits required for the project is the following:

- Environmental permit to Construct (NCEC).
- Environmental permit to Operate (NCEC).
- Municipal Permit.
- Industrial Permit.
- ECRA Permit.
- HCIS Permit (related to Industrial Security)

9.3. Proposed stakeholder engagement activities

9.3.1. Proposed engagement activities

In keeping with the applicable reference framework and the expectations of the stakeholders, the project will undertake regular engagement with the key stakeholder groups identified, throughout the life of the project.

Stakeholder engagement is an ongoing process that will be undertaken during the design, construction, and operational phases of the project. The process intends to be transparent, free of intimidation, interference, and coercion. The aim of this section is to describe what information will be disclosed, in what formats, the types of methods that will be used to communicate information and the consultation methods to be used with each of the stakeholder groups identified in the previous sections.

The primary purpose of the ongoing engagement will be to allow the stakeholders to participate in the decision-making process for the project.

9.3.2. Engagement Methods

The following methods will be used to inform stakeholders about the ongoing stakeholder engagement process during the construction and operations of the project:

- Letters, Phone calls, and email - Suitable to engage interest-based stakeholders listed in previous sections and to notify them of the engagement and disclosure mechanisms.
- Posters or Notices - Signboards and Illustrative posters (infographics) will be placed at the project entrance gate, including direct access to the grievance mechanism.
- Bilateral meetings - Suitable to engage impacted and interest-based stakeholders as identified, to allow these stakeholders to provide their views and opinions and to notify them of the engagement and disclosure mechanisms.
- Online – Useful for Interest-based Stakeholders. The engagement and disclosure mechanisms for the ESIA package during the construction and operational phases of the project will be advertised on the Ministry website with a contact point provided for comment.

9.3.2.1. Stakeholder Engagement During the design phase

Experience from the preparation of the SEP has demonstrated the benefits of a participatory approach, with stakeholders involved throughout the SEP preparation process, from the design stage and site selection. In particular, the early and ongoing involvement of local authority Members in the process brings significant benefits, to the process and understanding of the preferred policies which they will ultimately be asked to adopt.

Table 115 : Proposed Stakeholder Engagement Activities (Design Phase)

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
Information disclosure (Project, ESIA process, SEP)	Ministry of Municipal, Rural Affairs and Housing: - Taef Amanah • Trubah Municipality. • General Administration of Studies and Designs. • Construction Agency. • General Department of Urban Planning. • Provincial Planning Department.	Solar power plant on the territory (Master plan, Current and future plans to residential or commercial extension near the project area) / Municipal Permit	Communication with authorities will follow established procedures in line with Saudi regulations: Focus Discussions. Official emails or letters informing the stakeholders about the Project. Regular Meetings.	Share all required information related to the project: Master plan, Currents and future projects. Share all Requirements for Municipal permit
	Minister of Environment, Water and Agriculture	Plans for future protected area expansion / Predicted future Protected zone		Define the Protected Zone / Define the Buffer zone / future Predicted area
	• National Center For Vegetation Cover	Plans for future area (Agriculture / vegetation / parks)		Define the future agriculture zone and future Parks
	• National Center for Environmental Compliance	Environmental Permit to Construct / Environmental Permit to Operate		***
	• Water & Electricity Regulatory Authority(WERA)	ECRA - License / permit to practice the activities		Share all required information related to the project: Future networks grid and projects

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	Saudi Electricity Company	Neighbouring / Future projects : Substation, Network Grid.		Provides all technical information for the project, especially Saudi standards and specifications.
		Supporting the company's efforts by providing renewable energy sources		
	The Ministry of Transport and Logistic Services	Transport and traffic organization		Provides all current and furture Plans (railways, roads)
	Transport General Authority	Neighbouring / Transport and traffic organization		
	Saudi Railway Company (SAR)	Current and future plans for the railways around the project site		
	Ministry of Tourism	The project could impact tourism activities		Define all areas of tourist interest
	(Branch of Ministry of Tourism in Taef)			
	The Ministry of Culture	Interest in the development of the project. Interest may include potential environmental and social risks related to the project construction.		Define all historical and heritage area
	Heritage Commission	Heritage and historical features around the project site		
	Ministry of Labor and Social Development	Employment		****
	Minister of Commerce and Investment	The project will impact commercial and industrial development		Provides all current and future projects and plans arround the project site

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	The Ministry of Communications and Information Technology	Future projects: telecommunications networks, relay towers, broadcasting stations, and landline telephone lines at the project site		
	The Communications and Information Technology Commission	Future projects of the Commission close to the project site		
	Saudi Authority for Industrial Cities and Technology Zones The High Commission for Industrial Security	Industrial projects close to the project / Industrial Permit		
	Ministry of Interior	Security restrictions that must be taken into account		Define and clarify all restrictions and security precautions that must be taken in the project area
	Ministry of defense	Neighbouring / Security restrictions that must be taken into account		
	Ministry of National Guard	Neighbouring / Security restrictions that must be taken into account		
	National Center for Vegetation Cover	Biodiversity protection / Environmental restrictions		Define the Protected Zone / Define the Buffer zone / future Predicted area
	The National Centre for Wildlife	Biodiversity protection / Environmental restrictions		
	General Authority of Civil Aviation	The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)		Provide all flight way that may be affected

**The suitable participation method will be chosen by the Ministry of Energy
***Stakeholders not involved in this phase.

9.3.2.2. Stakeholder Engagement during Pre-Construction Phase

Before construction, in line with the respective SEP, the EPC will notify the local authorities to agree on the date and location of a 'Pre-Construction Awareness Meeting'. The EPC sends notification letters and meets local authorities' representatives to confirm the key activities to be undertaken, discuss sensitive areas for construction traffic safety, outline potential employment opportunities, discuss issues of concern for the local authorities, and confirm contact details.

The intended audiences of the pre-construction awareness meetings include interested stakeholders, representatives of local authorities and local businesses, land users, and other interested individuals.

The purpose of the meeting is to:

- Explain the upcoming construction activities in Haden site and present the works schedule.
- Discuss community health and safety aspects and arrangements.
- Notify attendees of available employment opportunities and the associated employment process.
- Present them of the grievance process and grievance mechanism contacts.
- Get stakeholders' feedback on issues and concerns.

Table 116 : Proposed Stakeholder Engagement Activities Pre-Construction Phase

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
Notify stakeholders of construction activities and construction timeline	- Ministry of Municipal, Rural Affairs and Housing:	Solar power plant on the territory (Master plan, Current and future plans to residential or commercial extension near the project area) / Municipal Permit	Communication with authorities will follow established procedures in line with Saudi regulations: Focus Discussions. Official emails or letters informing the stakeholders about the Project. Regular Meetings.	Approve the project and all construction plans
	- Taef Amanah			
	Trubah Municipality.			
	General Administration of Studies and Designs.			
	Construction Agency.			
	General Department of Urban Planning.			
	Provincial Planning Department.			
	- Minister of Environment, Water and Agriculture	Plans for future protected area expansion / Predicted future Protected zone		Environmental Permit to Construct
	National Center For Vegetation Cover	Plans for future area (Agriculture / vegetation / parks)		
	National Center for Environmental Compliance	Environmental Permit to Construct / Environmental Permit to Operate		
	Water & Electricity Regulatory Authority(WERA)	ECRA - License / permit to practice the activities		Ecra permit
	- Saudi Electricity Company	Neighbouring / Future projects : Substation, Network Grid.		Approval of the project after ensuring

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
		Supporting the company's efforts by providing renewable energy sources		that national specifications and standards are respected
	- The Ministry of Transport and Logistic Services	Transport and traffic organization		Approve the project and all construction plans
	Transport General Authority	Neighbouring / Transport and traffic organization		
	Saudi Railway Company (SAR)	Current and future plans for the railways around the project site		
	- Ministry of Tourism (Branch of Ministry of Tourism in Taef)	The project could impact tourism activities		
	- The Ministry of Culture	Interest in the development of the project. Interest may include potential environmental and social risks related to the project construction.		
	Heritage Commission	Heritage and historical features around the project site		
	- Ministry of Labor and Social Development	Employment		****
	- Minister of Commerce and Investment	The project will impact commercial and industrial development		Approve the project and all construction plans
	The Ministry of Communications and Information Technology	Future projects: telecommunications networks, relay towers, broadcasting stations, and landline telephone lines at the project site		

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	The Communications and Information Technology Commission	Future projects of the Commission close to the project site		
	Saudi Authority for Industrial Cities and Technology Zones High Commission for Industrial Security	Industrial projects close to the project / Industrial Permit		
	Ministry of Interior	Security restrictions that must be taken into account		Approval of the project after ensuring that security restrictions and precautions are respected
	Ministry of defense	Neighbouring / Security restrictions that must be taken into account		
	Ministry of National Guard	Neighbouring / Security restrictions that must be taken into account		
	National Center for Vegetation Cover	Biodiversity protection / Environmental restrictions		Approve the project and all construction plans
	The National Centre for Wildlife	Biodiversity protection / Environmental restrictions		
	General Authority of Civil Aviation	The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)		****

**The suitable participation method will be chosen by the Ministry of Energy
***Stakeholders not involved in this phase.

9.3.2.3. Stakeholder Engagement during Construction Phase

Permanent on-site presence is ensured by all stakeholder engagement function teams to address the concerns and requests of stakeholders during construction works.

Based on the local context and on community tier classification, engagement by the Integrated Stakeholder Engagement Team during construction in a particular community area may include:

- Stakeholder engagement/meetings.
- Health and safety awareness training.
- Communication campaigns (local TV, posters, leaflets, social media, etc.).
- Employment opportunities.
- Other engagement in response to the interests and needs of stakeholders.

Stakeholder engagement activities by EPC Contractors during construction include the disclosure of information and engagement relating to project impacts. This engagement addresses aspects related to environmental, community health and safety, and security issues as well as grievance management.

Table 117 : Proposed Stakeholder Engagement Activities during Construction Phase

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
Notify stakeholders of construction activities and construction timeline Implementation of grievance mechanism Monitoring of the project activities and regular engagement Project Status Update	- Ministry of Municipal, Rural Affairs and Housing:	Solar power plant on the territory (Master plan, Current and future plans to residential or commercial extension near the project area) / Municipal Permit	Communication with authorities will follow established procedures in line with Saudi regulations: Focus Discussions. Official emails or letters informing the stakeholders about the Project. Regular Meetings.	Municipal Inspection
	- Taef Amanah			
	Trubah Municipality.			
	General Administration of Studies and Designs.			
	Construction Agency.			
	General Department of Urban Planning.			
	Provincial Planning Department.			
	- Minister of Environment, Water and Agriculture	Plans for future protected area expansion / Predicted future Protected zone		Environmental Inspection
	National Center For Vegetation Cover	Plans for future area (Agriculture / vegetation / parks)		
	National Center for Environmental Compliance	Environmental Permit to Construct / Environmental Permit to Operate		
	Water & Electricity Regulatory Authority(WERA)	ECRA - License / permit to practice the activities		Ecra inspection
	- Saudi Electricity Company	Neighbouring / Future projects : Substation, Network Grid.		Ensure that national specifications and standards are respected
		Supporting the company's efforts by providing renewable energy sources		
	- The Ministry of Transport and Logistic Services	Transport and traffic organization		***

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	Transport General Authority	Neighbouring / Transport and traffic organization		***
	Saudi Railway Company (SAR)	Current and future plans for the railways around the project site		
	- Ministry of Tourism (Branch of Ministry of Tourism in Taef)	The project could impact tourism activities		
	- The Ministry of Culture	Interest in the development of the project. Interest may include potential environmental and social risks related to the project construction.		
	Heritage Commission	Heritage and historical features around the project site		
	- Ministry of Labor and Social Development	Employment		Inspection / Ensure the compliance with national laws
	- Minister of Commerce and Investment	The project will impact commercial and industrial development		***
	The Ministry of Communications and Information Technology	Future projects: telecommunications networks, relay towers, broadcasting stations, and landline telephone lines at the project site		
	The Communications and Information Technology Commission	Future projects of the Commission close to the project site		Coordination / Ensure that national specifications and standards are respected
	Saudi Authority for Industrial Cities and Technology Zones High Commission for Industrial Security	Industrial projects close to the project / Industrial Permit		

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	Ministry of Interior	Security restrictions that must be taken into account		Ensure that security restrictions and precautions are respected
	Ministry of defense	Neighbouring / Security restrictions that must be considered		
	Ministry of National Guard	Neighbouring / Security restrictions that must be taken into account		
	National Center for Vegetation Cover	Biodiversity protection / Environmental restrictions		Environmental Inspection
	The National Centre for Wildlife	Biodiversity protection / Environmental restrictions		
	General Authority of Civil Aviation	The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)		****
	Sheepherders / Camel herders	Neighbouring	Bi-Lateral meeting As described in the grievance mechanism section of this SEP	***

**The suitable participation method will be chosen by the Ministry of Energy

***Stakeholders not involved in this phase.

9.3.2.4. Stakeholder Engagement During Operation

Stakeholder engagement during the operational phase of the project will be the responsibility of the O&M Company, although it is expected that the Ministry of Energy will provide key support to ensure local cultural context during engagement activities.

It will be important for the Ministry of Energy and O&M Company to ensure a smooth transition between stakeholder engagements from the construction phase to the operational phase of the project by understating the techniques that have been most effective during construction. It will be important to continue these techniques to avoid the decrease in the frequency of stakeholder engagements, as the stakeholders are already familiar with the typical processes for engagement.

Table 118 : Proposed Stakeholder Engagement Activities during Operational Phase

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
Notify stakeholders of the transition from construction to operations Implementation of grievance mechanism Monitoring of the project activities and regular engagement Project Status Update	- Ministry of Municipal, Rural Affairs and Housing:	Solar power plant on the territory (Master plan, Current and future plans to residential or commercial extention near the project area) / Municipal Permit	Communication with authorities will follow established procedures in line with Saudi regulations: Focus Discussions. Official emails or letters informing the stakeholders about the Project. Regular Meetings.	Municipal Inspection
	- Taef Amanah			
	Trubah Municipality.			
	General Administration of Studies and Designs.			
	Construction Agency.			
	General Department of Urban Planning.			
	Provincial Planning Department.			
	- Minister of Environment, Water and Agriculture	Plans for future protected area expansion / Predicted future Protected zone		Environmental Permit to Operate / Inspection
	National Center For Vegetation Cover	Plans for future area (Agriculture / vegetation / parks)		
	National Center for Environmental Compliance	Environmental Permit to Construct / Environmental Permit to Operate		
	Water & Electricity Regulatory Authority(WERA)	ECRA - License / permit to practice the activities		Ecra inspection
	- Saudi Electricity Company	Neighbouring / Future projects : Substation, Network Grid.		Coordination with operational managers
		Supporting the company's efforts by providing renewable energy sources		

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	- The Ministry of Transport and Logistic Services	Transport and traffic organization		***
	Transport General Authority	Neighbouring / Transport and traffic organization		
	Saudi Railway Company (SAR)	Current and future plans for the railways around the project site		
	- Ministry of Tourism (Branch of Ministry of Tourism in Taef)	The project could impact tourism activities		
	- The Ministry of Culture	Interest in the development of the project. Interest may include potential environmental and social risks related to the project construction.		If any historical sites or monuments will be discovered
	Heritage Commission	Heritage and historical features around the project site		
	- Ministry of Labor and Social Development	Employment		Inspection / Ensure the compliance with national laws
	- Minister of Commerce and Investment	The project will impact commercial and industrial development		***
	The Ministry of Communications and Information Technology	Future projects: telecommunications networks, relay towers, broadcasting stations, and landline telephone lines at the project site		
	The Communications and Information Technology Commission	Future projects of the Commission close to the project site		
	Saudi Authority for Industrial Cities and Technology Zones High Commission for Industrial Security	Industrial projects close to the project / Industrial Permit		

Activity	Stakeholders	Relation with the project	Engagement Methods options**	Stakeholders Engagement
	Ministry of Interior	Security restrictions that must be taken into account		coordination with project manager
	Ministry of defence	Neighbouring / Security restrictions that must be taken into account		
	Ministry of National Guard	Neighbouring / Security restrictions that must be taken into account		
	National Center for Vegetation Cover	Biodiversity protection / Environmental restrictions		Environmental Inspection
	The National Centre for Wildlife	Biodiversity protection / Environmental restrictions		
	General Authority of Civil Aviation	The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)		****
	Sheepherders / Camel herders	Neighbouring	Bi-Lateral meeting As described in the grievance mechanism section of this SEP	***

**The suitable participation method will be chosen by the Ministry of Energy
***Stakeholders not involved in this phase.

9.4. Grievance Mechanism

For projects with environmental and social impacts, grievances are a fact of life. How a company responds when such grievances surface is important and can have significant implications for business performance.

A grievance mechanism should be scaled to fit the level of risks and impacts of a project. It should flow from a company's broader process of stakeholder engagement and business integrity principles and integrate the various elements of engagement discussed in the preceding sections. In fact, having a good overall community engagement process in place and providing access to information on a regular basis can substantially help to prevent grievances from arising in the first place, or from escalating to a level that can potentially undermine business performance.

The aim of the grievance mechanism is to establish a system to receive and facilitate resolution of the stakeholder's concerns and grievances about the Project's environmental and social performance. The grievance mechanism has the Affected Communities as its primary beneficiaries. It seeks to resolve concerns promptly, using an understandable and transparent consultative process that is culturally appropriate and readily accessible at no cost and without retribution to the party that originated the issue or concern. The mechanism will not impede access to judicial or administrative remedies.

9.4.1. Scope of Grievance Mechanism

The scope of the grievance mechanism is to cover all stakeholder's problems and concerns regarding project activities and the implementation of the mitigation and compensation measures. Generally, all claims from affected communities should be accepted and no judgment made prior to investigation, even if grievances are minor. However, according to best practice, the following claims should be directed outside of project-level mechanisms:

- Grievances clearly not related to the project: It is sometimes difficult to determine which issues are related to the project and which are not. If in doubt, employees designated to receive grievances should accept the grievance and assess its legitimacy.
- Issues related to government policy and government institutions.
- Grievances constituting criminal activity and violence: In these cases, complainants should be referred to the justice system.
- Commercial disputes: Commercial matters should be stipulated in contractual agreements and issues should be resolved through a variety of commercial dispute resolution mechanisms or civil courts.

The specific objectives of the grievance mechanism is:

- To implement a tool for the correct management of external communications for the project.
- to evaluate and address stakeholders' problems and concerns regarding project activities.
- To establish a communication instrument with stakeholders based on a request, suggestions and complaints resolution mechanism to resolve social interest issues in a systematic, transparent and monitored manner.
- To permit stakeholders to submit requests, suggestions or complaints via free and easily accessible mechanism.
- To keep a record of the external communications that provide elements to identify areas of opportunity in how to manage community relations.

9.4.2. Steps in Managing Grievance Mechanism

A policy or process for addressing complaints cannot be effective if nobody knows about it. A company's grievance procedures should be put into writing, publicized, and explained to relevant stakeholder groups. Simply put, people should know where to go and whom to talk to if they have a complaint and understand what the process will be for handling it.

9.4.2.1. Publicizing Grievance Management Procedures

The grievance mechanisms will be publicized in the following ways as a minimum:

- Posters at the site entrance; and
- Local authorities' site
- On the SEP disclosed online.

The information provided online and on posters will be available in all the relevant languages (i.e., Arabic and English) and will include at least the following:

- Who can raise grievances (i.e., all stakeholders).
- Where, when, and how community members can file grievances (to agree during the stakeholder engagement process).
- Who is responsible for receiving and responding to grievances.
- What sort of response complainants can expect, including the timing of response; and
- What other rights and protection are guaranteed.

In addition, specific measures have been included to ensure that grievances are reported (e.g. all vehicles dedicated full time for the project and circulating on roads outside the project site will have a clearly visible unique identification number and a sign with a telephone number for any road user to report grievances when required).

9.4.2.2. Receiving Grievance

The responsible will commit to a certain time frame in which all recorded grievances will be responded and to ensure that this response time frame is enforced. This treatment process and response duration are 30 days. By letting people know when they can expect to be contacted by responsible and/or receive a response to their grievance their frustration may be reduced.

Each grievance thus received, shall be recorded in a grievance register. The format for the grievance register shall be as follows.

Table 119 : Grievance register

No	Date	Grievance Number	Name of Grievant	Department	Medium of Communication	Details of Grievance	Concerned Department	Name of Recording Person	Present Status	Remarks
1										
2										
3										
4										

9.4.2.3. Reviewing and Investigating Grievances

To ensure that all grievances are adequately investigated and closed out, a grievance log will be kept, documenting all the actions taken to address each grievance.

An extensive investigation may be required when grievances are complex and cannot be resolved quickly. The Administrative Head will take full responsibility for investigating the details of grievances coming through its grievance mechanism, following the principle of "no cost to communities". Involving second parties during the investigation of grievances (i.e., The Project Company, the EPC, or subcontractors) when required is recommended.

In cases of sensitive grievances - such as those involving multiple interests and a large number of affected people - it may help to engage outside organizations in a joint investigation or allow for the participation of local authorities, only if the complainants agree to this approach.

For complex grievances, an investigation team will have to be appointed. If the investigation team is formed internally, issues that will be taken into consideration include potential conflicts of interest, qualifications, and budget.

Meetings with complainants and site visits can be useful for grievance investigation and will be undertaken, as appropriate.

9.4.2.4. Grievance Resolution Options and Responses

One of the potential advantages of a grievance mechanism is its flexibility. Rather than prescribe a specific procedure for each grievance, a list of possible options appropriate for different types of grievances are available. Options may include altering or halting harmful activities or restricting their timing and scope (e.g., for construction noise), providing an apology, replacing lost property, providing monetary compensation, revising the community's engagement strategy, and renegotiating existing commitments or policies.

The solution to the grievance will be communicated to the grievant either in written format or verbally depending on what format the grievant has selected as preferred, but in all cases, a written record will be kept. In cases where the grievance/claim is rejected or where the administrative responsible does not require action, the company representative will be diplomatic when informing the grievant about the outcome of the eligibility review process to prevent conflict from escalating. Where the claim is accepted, a proposed solution will be provided and communicated to the grievant within a stipulated period. If the grievant does not accept the proposed resolution, the company would re-assess the situation, discuss, and clarify the finding with the grievant and make sure that all alternatives within the grievance mechanism are explored. If the grievant is still not satisfied with the proposed resolution, the grievant will be allowed to take the dispute resolution mechanism outside of the company grievance mechanism (an external mechanism).

Close-up monitoring of a grievance will be undertaken, if possible, by collecting proof that the necessary actions have taken place. For example:

- If the issue was resolved with the satisfaction of the complainants, get a confirmation and file it along with the case documentation.
- Take photos or collect other documentary evidence to create a comprehensive record of the grievance and how these were resolved.

Where the grievant is not satisfied with the outcome of the proposed resolution, actions concerning further discussion and re-assessment shall be completed and advised within two weeks of notification of dissatisfaction by the grievant.

9.4.2.5. Grievance Mechanism in Construction Phase

The construction phase will require two separate grievance mechanisms to be implemented for the following parties:

- Internal parties; Construction personnel, workers, project staff, (including subcontractors' staff and visitors);
- External parties.

Although the Project Company will remain responsible and accountable, the EPC Contractor will manage internal and external grievance mechanisms. A member of staff will be assigned the responsibility to receive and follow up on all grievances. They will also be required to train related staff. Grievances will be investigated by the EPC contractor and may require coordination with the Ministry or other sub-contractors. All received grievances will be acknowledged within a week of receipt, or quicker depending on the urgency of the grievance.

Adequate resources will be allocated to the assigned staff member responsible for managing stakeholder engagement. This designated staff member will also be responsible for following up and managing grievances. An additional team or part of an existing team may support the member of staff; however, the staff will be experienced in engagement processes and will be familiar with the lender requirement for stakeholder engagement.

9.4.2.6. Grievance Mechanism in Operational Phase

The grievance mechanism in the operational phase of the project will be similar to that of the construction phase. The grievance mechanism will be available for both internal parties (site workers) and external parties.

A member of staff will be assigned and responsible for managing internal and external grievances received (recording, reviewing, investigating, and responding) appropriately.

Internal grievance forms will be made available in Arabic and English at key locations on-site with a sealed and locked 'post box' available for posting grievance at every location. The post box will be checked regularly.

9.5. Monitoring and reporting process

9.5.1. Periodic Monitoring

The review and appraisal process in any project is an extremely important component for the smooth functioning and the avoidance of major risks within a project. The importance of the review process lies in the fact that it allows for the corrections of any oversight which may have been made during the initial stages of a project through mid- course corrections. This also serves as an important quality assurance mechanism.

The auditing process will seek to report good environmental practices as well as reporting non compliances where necessary. Non- compliances will relate to specific breaches of the applicable environmental & social standards/regulations or the site- specific environmental & social management plans.

The review process becomes more important when it is kept in mind that the SEP is a 'live document' or in other words a document that needs to be revised in a timely manner so as

to make it comprehensive for any given period of time. This is so because of the fact that due to the life span of the project, it is difficult to properly identify and understand each stakeholder at the beginning of the project. The SEP thus requires regular reviews keeping in mind attributes such as the stakeholders, the engagement process for each stakeholder and the reporting time period for each.

9.5.2. Reporting

The initial years of Project construction and the Solar Power Plant implementation will witness a lot of flux in the profile of stakeholders identified and subsequently, the nature of their stakes may change. Additionally, the concerns and grievances of other stakeholders may also be more on account of the construction-related issues.

Thus, the performance of the SEP will be reviewed on a bi-annual basis during the initial years of SEP implementation. For the purpose of review, the quarterly reports will be considered for analysis and discussion. On the basis of these reports, a Stakeholder Engagement and Grievance Redressal Report will be prepared and disclosed biannually and annually, including a summary of issues raised by stakeholders, numbers, and subjects of grievances, a summary of key actions taken to address the concerns, analysis of trends and plans for engagement in the next time period.

For the purpose of ensuring the proper and effective implementation of the SEP, the project will ensure that this engagement process is given as much importance as the other project activities and ensure the availability of the required resources. The following subsections discuss both these resource requirements and manpower.

In order to ensure the proper maintenance and functioning of the SEP, the project will make available human resources as required in the form of internal resources within the project as well as external resources or other third parties.

9.5.3. Internal Resources

The project will identify specific project personnel who are to manage the stakeholder engagement and grievance redressal process through the life of the project. These personnel will be part of the Environmental and Social Management Cell for the project.

9.5.3.1. Project Management Specialist

The Project Management Specialist (PMS) will be the person involved in day-to-day oversight and management of the project. In terms of SEP, the PMS will be the key party responsible to provide information on project updates and important decision-making aspects to the project steering committee and technical committees. Also, the PMS will

provide guidance to all other staff in the implementation of this plan and other safeguards instruments.

Name	
Contact Details	

9.5.3.2. Environmental and Social Manager

To ensure that the project is implemented as per the environmental and social policies of the government, the project should employ an Environmental and Social Manager. The specialist will be responsible for:

- Identifying stakeholder environmental and social issues and acting appropriately to address those issues.
- Ensuring that the SEP and the available engagement methods are publicized by the Communications Specialist.
- Ensuring that project personnel are well briefed in regard to the SEP and grievance mechanism (including security personnel), and that the required resources (e.g. vehicles, company phones, office materials) are provided;
- Ensuring stakeholder meetings and disclosure of information are managed properly.
- Supervising the processing and resolution of all grievances; and
- Supervising the independent periodic monitoring and disclosure of the non-technical summary of the audit reports and of the full reports if required.

Name	
Contact Details	

9.5.4. External Resources

In case the internal resources at the project appear to be insufficient, the project will also consider engaging a reputed third party in the form of the organization familiar with the region and are acceptable to the community.

10. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environment and Social Management Plan specifies measures for addressing the limited negative risks and impacts and for enhancing the beneficial impacts. In addition, organizational capacity and training requirements, required to check and ensure effectiveness of the plan throughout the lifecycle of the project, have also been discussed.

EPC contractor is committed to implement an effective Environmental and Social Management System (hereinafter referred as ESMS) to continuously manage and communicate the potential social and environmental impacts and risks imposed on the project employees (direct and indirect) and maybe the existing communities in vicinity of the project. The outcomes of the Environmental and Social Impact Assessment of the project have been used to formulate an Environment and Social management & Management Plan, presented below. The Plan specifies measures for addressing the limited negative risks and impacts and for enhancing the beneficial impacts. In addition, organizational capacity and training requirements, required to check and ensure effectiveness of the plan throughout the lifecycle of the project, have also been discussed.

10.1. Training of Personnel & Contractors

EPC contractor should ensure that the job specific training and EHS Induction training needs are identified based on the specific requirements of ESMS and existing capacity of site and project personnel (including the contractors and sub-contractors). Special emphasis shall be placed on traffic management, stakeholder's engagement and grievance redressal. General environmental awareness shall be increased among the project's team to encourage the implementation of environmentally sound practices and compliance requirements of the project activities. This will help in minimizing adverse environmental impacts, ensuring compliance with the applicable regulations and standards, and achieving performance beyond compliance. The same level of awareness and commitment shall be imparted to the contractors and sub- contractors prior to the commencement of the project.

An environment and social management training program shall be conducted to ensure effective implementation of the management and control measures during construction and operation of the project. The training program shall ensure that all concerned members of the team understand the following aspects:

- Purpose of action plan for the project activities.
- Requirements of the specific Action Plans
- Understanding of the sensitive environmental and social features within and surrounding the project areas; and
- Aware of the potential risks from the project activities.

- A basic occupational training program and specialty courses shall be provided, as needed, to ensure that workers are oriented to the specific hazards of individual work assignments.
- Training shall be provided to management, supervisors, workers, and occasional visitors to areas of risks and hazards.
- Workers with rescue and first-aid duties must receive dedicated training so as not to inadvertently aggravate exposures and health hazards to themselves or their co-workers.
- Through appropriate contract specifications and monitoring, the employer shall ensure that service providers, as well as contracted and subcontracted labor, are trained adequately before assignments begin.

10.2. Monitoring

To implement the ESMP, the on-site team should adhere to a time-bound and action-oriented Environmental and Social Action Plan to implement the mitigation measures provided for each of the identified environmental and social impacts. This ESMP should be monitored on a regular basis, quarterly or half-yearly and all outcomes would need to be audited in accordance with existing EHS commitments.

The monitoring process should cover all stakeholders including contractors, laborers, suppliers and the local community impacted by the project activities and associated facilities thereby increasing the effectiveness of suggested mitigations measures. SBE should ensure that all the contractors comply with the requirements of conditions for all applicable permits, suggested action plans and scheduled monitoring. The inspections and audits should be carried out by an internal trained team and external agencies/experts. The entire process of inspections and audits shall be documented and key findings of which should be implemented by the proponent and contractors in their respective areas.

10.3. Documentation & Record Keeping

Documentation and record keeping system must be established to ensure updating and recording of requirements specified in ESMP. Responsibilities must be assigned to relevant personnel for ensuring that the ESMP documentation system is maintained, and that document control is ensured. The following records should be maintained at site:

- Documented Environment Management System;
- Legal Register;
- Operation control procedures;
- Work instructions;
- Incident reports;
- Emergency preparedness and response procedures;

- Training records;
- Monitoring reports;
- Auditing reports; and
- Complaints register and issues attended/ closed

10.4. Environmental and Social Management Plan (ESMP)

This section outlines the potential adverse impacts, mitigation measures, monitoring and management responsibilities during construction and operation phases of the Project.

The purpose of ESMP is to:

- Provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in ESIA designated to mitigation potentially adverse impacts are implemented.
- List all suggested mitigation measures and control technologies, safeguards identified through the ESIA process.
- Provide Project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place; and
- Assist in ensuring compliance with all relevant legislations at local, state and national level for the Project.

Table 120 : Environmental and Social Management Plan

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
Construction Phase										
Land resources/soil	Construction of temporary structure, access road & internal access roads,	Permanent and temporary changes in land use	Impact on Land Use	Minor	•the After construction work, any land taken for a temporary basis for storage of material will be restored to their original form. •Existing roads widened and developed for access to the project site with the exception of a small connection from the Mekkah-Riyadh highway to the plant site. •Construction activities should be restricted to designated area; •The land use in and around permanent project facilities should not be disturbed. • The construction activities will be restricted within the boundary of the proposed plant and will not alter the land use of the adjacent areas; •Proponent should take tree plantation program whereas possible in the plant boundary or along the access road side •Waste should not be allowed to litter in and around the project area; •On completion of construction activities, land used for temporary facilities will be restored to the extent possible; •The land should be restored back to the original state to the extent possible after completion of the life cycle of the project and in case there are plans not to continue further at the site.	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection Upon completion of work	Report from designated HSE personnel of EPC Contractor
	Site cleaning, leveling, compaction Civil construction activities	Impact on topography and drainage	Impact on topography and drainage	Minor	•The EPC contractor will be instructed to avoid any unnecessary changes in the topography. •Detail hydrology study should be carried out. •Appropriate number of cross drainage channels should be provided during access road construction to maintain flow in existing natural channels •Keep all natural channels to the extent possible at their original state •Design structures considering the natural functioning of the of drainage channels	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection Upon completion of work	Report from designated HSE personnel of EPC Contractor
		Impact on soil erosion and compaction	Impact on soil erosion and compaction	Minor	•The area to be cleared must be clearly demarcated and this footprint strictly maintained. •Soil conservation measures will be implemented such as stockpiling topsoil or gravel for the remediation of disturbed areas. •Scheduling activities (as far as possible) to avoid extreme weather events such as heavy rainfall and high winds; •Work areas will be clearly defined and where necessary demarcated to avoid unnecessary disturbance of areas outside the development footprint; •It is recommended to grow turf grass beneath solar panels to avoid soil erosion •Construction vehicles will remain on designated and prepared compacted gravel roads;	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
	•Maintenance of vehicles and heavy machinery •Storage of fuel and chemicals. Lubricating oil and other products	Soil contamination due to leaks and spills	Soil contamination leaks and spills	Minor	•Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area. •Sewage generated from the project site will be treated and disposed of through septic tank and soak pits; •Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of. •Construction vehicles and equipment will be serviced regularly •The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals; •Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system; •A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination. •Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively; and •The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination events	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
	•Empty paint container disposal •Construction waste; Wooden crates, cartons, plastic wrapping sheets, wooden crates, cartons, plastic wrapping sheets from solar panel packaging • Municipal solid waste produced at the temporary site office • Hazardous materials and waste including oil, used oil, oil containing rags etc.; •Leakage/spillage from construction equipment and vehicles, DG sets and storage areas, •Improper disposal of sewage; •Improper disposal of used lubricating oils and other used oils •Improper disposal of domestic waste	Soil contamination waste generation	Soil contamination waste generation	Minor	•The construction contractors will have control over the amount and types of waste (hazardous and non- hazardous) produced at the site. Workers will be strictly instructed about random disposal of any waste generated from the construction activity; •Construction contractor should ensure that no unauthorized dumping of used oil and other hazardous wastes is undertaken from the site; •Municipal domestic waste generated at site to be segregated onsite; •Ensure hazardous waste containers are properly labelled and stored onsite provided with an impervious surface, shed and secondary containment system; •Ensure routinely disposal of hazardous waste through approved vendors and records are properly documented; •Construction contractor should ensure daily collection and periodic (weekly) disposal of construction waste generated debris, concrete, metal cuttings wastes, waste/used oil etc.; •Ensure hazardous waste is properly labeled, stored onsite at a location provided with impervious surface, shed and secondary containment system and; •The municipal waste from the labor camp will only be routed through proper collection and handover to the local municipal body for further disposal. The hazardous wastes will be temporarily stored in labeled drums on the impervious surface at designated area onsite and will be disposed of through approved vendors.	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
water resources	Water demand for construction work Water demand for sanitary blocks	Impact on surface water availability	Impact on surface water availability	Moderate	•Construction labor deputed onsite to be sensitized about water conservation and encouraged for optimal use of water; •Regular inspection for identification of water leakages and preventing wastage of water from water supply tankers is necessary for efficient utilization of water; •It should be ensured that water supply for the Project to be procured from approved suppliers and the approval copy of the same to be maintained to ensure the right source; •Blending of low-quality water with fresh water for construction uses to ensure efficient use of natural resource. •Recycling/reusing to the extent possible •Use to extent possible wet technology for cleaning equipment to optimize the consumption of water •Implement if possible a system to treat and reuse the wastewater	minor	EPC Contractor HSE Manager	NCEC Supervisor	Permission letter (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
	•Sewage from labor camp • Liquid effluent from washing of equipment and vehicles •Storage of hazardous waste onsite	Surface Water contamination by spills /leaks	Contamination by spills /leaks	minor	•Fuel, oil and used oil storage areas will be contained in bunds of 110 percent capacity of the stored material. •Refueling will be carried out in designated areas using strict protocols. •Spill containment and clean up kits will be available on-site and clean-up from any spill will be appropriately contained and disposed of at a bound landfill site. •Project staff will not be permitted to utilize any water sources (stream, river, or other water bodies) for the purposes of bathing, washing of clothing. •Construction vehicles and equipment will be serviced regularly at off-site location. •Ensure that all construction plant and equipment is maintained in a good state of repair with minimal leaks. •Oil leakage or spillage will be contained and cleaned up immediately. Waste oil will be collected and stored for recycling or disposal. •Oil and grease separator shall be used for wastewater generated from cleaning activities. •Adequate sanitary facilities, i.e. toilets and showers, will be provided for the construction workforce; •Workers will be trained in the use of designated areas/bins for waste disposal and encouraged to use toilets. •Septic tanks will be provided to treat sanitary wastewater •Use of licensed contractors for management and disposal of waste and sludge and	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•All sewage and liquid effluent will be treated to meet the standards specified by the MEWA regulations and IFC guidelines EHS 2007					
	Earthworks in the project area may increase the erosion, especially during rainfall events, which may increase the suspended sediment concentrations and pollute water sources;	Surface water Contamination by loads of sediments	Contamination by loads sediments	minor	•The drainage pattern of the site will not be altered, and the natural slope of the site will be maintained. •Special care needs to be taken during the road construction to maintaining the standard slop as the soil cannot wash out in the water body. As well as need proper compaction of the road structure. •Cover all slopes of the road by first growing grass. •Adequate arrangement for stormwater management during construction period will be made to avoid sediment runoff from the site.	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
	•Improper disposal of sewage and wastewater from labor camp and construction debris •Unplanned event such as leaks and spills of oil, lubricants, fuel from heavy equipment	Impact on groundwater quality	Impact on groundwater quality	Minor	•Fuel, lubricating oil, and used oil storage areas will be contained in the bounded area. •Spill containment and clean up kits will be available onsite and clean-up from any spill will be appropriately contained and disposed of. •Construction vehicles and equipment will be serviced regularly •The Contractor will prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals; •Surface run-off from bunded areas will pass through oil/water separators prior to discharge to the stormwater system; •A site-specific Emergency Response Plan will be prepared by the contractor for soil clean-up and decontamination; •Any loading and unloading protocols should be prepared for diesel, oil and used oil respectively; and •The construction contractor will implement a training program to familiarize staff with emergency procedures and practices related to contamination event	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (monthly monitoring)	Report from designated HSE personnel of EPC Contractor
Ambient air quality	•Dust generation from earthworks such as leveling, grading, excavation works and movement of vehicles across dirt/unpaved roads, especially during windy conditions •Construction of access road •Construction of foundation of supporting structures od PV modules •construction of building, loading and unloading equipment •Dust generated from stockpiles of waste, topsoil handling and moving excavated material and transporting wastes on vehicles	Impact on air quality by dust generation from construction	Dust from construction	Moderate	•Implementation of a regular watering and sprinkling dust suppression regime, during the dry season. •Stockpiles of dusty materials will be enclosed or covered by suitable shade cloth or netting to prevent the escape of dust during loading and transfer from Site. •No stockpiles will be maintained outside, and maximum Possible distance between the stockpiles and receptors will be maintained. •Covering and/or watering of all stockpiles of dusty materials such as excavated spoils to avoid fugitive dust emissions. •During construction, the approach road will be kept clean, free from mud and slurry. •Material transport will be totally enclosed with impervious sheeting and wheel washing will be carried out at site. •Speed of vehicles on site and approach road will be limited to 15-20 km/hr which will help in minimizing fugitive dust emission due to vehicle movement •Idling of vehicles and equipment will be prevented and •Waste from construction will not be burned. •Concrete, sand and aggregates shall be stored as far from sensitive receptors as possible and screened/shielded if they are located within 100m of sensitive receptor. •The distance from receptors to dust emission sources (stockpiles etc) shall be maximized, with consideration of prevailing wind direction. •Dusty materials shall be removed from construction sites as soon as possible. •Transport of contaminated soil (if any) shall also be carried out with tight fitting covered trucks or closed containers. •Loaded trucks to or from the work site area shall avoid heavily travelling through residential roads in the localities around. •Traffic management measures shall reduce congestion: Planning of driving construction vehicles outside of the construction area during rush hour traffic. •Implementation of a Dust Control Plan	Minor	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
	•Exhaust emission from operation of machinery like pile drivers, vehicles	Air pollution by Exhaust/fugitive emission	Exhaust/fugitive emission	Minor	•The movement of construction vehicles will be minimized, and a 20 km/hr speed limit will be enforced in the project site as well as approach road; •Vehicles traveling on gravel roads will not exceed a speed of 30 km/hr;All diesel-	Negligeable	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
	•Point source emission from diesel generator •Vehicular emissions due to increased traffic movement on site and on the approach roads •Operation of heavy equipment				powered equipment will be regularly maintained and idling time reduced to minimize emissions; •Low sulfur diesel (S<0.5%) will be used in diesel-powered equipment in collaboration with best management practices; •Vehicle/equipment air emissions will be controlled by good practice procedures (such as turning off equipment when not in use); •Vehicle/equipment exhausts observed emitting significant black smoke in their exhausts will be serviced/ replaced; and •Implementation of an Engine Emission Management Program: •Solid waste burning in the project site is strictly prohibited					
Ambient Noise	•Construction activities •Transportation of construction materials, plant materials, machinery and personnel •Operation DG sets; •Operation of batching plant •Digging of trenches to accommodate underground power cables,	Ambient noise level increasing	Impact on ambient noise	minor	•The contractor should ensure that all construction equipment and vehicle is fitted with silencers (where possible); •The contractor should consider the noise emission characteristics of equipment when selecting equipment for the project and select the least noisy machine available to perform the specific work (this is a requirement of OSHA 2007); •The contractor should undertake additional post development noise monitoring in accordance with National and International noise standards. •Mobile noise sources such as cranes, earth moving equipment shall be routed in such a way that there is minimum disturbance to receptors; •Developer shall instruct their Safety Officers to arrange for inherently quiet construction equipment and machines to maintain the noise level to minimum; •Only limited construction activities shall be carried out during night-time; •Restrict the night time vehicle movement through the access road; •Adopt the vehicle speed limit in the access road •It is also to be ensured that no village road will be utilized for movement of equipment except the designated access road; •The number of equipment operating simultaneously should be reduced as far as practicable; •Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable; •All loud and sudden noises will be avoided wherever possible and fixed noise sources shall be located at least 50m away from the site boundary; •Rubber padding/noise isolators will be used for construction equipment •Temporary noise barriers shall be provided surrounding the high noise generating construction equipment; •The personnel involved in high noise generating activities shall be provided with personal protective devices to minimize their exposure to high noise levels; •Construction vehicles and machinery will be well maintained and not kept idling when not in use	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	Report from designated HSE personnel of EPC Contractor
Traffic and Transport	Transportation of construction materials, plant materials, machinery and personnel	Increasing of traffic level	Impact on traffic and transport	Moderate	•The contractor should ensure that all PV module and mounting structure components are transported in appropriate vehicles that adhere to the axle load limits. •Only trained drivers with valid license shall be recruited by the construction contractor. •Training programs shall be conducted at regular intervals for all the drivers for raising awareness about road safety and adopting best transport and traffic safety procedures once in every month. •Additionally, speed limits for all construction related vehicles shall be adhered to at all times to prevent damage to roads and other infrastructure •Mitigation measures such as emphasizing on safety amongst drivers, adopting limits for the trip duration and arranging driver roster to avoid overtiredness and avoiding dangerous routes and times of day to reduce the risk of the accident shall also be implemented. •High visibility colors should be used during the transportation of PV panels to the project site. •Regular maintenance of vehicles and use of manufacturer approved parts should be adopted to minimize potentially serious accidents caused by equipment malfunction or premature failure.	Minor	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (daily monitoring)	Report from designated HSE personnel of EPC Contractor

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•The villagers will be made aware of the schedule prior to the movement of trucks and transportation of power plant equipment in the project area. •Collaboration with local communities and responsible authorities to improve signage, visibility, and awareness of traffic and pedestrian safety; •Notify the governing body and local area responsible person prior to start the construction work and put adequate signage around the construction area on both way and instruct the driver for carefully driving in close to the sensitive area; •Coordination with emergency responders to ensure that appropriate first aid is provided in the event of accidents. •The existing earthen road should keep functional as the local people can use the road; •Movement of the project traffic should be limited to the planned route only and; •The traffic movement in the settlement areas should be limited for the daytime only					
Ecology and ecosystem	•Project site clearance; •Project site leveling; •Construction activities at site	on terrestrial flora and fauna,	Impacts on ecology and biodiversity	Minor	•Should as part of the Project any fencing be erected, it must be ensured that it allows for the natural movement of small faunal species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30 cm). •One major modification that could take place at the project site is the removal of the. trees. The trees are believed to be of significance for the biodiversity elements at the Project Site especially the birds. Therefore, the minimum number of trees should be removed from the project site in order to achieve the minimal impact possible on the biodiversity at the Project Site. The trees removed should be replaced by other trees to be planted in the vicinity of the project site in order to act as an offset for the removed trees and as a new refuge for the species affected. •Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following: •Prohibit hunting at any time and under any condition by construction workers onsite. •Ensure proper storage, collection, and disposal of waste streams generated. •Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances. •Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	•Site Inspection •Training records •Visual assessment by experts •(One-time monitoring during start of project activity and quarterly once monitoring)	Report from designated HSE personnel of EPC Contractor
Occupational Health and Safety Hazard	• Accidents and injurie associated with the operation of heavy machinery and other construction activities. • Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions of air, water pollution and noise generation from construction activities as well as from storage and handling of waste, particularly hazardous waste. • Loading and unloading activities of the construction materials • Working at height, working with rotating machinery and falling objects	Health risk of the worker	impact on occupational health and safety	Moderate	•The workers (both regular and contractual) on the project will be provided with training on the Health and Safety policy in place, and their role in the site and refresher courses will be provided throughout the life of the project. •Establish a grievance redressal mechanism in place, to allow for the employees and workers to report any concern or grievance related to work activities. •Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional. •The contractor should ensure that no person is engaged in driving or operating construction machinery unless he is sufficiently competent and reliable, possess the knowledge of risks involved in the operation and is medically examined periodically. •Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project. •Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures; •Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries; •Safety sign should also be marked at appropriate places. •It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls. •Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for the attention of everyone at the site.	Minor	EPC Contractor HSE Manager	NCEC Supervisor	•Site Inspection •Training records •Visual assessment (Monthly Monitoring)	Monthly progress report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also be carried out. •Dropping/lowering of construction material or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas.					
Socioeconomic aspect	• Traffic level increases due the project construction activities • Solid waste improper disposal and scattered around site • Improper handling of wastewater and other hazard waste that may causes diseases in the communities close to project	Inconvenience of communities in vicinity of the project and community health and safety issue	impact on community health and safety	Minor	**<u>for traffic</u>** •The truck drivers carrying construction machinery and materials will be instructed to drive within speed limits with careful consideration for villages traffic in vicinity. •Movement of heavy equipment and construction materials will be regulated during peak hours (09:00 AM to 06:00 PM). •Proper route of movement of project vehicles will be identified. •Depute traffic escorts as and when required near project site and major settlements to guide movement of project vehicles. •Keep limited speed of project vehicles near settlements and within the project site. •Provide necessary training to the drivers for speed restrictions and on do's and don'ts. **<u>For waste management and disposal</u>** •The excavated areas will be properly fenced for safety and sign boards in local languages will be put up; •No hazardous waste or any waste be stored within the site for long periods of time and be in contact with the soil. •The quantity of domestic waste generated daily from the labor camps will be small and limited as most of the workers will be hired locally. However, the construction contractor shall ensure that the camp sites provided at the site have adequate waste disposal facilities. Arrangements for collection of garbage in dustbins and daily disposal to the nearest dump site shall be made. Provision of toilets for workers shall be made at the campsites in order to maintain hygienic and clean surroundings. •Effort should be made to use the locally available labor for unskilled work purpose. •Construction contractor will be followed the 3R policy to manage the solid waste management. •Nearby municipality may also be contracted for regular disposal of the labor camp waste. •Washing and bathing areas will be provided with a proper drainage system so that wastewater is not accumulated in the campsites. Disposal of sewage shall be made through a septic tank – soak pit arrangement. •Used or waste oil generated from generators and construction machinery and equipment will be stored on a paved surface in a secure location at the project site. Appropriate secondary containment capable of containing the 110 percent of the largest tank is to be provided. •The waste oil, which is characterized as hazardous will be sold to authorized vendors at frequent intervals. •Empty fuel containers will also be stored at a secured area designated for scrap and sold to authorized vendors. All packaging material will also be collected at the storage area and sold to scrap dealers. •Construction debris and excavated material will be stored in a confined area to prevent spread by wind or water. •The construction debris will be used for backfilling of excavated areas and for foundation works at site	Negligible	EPC Contractor HSE Manager	NCEC Supervisor	Site inspection (daily monitoring)	Monthly progress report from designated HSE personnel
Creation of employment opportunities	Impact on community by job opportunities creation	impact on employment	Positive	•The local community is preferred by the project for the requirement of skilled, semiskilled and unskilled workers to the extent possible. •The sourcing of local labor wherever possible should be made obligatory for the sub- contractors and in all major procurement activities. •Preference should be given to the vulnerable population. •The EPC Contractor/ and the MoE/MEWA will establish a mechanism to audit subcontractors and suppliers with respect to compliance of utilizing local labor and	Positive	EPC Contractor	MoE/Ministry of human resources and social development		

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					resources.					
	Migrants workers hired for the project may have issue with the local residents and may transmit infectious diseases	impacts from migrants workers (social impacts, spreading of infectious disease.)	impacts from migrants workers (social impacts, spreading of infectious disease.)	Minor	•Engage as many locally available unskilled, semi-skilled and skilled human resources as practically possible to avoid large scale in migration of labor force. •Provision of infrastructure and amenities for migrant labor in construction camp to avoid dependence on limited local resources. •Adequate sanitation facility at labor camps to maintain hygiene and minimize spread of diseases. •Creating awareness about local tradition and culture among outside migrant and encouraging respect for same. •Providing awareness training regarding infectious diseases among the migrant population. •Proper disposal of wastes generated from the camp and construction activity to maintain general hygiene in the area. •Avoid unnecessary movement of vehicles through near settlement areas to avoid disturbance and traffic safety related issues	Negligible	EPC Contractor designated person	Person designated from Ministry of human resources and social development/Person designated from Ministry of health		
Operation and Maintenance Phase										
Soil environment	• Monitoring of solar PV plant operation; • Routine maintenance activities at PV module • Material handling and storage • Hazardous and Non-hazardous material and waste management	Soil contamination due to accidental spills leaks	Soil contamination due to accidental spills leaks	Moderate	•Ensure oil/ lubricants are stored on impervious floor in the storage area having secondary containment. •Use of spill control kits to contain and clean small spills and leaks during O&M activities; and •The guidelines and procedures shall be prepared and followed for immediate clean-up actions following any spillages.	Minor	O&M Contractor HSE Manager	NCEC Supervisor	Site inspection (Monthly monitoring)	report from designated HSE personnel
		Soil contamination due to improper waste disposal	Improper Waste Disposal		•The waste generated during operation phase will be disposed of through approved vendors; •The hazardous wastes will be stored onsite at separate designated covered area provided with impervious flooring and send for disposal to nearest designated dumping site; •During the operation phase, the quantity of municipal waste and hazardous waste generated is less and probability of the hazardous waste generation is only during maintenance and therefore occasional. The waste generated would be routed through proper collection and containment. •The water for cleaning purpose of the solar PV modules remove dust from it is likely to get evaporate or absorbed by the vegetation and soil underneath the solar panel; •The Operator/Contractor should make a MoU (Memorandum of Understanding) with the local municipality to collect the daily domestic for disposing of in the designated dumping site.		O&M Contractor HSE Manager	NCEC Supervisor	• Internal audit • Site inspection (Monthly monitoring)	Report from designated HSE personnel
Waste generation aspect	• Wastes likely to be generated during routine operations are dielectric fluids, clearing agents and solvents etc; • Repair and maintenance of underground cables and associated utilities will lead to generation of hazardous wastes as used oils • Wastewater from PV module cleaning; • The defunct / damaged photovoltaic cells will also be generated; • Domestic liquid and solid waste	Contamination of soil, surface and groundwater	Waste generation	Moderate	•The separate designated area should be earmarked for storage of hazardous waste like waste oil, transformer oil. These wastes shall be given to the MoE approved recyclers. •Operation waste management will be governed by an Environmental Management Plan (EMP) and will incorporate reduction, recycling, and reuse principles. •Material Safety Data Sheets for all applicable materials present on Site will be readily available to on-site personnel. •All wastes produced from project activities on site will be transferred to designated temporary storage areas and where possible into secure containers. •Solid wastes will be segregated to facilitate reuse and recycling of specific materials. •All wastes that cannot be reused or recycled will be collected by approved waste contractors and transferred to an appropriately licensed waste management facility for treatment and disposal. •First of all, inspection of PV modules for defects that can appear in the form of burn marks, discoloration, or broken glass is to be undertaken. An authorized person will walk the site to confirm that there are no broken modules (shattered glass) and broken modules should not be sprayed with water.	minor	O&M Contractor HSE Manager	NCEC Supervisor	• Internal audit • Site inspection (Monthly monitoring) • Site inspection and record	Report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•Broken or damaged solar panels are required to be immediately shifted to a designated area in a scrap yard to avoid any type of land contamination. A photograph is to be taken of the broken panel at the site to cater to Insurance settlement claims. •Once the PV panels have reached the end of their life cycle, the manufacturer of the PV panels will collect and recycle the PV panels and recover any hazardous substances in the PV modules. This provision forms part of the supply agreement between the proponent and the selected PV panel manufacturer. • Use the soak pit and septic tank in the office building and guard room for sewage.					
Water resources	• Water use for PV module cleaning; • Water Consumption for domestic use; • Possibility of groundwater level reduction due to compacted soil and covered by PV module • Surface water pollution due to the surface runoff from the project to the drainage network passing through the project • Surface and groundwater pollution due to the accidental leakage and spills of oil	Impact on Water availability	Water availability	moderate	•variability and projected changes in demand in the Project area; •Periodical training should provide to workers for best utilization of water; •Bore-wells could be should be established, if deep aquifer is available is after requisite permission from the regulatory authority. Meters should be installed at the bore-wells to monitor the abstraction of water; this option proposed should be studied and assessed in advance. •Wastage of water during cleaning of panels should be avoided; otherwise opt for dry cleaning technology. It would save considerably water. •Drinking water demand should be met by bottle potable water purchased •The wastewater emanating from cleaning operations shall be used for the irrigation of green spaces in project area. Wastewater reused should be in compliance with the Saudi regulations on wastewater reuse. and excess water shall be discharged after settling of the sediment. •Appropriate drainage network should be planned in the project site;	Minor	O&M Contractor HSE Manager	NCEC Supervisor	• Visual Inspection • Records of water consumption (daily Monitoring)	Report from designated HSE personnel
	Improper disposal of wastewater	Impact on water quality	Water quality	minor	•The drainage and sewerage system will be provided for the collection and treatment of wastewater at SCADA building/ CMS and substation areas by establishing a sceptic tank or portable Wastewater Treatment plant (WWTP). This Alternative (WWTP) could allow to reuse the treated wastewater in compliance with Saudi Regulations for Wastewater treatment and reuse and it could save water. The better choice between the two alternatives should be the object of a technical and economic study •No wastewater discharge on open land will be practiced; •The plant site should be provided with adequate drainage facility to drain-off the rainy water and prevent any waterlogging at site or in the surroundings; •No careless attitude in the handling of hazardous waste and oil should be tolerated during plant operation. If any oil spilled out accidentally, it should be cleaned and stored appropriately. •Fuel, oil and used oil storage areas will be contained in bunds of 110% capacity of the stored material.	negligeable	O&M Contractor HSE Manager	NCEC Supervisor	• Visual Inspection • Records of water quality (daily Monitoring)	Report from designated HSE personnel
Air Quality	• Maintenance of Vehicles • Transportation during operation and maintenance of the power plant	Air pollution	Air quality	minor	•Vehicles traveling on gravel roads should not exceed a speed of 30 km/hr. •Regular water spray is required on unpaved road as the dust not move during heavy wind; •Use clean fuel in vehicle as the exhaust emission will be low	Negligible	O&M Contractor HSE Manager	NCEC Supervisor	• Visual Inspection • Records (Monthly Monitoring)	Report from designated HSE personnel
Ambient Noise	• Vehicles movement • Noise from inverters and transformer • Repair and Maintenance Works of solar panels	Increase of noise level	Impact on Ambient Noise Levels	minor	•Periodic maintenance of machinery and vehicles used on the site. •Inverters and transformers should be well maintained and provided by noise reduction system. (noise barriers, sound absorbing noise barriers ..) •Periodic monitoring of noise near to the sources of generation, like transformers, to ensure compliance with design specification.	negligible	O&M Contractor HSE Manager	NCEC Supervisor	• Daily inspection • Records (Monthly monitoring)	
Ecology and ecosystem	• Glare/Reflection from solar module; • Electrocution from transmission line; • Hunting of mammals and avifauna	Impact on Ecology and biodiversity	Impact on Ecology and biodiversity	minor	•Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following: •Prohibit hunting at any time and under any condition by workers onsite. •Ensure proper storage, collection, and disposal of waste streams. •Restrict activities to allocated areas only, including movement of workers and	Negligible	O&M Contractor HSE Manager	NCEC Supervisor	•Site Inspection •Training records •Visual assessment by experts (Quarterly monitoring)	Report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
	• Increased risk of fires at the site due to failure of machinery or transmission line • Poisoning animals by hazards waste				vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances. As per monitoring and reporting requirements during operation phase the Project Operator should inspect the works at all times.					
Landscape and visual	Setup of PV module	Visual impact due to glare	Landscape and Visual Impact	minor	•The solar panels will be installed at a low height and will be kept closer to the ground so that it does not prop out of the general landscape of the area; •The panels will be arranged in a systematic manner which will give an aesthetic sense to it; •The proposed solar PV power project would include a boundary wall around the perimeter of the project to further obscure the peripheral view of the project and any indirect reflection. Impacts from glare would be minor; •All cables and power lines will be located underground as far as possible; •The substation, gatehouses and maintenance and storage buildings will be grouped as far as possible to avoid the scatter of buildings in the open landscape. •The design of the buildings will be compatible in scale and form with the building style of the region. •All yards and storage areas to be enclosed by masonry walls or screens; •The color of the solar array and structures, such as the supports and the rear of the panels, will be carefully selected, and to be in the light grey or white colors, to minimize visibility and avoid reflectivity. •External lighting will be confined to the substations and maintenance areas. Lights will be low-level and fitted with reflectors to avoid light spillage. •Signages related to the enterprise are to be discrete and confined to the entrance gates. No other corporate or advertising signage, particularly billboards or flags, to be permitted; •All lighting will be kept to a minimum within the requirements of safety and efficiency; •Where such lighting is deemed necessary, low-level lighting, which is shielded to reduce light spillage and pollution, will be used; •No naked light sources will be directly visible from a distance. Only reflected light will be visible from outside the Site; •External lighting will use down-lighters shielded in such a way as to minimize light spillage and pollution beyond the extent of the area that needs to be lit; •Security and perimeter lighting will also be shielded so that no light falls outside the area needing to be lit. Unnecessarily tall light poles are to be avoided; •Warning signs at appropriate distances indicating solar power plant location should be placed to alert road users.	Negligible	O&M Contractor HSE Manager	NCEC Supervisor	Internal audit and record (Daily Monitoring)	Report from designated HSE personnel
Occupational health and safety hazards	• Leaching of materials from broken or fire damaged PV modules • Vehicle accidents, replacement of components/parts Emergency Fire Hazard • Electrocution of workers • Electromagnetic radiation from PV modules	Health risk of the worker	Occupational Health and Safety	Moderate	•Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. •Adequate training regarding health and safety will be provided to the workers. •A health, safety, and environment (HSE) management system will be developed, rolled out and implemented. This system which will be reviewed annually or after a major accident or incident •The switchyard building will be provided with fire extinguishers and sand buckets at all strategic locations to deal with any incident of fire. •Safety incidents will be recorded and monitored with an aim that numbers are never significant, and gradually reduce. •Workers at site handling broken solar panels shall be provided with adequate PPEs (safety gear, goggles, and gloves). •The workers at the site are also on regular basis shall be appraised about the potential health risks associated with the handling of solar panels. •Ensure use of safety belt and need for safety net as required; •All work at height to be undertaken during daytime with sufficient sunlight except emergency (with proper illumination arrangement); •Fixtures shall be installed on tower components to facilitate the use of fall protection systems;	Minor	O&M Contractor HSE Manager	NCEC Supervisor	Internal audit, meeting with technical and other staff and record (Monthly Monitoring)	Report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•Only workers trained in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment shall be engaged for work at height; •Workers handling electricity and related components will be provided with shock resistant gloves, shoes and other protective gears. Adequate training regarding health and safety will be provided to the workers; •Access to areas containing exposed electrical equipment (such as transformers) shall be fenced and locked. Warning signs shall be posted at hazardous locations; •Firefighting equipment such as fire extinguishers and sand buckets shall be provided at appropriate locations; •Workers involved in electric operations shall be provided with Protective Equipment such as rubber gloves etc; •Employees involved in electrical works shall be trained in and familiar with the safety-related work practices, safety procedures, and other safety requirements that pertain to their respective job assignments. •First aid box/ arrangement to be ensured					
Traffic and transport	Bringing to the site special loads of solar panels, structures that will make inconvenience to the road users	Impact on traffic and transport	Traffic and transport	Negligible	•During operation, if abnormal loads are required for maintenance, the appropriate arrangements will be made to obtain the necessary transportation permits and the route agreed with the relevant authorities to minimize the impact of other road users.	Negligible	O&M Contractor HSE Manager	NCEC Supervisor	Site inspection (daily monitoring)	Report from designated HSE personnel
Renewable energy / NREP implementation	Setting up renewable energy Power plant	Positive impact	Impact on climate change	Positive		Positive				
Socioeconomic aspect	New employment opportunities for long-term	Positive impact	Impact on employment	positive	•The local community is preferred by the project for the requirement of skilled, semiskilled and unskilled workers to the extent possible. •The sourcing of local labor wherever possible should be made obligatory for the sub- contractors and in all major procurement activities. •Preference should be given to the vulnerable population. •The EPC Contractor/ and the MoE/MEWA will establish a mechanism to audit subcontractors and suppliers with respect to compliance of utilizing local labor and resources.	Positive	Person designated from O&M Contractor	Person designated from MoE/Ministry of Human resources and social development		
Decommissioning phase										
Soil Environment	Dismantling of solar panels Structure and tracking system Restoration of site to its initial state	Soil contamination	Impact on soil environment	minor	•The decommissioning of the solar plant will be carried out in a planned manner. •During decommissioning phase, the quantity of waste generated will be high. The waste will be routed through proper collection, storage and disposal. The waste will be evaluated for its recycling/ reuse/ scrap value and disposed accordingly. •The vehicular movement during decommissioning activities should be restricted to the designated route path; •The demolition/ dismantling waste should not be left over in the project area and to be collected and stored at designated area only for further segregation and disposal.	minor	Decommissioning Contractor	NCEC Supervisor	Site inspection (Monthly monitoring	Report from designated HSE personnel
	Wastewater disposal Solid waste disposal	Water contamination	Impact on Water Environment	minor	•The provisions of septic tank and soak pits will be provided onsite for treatment and disposal of sewage, thereby minimizing the impacts of wastewater discharge. Planning of toilets, soak pits and septic tanks, waste collection areas should be away from natural drainage channels; •Use of licensed contractors for management and disposal of waste and sludge; •Spill/ leakage clearance plan to be adopted for immediate cleaning of spills and leakages; •Water tankers with proper permissions will be utilized for water sourcing. •Ensure proper cover and stacking of loose construction material to prevent surface runoff and contamination of receiving water body; •Laborers will be given training towards proactive use of designated areas/bins for waste disposal and encouraged for use of toilets. Any random disposal of sewage shall be strictly restricted; •Construction labor deputed onsite to be sensitized about water conservation and encouraged for optimal use of water; •Regular inspection for identification of water leakages and preventing wastage of water from water supply tankers.	negligible	Decommissioning Contractor	NCEC Supervisor	Visual inspection Audit (daily monitoring	Report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					•Recycling/reusing to the extent possible.					
Ambient air quality	Dismantling of PV solar panels Restoring land	Air pollution	Impact on air quality	Negligible	•Emissions from the emergency DG set and other stationary machines will be controlled by ensuring that the engines are always properly tuned and maintained. •Minimize stockpiling by coordinating excavations, spreading and restoring land activities. •Speed of vehicles on site will be limited to 10-15 km/hr which will help in minimizing fugitive dust emissions due to vehicular movement •A dust management plan should be applied •Idling of vehicles and equipment will be prevented. •Burning of any waste material shall be prevented. •Laborers shall be provided with natural gas connection to prevent burning of fuel wood for cooking or heating purposes. •Work shall be ceased or phased down if excess fugitive dust is observed. Source of dust shall be investigated, and proper suppression measures ensured. •Proper maintenance of engines and use of vehicles well maintained shall be ensured. •Panel solar should be handled properly to do not be damaged on site	Negligible	Decommissioning Contractor	NCEC Supervisor	Visual inspection Records (monthly monitoring)	Report from designated HSE personnel
Ambient Noise	Dismantling of PV solar panels Restoring land Using of rotary cutting machines	Impact on ambient noise level	Impact on ambient noise	minor	•Normal working hours of the contractor to be defined (preferable 8 am to 6pm). If work needs to be undertaken outside these hours, it should be limited to activities which do not generate noise. •Only well-maintained equipment should be operated on-site; •If it is noticed that any particular equipment is generating too much noise then lubricating moving parts, tightening loose parts and replacing worn out components should be carried out to bring down the noise and placing such machinery far away from the households as possible. •Machinery and equipment that may be in intermittent use should be shut down or throttled down during non-work periods; and •Minimal use of vehicle horns and heavy engine breaking in the area needs to be encouraged.	negligible	Decommissioning Contractor HSE Manager	NCEC Supervisor	• Daily inspection • Records (Monthly monitoring)	Report from designated HSE personnel
Socioeconomic aspect	Loss of jobs Issue with employees when let them to leave	Impact on employment and community	Impact on employment and community	Minor	•O&M Contractor should ensure that retrenchment packages are provided for all staff who stand to lose their jobs when the plant is decommissioned. •The contractor shall inform the workers about the duration of work; •Reduction of worker will be done phase wise and corresponding to completion of each activity; and •All waste generated from demobilization shall be collected and disposed of at the nearest municipal disposal site.	negligible	O&M Contractor designated person	Person designated from MoE/Ministry of Human resources and social development		
Occupational health and safety	Risks associated with health and safety issues such as trip and fall, electrical hazard etc.;	Impact on occupational health and safety	Impact on occupational health and safety	Moderate	•The workers of decommissioning phase will be provided with training on the Health and Safety policy in place, and their role in the site and refresher courses will be provided throughout the life of the project. •Operation of loading-unloading equipment should be undertaken under the guidance/supervision of trained professional. •The contractor should ensure that no person is engaged in driving or operating dismantling machinery unless he is sufficiently competent and reliable, possess the knowledge of risks involved in the operation and is medically examined periodically. •Contractor should prepare a site Emergency Preparedness and Response Procedure, which should be followed for the subjected project. •Adequate training should be provided to staff about raising awareness about use of Personal Protection Equipment (PPE) and emergency response measures; •Job responsibility and shifting chart should be prepared so that no person shall be over exhausted, which will ultimately lead to the accident or injuries; •Safety sign should also be marked at appropriate places. •It shall also be ensured that good housekeeping at the construction site is maintained to avoid slips and falls. •Excessive waste debris and liquid spills will be cleaned up regularly, while electrical cords and ropes will be placed along identified corridors marked for the attention of everyone at the site. •Use of personal fall arrest system, such as full body harnesses as well as fall rescue procedures to deal with workers whose fall has been successfully arrested shall also	Minor	Decommissioning Contractor HSE Manager	NCEC Supervisor	Internal audit, meeting with technical and other staff and record (Monthly Monitoring)	Report from designated HSE personnel

Project Stage/ Affected Aspect	Project Activity	Potential impact	Potential Impact	Significance (Pre-mitigation)	Mitigation measures /Enhancement	residual significance (Post-Mitigation)	Responsibility for mitigation implementation	Responsibility for supervision of mitigation implementation	Means of verification and time/frequency of monitoring	Reporting Requirements
					be carried out. •Dropping/lowering dismantled objects or tool will be restricted and undertaken only under strict supervision if required. PPEs such as safety glasses with side shields, face shields, hard hats and safety shoes shall be mandatory at a construction site. Earplugs shall be provided for workers placed in high noise areas.					

11. CONCLUSION

The environmental and social impact assessment of the proposed Solar of Haden has been conducted in accordance with the administrative framework, identified herein, including national legislative requirement, the World Bank Policies, IFC's Performance Standards and World Bank's Environmental Health and Safety (EHS) Guidelines and the national Saudi environmental guidelines.

The ESIA study has been carried out based on the site visit, baseline environmental and social condition survey, stakeholder consultation, analysis of the possible project intervention and finally potential environmental impact associated with all aspects of the proposed project was identified and evaluated. The proposed project will be developed bare land with no human activity observed.

11.1. Alternative technology used

The panel technology adopted for the current PV solar plant was bifacial solar panels which operates with the same principle of ordinary solar photovoltaic but can produce solar power from both sides of the panel. bifacial modules expose both the front and backside of the solar cells to radiation. This technology offers many advantages such as

- Optimal sunlight absorption and transformation to electrical energy due to sun tracking system along daytime.
- Less spaces occupied for the same amount of energy produced if ordinary panels are used and thus less space disturb
- Less material used and less waste generation. Etc

11.2. Environmental and social impacts generated

The key environmental impact due to the project construction observed as an outcome of the ESIA study impacts on land use, drainage pattern change, water quality solid waste generation and disposal, increase traffic and transport and occupational health and safety. The economic opportunities in terms of local employment during construction and operation phase are assessed as positive. During the operation of the proposed project, the key issues related to the environment has been identified from the ESIA study are hazardous waste generation and management, ecological, visual impact and occupational health and safety.

In terms of biodiversity features, construction activities will have minor impacts on terrestrial habitats and flora due to removal of vegetation as well as disturbance and displacement of fauna. Operation phase will likely have no significant impact on the biodiversity as solar energy production is classified a green energy alternative.

The ESIA predicts that residual environmental impacts of minor to moderate significance may occur as a result of the Project. The ESIA study has established that potential impacts associated with the Project activities are not detrimental in nature and anticipated to be successfully managed through effective implementation of successful Environmental and social management plan

11.3. The Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) describes mitigation measures for impacts specific to the project activities and also discuss implementation mechanism for recommended mitigation measures along with monitoring plan.

The ESMP also suggest following number of Project specific management plans to be implemented by the Project Contractors.

Implementation of ESMP will help EPC contractor to comply with the national regulatory framework as well as to meet IFC Performance Standard requirements.

The project should take structurally protective measures towards winds, sandstorms as the site is located in a desert area where these climatologic phenomena are common.

11.4. Stakeholders and their roles

During the performance of the project, several coordination activities have been carried out between the Stakeholders and the Designs Consortium with two main objectives:

- To gather information and data required for the project.
- To reach agreements and non-objection statements to our project design from the various stakeholders' involved departments.

The following Stakeholders and their roles have been identified during the process of the project development as follow:

- Sheepherders / Camel herders: Project Affected People – Need to be resettled from the site.
- Turbah Municipality: Solar power plant on the territory
- Ministry of Interior: Security restrictions that must be considered
- Ministry of defence: Neighbouring / Security restrictions that must be considered
- Ministry of National Guard: Neighbouring / Security restrictions that must be considered
- National Center for Vegetation Cover: Biodiversity protection / Environmental restrictions
- The National Centre for Wildlife: Biodiversity protection / Environmental restrictions

- General Authority of Civil Aviation: The flight way, if any, in the project area (impacts of solar glint and glare on aviation activity)

Appendix A. Terrestrial Ecology Survey

REPORT

BIODIVERSITY ASSESSMENT FOR AL-HADEN SOLAR POWER PLANT

CONTENTS

1. INTRODUCTION 4

2. METHODS 6

2.1 Desktop Review 6
2.2 Field Survey 7
3. RESTULS 8

3.1 Habitats and Flora 8
3.1.1 Desktop Review 8
3.1.2 Field Survey 9
3.2 Birds 11
3.2.1 Desktop Review 11
3.2.2 Field Survey 13
3.3 Mammals and Reptiles 13
3.3.1 Desktop Review 13
3.3.2 Field Survey 19
3.4 Areas of Conservation Importance 19
4. ASSESSMENT OF POTENTIAL IMPACTS 21

4.1 Potential Impacts During the Construction Phase 21
4.1.1 Additional Studies/Surveys and Mitigation Measures 22
4.1.2 Monitoring and Reporting Requirements 23
4.2 Potential Impacts During the Operation Phase 23
4.2.1 Mitigation Measures 23
4.2.2 Monitoring and Reporting Requirements 24
5. SUMMARY 25

6. REFERENCES 27

LIST OF FIGURES

Figure 1 Project Site boundaries and location 5
Figure 2 Location of the Project Site in the Deserts and Sparsely vegetated Area (Ghazanfar & Fisher, 1998) (left), and the location of Project Site in the Southwest Arabian Escarpment Shrublands and Woodlands (Olson et al, 2001) (right) 8
Figure 3 Area of high vegetation cover at the Project Site 10
Figure 4 Flora Species Recorded on Site: *Clutia lanceolata* (top left) *Vachellia tortilis* (top right), *Indigofera spinosa* (bottom left) and *Calotropis procera* (bottom right) 11
Figure 5 Locations of nomadic settlements and livestock enclosures at the Project Site 20
Figure 6 Landscape views of the Project Site showing the highest (top) and lowest (bottom) levels of vegetation cover 26

LIST OF TABLES

Table 1: Flora Species Recorded on Site.....9
Table 2 Migratory Soaring Bird Species and Globally Threatened Species that the Project Site overlaps with their Distribution Range.....12
Table 3 Avifauna Species Recorded on Site.....13
Table 4 Reptile Species that the Project Site overlaps with their Distribution Range.....14
Table 5 Mammal Species that could be present the Project Site.....16

1. INTRODUCTION

Al-Haden Solar Power Project (henceforth referred to as 'the Project Site) has a surface area of approximately 60 Km^2 and is located roughly around 80 Km east of the city of Taif, see Figure 1. A biodiversity assessment was carried out at the Project Site to characterize the ecological features at and identify any biodiversity elements that require special consideration during the development stages of the project.

2. METHODS

The biodiversity assessment cover general ecology, biogeography, and habitats in addition to flora (annual and perennial) and fauna (mammals, herpetofauna, avifauna, and macro-invertebrates). The assessment aims to identify any ecologically sensitive areas in the study area and its surroundings, including Key Biodiversity Areas (KBAs), which include Important Bird Areas (IBAs).

Based on the results of the assessment, potential impacts of the project on all biodiversity were analyzed outlining those potential impacts at the various development stages of the project. Following up on the potential impacts, mitigation and monitoring measures were provided.

The assessment method of the Project Site is divided into two main parts: a comprehensive literature review and a field survey.

2.1 Desktop Review

The Desktop Review is based on previous studies, data, surveys, and records available in published scientific papers, books, and journals on biodiversity recorded within the study region in general. It is important to note that since the available literature on the Project site and its vicinity is relatively limited, the literature reviewed will include a wide spectrum of references including international references that have a wider focus than the area of the Project.

As part of the desktop assessment, habitat mapping and assessment was undertaken in order to identify any areas of conservation sensitivity present. Integrated Biodiversity Assessment Tool (IBAT) was referred to in order to identify all sites of biodiversity importance (Key Biodiversity Areas) and Protected Areas. In compliance with IFC's PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources, the review of IBAT was used to identify the need to undertake a Critical Habitat Assessment (CHA). As defined by PS6, critical habitats are '*areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered11 species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant*

concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

Based on this, it is crucial to undertake this desktop exercise at an early stage of the assessment in order to identify if there is a need to carry out a Critical Habitat Assessment or not at the Project Site. Also, on the habitat level, priority ecoregions of global conservation will be identified if present at the project areas according to Olson et al (2003).

2.2 Field Survey

A comprehensive walkover field survey was undertaken at the Project site, incorporating the following method:

- Field observations: the site was examined carefully for the presence of active animals, animal signs and tracts, active burrows, remains or any other vital signs that indicate the activity of animals. In addition, the site was surveyed for occurring plant species, which were noted and recorded to include number of species, coverage per species, etc. Routes of inspection were spread out across the project area to provide a comprehensive representation. Additionally, any areas that were identified as areas of special interest were visited and their biodiversity was recorded. Finally, any accidental records of any species at the project Site were added into the list of species recorded.

Items recorded during the survey will include the following:

- Landscape features.
- Flora species.
- Fauna species, including avifauna, and any relevant signs.

Land use features (human settlements, domestic animals, agricultures etc.).

3. RESTULS

3.1 Habitats and Flora

3.1.1 Desktop Review

The Project Site is part of the Southwest Arabian Escarpment Shrublands and Woodlands Ecoregion (Olson et al, 2001), which is part of the Desert and Xeric Shrublands Biome under the Afrotropic Realm (Figure 3 (right)). From a biogeographical perspective, the Project Site has its vegetation type described as 'Scarcely vegetated dunes and sandy gravel plains', as part of the Deserts and other scarcely vegetated areas of the Arabian Peninsula (Ghazanfar & Fisher, 1998) (Figure 3 (left).

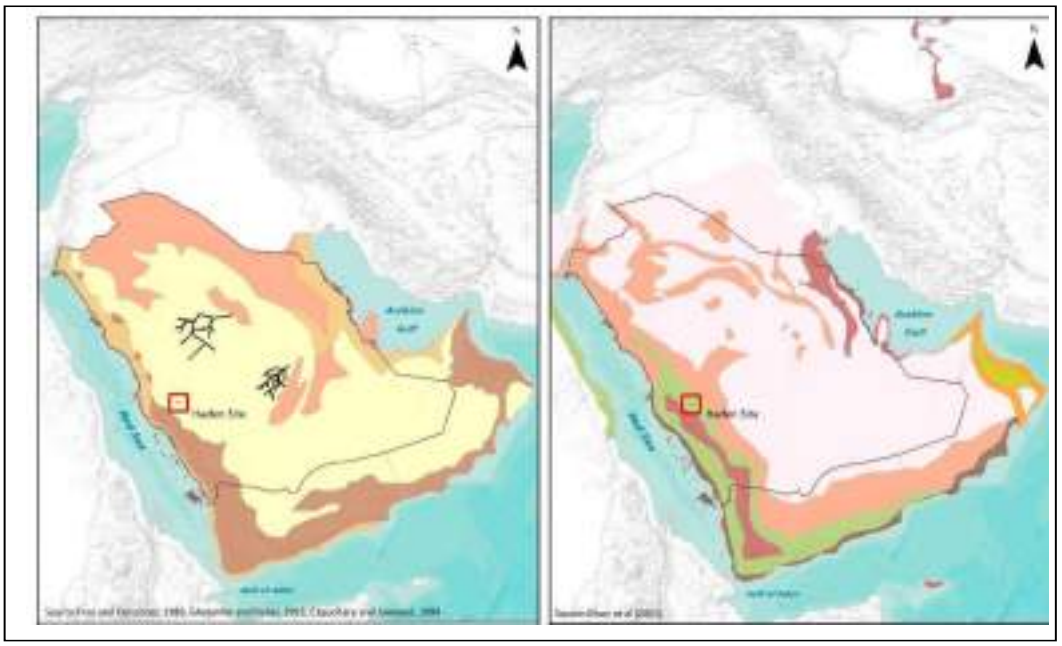


Figure 2 Location of the Project Site in the Deserts and Sparsely vegetated Area (Ghazanfar & Fisher, 1998) (left), and the location of Project Site in the Southwest Arabian Escarpment Shrublands and Woodlands (Olson et al, 2001) (right).

3.1.2 Field Survey

Based on the field survey, the Project Site is located in a sandy/gravel plain ranging in elevation between 1155 m and 1186 m asl. Generally, the area can be divided into two conspicuous parts; the western part with scarce vegetation and mainly sandy substrate and the eastern part that has a relatively high density of perennial species making it almost inaccessible with a vehicle in some part, see Figure 4.

Annual species were recorded across the Project Site were limited to grass species *Stipagrostis plumosa*, while perennial plant species recorded were limited to five species, see Table 1 and Figure 5. *Vachellia tortilis* was very scarcely recorded along with *Citrullus colocynthis* and *Indigofera spinosa,* while the highest coverage, including the western part of the Project Site was dominated by *Clutia lanceolata* and *Calotropis procera*.

Table 1: Flora Species Recorded on Site

Family	Name	Type	DAFOR	Endemism / Status	IUCN Threatened Species Status (2022)
Apocynaceae	*Calotropis procera*	Shrub	A	Native	Not Evaluated (NE)
Cucurbitaceae	*Citrullus colocynthis*	Shrub	R	Native	Not Evaluated (NE)
Fabaceae	*Vachellia tortilis*	Shrub	R	Native	Least Concern (LC)
Fabaceae	*Indigofera spinosa*	Shrub	R	Native	Not Evaluated (NE)
Graminae	*Stipagrostis plumosa*	Grass	R	Native	Not Evaluated (NE)
Peraceae	*Clutia lanceolata*	Shrub	A	Native	Not Evaluated (NE)

Figure 4 Flora Species Recorded on Site: *Clutia lanceolata* (top left) *Vachellia tortilis* (top right), *Indigofera spinosa* (bottom left) and *Calotropis procera* (bottom right)

3.2 Birds

3.2.1 Desktop Review

Based on the desktop review, the Project Site does not overlap with any Important Bird Areas (IBAs).

According to BirdLife International Sensitivity Mapping Tool for Migratory Soaring Birds (BirdLife, 2022), it shows that the Project Site does not potentially indicate a high level of migration. No satellite-tracked bird is documented to pass over the Project Site. On the other hand, nine species of Migratory Soaring Birds have the Project Site overlapping with their distribution range, in addition to another non-MSB globally threatened species bringing the overall number of species into ten see Table 2.

Table 2 Migratory Soaring Bird Species and Globally Threatened Species that the Project Site overlaps with their Distribution Range

Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)	IUCN Red List Status for Breeding Birds of Arabia (2015)
Griffon Vulture	*Gyps fulvus*	Extant (Resident)	Least Concern	Endangered
Egyptian Vulture	*Neophron percnopterus*	Extant (Resident)	Endangered	Vulnerable
Steppe Eagle	*Aquila nipalensis*	Extant (Non-breeding)	Endangered	Not Applicable
Eastern Imperial Eagle	*Aquila heliaca*	Extant (Non-breeding)	Vulnerable	Not Applicable
Greater Spotted Eagle	*Clanga clanga*	Extant (non-breeding / passage)	Vulnerable	Not Applicable
Shikra	*Accipiter badius*	Extant (Resident)	Least Concern	Least Concern
Saker Falcon	*Falco cherrug*	Extant (passage)	Endangered	Critically Endangered
Common Kestrel	*Falco tinnunculus*	Extant (Resident)	Least Concern	Least Concern
Great White Pelican	*Pelecanus onocrotalus*	Extant (passage)	Least Concern	Not Applicable
Asian Houbara	*Chlamydotis macqueenii*	Extant (Non-breeding)	Vulnerable	Critically Endangered

3.2.2 Field Survey

Incidental observations were limited to four species out of which a single species is globally evaluated as Near Threatened: Pallid Harrier *Circus macrourus*. Other avifaunal species of conservation importance that could be recorded at the Project Site are listed in the below table.

Table 3 Avifauna Species Recorded on Site

Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)	IUCN Red List Status for Breeding Birds of Arabia (2015)
Pallid Harrier	*Circus macrourus*	Extant (Passage)	Near Threatened	Not Applicable
Eurasian Collared-dove	*Streptopelia decaocto*	Extant (Resident)	Least Concern	Least Concern
Great Grey Shrike	*Lanius excubitor*	Extant (Resident)	Least Concern	Least Concern
Brown-necked Raven	*Corvus ruficollis*	Extant (Resident)	Least Concern	Least Concern

3.3 Mammals and Reptiles

3.3.1 Desktop Review

A list was compiled for all reptile and mammal species that the Project Site is located inside their distribution range. For reptiles, in total, the Project Site is located inside the distribution range of 18 reptile species. None of which are evaluated as globally threatened. No burrows of the species were noticed at the Project Site., see Table 4.

As for mammals, 23 species out of the 24 species are evaluated as Least Concern while a single species is recorded as Near Threatened; Striped Hyaena *Hyaena hyaena, see* Table 5. Due to its large home range and since the Project Site has several nomadic settlements and surrounded by several main road, it is believed that the species would not be using the Project Site and its vicinity extensively.

Table 4 Reptile Species that the Project Site overlaps with their Distribution Range

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Reptilia	Squamata	Lacertidae	Hadramaut Sand Lizard	*Mesalina adramitana*	Extant (Resident)	Least Concern
Reptilia	Squamata	Lacertidae	-	*Mesalina brevirostris*	Extant (Resident)	Least Concern
Reptilia	Squamata	Lacertidae	Bosk's Fringe-toed Lizard	*Acanthodactylus boskianus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Varanidae	Desert Monitor	*Varanus griseus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Phyllodactylidae	-	*Ptyodactylus hasselquistii*	Extant (Resident)	Least Concern
Reptilia	Squamata	Gekkonidae	Middle Eastern Short-fingered Gecko	*Stenodactylus doriae*	Extant (Resident)	Least Concern
Reptilia	Squamata	Scincidae	Common Skink	*Scincus scincus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Psammophiidae	Hooded Malpolon	*Rhagerhis moilensis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Psammophiidae	Afro-Asian Sand Snake	*Psammophis schokari*	Extant (Resident)	Least Concern

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Reptilia	Squamata	Atractaspididae	Mole Viper	*Atractaspis engaddensis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Viperidae	Arabian Horned Viper	*Cerastes gasperettii*	Extant (Resident)	Least Concern
Reptilia	Squamata	Viperidae	Palestine Saw-scaled Viper	*Echis coloratus*	Extant (Resident)	Least Concern
Reptilia	Squamata	Leptotyphlopidae	Beaked Thread Snake	*Myriopholis macrorhyncha*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Common Leaf-nosed Snake	*Lytorhynchus diadema*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Braid Snake	*Platyceps rhodorachis*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Arabian Cat Snake	*Telescopus dhara*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Diadem Snake	*Spalerosophis diadema*	Extant (Resident)	Least Concern
Reptilia	Squamata	Colubridae	Elegant Racer	*Platyceps elegantissimus*	Extant (Resident)	Least Concern

Table 5 Mammal Species that could be present the Project Site

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Mammalia	Carnivora	Felidae	Sand Cat	*Felis margarita*	Possibly Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Red Fox	*Vulpes vulpes*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Blanford's Fox	*Vulpes cana*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Rüppell's Fox	*Vulpes rueppellii*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Canidae	Grey Wolf	*Canis lupus*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Hyaenidae	Striped Hyaena	*Hyaena hyaena*	Extant (Resident)	Near Threatened
Mammalia	Carnivora	Mustelidae	Honey Badger	*Mellivora capensis*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Viverridae	Common Genet	*Genetta genetta*	Extant (Resident)	Least Concern
Mammalia	Carnivora	Herpestidae	White-tailed Mongoose	*Ichneumia albicauda*	Extant (Resident)	Least Concern
Mammalia	Hyracoidea	Procaviidae	Rock Hyrax	*Procavia capensis*	Extant (Resident)	Least Concern

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Mammalia	Eulipotyphla	Soricidae	Lesser Shrew	*Crocidura suaveolens*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Vespertilionidae	Sind Serotine Bat	*Rhyneptesicus nasutus*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Vespertilionidae	Kuhls Pipistrelle	*Pipistrellus kuhlii*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Hipposediridae	Geoffroy's Trident Leaf-nosed Bat	*Asellia tridens*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Rhinopomatidae	Lesser Mouse-tailed Bat	*Rhinopoma hardwickii*	Extant (Resident)	Least Concern
Mammalia	Chiroptera	Rhinopomatidae	Egyptian Mouse-tailed Bat	*Rhinopoma cystops*	Extant (Resident)	Least Concern
Mammalia	Eulipotyphla	Erinaceidae	Desert Hedgehog	*Paraechinus aethiopicus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Dipodidae	Lesser Egyptian Jerboa	*Jaculus jaculus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Pygmy Gerbil	*Gerbillus henleyi*	Extant (Resident)	Least Concern

Class	Order	Family	Common Name	Scientific Name	Distribution Status	IUCN Threatened Species Status (2022)
Mammalia	Rodentia	Muridae	Dwarf Gerbil	*Gerbillus nanus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Sundevall's Jird	*Meriones crassus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Arabian Spiny Mouse	*Acomys dimidiatus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Golden Spiny Mouse	*Acomys russatus*	Extant (Resident)	Least Concern
Mammalia	Rodentia	Muridae	Fat Sand Rat	*Psammomys obesus*	Extant (Resident)	Least Concern

3.3.2 Field Survey

No live mammals or reptiles and/or burrows were recorded throughout the survey. On the other hand, livestock (sheep and camels) and shepherd dogs were recorded all over the Project Site along with several nomadic settlements and livestock enclosures, see Figure 6. Indications of intense levels of grazing were observed across the vegetation at the Project Site.

3.4 Areas of Conservation Importance

The Project Site does not overlap with any areas of nature conservation importance. The closest area to the Project Site is a Key Biodiversity Area called National Wildlife Research Centre and Environs, which is located around 55 Km southwest of the Project Site. The KBA is around 40 Km^2 and is a fenced captive-breeding center. No protected areas are located near the Project Site.

4. ASSESSMENT OF POTENTIAL IMPACTS

4.1 Potential Impacts During the Construction Phase

It is anticipated that during the construction phase site preparation activities will take place (such as excavations, levelling, land clearing activities, etc.) for the various Project components. Such activities are expected to cause a major disturbance and removal of the semi-natural vegetation present at the project site, including the grasses and the trees. Such activities could also cause regular disturbance to the other wildlife species inhabiting the Project Site. Other impacts on the biodiversity of the site could be caused by improper management of the site, which could include improper conduct and housekeeping practices by workers (i.e., hunting of animals, discharge of hazardous waste to land, etc.).

As discussed in the results above, generally the Project Site is generally arid with very low vegetation cover and wildlife species presence, except for the southwestern part that has a high vegetation cover of arboreal species. As mentioned earlier, no threatened flora/fauna species or sensitive habitats have been observed within the Project Site and all recorded floral and faunal species are considered to be of least concern. The literature review also has not identified any globally threatened species. No burrows were observed at the Project Site.

In addition, the Project site is not located within any area of nature conservation concern such as protected areas and/or Key Biodiversity Areas (KBAs), including Important Bird and Biodiversity Areas (IBAs). However, the closest area to the Project Site is the National Wildlife Research Centre and Environs, which is a KBA located around 55km southwest of the Project Site. The KBA is around 40km^2 and is a fenced captive-breeding center. No protected areas are located near the Project Site.

Given all of the above, the potential impacts on biodiversity created during the construction phase would of a long-term duration as they would result in a permanent change in the natural biodiversity of the site. Such impacts are considered of negative nature and of a low magnitude given that the change

in the natural biodiversity of the site will be noticeable in limited individual footprints. However, as the site is considered of low ecological significance, the receiving environmental is determined to be of a low sensitivity. Given all of the above, such an impact is considered to be of minor significance.

4.1.1 Additional Studies/Surveys and Mitigation Measures

The following identifies the additional studies and mitigation measures to be applied by the EPC Contractor during the construction phase and which include:

- Should as part of the Project any fencing be erected, it must be ensured that it allows for the natural movement of small faunal species within the area. This could include for example a fence with an appropriate gap between the ground level and the first rail or strand (around 30 cm).
- One major modification that could take place at the project site is the removal of the. Trees, specifically in the southwestern part of the Project Site. The trees are believed to be of significance for the biodiversity elements at the Project Site especially the birds. Therefore, the minimum number of trees should be removed from the project site in order to achieve the minimal impact possible on the biodiversity at the Project Site. The trees removed should be replaced by other trees to be planted in the vicinity of the project site in order to act as an offset for the removed trees and as a new refuge for the species affected.
- Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following:
    - Prohibit hunting at any time and under any condition by construction workers onsite.
    - Ensure proper storage, collection, and disposal of waste streams generated.
    - Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

- Avoid unnecessary elevated noise levels at all times. In addition, apply adequate general noise suppressing measures.
- Following the implementation of these mitigation measures, the significance of the residual impact is categorized as low significant.

4.1.2 Monitoring and Reporting Requirements

The following identifies the monitoring and reporting requirements that must be adhered to by the EPC Contractor during the construction phase and which include:

- Inspection of the works should be carried out at all times.

4.2 Potential Impacts During the Operation Phase

The only impacts anticipated during the operation phase are related to improper management of the site as discussed earlier. This could include improper conduct and housekeeping practices by workers (i.e. hunting of animals, discharge of hazardous waste to land, etc.).

The potential impacts on biodiversity would of a long-term duration throughout the operation phase of the Project. Such impacts are of negative nature and of a low magnitude. However, as the site is considered of low ecological significance, the receiving environmental is determined to be of a low sensitivity. Given all of the above, such an impact is considered to be of minor significance.

4.2.1 Mitigation Measures

The following identifies the mitigation measures to be applied by the Project Operator during the operation phase and which include:

- Implement proper management measures to prevent damage to the biodiversity of the site. This could include establishing a proper code of conduct and awareness raising/training of personnel and good housekeeping which include the following:
  - Prohibit hunting at any time and under any condition by workers onsite.
  - Ensure proper storage, collection, and disposal of waste streams.

- Restrict activities to allocated areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

Following the implementation of these mitigation measures, the significance of the residual impact is categorized as not significant.

4.2.2 Monitoring and Reporting Requirements

The following identifies the monitoring and reporting requirements that must be adhered to by the Project Operator during the operation phase and which include:

- Inspection of the works should be carried out at all times.

5. SUMMARY

The survey was composed of an ecological walkover of the Project Site and therefore the data and observation collected represent only an instant glimpse of the ecological features observed at the time of the survey.

The Project Site is located on a flat sandy plain. The landscape is natural and does not feature any prominent human interventions, except for scattered nomadic settlements as mentioned earlier. Concurrently, high levels of grazing were observed across the Project Site.

Vegetation cover is limited to groups of perennial shrubs/trees. Some parts of the Project Site are completely devoid of any vegetation cover while in others, dense vegetation was observed, see Figure 6. The eastern part of the Project Site has the highest density of vegetation mainly composed of small trees of *Calotropis procera* and shrubs of *Clutia lanceolate.* No indications of animal presence, apart from domestic animals, were observed at the Project Site.

Based on the above, below are some considerations to be taken during the different phases of the development of the project:

- Construction at the areas of the highest vegetation cover should be avoided as much as possible. Removal of trees and any perennial shrubs should also be avoided.
- Restrict activities to allocated construction areas only, including movement of workers and vehicles to allocated roads within the site and prohibit off-roading to minimize disturbances.

Figure 6 Landscape views of the Project Site showing the highest (top) and lowest (bottom) levels of vegetation cover

6. REFERENCES

AbiSaid, M. & Dloniak, S.M.D. 2015. *Hyaena hyaena*. The IUCN Red List of Threatened Species 2015: e.T10274A45195080. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T10274A45195080.en.

Al Johany, A.M.H., Amr, Z.S.S., Baha El Din, S., Sadek, R., Disi, A.M., Hraoui-Bloquet, S. & Werner, Y.L. 2012. *Platyceps elegantissimus*. The IUCN Red List of Threatened Species 2012: e.T184057A1745726. https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T184057A1745726.en.

Al Johany, A.M.H., Amr, Z.S.S., Egan, D.M., Eid, E.K.A., Els, J., Sharifi, M., Papenfuss, T., Mateo, J.A., Disi, A.M., Böhme, W., Baha El Din, S. & Shafiei Bafti, S. 2021. *Scincus scincus*. The IUCN Red List of Threatened Species 2021: e.T164624A1062266. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T164624A1062266.en.

Amori, G., Hutterer, R., Kryštufek, B., Yigit, N., Mitsainas, G., Palomo, L. & Aulagnier, S. 2021. *Jaculus jaculus* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2021: e.T10912A197517244. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T10912A197517244.en.

Amr, Z.S.S., Al Johany, A.M.H., Aloufi, A.A.H., Anderson, S., Kaya, U., Baha El Din, S., Sevinç, M., Tok, C.V., Disi, A.M., Werner, Y.L., Ugurtas, I.H., Crochet, P.-A., Nilson, G., Akarsu, F., Spawls, S., Malonza, P.K. & Giri, V. 2021. *Myriopholis macrorhyncha*. The IUCN Red List of Threatened Species 2021: e.T164772A1074288. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T164772A1074288.en.

Amr, Z.S.S., Al Johany, A.M.H., Baha El Din, S., Disi, A.M. & Werner, Y.L. 2012. *Atractaspis engaddensis*. The IUCN Red List of Threatened Species 2012: e.T183147A1729605. https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T183147A1729605.en.

Amr, Z.S.S., Els, J., Al Johany, A.M.H., Soorae, P., Nilson, G., Shafiei Bafti, S., Anderson, S., Böhme, W., Joger, U., Geniez, P., Mateo, J.A., Disi, A.M., Baha El Din, S., Papenfuss, T., Sharifi, M., Wilms, T. & Wagner, P. 2013. *Lytorhynchus diadema*. The IUCN Red List of Threatened Species 2013: e.T164769A1074038. https://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T164769A1074038.en.

Benda, P. 2017. *Rhinopoma cystops*. The IUCN Red List of Threatened Species 2017: e.T82345555A82345569. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T82345555A82345569.en.

Benda, P., Srinivasulu, C. & Srinivasulu, B. 2019. *Eptesicus nasutus*. The IUCN Red List of Threatened Species 2019: e.T7935A22117147. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T7935A22117147.en.

BirdLife International. 2017. *Alaemon alaudipes* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22717262A118704240. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22717262A118704240.en.

BirdLife International. 2019. *Aquila heliaca* (amended version of 2017 assessment). The IUCN Red List of Threatened Species 2019: e.T22696048A155464885. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T22696048A155464885.en.

BirdLife International. 2021. *Aquila nipalensis*. The IUCN Red List of Threatened Species 2021: e.T22696038A205452572. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22696038A205452572.en.

BirdLife International. 2021. *Accipiter badius*. The IUCN Red List of Threatened Species 2021: e.T22695490A197951702. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22695490A197951702.en.

BirdLife International. 2021. *Chlamydotis macqueenii*. The IUCN Red List of Threatened Species 2021: e.T22733562A205364424. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22733562A205364424.en.

BirdLife International. 2021. *Clanga clanga*. The IUCN Red List of Threatened Species 2021: e.T22696027A203868747. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22696027A203868747.en.

BirdLife International. 2021. *Falco cherrug*. The IUCN Red List of Threatened Species 2021: e.T22696495A204182473. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22696495A204182473.en.

BirdLife International. 2021. *Falco tinnunculus*. The IUCN Red List of Threatened Species 2021: e.T22696362A206316110. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22696362A206316110.en.

BirdLife International. 2021. *Neophron percnopterus*. The IUCN Red List of Threatened Species 2021: e.T22695180A205187871. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22695180A205187871.en.

BirdLife International. 2021. *Pelecanus onocrotalus*. The IUCN Red List of Threatened Species 2021: e.T22697590A177120498. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22697590A177120498.en.

BirdLife International. 2021. *Torgos tracheliotos*. The IUCN Red List of Threatened Species 2021: e.T22695238A205352949. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22695238A205352949.en

Boitani, L., Phillips, M. & Jhala, Y. 2018. *Canis lupus* (*errata* version published in 2020). The IUCN Red List of Threatened Species 2018: e.T3746A163508960. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T3746A163508960.en.

Butynski, T., Hoeck, H., Koren, L. & de Jong, Y.A. 2015. *Procavia capensis*. The IUCN Red List of Threatened Species 2015: e.T41766A21285876. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T41766A21285876.en.

Cassola, F. 2016. *Acomys dimidiatus* (errata version published in 2017). The IUCN Red List of Threatened Species 2016: e.T136471A115208221. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T136471A22453198.en.

Corbet, G. (1992). The Mammals of Arabia David L. Harrison and Paul J. J. Bates Harrison Zoological Museum, Sevenoaks, 1991, 354 pp.

Do Linh San, E. 2015. *Ichneumia albicauda*. The IUCN Red List of Threatened Species 2015: e.T41620A45208640. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T41620A45208640.en.

Do Linh San, E., Begg, C., Begg, K. & Abramov, A.V. 2016. *Mellivora capensis*. The IUCN Red List of Threatened Species 2016: e.T41629A45210107. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T41629A45210107.en.

Egan, D.M., Amr, Z.S.S., Al Johany, A.M.H., Els, J., Papenfuss, T., Nilson, G., Sadek, R., Disi, A.M., Hraoui-Bloquet, S., Werner, Y.L. & Anderson, S. 2012. *Cerastes gasperettii*. The IUCN Red List of Threatened Species 2012: e.T164599A1060588. https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T164599A1060588.en.

Eid, E.K.A., Al Johany, A.M.H., Amr, Z.S.S., Baha El Din, S., Werner, Y.L. & Disi, A.M. 2021. *Echis coloratus*. The IUCN Red List of Threatened Species 2021: e.T197482A2488698. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T197482A2488698.en.

Els, J., Al Johany, A.M.H., Amr, Z.S.S., Baha El Din, S., Disi, A.M., Böhme, W., Geniez, P. & Werner, Y.L. 2021. *Telescopus dhara*. The IUCN Red List of Threatened Species 2021:

e.T184069A1747835. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T184069A1747835.en.

Els, J., Al Johany, A.M.H., Amr, Z.S.S., Baha El Din, S., Böhme, W., Geniez, P., Tuniyev, S., Orlov, N.L., Ananjeva, N.B., Cogălniceanu, D., Lymberakis, P., Avci, A., Aghasyan, A., Tuniyev, B., Andrén, C., Wilkinson, J., Üzüm, N., Podloucky, R., Kaya, U., Mateo, J.A., Hraoui-Bloquet, S., Wilms, T., Wagner, P., Borkin, L., Milto, K., Golynsky, E., Rustamov, A, Munkhbayar, K., Nuridjanov, D., Dujsebayeva, T. & Shestopal, A. 2021. *Spalerosophis diadema*. The IUCN Red List of Threatened Species 2021: e.T164593A1059945. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T164593A1059945.en.

Els, J., Al Johany, A.M.H., Amr, Z.S.S., Orlov, N.L., Shafiei Bafti, S., Werner, Y.L., Disi, A.M., Papenfuss, T., Ananjeva, N.B., Borkin, L., Milto, K., Golynsky, E., Rustamov, A, Munkhbayar, K., Nuridjanov, D., Dujsebayeva, T., Shestopal, A. & Das, A. 2021. *Platyceps rhodorachis*. The IUCN Red List of Threatened Species 2021: e.T164605A1060890. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T164605A1060890.en.

Els, J., Aloufi, A.A.H., Al Johany, A.M.H., Amr, Z.S.S., Baha El Din, S., Disi, A.M. & Werner, Y.L. 2021. *Ptyodactylus hasselquistii*. The IUCN Red List of Threatened Species 2021: e.T198399A2524966. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T198399A2524966.en.

Gaubert, P., Carvalho, F., Camps, D. & Do Linh San, E. 2015. *Genetta genetta*. The IUCN Red List of Threatened Species 2015: e.T41698A45218636. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T41698A45218636.en.

Ghazanfar, S. A., & Fisher, M. (Eds.). (1998). Vegetation of the Arabian Peninsula (No. 25). Springer Science & Business Media.

Granjon, L. 2016. *Gerbillus henleyi* (errata version published in 2017). The IUCN Red List of Threatened Species 2016: e.T9127A115090818. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T9127A22464262.en.

Granjon, L. 2016. *Meriones crassus*. The IUCN Red List of Threatened Species 2016: e.T13161A22433449. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T13161A22433449.en.

Granjon, L. 2016. *Psammomys obesus* (errata version published in 2017). The IUCN Red List of Threatened Species 2016: e.T18418A115143282. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T18418A22416093.en.

offmann, M. & Sillero-Zubiri, C. 2015. *Vulpes cana*. The IUCN Red List of Threatened Species 2015: e.T23050A48075169. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T23050A48075169.en.

Hoffmann, M. & Sillero-Zubiri, C. 2021. *Vulpes vulpes* (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2021: e.T23062A193903628. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T23062A193903628.en.

Hutterer, R. 2016. *Paraechinus aethiopicus*. The IUCN Red List of Threatened Species 2016: e.T40606A22326233. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T40606A22326233.en.

International Biodiversity Assessment Tool (IBAT). (2022). United Nations Environment World Conservation Monitoring Centre (UN-WCMC). https://www.ibat-alliance.org/

Juste, J. & Paunović, M. 2016. *Pipistrellus kuhlii*. The IUCN Red List of Threatened Species 2016: e.T17314A22132946. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T17314A22132946.en.

Mallon, D., Budd, K., & (eds). (2011). Regional Red List Status of Carnivores in the Arabian Peninsula. Cambridge, UK and Gland Switzerland: IUCN, and Sharjah, UAE: Environment and Protected Areas Authority vi+49pp

Mallon, D., Murdoch, J.D. & Wacher, T. 2015. *Vulpes rueppellii*. The IUCN Red List of Threatened Species 2015: e.T23053A46197483. https://dx.doi.org/10.2305/IUCN.UK.2015-4.RLTS.T23053A46197483.en.

Monadjem, A., Aulagnier, S., Palmeirim, J. & Benda, P. 2017. *Rhinopoma hardwickii*. The IUCN Red List of Threatened Species 2017: e.T82345477A21999269. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T82345477A21999269.en.

Monadjem, A., Bergmans, W., Mickleburgh, S., Kock, D., Amr, Z.S.S. & Hutson, A.M. 2017. *Asellia tridens*. The IUCN Red List of Threatened Species 2017: e.T80221529A21975715. https://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T80221529A21975715.en.

NCWCD, 2004. First Saudi Arabian National Report on the Convention on Biological Diversity., s.l.: s.n

Oldfield, S. 2020. *Vachellia tortilis*. The IUCN Red List of Threatened Species 2020: e.T19375415A165379871. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T19375415A165379871.en.

Olson, D. M., Dinerstein, E., Wikramanayake, E. D., Burgess, N. D., Powell, G. V., Underwood, E. C., ... & Kassem, K. R. (2001). Terrestrial Ecoregions of the World: A New Map of Life on Earth. BioScience, 51(11), 933-938.

Palomo, L., Krytufek, B., Amori, G. & Hutterer, R. 2016. *Crocidura suaveolens*. The IUCN Red List of Threatened Species 2016: e.T29656A22296429. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T29656A22296429.en.

Protected Planet. (2022). United Nations Environment World Conservation Monitoring Centre (UN-WCMC). https://www.protectedplanet.net/.

Shenbrot, G. 2016. *Acomys russatus*. The IUCN Red List of Threatened Species 2016: e.T273A22452593. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T273A22452593.en.

Shenbrot, G. 2016. *Gerbillus nanus* (errata version published in 2018). The IUCN Red List of Threatened Species 2016: e.T9136A135436781. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T9136A22463551.en.

Sliwa, A., Ghadirian, T., Appel, A., Banfield, L., Sher Shah, M. & Wacher, T. 2016. *Felis margarita*. The IUCN Red List of Threatened Species 2016: e.T8541A50651884. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T8541A50651884.en.

Soorae, P., Amr, Z.S.S., Al Johany, A.M.H., Els, J., Sharifi, M., Papenfuss, T., Sadek, R., Disi, A.M., Hraoui-Bloquet, S., Werner, Y.L. & Shafiei Bafti, S. 2012. *Stenodactylus doriae* (*errata* version published in 2017). The IUCN Red List of Threatened Species 2012: e.T164683A115304527.
https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T164683A1067541.en.

Soorae, P., Eid, E.K.A., Behbehani, S.J.Y., Al Johany, A.M.H., Amr, Z.S.S., Egan, D.M., Els, J., Baha El Din, S., Böhme, W., Orlov, N.L., Wilkinson, J., Tuniyev, B., Lymberakis, P., Aghasyan, A., Cogălniceanu, D., Ananjeva, N.B., Disi, A.M., Mateo, J.A., Sattorov, T., Nuridjanov, D. & Chirikova, M. 2021. *Varanus griseus*. The IUCN Red List of Threatened Species 2021: e.T62252A3110663. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T62252A3110663.en.

Symes, A., Taylor, J., Mallon, D., Porter, R., Simms, C. and Budd, K. (2015). The Conservation Status and Distribution of the Breeding Birds of the Arabian Peninsula.

Cambridge, UK and Gland, Switzerland: IUCN, and Sharjah, UAE: Environment and Protected Areas Authority.

Üzüm, N., Kumlutaş, Y., Baha El Din, S., Disi, A.M., Hraoui-Bloquet, S., Sadek, R., Werner, Y.L., Kaska, Y., Avci, A., Al Johany, A.M.H. & Els, J. 2021. *Mesalina brevirostris*. The IUCN Red List of Threatened Species 2021: e.T164728A1071123. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T164728A1071123.en.

Wagner, P., Wilms, T., Aloufi, A.A.H., Al Johany, A.M.H., Anderson, S., Baha El Din, S., Pleguezuelos, J., Disi, A.M., Böhme, W., Mateo, J.A., Papenfuss, T. & Spawls, S. 2021. *Rhagerhis moilensis*. The IUCN Red List of Threatened Species 2021: e.T164566A1058442. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T164566A1058442.en.

Wagner, P., Wilms, T., Niagate, B., Els, J., Al Johany, A.M.H., Amr, Z.S.S., Aloufi, A.A.H., Sindaco, R., Kumlutaş, Y., Baha El Din, S., Böhme, W., Disi, A.M., Mateo, J.A., Kaska, Y. & Avci, A. 2021. *Acanthodactylus boskianus*. The IUCN Red List of Threatened Species 2021: e.T164610A1061146.

Wilms, T., Aloufi, A.A.H., Al Johany, A.M.H. & Els, J. 2012. *Mesalina adramitana*. The IUCN Red List of Threatened Species 2012: e.T199611A2606621. https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T199611A2606621.en.

Wilms, T., Eid, E.K.A., Al Johany, A.M.H., Amr, Z.S.S., Els, J., Baha El Din, S., Disi, A.M., Sharifi, M., Papenfuss, T., Shafiei Bafti, S. & Werner, Y.L. 2012. *Uromastyx aegyptia* (errata version published in 2017). The IUCN Red List of Threatened Species 2012: e.T164729A115304711.
https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T164729A1071308.en.

Wilms, T., Wagner, P., Els, J., Al Johany, A.M.H., Amr, Z.S.S., Orlov, N.L., Shafiei Bafti, S., Baha El Din, S., Mateo, J.A., Geniez, P., Böhme, W., Hraoui-Bloquet, S., Papenfuss, T., Ananjeva, N.B., Borkin, L., Milto, K., Golynsky, E., Rustamov, A, Nuridjanov, D. & Munkhbayar, K. 2021. *Psammophis schokari*. The IUCN Red List of Threatened Species 2021: e.T164704A1069614. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T164704A1069614.en.

WFO (2022): World Flora Online. Published on the Internet; http://www.worldfloraonline.org.

Appendix B. Soil Analysis

Sample Location	Sample Soil-1
Lab Sample ID	G-2160222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	……	8.32	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	726	n/a
Chloride	EPA 9212	0.01	µg/g	102	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	18.3	n/a
Magnesium	EPA 3050	0.01	µg/g	25.8	n/a
Aluminium	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	16.2	n/a
Calcium	EPA 3050	0.01	µg/g	28.9	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.15	n/a
Iron	EPA 3050	0.01	µg/g	0.51	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.03	63
Zinc	EPA 3050	0.01	µg/g	0.24	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.6	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300

Sample Location	Sample Soil-1
Lab Sample ID	G-2160222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-2
Lab Sample ID	G-2170222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	……	7.69	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	673	n/a
Chloride	EPA 9212	0.01	µg/g	115	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	16.8	n/a
Magnesium	EPA 3050	0.01	µg/g	23.4	n/a
Aluminium	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	18.2	n/a
Calcium	EPA 3050	0.01	µg/g	27.2	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.09	n/a
Iron	EPA 3050	0.01	µg/g	0.46	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.17	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.2	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300

Sample Location	Sample Soil-2
Lab Sample ID	G-2170222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-3
Lab Sample ID	G-2180222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	8.5	0.01	pH unit	8.15	8.5
Electric Conductivity	n/a	0.1	µS/cm	712	n/a
Chloride	n/a	0.01	µg/g	119	n/a
Boron	3.3	0.01	µg/g	<0.01	3.3
Sodium	n/a	0.01	µg/g	13.8	n/a
Magnesium	n/a	0.01	µg/g	21.7	n/a
Aluminium	n/a	0.1	µg/g	<0.1	n/a
Potassium	n/a	0.01	µg/g	16.4	n/a
Calcium	n/a	0.01	µg/g	25.2	n/a
Chromium	64	0.1	µg/g	<0.1	64
Manganese	n/a	0.1	µg/g	1.14	n/a
Iron	n/a	0.01	µg/g	0.36	n/a
Cobalt	20	0.1	µg/g	<0.1	20
Nickel	45	0.01	µg/g	<0.01	45
Copper	63	0.2	µg/g	0.01	63
Zinc	200	0.01	µg/g	0.12	200
Arsenic	17	0.01	µg/g	<0.01	17
Silver	20	0.05	µg/g	<0.05	20
Cadmium	3.8	0.1	µg/g	<0.1	3.8
Barium	750	0.1	µg/g	<0.1	750
Mercury	12	0.3	µg/g	<0.001	12
Cyanide	0.9	0.01	µg/g	<0.01	0.9
Lead	70	0.01	µg/g	<0.01	70
Total Phosphorus	n/a	0.01	µg/g	1.1	n/a
Total Organic Carbon	n/a	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons	n/a	50	mg/Kg	<50	n/a
C6 – C10 Fraction	210	50	mg/Kg	<50	210
C10 - C16 Fraction	150	50	mg/Kg	<50	150
C16 – C34 Fraction	300	50	mg/Kg	<50	300
C34 – C50 Fraction	2800	50	mg/Kg	<50	2800
C29 - C36 Fraction	n/a	50	mg/Kg	<50	n/a
C37 - C40 Fraction	n/a	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-3
Lab Sample ID	G-2180222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Polyaromatic Hydrocarbons (PAH)	n/a	0.01	mg/Kg	<0.01	n/a
Fluoranthene	0.039	0.01	mg/Kg	<0.01	0.039
Pyrene	0.04	0.01	mg/Kg	<0.01	0.04
Chrysene	6.2	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	0.083	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	6.2	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	n/a	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	0.6	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	n/a	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	n/a	0.01	mg/Kg	<0.01	n/a
Benzene	0.078	0.01	mg/Kg	<0.01	0.078
Toluene	0.12	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	0.14	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	1.9	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-4
Lab Sample ID	G-2190222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	pH unit	8.42	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	723	n/a
Chloride	EPA 9212	0.01	µg/g	133	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	16.9	n/a
Magnesium	EPA 3050	0.01	µg/g	25.2	n/a
Aluminium	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	14.7	n/a
Calcium	EPA 3050	0.01	µg/g	23.8	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.31	n/a
Iron	EPA 3050	0.01	µg/g	0.28	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.12	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.1	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-4
Lab Sample ID	G-2190222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-5
Lab Sample ID	G-2200222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	pH unit	8.16	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	732	n/a
Chloride	EPA 9212	0.01	µg/g	116	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	17.2	n/a
Magnesium	EPA 3050	0.01	µg/g	26.8	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	19.1	n/a
Calcium	EPA 3050	0.01	µg/g	27.5	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.34	n/a
Iron	EPA 3050	0.01	µg/g	0.69	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.25	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.15	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300

Sample Location	Sample Soil-5
Lab Sample ID	G-2200222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 -8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-6
Lab Sample ID	G-2210222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	pH unit	8.39	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	729	n/a
Chloride	EPA 9212	0.01	µg/g	124	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	15.2	n/a
Magnesium	EPA 3050	0.01	µg/g	24.9	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	15.8	n/a
Calcium	EPA 3050	0.01	µg/g	26.3	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.19	n/a
Iron	EPA 3050	0.01	µg/g	0.47	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.37	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.25	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-6
Lab Sample ID	G-2210222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-7
Lab Sample ID	G-2220222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	pH unit	7.69	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	683	n/a
Chloride	EPA 9212	0.01	µg/g	121	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	18.2	n/a
Magnesium	EPA 3050	0.01	µg/g	26.3	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	17.5	n/a
Calcium	EPA 3050	0.01	µg/g	24.7	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.26	n/a
Iron	EPA 3050	0.01	µg/g	0.47	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.51	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.31	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-7
Lab Sample ID	G-2220222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-8
Lab Sample ID	G-2230222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	pH unit	7.15	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	649	n/a
Chloride	EPA 9212	0.01	µg/g	114	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	15.9	n/a
Magnesium	EPA 3050	0.01	µg/g	23.8	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	14.8	n/a
Calcium	EPA 3050	0.01	µg/g	23.2	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.19	n/a
Iron	EPA 3050	0.01	µg/g	0.39	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.79	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.16	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-8
Lab Sample ID	G-2230222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-9
Lab Sample ID	G-2240222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	……	8.32	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	743	n/a
Chloride	EPA 9212	0.01	µg/g	136	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	17.2	n/a
Magnesium	EPA 3050	0.01	µg/g	25.9	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	17.4	n/a
Calcium	EPA 3050	0.01	µg/g	26.8	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.27	n/a
Iron	EPA 3050	0.01	µg/g	0.46	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.01	63
Zinc	EPA 3050	0.01	µg/g	0.63	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.27	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-9
Lab Sample ID	G-2240222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene, ,	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Sample Location	Sample Soil-10
Lab Sample ID	G-2250222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
Hydrogen Value	EPA 9045 D	0.01	……	8.16	8.5
Electric Conductivity	EPA 2510 B	0.1	µS/cm	704	n/a
Chloride	EPA 9212	0.01	µg/g	126	n/a
Boron	EPA 3050	0.01	µg/g	<0.01	3.3
Sodium	EPA 3050	0.01	µg/g	16.6	n/a
Magnesium	EPA 3050	0.01	µg/g	25.2	n/a
Aluminum	EPA 3050	0.1	µg/g	<0.1	n/a
Potassium	EPA 3050	0.01	µg/g	15.8	n/a
Calcium	EPA 3050	0.01	µg/g	24.3	n/a
Chromium	EPA 3050	0.1	µg/g	<0.1	64
Manganese	EPA 3050	0.1	µg/g	1.17	n/a
Iron	EPA 3050	0.01	µg/g	0.49	n/a
Cobalt	EPA 3050	0.1	µg/g	<0.1	20
Nickel	EPA 3050	0.01	µg/g	<0.01	45
Copper	EPA 3050	0.2	µg/g	0.06	63
Zinc	EPA 3050	0.01	µg/g	0.41	200
Arsenic	EPA 3050	0.01	µg/g	<0.01	17
Silver	EPA 3050	0.05	µg/g	<0.05	20
Cadmium	EPA 3050	0.1	µg/g	<0.1	3.8
Barium	EPA 3050	0.1	µg/g	<0.1	750
Mercury	EPA 3050	0.3	µg/g	<0.001	12
Cyanide	EPA 3050	0.01	µg/g	<0.01	0.9
Lead	EPA 3050	0.01	µg/g	<0.01	70
Total Phosphorus	EPA 365.2	0.01	µg/g	1.15	n/a
Total Organic Carbon	EPA 9060	1	µg/g	<1	n/a
Total Petroleum Hydrocarbons (TPH)	USEPA 8260B	50	mg/Kg	<50	n/a
C6 – C10 Fraction	USEPA 8260B	50	mg/Kg	<50	210
C10 - C16 Fraction	USEPA 8260B	50	mg/Kg	<50	150
C16 – C34 Fraction	USEPA 8260B	50	mg/Kg	<50	300
C34 – C50 Fraction	USEPA 8260B	50	mg/Kg	<50	2800
C29 - C36 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a

Sample Location	Sample Soil-10
Lab Sample ID	G-2250222
Sampling Date	16-2-2022

Parameter	Methodology	Limit of Reporting (LOR)	Unit	Result	NCEC Limit
C37 - C40 Fraction	USEPA 8260B	50	mg/Kg	<50	n/a
Polyaromatic Hydrocarbons (PAH)	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.039
Pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.04
Chrysene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[a]anthracene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.083
Benzo[k]fluoranthene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	6.2
Benzo[e]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[a]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	0.6
Indeno[1,2,3-cd]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzo[ghi]pyrene	USEPA SW 846 - 8270B	0.01	mg/Kg	<0.01	n/a
Benzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.078
Toluene	USEPA 8260B	0.01	mg/Kg	<0.01	0.12
Ethylbenzene	USEPA 8260B	0.01	mg/Kg	<0.01	0.14
Xylene (BTEX)	USEPA 8260B	0.01	mg/Kg	<0.01	1.9

Appendix C. Air Quality Assessment

Hourly data of Air Quality 24 hrs monitoring in Point No 1

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind direction (º)	Wind speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOX (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	7:00:00	16.2	56	376.29	6.776	16.9371	62.176	84.21463	20.748	0.433245	0.4617	1.3696	117.9563	35.67369
7/2/2022	8:00:00	19.44	45.92	389.85	7.711	11.73629	53.5456	69.625	24.624	0.70975	0.486	1.4659	112.1047	35.67369
7/2/2022	9:00:00	22.68	36.96	308.49	8.371	8.064741	48.0008	59.925	30.21	0.80563	0.4941	1.5515	100.6068	37.82127
7/2/2022	10:00:00	24.84	30.24	5.65	9.009	7.136091	46.9336	57.82088	29.526	0.953275	0.4617	1.6692	93.21528	38.89506
7/2/2022	11:00:00	27	24.64	5.65	7.854	5.619009	28.9768	36.93538	32.718	1.3481	0.486	1.7976	153.2714	37.94058
7/2/2022	12:00:00	28.08	24.64	123.17	5.049	3.120141	15.834	20.23125	27.018	2.757145	0.4374	1.0272	119.4962	40.08816
7/2/2022	13:00:00	28.08	22.4	335.61	3.696	8.618241	49.9844	62.62088	20.064	0.302345	0.3969	1.2305	170.005	39.73023
7/2/2022	14:00:00	29.16	23.52	323.18	2.959	13.75755	68.15	87.41875	20.064	0.246075	0.3807	1.1449	116.8271	37.82127
7/2/2022	15:00:00	28.08	24.64	343.52	2.497	15.56356	63.394	84.12713	17.67	0.232645	0.4536	1.4017	197.3125	25.89027
7/2/2022	16:00:00	28.08	26.88	331.09	2.024	19.81936	68.1268	93.55	9.918	0.306595	0.4455	2.0972	118.2643	26.00958
7/2/2022	17:00:00	27	30.24	339	1.848	22.73864	71.4676	100.1209	7.752	0.368305	0.4374	2.033	109.1276	29.35026
7/2/2022	18:00:00	24.84	35.84	319.79	2.838	27.08866	73.7064	106.9584	12.312	0.396355	0.4131	2.3433	128.7356	25.0551
7/2/2022	19:00:00	23.76	40.32	282.5	2.277	31.05135	84.2508	122.3375	9.234	0.41888	0.4131	2.033	83.97588	24.69717
7/2/2022	20:00:00	21.6	40.32	211.31	1.199	13.97686	31.378	48.01663	15.276	0.1751	0.4212	2.8569	97.32168	26.36751
7/2/2022	21:00:00	21.6	42.56	167.24	1.595	8.5977	24.6732	35.32288	16.986	0.393125	0.4374	1.6371	94.4472	28.39578
7/2/2022	22:00:00	20.52	45.92	145.77	1.914	14.36431	30.4848	47.44375	12.54	0.388025	0.4536	1.4338	82.43598	32.57163
7/2/2022	23:00:00	19.44	47.04	171.76	3.146	24.55486	62.5704	92.38338	6.612	0.403495	0.4698	1.1877	106.0478	41.51988
7/2/2022	24:00:00	18.36	49.28	154.81	2.574	19.97114	42.0384	65.58963	8.436	0.48365	0.4131	1.2198	180.0656	33.76473

Hourly data of Air Quality 24 hrs monitoring in Point No 1

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind direction (º)	Wind speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOX (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	1:00:00	18.36	50.4	123.17	1.991	12.05806	31.6796	46.38963	7.866	0.57817	0.4131	1.2305	131.6101	30.30474
7/2/2022	2:00:00	18.36	50.4	131.08	2.497	22.6074	46.8988	73.51038	4.56	0.431545	0.4374	1.1342	104.9185	31.25922
7/2/2022	3:00:00	17.28	51.52	133.34	2.618	29.3232	65.3544	100.2229	5.358	0.31195	0.4536	1.1128	138.0777	31.49784
7/2/2022	4:00:00	16.2	53.76	111.87	1.98	23.91526	62.7676	91.94375	6.954	0.343655	0.4374	1.2412	170.6209	28.75371
7/2/2022	5:00:00	15.12	54.88	131.08	1.672	21.16424	70.412	97.38125	7.866	0.386155	0.4374	1.2519	130.4809	32.2137

Hourly data of Air Quality 24 hrs monitoring in Point No. 2

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind Direction (º)	Wind speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOx (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	8:00:00	16.362	56.56	383.8158	6.91152	15.7515	64.66304	76.63531	21.7854	0.411583	0.62305	1.29456	106.404	39.66512
7/2/2022	9:00:00	19.6344	46.3792	397.647	7.86522	10.91475	55.68742	63.35875	25.8552	0.674263	0.5576	1.22496	103.932	42.6994
7/2/2022	10:00:00	22.9068	37.3296	314.6598	8.53842	7.500209	49.92083	54.53175	31.7205	0.765349	0.5882	1.29572	129.3	50.00052
7/2/2022	11:00:00	25.0884	30.5424	5.763	9.18918	6.636565	48.81094	52.617	31.0023	0.905611	0.5593	1.57992	203.448	42.56796
7/2/2022	12:00:00	27.27	24.8864	5.763	8.01108	5.225678	30.13587	33.6112	34.3539	1.280695	0.54655	1.88848	193.164	32.5562
7/2/2022	13:00:00	28.3608	24.8864	125.6334	5.14998	2.901731	16.46736	18.41044	28.3689	2.619288	0.56015	2.43484	165.72	40.26528
7/2/2022	14:00:00	28.3608	22.624	342.3222	3.76992	8.014964	51.98378	56.985	21.0672	0.287228	0.54995	1.93372	223.608	36.10136
7/2/2022	15:00:00	29.4516	23.7552	329.6436	3.01818	12.79452	70.876	79.55106	21.0672	0.233771	0.5848	1.38388	179.64	36.39896
7/2/2022	16:00:00	28.3608	24.8864	350.3904	2.54694	14.47411	65.92976	76.55569	18.5535	0.221013	0.45985	1.80728	134.628	26.23964
7/2/2022	17:00:00	28.3608	27.1488	337.7118	2.06448	18.432	70.85187	85.1305	10.4139	0.291265	0.49385	1.73304	87.408	29.59012
7/2/2022	18:00:00	27.27	30.5424	345.78	1.88496	21.14694	74.3263	91.11002	8.1396	0.34989	0.4998	2.36756	114.336	27.85288
7/2/2022	19:00:00	25.0884	36.1984	326.1858	2.89476	25.19245	76.65466	97.33214	12.9276	0.376537	0.58225	1.33632	87.408	28.00664

Hourly data of Air Quality 24 hrs monitoring in Point No. 2

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind Direction (°)	Wind speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOx (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	20:00:00	23.9976	40.7232	288.15	2.32254	28.87776	87.62083	111.3271	9.6957	0.397936	0.5984	1.2412	219.312	32.50784
7/2/2022	21:00:00	21.816	40.7232	215.5362	1.22298	12.99848	32.63312	43.69513	16.0398	0.166345	0.5576	1.23424	130.992	33.40064
7/2/2022	22:00:00	21.816	42.9856	170.5848	1.6269	7.995861	25.66013	32.14382	17.8353	0.373469	0.5729	1.2412	116.556	40.07308
7/2/2022	23:00:00	20.7252	46.3792	148.6854	1.95228	13.35881	31.70419	43.17381	13.167	0.368624	0.6375	1.25512	153.492	55.73056
7/2/2022	24:00:00	19.6344	47.5104	175.1952	3.20892	22.83602	65.07322	84.06888	6.9426	0.38332	0.7361	2.88376	206.952	37.55216
7/2/2022	1:00:00	18.5436	49.7728	157.9062	2.62548	18.57316	43.71994	59.68656	8.8578	0.459468	0.7752	2.31072	109.008	37.48644
7/2/2022	2:00:00	18.5436	50.904	125.6334	2.03082	11.214	32.94678	42.21456	8.2593	0.549262	0.63155	1.653	208.524	30.81152
7/2/2022	3:00:00	18.5436	50.904	133.7016	2.54694	21.02488	48.77475	66.89445	4.788	0.409968	0.66215	1.61124	168.456	36.22288
7/2/2022	4:00:00	17.4528	52.0352	136.0068	2.67036	27.27058	67.96858	91.20284	5.6259	0.296353	0.5491	1.4152	176.124	36.6916
7/2/2022	5:00:00	16.362	54.2976	114.1074	2.0196	22.24119	65.2783	83.66881	7.3017	0.326472	0.5678	1.40244	200.064	32.59588
7/2/2022	6:00:00	15.2712	55.4288	133.7016	1.70544	19.68274	73.22848	88.61694	8.2593	0.366847	0.5287	1.6414	295.284	29.21812

Hourly data of Air Quality 24 hrs monitoring in Point No. 3

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind Direction (°)	Wind Speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOx (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	7:00:00	16.52562	57.1256	391.492	7.04975	15.43647	62.076518	72.80354	20.91398	0.415699	0.591898	1.268669	117.0444	42.83833
7/2/2022	8:00:00	19.83074	46.842992	405.6	8.022524	10.69646	53.459923	60.19081	24.82099	0.681006	0.52972	1.200461	114.3252	46.11535
7/2/2022	9:00:00	23.13587	37.702896	320.953	8.709188	7.350205	47.923997	51.80516	30.45168	0.773002	0.55879	1.269806	142.23	54.00056
7/2/2022	10:00:00	25.33928	30.847824	91.5	9.372964	6.503834	46.858502	49.98615	29.76221	0.914667	0.531335	1.548322	223.7928	45.9734
7/2/2022	11:00:00	27.5427	25.135264	91.5	8.171302	5.121164	28.930435	31.93064	32.97974	1.293502	0.519223	1.85071	212.4804	35.1607
7/2/2022	12:00:00	28.64441	25.135264	128.146	5.25298	2.843696	15.808666	17.48992	27.23414	2.645481	0.532143	2.386143	182.292	43.4865
7/2/2022	13:00:00	28.64441	22.85024	349.169	3.845318	7.854665	49.904429	54.13575	20.22451	0.2901	0.522453	1.895046	245.9688	38.98947
7/2/2022	14:00:00	29.74612	23.992752	336.236	3.078544	12.53863	68.04096	75.57351	20.22451	0.236109	0.55556	1.356202	197.604	39.31088
7/2/2022	15:00:00	28.64441	25.135264	357.398	2.597879	14.18463	63.29257	72.72791	17.81136	0.223223	0.436858	1.771134	148.0908	28.33881
7/2/2022	16:00:00	28.64441	27.420288	344.466	2.10577	18.06336	68.017795	80.87398	9.997344	0.294178	0.469158	1.698379	96.1488	31.95733
7/2/2022	17:00:00	27.5427	30.847824	352.696	1.922659	20.724	71.353248	86.55452	7.814016	0.353389	0.47481	2.320209	125.7696	30.08111
7/2/2022	18:00:00	25.33928	36.560384	332.71	2.952655	24.6886	73.588474	92.46553	12.4105	0.380302	0.553138	1.309594	96.1488	30.24717
7/2/2022	19:00:00	24.23758	41.130432	293.913	2.368991	28.3002	84.115997	105.7607	9.307872	0.401915	0.56848	1.216376	241.2432	35.10847
7/2/2022	20:00:00	22.03416	41.130432	219.847	1.24744	12.73851	31.327795	41.51037	15.39821	0.168008	0.52972	1.209555	144.0912	36.07269
7/2/2022	21:00:00	22.03416	43.415456	173.996	1.659438	7.835944	24.633725	30.53663	17.12189	0.377204	0.544255	1.216376	128.2116	43.27893
7/2/2022	22:00:00	20.93245	46.842992	151.659	1.991326	13.09163	30.436022	41.01512	12.64032	0.37231	0.605625	1.230018	168.8412	60.189
7/2/2022	23:00:00	19.83074	47.985504	178.699	3.273098	22.3793	62.470291	79.86544	6.664896	0.387153	0.699295	2.826085	227.6472	40.55633
7/2/2022	24:00:00	18.72904	50.270528	161.064	2.67799	18.2017	41.971142	56.70223	8.503488	0.464063	0.73644	2.264506	119.9088	40.48536
7/2/2022	1:00:00	18.72904	51.41304	128.146	2.071436	10.98972	31.628909	40.10383	7.928928	0.554755	0.599973	1.61994	229.3764	33.27644
7/2/2022	2:00:00	18.72904	51.41304	136.376	2.597879	20.60438	46.82376	63.54973	4.59648	0.414068	0.629043	1.579015	185.3016	39.12071
7/2/2022	3:00:00	17.62733	52.555552	138.727	2.723767	26.72517	65.249837	86.6427	5.400864	0.299317	0.521645	1.386896	193.7364	39.62693

Hourly data of Air Quality 24 hrs monitoring in Point No. 3

Date	Time at 24 Hours	Temp (°C)	Humidity (%)	Wind Direction (º)	Wind Speed (m/s)	NO (µg/m3)	NO2 (µg/m3)	NOx (µg/m3)	O3 (µg/m3)	H2S (µg/m3)	CO (µg/m3)	SO2 (µg/m3)	PM10 (µg/m3)	PM 2.5 (µg/m3)
7/2/2022	4:00:00	16.52562	54.840576	116.39	2.059992	21.79637	62.667168	79.48537	7.009632	0.329737	0.53941	1.374391	220.0704	35.20355
7/2/2022	5:00:00	15.42391	55.983088	136.376	1.739549	19.28909	70.299341	84.18609	7.928928	0.370515	0.502265	1.608572	324.8124	31.55557