Project TA No.: 6597-REG

Status: Final

Date: February 2023

Honiara wastewater mains and outfalls

Volume 1: EIA Report

Prepared for Solomon Water

This environmental impact assessment is a document of the borrower. The views expressed herein do not necessarily represent those of the ADB's Board of Directors, Management, or staff, and may be preliminary in nature.

In preparing any country program or strategy, financing any project, or by making any designation of or reference to a particular territory or geographic area in this document, the Asian Development Bank does not intend to make any judgments as to the legal or other status of any territory or area.

INTERNAL. This information is accessible to ADB Management and staff. It may be shared outside ADB with appropriate permission.

Table of Contents

Abbreviations

Executive Summary

1 Introduction 1

1.1 Background to the Subproject 1
1.2 Scope and Objectives of the Study 1

2 Administrative, Legal and Policy Framework 3

2.1 Environmental Legislation and Regulations in Solomon Islands 3
2.1.1 General 3
2.1.2 The Environment Act (1998) 3
2.1.3 Environment Regulation (2008) 4
2.1.4 Environment Impact Assessment Guideline, 2010: 5
2.2 Other Legislation Relevant to the Subproject 7
2.3 International Agreements 10
2.3.1 Regional 10
2.3.2 International - Chemicals, Wastes and Pollution 10
2.3.3 International – Biodiversity 10
2.3.4 International - Climate 11
2.3.5 International – Cultural 11
2.4 ADB Safeguards Policy 11
2.5 World Bank Safeguards Policies 12
2.6 Other Relevant Policies 16
2.6.1 Unexploded Ordnance (UXO). 16
2.6.2 COVID-19 Pandemic Control. 17
2.6.3 Greater Honiara Urban Development Strategy and Action Plan (GHUDSAP) 2018-2035 17
2.7 Guidelines for Fresh and Marine Water Quality 18
2.7.1 Protected Environmental Values 18
2.7.2 Recreational Water Quality – Parameter and Objective Selection 18
2.7.3 Aquatica Ecosystem Protection – Parameter Selection 20
2.7.4 Aquatica Ecosystem Protection – Criteria Quantification 24
2.8 Proposed Classification Foreshore & Water Quality Objectives 29

3 Subproject Description 32

3.1 Subproject Components 32
3.1.1 Subproject Location 32
3.1.2 Pump Stations and Associated Sewer Lines 35

3.1.3 Outfall Design and Construction 50
3.1.4 Equipment, Schedule and Workforce 54
3.2 Hydrodynamic Modelling to Determine Marine Ecological and Microbial Recreational Impacts 54
3.2.1 Background 54
3.2.2 Recreational Water Quality Predictions 57
3.2.3 Nutrient Modelling 65

4 Description of the Existing Environment 81
4.1 Physical Environment 81
4.1.1 Climate and Climate Change 81
4.1.2 Topography 88
4.1.3 Geology 88
4.1.4 Natural Hazards 90
4.1.5 Soils 96
4.1.6 River & Marine Water Quality 97
4.1.7 Air Quality & Noise Levels 110
4.2 Biological Environment 115
4.2.1 Marine Biodiversity 115
4.2.2 Terrestrial Biodiversity 132
4.3 Socio-Economic Environment 153
4.3.1 Population Profile 153
4.3.2 Economic Context 156
4.3.3 Cultural Component 156
4.3.4 Marine Resource Utilization 157
4.3.5 Health and Education Status 159
4.3.6 Land-Use and Settlement Pattern 160
4.3.7 Infrastructure, Services and Built Environment 171
4.4 Socio-Economic Baseline of Subproject Areas 192
4.4.1 Household Information 194
4.4.2 Livelihood, Income and Expenditure 195
4.4.3 Health 203
4.4.4 Marine 204
4.5 Land Use, Ownership and Settlement Pattern 205
4.6 Physical Cultural Resources 208

5 Environmental and Social Impact Assessment 210
5.1 Significance of impacts: 210
5.2 Potential Pre-Construction Impacts and Mitigating Measures 210
5.2.1 General Section 210
5.2.2 Pre-Construction Impacts on Physical Resources 219
5.2.3 Pre-Construction Impacts on Biological Resources 220

5.2.4 Pre-Construction Impacts on Socio-Economic Resources 220
5.3 Potential Construction Impacts and Mitigating Measures 221
5.3.1 Construction Impacts on Physical Resources 222
5.3.2 Construction Impacts on Biological Resources 224
5.3.3 Construction Impacts on Socio-Economic Resources 225
5.4 Potential Operational Impacts and Mitigating Measures 234
5.4.1 Operation Impacts on Physical Resources 234
5.4.2 Operation Impacts on Biological Resources 236
5.4.3 Operation Impacts on Socio-Economic Resources 238
5.5 Summary 240

6 Analysis of Alternatives 242
6.1 Do Nothing/Without Project 242
6.2 Alternative Number of Outfalls and Location Options 243
6.3 Alternatives and Options for Treatment 248

7 Grievance Redress Mechanism 252
7.1 Purpose 252
7.2 Process 252
7.2.1 Stage 1 252
7.2.2 Stage 2 253
7.2.3 Stage 3 253
7.2.4 Miscellaneous 255

8 Environmental and Social Management Plan 257
8.1 Introduction 257
8.2 Institutional Arrangement 257
8.3 Environmental and Social Management Plan 260
8.4 Monitoring and Reporting 276

9 Public Consultation and Participation 283
9.1 Consultations During Feasibility Study Stage 283
9.2 Consultations During Subproject Implementation 284
9.3 Disclosure 285
9.4 Response to MECDM Questions 285
9.4.1 Outfall Route Bathymetry 285
9.4.2 Sea Level Risk Assessment 287
9.4.3 Potential Impacts from Local Rivers on the Outfalls 287
9.4.4 Effects of Littoral Currents, Upwelling and Downwelling. 289

10 Conclusion 291

11 References 293

Figures

Figure 2-1: Procedural Steps of EIA..... 6
Figure 2-2: Comparison of Light and Nutrient Stimulation on Primary Productivity..... 23
Figure 2-3: Proposed Zoning of Marine Microbial Recreational Areas - Water Quality Guidelines (Short Term & Long Term)..... 31
Figure 3-1: Proposed Subproject for Honiara Wastewater..... 34
Figure 3-2: Overview of Honiara Wastewater System – KGVI to Goodwood..... 36
Figure 3-3: Overview of Honiara Wastewater System – Fisheries to Ranadi roundabout..... 37
Figure 3-4: Overview of Honiara Wastewater System – NRH system..... 39
Figure 3-5: Overview of Honiara Wastewater System – Ranadi system..... 42
Figure 3-6: Overview of Honiara Wastewater System – Pump Stations..... 44
Figure 3-7: Proposed Location of NRH Outfall..... 50
Figure 3-8: Proposed Location of Ranadi Outfall..... 51
Figure 3-9: Possible Outfall Construction Methods..... 52
Figure 3-10: UXO Survey report illustration UXO Contacts..... 56
Figure 3-11: Annual Wind Rose and Velocity 2015 to 2018..... 57
Figure 3-12: Current Recreational Water Quality Classification and enterococci Predictions..... 58
Figure 3-13: Predicted Recreational Water Quality Classifications..... 59
Figure 3-14: Outfall Scenario Options..... 60
Figure 3-15: 95 Percentile Indicator Plots for 350 m and 500 m NRH Outfall in 2025..... 60
Figure 3-16: 95 Percentile Indicator Plots for 2025 and 2035..... 61
Figure 3-17: 95 Percentile Indicator Plots for 2050 – No Wastewater Treatment..... 62
Figure 3-18: 95 Percentile Indicator Plots for 2050 –With Wastewater Treatment..... 62
Figure 3-19: Modelling Reporting Locations..... 63
Figure 3-20: Water Quality Objectives Versus Water Quality Predicted..... 64
Figure 3-21: Nitrogen Monthly Maximum Plots - Phase 1B..... 68
Figure 3-22: Phosphorus Monthly Maximum Plots - Phase 1B..... 69
Figure 3-23: Maximum Nutrient Concentration - Phase 1A..... 70
Figure 3-24: Percentage Exceedance N over 200µg/l and P over 25 µg/l - Phase 1A..... 71
Figure 3-25: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 1A..... 72
Figure 3-26: Maximum Nutrient Concentration - Phase 1B..... 73
Figure 3-27: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 1B..... 74
Figure 3-28: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 1B..... 75
Figure 3-29: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 2..... 76

Figure 3-30: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 2 77
Figure 3-31: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 3 78
Figure 3-32: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 3 79
Figure 4-1: Monthly Average Minimum and Maximum Temperature - Honiara (2021) 81
Figure 4-2: Percentile Rainfall Distributions of Annual, Dry Season and Wet Season Rainfall for Honiara and Henderson Stations 82
Figure 4-3: Annual Rainfall for Honiara from 1962 to 2011 82
Figure 4--4: El Nino Southern Oscillation 83
Figure 4-5: Past and Projected Sea Level of Solomon Islands 85
Figure 4-6: Geological Map of Immediate Honiara Area 90
Figure 4-7: Major Natural Hazards in Asia and the Pacific 91
Figure 4-8: Land Projected to be Below Annual Flood Level in 2050 92
Figure 4-9: Honiara City Council Wards and Outfall/PS sites exposure to natural hazards. 93
Figure 4-10: Solomon Islands Exposure to Earthquakes 94
Figure 4-11: Tropical Cyclone Pathway in Solomon Islands 95
Figure 4-12: Volcanoes in the Vicinity of Solomon Islands and Papua New Guinea. 96
Figure 4-13: CEFAS Sampling Locations 98
Figure 4-14: 2019 Honiara Foreshore Water Sampling Points 100
Figure 4-15: Location Map of proposed locations (1 to 6) of Noise Level reading and subsequent Monitoring of the subproject area of influence 111
Figure 4-16: Location Map of proposed locations (7 to 10) of Noise Level reading and subsequent Monitoring of the subproject area of influence 114
Figure 4-17: Marine Assessment Survey Sites at the Proposed NRH Site 119
Figure 4-18: Marine Assessment Survey Sites at the Proposed Ranadi Site. 119
Figure 4-19: Vegetation Type Along the Pipeline Route from Point Cruz-Chinatown – Ranadi Landfill Site 137
Figure 4-20: Vegetation Type at NRH sites 139
Figure 4-21: Vegetation near Proposed Ranadi Outfall 142
Figure 4-22: Areas of Freshwater Endemism in Solomon Islands. 145
Figure 4-23: Marine Protected Areas in Solomon Islands 151
Figure 4-24: Community Marine Managed Areas in Solomon Islands 152
Figure 4-25: Community Marine Managed Areas in Guadalcanal 153
Figure 4-26: Honiara Administrative Wards 154
Figure 4-27: Fishing Grounds for Fishers from Fishing Village. 158
Figure 4-28: Site of Church Land Required 161

Figure 4-29: Western Section of Sewerage Lines 162
Figure 4-30: Part A- Connections from Tuvaruhu to Vara Creek PS. 165
Figure 4-31: Part B - Connections from Tuvaruhu to Vara Creek PS. 166
Figure 4-32: Overall Eastern Section Connection 168
Figure 4-33: Honiara International Airport in relation to the Ranadi Outfall 171
Figure 4-34: Honiara International Seaport in relation to NRH Outfall 172
Figure 4-35: Honiara Main Highway 173
Figure 4-36: Recent Kukum Upgrading Works 174
Figure 4-37: Location Map of Traffic Count Stations 175
Figure 4-38:: Primary Water Supply Source 176
Figure 4-39: HH Accessing Water Sources 177
Figure 4-40: Overview of Honiara Wastewater System 179
Figure 4-41: Existing Outfall Locations 182
Figure 4-42: Sanitation Status of the HHs Surveyed 186
Figure 4-43: Septic Tanks Being Emptied 187
Figure 4-44: Households Accessing Power 190
Figure 4-45: Hospital and Clinics within the Subproject Area 192
Figure 4-46: Socio-economic Survey Communities along the Honiara Coastal Strip. 193
Figure 4-47: Household Head is the Respondent 194
Figure 4-48: Type of Dwelling Structure for the Surveyed Area 195
Figure 4-49: Dwelling Owners 195
Figure 4-50: Percentage of Enumeration Area Population less than 15 Years Old 198
Figure 4-51: HH Works for Salary 199
Figure 4-52: Household Head working for Salary 199
Figure 4-53: Total Household Members Working for Salary 200
Figure 4-54: Income Source Activities 200
Figure 4-55: Main Expenses 201
Figure 4-56: Average Monthly Income and Expenditure 202
Figure 4-57: Households able to Save Income 203
Figure 4-58: Incidence of Disease in Past 6 months by HHs 203
Figure 4-59: HH Responses to Coastal Activities 204
Figure 4-60: Effects of Activities along the Coast 205
Figure 4-61: Honiara Coastal Landform 207
Figure 5-1: UXO Surveys for NRH and Ranadi Outfalls 218
Figure 5-2: Impact of Sea Level Change + Cyclonic Wave Action at 2090 (RCP 8.5) 219

Figure 6-1: Current Water Quality Classification 242
Figure 6-2: Outfall Options NPV Comparison 247
Figure 7-1: Grievance Redress Mechanism 255
Figure 9-1: NRH Outfall Bathymetry 286
Figure 9-2: Ranadi Outfall Bathymetry 287

Tables

Table 2-1: World Bank Safeguard Policies: Main Objectives, Applicability and Triggered by the Subproject 13
Table 2-2: Programs and actions to address and achieve Strategic Goal 3. 18
Table 2-3: Water Quality Guidelines for Recreational Water (ANZECC Guidelines 2000) 19
Table 2-4: Water Quality Guidelines for Australian Recreational Water Quality Guidelines (2018) 19
Table 2-5: Levels of Aquatic Ecosystem Condition 26
Table 2-6: Water Quality Guidelines Summary 28
Table 3-1: NRH Gravity Pipework Stages 38
Table 3-2: Ranadi Gravity Pipework Stages 40
Table 3-3: Overflow Lengths and Diameters 43
Table 3-4: Rising Mains and Outfalls 43
Table 3-5: Proposed Pump Stations - Dimensions and Capacities 46
Table 3-6: Pump Station Environmental Aspects 47
Table 3-7: Water Quality Objectives Versus Water Quality Predicted for NRH Outfall Options Only 61
Table 3-8: Water Quality Objectives Versus Water Quality Predicted 64
Table 3-9: Flow rate and concentration for discharge scenarios 66
Table 4-1: Extreme Seasonal Low Rainfall for Honiara 83
Table 4-2: Projected Changes of Average Annual and Seasonal Rainfall in Honiara 86
Table 4-3: Historical Extreme RIDF Event and Projected Change for 2050 86
Table 4-4:: Extreme Monthly Rainfall for 2050 and 2100 (mm) 87
Table 4-5: Stratigraphic Classification of Honiara City Area 89
Table 4-6: 2019 Water Quality Monitoring Results 101
Table 4-7: 2022 Survey Sampling Locations And Procedures 104
Table 4-8: 2022 Water Quality Survey Sample Results – water samples 105
Table 4-9: 2022 Water Quality Survey Sample Results – Wastewater Samples 106
Table 4-10: Proposed locations for noise level reading and subsequent monitoring at Western Section of the subproject area of Influence. 111

Table 4-11:* Proposed locations for noise level reading and subsequent monitoring at Eastern Section of the subproject area of Influence. 113
Table 4-12: Key Marine Benthic Biodiversity Conservation and Sustainable Natural Resource Management Status 131
Table 4-13:Terrestrial Protected Areas 151
Table 4-14: Summary of Demographics (Solomon Island's Population Census) 155
Table 4-15: Ward Populations 155
Table 4-16: Honiara Western Section Connections 163
Table 4-17: Eastern Section Land Status 169
Table 4-18: Future Traffic Volume (2013-2033), Passenger Car Unit PCU/day 174
Table 4-19: Existing Wastewater Flows (l/s) 177
Table 4-20: Summary of Existing Coastal Outfalls 181
Table 4-21: Area and Sample Population for the Survey 193
Table 4-22: Summary of the Total Population 194
Table 5-1: Bedding Material Requirements – Sample Calculation 216
Table 5-2: Summary of Quarry Material Requirements 216
Table 5-3: Climate-Proofing Measures for Wastewater Subproject 220
Table 5-4: Sensitive Receptors in relation to Pump Stations 221
Table 6-1: Initial Outfall Combination Options 244
Table 6-2: Outfall Combinations and Preliminary Costings 245
Table 6-3: Detailed Costings for Outfall Combinations (USDM) 246
Table: 6-4: Comparison of NRH Outfall Lengths 248
Table: 6-5: CAPEX estimates (USD) for each treatment scenario 249
Table 8-1: Summary of Environmental and Social Management Responsibilities for the Subproject .. 258
Table 8-2: Environmental and Social Management Plan for Pumping Stations, Associated Sewer Lines and Outfalls Subproject 261
Table 8-3: Environmental Monitoring Plan for Sewer Pumping Stations and Associated Sewer Lines Subproject 277
Table 8-4: Environmental Monitoring Plan for Outfall Construction Subproject 280
Table 9-1: Consultation Summary 283

Plates

Plate 2-1: Red Tide in the Marine Environment 22
Plate 4-1: Foreshore Reclamation East of the Proposed Ranadi outfall (including Solfish infrastructure and vessel mooring sites). 120

Plate 4-2: Foreshore Reclamation West of the Proposed Ranadi outfall. 121
Plate 4-3: (a) Landfill Facility; (b and c) Location of Sand Removed from the stream; (d) Shipwrecks to the east of the proposed Ranadi outfall pipeline..... 122
Plate 4-4: Foreshore directly adjacent to the Proposed Ranadi outfall. 123
Plate 4-5: Benthic Substrate associated with the Proposed Ranadi Outfall. 124
Plate 4-6: Coastal Reclamation to the East (a and b) and West (c and d) of the Proposed NRH Outfall. 126
Plate 4-7: Foreshore Environments Adjacent to the Proposed NRH outfall. 127
Plate 4-8: Turbidity in Shallow Water Environments during Reclamation adjacent to the Proposed NRH outfall. 128
Plate 4-9: Benthic Substrate associated with the Proposed NRH outfall. 129
Plate 4-10:Typical Secondary Vegetation found along the Pipeline Route: (a)Vara Creek (b) Chinatown (c) NRH (d) Kukum (c) Ranadi (d) Ranadi Landfill. 135
Plate 4-11: Typical vegetation found at the PS Sites : (a) Market PS (b) NRH PS (c) Ranadi PS (d) Vara Creek (e) Ranadi Landfill PS (f) Naha PS 138
Plate 4-12: Vegetation near the NRH Outfall Site..... 140
Plate 4-13: Vegetation near the Proposed Ranadi Outfall 141
Plate 4-14 :Terrestrial Fauna Observed at the NRH PS Site 144
Plate 4-15: Typical Riparian Vegetation at Tuvaruhu, Lower Section of Mataniko River..... 146
Plate 4-16: Aquatic Flora and Algal Blooms at Upper Mataniko Bridge and Estuarine Flora at Lower Mataniko Bridge, China Town. 147
Plate 4-17: Freshwater Fauna Species found at Tuvaruhu, Mataniko River 148
Plate 4-18: Vara Creek Junction with Mataniko River. 148
Plate 4-19: Kukum Creek, Naha PS Site..... 149
Plate 4-20: Burns Creek Stream, Ranadi Landfill Site 149
Plate 4-21: Existing Pumping Stations at Point Cruz and King George VI School 180
Plate 4-22: Ranadi TGA Outfall..... 183
Plate 4-23: Tuvaruhu Discharge 183
Plate 4-24: NRH Foreshore Reclamation 184
Plate 4-25: NRH Outfall Pipe Inside Reclamation Area 185
Plate 4-26: Plastic Waste along the Honiara Coastline 188
Plate 4-27: Shipwreck Leaking Oil at Ranadi 189
Plate 5-1: Typical Quarrying Activities on Lungga River. 217

Contents of Volume 2: EIS Appendices

Appendix 1: Terms of Reference.

Appendix 2: International and Regional Agreements

Appendix 3: COVID-19 Controls.

Appendix 4: Updated Marine Impact Study, May 2021

Appendix 5: Honiara Outfalls Note to SW, October 2021

Appendix 6: Dispersion Modelling of Nutrients in Honiara, Solomon Islands, 2022

Appendix 7: 2019 Water Quality Monitoring Results

Appendix 8: 2022 Water Quality Monitoring Results

Appendix 9: Marine Ecological Assessment

Appendix 10:Terrestrial Ecological Assessment

Appendix 11: Red List - Globally Threatened Avifauna in the Solomon Islands.

Appendix 12: Areas of Freshwater and Species Endemism in the Solomon Islands

Appendix 13: List of Terrestrial Protected Areas within the Solomon Islands

Appendix 14: List of Marine Protected Areas within the Solomon Islands.

Appendix 15: Household Survey Report

Appendix 16: UXO Study Area, Honiara 2020.

Appendix 17: Grievance Redress Forms

Appendix 18: Records of Public Consultation and Participation.

Abbreviations

ADB	Asian Development Bank
aMSL	Above Mean Sea Level
ANZ	Australian and New Zealand
AXO	Abandoned Explosive Ordnance
BCD	Bid and Contact Documents
BMP	Building Materials Permit
BOD	Biochemical Oxygen Demand
CAC	Community Advisory Committee
CCP	Communications and Consultation Plan
CESMP	Construction Environmental and Social Management Plan
CITES	Convention on International Trade in Endangered Species
CoC	Code of Conduct
CoL	Commissioner of Land
CLO	Community Liaison Officer
CSHSMP	Construction Site Health and Safety Management Plan
CSS	Country Safeguard System
CST	Community Septic Tank
DC	Development Consent
DN	Diameter Nominal
DED	Detailed Engineering Design
DMA	District Metered Areas
EARF	Environmental Assessment and Review Framework
ECD	Environment Conservation Division
EDS	Environmental Impact Assessment Decision Statement
EHSG	Environment, Health and Safety Guidelines

EHSO	Environment, Health and Safety Officer
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement (under the CSS)
EMoP	Environmental Monitoring Plan
ERW	Explosive Remnants of War
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESO	Environmental Safeguards Officer (in the PMU)
FGD	Focus Group Discussion
FOG	Fat, Oil and Grease
GRM	Grievance Redress Mechanism
GBV	Gender Based Violence
GI	Gastrointestinal Infection
HCC	Honiara City Council
HDPE	High Density Polyethylene
HSP	Health and Safety Plan
IEE	Initial Environmental Examination
IP	Indigenous People
IPP	Indigenous Peoples Plan
IPPF	Indigenous Peoples Planning Framework
ISDS	Integrated Safeguards Data Sheet
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
LARP	Land Acquisition and Resettlement Plan
MDAPC	Ministry of Development Planning and Aid Coordination
MECDM	Min. of Environment, Climate Change, Disaster Management and Meteorology

MID	Ministry of Infrastructure Development
MLD	Million liters per day
MMERE	Ministry of Mines, Energy and Rural Electrification
MOFT	Ministry of Finance and Treasury
N	Nitrogen
NDS	National Development Strategy
NRH	National Referral Hospital
P	Phosphorus
PCCSP	Pacific Climate Change Science Program
PER	Public Environment Report
PMU	Project Management Unit (in SW)
POP	Persistent Organic Pollutant
PPE	Personal Protective Equipment
PVC	Poly-Vinyl Chloride
RAP	Resettlement Action Plan
RF	Resettlement Framework
RP	Resettlement Plan
ROW	Right of Way
SBD	Solomon Island Dollars (code)
SCADA	Supervisory Control and Data Acquisition
SIPA	Solomon Island's Port Authority
SPM	Safeguards Procedural Manual of Ministry of Infrastructure Development
SPS	Safeguard Policy Statement 2009
SW	Solomon Islands Water Authority trading as Solomon Water
TOR	Terms of Reference
UWSSSP	Urban Water Supply and Sanitation Sector Project

UXO	Unexploded Ordnance
WASH	Water Awareness, Sanitation and Health
WB	World Bank
WBSP	World Bank Safeguard Policies
WHO	World Health Organization
WSP	Water Safety Plan
WTP	Water Treatment Plant

Executive Summary

1. The Asian Development Bank (ADB) and World Bank (WB) are supporting the Government of Solomon Islands (the government) to develop the Solomon Islands Urban Water Supply and Sanitation Sector Project (UWSSSP). This subproject aims to improve access to safe water and improved sanitation in urban and peri-urban areas by implementing high-priority components of the Solomon Water (SW) 30-Year Strategic Plan and 5-Year Action Plan. Project outputs include secure and safe urban water supplies; effective, efficient and safe urban sanitation services; enhanced awareness of hygiene and water issues and sustained improved hygiene behavior; and the financial and technical sustainability of SW, the state-owned enterprise responsible for the management and development of urban water resources and sewerage services in the Solomon Islands.

2. This Environmental Impact Statement (EIS) has been carried out for the subproject under the requirements of the Asian Development Bank (ADB) Safeguard Policy Statement 2009 (SPS) and the country safeguard system (CSS) of the Solomon Islands including environmental and social legislation and development consent procedures. Due to the very limited impact of the subproject on areas of aquatic and terrestrial habitat, ADB has determined that the subproject is Category B for environment, as per the SPS.

3. The EIS is to complete the required environmental due diligence for the Honiara wastewater mains component including outfalls. Given that the subproject will impact both terrestrial and marine environments, the Environment and Conservation Department (ECD) require that an environmental impact statement (EIS) be prepared. The objective of this assignment was to develop an EIS for the Honiara wastewater mains component of the subproject undertaken in accordance with Solomon Islands' country safeguard system (CSS) including the Environmental Act 1998 ad Environment Regulations 2008 and specific requirements of ECD (Attachments 1 and 2), ADB Safeguard Policy Statement 2009 (SPS) and WB safeguard policies which will address inter alia: (i) modified, natural and critical habitat; (ii) operation risks and impacts including discharge loads, suspended plume and modeling results; (iii) risks and impacts during construction activities; (iv) effects on coastal processes as a result of outfalls; (v) socio-economic issues including health impacts and benefits and occupational health and safety; (v) climate change; (vi) physical cultural resources; (vii) analysis of alternatives; and (viii) the sewer upgrading packages as associated facilities. The EIS covers the following outfall scenarios: 1) National Referral Hospital (NRH) only. 2) Ranadi only, and 3) NRH and Ranadi.

4. **Categorization:** The subproject is classified as Category B in accordance with the SPS, as the subproject's potential adverse environmental impacts are site-specific, few if any of them are irreversible, and mitigation measures can be designed readily to ensure potential impacts are avoided or minimised to acceptable levels

5. **Subproject Description**: The wastewater subproject covered in this EIS and to be financed under UWSSSP include wastewater Pump Stations (PS), associated pressure and gravity sewer mains, and ocean outfall construction. As a result of the topographical survey and staging to minimize costs, the system has been divided into two systems (the NRH system covering the West, and the Ranadi system covering the East). This will include the laying of approximately 15.0 km of pipes split between gravity mains (12.6 km) and rising mains (2.4 km), relocation and closure of the existing Point Cruz Pump Station (PS) and the construction of 4 small PS. It will include the construction of two outfall

PSs (PS NRH and PS Ranadi Outfall) that will pump the effluent into the ocean through two outfall pipes.

6. The subproject is planned in 4 phases; Phase 0 (2023) - Industrial area between KGVI school and Goodwood industry; Phase 1A (2025): - NRH catchment; Phase 1B (2030) - Ranadi catchment; Phase 2 (2035) -: an additional 127ha of sub-catchments are connected to the network; and Phase 3 (2050 - collect all wastewater to a single outfall at Ranadi Landfill PS.

7. This will allow decommissioning most of the current 17 outfalls, many of which discharge onto the foreshore or river beds. There will be two new purpose-built ocean outfalls, and retention of two recently extended outfalls at Rove and Naha. All existing outfalls discharge either untreated wastewater or have a component of septic tank effluent.

8. Apart from fine screening, wastewater treatment will initially not be provided. However sufficient land has been obtained to allow future installation of wastewater treatment if ongoing monitoring indicates this is necessary. Wastewater treatment will cost over US$6 million[1] because land availability is very limited, and therefore higher technology and more expensive treatment options are necessary. Low technology, lower cost options such as lagoons or reedbeds require too much land. Detailed modelling confirms that the upgrading of the collection network and reducing the number of short outfalls will significantly improve upon the current baseline conditions, in terms of both bathing water quality and environmental aspects.

9. All six PSs are fitted with standby pumps that will automatically start if the duty pumps fail to start or cannot pump at a rate sufficient to lower the wastewater level in the wet well. This is desirable at all PSs as it reduces the risk of overflows from the network.

10. Standby power generation is to be provided permanently at the two outfall PSs and by using portable generators at the other four smaller PSs, as and when required. Both the permanent and portable standby generators will have fuel cells contained within the generator chassis. Therefore there will be no need to have a separate fuel tank or a tank farm at any of the PSs. This obviates the need for special bunding and other hardstand requirements as for a dedicated fuel storage facility.

11. A controlled outlet (called an overflow) is to be provided either at the PS wet well or at an upstream manhole in all catchments. This means that any overflows or surcharges from the network are managed in a controlled manner, usually directing flows to local drains or watercourses, rather than surcharging manholes throughout the sewer catchment and introducing health risks to the community.

12. **Implementation Arrangements:** The Asian Development Bank (ADB), World Bank (WB), and European Union (EU) are providing loans, grants and design advances to the Government of Solomon Islands (the government) to implement the Urban Water Supply and Sanitation Sector Project (UWSSSP). The UWSSSP will be implemented from November 2019 to June 2027 and will increase access to safe water and improved sanitation in urban areas. Solomon Water (SW) is the implementing agency and has established a project management unit (PMU) to deliver the project.

13. **Policy, Legal and Administrative Framework:** The subproject will comply with the requirements of the Solomon Island Environment Act 1998 and The Environment Regulations 2008 which require that development consent must be obtained from ECD. The development consent application will be in accordance with the Environment Regulations 2008 and associated guidelines. In the case of the

[1] Suez Design Report Update, 2019

proposed UWSSSP sewerage subproject, a Public Environmental Report will be required to be submitted to obtain development consent. The subproject will also comply with the requirements of ADB's SPS which amongst other things require compliance with the World Bank Group's (WB) Environmental Health and Safety Guidelines (EHSG).

14. **Bacteriological and Nutrient Modelling:** The final outfall combination modelled is a 350 m long outfall at NRH discharging into more than 10 m of water, and a 500 m long outfall at Ranadi discharging into more than 40 m of water.

15. The bacteriological objective in the long-term is to classify the Point Cruz coast as Class A [2]for swimming; the coast from Mataniko Riverbank to Ranadi Landfill as Class B for nautical activities, and the area around Ranadi landfill as Class C for limited recreational activities because of the presence of industries. Currently, the foreshore between Point Cruz and Ranadi is all Class D, which makes it unsafe for all recreational water pursuits. The proposal is between 2025 and 2050 to have Class B around Point Cruz, Class C along the foreshore and then Class D around Ranadi industrial areas. For 2050, it will be Class A around point Cruz point, Class B be between point Cruz and Ranadi, and Class C around Ranadi industrial area.

16. Based on the modelling results, the proposed outfall scenarios exceed these water quality bacteriological objectives for all phases at all locations, with just one area failing to meet the objectives in the first phase (2025 to 2050) only. This location near the NRH hospital only meets the water quality objectives 10% of the time, but just in this first phase. This level of exceedance was considered acceptable based on community meetings, and the fact there is significant ongoing reclamation at NRH which essentially precludes access to the beach either through installation of further rock revetments or the actual fencing off of old access paths.

17. The same model was used for the nutrient modelling, but with different input concentrations and decay rates.

18. The results show plumes with a maximum concentration around the outfalls as expected, and a dispersion pattern essentially from East to West paralleling the shoreline. Maps of maximum concentration indicate an extensive plume for some scenarios, but these plots represent instantaneous status. The ecosystem may not have sufficient time to respond to such short nutrient elevations.

19. Overall, as expected, higher concentrations are associated with the NRH outfall which is located in shallower waters compared with Ranadi. At Ranadi, the depth of the water column allows greater initial dilution of the plume and consequently lower surface concentrations of nutrients. The plumes from the two outfalls can intermix in some situations, for example, for Phosphorus in Phase 2. Nutrient modelling indicates good compliance will be achieved with the adopted water quality objectives overall.

20. **Description of the Existing Environment:** The existing environment is described initially through reference to climate and climate change, topography, geology, soils and natural hazards including flooding, cyclones, earthquakes and volcanoes. Since much of the infrastructure is to be located close to the shoreline or in the marine environment, the impact of these events on the infrastructure has been addressed in the EIS.

[2] Australian and New Zealand Environment and Conservation Council. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - National Water Quality Management Strategy

21. **Current Water Quality:** There is a paucity of historical water quality data for the local riverine and marine systems. Single water quality surveys were conducted in 2019 and 2022 to supplement the historical dataset. Water quality is poor in the lower reaches of the river, and even the uppermost sampling sites above most catchment development still recorded pathogen indicators being present. Dissolved oxygen concentrations approach zero in some river reaches based on one survey. In the marine environment, dissolved oxygen concentrations and turbidity satisfy the adopted water quality guidelines. Selected persistent organic pollutants (POPs) were analysed between 2017 and 2019 including pesticides, Polycyclic Aromatic Hydrocarbons (PAH) and Poly-Chlorinated Biphenyls (PCB) concentrations. Comparing results for specific parameters with those quantified in the guidelines indicated that all the POPs were below the ANZECC 2000 trigger levels. Eight heavy metals were analysed in the water column during the 2022 sampling. Only lead and zinc exceeded the detection limits, and then only along the two outfall routes. Given that the higher concentrations were well offshore, this may indicate that the lead and zinc sources are from shipping maintenance and repair activities rather than domestic wastewater flows. Metals concentrations in the two domestic wastewater samples were low. Nutrient levels along the foreshore exceed the water quality objectives in some locations, especially when close to an existing domestic wastewater outfall.

22. Concluding, water quality within the Mataniko River system is significantly impacted; marine water quality close to the existing sewage outfalls is exhibiting elevated concentrations of nutrients and pathogen indicators; the majority of the offshore waters are relatively uncontaminated apart from some isolated heavy metal and *enterococci* readings with POPs being low, and oxygen concentrations remain acceptable. This confirms a need to remove wastewater currently entering the foreshore areas to improve recreational water quality as well as protect local ecosystems.

23. **Marine Assessment:** A marine biological baseline assessment was undertaken on the coastal and marine biomes associated with both the intertidal and shallow subtidal marine habitats and benthic substrate within and surrounding the two proposed outfall pipeline sites. The marine benthic substrate associated with the two proposed outfall sites is impacted by its environmental characteristics and past extensive foreshore and intertidal reclamation activities, leading to silt and sand substrate. The marine benthic habitat within the proposed areas has very low marine biodiversity and can be considered to have a very low ecological habitat and value. There was a paucity of sessile benthic invertebrate species and no coral reef systems located at either proposed outfall site. Mobile invertebrates' abundance and diversity were very low at both sites. Mobile vertebrates, including finfish, were recorded in very low population and species numbers - there was a noticeable lack of predatory finfish at both proposed site locations. Marine sea weed diversity and population densities were very low throughout the entire area assessed and two small, isolated sea grass patches were located to the east of the NRH site well outside the subproject's indirect area of influence (200 plus m). No mangrove trees were recorded within the subproject's direct and/or indirect area of influence at both sites. All marine sites have a very low biodiversity and paucity of benthic sessile and sedentary flora and fauna.

24. **Critical Habitats.** There are no critical foreshore or marine habitats associated with the subproject area of influence. The subproject natural foreshore and shallow water marine areas at both outfall site locations have previously been significantly modified and disturbed by numerous levels of development including extensive shoreline reclamation and associated infrastructure developments resulting in a high degree of habitat conversion, alteration and degradation. There were no national, regional or global importance species or habitats of conservation importance nor threated or endangered species located at either proposed outfall site.

25. Field observations within the subproject area of influence did not record any threatened, endemic or endangered species within the subproject area of influence.

26. **Protected Areas:** There are no marine or coastal designated marine protected areas or areas of significant biodiversity within or in close proximity to the proposed outfall sites. Nor does the area possess any sites of cultural, customary or heritage significance nor any national or international endangered, endemic or protected species within and adjacent to the proposed area of influence.

27. **Terrestrial assessment:** The natural vegetation associated with the subproject area of influence has been highly modified by urban development and bears little resemblance to the original natural vegetation and terrestrial ecosystem. The vegetation is composed of scattered and degraded lowland forest and coastal vegetation. Significant settlements are located along the narrow coastal land strip, where the land is relatively flat before the fringing ridges and hills. Urban developments and City expansions are confined to the coastal zones because of land ownership issues.

28. The gravity and rising mains are located within the road corridor in the subproject boundaries along Mendana Avenue, China Town, Kukum Highway and Ranadi. Vegetation along the pipeline corridor is secondary regrowth as it was previously cleared with no traces of original flora present. The vegetation recorded along the mains route has no significant value and no threatened or endangered flora was recorded.

29. At the PS sites, the surrounding vegetation is secondary regrowth. The vegetation on the PS sites has been previously cleared for development expansions such as community halls, port jetties, land reclamations for roads and additional land for development. The majority of the vegetation that occurs on the sites is highly tolerant to disturbance and no threatened or endangered flora species were present

30. At the subproject sites, much of the vegetation has been degraded and modified with non-native trees and invasive grasses and vines dominating, whilst the quality of habitats and ecological functions are consequently on the decline and this determined the species composition, abundance and distribution of fauna. The water bodies within the sites are highly polluted and this minimizes the ecosystem's capacity to fully support aquatic wildlife. The sandy shorelines along the NRH site have been significantly altered and disturbed with ongoing reclamation activities and, as such, minimizes the presence of organisms that burrow in sand to even survive. This is also the same for the sandy shores at the Ranadi site.

31. The terrestrial habitats found within the subproject area of influence at each PS and Outfall sites still provide habitation for birds, reptiles/lizards, amphibians, domesticated animals and other vertebrates. Domesticated animals found in communities along the subproject sites include dogs, cats, rats, chickens and pigs. Other fauna observed habiting the waterways along the subproject area of influence include many unidentified species of insects (grasshoppers, moths, beetles and dragonflies and including some fish species.

32. **Freshwater (Riparian) ecology:** Freshwater habitats at the upper catchment of Mataniko River are dominated by riparian plants distributed along the riverbanks and the flood plains. Much of the vegetation is still intact despite being threatened by anthropogenic activities and expanding human settlements. The riparian vegetation at the upper catchment includes herbs, ferns, palms and trees.

33. The lower sections of the Mataniko River, specifically at Tuvaruhu and Vara Creek, lack any habitats suitable for significant aquatic flora and fauna as these areas were highly disturbed by anthropogenic activities such as settlement, farming and waste disposal (sewage, household wastes etc.) and have altered the water quality and aquatic flora and fauna composition.

34. Despite the river being very polluted and disturbed, freshwater fauna are habiting the aquatic environment. The freshwater species live and spawn in the rivers and larvae drift to the ocean to live as pelagic/oceanic marine larvae before returning to freshwater as juveniles to mature.

35. **Critical Habitats**: There are no critical terrestrial habitats associated with the subproject area of influence. The subproject area of influence has previously been highly modified and natural habitats have been significantly disturbed by numerous levels of development including settlement, infrastructure development and town expansion, resulting in a high degree of habitat conversion, alteration, degradation and loss. Flora and fauna found habiting the modified environment have adapted and tolerate these disturbances.

36. Field observations along the subproject area of influence did not show any significant wildlife species and endemic or endangered species within the subproject area of influence, and no significant habitats remain in the area as it has already been developed and is highly disturbed.

37. **Protected Areas**: There are no terrestrial protected and conservation areas or critical habitats within the vicinity of the subproject area of influence that would be affected by the proposed development.

38. **Socio-economic Environment**: Details have been established by both desktop reviews, and interviews. The estimated population of Guadalcanal in 2018 was 145,000. Based on the estimation, the population of Honiara is 86,529, with the highest number of citizens aged less than 15 years. Solomon Island's per-capita gross domestic product of US$600 ranks it as a lesser-developed nation, and more than 75% of its labor force is engaged in subsistence and fishing.

39. **Health**: The Ministry of Health and Medical Services is the key health provider in the Solomon Islands. Health services are concentrated in urban centers with a hierarchy of facilities available ranging from nurse aide posts and rural clinics to the National Referral Hospital. There is no specific data on causes of death but communicable diseases including malaria and tuberculosis are important health issues. The increasing prevalence of obesity due to lifestyle, diabetes, hypertension and tobacco and alcohol use has increased the rate of non-communicable diseases which will soon overtake communicable diseases as the leading burden of disease. The most common illness associated with recreational activities in sewage-contaminated water is a 24-hour gastrointestinal event caused by the Norwalk type A virus. These sorts of illnesses are often not reported to the health authorities, or if they are, are often misdiagnosed as being associated with contaminated drinking water, community spread or food poisoning.

40. **Land use:** Ownership and Settlement Patterns: Most land (86%) in the Solomon Islands is still held under customary tenure, where every member of the landholding entity, such as tribal, clan or family is vested with the rights to use and access it. Non-owners usually have limited rights such as right of use, easement or right of way. There is no system which allows for customary land to be surveyed and registered, it is often very difficult for outsiders to identify land boundaries and to identify who 'owns' the customary land.

41. Approximately 35 percent of Honiara residents (22,600 persons) live in informal settlements

42. Land is actively being reclaimed along the foreshore in numerous locations. For example, in front of the NRH hospital, reclamation is ongoing, even though this activity has not been approved or permitted by MECDM as yet. The ownership and legality of this reclamation are being tested in the courts at present but may be an issue for the NRH outfall construction and ongoing maintenance access.

43. **Infrastructure, Services and Built Environment**: These elements include road networks, water supply, wastewater connections and catchments, solid waste management, electricity, information and communication technology and health services. Of most relevance to this EIS, the existing wastewater system services only some 15% of the total Honiara population. Some residents have septic tank systems but without the requisite infiltration trenches or beds, and many discharge direct to local watercourses. There are also large areas that still use basic earth closets or pit toilets. Effluent from the community septic tanks is discharged through a series of short outfalls. Some 14 coastal outfalls will be phased out and two inland outfalls. Rove and Naha outfalls were recently extended by SW and will be retained. The other outfalls discharge directly onto the beach or into the surf zone, or onto the watercourse bed for those inland. Reclamation activities are also re-routing some of these outfalls by extending them to discharge through the new seawalls.

44. **Socio-economic baseline**: A number of socio-economic surveys were already conducted around the subproject sites; these consisted of household surveys during the development of the feasibility study report (FSR) and additional surveys undertaken during the detailed design phase. For the EIS, 200 households within the communities currently residing along the coast of Honiara from Ranadi (eastern end) to White River (western end) were surveyed. Topics included gender representation, dwelling permanency, income basis, expenses, water and electricity supply, sanitation services health issues, access to shorelines and marine harvesting.

45. Detailed household information was collected from a survey including the following:

- only 23% of the households are female-headed.
- 55% of the dwelling structures are permanent
- 56% work for a salary and most of those are government-related employment
- other sources of income are dominated by selling of betel nut and cigarettes
- household main expenses have been broken down into education, electricity, clothing, medical, gas/firewood, loan repayment, transport, telephone and customs or church obligations.
- Electricity is provided by a mix of the National Grid, solar power or a generator
- most households connect to the SW reticulation with others using rainwater tanks, water vendor supply, non-pipe water or other sources
- access to sanitation varies from connection to the NSW system, connected to a septic tank, directly flush to the ocean, or a communal area for toiletry activities. The ratio within each ward varies depending upon whether the households of formal or informal, and the socio-economic status. Respondents were also asked about the frequency with which their septic systems were emptied.
- Regarding health respondents were asked about infections over the last six months. He's covered the range of typhoid, cholera, dysentery, diarrhoea, hepatitis A, gastroenteritis, Giardia, scabies or Worms.

46. Respondents noted many activities along the foreshore now limit access and general attractiveness of the precinct. These included sand mining, marine litter, erosion, other development, water pollution and the legal reclamation of the foreshore.

47. Respondents also noted that access to the foreshore is now becoming more difficult in the subproject area between Point Cruz and Ranadi. This is because there are more private developments where

the owners have fenced-off beach access to outsiders, or there has been further reclamation which means there is no intertidal beach profile left collectively making scavenging very difficult. Furthermore, many of the local residents are concerned about the water quality and would not harvest from the foreshore area in this vicinity in any case.

48. **Environmental and Social Impact:** The potential environmental and social impacts of the subproject have been identified and their significance assessed. The duration of the impacts have been assessed with reference to the scope of work, and the physical and socio-economic environment at the subproject site. Mitigation measures are designed to avoid and/or minimize each of the potential physical and socio-economic environmental impacts. For this development, the impacts would be very minor during preconstruction and construction, and in fact, net benefits would result during the operations period.

49. **Land Access**: All landholders with properties that will be accessed or required for the proposed development have been identified and negotiations for easements or purchase are well advanced, with terms still to be resolved with only one landholder. No resettlement is required. In summary, there is no indication that land agreements cannot be finalised prior to construction starting.

50. **Access to Materials**: The rate at which quarry materials will be required has been calculated. Discussions with just one of the major quarries confirmed this business alone would be able to supply the quarry materials such as sand, bedding for pipes, and aggregate for concrete at the required rate. For armor rock that may be required for outfall protection, rocks in the 150 to 300 mm range are readily available. However, if larger rocks are required, then a significant notice period would be required.

51. **UXO**: A preliminary UXO survey has been undertaken using a mixture of side scan sonar and magnetometers. This preliminary survey detected 30 contacts using SSS and 56 using the magnetometer on the NRH alignment. For the Ranadi outfall alignment, the SSS and magnetometer yielded 15 and 25 contacts respectively. SW has required the consulting engineers to arrange more detailed surveys using divers and complete the clean-ups in association with the RSIPF specialist team before going to construction contracting. The required diving activities will also investigate any relics and alert the appropriate authorities if any are located.

52. **Potential impacts:** Potential impacts occurring as a result of the subproject have been divided into the preconstruction, construction, operations and decommissioning phases. Within these phases, the impacts have been further divided into physical, biological and socio-economic. All are considered minor, especially when mitigation measures detailed are followed.

53. **Analysis of Alternatives**: In terms of the do-nothing option, the existing wastewater discharge situation presents both health and ecosystem risks, as well as having an economic impact on tourism activities. Furthermore, these negative impacts will only worsen over time unless systemic changes are introduced. Numerous options and sub- options have been investigated for the gravity sewer network layout, pump station numbers and locations, rising main sizing and location, as well as the option of one, two or three ocean outfalls, and finally, the phasing and interconnection of works. With the ocean outfalls, a number of outfall lengths and construction options have been considered.

54. In terms of considering a different overall approach to wastewater management, options such as providing wastewater treatment have been investigated and costed. However the entire approach to this project is a stepwise or staged implementation. To this end, land has been obtained and set aside for any future wastewater treatment plant requirements. The environmental modelling is based on the ultimate flow at the end of the design period to 2050. In the initial years, the wastewater flow will

be far smaller. This gradual increase in flow rate will allow ongoing environmental monitoring to be undertaken thereby allowing any changes or interventions to be made in a timely manner, such as the possible inclusion of wastewater treatment.

55. In terms of alternative methods for disposal of the wastewater, either treated or untreated, irrigation of would be essentially unaffordable. Large tracts of land would be required including significant flatter areas to allow the construction of wet weather storages to avoid run-off in protracted wet periods. Such large areas of land are essentially unavailable.

56. Environmental and Social Management Plan: The role of ESMP is to outline the mitigation measures to be considered during subproject implementation and operation to avoid or control adverse environmental and social impacts and the actions deemed necessary to implement these measures.

57. Environmental assessment has determined that the subproject will have low significant impacts on the environment. Social impacts are not expected to be significant with land acquisition and resettlement impacts generally avoided and residual impacts mitigated. The subproject can be implemented in an environmentally acceptable manner provided that the mitigation measures to avoid or reduce the environmental impacts will be provided. This ESMP includes: (i) implementation arrangement, (ii) mitigating measures to be implemented; (iii) required monitoring associated with the mitigating measures. It also describes the institutional roles and responsibilities during pre-construction, construction, and operation phases

58. Mitigation measures, environmental monitoring, and capacity development are required to minimize the environmental impacts in the pre-construction, construction and operation phases. The PMU will be tasked with finalizing the detailed design and updating the EIS and Environmental and Social Management Plan (ESMP). The contractor will be responsible for implementing the provisions of the EMP. The EIS document includes these EMPs identifying (i) mitigation measures for potential environmental impacts encountered during implementation, (ii) an environmental monitoring program to ensure that mitigation is in place and operating effectively; and (iii) identification of the responsible entities for mitigation, monitoring, and reporting.

59. The construction phase ESMP will be included in subproject bidding documents for the subproject for adoption by the contractors, though it will be a contract requirement that the construction contractor will be required to develop and gain approval for their own site and methodology-specific CESMP including site-specific plans and sub-plans. The CESMP will include site plans, construction methodology, waste management, materials management and other sub-plans, including grievance redress and communications as required. A framework for the management and monitoring plans and an outline of each of the plans are included in the EIS.

60. **Information Disclosure, Consultation and Participation**: The stakeholder consultation process disseminated information to the public, project-affected communities and key environmental stakeholders. Information was provided on the scale and scope of the subproject and the expected impacts and the proposed mitigation measures through consultation with government departments, local authorities and the public in meetings. Nine public consultation meetings were also completed between 2018 to 2022, conducted by SW along with their respective consultants.

61. **Grievance Redress Mechanism**: A grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate the resolution of affected people's concerns, complaints and grievances about the environmental and social performance of the subproject. The GRM is based on accepted practices in the Solomon Islands and provides an accessible, time-bound and transparent

mechanism for the affected persons to voice and resolve social and environmental concerns linked to the subproject.

62. **Conclusion**: The EIS concludes that the potential socio-environmental impacts arising from design, construction and operation of the best alternative as outlined in Section 6 of this report for this UWSSSP subproject will be minor, localized and acceptable provided that the mitigation measures set out in the ESMP are incorporated into the design and implemented. Key findings are summarized below:

- existing water quality is significantly compromised, especially, near existing short wastewater outfalls, representing both a health risk due to elevated concentrations of sewage pathogens and a potential ecological risk due to elevated nutrient levels
- there are no terrestrial nor marine protected areas within the area of influence, nor contiguous to it.
- the marine, terrestrial and freshwater ecological assessment indicated there are no rare, threatened or endangered flora or fauna species within the area of influence. Thus there are no critical habitats, species or natural habitats of ecological significance.
- All subproject areas have been heavily disturbed with significant land clearing and reclamation activities undertaken. Native fauna was also absent, replaced predominantly by domestic animals.
- The marine biota survey indicated that the biota is extremely sparse along and adjacent to the proposed outfall alignments, and there was no evidence of coral reefs, extensive seagrass beds or sessile marine fauna.
- The impacts derived from the marine scope of works for both proposed outfall pipelines are expected to be very minor, localized to the immediate footprint of the works, and easily managed through standard engineering good practice mitigation measures. There are no threats to the area's marine and coastal biodiversity associated with the subproject. As such the potential impacts of the works on the marine environment are considered to be minor, temporary, mitigatable and overall insignificant.
- The proposed infrastructure will be located on a mix of public and private land. There are standard processes for gaining easements over public land such as road reserves and these are well underway. Only one of the private landholders is still requiring further negotiations to finalise land access.
- Community engagement has been extensive and the overall feedback is very positive about the proposed subproject.
- Alternatives to the proposed wastewater infrastructure subproject have been reviewed and are all considered far too complex or expensive given that the proposed system will not result in unsustainable socio-environmental impacts. The proposed sewerage infrastructure and outfalls will significantly reduce current health risks based on recreational water quality modelling in terms of primary and secondary contact recreation, and lead to improved water quality generally.
- A grievance redress mechanism is in place.
- Alternatives to the proposed wastewater infrastructure have been reviewed and are all considered far too complex or expensive given that the proposed system will not have unsustainable socio-environmental impacts.

- The proposed sewerage infrastructure and outfalls will significantly reduce current health risks based on recreational water quality modelling in terms of primary and secondary contact recreation.
- Nutrient modelling indicates that there will be little, if any, negative impact on the local water column and the additional nutrients offshore may help to establish a more populous marine ecosystem.
- The overall potential impact of the works on both the terrestrial and marine biological environment is expected to be very minor, localized and overall insignificant, provided standard mitigation measures associated with good engineering practice as identified above are implemented.
- The ESMP will ensure that the preconstruction, construction and operational phases are all suitably monitored and managed. Should any unexpected impacts occur, then suitable interventions can be initiated.

1 Introduction

1.1 Background to the Subproject

63. The Asian Development Bank (ADB) and World Bank (WB) are supporting the Government of Solomon Islands (the government) to develop the Solomon Islands Urban Water Supply and Sanitation Sector Project (UWSSSP). This project aims to improve access to safe water and improved sanitation in urban and peri-urban areas by implementing high priority components of the Solomon Water (SW) 30-Year Strategic Plan and 5-Year Action Plan. Project outputs include secure and safe urban water supplies; effective, efficient and safe urban sanitation services; enhanced awareness of hygiene and water issues and sustained improved hygiene behavior; and the financial and technical sustainability of SW, the state-owned enterprise responsible for the management and development of urban water resources and sewerage services in the Solomon Islands.

64. The Ministry of Finance and Treasury (MOFT) is the Project executing agency and SW is the implementing agency, operating through a Project Management Unit (PMU). To ensure compliance with the required safeguards, the PMU will ensure that the Project will be implemented in accordance with the Project's Environmental and Social Assessment and Review Framework (EARF) and resettlement framework (RF).

65. The EARF has been prepared which establishes the process and procedures that must be followed for the screening, assessment, review and monitoring of each component or subproject that will be prepared during Project implementation. The EARF will ensure that during implementation, the components, and the Project overall, will comply with the requirements of the country safeguards system (CSS), WB's Safeguard Policies (WBSP) and the ADB's Safeguard Policy Statement 2009 (SPS).

66. In accordance with the EARF, this EIS has been prepared for the wastewater component covering the subprojects identified for the City of Honiara[3] notably the sewer pumping stations and associated sewer lines and outfall construction.

67. The EIS provides the baseline conditions, an assessment of the environmental impacts and risks created by the subproject during pre-construction, construction and operation. It is based on field visits to the proposed subproject's areas; review of available information; and discussions with government agencies and communities in subproject areas.

68. Following the EARF guidelines, the subproject has been screened as Category B based on the on the specific physical, biological and socio-economic conditions of the site and the significance of its environmental impacts and risks which are largely site-specific, mainly related to the construction phase and many of which can be readily managed or mitigated through implementation of the measures identified in the environmental and social management plan (ESMP).

1.2 Scope and Objectives of the Study

69. The main objective of this EIS is to identify potential environmental and social impacts of the wastewater subproject and the necessary measures that will ensure the proposed subproject

[3] This Background Information Report does not cover the septage management subproject which are the subject of separate documentation.

mitigates any potential adverse impacts on the environment and communities during subproject construction and implementation. See **Appendix 1: Terms of Reference**.

70. The assessment was undertaken in compliance with the Country Safeguard System (CSS) including Environment Act 1998 and Regulation 2008. In addition, appropriate sectoral legal provisions relevant to such activities have also been referred to for the necessary considerations during the pre-construction, construction, and operation of the subproject. The Environment and Conservation Division accepted the Terms of Reference (See Appendix 1 – Terms of Reference) in their letter dated 28th of February 2022. In this letter, ECD also requested the examination of a number of specific items which are listed and addressed in this EIS. (See Section 9.4)

71. Specific objectives of the study include (but not limited to) the following:

- Define the subproject area and establish the environmental baseline conditions through review of available information and data and additional surveys/investigations where required;
- Describe the works and activities that will be undertaken at each of the locations;
- Based on the above identify environmental impacts associated with the proposed subproject implementation;
- Describe the consultation activities and feedback;
- Establish a comprehensive ESMP which will address the impacts expected during pre-construction, construction, and operational phases of the subproject.

2 Administrative, Legal and Policy Framework

72. Implementation of the subproject will be governed by the environmental laws and regulations of the Government of Solomon Islands and the safeguard policies of the ADB and World Bank Group's Environmental Health and Safety Guidelines (EHSG)

2.1 Environmental Legislation and Regulations in Solomon Islands

2.1.1 General

73. In the Solomon Islands, the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM) is the institution that administers the Environment Act 1998 and Regulation 2008. The Environment and Conservation Division (ECD) within MECDM implements the Environment Act and Environment Regulations which stipulate the type of activities for which development consent must be sought and which proposed developments require environmental assessment. ECD is also the government agency responsible for reviewing the proposal and environmental and social impact assessment reports and gives clearance to the proposed development before the Director issues the development consent. They are also the responsible agency to manage the environmental and social compliance of all projects. This administrative body was formed after the national government structure was reorganized in December 2007.

74. The proposed UWSSSP- Honiara Waste Water Mains and Outfalls subproject is required to comply with the Environment Act and Regulations.

2.1.2 The Environment Act (1998)

75. The Environmental Act (1998) provides for the protection and conservation of the environment, through the establishment of the Environment and Conservation Division (ECD) and the Environment Advisory Committee (EAC). The Environment Act 1998 governs the Environmental Policy of Solomon Islands. The core objectives of the Act are to provide for and establish integrated systems of development control, environmental impact assessment (EIA) and pollution control, including:

- Prevention, control and monitor pollution;
- Reducing risks to human health and prevent degradation of the environment by all practical means, including the following:
- Regulating the discharge of pollution to the air, water and land; and
- Regulating the transport, collection, treatment, storage and disposal of wastes;
- Promoting recycling, re-use and recovery of materials in an economically viable manner; and
- To comply with and give effect to regional and international conventions and obligations relating to the environment.

76. The Act is divided into the following four sections:

- Part I Article 4.1 provides the Act with considerable power which states that in the event of conflict between the Environment Act and other legislation, the Environment Act will prevail;

- Part II establishes and defines the powers and role of the ECD;
- Part III establishes the requirements for environmental assessment, review and monitoring. This provides for an environmental assessment to consist of either a Public Environmental Report (PER) or if the development is shown to be of such a nature as to cause more serious impacts, then the developer is required to submit an Environmental Impact Statement (EIS) to the MECDM;
- Part IV details requirements for pollution control and emissions (noise, odor and electromagnetic radiation) and requirements for permits for the discharge of waste. Noise (restrictions on emitting unreasonable noise) is covered in Article 51(1).

77. Key functions of the Act are to:

- Promote coordination among Ministries and government divisions;
- Revise and amend the national environmental strategies and program as necessary;
- Develop, coordinate and facilitate implementation of national policy concerning environmental planning, environmental impact assessment and pollution control; and
- Monitor and advise on international developments in environmental matters and to ensure the fulfilment of obligations of Solomon Islands under the relevant international and required treaties and conventions.

78. **Schedule** 2 of the Act lists prescribed developments for which consent, accompanied by an EIA, are required.

79. All prescribed projects require a simple assessment through a “screening” or “scoping”, procedure to see what form of additional assessment is required. Most prescribed projects require a Public Environmental Report (PER), while many major projects such as logging, large agricultural developments, mining, large scale tourism developments, and infrastructure projects will also need a second stage of appraisal (environmental impact assessment) which includes technical, economic, environmental and social investigations. All of these are to be presented in an Environmental Impact Statement (EIS).

80. The level of assessment under this EIS has been confirmed acceptable to the requirements of the Act upon consultation with the ECD during the preparation of the document. The project is required to comply with the Act to obtain development consent.

2.1.3 Environment Regulation (2008)

81. The Environment Regulations (2008) establish the procedures for undertaking the environmental assessment of any projects categorized as ‘Prescribed Activities’. The developer is required to first submit a “Development Proposal Application” following which the MECDM determines the next step. The results of the review may include:

- No further assessment is required, as such the Development Application is accepted;
- A PER is required, (a PER is roughly equivalent to an ADB IEE and therefore this document also meets government’s requirements); or

- Where major projects are considered such as logging, large agricultural developments, mining and large-scale tourism developments and infrastructure projects, an Environment Impact Statement (EIS) is required which includes technical, economic, environmental and social investigations.

82. Both the PER and EIS require public consultation. Following approval by the MECDM the subproject's Development Consent is issued either with or without conditions.

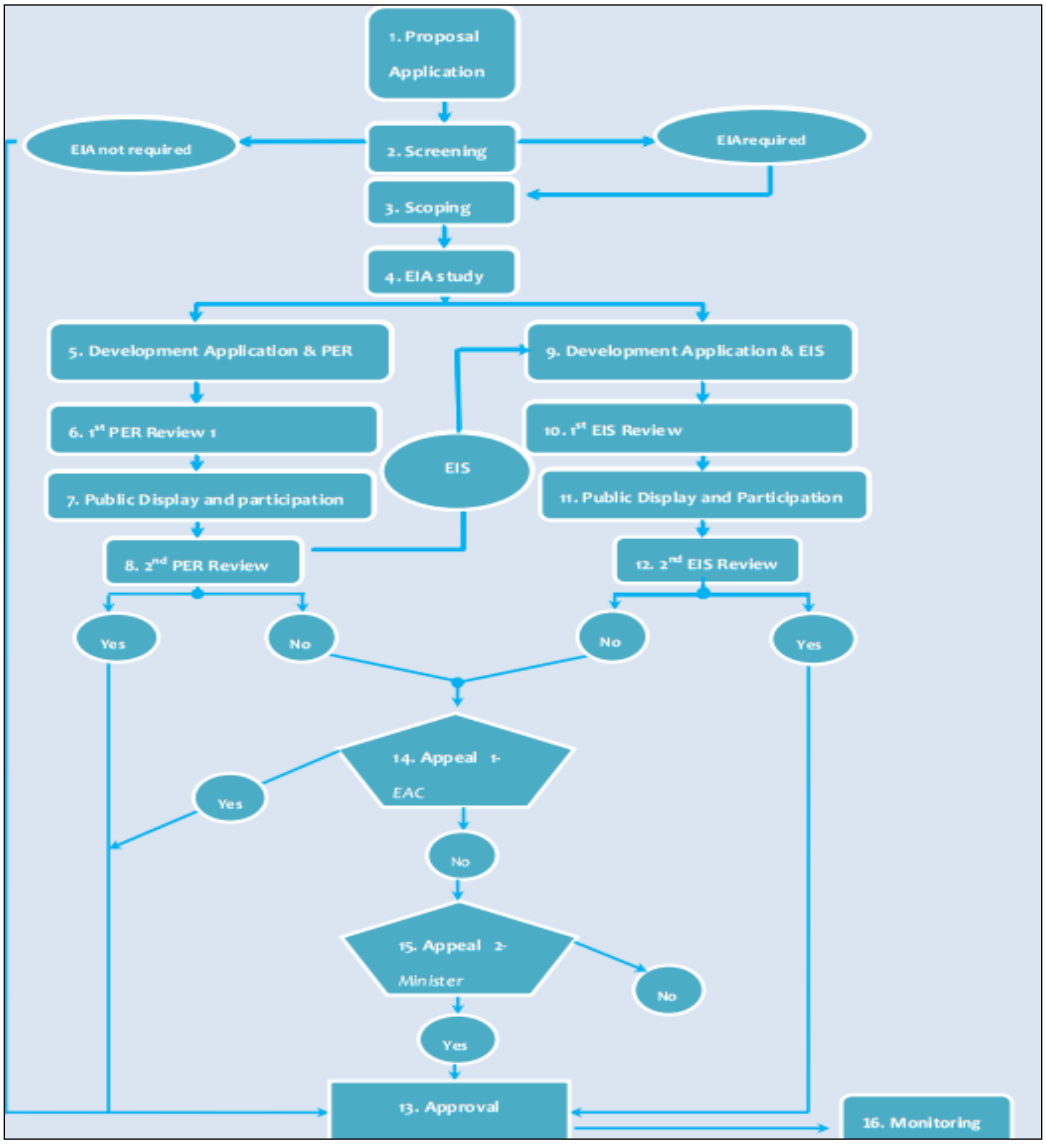
83. The project must also comply with the Environment Regulations in order to obtain development consent.

2.1.4 Environment Impact Assessment Guideline, 2010:

84. The EIA guideline is designed to administer schedule 16 of the Environment Act 1998. The guideline comprises of EIA procedural descriptions, stakeholders in the EIA process (see **Figure 2-1**) and fees required for development type. "The guideline was prepared by the ECD with the aim of simplifying the procedures in the Act, provide basic advice and guidance to government officers, planners, developers, resource owners on the environmental impact assessment process" (MECDM, 2010).

85. The Solomon Islands do not have emission, water or air quality standards. While environmental standards are not provided in the Regulation, the MECDM usually uses internationally recognized standards such as the World Health Organization (WHO) standards for water and air quality. While the Guidelines provide for licenses to discharge waste or emissions, the enforcement of these is problematic without defined standards.

Figure 2-1: Procedural Steps of EIA



Source: MECDM, EIA Guideline 2010

86. **Environmental Permits required for the Subproject**: Under the Environment Regulation (2008), any developer must submit an EIA Report to the MECDM for any prescribed development. The Ministry would also require an environmental management plan (EMP) and a corporate policy for each of the companies involved in the project development.

87. The Director shall not issue any development consent under this part, if the following had occurred:

- The PER or EIS did not support the application;
- The discharge of waste, noise, odor, radiation, or other forms of pollution is inevitable; or
- The discharge of waste or emission of noise, odor or electromagnetic radiation would be harmful to the environment.

88. Under the Environmental Regulation (Amendment) Regulation 2014, a permit is required for discharge of potentially polluting liquids. It also specifies the prescribed fees for each of the discharges. The developer will apply to the Director for a discharge license to be able to discharge any polluting liquids into the environment. For UWSSSP, SW will be responsible to apply for a discharge permit from the Director after it has constructed the Marine Outfalls and PS and prior to operation of the systems.

89. **Environmental Impact Assessment Decision Statement (EDS):** The EDS will be issued by the Ministry of Environment upon satisfactory review of the EIA. The process is that upon receiving the PER or the EIS Report, the Director of Environment shall convene a meeting (or a Public Hearing) and the Director shall receive both oral and written submissions from any person in relation to the application.

90. The Director, within 15 working days, will issue a development consent if there is no objection made to the application.

91. The Director may also amend the license, if the discharge or emission will be carried out in a manner consistent with all relevant environmental policies.

2.2 Other Legislation Relevant to the Subproject

92. **The Solomon Islands Water Authority Act 1992**. This Act makes provision for the establishment of a Water Authority for Solomon Islands, to provide for the proper management and development of urban water resources and services and sewerage services in Solomon Islands and for other matters connected therewith or incidental thereto.

93. **Rivers and Water Act (1996)** was enacted to administer and control developments that would impact on a river. The Act, however, only applies to rivers that have been designated under the Act. This means that all activities taking place within and around the vicinity of the declared Rivers are governed under the Rivers and Waters Act 1996.

94. **Waters Resource Bill (2006**) has been prepared to go through parliament and if approved, passed, and published, it will supersede the Rivers and Water Act (Revised edition1996). The purpose of the Act is:

- To provide for the integrated water resource management of Solomon Islands;
- To promote the most efficient, fair and beneficial use of natural water;
- To ensure the natural water resources are available for the sustainable use for the benefit of all present and future Solomon Islanders;
- To provide for the protection of natural watercourses and water catchments;
- To provide for the control of activities occurring over or beside waterways or watercourses

95. The Act requires a Waters Resources Advisory Board, whose function is to advise the Minister on matters pertaining to the Act and consult with the Director of Water Resources on technical matters. The Director with his/her staff shall administer, manage, and implement the Act accordingly to achieve the purpose of the act. The Act covers all water bodies, rivers, and streams whether in a registered or non-registered, public, private or customary land in Solomon Islands.

96. The Water Resources Department is located within the Ministry of Mines, Energy & Rural Electrification (MMERE). The Ministry has the authority to control the use and development of all water catchments and riverbanks. Logging, mining and sands and gravel extraction in water catchments, riverbanks and riverbeds may be restricted by the Ministry according to the requirements of the catchment management and conservation.

97. Section 21 of the Act provides for the Ministry to recommend to the Board to declare a water body such as a catchment, groundwater, or flood control zone as a Water Control Area. If approved by the Minister and published, mining of sand and gravel will be prohibited. This also includes any contraction, altering, removing or in any way impede or be likely to impede flow or movement of surface water. This clause of the Act is significant as it may have a direct impact on sand and gravel extraction in the future if the current activities are not sustainably managed.

98. The Act clearly states that a development must not obstruct, divert or dam the river, if so it must make application to the Minister who upon receiving the request will direct the Director and/or his officers to assess and if agreed will issue a license accordingly.

99. **Environmental Health Act 1980**. This Act provides for the management and control of public health in Solomon Islands. It defines local authority responsibilities in relation to the construction, operation, and management of sewerage systems, including sewage disposal works. It also provides penalties for the willful pollution of a water supply source.

100. **Town and Country Planning Act,1997** provides for the administration of town and country planning in Solomon Islands; preparation of local planning schemes; and control and development of land. It applies to all urban areas.

101. **Provincial Government Act 1997.** The Provincial Government Act of 1997 gives power to the provinces to make their own legislation including environment and conservation. Schedule 3 of the Act provides a list of activities for which the provinces have responsibility and have the power to pass ordinances. These include:

- Trade and Industry - local licensing of professions, trades and businesses and markets.
- Cultural and Environment - protection of wildlife, coastal and lagoon shipping.
- Agriculture and Fishing - protection, improvement and maintenance of freshwater and reef fisheries.
- Land and Land Use - codification and amendment of existing customary laws about land. Registration of customary rights in respect of land including customary fishing rights. Physical planning except within a local planning area.
- Local matters - waste disposal.
- Rivers and Water - control and use of river waters, water pollution.
- Corporate or Statutory Bodies - establishment of corporate or statutory bodies for provincial services including those for economic activities.

102. According to the State of the Environment Report (2008) eight Provincial Ordinances have been passed and including two for Guadalcanal Province: (i) Guadalcanal Wildlife Management Area Ordinance 1990 and (ii) Guadalcanal Province Protection of Historical Places Ordinance 1985.

103. **Mines and Minerals Act, 2008** regulates the mining and extraction of aggregate or gravels from rivers. It requires that building material permits (BMP) be applied for prior to any extraction of construction or building materials. The application for BMP may require a PER and will require preparation of an extraction plan.

104. **Mines and Minerals Regulation, 1996** complements and gives a clear detail of the Mines and Minerals Act. It further elaborates on the need for achieving a sound minerals resource administration and management in the country. The Regulation has provisions that specify mineral rights holders which include BMP holders, to adhere to good mining practice so that their activities result in minimum ecological damage or destruction, prevent avoidable damage to trees and avoid harm to freshwater, marine and animal life.

105. **Labor Act 1978**. This act deals with protections for workers. Part IX Care of Workers requires the employer to provide workers with rations (Article 65); protect workers and dependents from malaria (Article 66); provide workers with an accessible supply of clean, non-polluted water for drinking, washing and for other domestic purposes (Article 67); make sufficient and proper sanitary arrangements for workers (Article 68); provide accommodation for the worker and family if they are not conveniently located to the workplace (Article 69). Article 70 requires the employer to provide medical care at the workplace including: (i) treatment facilities, medicines, first aid equipment and transportation facilities; (ii) responsibility to move workers as quickly as possible either to the employer's treatment facilities or to the nearest medical facilities; (iii) treatment for workers or hospitalization; and (iv) should a worker die the employer is obliged to pay for funeral costs. Article 71 states that the employer may be required to provide medical facilities and services of a medical practitioner and the employer is to maintain a register of workers treated.

106. **Safety at Work Act, 1996** states that it is the duty of every employer to provide a safe workplace and to ensure the health and safety of employees under his control. This Act is linked to the Labor Act of 1978.

107. **Biosecurity Act 2013**. This Act is to prevent the entry of animal and plant pests and disease to Solomon Islands; to control their establishment and spread in Solomon Islands, to regulate the movement of animal, plant pests and diseases and of animals and plants and their products; to facilitate international cooperation in respect of animal and plant diseases and related matters. The Act is supported by Bio-Security Regulations 2015.

108. **Wildlife Protection and Management Act 1998**. This law provides for the protection, conservation, and management of wildlife in Solomon Islands by regulating the export and import of certain animals and plants. It is also intended to address the compliance with the obligations imposed on Solomon Islands under the Convention on International Trade in Endangered Species (CITES). It provides lists of: (i) "Prohibited or Restricted Exports" in Schedule I, (ii) and "Regulated and Controlled Species" in Schedule II. It was amended in 2017 to strengthen Solomon Islands' compliance with the requirements of CITES.

109. **Protection of Wreck and War Relics ACT 1980** is an Act to secure the protection of wrecked vessels and aircraft and war relics and for connected purposes. Section 4, refers to the protection of the wrecks and Section 4 (1) subjects to section 8 and it clearly states; a person commits an offence if, in a restricted area,

- he tampers with, damages, or removes any part of a vessel or aircraft lying wrecked, any object formerly contained in such a vessel or aircraft, or any war relics; or,

- he carries out excavation, diving or salvage operations directed to the exploration of any site or to removing objects from it or from the ground or sea bed, or uses equipment constructed or adapted for any purpose of excavation or diving or salvage operations; or
- he deposits in the case of a restricted area in Solomon Islands waters, so as to fall and lie abandoned on the sea bed, anything which, if it were to fall on the site of a wreck (whether it so falls or not), would wholly or partly obliterate the site or obstruct access to it, or damage any part of the wreck, and also commits an offence if he causes or permits any of those things to be done by others in a restricted area, otherwise than under the authority of such a license.

2.3 International Agreements

110. Solomon Islands is a signatory to a number of international agreements (treaties and conventions) with environmental and conservation implications as well as for the protection, promotion and safeguarding of cultural heritage and traditional knowledge. These are provided in **Appendix 2: International and Regional Agreements** of this document.

2.3.1 Regional

- Pollution Protocol for Dumping. Ratified 1998. Prevention of pollution of the South Pacific region by dumping.
- Pollution Protocol for Emergencies. Ratified 1998. Co-operation in combating pollution emergencies in the South Pacific region.
- Natural Resources & Environment of South Pacific Region (SPREP Convention). Ratified 1998.
- Waigani Convention on Hazardous & Radioactive Wastes 1995. Ratified 1998. Bans the importation and the trans-boundary movement and management of hazardous wastes within the South Pacific region.

2.3.2 International - Chemicals, Wastes and Pollution

- Liability for Oil Pollution Damage. Ratified. Liability of ship owner for pollution damage.
- (Marine Pollution Convention (London). Ratified. Prevention of marine pollution by dumping of wastes.
- POPs Convention (Stockholm). 2004. Bans use of persistent organic pollutants.

2.3.3 International – Biodiversity

- CITES, ratified 1998. Regulates trade in wild animals and plants
- (World Heritage Convention. Acceded 1992. Protection of sites of Outstanding Universal Values. (East Rannell Island is listed as a World Heritage site).
- Convention on Biological Diversity (UNCBD). Ratified 1995.
- Desertification (UNCCD). Acceded 1999. Agreement to combat desertification and drought.

- Cartegena Protocol on Biosafety. Acceded 2004. Protection of human health and the environment from possible adverse effects of modern biotechnology.

2.3.4 International - Climate

- Montreal Protocol. Acceded 1993. Phase out of substances that deplete the ozone layer.
- Ozone Layer Convention (Vienna). Acceded 1993. Protection of the ozone layer.
- Climate Change (UNFCC). Ratified 1994.
- Kyoto Protocol. Ratified 2003. Reduce greenhouse gases especially CO2 by an average of 5.2% by 2012.

2.3.5 International – Cultural

- World Heritage Convention. Acceded 1992. Protection of sites of Outstanding Universal Values. (East Rannell Island is listed as a World Heritage site).
- The Convention for the Safeguarding of the Intangible Cultural Heritage 2003
- The Convention of the Protection and Promotion of the Diversity of Cultural Expressions 2005

2.4 ADB Safeguards Policy

111. The ADB Safeguard Policy Statement 2009 (SPS) has the objectives to (i) avoid adverse impacts of projects on the environment and affected people; (ii) where possible; minimize, mitigate, and/or compensate for adverse project impacts on the environment and affected people when avoidance is not possible; and (iii) help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. The environmental safeguards require due diligence which entails addressing environmental concerns, if any, of a proposed activity in the initial stages of project preparation.

112. In accordance with the SPS, screening and categorization of a project (including its subprojects and/or components) is undertaken to reflect the significance of potential project impacts or risks; to identify the level of assessment and institutional resources required for the safeguard measures; and determine disclosure requirements. The Waste Water Mains and Outfalls subproject has been deemed Category B for the environment based on the significance of its potential environmental impacts and risks. An EIS is the appropriate level of assessment for a Category B classification.

113. An EARF has been prepared which establishes the process and procedures that must be followed for the screening, assessment, review and monitoring of each component or subprojects that will be prepared during implementation. The EARF will ensure that during implementation, the components will comply with the requirements of the country safeguards system (CSS), WB's Safeguard Policies (WBSP) and the ADB's Safeguard Policy Statement 2009 (SPS).

114. The SPS requires compliance with the ADB Environment, Health and Safety Guidelines (EHSG). The EHSG requires that workers be provided with a safe and healthy working environment, considering inherent risks, and any hazards in the work areas, including physical, chemical, and biological hazards. The EHSG requirements are integrated into the ESMP.

2.5 World Bank Safeguards Policies

115. The WBSP aims to prevent and mitigate potential damage to the environment and communities generated in the development process. The WBSP provide the environmental and social safeguard requirements that must be complied with during the identification, preparation and implementation of WB-financed programs and projects.

116. The WBSP include ten safeguard policies established to inform decision making, ensuring that projects financed by the WB are environmentally and socially sustainable. The wastewater subproject may be covered by these policies: Environmental Assessment (OP/BP 4.01), Natural Habitats (OP/BP 4.04), Indigenous Peoples (OP/BP 4.10), Physical Cultural Resources (OP/BP 4.11) and Involuntary Resettlement (OP/BP 4.12). **Table2-1** presents these policies and their applicability to the component.

117. The EHSG are technical reference documents with general and industry-specific examples of good international industry practice. When one or more members of the World Bank Group are involved in a project, these EHSGs are applied as required by their respective policies and standards. The General EHSG are designed to be used together with the relevant industry sector EHSG which provide guidance on issues in specific industry sectors. When host country regulations differ from the levels and measures presented in the EHSG, projects are expected to achieve whichever is more stringent.

118. The General and Industry Sector EHSG are available at the following link - http://www.ifc.org/ehsguidelines.

Table 2-1: World Bank Safeguard Policies: Main Objectives, Applicability and Triggered by the Subproject[4]

Safeguard Policies	Main Objective	Applicability	Application to Honiara Wastewater Components
OP 4.01 Environmental Assessment	The objective of this policy is to ensure that projects financed by the World Bank are environmentally sound and sustainable, and that decision making is improved through adequate analysis of actions and their possible risks and environmental impacts in the natural environment (air, water and soils); human health & security; physical-cultural resources; and global and transboundary and global environmental aspects.	This policy is applicable when a project or sub-project has potential to cause negative environmental impacts in its area of influence.	**Triggered** Environmental risks associated with the project include temporary noise, waste and air quality impacts associated with construction, potentially limited vegetation clearing for the purpose of creating access to new sewer lines, constructing the pumping stations and outfall, etc. This Background Information Report ((equivalent to WB ESIA/ESMP), the EARF (equivalent to WB ESMF) and Resettlement Framework (RF) (equivalent to WB RPF) and Resettlement Plan (RF) establish the process to mitigate these impacts. Consultations with stakeholders and affected communities are used to inform the decision-making process.
OP 4.04 Natural Habitats	This policy recognizes that the preservation of natural habitats is essential to protect original biodiversity, for the preservation of environmental services and products for human society and for long-term sustainable development. Therefore, the Bank supports the protection, management and restoration of natural habitats by funding projects as well as via political dialogue, sector work and the economic sector. By funding projects, the Bank expects the proponents to apply the precautionary principle in the management of natural resources, in order to ensure opportunities for sustainable environmental development.	This policy is used by any Project or sub-projects considered as potential originators of significant changes (loss) or degradation of natural habitats, be it directly (through the construction) or indirectly (with the human activities caused by the project). OP4.04 defines a natural habitat as land and water areas where (i) the ecosystems' biological communities are formed largely by native plant and animal species, and (ii) human activity has not essentially modified the area's primary ecological functions.	**Triggered** The policy OP4.04 was triggered for the project to be consistent with the ISDS. The Background Information Report established that the project is not located in areas where there will significant changes (loss) or degradation of natural habitats, be it directly (through the construction) or indirectly (with the human activities caused by the project). Construction will occur in areas of highly modified ecosystems and impacts during operations on environmental and socioeconomic values will be minor.

[4] This table was taken from the EARF of the UWSSSP. The application to Honiara Wastewater subproject is explained in the last column.

Safeguard Policies	Main Objective	Applicability	Application to Honiara Wastewater Components
OP 4.10 Indigenous Peoples	For all projects proposed for Bank funding that affect indigenous peoples, the Bank requires the borrower to undertake free, prior and informed consultation with affected Indigenous Peoples to ascertain their broad community support for projects affecting them. The project financed by the Bank must include measures to: (a) avoid adverse effects on indigenous populations; or (b) when it is not possible to avoid the effects, minimizes, mitigates, or compensates for such purposes. The projects financed by the Bank are designed with the assurance that indigenous people receive social and economic benefits that are culturally appropriate and adequate for gender and inter-generations.	This policy is applied when the Project affects direct or indirectly indigenous people.	**Triggered** The OP4.10 policy is triggered for the project to be consistent with the World Bank Integrated Safeguards Data Sheet (ISDS, p.16 May 2018). However, the project is located in areas where Indigenous Peoples are the sole or the overwhelming majority of direct project beneficiaries. They are not a discriminated, marginalized group, but part of the majority population, sharing the same culture, identity, and characteristics. IP aspects have been integrated into the Project Design ensuring FPIC principles, and broad community support for the project. The project will focus on rehabilitating failed wastewater infrastructure or providing new infrastructure, this will benefit the community. An RF will be prepared which sets out the methodology for land acquisition / access for the subproject, if needed. Once land access is required, the process will include consultations with local government, local communities and various community groups (i.e. youth and women groups). The Background Information Report /EARF will ensure free and prior informed consultation is undertaken and broad community support is achieved for the project.
OP 4.11 Physical Cultural Resources	The objective of this policy is to assist countries to avoid or mitigate adverse impacts on physical cultural resources from development projects that it finances. Physical cultural resources are important as sources of valuable	This policy is used by any Project or sub-projects considered as potential to cause changes (loss) or degradation of physical cultural resources. OP 4.11 defines physical cultural resources as movable or immovable objects, sites, structures, groups of structures, and natural	**Triggered** The project involves construction works in modified urban and peri-urban areas, where it is unlikely that unknown physical cultural resources will be encountered.

Safeguard Policies	Main Objective	Applicability	Application to Honiara Wastewater Components
	scientific and historical information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices.	features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Depending on the project and the nature of its impacts, various instruments can be used. An Environmental Assessment capturing impacts on physical cultural resources is required for the project and sub-projects.	However, a Chance Find procedure will be included in the CESMP to ensure appropriate measures are taken in the event cultural resources are encountered. The chance finds procedure is a project-specific procedure that outlines what will happen if previously unknown heritage resources, particularly archaeological resources, are encountered during project construction or operation. The procedure includes record keeping and expert verification procedures, chain of custody instructions for movable finds, and clear criteria for potential temporary work stoppages that could be required for rapid disposition of issues related to the finds. It is important that this procedure outlines the roles and responsibilities and the response times required from both project staff, and any relevant heritage authority, as well as any agreed consultation procedures.[5]
OP 4.12 Involuntary Resettlement	The objective of this policy is to: (i) avoid or minimize involuntary resettlement, where feasible and explore all viable alternative project designs, (ii) assist displaced people in improving their former living standards, income earning capacity, and production levels, or at let in restoring them, (iii) encourage community participation in planning and implementing resettlement; and (iv) provide assistance to affected people regardless of the legality of land tenure.	This policy does not cover only physical relocation but any loss of income sources resulting in: (i) relocation or loss of shelter, (ii) loss of assets or means of livelihood, (iii) loss of income sources or means of subsistence, whether or not the affected people must move to another location. This policy also applies to the involuntary restriction of access to legally designated parks and protected areas, resulting in adverse impacts on the livelihood of the displaced persons. In these cases, the World Bank requires the establishment of a Resettlement Action Plan (RAP), based on the RF for any project or sub-project.	**Triggered** The projects involve a small amount of land acquisition and impacts related to use of easement for new sewer lines. An RF has been prepared to assess potential impacts and outline measures to avoid, mitigate or manage these impacts. In the case land access is required, a Resettlement Plan (RP) will be developed. Communities will be consulted to ensure there are no pending issues. A formal grievance redress mechanism will be established to channel and manage potential grievances arising during project implementation.

[5] Guidance Note 8 - International Finance Corporation

2.6 Other Relevant Policies

119. The following policies are an important consideration in terms of services provided by SW in the country.

120. **National Development Strategy (NDS).** The National Development Strategy (NDS) is a very comprehensive policy that strategizes ways to achieve the development aspirations of the country. The NDS focuses on two key areas: social and economic livelihoods. These two key areas are enshrined in the NDS National Vision "Improving the Social and Economic Livelihoods of all Solomon Islanders".

121. Therefore, to achieve all those NDS Objectives, SW as one of the country's SOE ensures that it provides access to clean water to its clients. Being an SOE, SW strives to improve the quality and accessibility of water it provides to households, government houses, business houses and industries in the urban areas. Such is important to improving the social and economic livelihoods of people and more so to support growth and economic development of the country.

122. **Local Planning Scheme 2015.** The Country developed its first Local Planning Scheme in 2015 and it is prepared in accordance with Part III of the Town and Country Planning Act [cap. 154]. The LPS 2015 was developed to "guide and control land use and development"' in response to a number of acute land use and urban planning issues. The LPS put forward six visions for the city, namely i) Cultural and economic hub, ii) Livable city, iii) City for local and international tourists, iii) City with efficient transport, iv) City with multiple nodes and centers, and vi) City of resilience.

123. **Climate Change Policy.** Solomon Islands Government through the MECDM launched the Climate Change Policy, highlighting steps the government would take in aiding the country and its people to exist and adapt to present imminent climate change and its impact. The Policy aims to integrate climate considerations within the framework of national policies and guiding the government and its partners so as to ensure the people, natural environment and economy of the country are resilient and able to adapt to the predicted impacts of climate change.

124. **National Climate Change Policy 2012-2017** is the guiding framework to: (a) integrate climate considerations and support the implementation and achievement of the National Development Strategy and other regional and international policies and frameworks; and (b) to guide the government and its partners' efforts in ensuring that; (i) the people, natural environment, and economy of the country are able to adapt to the predicted impacts of climate change; and (ii) the country benefits from clean and renewable energy, energy efficiency, and mitigation technologies that improve people's livelihoods and the national economy.

125. **National Energy Policy.** The National Energy Policy recognizes the importance of reducing dependency on imported fossil fuel. Solomon Islands have abundant of resources renewable energy sources such as solar, hydropower, geothermal and biomass and wind energy.

2.6.1 Unexploded Ordnance (UXO).

126. Technically WWII ordnance found in the Pacific Islands can be defined as either unexploded ordnance (UXO) or abandoned explosive ordnance (AXO). UXO is defined as explosive ordnance that has been primed, fused, armed, or otherwise prepared for use in armed conflict but has failed to explode. AXO is defined as explosive ordinance unused during an armed conflict and subsequently

abandoned or left behind. UXO and AXO are defined collectively as Explosive Remnants of War (ERW). Solomon Islands was the scene of bitter fighting during World War II. While this was over 70 years ago, UXO may still be found around Solomon Island. Should UXO be discovered at the project site, the contractor is to immediately cordon off the area, arrange the evacuation of nearby residences and inform the relevant division within the Royal Solomon Island Police Force (RSIPF) to remove the UXO. Currently all UXO/AXO finds are reported to the RSIPF which arranges the pickup, transport, storage, and ultimate disposal of the finds.

2.6.2 COVID-19 Pandemic Control.

127. The severity of the pandemic has weakened over the last year, and Solomon Islands government has reopened the borders with now only limited community restrictions and general guidelines applying. However, given that COVID-19 variants are continuing to evolve, there may be a local re-escalation of cases leading to the need to apply border and community controls again. The combined ESF/Safeguards Interim Notes are provided as **Appendix 3: COVID-19 Controls.**

2.6.3 Greater Honiara Urban Development Strategy and Action Plan (GHUDSAP) 2018-2035

128. The Greater Honiara Urban Development Strategy and Action Plan (GHUDSAP) 2018-2015 has been prepared in response to the need for integrated urban planning and development caused by the rapid urban growth of Honiara City and adjacent areas of Guadalcanal Province. GHUDSAP includes a Greater Honiara Urban Development Strategy (GHUDS) which addresses the issues faced and provides a framework for guiding integrated urban development and long-term sustainable growth to 2035. It also provides guidance on what is required of Solomon Islands Government, State Owned Enterprises, Honiara City Council, Guadalcanal Provincial Government, development partners and other stakeholders to ensure that their initiatives are well-coordinated to yield optimal results faced by the SIG, HCC, and GPG.

129. GHUDS is anchored on a vision which sees GHA to be Peaceful, Resilient, Inclusive, Sustainable, Master planned and with Effective governance. The vision is supported by six strategic Goals*, (1) Establish a peaceful community*, *(2) Improve resilience to natural hazards and climate change, (3) Ensure inclusive development, (4) Support sustainable economic growth (5) Master planned urban development (6) Effective urban growth management.*

130. Under the Strategic Goal 3 are sub-goals 3WW and 3SW and this sub-goal focuses on expanding wastewater services and ensures solid waste management for all to address the issues of environmental degradation and inadequate provision of basic urban services and infrastructure. The programs and actions to address and achieve this are detailed in **Table 2-2** below.

Table 2-2: Programs and actions to address and achieve Strategic Goal 3.

Goal	Program	Action
Expand Wastewater services	Ensure Effective Planning and Institutional Strengthening	institutional Strengthening Programme for septage management
	Improve Wastewater Management Infrastructure	FS, design and construction of upgraded/temporary new sewer outfalls and FS and design for permanent outfall FS and design of septage treatment facility Construction of septage treatment facility Design and construction of new rising mains Design and construction of new sewers & connections

Source: Greater Honiara Urban Development Strategy and Action Plan

2.7 Guidelines for Fresh and Marine Water Quality

2.7.1 Protected Environmental Values

131. The potential effects of discharging treated effluent into a receiving water are generally linked to the protected environmental values that are adopted, or that are desired as a community-based goal. For the local embayment, the primary environmental values include;

- recreation activities including swimming, boating and fishing
- protection of aquatic ecosystems including seagrass and coral habitats (subject to field survey results) in the local area
- production of edible fish, crustaceans and shellfish for human consumption
- aesthetic value of the waterbody
- water-based transport

132. Currently there are no guidelines for fresh and marine water quality in Solomon Islands.

2.7.2 Recreational Water Quality – Parameter and Objective Selection

133. The first PEV relates to microbiological parameters for recreational water quality, more commonly called bathing water guidelines. Following the EARF documents, it has been agreed to use relevant ANZECC guidance documents to develop recreational water quality approaches for Solomon Islands.

134. **Table 2-3** shows the water quality guidelines for recreational waters based on the ANZECC guidelines used in the initial analysis for the development of the Background Information Report. Subsequent analysis has been based on updated guidelines as summarized in **Table 2-4.**

Table 2-3: Water Quality Guidelines for Recreational Water (ANZECC Guidelines 2000)

Microbiological Parameter

- **Primary Contact** - The median bacterial content in fresh and marine waters taken over the bathing season should not exceed 150 faecal coliform organisms/100 ml or 35 *enterococci* organisms/100 ml. Pathogenic free-living protozoans should be absent from bodies of fresh water.
- **Secondary Contact** - The median value in fresh and marine waters should not exceed 1000 fecal coliform organisms/100 ml or 230 *enterococci* organisms/100 ml.

Physical and Chemical Parameter

Color

- To protect the aesthetic quality of a waterbody:
  - the natural visual clarity should not be reduced by more than 20%;
  - the natural hue of the water should not be changed by more than 10 points on the Munsell Scale;
  - the natural reflectance of the water should not be changed by more than 50%.
- To protect the visual clarity of waters used for swimming, the horizontal sighting of a 200 mm diameter black disc should exceed 1.6 m.

pH

- The pH of the water should be within the range 5.0–9.0, assuming that the buffering capacity of the water is low near the extremes of the pH limits.

Temperature

- For prolonged exposure, temperatures should be in the range 15–35°C.

Toxic Chemicals

- Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation.

Surface Films

- Oil and petrochemicals should not be noticeable as a visible film on the water nor should they be detectable by odor.

Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)

Table 2-4: Water Quality Guidelines for Australian Recreational Water Quality Guidelines (2018)

Class/ Category	95th percentile value for intestinal *enterococci*/ 100 ml (Rounded values)	Basis of derivation	Estimation of Probability
A	<40	This value is below the NOAEL in most epidemiological studies.	GI illness risk: < 1% AFRI risk: < 0.3% The upper 95th percentile value of 40/100 ml relates to an average probability of less than one case of gastroenteritis in every 100 exposures. The AFRI burden would be negligible.
B	41–200	The 200/100 ml value is above the threshold of illness transmission reported in most epidemiological studies	GI illness risk: 1–5% AFRI risk: 0.3–1.9% The upper 95th percentile value of 200/100 ml relates to an average probability of one case of gastroenteritis in 20 exposures. The AFRI illness rate would be 19 per 1000 exposures or approximately 1 in 50 exposures.

		that have attempted to define a NOAEL or LOAEL for GI illness and AFRI.	
C	201–500	This represents a substantial elevation in the probability of all adverse health outcomes for which dose–response data are available.	GI illness risk: 5–10% AFRI risk: 1.9–3.9% This range of 95th percentile values represent a probability of 1 in 20 to 1 in 10 risk of gastroenteritis for a single exposure. Exposures in this category also suggest a risk of AFRI in the range of 19–39 per 1000 exposures or a range of approximately 1 in 50 to 1 in 25 exposures.
D	> 501	Above this level there may be a significant risk of high levels of illness transmission.	GI illness risk: > 10% AFRI risk: > 3.9% There is a greater than 10% chance of illness per single exposure. The AFRI illness rate at the guideline value of 500 *enterococci* per 100 ml would be 39 per 1000 exposures or approximately 1 in 25 exposures.

Source: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)
Note: AFRI - Acute Febrile Respiratory Infection

2.7.3 Aquatica Ecosystem Protection – Parameter Selection

135. Environmental values each have associated water quality criteria. The most stringent criterion for each parameter then becomes the water quality objective. Locally, the most stringent set of water quality criteria will meet the requirements of protecting the local aquatic ecosystem and to ensure that any seafood production is safe for human consumption. Therefore relevant parameters and associated criteria must be selected to ensure long-term protection of these PEVs.

136. The sewage components which may have an acute, or a rapid adverse effect on marine water quality and human health include ammonia, fecal coliforms and high BOD loads which can result in significant dissolved oxygen depletion.

137. Adequate dissolved oxygen (DO) concentrations within receiving waters are critical and can be reduced by the biochemical decay of organic matter. Low dissolved oxygen concentrations can reduce the physiological efficiency of fish and other non-breathing invertebrates. Under extreme conditions, fish kills can occur. Algal blooms can also introduce significant dissolved oxygen fluctuations due to diurnal photosynthesis and respiration processes.

138. Two marine water quality datasets of in situ readings such as pH, turbidity and dissolved oxygen could be located. The first was from the Commonwealth Marine Economies Program (CPEM) survey for the UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS) undertaken on the 23rd and 24th of September, 2017. This program sampled much of the Honiara foreshore starting west of Point Cruz and continuing past Ranadi, plus the local river systems. Some 69 in-situ readings were taken overall. The lower saturation readings were all recorded in the freshwater environments associated with the Mataniko River system, with the lowest reading of all being 46% saturation or a dissolved oxygen level of 3.5 mg/l. The marine readings were all close to or above saturation. Overall, the average dissolved oxygen saturation level from all samples was 102%. The ANZECC (2000)

guideline[6] minimum values are 85% saturation for lower reach freshwaters, and 90% minimum saturation for inshore marine waters, with a maximum of 120% saturation.

139. The second study incorporating in-situ results was part of a rapid assessment of the Mataniko River environs undertaken by GEF in 2020 as part of the Pacific International Waters Ridge to Reef Regional Project.[7] The results of physical parameters measured at the seven sites on Mataniko were combined with the results of measurements taken at an additional eight freshwater sites in rivers east and west of Honiara, and 15 marine sites. For the freshwater sites, the dissolved oxygen percent saturation ranged from 2.7% to 113%. For marine waters, percent saturation ranges from 87% to 120%. Based on the ANZECC (2000) water quality guidelines, the DO results for the freshwater reaches of the river do not meet the guidelines but results generally meet the guidelines in the marine waters.

140. Therefore based on these two available surveys, and observations by the EIS team along the foreshore, dissolved oxygen concentrations alone would not be expected to impact the estuarine and marine water ecology at present but may impact upon the freshwater ecology. Dissolved oxygen concentrations at 2 mg/l (in the order of 25% saturation) will certainly impact upon species diversity, and only very coarse fish species could survive at less than 1 mg/l (in the order of 12% saturation).

141. Given the current low organic load emanating from a relatively small, connected population through the existing near-shore outfalls, and the high level of advection and dispersion that would be achieved in the unconfined littoral environment, the current DO level could be expected to approach saturation. Therefore modeling of DO is considered unnecessary.

142. Free ammonia is highly soluble and is toxic to fish. The toxicity depends on the pH of the water and toxic concentrations can occur under alkaline conditions with relatively low ammonia concentrations (<0.2 mg/l). Ammonia only persists in the aquatic environment for short periods as it is rapidly oxidized. Mineralization of the organic nitrogen fraction in raw sewage will likely largely happen within any remaining septic tanks connected to the new sewerage network and also just during flow through the sewerage system and retention in pump station wet wells. Once being released into the aquatic environment, Nitrosomonas bacteria will oxidize the ammonia to nitrite, and then Nitrobacter bacteria will rapidly oxidize the nitrite to nitrate. All these three inorganic nitrogen forms are bioavailable and the less oxidized fractions can still be utilized by aquatic systems, prior to full oxidation. Given the significant initial and far field dilutions to be achieved, and the relatively low strength raw wastewater due to significant inflow and infiltration in the older networks to be interconnected, ammonia toxicity is not expected to be a concern. It traditionally is not a toxicity concern near ocean outfalls discharging raw sewage. It is generally more of a toxicity concern when associated with industrial wastewater discharges which can be very high in ammonia.

143. After the initial mixing of effluent and oceanic waters, nutrients associated with the sewage will be distributed by tidal and wind processes. This will lead to a widespread distribution of nutrients within the environment, which can possibly cause long-term or chronic impacts. Nutrient enrichment, or eutrophication, of waterbodies causing algal blooms is an example of a long term impact as shown in **Plate 2-1**.

[6] Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines / Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. 2000

[7] Milika, S. GEF et al, Suva, Fiji SPC 2020. Rapid Coastal Assessment of Mataniko River Catchment Report, Honiara, Guadalcanal Island, Solomon Islands.,

Plate 2-1: Red Tide in the Marine Environment

144. Algal concentrations are of greater environmental management interest, as elevated nutrient concentrations themselves are not going to result in ecological imbalance unless unionized ammonia is present in high levels. The concern is that elevated nutrients can lead to excessive primary productivity. This can cause algal blooms resulting in fish kills, or excess attached algae smothering seagrass swards and corals.

145. Nitrogen and phosphorus are the two main nutrients of concern, given their elevated concentrations in untreated domestic sewage and septage.

146. V. H. Smith (2006)[8] undertook a cross-ecosystem comparison of data obtained from 92 coastal zone ecosystems worldwide. Overall, these revealed a strong positive response of marine phytoplankton biomass to nutrient enrichment that is highly consistent with the general patterns reported previously in the limnological literature for freshwater lakes and reservoirs. Average concentrations of chlorophyll-a in estuarine and coastal marine systems were strongly dependent on the mean concentrations of total nitrogen and total phosphorus in the water column. Moreover, as is true of freshwater ecosystems, the identity of the primary growth-limiting nutrient for marine phytoplankton appeared to be generally predictable from water column total nitrogen: total phosphorus (TN : TP) ratios.

147. The data presented confirm that phytoplankton algae have a common response to the TN:TP ratio, regardless of whether they are marine or freshwater in origin. The threshold TN:TP ratio at which strong N limitation of algal growth occurs (TN :TP, 20 : 1) appears to be very similar and may be statistically indistinguishable in marine and freshwater ecosystems. The stoichiometry of N and P

[8] Val H. Smith. Department of Ecology and Evolutionary Biology, University of Kansas, Lawrence, Kansas 66045 Limnol. Oceanogr., 51(1, part 2), 2006, 377–384 q 2006, by the American Society of Limnology and Oceanography, Inc. “Responses of estuarine and coastal marine phytoplankton to nitrogen and phosphorus enrichment”

supplies to the water column thus has a central and essential control on phytoplankton primary production in freshwater, estuarine and coastal marine ecosystems worldwide.

148. The author concluded that strong nitrogen-phosphorus interactions reported here support previous arguments that controlling the eutrophication of coastal zone waters will likely require careful basin-specific management practices for both N and P.

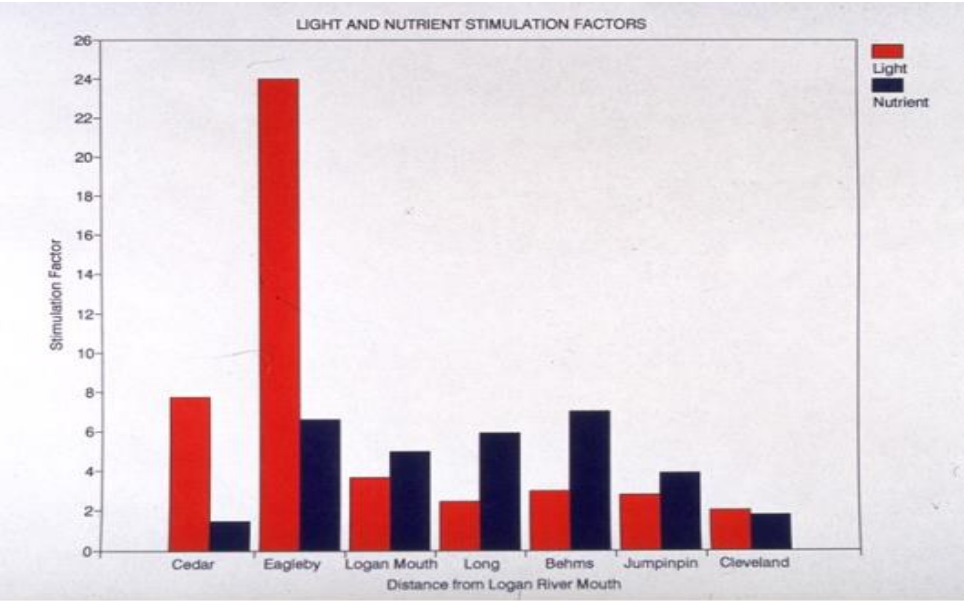
149. In conclusion, based on this and other papers, research globally indicates it is not one of the primary nutrients that will always be growth limiting, but rather the ratio which presents as the growth limitation. Given that this ambient ratio will change over time due to nonpoint source inputs as well as possible future wastewater treatment activities, then it would be safer to also investigate the impact on phosphorus concentrations from the proposed outfalls.

150. The rapid mineralization of organic nitrogen, together with the rapid oxidation of ammonia to nitrite to nitrate, means that it would be difficult to model one of the nitrogen forms, together with the possible ecological uptake of any of these inorganic forms during the oxidation process. Therefore, modelling of total nitrogen would be the appropriate parameter to select for ecological management.

151. Similarly, modelling of total phosphorus would be appropriate given the dynamics of mineralization and uptake would be hard to model individually.

152. However, even elevated concentrations of the growth limiting nutrient may not result in excessive primary productivity. Light limitation can severely disrupt primary productivity and prevent excessive growth rates. The following data was extracted from the Logan, Coomera, South Moreton Bay study[9] showing the impact of light on growth reducing going from the headwaters at Cedar Creek down to the ocean at Cleveland in **Figure 2-2**.

Figure 2-2: Comparison of Light and Nutrient Stimulation on Primary Productivity



Source: SKM, 1995. Logan, Coomera, South Moreton Bay Wastewater Management Study

[9] SKM, 1995. Logan, Coomera, South Moreton Bay Wastewater Management Study

153. Sometimes, there is the potential for an ecosystem to become unstable in wet weather if the algae can rapidly utilise the additional nutrients resulting from runoff, or require some micro-nutrient which otherwise limits algal growth in dry periods.

154. However, it is common for the nonpoint source nutrients to be advected or dispersed out of the system before they can be utilized by the standing crop of phytoplankton. The Logan, Coomera and Southern Moreton Bay study showed that 90% of the nitrogen load in the Logan River was nonpoint source based, but specialist del-15 nitrogen isotope studies confirmed that 90% of the nitrogen in the phytoplankton was derived from point sources, meaning from sewage discharges. Therefore even though there may be large quantities of nonpoint source nutrients entering the bay system, these are often not effectively bioavailable and merely flush out of the system prior to the phytoplankton responding. Often the nonpoint source events are associated with elevated turbidity levels, further reducing the ability of the phytoplankton to bio-access the nutrients.

155. In addition to the phytoplankton aspect, sewage nitrogen is more energy efficient to process for the seagrass through their leaves, so it will use this source and pathway in preference to fixing atmospheric nitrogen through the rhizomes or utilising other nonpoint source nitrogen forms being available.

156. Because of this, there is no recommendation to model nonpoint source emissions as the nexus between nonpoint source nutrient fluxes entering the marine environment versus the phytoplankton response would require specialist monitoring and model development which is considered unnecessary in this case.

157. In conclusion, nutrients will be the key ecological parameter group to model, rather than dissolved oxygen or BOD.

158. Australian-based research indicated that Nitrogen is the growth limiting nutrient in the littoral and marine environment, but international research indicates algal densities are strongly correlated to the nitrogen: phosphorus ratio. Therefore both parameters should be modelled.

159. Total nitrogen and total phosphorus should be modelled to cover the dynamics of the various organic and inorganic forms. Unionized ammonia concentrations will be highly dynamic given the rapid mineralization and oxidation of organic nitrogen, in parallel with the uptake of inorganic nitrogen by phytoplankton and any benthic biomass.

160. Modelling should be restricted to point source discharges and not attempt to model the impact of nonpoint source nutrients.

2.7.4 Aquatica Ecosystem Protection – Criteria Quantification

161. As noted above, Solomon Islands does not have established water quality criteria. For bacteriological quality in recreational water quality, the ANZECC guidelines have been adopted. However, for protection of aquatic ecosystems, guideline values are unavailable in their latest publications. Therefore a literature review was undertaken looking at the progression of ANZECC guidelines, Australian state-based guidelines for similar climatic conditions and also international guidelines.

162. The Secretariat of the Pacific Regional Environment Program (SPREP) published water quality protection criteria for the South Pacific in 1996.[10] The document only provides criteria for Class A waters, meaning waters suitable for environmental research and studies and are essentially pristine. The inorganic phosphorus limit is 10 µg/l and the inorganic nitrogen limit is also 10 µg/l. For Class B waters, that is those that have some minor impact but are still ecologically sustainable, the document notes that higher values can be used but does not quantify this explanation.

163. The USEPA ambient water quality criteria recommendations relating to nutrient criteria were last updated in the year 2000 and only contained phosphorus criteria at 10 µg/l.[11]

164. In 2004, the South Pacific Islands Applied Geoscience Commission (SOPAC) produced a water quality monitoring handbook for Pacific Island countries. In this report, they merely referenced the water quality criteria in the ANZECC 2000 guidelines.[12]

165. The 2008 ASEAN guidelines only give criteria for inorganic nutrients with inorganic nitrogen at 185 µg/l and inorganic phosphorus at 15 µg/l. The guidelines did not give any indication of whether this is for highly valued sensitive ecosystems or those that are somewhat compromised.[13]

166. The European Union directive in 2008 did not provide any criteria for nutrients and only provided guideline values for heavy metals and persistent organic pollutants.[14]

167. In 2020, Palau promulgated water quality regulations which included marine water quality criteria for water body classifications A and B.[15] Marine waters Class A are slightly modified ecosystems suitable for recreation and aquatic ecosystem protection, and marine waters Class B are for modified ecosystems such as boat harbors. For Class A waters, the total nitrogen limit is 800 µg/l and total phosphorus is 25 µg/l. For Class B waters, the total nitrogen limit is 800 µg/l and total phosphorus is 500 µg/l.

168. In a 2021 water quality monitoring paper for the Suva foreshore in Fiji prepared by Lal et al, the authors noted that the best available water quality guidelines were still those presented in the ANZECC 2000 Guidelines for Fresh and Marine Waters.[16] The authors also noted there was insufficient data available to prepare locally specific guidelines.

169. The 1992 Australian Water Quality Guidelines for Fresh and Marine Waters[17] noted that:

[10] Secretariat for the Pacific Region Environment Programme, 1996.Water Quality Protection Criteria for The South Pacific, including Standards for the Discharge of Sewage Effluent.

[11] USEPA, Office of Water, Office of Science and Technology, Health - ecological criteria division, Washington, December 2000 EPA 822 – B – 00 – 023

[12] South Pacific Islands Applied Geoscience Commission Technical Report 381, SOPAC, 2004. Water Quality Monitoring in Pacific Island Countries

[13] Association of Southeast Asian Nations (ASEAN) Marine Water Quality Management Guidelines and Monitoring Manual - 2008

[14] Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council

[15] Palau Government, 2020. 2020 Marine and Freshwater Quality Regulations - Chapter 2401 – 11,

[16] Lal, Juste-Poinapen and Poinapen, Water Science and Technology Volume 84 Number 10 – 11, 2021. Assessing the Water Quality Suva Foreshore for the Establishment of Estuary and Marine Recreational Water Quality Guidelines in the Fiji Islands

[17] ANZECC November 1992Australian Water Quality Guidelines for Fresh and Marine Waters - National Water Quality Management Strategy,

"It is not possible to recommend a single set of nitrogen and phosphorus concentrations that will prevent phytoplankton problems in estuaries and coastal waters throughout Australia. Rather, it is strongly recommended that site-specific studies be undertaken to determine appropriate concentrations for each particular system. The concentration values or ranges listed below are provided as an indication of levels at or above which problems have been known to occur, depending upon a range of other factors. It is expected that, following site-specific studies, guideline values for nitrogen and phosphorus may be determined for specific waterbodies that are higher or lower than the values or ranges indicated in the text. The indicative concentration values or ranges are:

- PO_4-P: 1–10 µg/l
- NO_3-N: 10–60 µg/l
- NH_4-N: < 5 µg/l

170. The ANZECC 2000 guidelines[18] present "trigger values" for nitrogen and phosphorus in Table 3.3.4 of 100 µg/l and 15 µg/l respectively, for tropical areas such as northern Queensland. These values apply to slightly disturbed tropical waters which would be an appropriate classification for the Honiara foreshore waters. The guidelines also note that the locally developed value should be used in preference to these generic trigger values.

171. The Guidelines establish a framework for developing water quality guideline values (numbers) based on the condition of aquatic ecosystems and the levels of protection provided to those ecosystems. This represents an important starting point in the process to derive water quality guidelines. The three levels of aquatic ecosystem condition are summarized in **Table 2-5** below, and are:

- High ecological/conservation value systems (henceforth referred to as high ecological value systems);
- Slightly to moderately disturbed systems; and
- Highly disturbed systems.

Table 2-5: Levels of Aquatic Ecosystem Condition

Item	Definition
Level 1 High ecological/ conservation value (HEV) ecosystems	'These are effectively unmodified or other highly valued systems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations. While there are no aquatic ecosystems in Australia and New Zealand that are entirely without some human influence, the ecological integrity of high conservation/ecological-value systems is regarded as intact.' (ANZECC 2000; 3.1–10)
Level 2 Slightly to moderately disturbed (SMD) ecosystems 1	'Ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation; marine systems would have largely intact habitats and associated biological communities. Slightly to moderately disturbed systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism, or marine ecosystems lying immediately adjacent to metropolitan areas.' (ANZECC 2000; 3.1–10) 1

[18] Australian and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand, 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - National Water Quality Management Strategy

Level 3 Highly disturbed (HD) ecosystems	'These are measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture. The third ecosystem condition recognises that degraded aquatic ecosystems still retain, or after rehabilitation may have, ecological or conservation values, but for practical reasons it may not be feasible to return them to slightly to moderately disturbed condition.' (ANZECC 2000; 3.1–10)

Source: ANZECC 2000 guidelines

172. These levels of ecosystem protection are considered appropriate for adoption in the current study area. The high level of protection however is inappropriate given the significant development within the adjacent catchment area of the foreshore and bay area. Level 2 could be associated with the majority of the foreshore, whilst Level 3 would be associated with the port area and other heavy commercial and industrial activities.

173. The ANZECC 2018 guidelines[19] do not provide site-specific guideline values for nutrients. The guideline notes that "you should use guideline values that are relevant to your local conditions or situation. We call these 'site-specific guideline values".

174. The document then provides guidance on methods for deriving site-specific guideline values for protecting surface water aquatic ecosystems, which focus on the use of biological field-effects data, laboratory-effects data, reference-site data and the use of multiple lines of evidence.

175. The guidelines do provide Default Guideline Values (DGVs) for surface water aquatic ecosystem protection and primary industries, and direct you to DGVs for human health (e.g. drinking water, recreation and aesthetics). However, the default guideline values given are only for toxicants and not for nutrients or other ecological parameters

176. The Queensland Water Quality Guidelines were prepared by the Environmental Policy and Planning Division, Department of Environment and Heritage Protection in 2009, and updated in 2013[20]. The state has been divided into various areas and the wet tropics region would be most similar to Solomon Islands' marine environment conditions.

177. For slightly to moderately disturbed ecosystems in the tropical areas, Table 3.3.1b gives the total nitrogen and total phosphorus guidelines as 140 µg/l and 20 µg/l respectively. Given the overlap of the Queensland government area of control and the Great Barrier Reef Marine Park Authority control areas, a protocol for managing the relationship of QWQG regions' guideline values to Great Barrier Reef Marine Park guidelines has been developed. Offshore from the Enclosed Coastal zone and within waters of the GBR Marine Park, the GBR guidelines will apply. Where there are no Great Barrier Reef Marine Park water quality guidelines provided for a specific indicator, the QWQG will apply in the Marine Park. The above values reflect this agreement. Table 3.3.2 then provides further granularity to these data noting that some areas, such as outside the Endeavour River estuary, can have a total nitrogen criterion of 300 µg/l, as opposed to the general 140 µg/l for total N.

[19] Australian and New Zealand Environment and Conservation Council, 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - National Water Quality Management Strategy

[20] Environmental Policy and Planning Division, Department of Environment and Heritage Protection, 2009, and updated in 2013. Queensland Water Quality Guidelines

178. The Queensland Environmental Protection Policy in 2019[21] provided environmental water quality objectives for some North Queensland catchments such as the Daintree and Mossman River areas. In this update, the total nitrogen objective was altered to 125 µg/l and phosphorus remained at 20 µg/l for open coastal waters, and 160 µg/l for embayments and enclosed coastal waters.

179. This 2019 policy also provided some guidance on relative objective levels in the dry and wet seasons. For example, it showed that the total nitrogen objective in the wet season (November to April) was approximately 10% greater than that objective in the dry season.

180. These data are presented below in **Table 2-6: Water Quality Guidelines Summary**.

Table 2-6: Water Quality Guidelines Summary

Source	Total Nitrogen (µg/l)	Total Phosphorus (µg/l)	Comments
SPREP 1996	10	10	Class A waters (high value areas)
USEPA 2000	-	10	
SOPAC 2004	100	15	ANZECC 2000 values adopted
ASEAN 2008	185	15	Inorganic fractions only
EU 2008	-	-	Toxicants only
Palau 2020	800	500	Class B waters (Slightly to moderately impacted)
Fiji 2021	100	15	ANZECC 2000 values adopted
ANZECC 1992	65	10	Inorganic fractions only
ANZECC 2000	100	15	
ANZECC 2018	-	-	No values given
QWQG 2009/2013	140	20	For high value areas
QWQG 2009/2013	300	20	For areas impacted by local river systems
QWQG 2019	125	20	For open oceanic waters
QWQG 2019	160	20	Embayments and near shore waters – dry season
QWQG 2019	180	20	Embayments and near shore waters – wet season

181. There are a number of factors that need to be considered on the appropriateness or otherwise of these guidelines, and the likelihood of meeting this threshold.

- The marine ecological surveys along and contiguous to the two proposed outfall routes indicated very little marine benthos was present. It is basically just sand and mud. So elevated nutrient concentrations offshore may in fact assist in developing more benthic biomass leading to a more robust marine ecosystem locally.
- Significant areas of the catchment will still remain unsewered, and it is expected that at least some septic tanks will still be directly connected to local drains and riverine systems for some

[21] Environmental Protection Water And Wetland Biodiversity Policy, Environmental Policy and Planning Division, Department of Environment and Science – Daintree and Mossman River Basins Environmental Values and Water Quality Objectives, 2019

years. Also, there are small piggeries established in the catchment as well as unsewered areas using outdoor pit toilets. Therefore, there will still be significant nutrient loads due to these nonpoint source discharges, which will occur even in dry weather.

- There will be very wide variations in the nonpoint source (NPS) loads depending on whether it is a wet or dry period. Other catchment activities such as ongoing land parcel development and logging all increase nutrient concentrations in rainwater run-off. These would also add to the nutrient levels entering the bay in wet periods.
- Furthermore, when there is a significant nutrient elevation in waters close to the shore associated with wet weather runoff events, turbidity is likely to increase significantly at the same time. Therefore, there will be less chance of these NPS nutrients being bioavailable prior to being dispersed through tidal activities, waves and general dispersion.

182. Whilst there is significant variation in the above guideline values, it would appear *that 200 µg/l for total nitrogen and 25 µg/l for total phosphorus would be appropriate for slightly to mildly disturbed near-coastal waters* with such a highly developed catchment in the more critical dry season. This will be less than the levels currently being monitored near existing outfalls along Honiara foreshore areas.

183. A compliance time component could also be applied to these nutrient objectives at a later date once monitoring results become available during outfall operation.

184. It is important to note that total nitrogen and total phosphorus are merely indirect indicators of ecosystem stress. The direct measurement of ecosystems would require ongoing marine water and benthic surveys, as well as testing for primary productivity, such as chlorophyll-a. Chlorophyll-a modelling is possible but would require a number of years of very advanced monitoring to determine the local relationship between nutrients and productivity, taking into account items such as highly variable turbidity due to the sediment load coming from the local rivers, need for micronutrients, sunlight penetration and so on.

185. Therefore it is considered that at this time that direct ecological monitoring and modelling are too complex and that indicators such as total nitrogen and total phosphorus will be valid substitutes. If in the future local monitoring does indicate ecosystem impacts, then the testing regimes can be modified to include direct ecological monitoring. However given that there is little benthic biomass in situ at present, this is very unlikely to be an outcome.

2.8 Proposed Classification Foreshore & Water Quality Objectives

186. There is currently no systematic monitoring or classification of water quality on the Mataniko River nor on the foreshore in Honiara. Observations and simulations were undertaken during the development of this Background Information Report to quantify existing water quality conditions.

187. As shown in **Figure 2-3**, the objectives for the short-term (terminology used in referenced report for the period 2025 to 2050) and long-term (Post 2050) horizons (which are based on the hydraulic network construction phases) aim for Class B Microbial Recreational Guideline along Point Cruz and Mataniko River In the “short-term”, with an evolution to Microbial Recreational Guideline Class A in the long-term. As for the coastline between Point Cruz and Ranadi area, the evolution is from Class C Microbial Recreational Guideline to Class B Microbial Recreational Guideline. Finally, around the Ranadi Industrial area, the objective is to evolve from Class D Microbial Recreational Guidelines to Class C Microbial Recreational Guidelines in the long-term. These objectives are based on impacts from the local industrial activities, and the network design configuration where two outfalls operate

during the short-term (NRH and Ranadi) and only one outfall with a wastewater treatment plant (Ranadi) during the long-term.

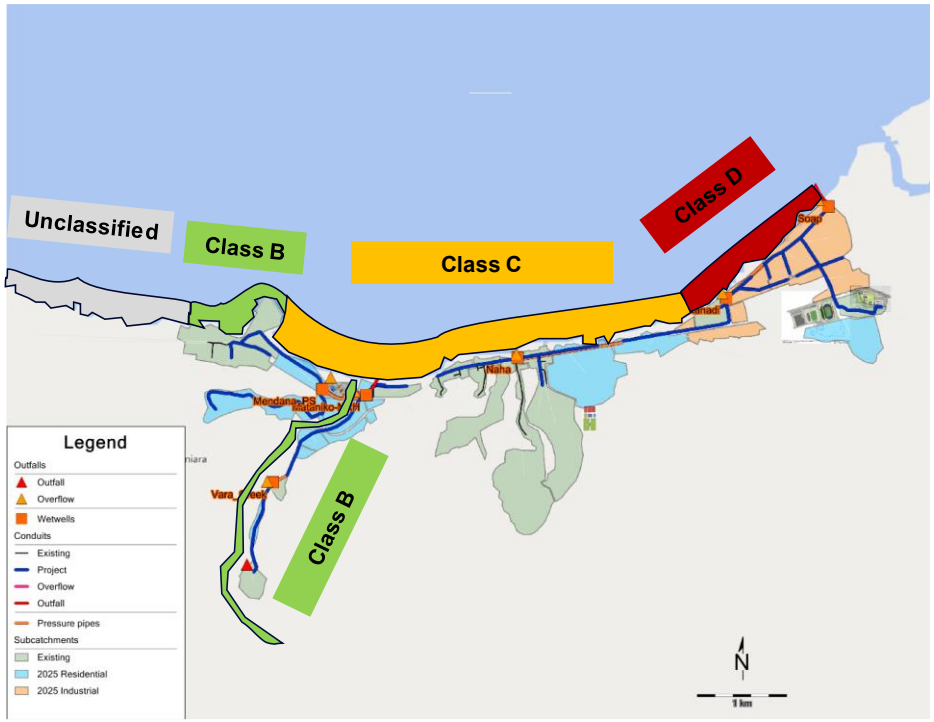
188. With respect to aquatic ecosystem protection, the classifications provided in ANZECC are considered appropriate. The high-value area classification is usually retained for precincts such as marine parks being reserved for research and long-term conservation. This classification is too restrictive for the Honiara foreshore which is highly impacted by the adjacent catchment development.

189. The slightly to moderately disturbed classification would be appropriate for most of the foreshore embayment where there are some impacts from the catchment development and also from the proposed sewage outfalls with the marine ecology worthy of protection.

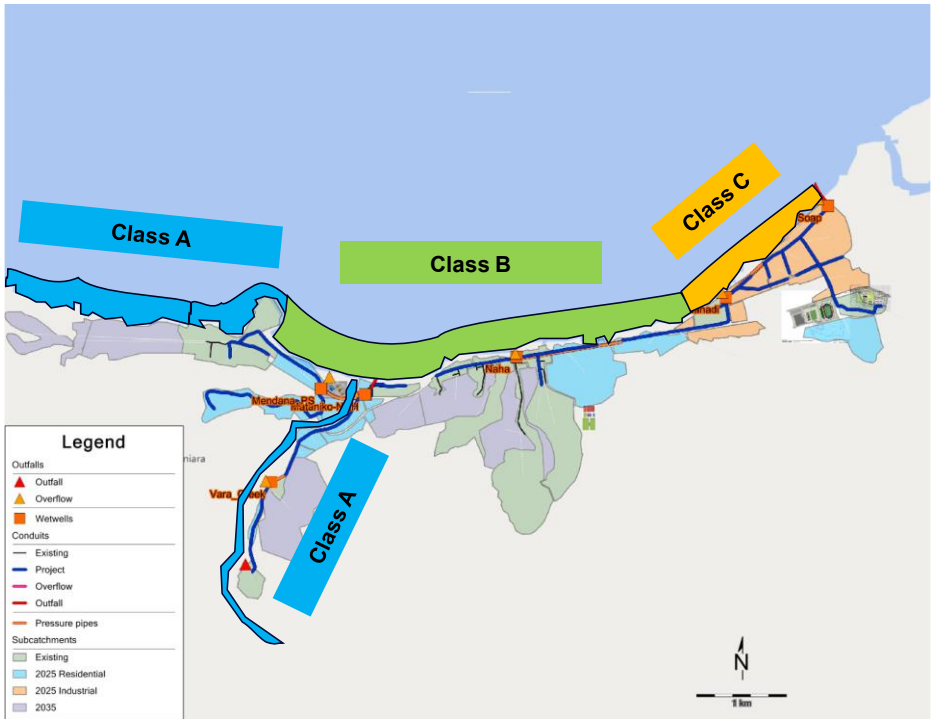
190. The highly disturbed classification would be appropriate for the various wharf areas and other heavy industrial and commercial activity precincts. In these areas, the proposed nitrogen and phosphorus concentrations could be exceeded as there are already other activities impacting upon the marine ecosystem locally.

Figure 2-3: Proposed Zoning of Marine Microbial Recreational Areas - Water Quality Guidelines (Short Term & Long Term)

Short Term (2025-2050)



Long Term (post 2050)



Source: SW Background Information Report

3 Subproject Description

3.1 Subproject Components

3.1.1 Subproject Location

191. The subproject is located in Greater Honiara (comprising Honiara City itself and externally linked suburban areas) in the Province of Guadalcanal, Solomon Islands. Greater Honiara is the largest urban area of Solomon Islands and Honiara City is the capital.

192. The wastewater subproject covered in this EIS and to be financed under UWSSSP cover wastewater Pump Stations (PS), associated pressure and gravity sewer mains, and ocean outfall construction.

193. As a result of the topographical survey and staging to minimize costs and provide an affordable budget schedule, the proposed system upgrade has been divided into two systems (the NRH system covering the West, and the Ranadi system covering the East).

194. The collection system of Honiara has been redesigned to cover (i) upstream PSs and sewer networks and (ii) main PSs and ocean outfalls.

195. The subproject is planned in 4 phases as described below. The following sections are drawn principally from the Background Information Report 2021[22] and meetings with the consultant SUEZ during the preparation of the EIS:

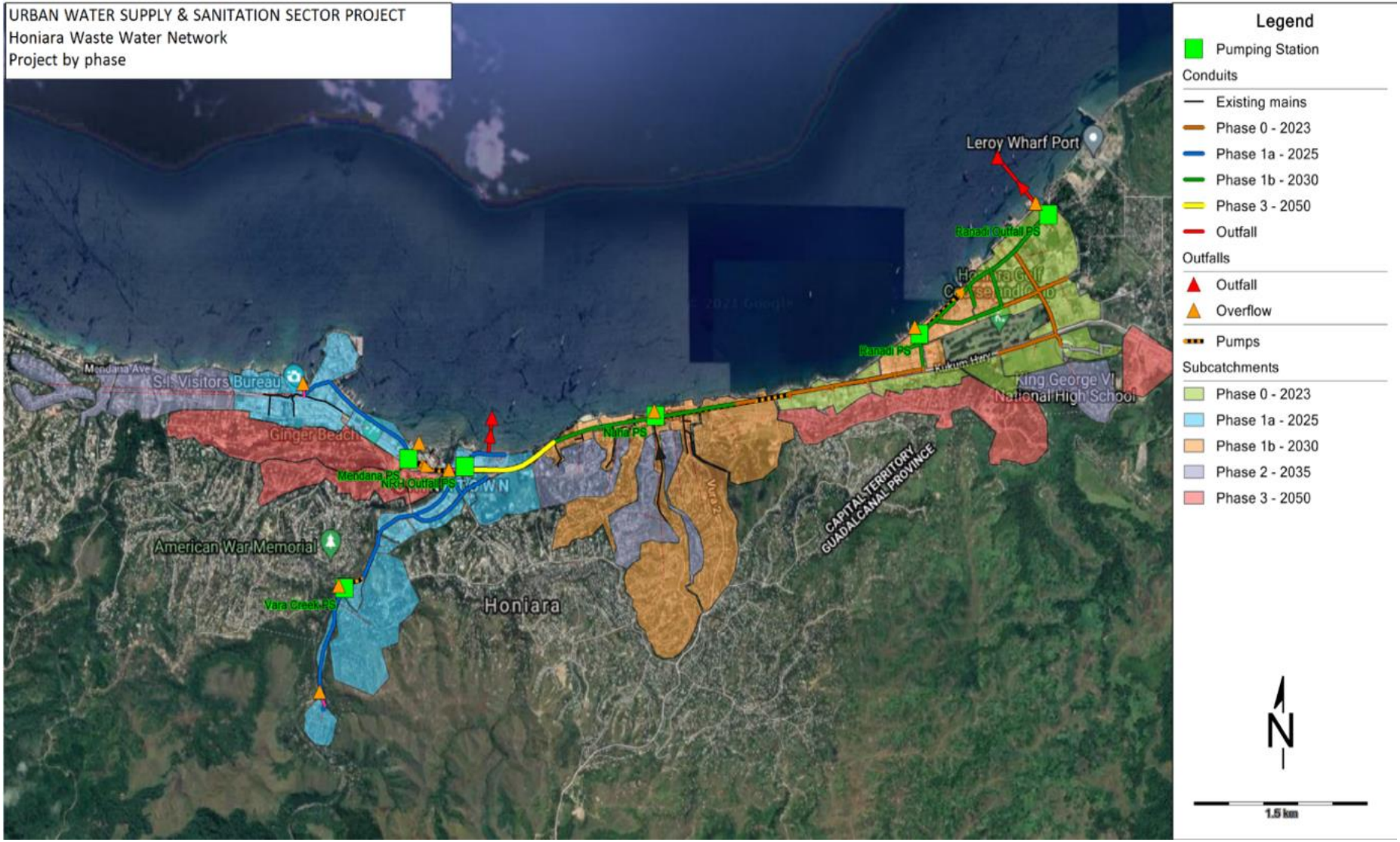
- **Phase 0 (2023)**: the rising main and PSs capacity are designed to collect the effluents of the mid-term peak dry weather flow (Phase 2) of the industrial area between KGVI school and Goodwood industry. For the purpose of work coordination with the road infrastructure department, two sections of Phase 1B scope are included in Phase 0 scope: the industrial area between KGVI school and Goodwood industry and the main road section between the fisheries and Ranadi roundabout;
- **Phase 1A (2025)**: the rising main and PSs capacity are designed to collect the effluents of the long-term peak dry weather flow (Phase 3) of the NRH system. At this phase, 410ha of sub-catchments and one sports venue are connected to the network (Lawson Tama sports centre);
- **Phase 1B (2030)**: the rising mains and PSs capacity for the Ranadi catchment are designed to collect the effluents of the long-term peak dry weather flow (phase 3). At this phase, the two sections constructed in phase 1A are connected to the complete system with an additional 111ha of sub-catchments;
- **Phase 2 (2035)**: the network structure remains the same and an additional 127ha of sub-catchments are connected to the network;
- **Phase 3 (2050)**: in the long-term, it is planned to direct all wastewater into a single outfall at Ranadi Landfill PS. The structural addition after phase 3 is the construction of a rising main from NRH outfall PS to Naha gravity main. The NRH outfall will be retained for emergency purposes. Consideration will also be given to installing wastewater treatment at the Ranadi

[22] Solomon Water, 2021. Background Information Report - Honiara Wastewater Components, Guadalcanal, Solomon Islands.

outfall PS site. Also during this phase, an additional 175ha of sub-catchments is to be connected to the network.

196. **Figure 3-1** shows the proposed subproject for Honiara wastewater.

Figure 3-1: Proposed Subproject for Honiara Wastewater



Source: Network design note, October 21

3.1.2 Pump Stations and Associated Sewer Lines

197. This subproject will include laying of approximately 15.0 km of pipes split between gravity mains (12.6 km) and rising mains (2.4 km), ranging from DN200 to DN800 constructed of PVC/HDPE, relocation and closure of the existing Point Cruz Pump Station (PS) and the construction of 4 small PS.

198. This subproject will include the construction of two outfall PSs (PS NRH and PS Ranadi Outfall) that will pump the effluent into the ocean through two outfall pipes with an internal diameter of 400 mm and 800 mm respectively and a length of 350 m for NRH and 500m for Ranadi.

199. Additional connections will include new sewered areas and also the communal septic tanks outfalls at Tuvaruhu and Vara Creek along the Mataniko River.

200. The sub-catchments connected to the collection network are subdivided into three types:

- The existing sub-catchments which represent the areas where the population is connected to the existing wastewater network;
- The future connections which represent the extended urban area that is planned to be connected to the project's network;
- The future industrial connections represent the extended industrial area that is planned to be connected to the subproject's network.

201. The network design is validated for Peak Wet Weather Flow (PDWF) being equal to 5 times Average Dry Weather Flow (ADWF) for all catchment types with an additional percentage of groundwater infiltration. This is the standard ratio used in many countries and is considered appropriate.

202. Note that the current design of all elements takes into account the potential impacts of climate change, as presented in section 4.1.1.

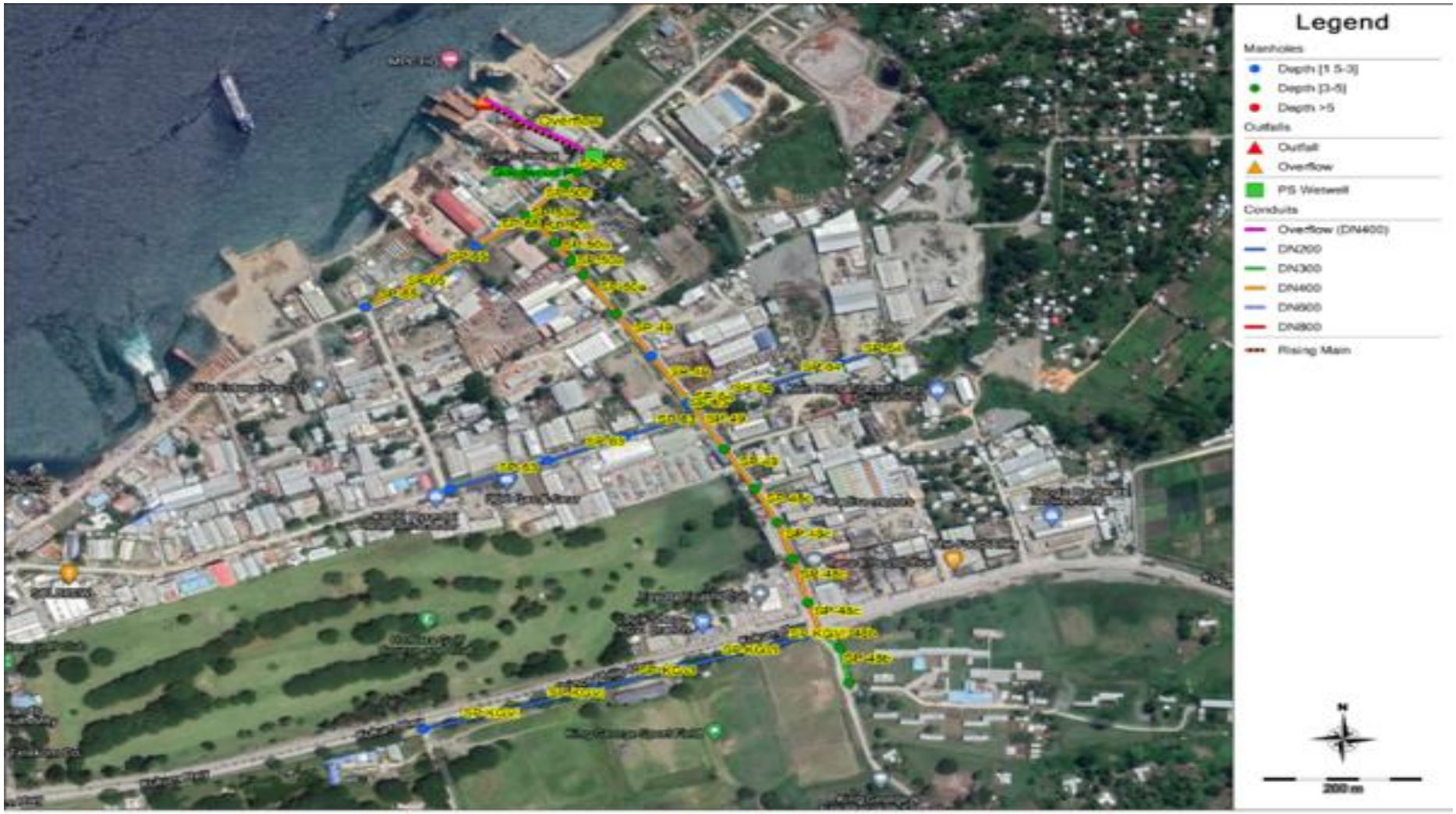
3.1.2.1 Phase 0 – KGVI to Goodwood and Fisheries to Ranadi roundabout system

203. The first system (see) covers the area from KGVI to Ranadi industrial zone. The main purpose of the system is to collect and discharge effluents from the new stadium before the Pacific Games. The network extends to the shore to collect additional discharge from the industrial area. In order to discharge the wastewater to the sea, a package PS is located at the end of the network (called Goodwood PS).

204. This system will connect into the Ranadi network when it is constructed in Phase 1B, and the temporary Goodwood PS abandoned.

205. The second system (see Figure 3-3), Fisheries to Ranadi roundabout, is located on Kukum highway and split into two gravity mains and one rising main.

Figure 3-2: Overview of Honiara Wastewater System – KGVI to Goodwood



Source: Network design note, October 21

Figure 3-3: Overview of Honiara Wastewater System – Fisheries to Ranadi roundabout

Source: Network design note, October 21

3.1.2.2 Phase 1A – NRH system

206. The NRH system (see Figure 3.4) extends from Point Cruz in the west to the hospital in the east. It also takes into account the catchments along the Mataniko River and potential new catchments upstream of Point Cruz and also along Mendana Avenue, the new stadium area and the areas around the existing MID/Solomon Water offices. The pipe network is divided into two sub-phases as shown in **Table 3-1: NRH Pipework Stages** below:

Table 3-1: NRH Gravity Pipework Stages

Profile ID - NRH 1	***SP-01***	***SP-02***	***SP-03***	***SP-04***	***SP-05***	***SP-06***	***SP-07***	***SP-08***
Length (m)	330	223	480	70	347	329	255	357
DN average (mm)	225	244	300	300	300	320	400	454
Material	PVC	PVC	PVC	PVC	PVC	PVC	HDPE	HDPE
#Manholes	8	5	10	2	6	6	4	8
Average Depth	2.4	2.5	5.6	2.4	3.1	3.4	4.0	5.0
Min Depth	2.0	2.0	2.9	2.4	2.2	2.6	3.1	4.0
Max Depth	3.4	3.5	8.0	2.4	4.6	3.9	5.0	5.8

Profile ID - NRH 2	**SP-21**	**SP-22**	**SP-23**	**SP-24**	**SP-15 to 19**	**SP-20**	**SP-27**	**SP-28**
Length (m)	265	315	317	230	789	395	174	258
DN average (mm)	225	225	225	225	600	400	225	225
Material	PVC	PVC	PVC	PVC	HDPE	HDPE	PVC	PVC
#Manholes	5.0	8.0	9.0	3.0	11.0	8.0	4.0	10.0
Average Depth	2.5	3.2	2.2	1.6	3.5	1.6	2.8	3.3
Min Depth	1.8	2.1	1.7	1.5	2.1	1.5	2.3	2.6
Max Depth	3.1	5.0	2.6	1.7	4.8	1.9	3.2	4.0

Source: Suez. October 2021. Network design note

207. Two intermediate PSs are located in this system. The relocated Point Cruz PS to Mendana roundabout is planned to pass along the foreshore behind Hyundai Mall, the Central Market and two churches to avoid potential disruptions to Mendana Avenue. (the Market or SIPA PS).The Vara Creek PS is essential due to the topographic context in the area, meaning that the local sub-catchments cannot drain to connect into the other PS located along the foreshore.

208. The purpose of the network is to collect the effluent at a common point near the hospital, next to the existing hospital treatment plant. From this point, effluent will be pumped (New PS NRH) into the ocean through the proposed NRH outfall. This new PS NRH will be fed by 3 mains.

209. The NRH PS is in fact two PSs within one footprint. A small PS is serving the hospital which then lifts the wastewater into the main PS serving the outfall. In effect though, it is one PS.

Figure 3-4: Overview of Honiara Wastewater System – NRH system

Source: Network design note, October 21

3.1.2.3 Phase 1B- Ranadi system

210. This system extends from Bahai to Ranadi Landfill. The purpose of the network is to collect wastewater at a common point – from this point, it will be pumped from a new PS at Naha to the Eastern Area, then from a new PS at Ranadi and finally to the outfall PS at Ranadi landfill. The three PSs collect wastewater from a gravity main along Kukum Highway to Ranadi and additional connections at Ranadi. The outfall PS discharges effluent into the ocean through the second proposed outfall located near the Ranadi landfill. The pipe network is divided into three sub-phases as shown in **Table3-2: Ranadi Pipework Stages** below:

Table 3-2: Ranadi Gravity Pipework Stages

Profile ID - Ranadi 1	SP-29	SP-30	SP-31	SP-32	SP-33	SP-34	SP-38	SP-39	SP-40	SP-41	SP-42	SP-56
Length (m)	249	287	396	181	343	347	204	289	320	386	246	197
DN average (mm)	600	600	600	400	400	500	700	700	700	700	800	225
Material	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	HDPE	PVC
#Manholes	3	4	6	3	4	5	3	4	4	5	4	4
Average Depth	4.3	5.1	5.2	1.9	3.5	4.0	2.7	3.0	3.5	5.7	6.2	2.5
Min Depth	4.0	4.6	4.6	1.6	2.8	3.5	2.5	2.7	3.4	4.7	6.1	2.1
Max Depth	4.5	5.6	5.9	2.2	3.9	4.7	2.9	3.3	3.7	6.2	6.4	2.9

Profile ID - Ranadi 2	SP-57	SP-58	SP-59	SP-60	SP-61	SP-62	SP-45	SP-44	SP-51	SP-52
Length (m)	108	306	173	305	284	322	197	83	576	108
DN average (mm)	225	225	225	225	225	225	800	800	800	800
Material	PVC	PVC	PVC	PVC	PVC	PVC	HDPE	HDPE	HDPE	HDPE
#Manholes	2	5	3	4	3	5	5	2	11	4
Average Depth	1.8	3.9	2.4	2.2	2.0	3.1	3.2	2.6	4.6	5.3
Min Depth	1.8	2.4	2.2	2.1	1.8	2.7	2.3	2.6	3.8	5.1
Max Depth	1.8	6.3	2.5	2.3	2.3	3.5	3.7	2.6	5.3	5.5

Profile ID - Ranadi 3	SP-KGVI	SP-48a	SP-48b	SP-48c	SP-49	SP-50a	SP-63	SP-64
Length (m)	525	75	91	245	329	193	347	271
DN average (mm)	225	300	300	400	400	400	225	225
Material	PVC	PVC	PVC	HDPE	HDPE	HDPE	PVC	PVC
#Manholes	6	3	3	5	5	6	5	5
Average Depth	2.5	3.5	4.0	4.0	3.2	3.6	2.0	2.9
Min Depth	1.7	3.2	4.0	3.8	2.9	3.3	1.5	2.7
Max Depth	3.8	3.8	4.1	4.4	3.6	3.9	2.7	3.1

Source: Suez. October 2021. Network design note

211. The two sections constructed earlier (KGVI to Goodwood and Fisheries to Ranadi) will be connected into the Ranadi system, and the Goodwood PS abandoned.

212. The proposed sewerage layout for the Ranadi system is shown in **Figure 3-5.**

Figure 3-5: Overview of Honiara Wastewater System – Ranadi system

Source: Network design note, October 21

213. In addition to the gravity mains in the above systems, overflow pipes will also be installed as per **Table 3-3: Overflow Lengths and Diameters** below. Note that these overflow pipes will be connected either into the wet well at the relevant PS or an upstream manhole.

Table 3-3: Overflow Lengths and Diameters

Name	Length	Diameter
	m	mm
Vara Creek	55	300
Market PS	20	400
NRH Outfall PS	125	400
Naha	125	400
Ranadi	85	525
Ranadi Outfall PS	165	800

Source: Suez. October 2021. Network design note

214. There are also rising mains from the PSs as well as the two outfalls. **Table 3-4: Rising Mains and Outfalls** below shows the diameter and length of the rising mains and two ocean outfalls.

Table 3-4: Rising Mains and Outfalls

Name	Length	Diameter	Diameter Outfall	Outfall in-land	Outfall sea
				Length	Length
	m	mm	mm	m	m
Vara Creek	55	300			
Market PS (SIPA)	20	400			
NRH Outfall PS	125	400	400	440	350
Naha	125	400			
Ranadi	85	525			
Ranadi Outfall PS	165	800	800	165	500

Source: Suez. October 2021. Network design note

3.1.2.4 Pumping Stations

215. The design of the sewer network of Honiara includes 6 PSs. Their role is to pump effluent at locations where flows cannot be transferred by gravity. The principal is to collect the wastewater in a wet-well where the pumps are installed to raise the total head of the effluent and have effluent enter a rising or pressure main. The effluent then flows into another gravity trunk main or an ocean outfall installed downstream. The layout of the pumping system is shown in **Figure 3-6; Overview of Honiara Wastewater System - Pump Stations** below.

Figure 3-6: Overview of Honiara Wastewater System – Pump Stations

Source: Network design note, October 21

216. In addition to the six new PS, the existing Point Cruz PS needs rehabilitation in order to manage the future flow rates. It has been chosen to abandon this PS and transfer the wastewater by gravity from the Point Cruz area to a new PS at Mendana avenue, called the Market PS, when the market PS is constructed.

217. The six PSs are described below:

- **Vara Creek PS**: the PS is located at the beginning of Chung Wah road and collects the wastewater from the Vara Creek existing catchment, Tuvaruhu catchment and the sub-catchments upstream;
- **Market PS (also termed the SIPA PS)**: the new proposed PS is located at Mendana Avenue roundabout before the bridge at Mataniko river. The PS will collect the wastewater from Point Cruz and Mokonavera's catchments;
- **NRH PS**: as mentioned above, this PS in fact contains two separate pumping systems. One is a small wet well just to serve the hospital and then lift the waste into the main PS wet well which discharges the effluent through the ocean outfall. Whilst it is shown as two separate PSs on the plan below, both PSs are in fact contained within the one site. The main PS collects the wastewater from Point-Cruz, Mataniko and Mbokonavera catchments. In phases 1A and 1B, the PS discharges to an outfall pipe to the sea. In phase 3, the objective is to operate with a single outfall at Ranadi PS. Thereafter, the NRH outfall will be retained just as an emergency-outfall pipe and NRH PS connected to the Naha sub-catchment via a rising main;
- **Naha PS:** it is located on the coast on Kukum Highway. In phases 1A and 1B, the PS collects the wastewater from Naha and Vura sub-catchments and from the sub-catchments covering the coastal highway (Kukum, Bahai, and Sinu). In phase 2, the PS will also accept flow from the NRH PS;
- **Ranadi PS**: the PS is located on the street of the Electricity Authority building. It collects the wastewater from Naha PS and from the local sub-catchments upstream.
- **Ranadi landfill outfall PS**: it is located downstream of the sewer network on the coast at Burns Creek. The PS collects the wastewater from Ranadi PS and King George VI catchment. The PS discharges to an outfall pipe to the sea.

218. With the Vara PS, for topographical reasons, it has to be located at the bottom of the catchment so all local wastewaters can flow by gravity to the wet well at the PS. As a result of this location imperative, the PS is located in an area subject to occasional flooding. Level information related to the PS is as follows:

- The riverbank is 1.75m aMSL.
- The natural surface level at the PS is 3m aMSL
- The design flood level at the PS is 4.5m aMSL
- The electrical panel is designed above 4.5m aMSL

219. Therefore, whilst the lower concrete work associated with the PS may be inundated at design flood flows, the electrical work will be above the design flood level and will not be damaged. The PS would still be able to operate. **Table 3-5** presents design details of the proposed PSs.

Table 3-5: Proposed Pump Stations - Dimensions and Capacities

Pump Station	Total Flow Phase 1 and 2 (l/s)	Total Flow Phase 3 (l/s)	Duty Pumps (N°)	Spare Pump (N°)	Wet Well Invert Level (aMSL)	Power Motor + 10%/pump (kW)	Variable Frequency Drive
Vara Creek	32	32	1	1	-0.7	5.69	No
Market	110	130	2	1	-3	15.15	No
NRH Outfall PS	180	215	2	1	-2.6	29.91	Yes
Naha	200	430	2	1	-2.5	9.41	No
Ranadi	230	491	2	1	-4.1	24.03	No
Ranadi Outfall PS	340	576	2	1	-4.5	22.88	Yes

Pump Station	Invert Level	Total Height of wet well	Useful Height of wet well	Wet-well max useful volume	Area	Diameter
	m	M	m	m^3	m^2	m
Vara Creek	-0.4	3.6	1	4.2	4.2	2.3
Market	-5.0	6.0	1	23.2	23.2	5.4
NRH Hospital	-2.2	5.0	1	2.0	2.0	1.6
NRH Outfall	-4.0	6.4	1	33.0	33.0	6.5
Naha	-6.6	8.0	1	71.9	71.9	9.6
Ranadi	-5	8.3	1	82.0	82.0	10.2
Ranadi Outfall	-5	7.2	1	97.5	97.5	11.1

Source: Network design note, October 21

220. In addition to the design data above, further information is provided on the PSs in **Table 3-6: Pump Station Environmental Aspects** below relating to the environmental aspects of the PS's design and control components.

Table 3-6: Pump Station Environmental Aspects

	NRH Outfall	Market	Naha	Vara	Ranadi	Ranadi Outfall
Standby pumps - are these automatically started when the wastewater level reaches a higher level electrode in the wet well.	Yes	Yes	Yes	Yes	Yes	Yes
Standby power generators provided	Yes	Mobile Genset				Yes
What type of fuel storage will be provided – the built-in tank within the generator chassis or a separate elevated fuel tank,	Built-in	N/A				Built-in
Overflows provided,	Yes	Yes	Yes	Yes	Yes	Yes
Time before overflow occurs if both pumps fail (determined at ADWF say?)	Between 10 and 15 min					
Overflows fitted with screens,	Not in specifications, but can be installed after construction, during operation, if later considered necessary.					
Any storage provided apart from the wet well prior to overflows occurring	No					
Any alarms (sirens, external flashing lights, back-to-base phone calls, etc.)	SCADA system at all PSs					

Source: SUEZ Pers Comm, September 2022

221. All six PSs are fitted with standby pumps that will automatically start if the duty pumps fail to start or cannot pump at a rate sufficient to lower the wastewater level in the wet well. This is desirable at all PSs as it reduces the risk of overflows from the network.

222. Standby power generation is to be provided permanently at the two outfall PSs and by using portable generators at the other four smaller PSs, as and when required. Both the permanent and portable standby generators will have fuel cells contained within the generator chassis. Therefore there will be no need to have a separate fuel tank or a tank farm at any of the PSs. This obviates the need for special bunding and other hardstand requirements as for a dedicated fuel storage facility.

223. A controlled outlet (called an overflow) is to be provided either at the PS wet well or at an upstream manhole in all catchments. This means that any overflows or surcharges from the network are managed in a controlled manner, usually directing flows to local drains or watercourses, rather than surcharging manholes throughout the sewer catchment and introducing health risks to the community.

224. The overflows are not to be initially fitted with screens, but they can be retrofitted at a later date if found necessary. Screens are usually provided to prevent the discharge of gross solids and rags which can cause community upset if observed in local waterways. However, in PSs of such a relatively small size, screens would not be automatically raked or cleaned and would be susceptible to blockage. That is why not having screens on overflows is often the preferred solution from an operational viewpoint. The impact of any overflow events on the community and the environment can be assessed during operation, and if considered necessary, a screening system can be retrofitted.

225. No dedicated overflow storage is provided in the network, and this is not unusual. Dedicated overflow storage is usually only provided for sewerage networks located in the most susceptible environments. The wet wells provide an average of 10 to 15 minutes of operational storage (above the level of the

cut-in electrode for the standby pump) before overflow. This storage time is typical of many wastewater PS systems.

226. All PSs are connected to the SCADA network. This means that the operation of the PSs can be monitored remotely and in the case of the larger PSs, can actually be run from a remote location by overriding the automatic systems at the PS itself. Therefore if any faults are occurring in the system, a rapid response is possible to minimise any environmental impacts resulting from pumping infrastructure failure.

227. All pump stations, even the small ones, are equipped with a SCADA system so there will be real-time alerts sent to maintenance teams if the wastewater level in the wet well goes above the normal operating level. This would allow maintenance crews to rapidly respond and undertake any maintenance or repairs required at the pump station, hopefully avoiding most overflow events. As noted above, initially the wastewater flows going through the system will be only a fraction of the ultimate design capacity to be reached in the following 25 years. Therefore there will be ample time to monitor the performance of the pump stations including the frequency and impacts of the overflows to then be able to consider interventions such as larger pump capacities, different pump station operation in terms of electrode cut in-cut out levels, potential retrofitting of overflow screens and possibly phasing of pumping times where pump stations are piggybacked. This allows flow rates into downstream pump stations to be better controlled.

3.1.2.5 Sewer and Pump Station Construction Methods

228. Both the gravity sewers and pressure (rising) mains have a similar construction approach as follows:

- Final planning of route and surveying
- Completion of all permitting requirements
- Confirmation that the right-of-way, easement or ownership is finalised for the exact route
- Community information campaign for affected stakeholders
- Signposting of route and installation of barriers and safety warnings
- Topsoil, or hard stand in the case of footpaths or road easements, is removed
- Trench excavated in lengths to suit the laying speeds, so that time that trenches remain open is minimised. In unstable soils such as noncohesive soils or with high water tables, or for deep trenches, appropriate trench shoring methods would be installed.
- Excess excavated spoil hauled to an agreed stockpiling location.
- Noncohesive aggregate laid down as bedding, compacted and profiled
- Pipe installed and joined, such as by welding or solvent adhesives, depending on pipe material
- Pipe is contoured to ensure correct horizontal and vertical alignment
- Aggregate placed beside and on top of the pipe and progressively compacted
- Pipe is tested for leakage as appropriate, depending on whether a gravity or pressure pipe
- Trench is backfilled with material previously excavated with a small crown to allow for settlement and compaction
- Once the backfill is suitably compacted and stabilized, then the topsoil would be replaced or hard stand such as asphalt or concrete reapplied.

- The site would then be cleaned up and any solid waste removed to an appropriate disposal facility

229. Pump stations are all of an underground wet well design, so the general approach to construction would be as follows:

- Final planning of pump station footprint and surveying
- Completion of all permitting requirements
- Confirmation that ownership is finalised for the exact footprint
- Community information campaign for affected stakeholders
- Signposting of site and installation of barriers and safety warnings
- Site excavated to the depth required for the installation of services and any drainage requirements and to the depth required for the wet well. In unstable soils such as noncohesive soils or with high water tables, or for deep excavations, appropriate shoring methods would be installed.
- Excess excavated spoil hauled to an agreed stockpiling location. The soil does not have acidic properties and there is high demand for soil for backfilling on other projects and activities locally.
- Noncohesive aggregate laid down as bedding, compacted and profiled
- A blinding layer of concrete or a membrane installed under where the base of the wet well is to be poured
- Formwork installed to define the slab under the wet well and the wet well walls
- Reinforcing steel and any penetrations installed, such as for incoming sewers
- Concrete poured for the base slab and walls
- Formwork installed within the wet well footprint to support the reinforcing and then to pour the top slab
- Aggregate placed around the wet well walls backfilled to ground level
- Above ground building constructed with the size depending on whether it is one of the four smaller pump stations or the larger outfall pump stations.
- Upon completion of all civil works, the electrical and mechanical items would be installed such as the pump rails, pumps and all electrical power and control equipment, standby generators at the outfall pumpstations, lighting et cetera.
- Permanent security fence would be installed around the facility.
- Pump station would then be commissioned using clean water
- The site would then be cleaned up and any solid waste removed to an appropriate disposal facility

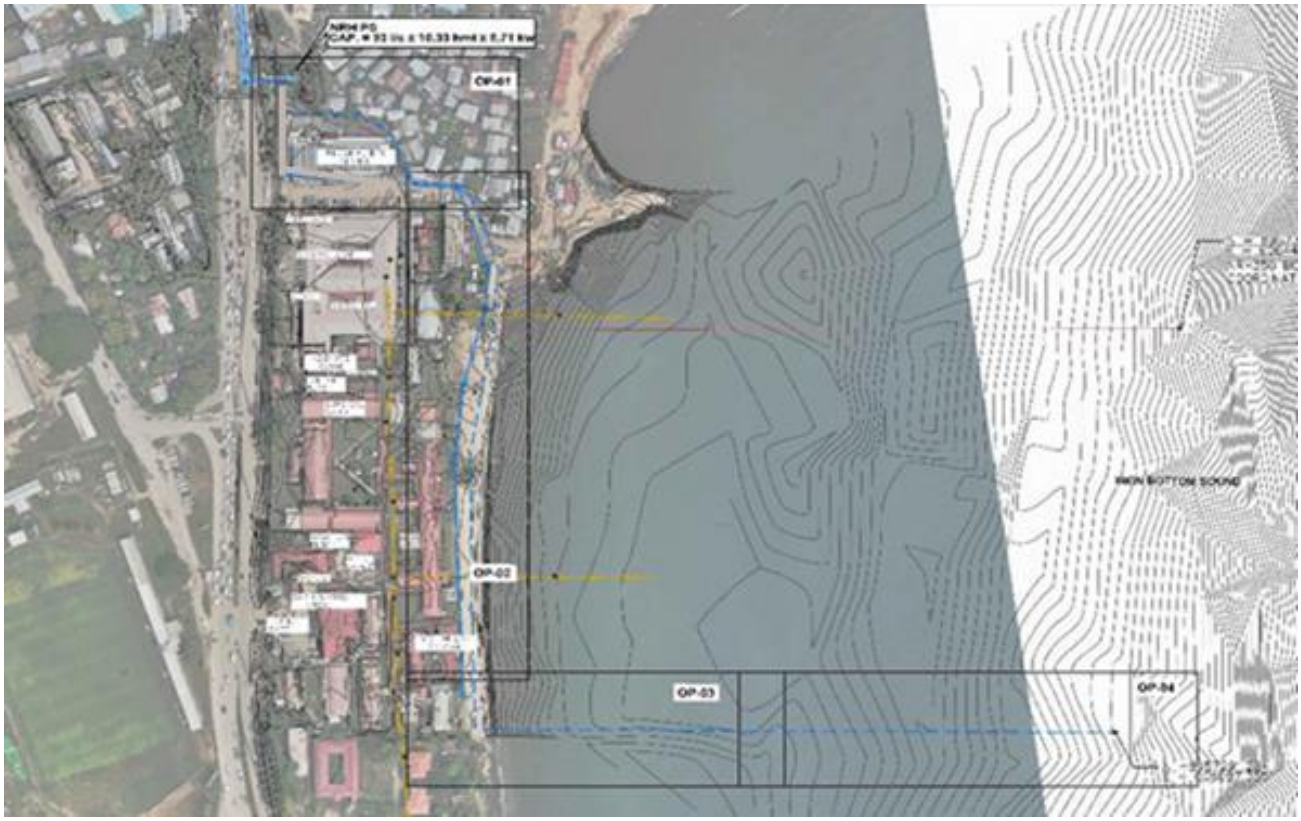
230. As part of the tender and construction approval process, contractors will be required to submit method statements for all construction activities which would provide more detail than the above, but will generally follow the steps described above.

3.1.3 Outfall Design and Construction

231. This subproject will include the construction of two new marine outfalls at the National Referral Hospital (NRH) and Ranadi Landfill. Details are provided in **Table 3-6: Rising Mains and Outfalls** above.

232. **Figure 3-7** shows the proposed location of the outfall PS, equilibrium chamber and outfall at NRH.

Figure 3-7: Proposed Location of NRH Outfall



Source: Network design note, October 21

233. The second outfall PS and outfall are located at the Ranadi Landfill site with the outfall PS located at the northwest corner of the existing landfill and the outfall surge tank located close to the outfall. **Figure 3-8** shows the proposed location of outfall PS, surge chamber and outfall at Ranadi Landfill.

Figure 3-8: Proposed Location of Ranadi Outfall

Source: Network design note, October 21

234. The design flow of the PS and the outfalls have been evaluated with a peak factor of five. (Peak Wet Weather Flow (PWWF) = 5 x ADWF for the long-term horizon).

- NRH Outfall: 180 l/s at Phase 1A and 215 l/s at Phase 3
- Ranadi Outfall: 340 l/s at Phase 1B and 576 l/s at Phase 3

235. The position of the discharge point is 350 m from the coast for the NRH outfall and 500m for Ranadi Outfall. The depth reached at the discharge point will depend on the exact alignment, but 8 m has been assumed for NRH and 30 m for Ranadi. These are the depths used in the modelling results presented later. However, based on the records from the diving activities during the marine survey, these depths would appear conservative and are more likely to be or exceed 10 m and around 40 m respectively. This means that the modelling predictions would be conservative as greater depth introduces greater initial dilution to the plume.

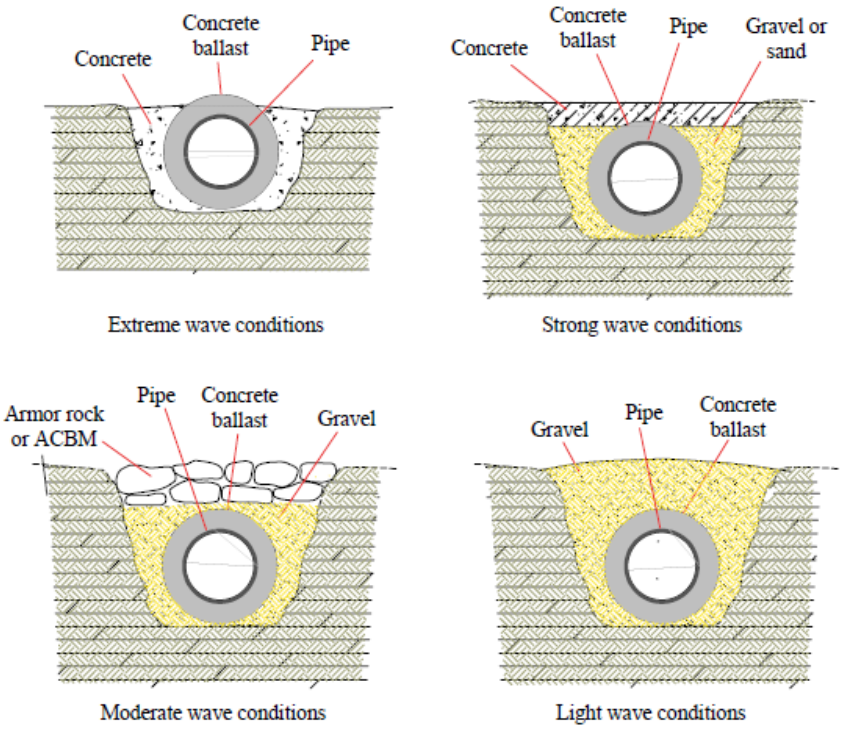
236. The flow velocities within the outfalls have to exceed a minimum of 0.6 m/s to be self-cleaning, meaning that the flow velocities in the outfalls are sufficient to ensure that solids do not settle out within the conduit and could eventually lead to blockages. The internal diameters of the outfalls have therefore been determined as:

- NRH Outfall: 400 mm diameter
- Ranadi Outfall: 800 mm diameter

237. The method of construction for the outfalls had not been finalised at the time of preparing this EIS. A geotechnical assessment of the bed profile, including at depth, has recently been made along the two outfall routes to assist in determining the most suitable construction method. This indicated that the bed material down to a depth of approximately 2 m was relatively easy to excavate, and so the trenching method would be possible.

238. There is a range of options for installing an outfall and four options are presented below in **Figure 3-9: Possible Outfall Construction Methods**, for situations where the bed material is readily excavatable. Note that ACBM refers to Articulated Concrete Block Mat in the figure.

Figure 3-9: Possible Outfall Construction Methods



Source: CERES Consultants, 2020. Preliminary UXO Study of Honiara Area

239. The amount of anchoring and protection required for the outfall, regardless of whether it is going to be trenched or placed on top of the seabed, depends upon the severity of the local wave conditions. In relation to wave conditions and associated up-lift forces, results from the hydrodynamic studies indicated generally wave heights less than 3m and bottom orbital velocities less than 0.3m/s for cyclonic conditions. Wave conditions were considered to be moderate even in cyclonic conditions due to the presence of local islands and coastlines.

240. This indicates that a configuration with an armor rock or ACBM would be appropriate, and which would also provide additional protection in the relation to observed ship anchoring.

241. It is possible that more than one design approach will be adopted and varied along the length of the outfall. For example, during the on-land chainage of the outfall, it would be fully buried as would any other gravity or rising main as part of the overall sewer network.

242. Also where the outfalls transition through the beach area and surf zone, including the intertidal zone, the outfall again would be fully buried to protect against accidental damage or vandalism when exposed above the water level.

243. For the purposes of assessing the potential environmental aspects of the construction of the outfall, it has been assumed that it will be fully trenched and then covered with a rock armor layer. This is the construction method with the greatest potential environmental impact, and therefore the assessment of potential impacts will be conservative. The particular construction method involves the largest amount of trench excavation in the marine environment, followed by the relocation of the spoil back over the pipe prior to the placement of an armor rock mat above.

244. The unknown is how the outfall will actually be laid beyond the intertidal zone. The final construction and installation method will be required to be specified by the contractor for SW to assess as part of their tender review. This will avoid any potential delays associated with agreeing the methods statement once the contract is active. Only once SW accepts the detailed approach specified in the tender, and has this agreed by the donor partners and other key stakeholders, would the contract be awarded.

245. However, based on the excavation approach being possible, it is most likely that the full length of the outfall trench would be excavated and spoil placed beside the trench. The outfall pipe would be sealed full of air, floated into position and then sunk into the trench with the diffuser head attached. Most of the excavated spoil would then be backfilled into the trench, and the rock armor layer installed. Excess spoil will slowly redisperse to form a stable bed shape by redepositing over the adjacent seabed. Based on the detailed marine benthic assessment, the seabed locally exhibits a paucity of invertebrates, vertebrates and flora with no threatened, endemic or IUCN red listed species being recorded. Thus impacts to the coastal and marine environments would be minor, very short lived and totally reversible.

246. Existing outfalls will be decommissioned once no longer required. Ones that are easily removed, such as small diameter PVC pipes discharging above the water line, will be cut off where they exit the seawall and plugged. Any small fixings such as support frames will also be removed. Some of the outfalls such as Naha and Vura are buried and concrete encased, and these will be retained in position but decommissioned and sealed.

247. Inspection of the seabed or river bed near the exposed outfalls indicated very little if any contamination as the seabed below the outfall is flushed by the tide every day, and river bed for the freshwater outfalls is flushed following significant rain events. With the submerged outfalls, the less dense sewage will float rather than sink at the outlet so contamination of the local seabed would be very minor.

3.1.4 Equipment, Schedule and Workforce

248. Most of the equipment that will be required for the construction activities is already available within the greater Honiara area. This would include mobile equipment such as excavators, end loaders, tip trucks, compactors and so on. Also, fixed equipment such as formwork and trench anchors are available. Some specialized equipment may need to be imported relating to the pumping station control systems and for outfall construction, depending upon the construction method finally adopted.

249. Construction of the facilities is envisaged to take two years for the outfalls and outfall PSs and up to three years for each of Stages IA and 1B incorporating the sewer and rising main networks, and four small PSs. Each component will be developed as a separate contract with up to 50 workers for the former and 100 for the latter (dependent on the contractors' working arrangements, and how many active sites the contractor wishes to operate at any time to expedite overall subproject completion).

250. Based on local experience with current construction activities, especially pipe laying, up to 40 % of workers will be from outside of the Greater Honiara Area. This will include the need to incorporate a small number of expatriate specialists given the difficulty of pipe installation in some locations. This is due to the high water table combined with deep trenching, necessitating specialist construction and installation techniques to achieve the required level of safety (whilst achieving suitable laying speeds).

251. However, the majority of the work required will be unskilled or semiskilled, so there will be significant opportunities for local employment drawing from the greater Honiara area. This blended labor force system will also provide a training opportunity for workers from within the greater Honiara area. They will then be able to apply for more skilled roles in later stages of the subproject rollout. As such, any social conflict is not expected.

252. For obvious reasons, scheduling of the marine works will avoid, as much as possible, the wet/typhoon season.

3.2 Hydrodynamic Modelling to Determine Marine Ecological and Microbial Recreational Impacts

3.2.1 Background

253. A model was developed to allow predictions of the future water quality in terms of bacteriological quality and nutrients. These models consist of two parts, the first being the hydrodynamic model which mimics the water movement within the study area for a range of seasons and weather impacts. The second component is the water quality module. In this case, a component was firstly developed for the bacteriological assessment, the predictions from which could then be compared with the adopted water quality objectives using the selected indicator organisms for bathing water and secondary contact recreation. A second water quality module was then developed to predict future nutrient concentrations in the area of interest, specifically total nitrogen and total phosphorus.

254. During the life of the subproject over at least four years, there have been numerous changes to the basis of design, such as the number of outfalls, different sewer catchment geometries, changing wastewater flowrates at the various outfall locations, outfall length options and associated diffuser submergence. This large number of options was assessed to determine the optimum trade-off between protection of water quality for both recreational water and ecosystem protection compared against the total subproject costs. For example, the CAPEX difference between the long and short outfall options was more than USD7 million

255. In addition to the infrastructure options assessed by the model, there were also changes during the life of the model in terms of adopted bacteriological indicator types, bacteriological indicator densities in raw wastewater and indicator die-off rates.

256. Given these numerous changes, the details below simply provide a quick summary of model development leading to the final option assessments, and then provide the results from these final options assessments, for ease of understanding. However, more detail on the development of the various options and modelling iterations are provided in **Appendix 4: Updated Marine Impact Study, May 2021** and **Appendix 5: Honiara Outfalls Note to SW, October 2021**.

3.2.1.1 Model Development

257. To validate the hydrodynamic model, current measurements were undertaken from August to September 2019. A doppler current meter was moored near the originally planned position of the NRH outfall, in approximately 40 meters of water. It was subsequently observed that while the model used in the first phase was able to predict tidal oscillations, observed currents could not be adequately reproduced when undertaking the verification stage. The consequence was that the extent of the plumes was not correctly estimated with potential underestimation of the impact on the water quality along the foreshore. In subsequent studies, the following strategy adopted was as follows:

- Use the 3D model (SEAMER) to compute a first estimation of the plume shapes (as per the previous study)
- Use a near-field model (CORMIX) to compute more precisely the width and length of the plumes by using the observed currents to drive the modelling.

3.2.1.2 Surveys Undertaken

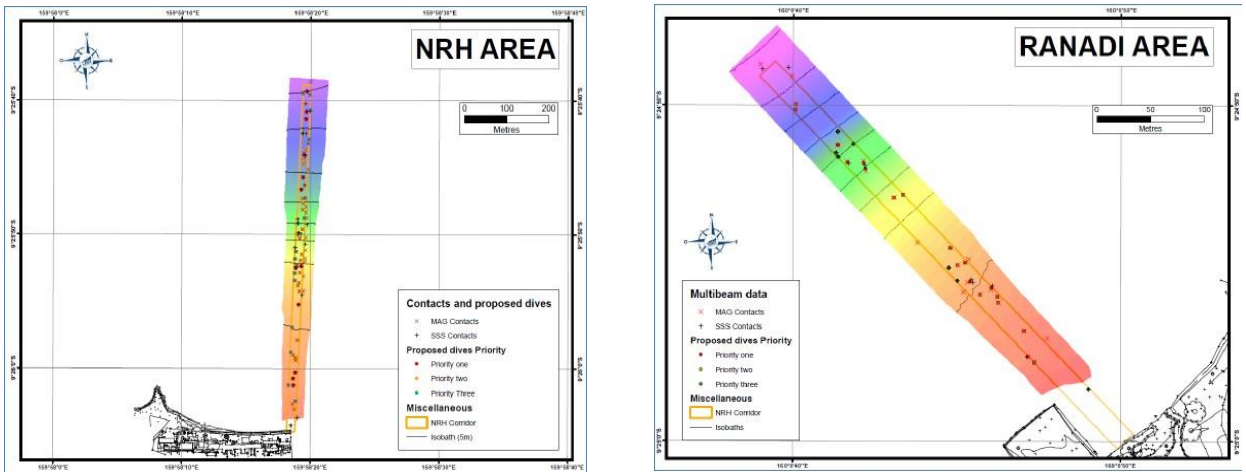
258. In addition to the ocean current surveys, a detailed bathymetric, sea bed profile and UXO surveys were undertaken in early February 2020 revealing:

- A large number of potential UXO contacts were registered from both sonar and magnetometer measurements[23], as shown in **Figure 3-10**. Divers are now to inspect these potential UXO contacts to determine if UXO clearance will subsequently be required. SW has advised that the UXO clearances must be obtained prior to going to tender for the construction of the outfalls, rather than making this a component of the contractor's responsibilities. See **Figure 3-10.**
- Small depths of unconsolidated sand on the foreshore going out to 220 m with large sand depths thereafter

[23] CERES Consultants, 2020. Preliminary UXO Study of Honiara Area

- Presence of tracks indicating a history of anchoring along the proposed alignments of the outfalls. This has implications for the type of construction of the outfalls to prevent anchor damage. Traditionally the outfall alignments are posted as “no anchor” zones but there are still cases where anchors may be deployed and damage an unprotected outfall line.

Figure 3-10: UXO Survey Report showing UXO Contacts



Source: CERES Consultants, 2020. Preliminary UXO Study of Honiara Area

3.2.1.3 Outfall Configurations Overview

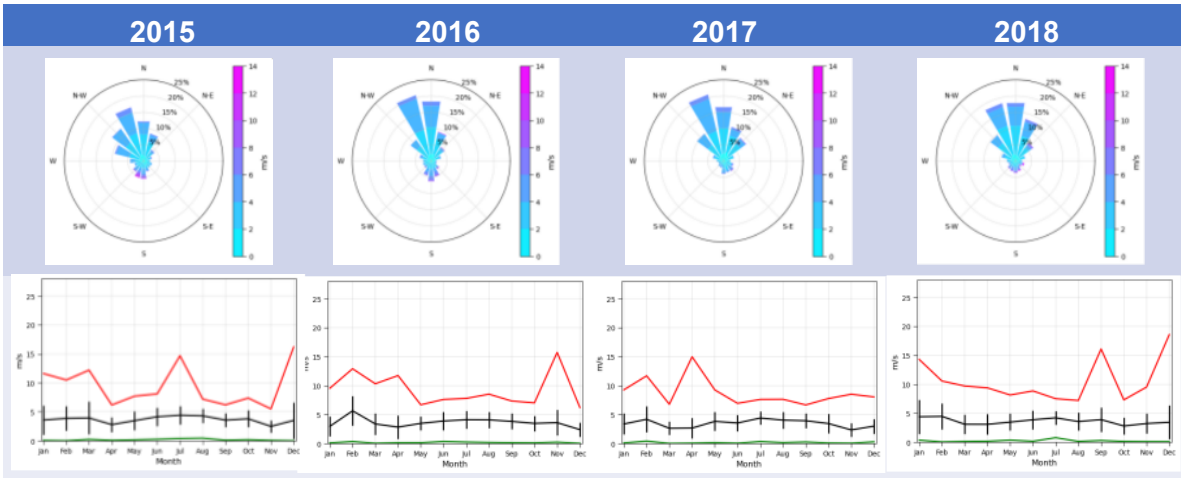
259. As part of the Basis of Design Report May 2019, a large range of options was considered in terms of outfall configurations involving one, two and three outfalls. Subsequent least cost analysis indicated that the single outfall solution was cost prohibitive in terms of the collection system Following further studies of the remaining options, the detailed design and draft tender drawings were presented to SW for review during October 2019.

260. These options were further discussed during the ADB/WB/SW Mission (October 2019). The consultant was requested to study alternative scenarios, particularly in relation to combinations of different wastewater treatment options associated with different outfall lengths, essentially generating two types of scenarios:

- Scenario 1: Long outfalls which can function in both the short and long term ;
- Scenario 2: Shorter outfalls with treatment added in the longer term.

261. The marine model was set-up for year 2017 wind and tidal conditions, selected between four years of wind and current speed data. The mean current speed is around 3m/s and the peak current speed value of 15m/s. As for the wind rose, year 2017 is representative of a typical situation as shown in **Figure 3-11**.

Figure 3-11: Annual Wind Rose and Velocity 2015 to 2018



Source: Basis of Design Report May 2019

262. With the near-field modelling system, ten different outfall scenarios were studied in order to compute the indicator bacteria concentration in the vicinity of the outfall, to estimate the length of the plumes and the impact on sensitive points (notably Point Cruz and Mataniko). The scenarios considered different outfall lengths, different treatment configurations, and different flowrates. Two time horizons were considered: short-term (2025) and long-term (2050).

263. The results showed that for long-term conditions, configurations with short outfalls (initially set at 250m) and treatment (enhanced primary) provided results at least as good as the long outfall solutions. For the short-term conditions, an outfall of length 250m was insufficient to protect the coastline, and an outfall length of 350 m was therefore proposed.

264. This latter scenario has also been tested for short-term conditions without treatment. Results indicate that the concentration is under 230 E.coli/100ml at 1250m from the outfall for all the ocean current speeds, and the width of the plume is similar to the width of other scenarios previously studied. Consequently, an NRH outfall length of 350m will avoid the plume reaching the coastline in all the current scenarios.

265. In addition, simulations demonstrate that improved results are obtained by directing flows from the Naha PS to Ranadi rather than NRH.

3.2.2 Recreational Water Quality Predictions

266. During the course of the initial subproject preparation, the recreational water quality modelling was based solely on E-Coli and did not include *enterococci*. Both E. coli and *enterococci* are now included in the recreational water quality objectives adopted for this subproject.

267. As a result, the models were rerun with *enterococci* indicating that at approximately 1700 m from the outfall (the distance of Point Cruz sensitive zones), the concentration of *enterococci* will be less than

230 / 100ml (objective for secondary contact recreation) for all cases when the current velocity is 0.3 m/s or lower. Only for exceptional cases of 0.4 and 0.5 m/s would the concentration exceed the above limit. During the period of measurement (August/September 2019) lateral coastline currents were always below 0.4 m/s (peaks of around 0.3 m/s with average values of 0.2 m/s)

268. In the case of the 2050 simulations with an assumed enhanced primary treatment system, compliance with the 230 / 100 ml limit is demonstrated for all cases.

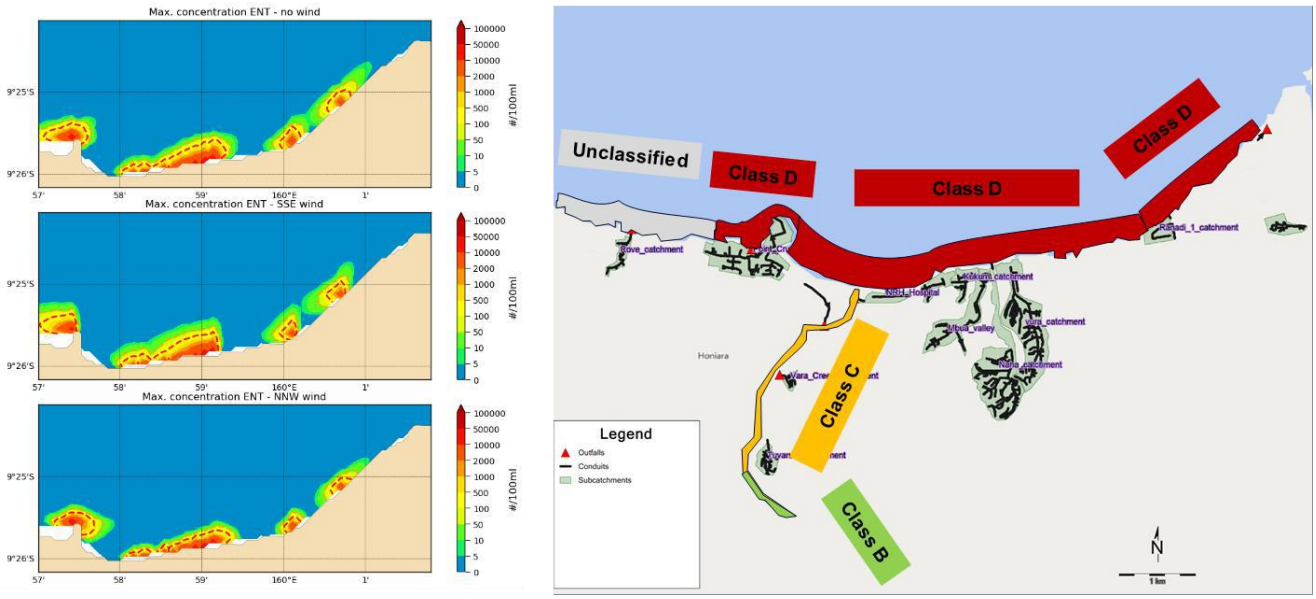
269. In both the short and long-term scenarios (the latter with treatment), the revised modelling indicates that the approach involving shorter outfalls provides sufficient protection in terms of water quality, in all observed conditions.

270. Following the results based on a new approach that applies mixed standards in simulation to cover both E. coli and *enterococci*, another set of simulations was completed and presented during the subproject review mission in December 2020 and then additional results were again presented in August 2021.

271. The later simulations include 9 scenarios where all the scenarios have two outfalls (NRH and Ranadi), the discharge flowrate is the same for each scenario, the diameter of the outfalls for each scenario is also the same, but the only variable between each scenario is the length of the outfall.

272. The existing baseline is presented below, on the left are the marine modelling plumes with *enterococci* concentrations, and on the right is the coastline classification. See **Figure 3-12: Current Recreational Water Quality Classification and *enterococci* Predictions.**

Figure 3-12: Current Recreational Water Quality Classification and *enterococci* Predictions

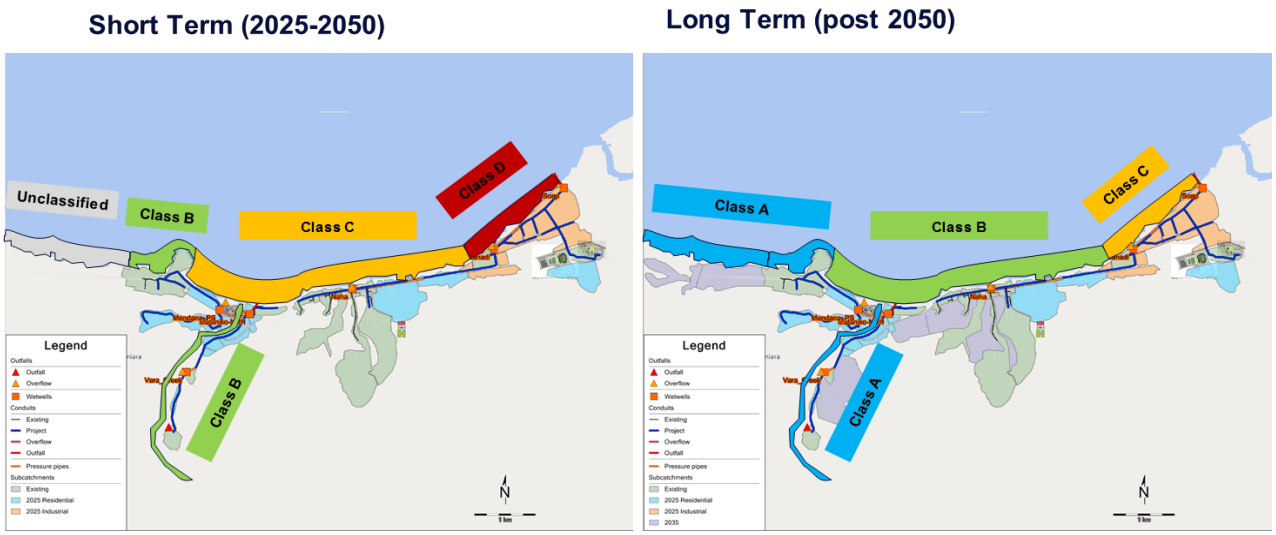


Source: Suez. October 2021. Network design note

273. The objectives for the short-term and long-term horizons (based on the construction phases), aim for Class B along Point Cruz and Mataniko River in the short- term, with an evolution to Class A in the long-term. As for the coastline between Point Cruz and the Ranadi area, the evolution is from Class C to Class B. Finally, around Ranadi Industrial area, the objective is to evolve from Class D to Class

C in the long-term. Those objectives are where two outfalls operate during the short-term (NRH and Ranadi) and only one outfall with a wastewater treatment plant (Ranadi) during the long-term. See **Figure 3-13: Predicted Recreational Water Quality Classifications.**

Figure 3-13: Predicted Recreational Water Quality Classifications.



Source: Suez. October 2021. Network design note

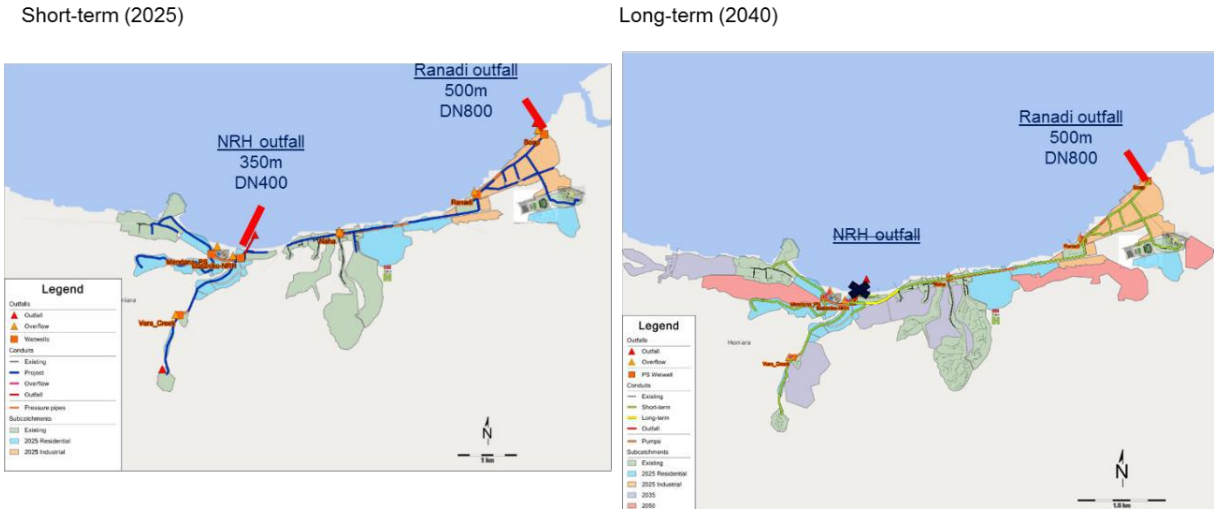
3.2.2.1 Updated Recreational Water Quality Predictions

274. Following further financial analysis, revised outfall configuration options were selected for additional recreational water quality modelling. See **Figure 3-14: Outfall Scenario Options**

275. Following further research in the interim, the die-off rates for both indicator bacteria (E. coli and *enterococci*) were also reviewed.

276. Finally, the initial concentrations for the indicator bacteria were also amended to reflect a greater reduction due to possible primary treatment at the Ranadi outfall in the long-term. Previously it had been assumed that the bacterial reduction during primary treatment would be 25%, but this was now increased to a 50% reduction. This is still considered conservative as in many situations, full primary treatment involving sedimentation or settling activities would result in at least an order of magnitude reduction in pathogens. Therefore the modelling results for the long-term were a treatment plant to be provided are considered conservative.

Figure 3-14: Outfall Scenario Options

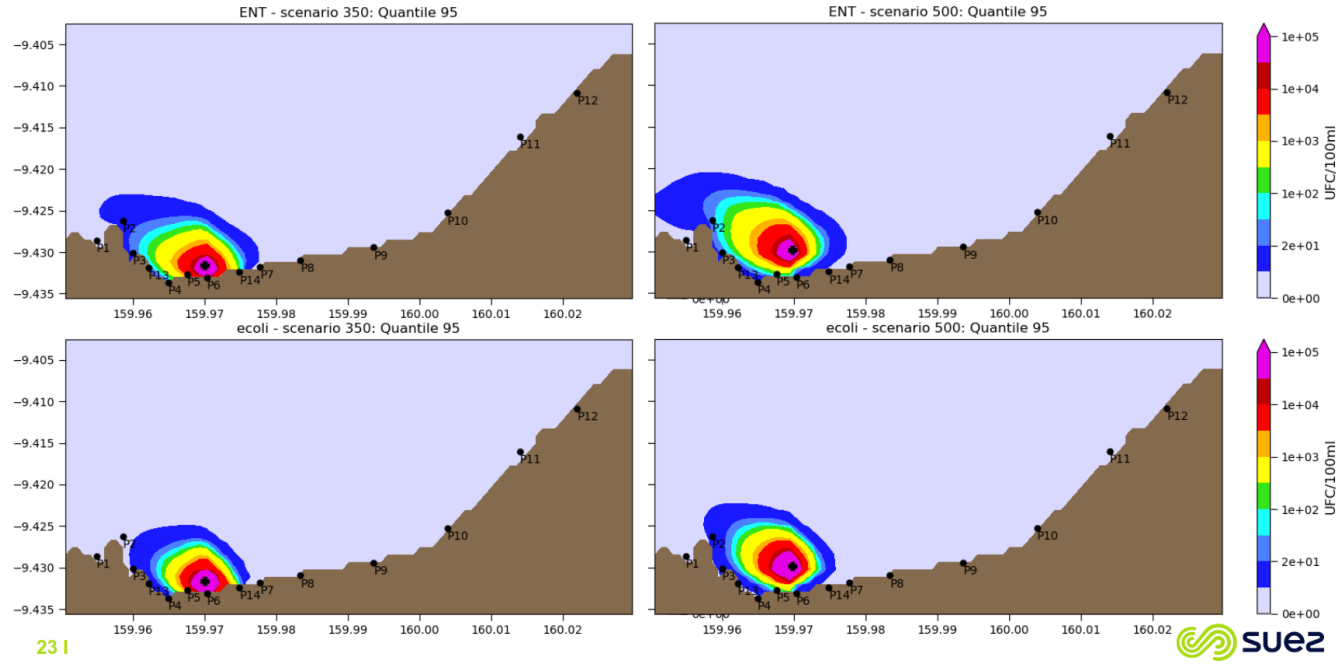


Source: Suez. October 2021. Network design note

277. An additional final sub-option was also modelled where the outfall at NRH was 500 m long, in addition to the 350 m long option.

278. The 95 percentile plumes are presented in the **Figure 3-15: 95 Percentile Indicator Plots for 350 m and 500 m NRH Outfall in 2025** below. This represents the limit of the plume which is only exceeded 5% of the time throughout the adopted weather and climactic year.

Figure 3-15: 95 Percentile Indicator Plots for 350 m and 500 m NRH Outfall in 2025



Source: Suez. October 2021. Network design note

279. A tabular summary of these plots is presented below in **Table 3-7: Water Quality Objectives Versus Water Quality Predicted for NRH Outfall Only.**

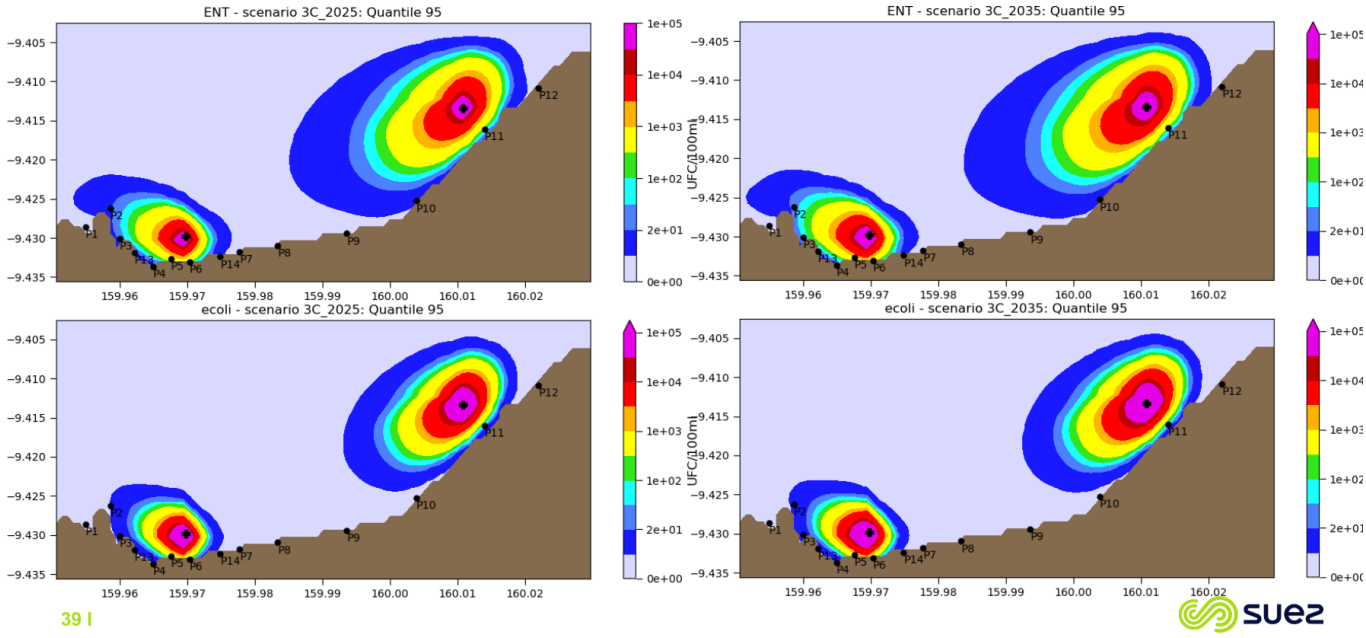
Table 3-7: Water Quality Objectives Versus Water Quality Predicted for NRH Outfall Options Only

Point	Region	Conclusion of the Marine simulations
P1, P2	Ports Authority	Class A for both scenarios
P3, P13, P4	Point Cruz Wharf – West Mataniko	Scenario one has less impact further to the west of the Mataniko Riverbank
P5, P6	NRH	The coastline directly in front of NRH is class D with the 350 m long outfall and class C with the 500 m long outfall.
P14, P7, P8, P9, P10	Naha to Ranadi	For both scenarios, the marine simulations results are under 5% exceedance of Class A standard (40 ENT Counts/100ml)
P11, P12	Ranadi to Lungga	For both scenarios, the marine simulation results are under 5% exceedance for Class A standard (40 ENT Counts/100ml) in the short- term.

Source: Suez. October 2021. Network design note

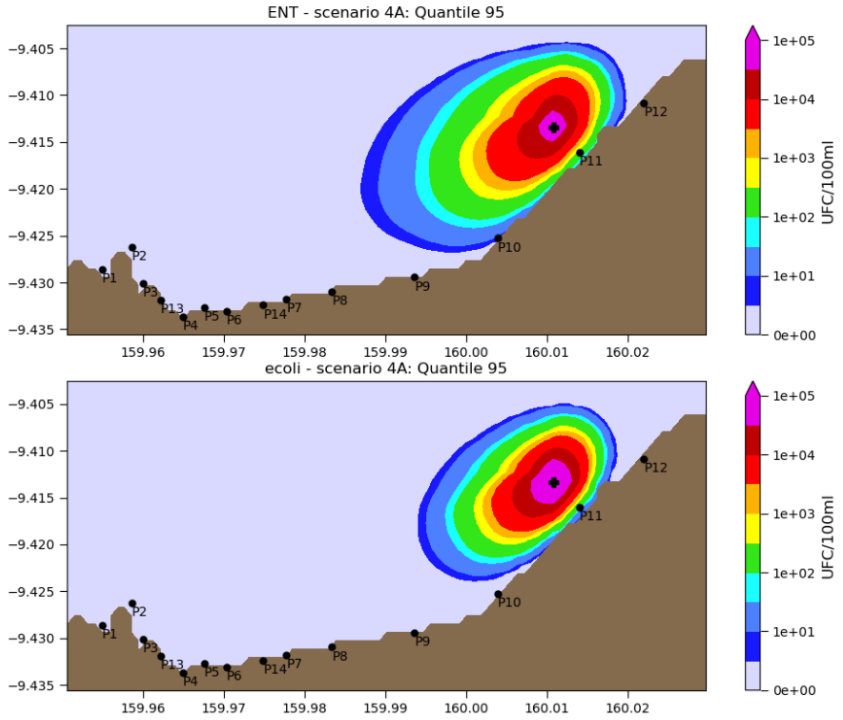
280. The following figures respectively cover **Figure 3-16: 95 Percentile Indicator Plots for 2025 and 2035, Figure 3-17: 95 Percentile Indicator Plots for 2050 – No Wastewater Treatment** and **Figure 3-18: 95 Percentile Indicator Plots for 2050 – With Wastewater Treatment**.

Figure 3-16: 95 Percentile Indicator Plots for 2025 and 2035



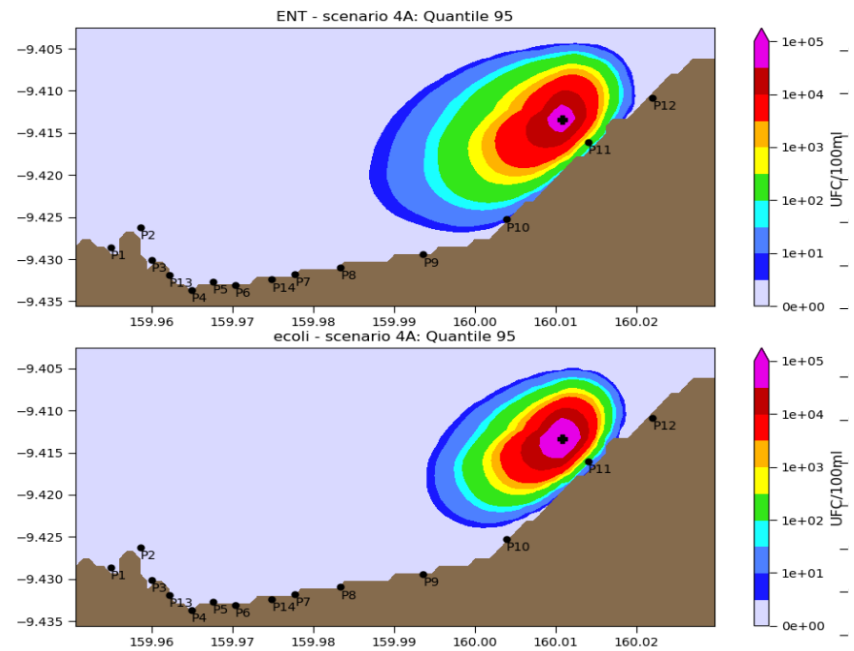
Source: Suez. October 2021. Network design note

Figure 3-17: 95 Percentile Indicator Plots for 2050 – No Wastewater Treatment



Source: Suez. October 2021. Network design note

Figure 3-18: 95 Percentile Indicator Plots for 2050 –With Wastewater Treatment

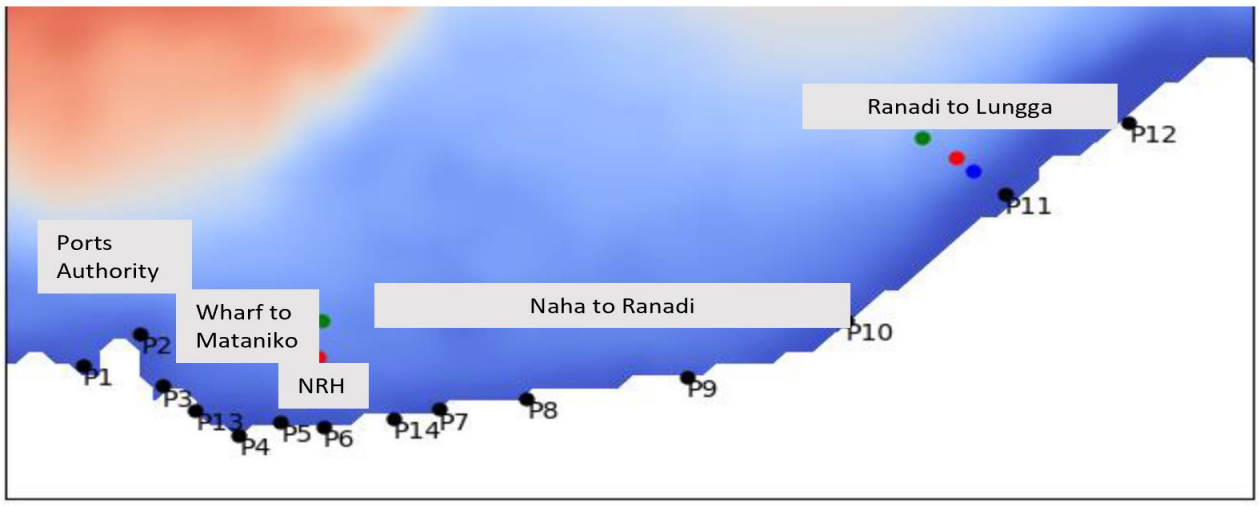


Source: Suez. October 2021. Network design note

281. The above percentile plots are a good guide to indicate how far the indicator organisms, and therefore the sewage pathogens, will move from the outfall diffuser outlets. However, these are difficult to interpret in terms of impacts on the five zones adopted in the water quality objectives section. The results have therefore been combined and presented in various tabular forms below.

282. The results are compared at 14 locations as shown in **Figure 3-19: Modelling Reporting Locations**.

Figure 3-19: Modelling Reporting Locations

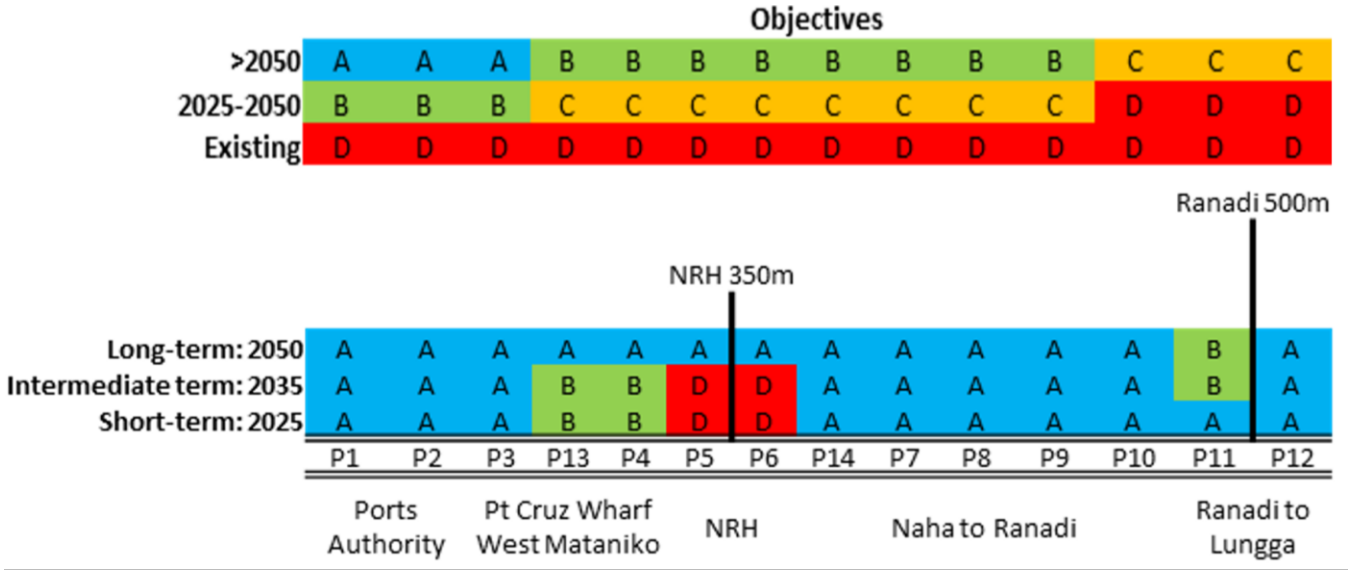


Source: Suez. October 2021. Network design note

283. Overall, the quantitative and qualitative results yield similar results for the long-term horizon between both NRH outfall length options (where only point P11 is in class B), as for the short and mid-term horizons, the water quality is improved along NRH for the 2nd solution but improved along Point Cruz for the first solution.

284. The objective in the long-term is to classify Point Cruz coast as Class A for swimming, the coast from Mataniko Riverbank to Ranadi Landfill as Class B for nautical activities, and the area around Ranadi landfill as Class C because of the presence of industries. The results based on quantitative results do not take into consideration the industries' discharges that are not included in the simulations. The results comparison between both options and the WQOs are presented below in **Figure 3-20: Water Quality Objectives Versus Water Quality Predicted**.

Figure 3-20: Water Quality Objectives Versus Water Quality Predicted



Source: Suez. October 2021. Network design note

285. A comparison table showing the exceedance of coastline objectives is presented below in **Table 3-8: Water Quality Objectives Versus Water Quality Predicted.**

Table 3-8: Water Quality Objectives Versus Water Quality Predicted

				2025	2035
	Water Quality Class	ENT (FC/100mL)	Baseline (2019)	350m @NRH & 500m @Ranadi	350m @NRH & 500m @Ranadi
P1	B	>200	100	0	0
P2	B	>200	100	0	0
P3	C	>500	100	0	0
P13	C	>500	100	0	0
P4	C	>500	100	0	0
P5	C	>500	100	12	30
P6	C	>500	100	10	83
P14	C	>500	100	0	0
P7	C	>500	100	0	0
P8	C	>500	100	0	0
P9	C	>500	100	0	0
P10	D		100	0	0
P11	D		100	0	0
P12	D		100	0	0

Source: Suez. October 2021. Network design note

3.2.2.2 Conclusions for Recreational Water Quality Modelling

286. The subproject brings a significant improvement in foreshore water quality. All investigated scenarios enable a very significant improvement to be made when compared with the existing situation.

287. Clearly going immediately for a one-outfall approach is not the least cost option (due to large initial OPEX costs) nor is having longer outfalls

288. Proposed scenario is two outfalls in short term with the NRH considered as a temporary outfall (350 or 500 m lengths) and one outfall in the long term at Ranadi (500 m length)

289. The two outfall scenarios of short to medium length represent the least cost option, and exceed water quality objectives in the short term (but only in 2 positions for about 10% of the time). This level of exceedance was considered acceptable.

290. The transfer system has been designed to be economically efficient in the short term but also to be able to operate in the longer term with a one outfall scenario with retrofitting additional sewers, rising mains and pump sets.

291. The NRH outfall would be phased out in the mid to long-term scenario. Ranadi could thereafter be the long-term wastewater treatment site; although treatment may not be necessary in the long term and certainly higher forms of treatment (such as activated sludge would not be necessary)

3.2.3 Nutrient Modelling

3.2.3.1 Metocean scenarios and model establishment

292. The full modelling report is presented in **Appendix 6: 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands**

293. The same hydrodynamic model was used for the nutrient modelling as for the recreational water quality modelling. The same water quality modules were also used, but with different input concentrations and decay rates. Simulations were performed over the same year (2017) as per modelling for the recreational indicators modelling. Wind conditions for this year have been considered representative of a typical year.

294. Four discharge scenarios have been studied[24], corresponding to different stages of UWSSSP subproject implementation. The flow rate and the concentration are summarized in **Table 3-9**.

295. As the simulation is conducted over a complete year, hourly variations in the flow rate are considered negligible on the concentration plume. Only daily rates are then considered.

[24] Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

Table 3-9: Flow rate and concentration for discharge scenarios

Scenario	Daily flow rate (l/s)		Concentration	
	Ranadi	NRH	Total Nitrogen (mg/l)	Total Phosphorus (mg/l)
Phase 1A (2025)	98.6	42.4	40	10
Phase 1B (2030)	109	48.4	40	10
Phase 2 (2035)	152	66.3	40	10
Phase 3 (2050)	281	0	40	2

Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

296. As no simple method can be applied to determine the overall nutrient cycle dynamics, including the decay rate of Nitrogen and Phosphorus in seawater, both were considered as conservative tracers in the model. This means that there is no physical or biochemical degradation of Phosphorus and Nitrogen in the water column during the simulations.

297. Nitrogen in raw wastewater is traditionally almost exclusively composed of organic and ammonia nitrogen called Kjeldahl nitrogen. Upon entering the aerobic environment in the ocean, the ammonia is oxidized to nitrite (Nitrosomonas bacteria) and then rapidly to nitrate (Nitrobacter bacteria). These inorganic forms of N are bioavailable and can be taken up by phytoplankton or macro species, such as seaweed and macro algae when present. These materials will then eventually die-off and release nutrients back into the water column to re-enter the cycle. For phosphorus, the organic fraction will be oxidized to phosphates which are bioavailable and can then move through the same organic cycle as for nitrogen. Quantifying the conversion and decay rates of these biochemical reactions would require a very protracted monitoring program, and even then, this could be inaccurate given the idiosyncrasies of the local ecosystem. Therefore, it is considered a reasonable and conservative approach to model the nutrients as conservative parameters.

298. As a result of the above assumption, the nutrient concentrations decreased only by mixing and dissipation processes. This is a very conservative assumption, ensuring that the modelled concentration will be higher than the actual concentrations. So, if the predicted concentration is acceptable for the modelled processes, it will also be acceptable in the real environment.

299. The exceedances plots for phosphorus occupy a larger physical area because the ratio of raw sewage phosphorus (10 mg/l) to the water quality objective for phosphorus (0.025 mg/l) is twice the same ratio for total nitrogen (40 mg/l to 0.2 mg/l).

300. Three types of results are presented in this section:

- **Maximum concentration maps -** Results are presented as maps of maximum concentration over the water column throughout the whole simulation period. These maps do not represent an instantaneous state of the plumes but can be seen as the maximum envelope of the plumes for the simulation period. The maximum concentration is always reached at the surface as the plume is composed of lower-density freshwater compared with saline marine water. Therefore the potential impact on any benthic organisms such as seagrass or any coral would be very much less, given that the outfalls are releasing into water depths between 10 and 40 m.

However, the nutrients would be available for phytoplankton, assuming various growth conditions are satisfied such as sufficient light penetration, adequate dissolved carbon dioxide and presence of essential micronutrients.

- **Exceedance time of thresholds -** The maps represent the percentage of time the concentration is over a given concentration for a typical year. The thresholds are 200 µg/l for Total Nitrogen and 25µg/l for Total Phosphorus.

- **Percentiles -** The 90th percentile is plotted for Phosphorus and Nitrogen. The percentile 90 means that the concentration is over this concentration only 10% of the time in a typical year. This is essentially presenting the plume extent of the worst case scenario.

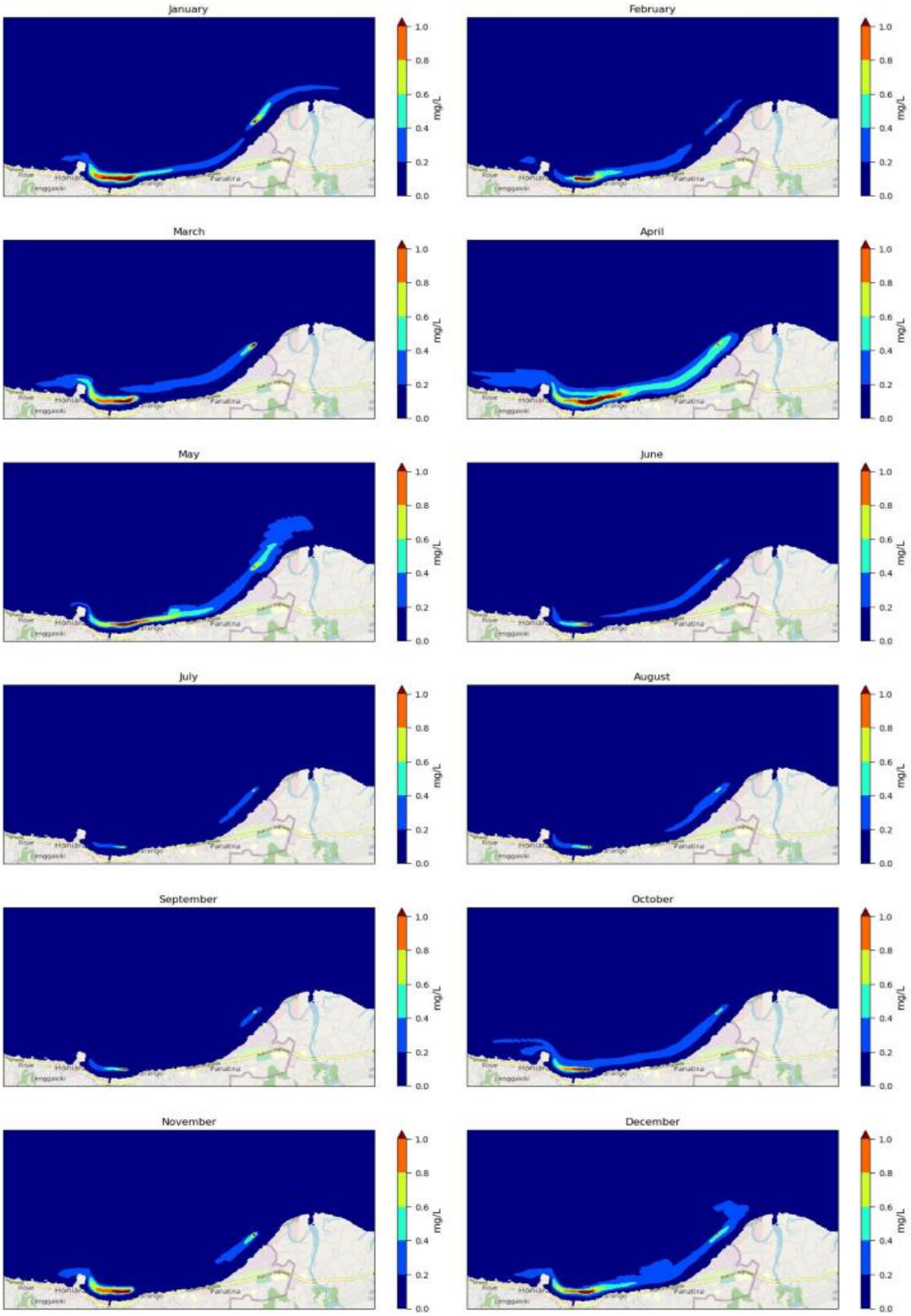
301. Note that the wastewater discharge flowrates will be starting at a fraction of the 2050 design flows and the modelling is based on the 2050 flowrates and therefore presents the maximum expected in 25 years. During this period, the water quality and ecological monitoring will be able to determine if there is a trend towards unacceptable environmental impact as the flowrates gradually increase over time. If some concerns develop based on the monitoring, one initial response would be to include direct ecological response parameter in the monitoring suite such as increased chlorophyll-a activity. If ecological monitoring does show significant impact, then interventions could include installing wastewater treatment on the land already set aside for this purpose. However given the paucity of biota, including benthic biomass in the area of influence, any impacts are expected to be minor and may in fact as mentioned elsewhere may increase the local biomass in a positive way.

302. As both the water quality and ecological monitoring continues, the guideline or indicative target values for nutrients will be periodically reassessed to better relate nutrient level objectives to ecological response.

303. In addition to these results, monthly maps have been produced, to give an indication of the variability in plume dimensions and directions throughout the seasonal changes. See **Figure3-21: Nitrogen Monthly Maximum Plots - Phase 1B** and **Figure 3-22: Phosphorus Monthly Maximum Plots - Phase 1B** below which present the monthly maximum results. The caveats described above regarding interpreting ecosystem response to these maximums apply, namely that these short term elevations may not allow sufficient time for the ecosystem's macrobiota to respond before the nutrients are advected and dispersed.

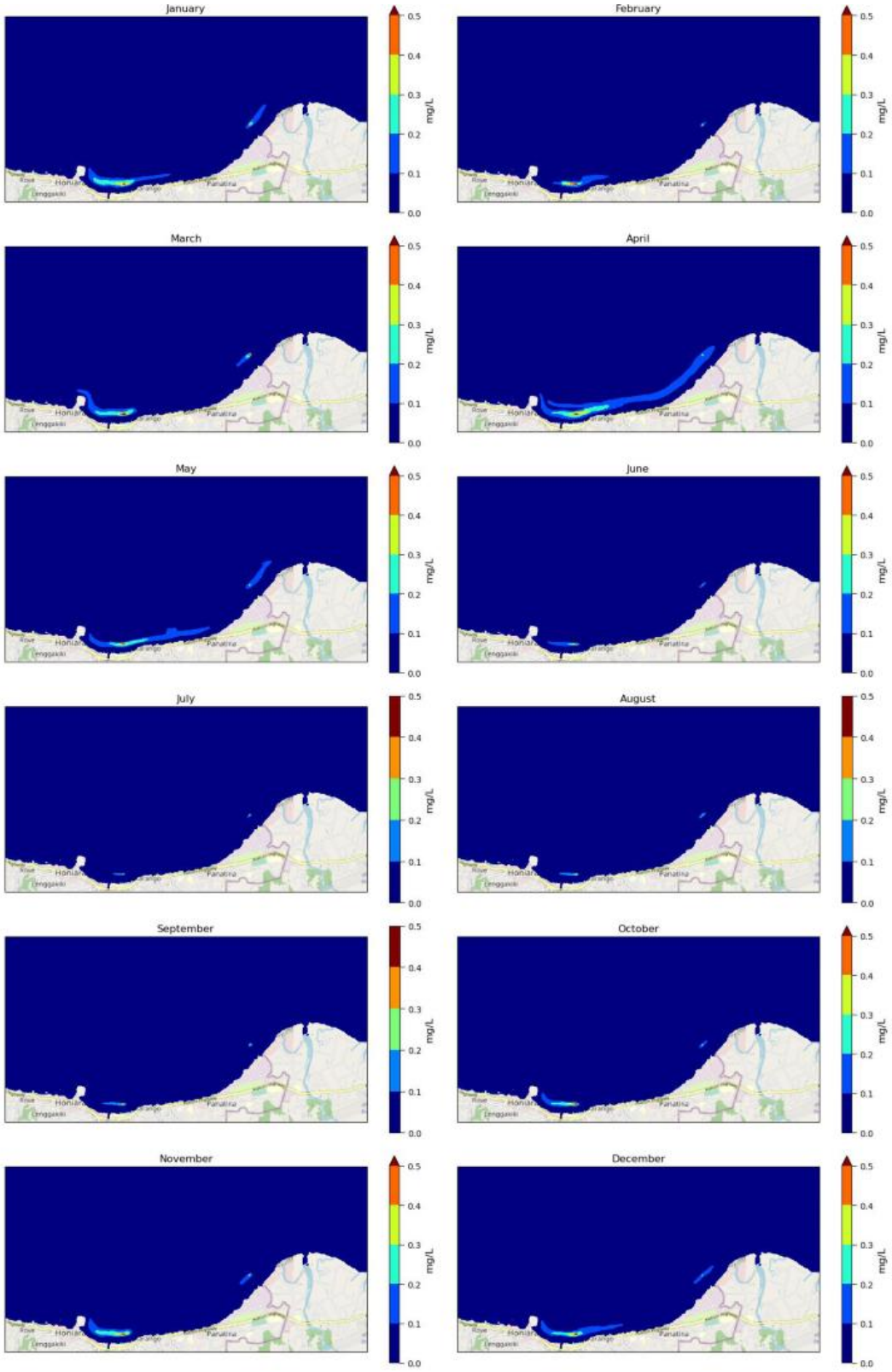
304. The modelling indicates that the nutrient plumes are always paralleling the coastline, regardless of the season.

Figure 3-21: Nitrogen Monthly Maximum Plots - Phase 1B



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

Figure 3-22: Phosphorus Monthly Maximum Plots - Phase 1B

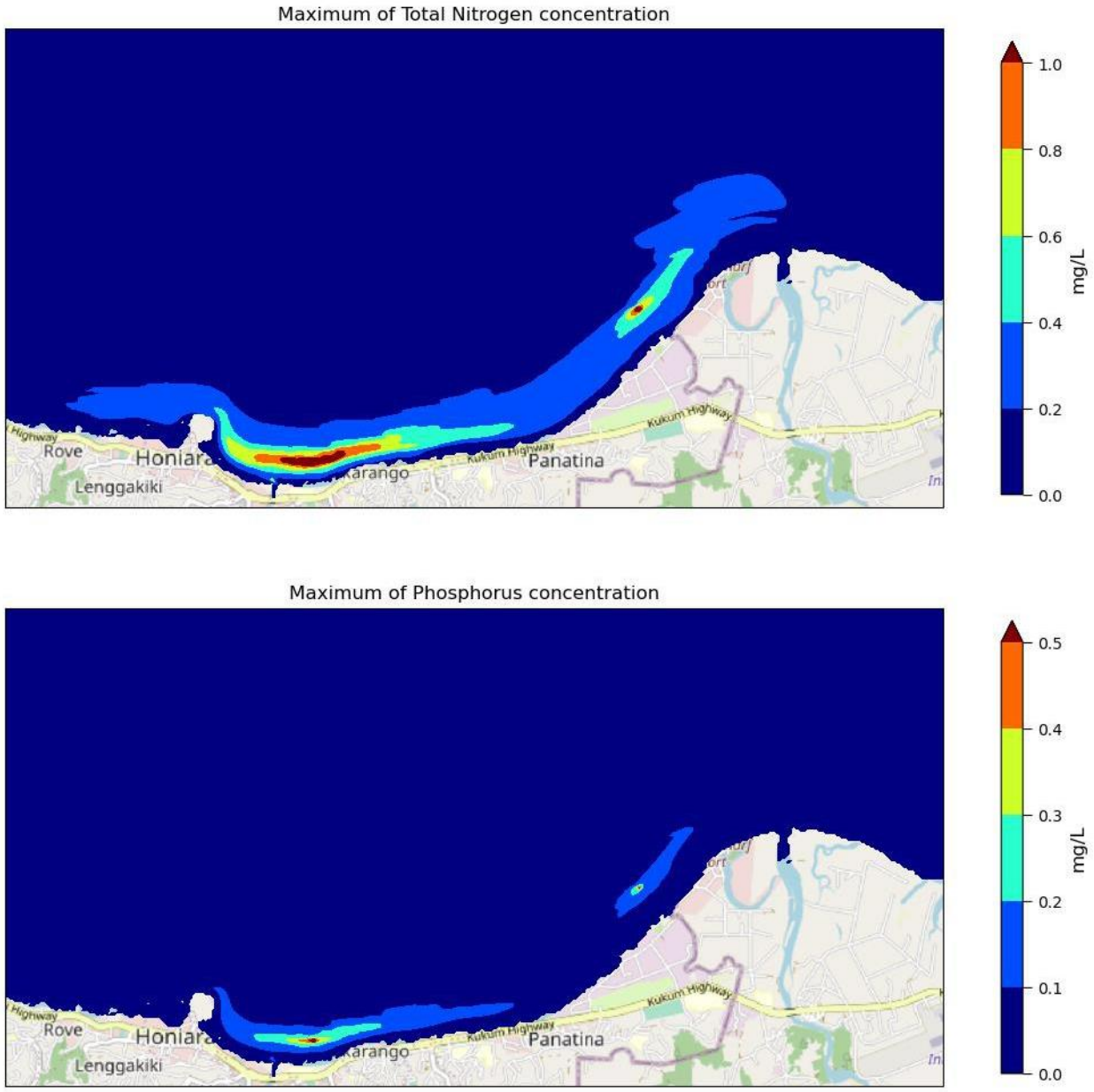


Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

3.2.3.2 Phase 1A

305. **Figure 3-23** indicates that the nutrient plumes are essentially linear and located some distance off the shoreline. The area of influence remains small, and it must be understood that these are maximums obtained at any time throughout the year and are essentially instantaneous. Therefore the ecosystem response to such short exposure to elevated nutrients would be expected to be muted.

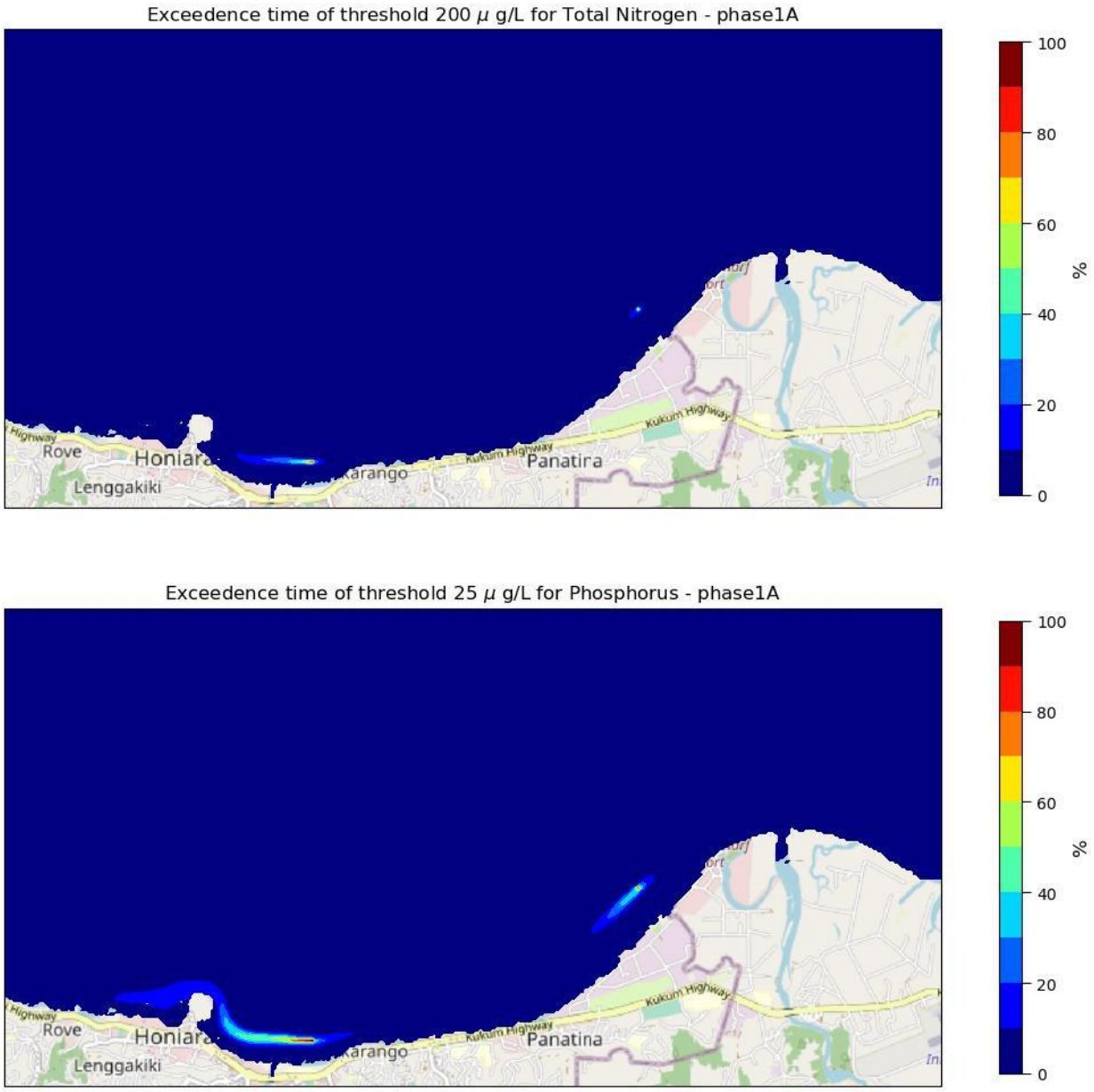
Figure 3-23: Maximum Nutrient Concentration - Phase 1A



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

306. The percentage exceedances plots **(Figure 3-24)** again present a linear pattern parallel to the shore line, extending from the diffuser outlets for both outfalls as expected. The physical extent of the exceedances plots is very small and does not reach the shoreline except around part of Point Cruz for phosphorus at very low percentage exceedances rates.

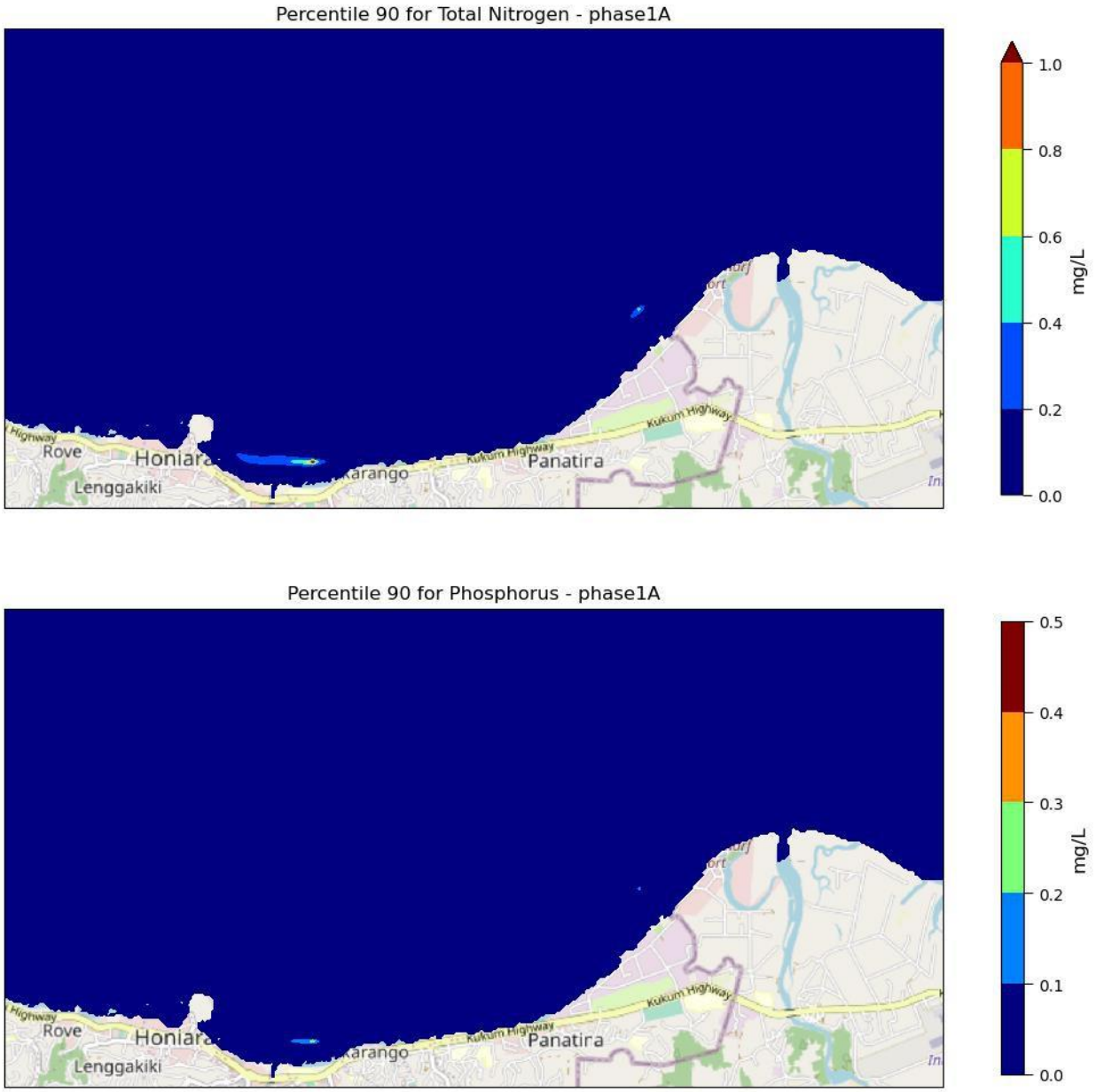
Figure 3-24: Percentage Exceedance N over 200µg/l and P over 25 µg/l - Phase 1A



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

307. The extent of the plumes below **(Figure 3-25)** for both N and P indicates only very small areas will have these elevated nutrient levels at the surface, for less than 10% of the time.

Figure 3-25: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 1A



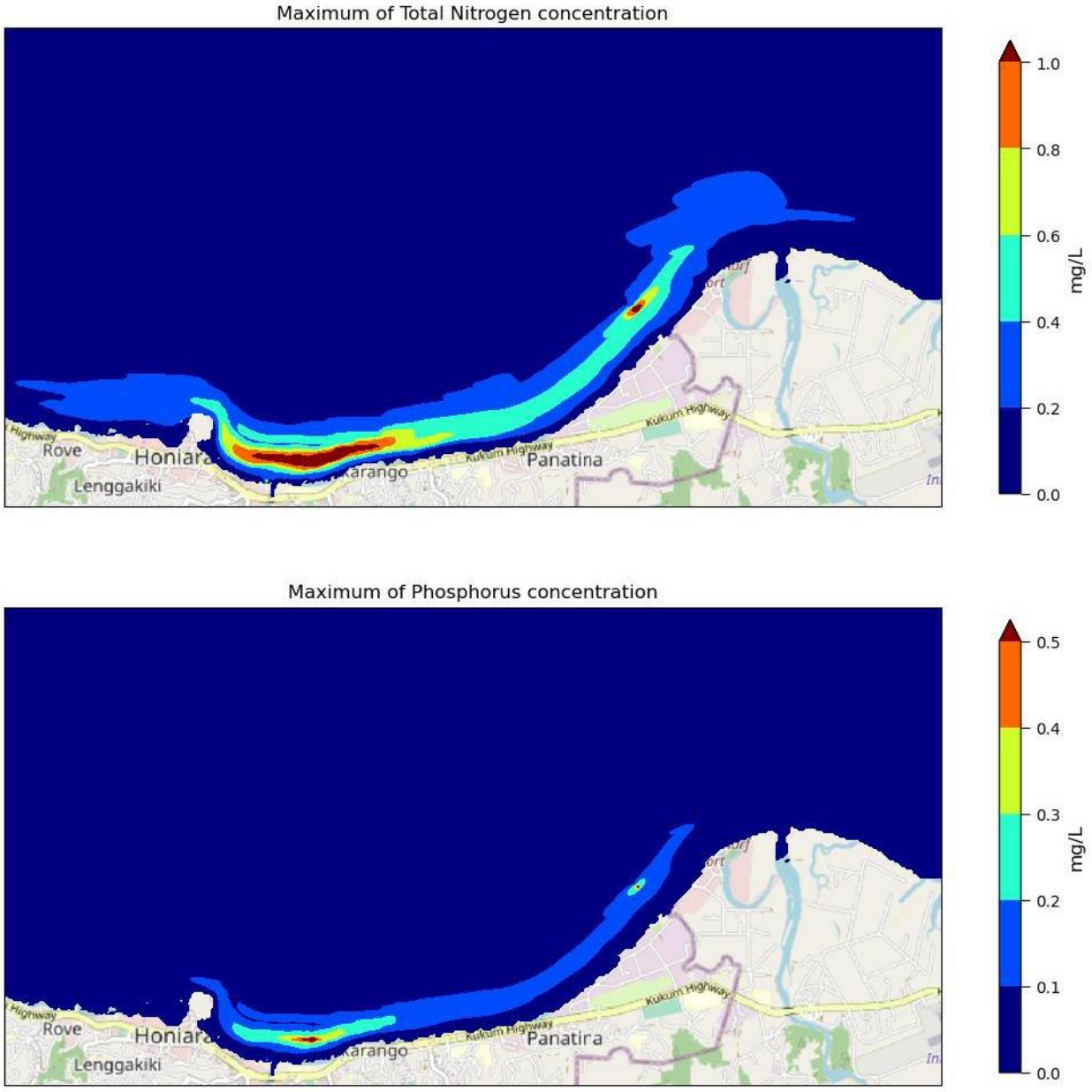
Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

3.2.3.3 Phase 1B

308. As for Phase 1A, **Figure 3-26** indicates that the nutrient plumes are essentially linear and located some distance off the shoreline. The area of influence remains relatively small, and as these are maximums obtained at any time throughout the year, and are essentially instantaneous. Areas where the predicted nutrient concentrations are over 2 to 3 times the water quality objective are relatively small and do not generate a band connecting the two outfalls plumes.

309. The ecosystem response to such short exposure to elevated nutrients would be expected to be muted. Note in the modelling description above, these results are at the water surface and nutrient concentrations would be less at the seabed if the ecosystem response concern related to sea grasses or corals (if any were present).

Figure 3-26: Maximum Nutrient Concentration - Phase 1B



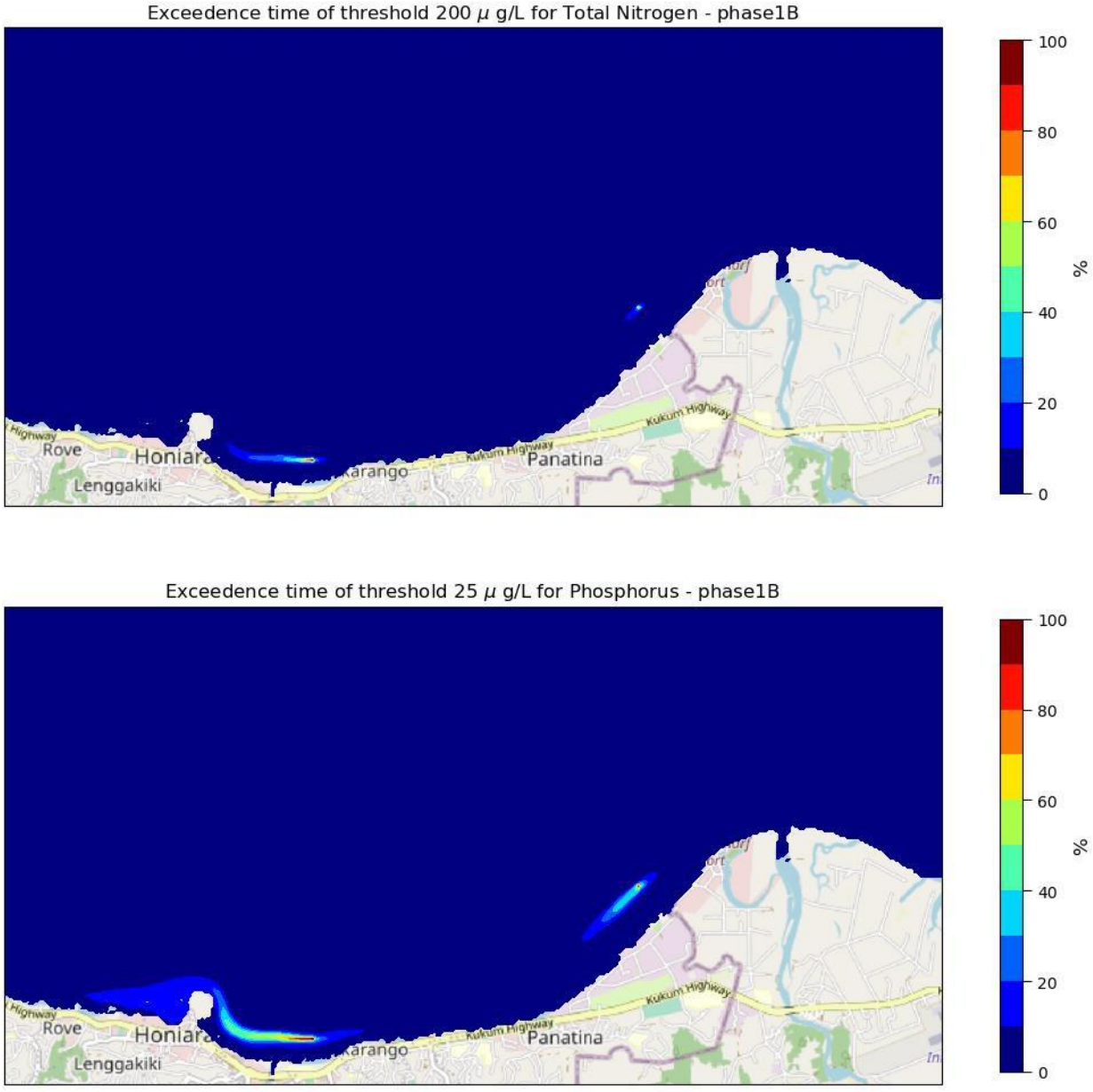
Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

310. The percentage exceedances plots **(Figure 3-27)** are again a linear pattern parallel to the shore line, extending from the diffuser outlets for both outfalls as expected. The physical extent of the

exceedances plots is very small and does not reach the shoreline except around part of Point Cruz for phosphorus at very low percentage exceedances rates.

311. Again these exceedances plumes only relate to nutrient concentrations at the surface which would be far less at depth throughout the water column, as the nutrients are progressively dispersed vertically.

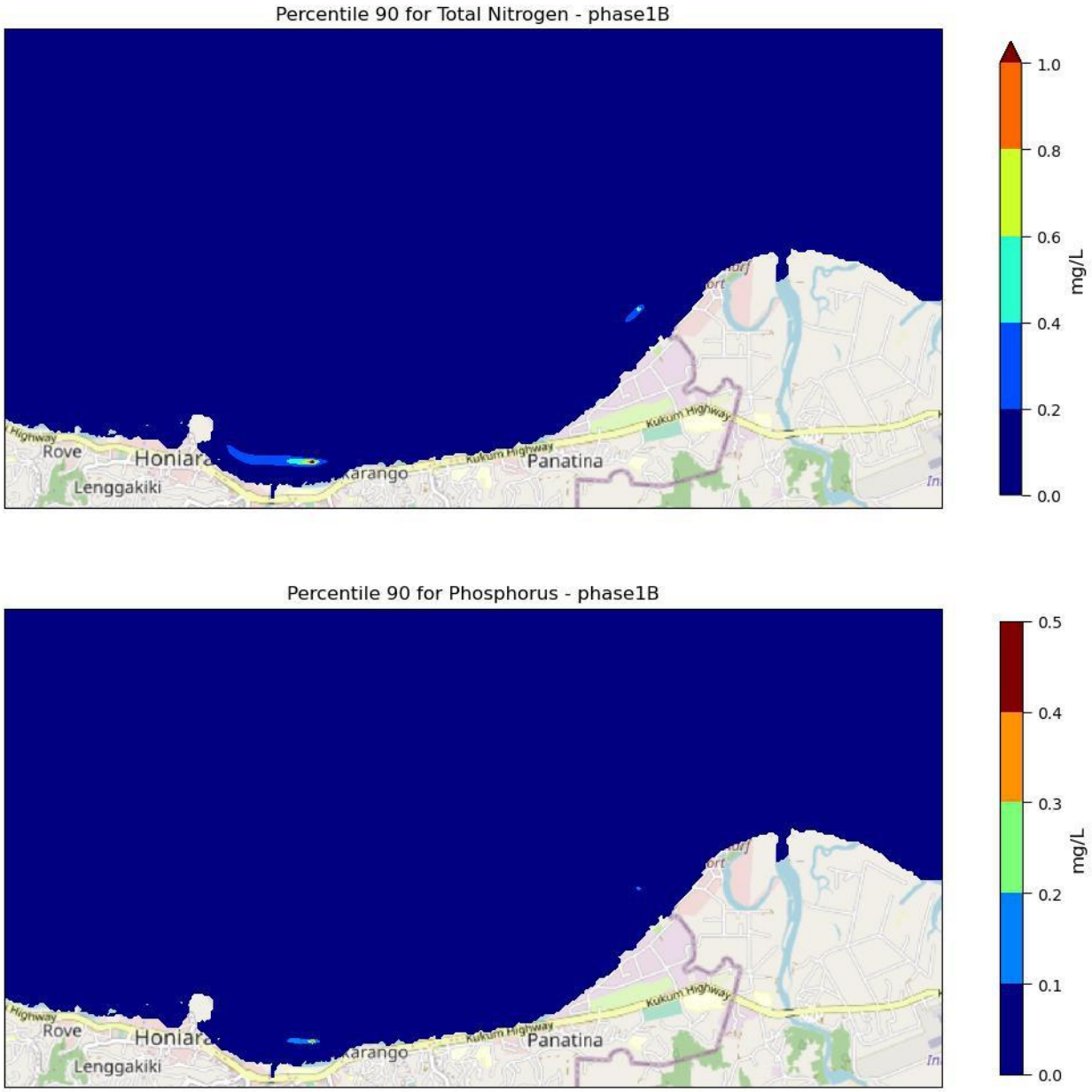
Figure 3-27: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 1B



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

312. The extent of the 90 percentile plumes for both N and P indicates only very small areas will have elevated nutrient concentrations at the surface, for less than 10% of the time. **(Figure 3-28)**

Figure 3-28: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 1B



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

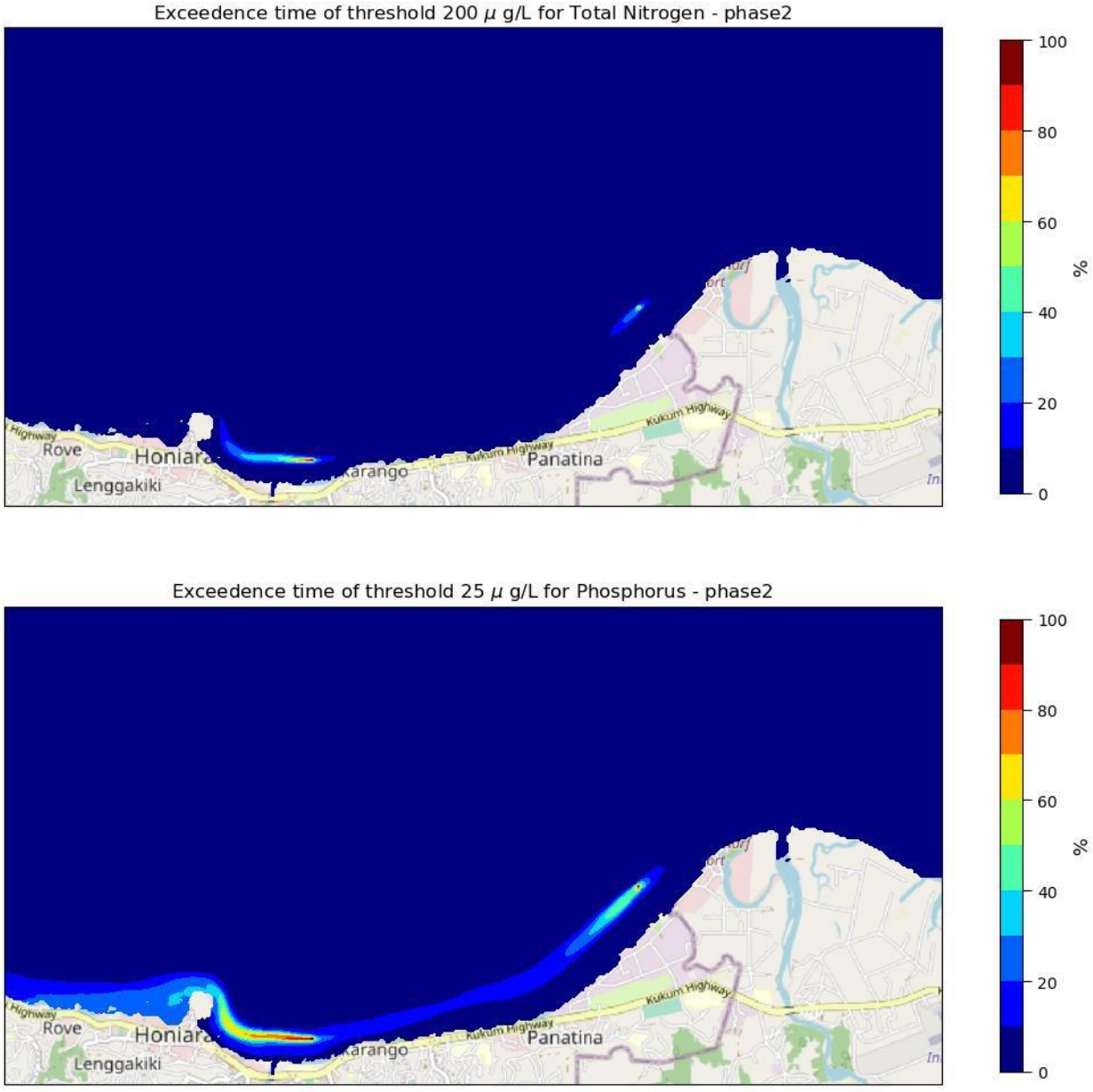
3.2.3.4 Phase 2

313. The percentage exceedances plots **(Figure 3-29)** are again a linear pattern parallel to the shore line, extending from the diffuser outlets for both outfalls as expected. The physical extent of the exceedances plots is small and does not reach the shoreline except around part of Point Cruz for phosphorus at percentage exceedances rates in the order of 20%.

314. Areas of higher exceedances are restricted mainly to the linear areas parallel to the shoreline and within a few hundred metres of the outfall diffuser.

315. Again these exceedances plumes only relate to nutrient concentrations at the surface which would be far less at depth throughout the water column, as the nutrients are progressively dispersed vertically.

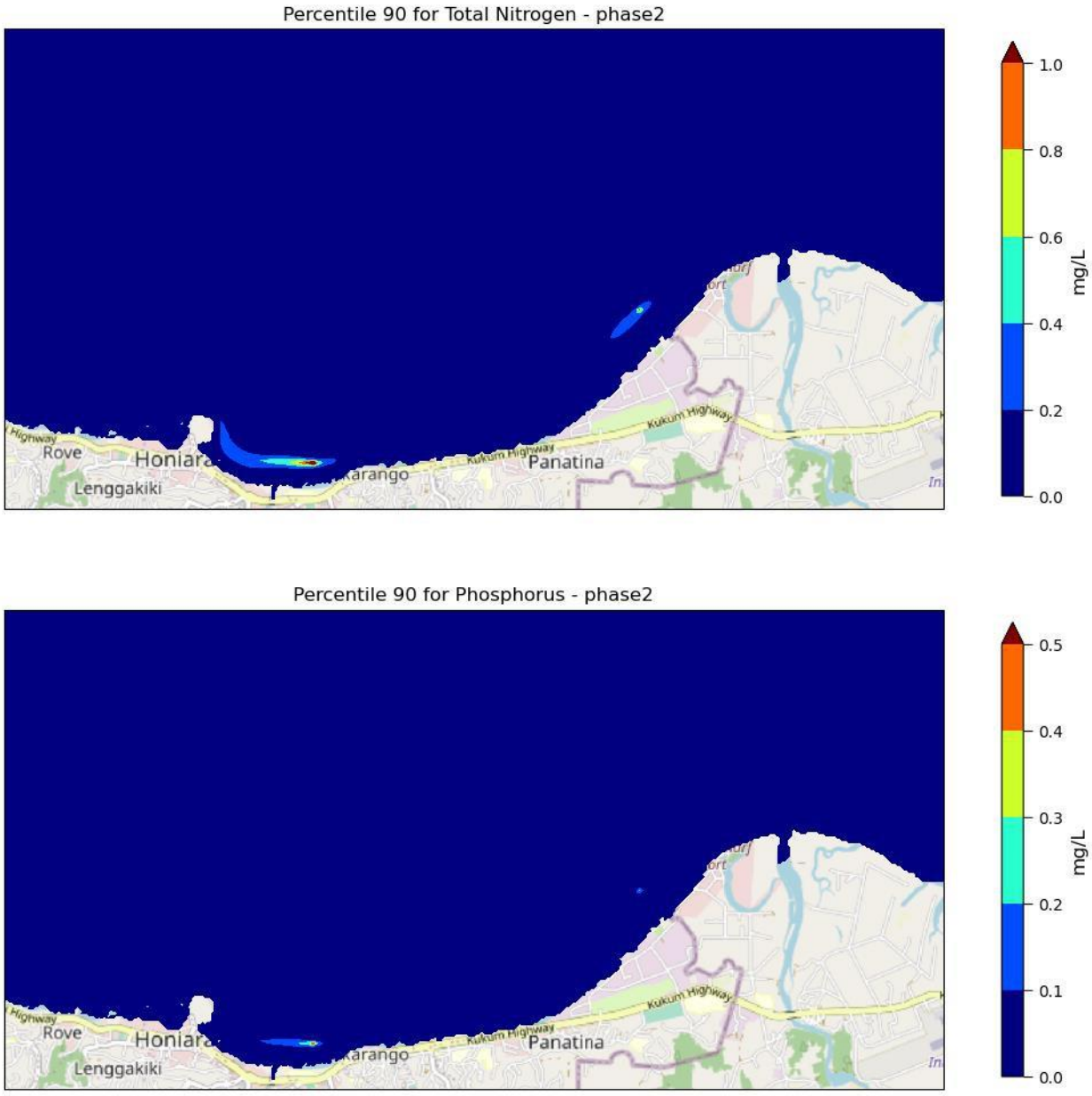
Figure 3-29: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 2



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

316. The extent of the 90 percentile plumes for both N and P indicates only very small areas will have elevated nutrient concentrations at the surface, for less than 10% of the time. **(Figure 3-30)**

Figure 3-30: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 2



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

3.2.3.5 Phase 3

317. As noted above, the ratio of the raw wastewater nutrient content versus the water quality objective is smaller for phosphorus compared with nitrogen. Therefore the phosphorus plots are always more extensive than the nitrogen footprints, because a zero decay rate has been assumed for both nutrients. The phosphorus plots even though they present a larger footprint than the nitrogen plots, are still constrained with few exceedances above the 20 or 30 percentile.

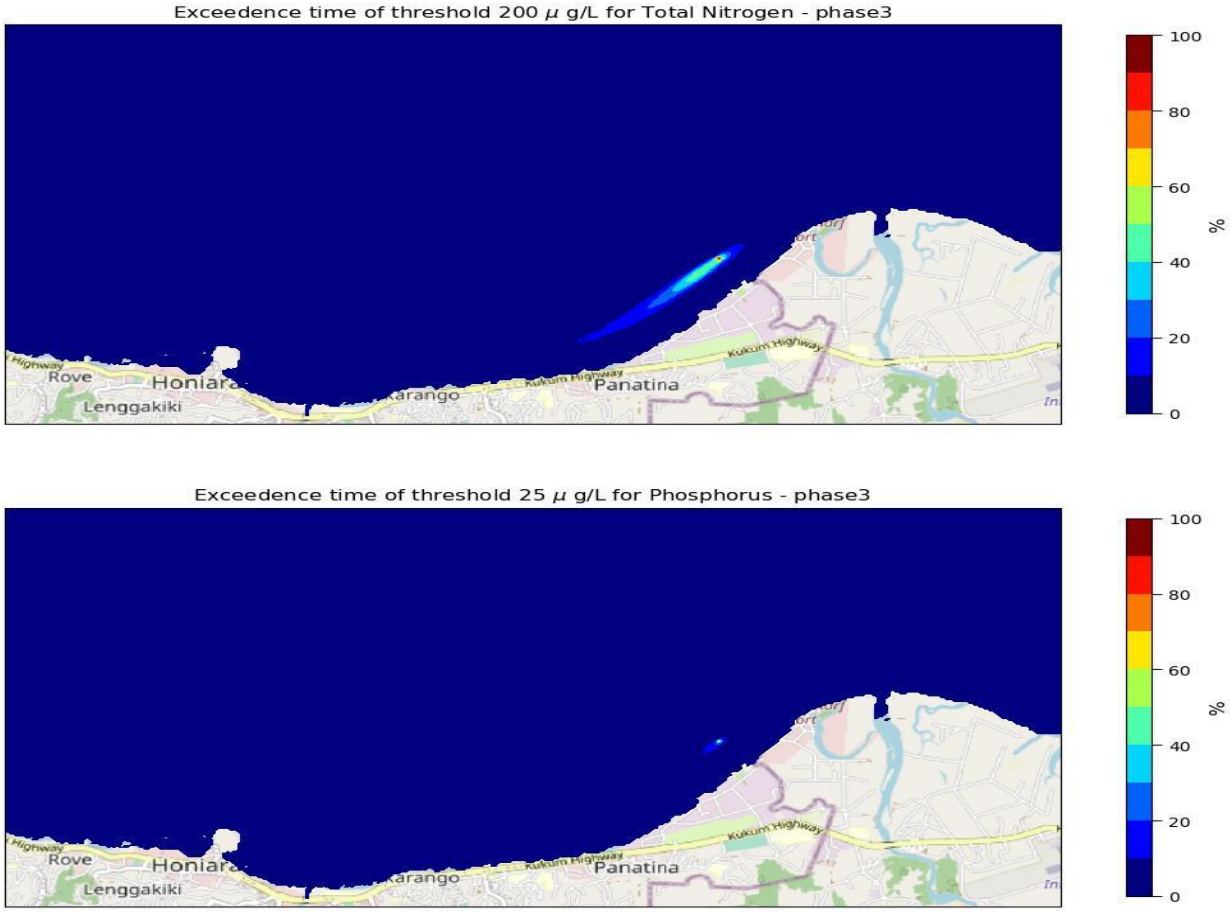
318. However, the stage 3 plots reflected the option of installing wastewater treatment which for the processes being considered, will only reduce the phosphorus and not the nitrogen. As a result, the phosphorus plume extent is greatly reduced even though the flow rate has increased from phase 2 to phase 3. Without treatment, the extent of the phosphorus plots would be approximately twice those shown for the Ranadi outfall in Phase 2, given that the flow rate has increased from approximately 150 to 280 l/s. Alternatively, given that both Nitrogen and Phosphorus are modelled with a zero decay rate, the Phosphorus exceedance plot would be 2.25 times that of the N plot below as an indication of footprint size.

319. The percentage exceedances plots are again a linear pattern parallel to the shore line, extending from the diffuser outlets for both outfalls as expected. The physical extent of the exceedances plots is small, especially for the P plot. **(Figure 3-31)**

320. Areas of higher exceedances are restricted mainly to the linear areas parallel to the shoreline and within a few hundred metres of the outfall diffuser.

321. Again these exceedances plumes only relate to nutrient concentrations at the surface which would be far less at depth throughout the water column, as the nutrients are progressively dispersed vertically.

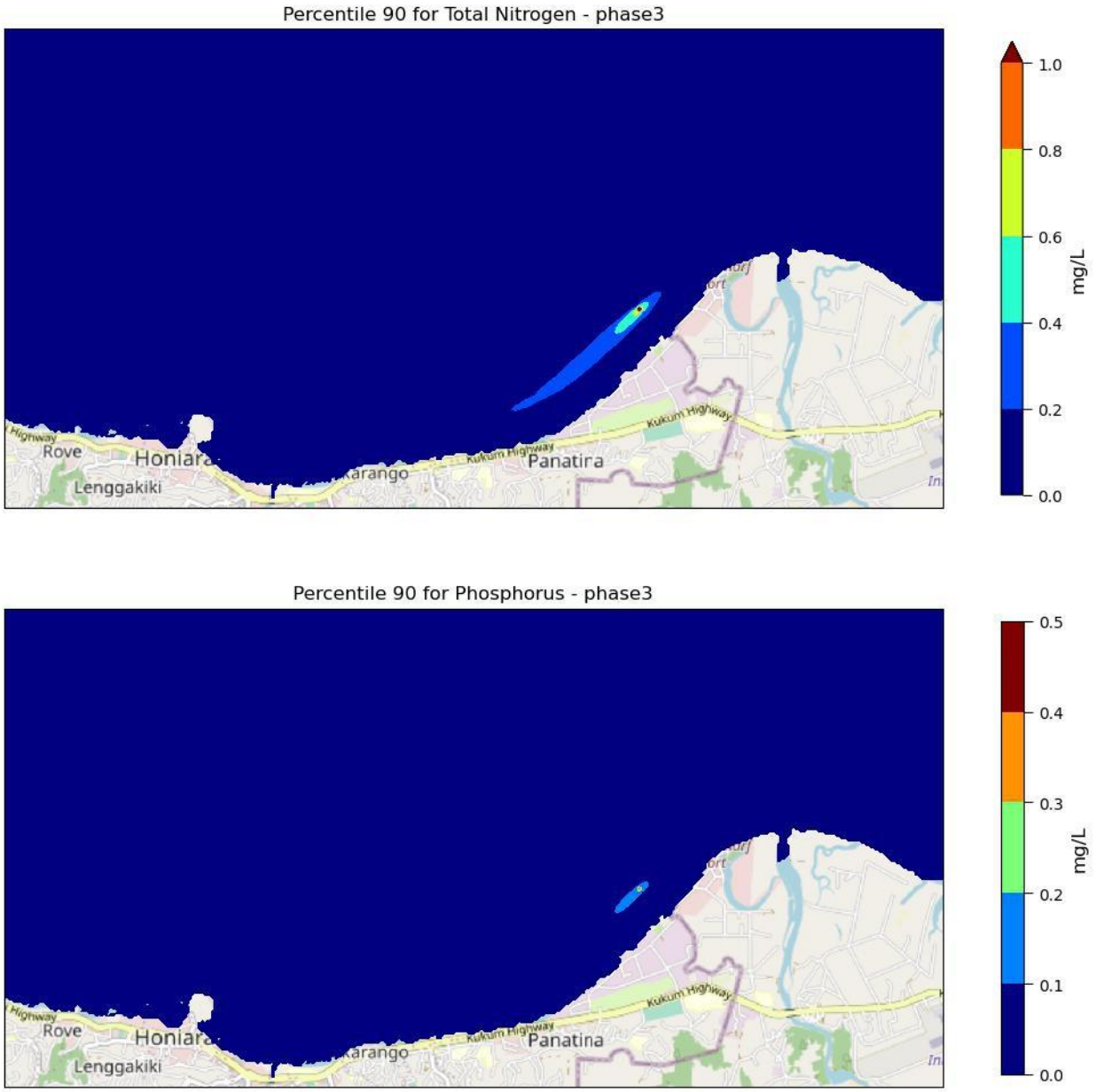
Figure 3-31: Percentage Exceedance N over 200µg/l and P over 25 µg/l – Phase 3



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

322. The extent of the 90 percentile plumes for both N and P indicates only very small areas will have elevated nutrient concentrations at the surface, for less than 10% of the time. **(Figure 3-32)**

Figure 3-32: 90th Percentile Nitrogen and Phosphorus Concentrations – Phase 3



Source: Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

3.2.3.6 Nutrient Modelling Conclusions

323. Simulations have been performed for Phosphorus and Nitrogen over a complete year. The year 2017 has been chosen as it presents typical wind characteristics.

324. Four discharge scenarios have been studied, from 2025 to 2050, with different flow rates and concentrations as per the adopted UWSSSP Phases.

325. The results are only for concentrations of nutrients at the surface, not distributed throughout the water column. The nutrient concentrations will decrease at depth due to vertical dispersion of the freshwater wastewater into the saline denser water column.

326. Given the complexity of quantifying nutrient cycling through organic to inorganic and back to organic forms, the model has adopted a zero decay rate which is very conservative.

327. The results show plumes with a maximum around the outfalls as expected, and a dispersion pattern essentially from East to West paralleling the shoreline. Maps of maximum concentration indicate an extensive plume for some scenarios, but these plots represent instantaneous status. The ecosystem may not have sufficient time to respond to such short nutrient elevations.

328. The other plots of percent exceedances and concentration percentiles indicate only small areas of nutrients significantly above the WQOs and, again, these are surface concentrations.

329. Overall, as expected, higher concentrations are associated with the NRH outfall which is located in shallower waters compared with Ranadi. At Ranadi, the depth of the water column allows greater dispersion of the plume and consequently lower surface concentrations of nutrients. The plumes from the 2 outfalls can intermix in some situations, for example for Phosphorus in Phase 2.

4 Description of the Existing Environment

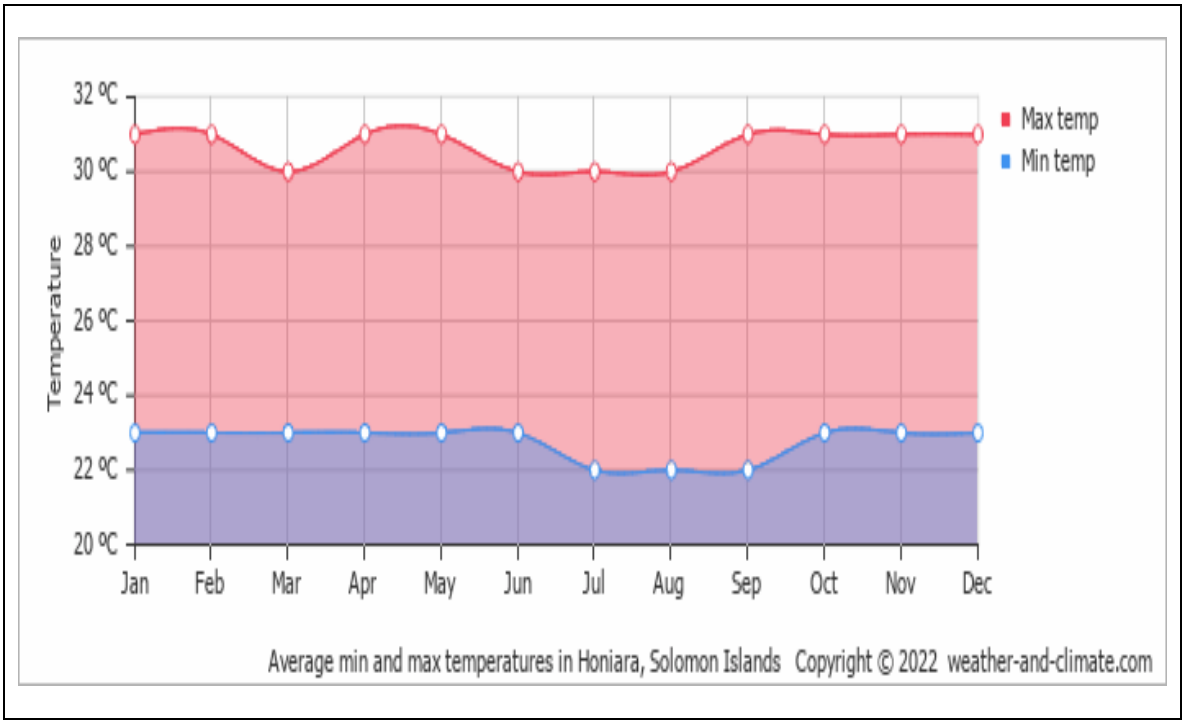
4.1 Physical Environment

4.1.1 Climate and Climate Change

4.1.1.1 Climatic Conditions

330. Honiara has a two-season tropical monsoon climate with minimum daily temperatures ranging on average from 22.0°C to 23.5°C and maximum daily temperatures ranging on average from 30.1°C to 30.7°C. Seventy percent of the average annual rainfall falls within the November-April wet season, while rainfall during the dry season averages 110 mm per month. The monthly average maximum and minimum temperatures observed for 2021 in Honiara are as shown in **Figure 4-1.**

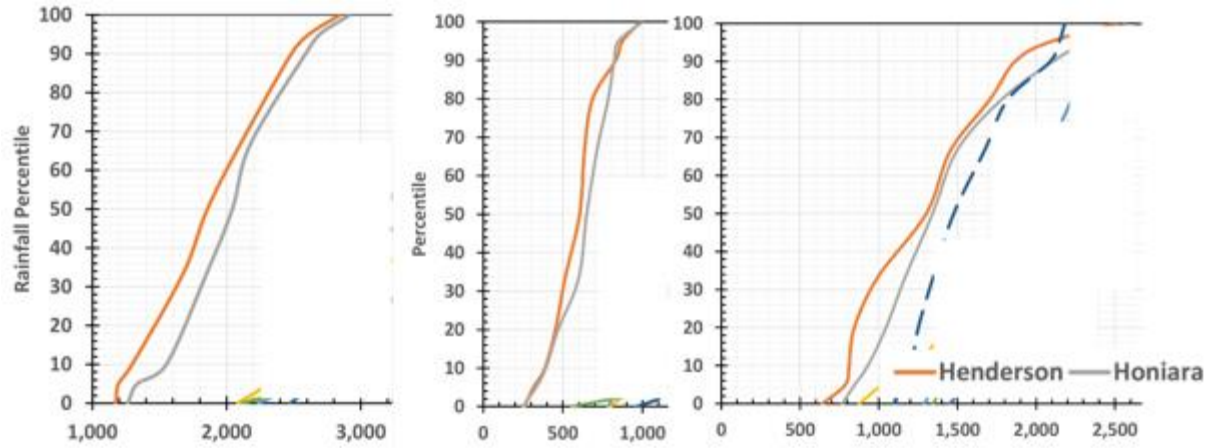
Figure 4-1: Monthly Average Minimum and Maximum Temperature - Honiara (2021)



Source: World Weather & Climatic Information (2022)

331. The percentile distributions of annual rainfall for the two climate stations near Honiara are shown in **Figure 4-2.**

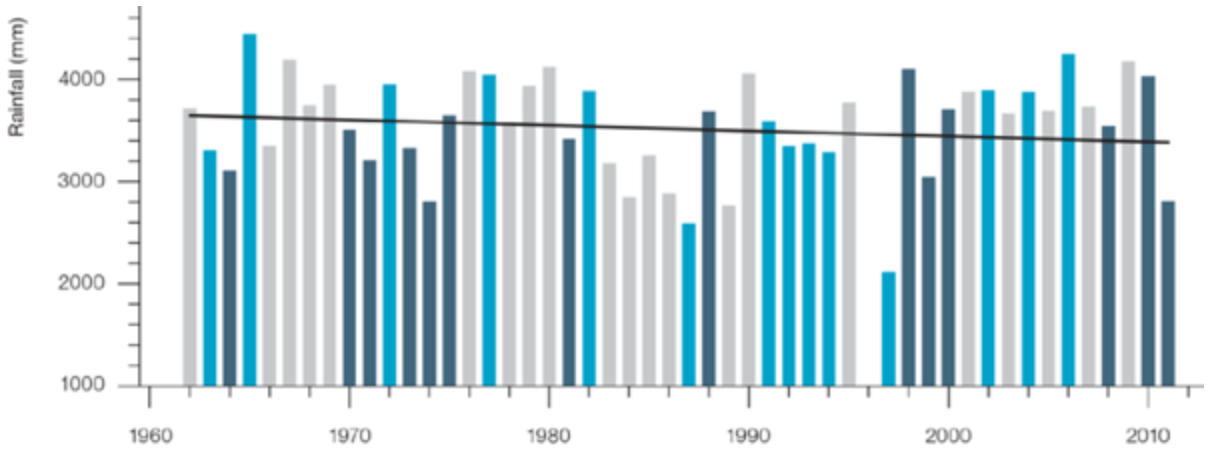
Figure 4-2: Percentile Rainfall Distributions of Annual, Dry Season and Wet Season Rainfall for Honiara and Henderson Stations



Source: Climate Change Impacts and Adaptation Options. 2018

332. The annual rainfall pattern for Honiara from 1962 to 2011 is shown in **Figure 4-3: Annual Rainfall for Honiara from 1962 to 2011**. It shows that over this period, there has been substantial variation in rainfall from year to year. The highest recorded rainfall of 281 mm over a 12-hour period was recorded in 2009 resulting in destructive flooding and loss of lives. In April 2014, the highest recorded daily rainfall of 318mm was recorded, which caused widespread flooding and damage to property, infrastructure, and loss of 23 lives along the Mataniko River, Central Honiara.

Figure 4-3: Annual Rainfall for Honiara from 1962 to 2011



Note: Light blue bars indicate El Niño years, dark blue bars indicate La Niña years and the grey bars indicate neutral years
Source: Climate Change Impacts and Adaptation Options. 2018.

333. From the studies conducted, it was observed that there is a decrease in the number of rain days indicating that rainfall now arrives in larger event days, but these days are less than the annual maximum wet day total. This implies that the rainfall from extreme event days is not increasing. Regardless of this, between 1966 and 2015, there were 12 years with heavy rainfall due to cyclones or a very wet season that led to some flooding, so it is not just the very extreme events that cause flooding.

334. The data for evaporation shows that the estimated annual evaporation losses for Honiara is around 1,230 - 1,300 mm/year with the estimated dry season evaporation to be in the range of 600 – 630 mm and wet season evaporation to be in the range of 630 – 670 mm.

335. The data for drought in Honiara shows that the lowest dry season rainfall recorded in the region was ~250 mm while the lowest wet season rainfall was ~850 mm. **Table 4-1** shows the extreme seasonal low rainfall for Honiara.

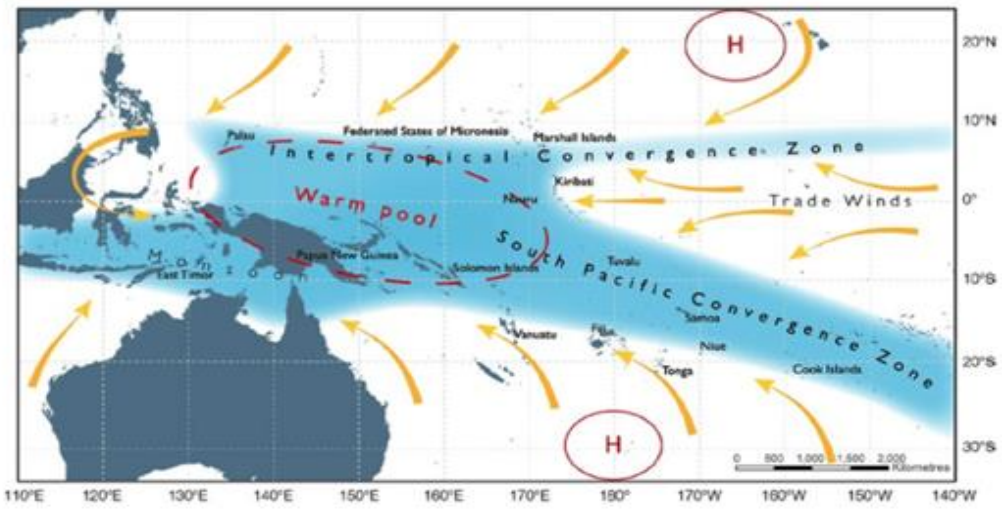
Table 4-1: Extreme Seasonal Low Rainfall for Honiara

Station	Honiara
Mean Annual Rainfall, mm	2,040
Mean Dry Season Rainfall, mm	637
Lowest Dry Season Rainfall, mm	248
Mean Wet Season Rainfall, mm	1,414
Lowest Wet Season Rainfall, mm	847

Source: Climate Change Impacts and Adaptation Options. 2018.

336. The most important driver of global climate as well as Pacific wave climate is the El Nino Southern Oscillation (ENSO), whose ocean-atmosphere mechanisms play out in the equatorial Pacific. ENSO oscillates with a period of 2-7 years between El Nino, which brings lower than normal sea levels, weaker trade winds, cooler ocean temperatures and higher barometric pressures across the western equatorial Pacific, and La Nina, which brings the opposite conditions **(Figure 4-4**).

Figure 4--4: El Nino Southern Oscillation



Source: Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports: 2014

337. Data sourced from the Integrated Global Ocean Services System (IGOSS), demonstrate that the sea level for Honiara is usually higher from November to March. This is believed to be a seasonal effect due to fluctuations in temporal and spatial wind patterns from nearby cyclones. It is also understood

that sea level variations occur annually depending on the strength of the El Nino - Southern Oscillations (ENSO).

338. Predominant trade winds and easterlies are shown with yellow arrows, convergence zones with rainfall are shown in blue. The warm pool of near surface water that oscillates in depth and extent across the equator during ENSO is shown in red along with high pressure systems indicated with 'H'.

339. Wave climate and climate change trends around Solomon Islands are affected by processes occurring over large areas of the Pacific Ocean, from the northern to the southern subtropical zones (35°N to 35°S), and across the equator. The wave environment of Solomon Islands is generally made up of four major components:

- Prevailing northeast to southeast seas and swell waves associated with prevailing easterly trade winds;
- Periods of westerly seas generated by westerly gales during the wet season in equatorial regions;
- Short-term, large seas and swell waves from variable directions generated by tropical storms and cyclones; and
- Seasonal north and south swell waves generated by mid-latitude storms in both the north and south Pacific Ocean.

340. In addition to the seasonal winds, there is also a strong diurnal wind pattern caused by the islands themselves and several effects contribute to this. Over the land areas, the wind speed tends to increase during the morning, reaching maximum during the afternoon at the time of the maximum temperature, and then decreasing at night to become light and variable or calm. In coastal areas, the greater heating of the land during the day allows a flow of air from over slightly cooler sea, the sea breeze strength is typically 20 -30km/hr. Conversely, at night a land breeze can occur because of the more rapid cooling of the land. The offshore breeze is much weaker than the sea breeze. Where there is hilly or mountainous terrain, cool and relatively dense air can flow downhill at night as a katabatic wind. If this reaches the coast, it can combine with the land breeze effect to give an offshore wind as strong as 20 km/hr in the early morning. All these effects are important in Solomon Islands in determining the daily wind pattern at any particular location.

341. For the strong winds, these may be caused by the occasional tropical cyclone between November and April season, or thunderstorm squalls at any time of the year. A very intense cyclone would be rare but have winds of 200 km/hr near its center. The frequency of strong winds at places for which measured wind speeds are available is quite low. Strong winds with speeds averaging at least 39 km/hr are likely to happen less than six days each year.

4.1.1.2 Climate Change

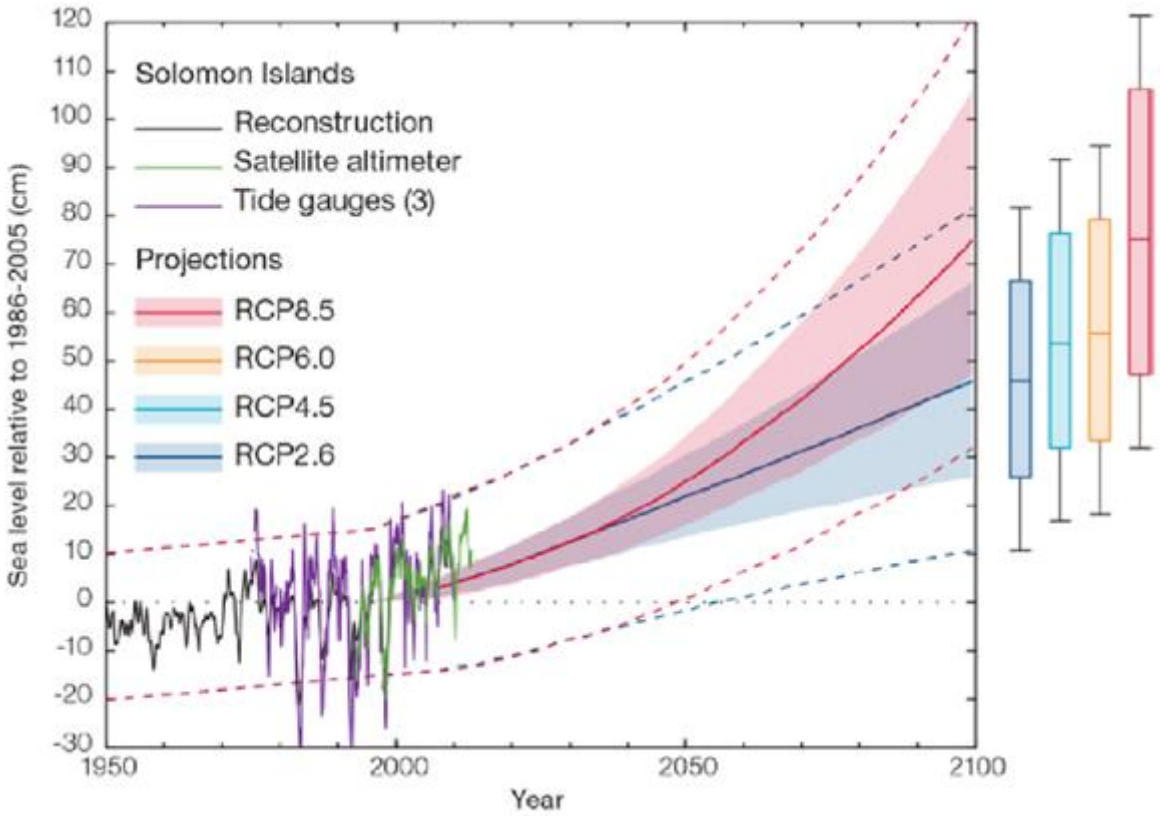
342. Based on the study conducted by the Australian Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organization BoM and CSIRO (2014), the duration of meteorological drought may increase by 20% from 25 to 30 months and the frequency may increase from 0.65 extreme droughts per decade to 1 per decade. In terms of frequency and duration of hydrological drought, the analysis shows that it may occur up to 5 times per decade and it will last on average 8 days and may last up to 19 days.

343. There is a projected increase in temperature for a 1-in-20-year event by 1.4˚C ± 0.7˚C25. Also, high temperatures for a 1-in-20-year event will increase from 35.9 ˚C to 37.3 ˚C and for a 1-in-100-year event from 37.3 ˚C to 38.8 ˚C26.

344. The tropical cyclones are likely to decrease but the intensity is likely to increase by 1.3 m/s. Also, there will be an increase in mean maximum wind speed by 2-11% and in rainfall rates by 20% within 100 km of the cyclone center.

345. The projected changes in Solomon Islands (SI) wave properties include a decrease in mean wave height during December-March. The comparison of the recorded and projected sea level rise is shown in **Figure 4-5**.

Figure 4-5: Past and Projected Sea Level of Solomon Islands



Note: Bars on the right – ranges of projections for four emission scenarios; Dashed lines – estimate of inter-annual variability in sea level
Source: Climate Change Impacts and Adaptation Options. 2018.

346. The projected changes in rainfall are presented in **Table 4-2.**

[25] BoM & CSIRO (2014)

[26] CLIMsystems (2017)

Table 4-2: Projected Changes of Average Annual and Seasonal Rainfall in Honiara

Variable	Historical, mm	Change, mm	Projected, mm
Annual	2,052	61.6	2,114
Wet Season	1,420	42.6	1,462
Dry Season	625	18.8	644

Source: Climate Change Impacts and Adaptation Options. 2018.

347. Based on the study conducted by BoM & CSIRO (2014), a 1-in-20-year 24-hour extreme high rainfall event will become 3.5% or 9mm larger by 2030. Based on the study conducted by Clumsiest (2017), the projected rainfall Intensity, Duration, Frequency (IDF) shown in **Table 4-3** indicates that the 1-in-20-year 24-hour extreme high rainfall event will change from 220 mm to 236 mm by 2050 (a change of 15.5 mm or 7%).

Table 4-3: Historical Extreme RIDF Event and Projected Change for 2050

ARI	Duration								
	30 min	1 hour	3 hours	6 hours	12 hours	18 hours	24 hours	48 hours	72 hours
2	26.9	34.3	50.4	64.2	81.8	94.3	104.3	132.9	153.2
3	32.5	41.4	60.8	77.5	98.8	113.8	125.9	160.5	184.9
5	39	49.7	73.1	93.1	118.7	136.8	151.3	192.8	222.2
10	47.8	60.9	89.5	114	145.4	167.5	185.3	236.1	272.1
15	53	67.6	99.3	126.5	161.2	185.8	205.5	261.9	301.9
20	56.8	72.4	106.3	135.5	172.7	199.1	220.2	280.6	323.4
25	59.8	76.2	111.9	142.7	181.8	209.5	231.7	295.4	340.4
30	62.3	79.3	116.6	148.6	189.3	218.2	241.3	307.6	354.5
40	66.2	84.4	124	158	201.4	232.2	256.8	327.2	377.1
50	69.4	88.4	129.9	165.6	211	243.2	269	342.8	395.1
100	79.6	101.4	148.9	189.8	242	278.9	308.4	393.1	453
150	85.8	109.4	160.6	204.7	261	300.8	332.6	423.9	488.6
200	90.4	115.2	169.2	215.7	274.9	316.8	350.3	446.5	514.6
300	97	123.7	181.6	231.5	295.1	340.1	376.1	479.4	552.5
Projected Change for 2050									
ARI	**Duration**								
	30 min	**1 hour**	**3 hours**	**6 hours**	**12 hours**	**18 hours**	**24 hours**	**48 hours**	**72 hours**
2	27.9	35.6	52.3	66.5	84.6	97.5	107.5	136.9	157.6
3	34	43.3	63.6	81	102.9	118.6	130.8	166.4	191.6
5	41.2	52.5	77.1	98	124.6	143.6	158.3	201.4	231.8
10	51.1	65.1	95.6	121.4	154.3	177.8	196	249	286.7
15	57.1	72.7	106.8	135.6	172.3	198.6	218.9	278.1	320
20	61.5	78.3	115.1	146	185.5	213.8	235.7	299.4	344.6
25	65	82.8	121.7	154.3	196.1	226	249.1	316.4	364.2

30	67.9	86.6	127.2	161.2	204.9	236.1	260.3	330.5	380.5
40	72.7	92.6	136	172.5	219.1	252.5	278.4	353.5	407
50	76.4	97.4	143.1	181.4	230.5	265.6	293	371.9	428.1
100	88.9	113.3	166.4	210.7	267.8	308.7	340.7	432.2	497.8
150	96.7	123.2	181	229	291.3	335.7	370.8	470.2	541.6
200	102.4	130.5	191.8	242.6	308.6	355.7	393	498.4	574.1
300	110.9	141.4	207.7	262.5	334.2	385.1	425.9	539.8	622

Source: Climate Change Impacts and Adaptation Options. 2018.

348. The extreme monthly rainfall is projected to decrease in the future. **Table 4-4** shows the extreme monthly rainfall for 2050 and 2100 in comparison to baseline conditions.

Table 4-4:: Extreme Monthly Rainfall for 2050 and 2100 (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Dry	Wet	ANNUAL
CURRENT	270	286	304	200	132	92	99	92	92	127	146	204	634	1410	2044
2050	231	245	253	187	119	69	65	79	78	121	135	196	531	1247	1778
2100	230	261	236	187	108	74	83	75	68	84	106	188	492	1207	1699

Source: Climate Change Impacts and Adaptation Options. 2018.

349. According to UWSSSP Climatic Risk Assessment Report (2019) and other studies conducted by BoM & CSIRO (2014) clearly stated that Solomon Islands is highly vulnerable to natural hazards and have projected that climate related risks will continue to increase. The Climate change induced risks to sanitation infrastructure are envisaged and include:

- Increase in average annual rainfall, intensity of extreme rainfall events and changes in average recurrence interval (ARI) for 24-hour rainfall event;
- Sea level rise;
- Storm surge;
- Increased temperatures; and
- Changes in wind and wave climate and increases in extreme wave heights and ocean acidity.

350. The proposed new sanitation infrastructure (pumps, pipes and outfalls) are all located in low-lying areas which are potentially subject to coastal and riverine flooding. The associated impacts from the induced risk are listed below:

- Ocean discharge from treated wastewater outfalls can be impaired by sea-level rise, particularly during high tides or storm surges.
- Increased precipitation and floods may directly or indirectly (through erosion) physically undermine the new sanitation infrastructure (pumps, transmission pipes, outfalls and collecting pipes).
- Increased precipitation and floods may directly or indirectly (through erosion) physically undermine the newly created septage facilities (reedbed treatment plant), or the increased

flooding of the beds may lead to contamination of nearby and water sources, and this may increase the incidence of waterborne and water related diseases.

- Coastal storms in combination with sea-level rise can damage wastewater treatment facilities.

351. Therefore, it is necessary for the project to ensure that its sanitation infrastructures are designed to be climate resilient and also taking into account the projected levels of extreme floods for the year 2050.

4.1.2 Topography

352. The island of Guadalcanal is approximately 148 km long and 50 km wide with a northwest-southeast orientation. The islands topography and physical environment are highlighted by marked extremes, including rugged mountainous terrain including the nation's two highest peaks, Mount Popomanaseu (2,335 m) towards the eastern end of the island and Mount Makarakomburu (2,310 m) approximately 32 km south of Honiara, these are flanked by hilly plateaus lightly dissected hills and narrow coastal terrace with interspersed swamps, valleys and significant river catchment areas surrounded by a diverse coral reef and a large and highly productive area in the north, known as the Guadalcanal Plains.

353. A relatively expansive alluvial plain (Guadalcanal Plains) lies along the north coast, west from Honiara stretching 30 km along the coast and up to 8 km inland to the foothills. The plains are important for agriculture comprising flat land, fertile soils and suitable rainfall. In contrast, the physical environment of the southern coast makes it difficult for agricultural production with very high rainfall (about 5000 mm per year), steep topography and infertile soils.

4.1.3 Geology

354. The geology of Guadalcanal Province associated with the northern and north-western coastline including Honiara city is dominated by extrusive igneous rocks generated by volcanism during the Oligocene to Pleistocene periods. These mostly comprise basaltic and andesitic lavas and ash deposits with the Tiaro tuff Breccias and Gallego Andestites the most common rocks. The area also has significant alluvial deposits along the coast and along the river valleys.

355. Rock formation in Honiara consists of limestone, calcareous sandstone/mudstone of Miocene to the recent, which overlies the basement rock, diorite of Oligocene. The stratigraphic classification of Honiara area is shown in **Table 4-5: Stratigraphic Classification of Honiara City Area**

Table 4-5: Stratigraphic Classification of Honiara City Area

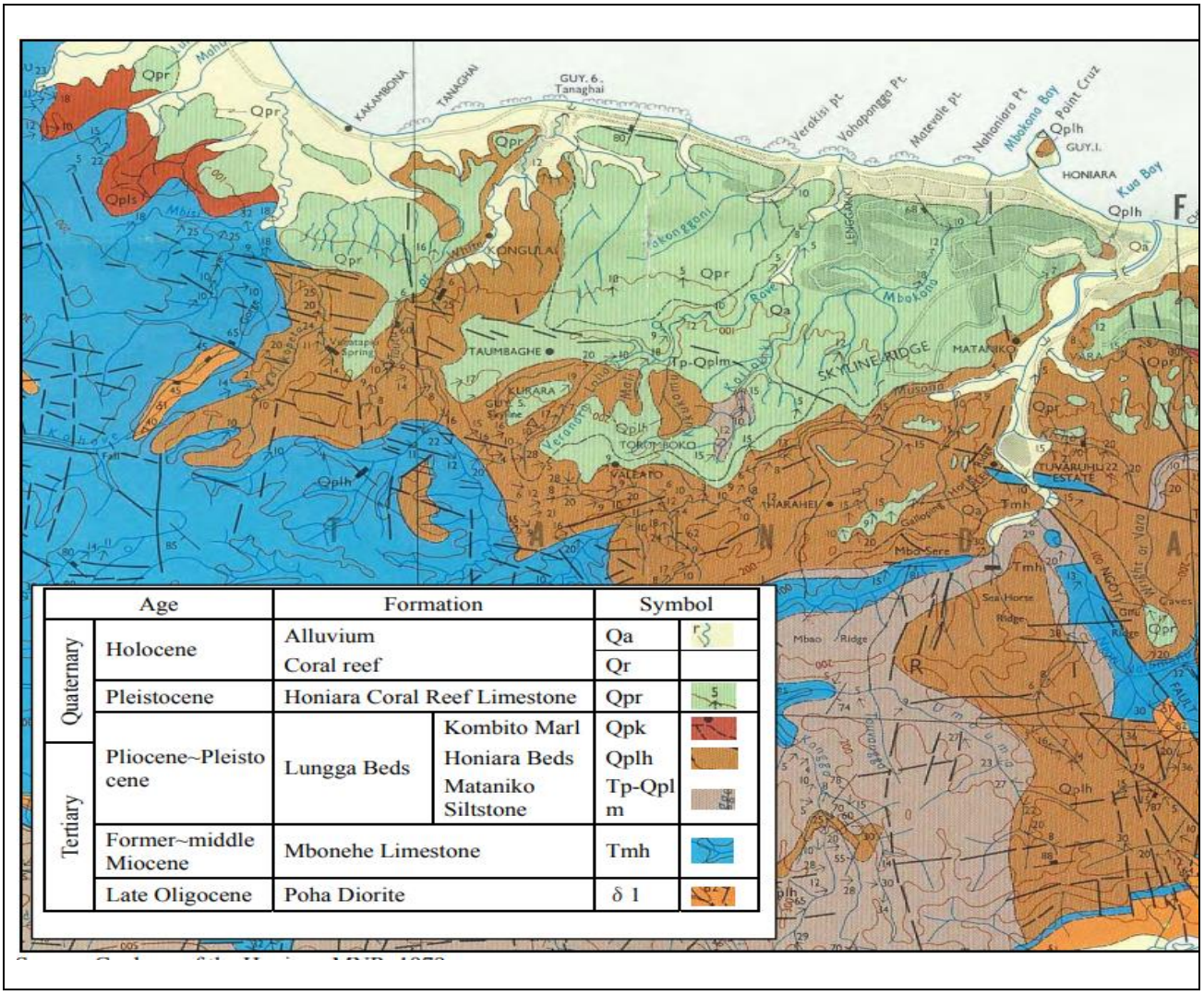
Age		Formation	Rock facies	Thickness of formation	Distribution in Honiara City
Quaternary	Holocene	Alluvium	Sand, clay, gravel	<30m	Distributed in the coastal plain and bottom of valleys
	Pleistocene	Honiara Coral Reef Limestone	Coral Limestone	<60m	Distributed upper half of Marine terrace
Tertiary	Pliocene~Pleistocene	Honiara Beds	Calcareous sandstone, mudstone, conglomerate, limestone	<200m	Outcropping in the foot of marine terrace and can be encountered shallower than 200m from the ground surface.
	Former~middle Miocene	Mbonehe Limestone	Limestone	<100m	Not outcropping in Honiara City and encountered deeper than 100m from the ground surface.
	Late Oligocene	Poha Diorite	Fine Diorite	-	Not outcropping in Honiara City and encountered deeper than 200m from the ground surface.

Source : Geology of the Honiara, MNR, 1979

356. Main faults extend in the north-south direction and the west - east direction. Ngossi Fault and White River Fault with their branches represent faults in the north-south direction. There are many small faults extending from the west to the east parallel with the coastal line. In the Mount Austin area, many faults were formed when the mountain was lifted up.

357. Most of the coastal areas are fringed with dead corals (Quaternary period), which is being swamped by alluvions. Extensive alluvial valleys occur along the courses of the Lungga, Poha and Umasani Rivers.

Figure 4-6: Geological Map of Immediate Honiara Area

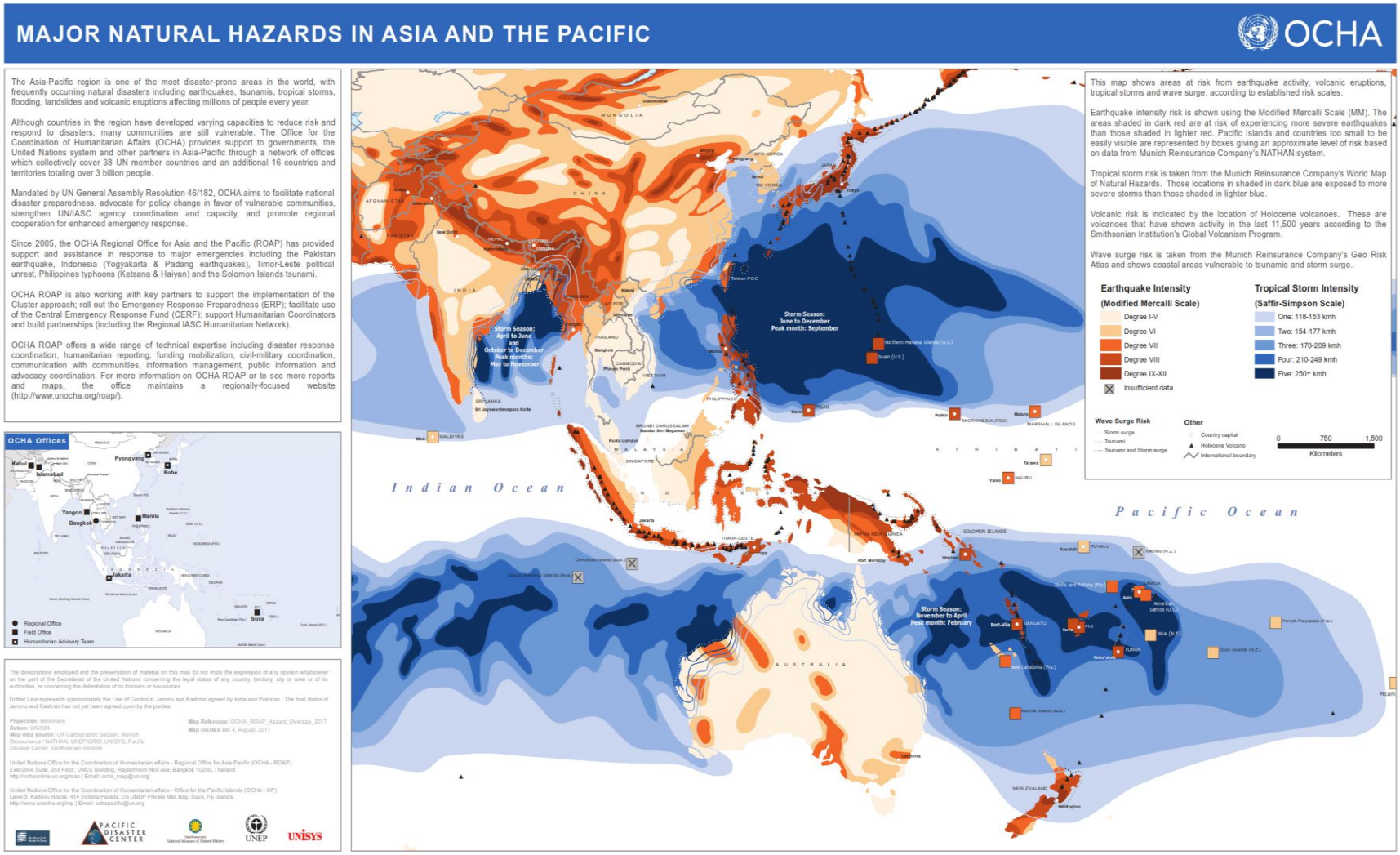


SOLOMON ISLANDS (jica.go.jp)

4.1.4 Natural Hazards

358. Solomon Islands has been identified by the World Bank (WB) as one of the top 15 countries exposed to multiple hazards (**Figure 4-7**) such as severe flooding, earthquakes, tsunamis, volcanic eruptions, landslides and cyclones. Owing to the location of Solomon Islands at the junction of tectonic plates, there is constant seismic activity. The subproject area is within a tropical storm intensity zone 3 (178-209 km/h on the Saffir-Simpson Scale). It is located in an earthquake zone of intensity VIII of the Modified Mercalli Scale (OCHA. March 2016): an intensity which is considered 'severe' and can cause considerable damage in ordinary substantial buildings with partial collapse; it can cause great damage to poorly built structures.

Figure 4-7: Major Natural Hazards in Asia and the Pacific



Source: Office for the Coordination of Humanitarian Affairs (OCHA), 2016.

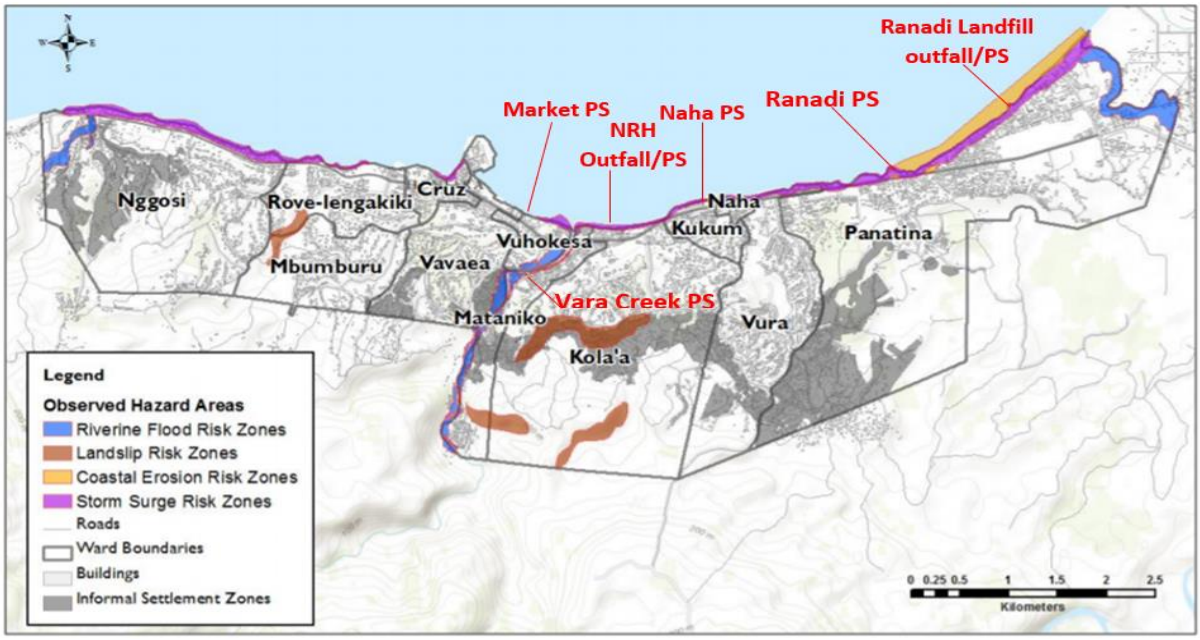
359. **Severe flooding of Honiara**. Honiara is vulnerable to severe flooding and has suffered flooding as a result of extreme rainfall since 2009. Most recently demonstrated in April 2014 when a slow-moving tropical depression delivered more than 732 mm of rain over four days in Honiara. The resulting flooding affected approximately 52,000 people and caused severe damage to several residential and commercial areas and urban infrastructure, including significant debris discharge through rivers and streams into the coastal environmental .

360. For the past 20 years, the sea in Solomon Island has risen around 7-10 mm per year (two times of the global average of 3-5 mm per year) since 1993. From the study conducted in the country, wave energy plays an important role in coastal erosion. Islands exposed to higher wave energy in addition to sea level rise experienced greatly accelerated loss. **Error! Reference source not found.Figure 4-8: Land Projected to be Below Annual Flood Level in 2050,** and **Figure 4-9 Honiara City Council Wards and Outfall/PS sites exposure to natural hazards** are presented below**.**

Figure 4-8: Land Projected to be Below Annual Flood Level in 2050

Source: coastal.climatecentral.org.
Note: Land below water level in red color. Elevation data used is Legacy data.

Figure 4-9: Honiara City Council Wards and Outfall/PS sites exposure to natural hazards.

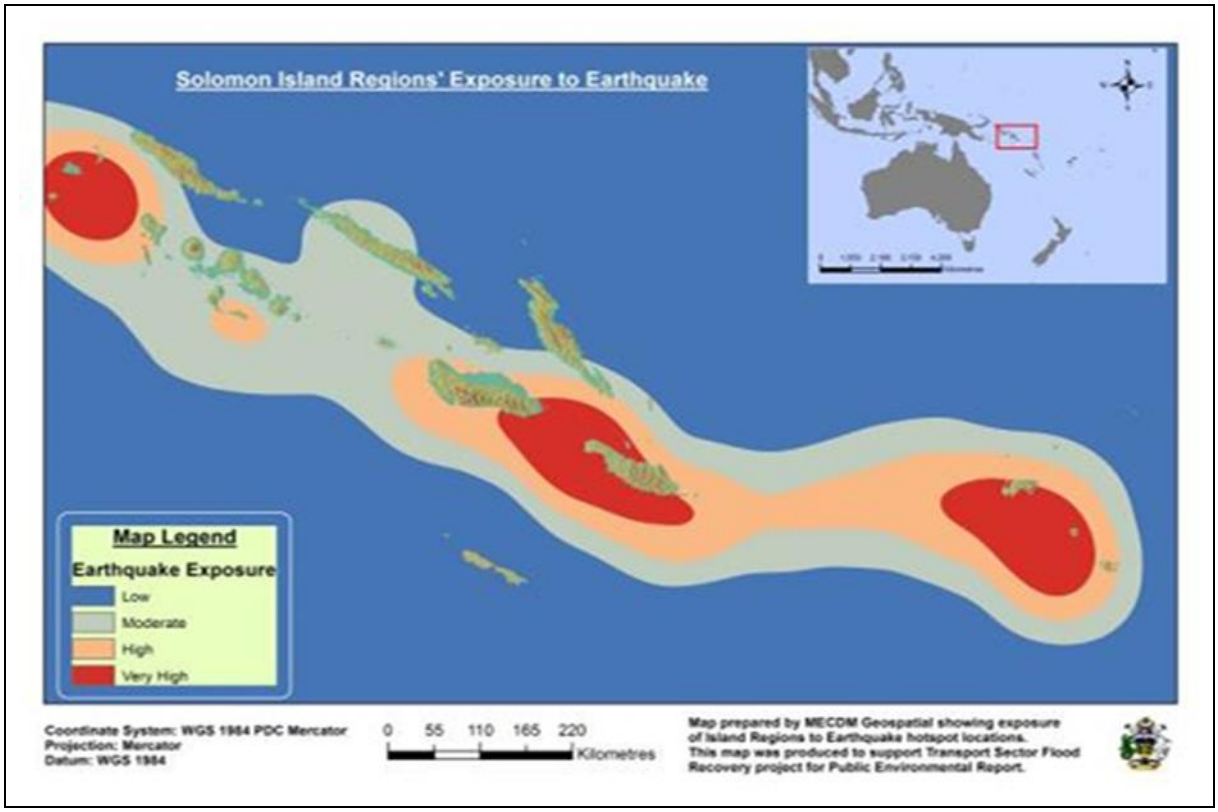


Source: UN-Habitat (2016a)

361. **Tsunami.** The threat from tsunamis is real in Solomon Islands due to the occurrence of strong earthquakes. Tsunamis are caused by vertical displacement of seabed fault lines during earthquakes, or by other processes such as a volcanic eruption, volcanic collapse or submarine landslide. Solomon Islands has been impacted by 22 tsunami events between 1926 to 2016. Four tsunamis caused loss of life including the two recent ones, triggered by a magnitude 8.1 earthquake in April 2007 caused significant damage and loss of life (PCMSC. 2016) and again in February 2013, an 8.0-magnitude undersea earthquake generated a tsunami that hit Santa Cruz and other islands, causing damage. At least five tsunamis caused significant damage to structures, four of which had increased sea wave heights of 3 to 6 m. The Pacific Tsunami Warning Centre in Hawaii provides tsunami warning advice for the Pacific Island Countries, including Solomon Islands.

362. **Earthquake**. Solomon Islands experience earthquakes of magnitude 4.5 and above on average 12 times every month. In recent years, Solomon Islands experience some of the most devastating earthquakes with magnitudes of 7 and 8 on the Richter scale. The most recent destructive earthquake was on the December 9, 2016 and three provinces are affected by the magnitude 8 earthquake and followed by aftershocks including a second magnitude 6.9 quake the next day. Again, on 2013 February 6, off the coast of the Santa Cruz Islands in the southeast Solomon Islands, a magnitude 8.0 quake generates a 3-foot tsunami wave that kills 10 and damages or destroys more than 700 homes. Similarly, a destructive earthquake of 8.1 magnitude triggering a tsunami in Western and Choiseul provinces on 2nd April 2007 that kills at least 34 people and displaces 5,000 in coastal areas. **(Figure 4-10)**

Figure 4-10: Solomon Islands Exposure to Earthquakes

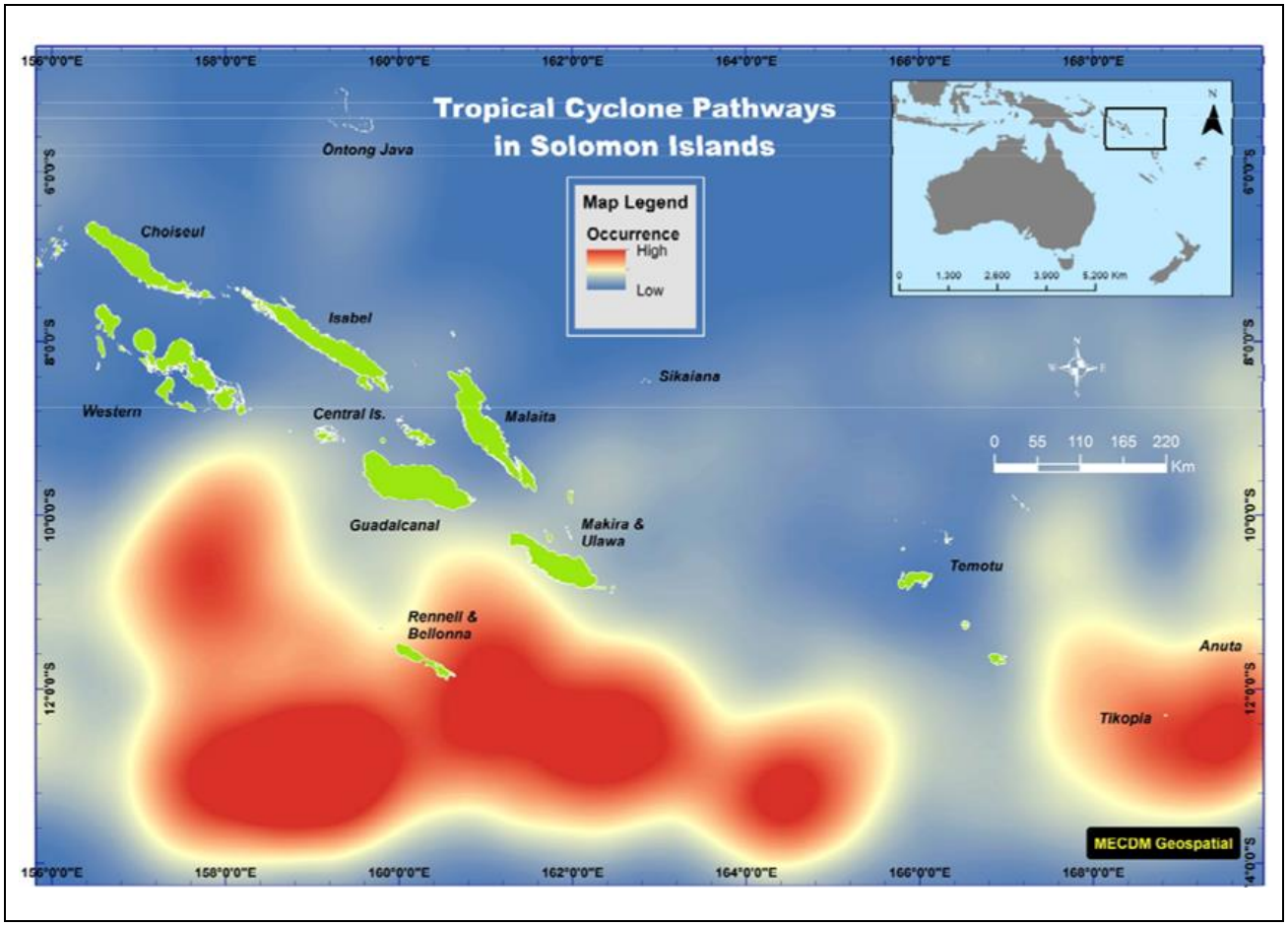


Source: MECDM, 2018

363. **Cyclone.** A number of tropical low-pressure systems occur each year over Solomon Islands at times when the equatorial trough is in the vicinity, but few of these develop into tropical cyclones. The average frequency of tropical cyclones is between one and two per year, tending to increase southwards (**Figure 4-11**). Since the tropical cyclones are usually in the early stage of their life cycle, they are relatively small but can result in serious damage due to strong winds and heavy rainfall.

364. In addition, tropical cyclones will naturally result in abnormally high ocean tides that may rise up to 3-6 m above the regular tide. This is due to the pooling of seawater by the frictional effect of very strong winds persistently gusting on shore as the cyclone approaches a shallow coastline. This can result in inundation of low-lying coastal plains and impacts on the shoreline and beach on beach profiles.

Figure 4-11: Tropical Cyclone Pathway in Solomon Islands



Source: MECDM, 2018

365. **Volcanoes.** There are 16 volcanoes in the vicinity of Solomon Islands and this includes, Coleman Seamount (Western Solomons), Cook (Western Solomons), Gallego (NW end of Guadalcanal Island), Kana Keoki (Western Solomons,), Kavachi (South of Vangunu Island, Western Solomons), Kolombangara (New Georgia Islands group, Western Solomons), Maetambe, (East Choiseul) Mbareke (Vangunu, Western Solomons), Nggatokae (Western Solomons), Nonda (Vella La Vella, Western Solomons), Rendova (New Georgia Group, Western Solomons), Savo (14km off Guadalcanal), Simbo (Western Solomons), Tinakula (Temotu), Vangunu (Western Solomons) and including an unnamed volcano (7 km NW of Kavachi, Western Solomons). The four active volcanoes are Savo, Kavachi, Cook and Tinakula. (**Figure 4-12)**

Figure 4-12: Volcanoes in the Vicinity of Solomon Islands and Papua New Guinea.

Source: Siebert, Simkin & Kimberly (2010)

4.1.5 Soils

366. There are 27 soil groups in Solomon Islands. Soils vary in type and fertility depending on the parent material and land use. Basalt derived soils are generally rich in nitrogen, phosphorous and organic carbon, but poor in potassium. The alluvial soils are deep, freely drained yellowish brown to red humus-rich soils and have reasonable natural fertility. The hill soils are older and have weathered to well-structured clays with poor internal drainage. Such soils have limited use and where they are retained in forests, are used for subsistence gardens, otherwise, these areas have reverted to extensive areas of grassland and have limited agricultural use. The most fertile and agriculturally important of all soils found in Solomon Islands are the recent alluvial soils located on the northern Guadalcanal alluvial plains (Hansell & Wall, 1974).

367. Along each of the subproject construction sites, different soil types were also observed. At the Vara Creek PS Site, Soil type present is sandy loam which is very fertile and rich in nutrients. The soil type associated with the Naha PS consists of backfill materials mostly of limestone mixture with river gravels and sand. Soil fertility for this type of soil is low. At the Ranadi PS, the type of soil present consists mostly of sand with some river gravels which was previously backfilled during the road construction. The associated soil type at the Ranadi Landfill PS comprises of backfilled material with mostly a mixture of limestone while the soil type associated with the outfall site is shallow to deep mixture of sandy loam and clay towards the stream while at the outfall pipeline route, the soil type is a combination of sand, coronous and fragmentation of limestone and at the shoreline is mostly fine black sand.

4.1.6 River & Marine Water Quality

368. Water quality data for the river and coastal water systems in Honiara are very limited.

369. With respect to in situ readings such as pH, turbidity and dissolved oxygen, only two datasets could be located. The first was from the Commonwealth Marine Economies Program (CPEM) survey for the UK Centre for Environment, Fisheries and Aquaculture Science (CEFAS) undertaken on the 23rd and 24th of September, 2017. This program sampled much of the Honiara foreshore starting immediately west of Point Cruz and continuing through past Ranadi, plus the local river systems. Some 69 in-situ readings were taken overall. The lower saturation readings were all recorded in the freshwater environments associated with the Mataniko River system, with the lowest reading of all being 46% saturation or a dissolved oxygen level of 3.5 mg/l. The marine readings were all close to or above saturation. Overall, the average dissolved oxygen saturation level from all samples was 102%. The ANZECC (2000) guideline[27] minimum values are 85% saturation for lower reach freshwaters, and 90% minimum saturation for inshore marine waters, with a maximum of 120% saturation.

370. The second study incorporating in-situ results was part of a rapid assessment of the Mataniko River environs undertaken by Global Environmental Fund (GEF) in 2020 as part of the Pacific International Waters Ridge to Reef Regional Project.[28] The results of physical parameters measured at the seven sites on Mataniko were combined with the results of measurements taken at an additional eight freshwater sites in rivers east and west of Honiara, and 15 marine sites, as shown in **Figure 4-13** below. For the freshwater sites, the dissolved oxygen percent saturation ranged from 2.7% to 113%. For marine waters, the percent saturation range from 87% to 120%. Based on the ANZECC (2000) water quality guidelines, the values for the freshwater reaches of the river do not meet the guidelines but results generally meet the guidelines in the marine waters.

371. Therefore based on these two available surveys, and observations by the current projects EIS team along the foreshore, dissolved oxygen concentrations alone would not be expected to impact the estuarine and marine water ecology at present but may impact upon the freshwater ecology. Dissolved oxygen concentrations at 2 mg/l (in the order of 25% saturation) will certainly impact upon species diversity, and only very coarse species could survive at less than 1 mg/l (in the order of 12% saturation).

372. The 2020 GEF Study also monitored the total coliform counts at these sites. Six of the sites exceeded the 500 CFU/100 ml guideline for European Bathing waters[29] as reported in the study, while three sites exceeded the upper mandatory limit of 10,000 CFU/100 ml.

373. The three sites that exceeded the limit of 10,000 CFU/100 ml for European bathing waters were at the Mataniko River mouth and sites downstream of wastewater outfalls from Tuvaruhu and Vara Creek informal settlements, as reported in the study. The only site that showed low coliform concentrations was the one furthest upstream away from human influence. Unfortunately, there were no fecal coliform counts measured to be able to compare with the ANZECC 2000 recreational water

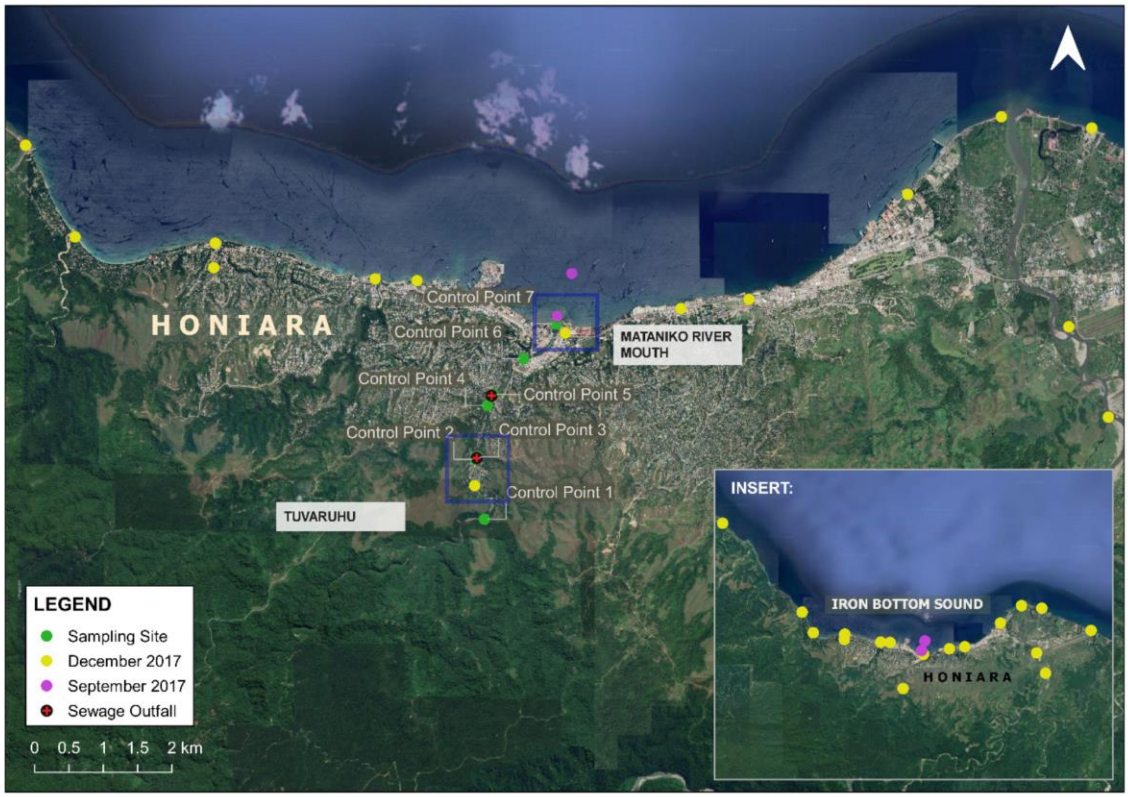
[27] Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. 2000. Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines /

[28] Milika, S. GEF et al, Suva, Fiji SPC (2020) Rapid Coastal Assessment of Mataniko River Catchment Report, Honiara, Guadalcanal Island, Solomon Islands.

[29] EEC Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160

quality guidelines, but one can assume that the *E. coli* (*Escherichia coli*) or fecal coliform concentrations would be high.

Figure 4-13: CEFAS Sampling Locations



Source: Year 2 report. Cefas, UK

374. In a separate study by Cefas[30], fecal coliform (E. coli effectively, as E. coli is by far the dominant species in the fecal coliform grouping) measurements were taken at 15 sites along the length of the Mataniko River and its tributaries. The study found that even the control site in the upper catchment still showed traces of fecal contamination, but the total coliform concentrations and fecal coliform concentrations increased progressively from upstream to downstream. Fecal coliform levels downstream exceeded the maximum detection limit of 24,196 MPN/100 ml and the report noted that the main source was sewage effluent from settlements along the river. Unsealed pit toilets are common in informal settlements and leach into the Mataniko River, as well as discharges from communal septic tanks. The sewage, combined with the large volume of solid waste due to poor disposal practices of the residents, resulted in a polluted river that poses a public health risk.

375. Water samples were also collected as part of CEFAS 2018 from East Mataniko, Mataniko River mouth and Mataniko beach. Samples were analyzed for fecal coliform and fecal *Streptococci sp*.. All three sites showed fecal coliform concentrations that exceeded the water quality objectives based on the ANZECC 2000 guidelines of 150 E. coli/100ml.

[30] Devlin, M., Bacon, J., Haverson, D., Graham, J., Smith, A. et al. Cefas, UK 2018. Pacific Water Quality and Resilience Framework – Year 2 report.

376. A toxicant survey[31] was undertaken in Solomon Islands between 2017 and 2019, where Persistent Organic Pollutants (POPs) were measured. Four samplers were placed in 2017 with two recovered, whilst in 2018/19 six were deployed and four were recovered. One was from a control area, Boneghe, which was relatively undeveloped. It was the site furthest from the commercial and industrial activities in Honiara.

377. In the 2017 deployment, the field control samplers were found to have consistently recorded Polycyclic Aromatic Hydrocarbons (PAH) values above the detection limit. During the collection process, it was later noted that an engine fault on the boat led to increased exhaust emissions. This needs to be factored into the analysis of deployed samplers and is likely to have increased the PAH concentrations in the deployed samplers, but by an unknown amount. The concentrations of contaminants recorded from Boneghe were generally the lowest recorded for most determinants. The highest recorded PAH level was for naphthalene at 0.012 mg/l at the central market in 2017. However, most samples recorded 1000 times less than that and below or close to the level of detection in the picogram range. The ANZECC guidelines only have PAH guideline concentrations for naphthalene at 0.070 mg/l, well above the concentrations recorded.

378. Individual PAH readings were generally low. This suggests a broad range of PAHs from several different sources, rather than one significant input type or source. For example, at the Mataniko and Point Cruz East sites, the calculated concentration of perylene is at least five to six times higher than for the other sites sampled.

379. The sum of Dichlorodiphenyltrichloroethane (DDT) pesticide and its metabolites is the most significant set of data for Solomon Islands. All sites show these DDT pesticides are present, although at the Boneghe site they are at the lowest concentrations among the Solomon Islands samples. The only organochlorine pesticide listed in the ANZECC 2000 guidelines is endosulfan which has a guideline value of less than 10 picograms per liter compared with the highest actual reading of less than 2 picograms per liter.

380. For Poly-Chlorinated Biphenyls (PCBs), ANZECC guidelines are given only for freshwater and are in the range of 30 to 1700 picograms per liter. The highest recorded PCB reading was 2.5 picograms per liter.

381. Most of the other chemicals are at barely detectable concentrations, in the low picograms per liter range.

382. As part of the UWSSSP project, water quality samples were collected in 2019 on the Mataniko River and at the major existing outfalls in Honiara, as indicated in **Figure 4-1**Error! Reference source not f ound.**4: 2019 Honiara Foreshore Water Sampling Points**. The samples represent high and low tides to better characterize the impact of the sewerage system on Honiara's foreshore water quality. The original laboratory results are provided in **Appendix 7: 2019 Water Quality Monitoring Results,** and **Table 4-6: 2019 Water Quality Monitoring Results** summarizes the results of this survey.

[31] A.J. Smith, J. Barber, S. Davis, C. Jones, K.K. Kotra, S. Losada, B.P. Lyons, M. Mataki, K.D. Potter, M.J. Devlin Marine Pollution Bulletin 165 (2021) Aquatic contaminants in Solomon Islands and Vanuatu: Evidence from passive samplers and Microtox toxicity assessment, 112118

Figure 4-14: 2019 Honiara Foreshore Water Sampling Points

Source: SW Background Information Report

Table 4-6: 2019 Water Quality Monitoring Results

PARAMETER		LOCATION											
	Water Quality Guidelines/Objectives	Tuvaruhu Up	Tuvaruhu Outlet	Point Cruz (Ports Authority Area)	Kukum (Pacific Casino)	Kukum (Didao)	China Town (New Bridge)	Rove	NRH	Panatina (Marine School)	China Town (Old Bridge)	Ranadi (Silent World)	Kukum (Spice Bar)
pH	5 - 9	7.76	8.16	8.53	8.43	8.64	8.73	8.67	8.40	8.35	7.82	7.70	8.47
Temperature, °C	15 - 35	26.10	25.55	25.30	25.65	24.60	24.45	26.05	25.75	26.25	22.40	26.15	25.60
Phosphorous, mg/l	-	0.31	1.21	1.30	1.36	1.36	1.38	1.31	1.47	1.17	1.32	1.32	1.37
BOD, mg/l (level of detection should really be set at 2 mg/l)	-	0.55	0.86	2.01	0.58	0.56	1.13	0.51	0.79	0.61	1.88	1.02	0.79
COD, mg/l	-	161.50	153.00	19.00	161.00	96.00	57.00	57.00	81.00	152.00	74.50	150.50	132.00
TSS, mg/l	-	1.57	2.22	1.44	2.41	2.27	1.90	2.26	1.42	1.32	1.80	1.80	1.73
Oxidized Nitrogen, mg/l	-	0.11	0.27	0.18	0.20	0.25	0.14	0.20	0.17	0.22	0.16	0.45	0.37
Ammonia, mg/l (NH3)	-	0.58	0.84	0.39	0.31	0.58	0.80	0.58	0.84	0.39	0.31	0.58	0.80
Ammonium Ion, mg/l (NH4)	-	0.62	0.96	0.53	0.50	0.90	1.56	0.62	0.96	0.53	0.50	0.90	1.56
E. Coli, unit/100 ml (high tide, low tide, logarithmic mean)	150/100ml Primary 1000/100ml Secondary	73/139 97	416/549 477	23/1011 152	245/80 139	19/1011 138	195/52 101	138/110 123	173/1011 417	170/214 186	251/353 297	319/162 226	501/1732 930

Note: Values are arithmetic averages of low and high tide results, except for E. coli which are logarithmic means.

383. Some of the results presented in the table above indicate some concerns with the robustness of the results. Starting with Biochemical Oxygen Demand (BOD), this test is undertaken by adding a biological seed to the sample to initiate the biochemical consumption of the oxygen. This seed is often primary settled sewage. Because biological elements are being added to the sample, a BOD reading will always be present at low concentrations. For that reason, laboratories typically only report BOD down to values of more than 2 mg/l. However, the results from this survey have BOD values down as low as 0.51 mg/l which would in effect just be the seed impact. Furthermore, the BOD test is not sufficiently robust to be able to report down to .01 mg/l. The reported BOD results, which are all at two or less milligrams per liter, are essentially showing that there is immeasurable BOD in these waters, and should have been considered as such.

384. The “nitrogen” values in the original laboratory results appended do not specify what nitrogen fraction this is reporting. Typically if the word nitrogen is presented without further description, it refers to total nitrogen. However discussions with the laboratory indicated that this is in fact oxidized nitrogen, that is, nitrite plus nitrate. This has been noted in the table below. The “nitrogen” values reported in the original laboratory results show nitrogen down to an accuracy of 0.001 mg/l. This is much lower than the usual limit of reporting of 0.01 mg/l. Reporting the results to this level of accuracy is inconsistent with good laboratory practice, and therefore the nutrient results presented below have only been reported to 0.01 mg/l concentrations

385. The bacteriological results for *E. coli*, total coliforms and HPC (total plate count effectively) in the appendix are presented as “units per milliliter” whereas it should be “units per 100 ml.” This was confirmed by discussions with the laboratory. The results in the table below are correctly reported as units per 100 ml.

386. Even with these caveats, it can be seen that the water quality of the Mataniko river reduces significantly downstream of the communal septic tanks (CSTs) previously mentioned. This accords with other monitoring results from the river.

387. The pH is alkaline in all cases and would satisfy both recreational and protection of aquatic ecosystem objectives.

388. The BOD is essentially at background concentrations, and corresponds well with the dissolved oxygen readings discussed above, meaning that there is little dissolved oxygen stress in the marine waters. By contrast, some reaches of the river and tributaries have recorded almost zero dissolved oxygen in other studies referenced above.

389. Regarding nutrients from the 2019 survey, phosphorus is consistently above 1 mg/l throughout. This is well above the adopted local water quality objective of 0.025 mg/l. Similarly, adding together the oxidized nitrogen and ammonia gives an indicator of Total Nitrogen concentrations, excluding organic nitrogen, which was not analyzed, ranging from 0.47 mg/l to 1.17 mg/l. Again this is well above the water quality objective of 0.2 mg/l for Total N.

390. *E. coli* counts are logarithmically distributed in a survey, not arithmetically distributed. Therefore the average results for *E. coli* shown in earlier reports are incorrect as they were arithmetic averages. Both the high tide and low tide results for *E. coli* respectively are shown in the table below, together with the logarithmic mean. When individual results are close together in the distribution, there is little difference between the arithmetic and logarithmic mean. However for results in this survey where the low-end high tide results varied by an order of magnitude in some cases, then the difference is significant. For example with the Ports Authority area samples, the arithmetic mean of the high and low tide results is 517 *E. coli* per 100 ml, whereas the logarithmic mean is 152 *E. coli* per 100 ml. At

Kukum Didao where the high and low tide *E. coli* readings were 19 and 1,011 respectively, the arithmetic mean is 515 as opposed to the logarithmic mean of 138 *E. coli* per 100 ml. Therefore in this example, the site actually meets the primary contact recreation water quality guidelines, whereas the arithmetic mean indicates that it fails to meet these guidelines.

391. Overall, only five of the 12 sites meet the recreational water quality guidelines for the primary contact of 150 *E. coli* per 100 ml. None of the 12 sites were above the secondary contact recreational guidelines of 1000 *E. coli* per 100ml. It must be noted however that given the logarithmic distribution of *E. coli* data sets, then a much larger and comprehensive survey set would be required before definitive conclusions could be drawn on local suitability for primary or secondary contact recreation.

392. There was no consistent difference between the high tide and the low tide results which would be expected in a fully mixed foreshore environment.

393. In summary, the 2019 results confirm earlier surveys indicating that BOD and dissolved oxygen concentrations are not of concern in terms of protecting the marine aquatic ecosystems. Some reaches of the Mataniko River system are oxygen deprived, however, especially downstream of CST outlets. Nutrient concentrations are well above the adopted water quality objectives. The *E. coli* concentrations from the survey are lower than those obtained in previous surveys and would indicate that the majority of the sites along the foreshore would generally be safe for secondary contact recreation but would need to be more closely monitored to be confident that the guidelines for primary contact recreation were consistently achieved.

394. A water quality survey was undertaken specifically for the EIS preparation on 30 August 2022. The laboratory results are presented in **Appendix 8: 2022 Water Quality Results**. It was a fine day with only moderate wind and little rain in the preceding days. High tide was 0.9 m at 5:11 AM and low tide was 0.4 m at 12:24 PM.

395. Single event surveys do not provide a statistically valid data set. However, to maximize the utility of the samples, multiple samples or replicates were taken at each sampling site. This reduces the probability of the sample not reflecting the local environment, for example, if the sample happens to contain some fecal matter or other material that is not typical of the water status at that location.

396. For the surface water samples, five grab sample replicates were taken a few minutes apart at each site and then composited and subsampled, to reduce the impact of inevitable intrasite variability. For the deeper sites along the outfall alignments, a sampling tube was lowered, up to a maximum of 30 m, and the sample tube sealed and withdrawn collecting a depth-averaged sample. This was done at least three times at each location to overcome any within-site variability, composited and then subsampled. Samples of raw wastewater were also collected at two sites, making 12 sites in total that were sampled. The samples were also replicated by compositing a number of individual grab samples and then subsampled.

397. Therefore both surface and depth samples were replicated to maximize the utility of the results. The sample locations, times, geocoordinates, sampling protocols and site observations are presented in **Table 4-7: 2022 Survey Sampling Locations And Procedures** below. Note that three of the sites are the same as those sampled in 2019, namely Pacific Casino, Panatina marine school and Spice Bar.

398. Results are presented in **Table 4-8: 2022 Water Quality Survey Sample Results - Water Samples** and **Table 4-9: 2022 Water Quality Survey Sample Results – Wastewater Samples** below.

Table 4-7: 2022 Survey Sampling Locations And Procedures

Sample	Sample Location Description	Sample time	Northing	Easting	Sample depth	Sampling method	Location notes
1 - NRH5	National Referral Hospital outfall alignment - 5 m from shore	8:00:00 AM	9.434506	159.972178	200mm below the surface	Composite of 5 grab samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
2 -NRH170	National Referral Hospital outfall alignment - 170 m from shore	8:35:00 AM	9.432961	159.972178	Surface to 5m deep	Composite of 3 "hose" depth-averaged samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
3 -NRH350	National Referral Hospital outfall alignment - 350 m from shore	8:25:00 AM	9.431318	159.972178	Surface to 11m deep	Composite of 3 "hose" depth-averaged samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
4 - RAN5	Ranadi outfall alignment - 5 m from shore	9:35:00 AM	9.416588	160.013853	200mm below surface	Composite of 5 grab samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
5 - RAN170	Ranadi outfall alignment - 170 m from shore	9:29:00 AM	9.415422	160.012712	Surface to 8m deep	Composite of 3 "hose" depth-averaged samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
6 - RAN340	Ranadi outfall alignment - 340 m from shore	9:19:00 AM	9.414532	160.011592	Surface to 15m deep	Composite of 3 "hose" depth-averaged samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
7 - RAN500	Ranadi outfall alignment - 500 m from shore	9:09:00 AM	9.413468	160.010514	Surface to 30m deep (end of sample hose)	Composite of 3 "hose" depth-averaged samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
8 - SEW1	Tuvaruhu outfall	12:05:00 PM	9.452	159.9568	Outlet pipe sampled from above dry creek bed	Composite of 5 grab samples	Light-colored sewage and some odor. Very few floatables or solids.
9 - SEW2	Ranadi TGA outfall	9:46:00 AM	9.4269	160.0024	Outlet pipe above water sampled from beach	Composite of 5 grab samples	Appeared very lightly colored and very little odor. Toilet paper observed in surf zone.
10 - Pacific Casino	5m from shore near outfall	10:19:00 AM	9.4323	159.4722	200mm below surface	Composite of 5 grab samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
11 - Spice Bar	5m from shore at Kukum	10:12:00 AM	9.4317	159.9826	200mm below surface	Composite of 5 grab samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site
12 - Panatina Marine School	5m from shore	9:56:00 AM	9.4284	160.0001	200mm below surface	Composite of 5 grab samples	Clear water. No surface slicks. No turbidity from reclamation at sampling site

Table 4-8: 2022 Water Quality Survey Sample Results – water samples

		Sample Number		1	2	3	4	5	6	7	10	11	12
		Sample location		NRH outfall alignment - 5 m from shore	NRH outfall alignment - 170 m from shore	NRH outfall alignment - 350 m from shore	Ranadi outfall alignment - 5 m from shore	Ranadi outfall alignment - 170 m from shore	Ranadi outfall alignment - 340 m from shore	Ranadi outfall alignment - 500 m from shore	Pacific Casino	Spice Bar	Panatina Marine School
Analyte	**Unit**	**Limit of reporting**	**WQO**										
pH Value	pH Unit	0.01	6.5-8.5	**8.08**	**8.08**	**8.13**	**8.08**	**8.10**	**8.13**	**8.13**	**8.04**	**8.12**	**8.13**
Suspended Solids	mg/l	5	N/A	**13**	**6**	<5	<5	**9**	<5	<5	<5	<5	<5
Turbidity	NTU	0.1	1.0- 20	**7.3**	**0.9**	**0.6**	**1.1**	**0.6**	**0.6**	**0.2**	**0.5**	**0.9**	**0.5**
Arsenic	mg/l	0.001	0.36	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cadmium	mg/l	0.0001	0.036	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Chromium	mg/l	0.001	0.09	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	mg/l	0.001	0.008	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	mg/l	0.001	0.012	<0.005	**0.150**	**0.235**	<0.005	**0.103**	**0.134**	**0.125**	<0.005	<0.005	<0.005
Nickel	mg/l	0.001	0.56	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc	mg/l	0.005	0.043	**0.059**	**0.028**	**0.048**	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026
Mercury	mg/l	0.0001	0.0014	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
NO_2 + NO_3 as N	mg/l	0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.05**	**0.02**	**0.03**
TKN as N	mg/l	0.1		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total N as N	mg/l	0.1	0.2	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total P as P	mg/l	0.01	0.025	<0.05	<0.05	<0.05	**0.05**	<0.05	<0.05	<0.05	**0.05**	<0.05	<0.05
BOD	mg/l	2	N/A	<2	<2	**4**	<2	<2	**2**	**3**	<2	<2	<2
enterococci	Count/ 100ml	-	40 (Class A Recreation)	7701	20	195	1872	228	>24,196	63	>24,196	75	41

Table 4-9: 2022 Water Quality Survey Sample Results – Wastewater Samples

		Sample Number		8	9
		Sample location		Tuvaruhu sewage outfall	Ranadi TGA sewage outfall
Analyte grouping/Analyte	**Unit**	**Limit of reporting**	**WQO**		
pH Value	pH Unit	0.01	6.5-8.5	**7.71**	**8.05**
Suspended Solids (SS)	mg/l	5	N/A	**195**	**25**
Turbidity	NTU	0.1	1.0- 20	**176**	**14.4**
Arsenic	mg/l	0.001	0.36	**0.004**	**0.001**
Cadmium	mg/l	0.0001	0.036	**0.0001**	<0.0001
Chromium	mg/l	0.001	0.09	**0.002**	<0.001
Copper	mg/l	0.001	0.008	**0.021**	**0.005**
Lead	mg/l	0.001	0.012	**0.002**	<0.001
Nickel	mg/l	0.001	0.56	**0.003**	**0.002**
Zinc	mg/l	0.005	0.43	**0.191**	**0.038**
Mercury	mg/l	0.0001	0.0014	<0.0001	<0.0001
Nitrite + Nitrate as N	mg/l	0.01		**0.04**	**0.36**
TKN as N	mg/l	0.1		**68.8**	**10.5**
Total Nitrogen as N	mg/l	0.1	0.2	**68.8**	**10.9**
Total P as P	mg/l	0.01	0.025	**7.56**	**1.29**
BOD	mg/l	2	N/A	**256**	**47**
enterococci	Count/100ml		40 (Class A Recreation)	>24,196	41

399. Results of the 10 ambient water quality samples for pH, suspended solids and turbidity all satisfy the ANZECC 2000 and 2018 guidelines for the protection of aquatic ecosystems.

400. Analyses were also conducted for heavy metals in the water column. Based on this one water sampling event, arsenic, cadmium, chromium, copper, nickel and mercury were all below the level of detection at all 12 sites. For these parameters, the level of detection is much lower than the water quality trigger values specified in the ANZECC guidelines.

401. Heavy metal concentrations are typically low in marine waters and as such, quite often heavy metal monitoring programs include sediment sampling. Many metals attach to clay colloids and silts and provide a longer-term indicator of the presence of metals. As noted above, a series of surveys would have to be undertaken, preferably incorporating benthic sampling, to confirm the absence of these heavy metals.

402. Lead was detected in the offshore samples for both the NRH and the Ranadi outfall alignments, starting at 170 m from the shore and extending to 350 m at the NRH outfall and 500 m offshore at the Ranadi outfall. Lead levels varied from 0.1 to 0.235 mg/l, compared with the ANZECC 2000 water quality guidelines level of 0.012 mg/l. Therefore the lead concentrations were 10 to 20 times the

trigger values suggested in the guidelines. However, lead was not detected at the nearshore samples along both outfalls' future alignments, nor at any other foreshore sites.

403. Zinc was detected at all three locations along the NRH outfall which starts at 5 m offshore, then 170 m and finally 350 m offshore. Zinc concentrations above the level of detection along the outfall alignment range from 0.028 to 0.059 mg/l compared with the ANZECC 2000 guidelines trigger value of 0.043 mg/l. Therefore the recorded zinc levels were only slightly higher than the trigger value. Zinc was not detected along the Ranadi outfall alignment or at any other sites.

404. Both lead and zinc are used in hull antifouling and protective coatings on ships. It is common for ships to moor offshore from Honiara to undertake remedial and maintenance work, including painting and other repair works. This could explain the elevated lead and zinc concentrations offshore and the lack of elevated levels inshore. Prior to implementing any significant management interventions, however, it would be necessary to undertake several surveys in these locations for heavy metals, and, as noted above, incorporate benthic samplings to obtain a longer-term perspective of the actual lead and zinc concentrations. However, there will be some difficulties with interpreting any benthic results given the mobility of the sediments being so fine in these locations.

405. In terms of nutrients, the analyses requested included the organic fraction of both nitrogen and phosphorus to ensure that a complete picture was available of the overall nutrient cycles. Because the detection limit for the organic fractions of both nitrogen and phosphorus is reasonably high, none of the seven samples along the two outfall routes were above the level of detection. Also for oxidized nitrogen (nitrite and nitrate), none of these seven samples were above the level of detection which is 0.01 mg/l. When both organic and ammonia forms of nitrogen enter the marine environment, they are usually rapidly mineralized and then oxidized to nitrite and nitrate. Therefore given that the Total Kjeldahl Nitrogen (TKN) concentrations are all below the level of detection of 0.5 mg/l, it could be inferred that the current total nitrogen levels could approach the water quality objective of 0.2 mg/l total nitrogen. Similar comments apply to the total phosphorus results which are all below the level of detection at these seven sites. Note that the Total P level of detection is twice the water quality objective of 0.025 mg/l however.

406. These results are not surprising given that there is significant advection due to the river systems to the east and west of the sampling area, and tidal dispersion of any contaminants.

407. The 2022 sampling sites at Pacific Casino, Spice Bar and the Panatina marine school correspond with three of the sampling sites from the 2019 survey. The 2022 sampling all gave detectable limits of oxidized nitrogen ranging from 0.02 to 0.05 mg/l. These are well below the water quality objective for total nitrogen of 0.2 mg/l. In addition to the oxidized nitrogen content, there will also be some organic and ammonia nitrogen but again, even at these sites, the TKN was below the level of reporting of 0.5 mg/l.

408. In terms of total phosphorus at these sites, only Pacific Casino recorded a total phosphorus concentrations equal to the level of detection, that is 0.05 mg/l compared with the water quality objective of 0.025 mg/l. Based on these 2022 nutrient results from one survey, it could be hypothesized that the offshore ocean waters are generally low in nutrients as would be expected. Those monitoring sites along the shoreline, particularly close to known existing outfalls, do have elevated nutrient concentrations, but only total phosphorus exceeded the water quality objective.

409. The 2022 oxidized nitrogen results at these three sites were approximately 10% of the 2019 oxidized nitrogen concentrations reported at the same sites. The 2019 ammonia concentrations at these three sites varied from 0.5 to 1.56 mg/l compared with the 2022 TKN levels of less than 0.5 mg/l – the

detection limit. This indicates that the 2019 nitrogen concentrations were reportedly far higher than those in 2022. This could be due to numerous factors such as improved catchment management and reduced outfall flows in the intervening 3-year period. However, discussions with SW staff indicated that any improvements would have been minor, and probably would have been masked by population growth within the catchment. Further, there is the issue that the results from two single sample surveys cannot realistically be compared statistically as the statistical error band would be far greater than the difference in the values from the two sampling runs.

410. One other explanation would be that the testing protocols used in 2019 at a local laboratory were different and perhaps less accurate than those used in the 2022 samples analyzed at an international laboratory.

411. Two samples of raw sewage were also collected, one from the inland Tuvaruhu outfall and one from the Ranadi TGA sewerage outfall. The field sampling notes indicated that the Ranadi outfall sewage appeared to be very weak and this has been confirmed in the monitoring results. The BOD was 47 and 256 mg/l respectively and the suspended solids were 25 and 195 mg/l respectively for Ranadi and Tuvaruhu discharges. These key parameters would indicate that the Tuvaruhu sewage is diluted possibly through significant inflow or other sources of dilution, or undergoing some pre-treatment such as in a septic tank. The Ranadi sample was typical of mid-strength wastewater.

412. Heavy metals content in the sewage samples was below the water quality trigger level except for copper which was three times the trigger level in the Tuvaruhu sample. This is still not a concern even if it is a representative sample as these are the ambient trigger concentrations following dilution of the sewage in the receiving waters, not a discharge standard.

413. In terms of nutrients, the Tuvaruhu sewage has 0.04 mg/l of oxidized nitrogen which is unsurprising given that nutrient speciation within raw domestic wastewater is often mainly present in organic or ammonia fractions (TKN). The TKN of this sewage was 69 mg/l which is relatively high for mid-strength domestic wastewater, and the total phosphorus was 7.6 mg/l which is typical for such strength domestic wastewater.

414. The weaker Ranadi sewage had an oxidized nitrogen level of 0.36 mg/l and total nitrogen of 10.9 mg/l accompanying a total phosphorus level of 1.3 mg/l. These are low concentrations and would be expected in such weak domestic wastewater.

415. Water samples were also submitted to a local laboratory for bacteriological indicator organism analysis. Unfortunately, the laboratory could not obtain sufficient media to undertake the *E. coli* tests, so only *enterococci* results are available.

416. For the 10 ambient water quality samples, only one satisfied the adopted water quality objective of 40 *enterococci* organisms /100ml. This was at 170 m offshore along the NRH outfall alignment.

417. The five nearshore samples, one each at the start of the two outfall alignments and the other three at Pacific Casino, Spice Bar and Panatina school, all exceeded this recreational water objective for primary contact recreation. However, three of the five sites satisfied the secondary contact recreational guideline of 200 *enterococci*/100ml. These data obviously confirm significant bacteriological contamination along the entire foreshore between NRH and Ranadi. At Pacific Casino, for example, the count was greater than 24,196/100ml - the maximum detection limit. Spice Bar and Panatina school recorded 71 and 41/100ml respectively for *enterococci.*

418. Traditionally you would expect their bacteriological concentrations to reduce as you move further offshore given that the wastewater sources of primary interest to the study are all shoreline based. However, from the single survey, the *enterococci* level initially drops from 7,701 to 20/ 100ml at the 170 m offshore mark along the NRH alignment. However, the count then increases to an *enterococci* level of 195/100ml at 350 m offshore. A similar profile was recorded along the Ranadi outfall alignment. The *enterococci* level at this shoreline was 1,872 /100ml, and then changing to 228, >24,196 and finally 63/100ml respectively at distances offshore of 170 m, 340 m and finally 500 m.

419. This would indicate that there is a secondary source of fecal contamination some hundreds of meters offshore. As noted in the discussion for the heavy metal concentrations, particularly lead, ships moor offshore for maintenance work for protracted periods and would be discharging domestic wastewater during these mooring periods. This could explain the band of fecal contamination offshore.

420. With the two sewage samples, the weak sewage at the Tuvaruhu outlet recorded only 41/ 100ml for *enterococci*, compared with the Ranadi TGA outlet yielding greater than 24,196/100ml - above the maximum detection limit for the test. These bacterial results correspond well with the other results confirming a weak compared with a mid-strength domestic wastewater respectively.

421. Overall the ambient water quality may be summarized as follows:

- Water quality is poor in the lower reaches of the river, and even the uppermost sampling sites above most catchment development still recorded pathogen indicators being present. Dissolved oxygen concentrations approach zero in some river reaches based on one survey.
- In the marine environment, dissolved oxygen levels and turbidity satisfy the ANZECC 2000 water quality guidelines.
- Selected POPs were analyzed between 2017 and 2019 including pesticides, PAH and PCB concentrations. Comparing results for specific parameters with those actually quantified in the guidelines indicated that all the POPs were below the ANZECC 2000 trigger levels.
- Eight heavy metals were analyzed in the water column during the 2022 sampling. Only lead and zinc exceeded the detection limits, and then only along the two outfall routes. Given that the higher levels were well offshore, this may indicate that the lead and zinc sources are from shipping maintenance and repair activities rather than domestic wastewater flows. Metals concentrations in the two domestic wastewater samples were low.
- Nutrient concentrations throughout the bay and inshore locations away from existing wastewater outfalls were all below the level of detection. Because nitrogen and phosphorus tests included organic fractions, these levels of detection were higher than the adopted water quality objectives. However, oxidized nitrogen levels were less than 0.01 mg/l in these locations and would be expected to represent the most common species given that organic and ammonia nitrogen would be rapidly mineralized and then oxidized in the marine environment.
- Three of the 2022 survey shoreline samples were taken at the same locations as those used in the 2019 survey. These sites all recorded oxidized nitrogen above the detection limit but below the adopted water quality objective of 0.2 mg/l for Total N. One phosphorus result of 0.05 mg/l was recorded, compared with the water quality objective of 0.025 mg/l for Total P. The 2022 nutrient levels were far lower than those recorded from the 2019 sampling, although there could be many reasons for this including catchment management interventions or different laboratory techniques and capabilities. Even with this uncertainty, the nutrient

concentrations along the foreshore exceed the water quality objectives in some locations, especially when close to an existing domestic wastewater outfall.

- Fecal bacteriological contamination in earlier studies indicated that the river system was highly contaminated as a result of domestic wastewater outfalls and failed septic systems together with low diluting flows in dry seasons. Results along the foreshore were highly variable but earlier studies indicated that the foreshore did not consistently meet primary contact recreational guidelines but may be suitable for secondary contact recreation. The 2022 survey indicated that the five nearshore samples, one each at the start of the two outfall alignments and at Pacific Casino, Spice Bar and Panatina school, all exceeded this recreational water objective for primary contact recreation at 40 *enterococci*/00ml. However, three of these five sites satisfied the secondary contact recreational criteria. There is a band of bacteriological fecal contamination some hundreds of metres offshore, that is likely a result of moored ships releasing their domestic wastewater.
- The two sewage samples collected represented a range from very weak to typical mid-strength sewage in terms of the key parameters BOD, suspended solids, nutrient profiles and enterococci concentrations. The heavy metal levels were very low and would not be contributing to the elevated zinc and lead levels detected offshore.

422. Concluding, i) water quality within the river system is significantly impacted; ii) marine water quality close to the existing small sewage outfalls is exhibiting elevated concentrations of nutrients and pathogen indicators; iii) the majority of the offshore waters are relatively uncontaminated apart from some isolated heavy metal and *enterococci* readings with POPs being low, and oxygen concentrations remain acceptable. This confirms a need to remove wastewaters currently entering the foreshore areas to improve water quality for recreational activities as well as protect local ecosystems.

4.1.7 Air Quality & Noise Levels

423. Air quality in Solomon Islands is generally very good, largely as a result of there being very few industries and a relatively small vehicle fleet generating emissions. However, recent road upgrading activities within and around Honiara have caused significant increases in air born dust as a result of construction activities. These temporarily increased levels of dust are expected to greatly subside once sealing activities are undertaken. There are no air quality or emissions standards in Solomon Islands and no monitoring is undertaken.

424. Noise levels in Solomon Island are generally very low as a result of very few industries and a relatively small commercial sector, most of which is restricted to the light industrial areas within and around Honiara.

425. In areas where the PS and outfalls will be constructed, noise levels are expected to be intermittently elevated. Construction noise will be intermittent, quickly attenuates with distance, and depends on the type of operation, location and function of equipment. Trucks and construction equipment, which can generate noise of 80 dB(A) from a distance of 30 meters are the main potential sources of noise during construction.

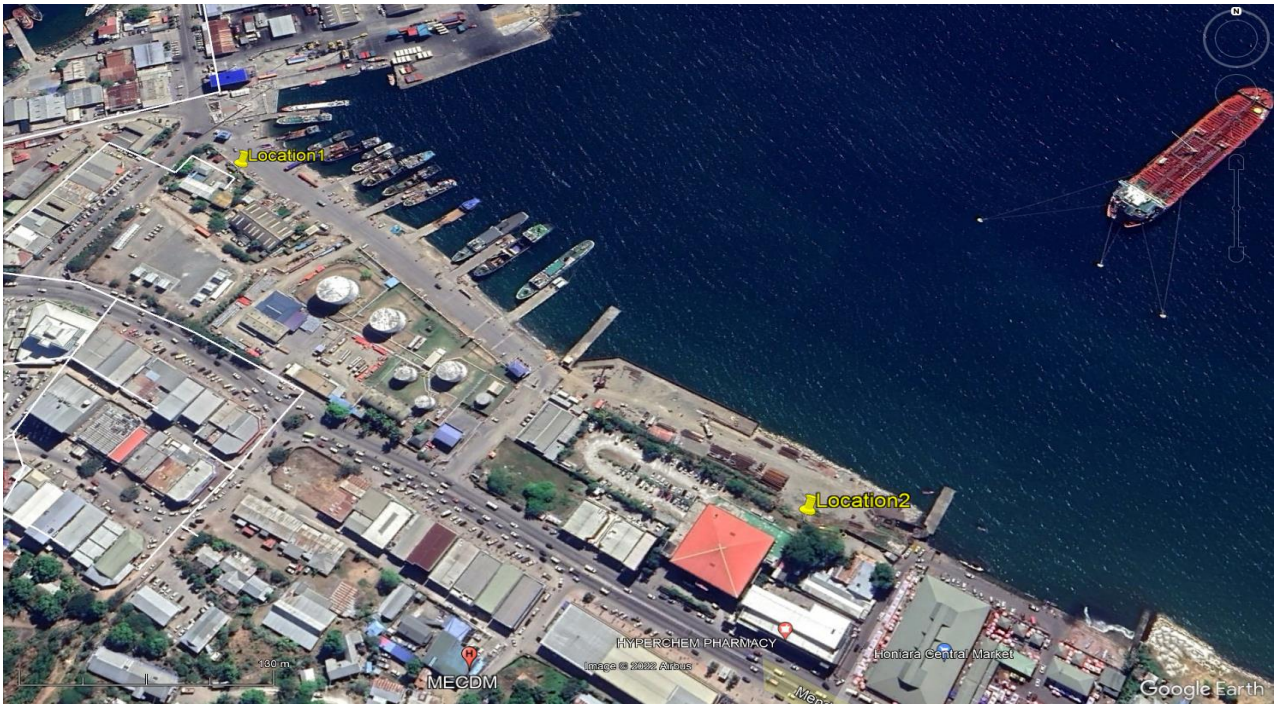
426. No baseline monitoring of air and noise is required for this sub-project, but readings will be taken during construction using a noise meter and handheld PM10 dust meter.

427. The locations proposed for noise level reading and subsequent monitoring for the project are identified in **Tables 4-10** and **4-11**. Location of the suggested noise monitoring sites are in **Figures 4-15** and **4-16**

Table 4-10: Proposed locations for noise level reading and subsequent monitoring at Western Section of the subproject area of Influence.

Proposed Locations	Location Description	GPS COORDINATES	
		LATITUDE	LONGTITUDE
1	Sol Islands Port Authority	9° 25.803'S	159° 57.475'E
2	Market PS at SIPA	9° 25.951'S	159° 57.671'E
3	United Church Sea front	9° 26.025'S	159° 57.796'
4	Ministry of Health/NRH Pumping Station	9° 26.129'S	159° 58.097'E
5	NRH Outfall pipeline from NRH boundary	9° 26.092'S	159° 58.306'E
6	Vara Creek- near the bridge	9° 26.662'S	159° 57.527'E

Figure 4-15: Location Map of proposed locations (1 to 6) of Noise Level reading and subsequent Monitoring of the subproject area of influence



Honiara Central Market
Location3
Public Solicitor's Office
Wesley United Church
Honiara Magistrate Court
Image © 2022 Airbus
Google Earth

Location4
Location5
Image © 2022 Airbus
Google Earth

Source: Google Earth

Table 4-11: Proposed locations for noise level reading and subsequent monitoring at Eastern Section of the subproject area of Influence.

Proposed Locations	**Location Description**	**GPS COORDINATES**	
		LATITUDE	**LONGTITUDE**
7	Naha PS Site	9° 25.920'S	159° 58.994'
8	Ranadi area PS (Sol green)	9° 25.559'S	160° 0.271'E
9	Ranadi Goodwood Outfall	9° 25.169'S	160° 0.692'E
10	Ranadi Landfill Outfall	9° 25.033'S	160° 0.875'E

Figure 4-16: Location Map of proposed locations (7 to 10) of Noise Level reading and subsequent Monitoring of the subproject area of influence

Source: Google Earth

428. The significant sensitive receptors are the Churches (SSEC & United Church) and the National Referral Hospital (NRH), Lord Howe Settlement, Vara Creek Settlement, and Commercial Business Offices.

4.2 Biological Environment

4.2.1 Marine Biodiversity

4.2.1.1 Background

429. The biodiversity of Solomon Islands is recognized as part of the most geographically complex area on Earth. The coastal and marine biodiversity is categorized as part of the global marine biodiversity hotspot and serves as a potential refuge and reservoir for the marine life known as the Coral Triangle region.

430. The marine and coastal ecosystems of Solomon Islands are part of the Western Pacific center of marine biodiversity. The coastal and marine ecosystems are significant to the livelihood and wellbeing of the people. They provide benefits which include daily nourishment and livelihoods, coastline protection and tourism. The fisheries and marine resources are a source of export income and contribute significantly to the national and local economy.

431. The country's coastal zones are characterized by highly variable patchy ecosystems that include estuaries, lagoons, beaches, mangroves, coral reef areas, sea grass beds, algal beds and small

islands. Coral reefs are narrow, fringing, and intermittently distributed around the high islands, with barrier reefs and expansive inter-tidal reefs not common. The coral reefs are most often associated with either uplifted shores attached to volcanic coastlines or seaward elevated coral limestone beaches.

432. With healthy coral reef systems across the islands, coral species diversity is high. Solomon Islands has recorded 485 hard coral species. The associated coral reef fish stand at a record of 1,019 species from 82 families and 348 genera. The composition and diversity of the country's fish community are thought to be influenced by habitat type and food availability. The greatest degree of species diversity is found in the western part of the country. Large marine vertebrates—including eight whale species, nine dolphin species, and one dugong species, as well as five species of turtle and one species of crocodile—have been recorded.

433. Mangrove and seagrass ecosystems cover the shallow sub tidal and intertidal zones of the islands. Mangroves cover about 65,000 hectares with a record of 17 species and 2 hybrids species from 15 genera and 13 families. On the Island of Guadalcanal, the mangrove strands are more or less confined to Marau Sound, situated in the eastern tip of the Island. In Marau alone, 11 species of Mangroves have been recorded and *Rhizophora stylosa*, *R.apiculata*, *Bruguiera gymnorhiza* and *Lumnitzera littorea* as the dominating species. Other mangrove species record also include *R. mucronate*, *B. parviflora*, *C.tagal*, *S. Ovata*, *Excoecaria agallocha*, *X. granatum* and *S. hydrophyllacea*.

434. No mangroves are found in the UWSSSP subproject area of influence.

435. A significant coastal habitat which contains high biodiversity value is the sea grass meadows. Seagrasses are essential marine ecosystems as they are the main food source for species such as the endangered green sea turtle (*Chelonia mydas*) and dugongs (*Dugong dugon*), which are found throughout Solomon Islands. Sea grasses grow fully submerged and rooted in soft bottom estuarine and marine environments and can be found in habitats extending from the intertidal zone to sub tidal, along mangrove coastlines, estuaries, shallow embayments and also coral reef, inter reef and offshore islands. There are ten species of sea grass identified with significant patches recorded around Guadalcanal.

436. Seagrass beds in Guadalcanal Island are confined to the northwestern shores than the southern coast shores. The northwestern shores have calmer bays and fringing reefs and the extensive reef complexes at the island's most easterly extent. The southern coast is exposed to the south-easterly trade winds and heavy rainfall, associated with strong currents and large oceanic swells therefore the likelihood of seagrass persisting in such environments is very low. Seagrass beds cover about 10,000 hectares with a record of 10 species on Guadalcanal. Seagrasses have been reported from the Catholic Mission (Visale Village), west of Cape Esperance and in Komimbo (northwest Guadalcanal), the sand-mud flats are generally dominated by *Thalassia hemprichii* shoreward and *Enhalus acoroides* seaward. In Marau Sound on the eastern tip of Guadalcanal the fringing reefs were dominated by *Enhalus acoroides*/*Cymodocea rotundata* close to shore (0-10m from beach), *Thalassia hemprichii*/*Cymodocea rotundata* (20-50m from beach) and *Thalassia hemprichii*/*Halophila ovalis* (50+m from shore).

437. Two species of sea grass were located to the east of the subprojects NRH proposed outfall site, with both species recording low densities and restricted to small, isolated patches over 200 m form the proposed outfall pipeline sites, and as such are well outside the UWSSSP subproject's area of influence. There are no expected impacts on these small, isolated seagrass communities from the subproject's activities

438. In terms of highly mobile and migratory species, there are 8 species of whales, 9 species of dolphins, 1 species of dugong, 5 species of turtles and many species of sharks present in the waters of Solomon Islands. Cetacean species are common in Solomon waters and their habitat is usually major rivers, mangroves and open ocean environments such as oceanic islands, oceanic fronts and upwelling, seamounts, canyons, deep-sea trenches and the water column itself. According to The Nature Conservancy (2006), cetacean movements between the South Pacific and North Pacific are known or suspected (depending on the species) to occur through the major island passages of Solomon Islands' archipelago, such as Indispensable Strait, Bougainville Strait - separating Solomon Islands from Papua New Guinea (PNG), Manning Strait and New Georgia Sound. These areas have been classified as the migratory corridor for these marine mammals. There is no known readily available information on their seasonal migrations.

439. No migrator marine species were recorded within nor in close proximity to the proposed sites nor is there any evidence that these species, especially dugongs and turtles, are feeding in these areas (no resources for them). There is no evidence nor anecdotal information to indicate marine turtles are and have used the shorelines at both sites for nesting, especially as the significant alteration of the shoreline largely precludes access.

440. None of the endangered nor the critical highly mobile and migratory species identified are found in the subproject area of influence.

441. Commercially, tuna species which include the yellow fin tuna, south pacific albacore tuna, skipjack tuna and bigeye tuna have huge contributions to the country's economy. Solomon Island's Tuna accounts for around 7 percent of the total western and central Pacific Ocean catch with an estimated US180 million. Tuna is caught by pole and line, purse seining and long lining and most catches are by foreign fishing vessels. SolTuna based in Noro Town in Western Province is the country's only Tuna Processing Facility.

442. The dominant marine ecosystems of Guadalcanal adjacent to the two proposed outfall sites site includes the remnants of a coastal foreshore beach and coastal intertidal and subtidal marine habitats which do not including coral reef systems. All coastal ecological systems associated with the subprojects, which are within the urban areas of Honiara adjacent to the project sites have been significantly impacted by anthropogenic activities for many years and degradation of the natural system has and continues to occur.

4.2.1.2 Inshore Marine Environment Baseline Assessment

443. The marine biological baseline assessment was undertaken on the coastal and marine biomes associated with both the intertidal and shallow subtidal marine habitats and benthic substrate within and surrounding the two proposed outfall pipeline sites. The in water marine assessments were undertaken during the period from Tuesday the 16th through to Thursday the 18th of August 2022 using a combination of free diving (snorkeling) and SCUBA diving qualitative and quantitative benthic habitat and resource assessment scientific visual survey methods.

444. **Appendix 9: Marine Ecological Assessment** presents the full report**,** and the main findings of the inshore baseline ecological survey for that report are presented below.

4.2.1.3 Methodology

445. In total, eleven (11) SCUBA dives were undertaken during the assessment. Six (6) SCUBA dives were undertaken at the Ranadi site ranging in water depth between 7 – 42 meters (m), (**Figure 4-15**) whilst five (5) SCUBA dives were undertaken at the NRH site **(Figure 4-16**) with a range of water depth between 5 – 11 m. Each SCUBA dive, once the sea floor was reached, data was recorded (photo/video) which included benthic biotic (fauna and flora) and abiotic resources. The area assessed differed between each dive and ranged between 36 m^2 and 144 m^2 for Ranadi and 25 m^2 and 256 m^2 for NRH. Total area assessed for all SCUBA dive site locations for Ranadi was 496m^2 (0.0496 hectare) and 545m^2 (0.0545 hectare) for NRH.

446. In total, eight (8) Free dives (snorkeling) were undertaken during the assessment. Four (4) undertaken at the Ranadi site (Refer **Figure 4-17**) ranging in water depth between 1 – 4 m, and four (4) Free dives were undertaken at the NRH site (refer **Figure 4-18**) with a range of water depth between 2.5 – 5m. Each Free dive recorded (photo/video) the benthic biotic (fauna and flora) and abiotic resources. The area assessed differed between each dive and ranged between 225 m^2 and 625 m^2 for Ranadi and 144 m^2 and 400 m^2 for NRH. Total area assessed for all Free dive site locations for Ranadi was 1,700 m^2 (0.170 hectare) and 1,344 m^2 (0.134 hectare) for NRH.

447. As part of the overall subproject preparatory investigations, the preliminary UXO study report prepared by CERES in 2020[32] was reviewed as it provided information on bed profiles along the outfall alignments. Regarding water depth along the proposed NRH outfall, for the first 330 m of the corridor, the slope is gentle at around 1.1°. Then there is a strong inflection at around 390 m from the shore with an average slope of some 6°. From approximately 410 m from the shoreline to 700 m, the slope reduces back to about 3°. Over this entire length, there are no major drop-offs. At the Ranadi outfall, for the first 250 m of the corridor, the slope is gentle at 1.9°. Then an inflection occurs at around 290 m with an average slope of 11° until approximately 430 m. Then the slope reduces to 7° from approximately 430 to 490 m, or 560 m offshore allowing for the 70 m offshore starting location

[32] CERES Consultants. 2020. UXO Study of Honiara Area

Figure 4-17: Marine Assessment Survey Sites at the Proposed NRH Site

Source: Google Earth

Figure 4-18: Marine Assessment Survey Sites at the Proposed Ranadi Site.

Source: Google Earth

4.2.1.4 General Description of the Marine Environments of the proposed outfall sites and key summary assessment results

Ranadi Site

448. The proposed new sewage outfall pipe line exits the shoreline (9025'.00.8"S and 1600 00'387."E) and is proposed to extend 500 m directly offshore perpendicular to the shoreline (northerly direction) and will terminate approximately (09025'03.2"S 160000'84.2"E) in 41 m of water.

449. Significant foreshore alteration has taken place along the coastline directly adjacent to as well as to the west and east of the proposed outfall coastal entry location. To the east Solfish, a commercial domestic fishing and trading company has reclaimed an extensive coastal area for operations including the development of a wharf approximately 300 m in length (**Plate 4-1a and 4-1b**) that runs perpendicular to the shoreline and several large vessel permanent mooring sites (**Plate 4-1c and 4-1d**) located approximately 200 m to the east of the proposed outfall pipeline.

450. To the west the foreshore and coastal areas have been reclaimed to support vessel access to transfer timber and other domestic goods (**Plate 4-2**).

Plate 4-1: Foreshore Reclamation East of the Proposed Ranadi outfall (including Solfish infrastructure and vessel mooring sites).

Plate 4-2: Foreshore Reclamation West of the Proposed Ranadi outfall.

451. The proposed outfall site enters the foreshore directly north of the Honiara city waste landfill facility (**Plate 4-3a**) and includes a small stream that receives runoff and material from the landfill site that enters the foreshore directly east (60 m) of the proposed outfall site. Water level and discharge rates of the stream fluctuate and are directly related to rainfall events. Sand is collected at the mouth of the stream and the shallow water foreshore, stockpiled adjacent to the stream and used for domestic building material **(Plate 4-3b and c)**. Directly to the east of the river mouth, several shipwrecks are located in shallow water (**Plate 4-3d**).

Plate 4-3: (a) Landfill Facility; (b and c) Location of Sand Removed from the stream; (d) Shipwrecks to the east of the proposed Ranadi outfall pipeline.

452. The proposed outfall pipeline location is situated on an open beach shoreline running east to west with the ocean side to the north. There are no coral reef systems, seagrass beds nor mangroves associated with this area. The site is marine with the benthic substrate dominated by both terrigenous and marine (calcium carbonate) sediments. The subtidal benthic substrate extends seawards (north) and descends gradually to a depth of 40-42 m 500 meters from highwater mark at the proposed pipeline entry location. The benthic substrate consists of granular sand and finer sediment particles with the latter revealing highlight percentage levels as depth is attained. There is an absence of large size benthic substrate material (rocks, boulders etc.) throughout the assessed area.

453. The foreshore and coastal waters directly adjacent to the proposed outfall entry point have been significantly altered by anthropogenic activities including extensive reclamation of the original shallow water intertidal and exposed beach areas (**Plate 4-4**). The coastline associated with the proposed outfall boundary is protected by a rock revetment seawall (calcareous limestone rock) designed to provide all year round protection from storm surge and waves whilst allowing deeper water access to the shoreline for coastal vessels.

Plate 4-4: Foreshore directly adjacent to the Proposed Ranadi outfall.

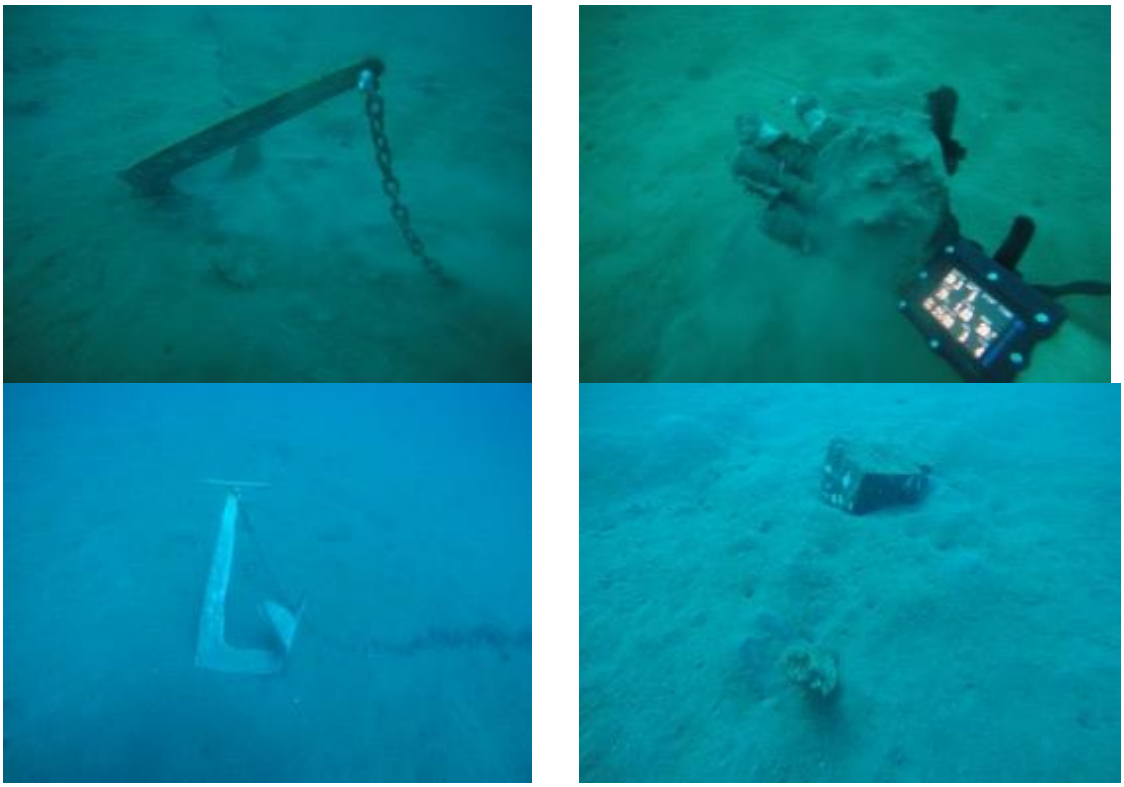
454. During periods of high precipitation, the foreshore waters exhibit small fluctuations in salinity and increased turbidity due to the stream discharge and surface water runoff from neighboring land surfaces, however anecdotal information acquired suggests these changes are short lived and disperse quickly. The stream is a source of significant pollution (associated with the Honiara city waste fill site) including significant domestic waste (plastics and other rubbish), sewage and petrochemical products. This discharge has a direct impact on the marine water quality associated with the inshore and offshore waters associated with the proposed outfall pipeline.

455. The intertidal and subtidal marine environments located within the proposed outfall pipeline at the Ranadi site are all but devoid of coral reefs and associated reef benthic resource due to the inshore areas past extensive and continued shoreline reclamation activities and deposition of sediments discharged from coastal rivers and streams adjacent to the site. Similarly, mangrove trees are absent and recent anecdotal information indicates that they have not been located at this site for an extended period of time.

456. The northern shoreline, directly adjacent (west) of the proposed outfall pipeline entry point location has been reclaimed and is bordered by a rock revetment breakwater which includes a small number of newly recruited hard coral colonies and associated marine resources. These benthic reef resources are highly modified and are impacted by past and existing activities associated with this area of shoreline.

457. The seabed substrate is relatively homogenous throughout the assessment site and is characterized by a bottom layer of coarse sand derived from terrigenous and coral reef origins with a thin top layer of fine sediment - silt originating from alluvial deposits (**Plate 4-5**). The sediment layer is more pronounced towards the offshore assessed areas, however fluctuations in the depth of the sediment layer and resulting water turbidity are directly related to weather conditions prevailing at any given time. These sediments do impact the water quality associated with the subproject site and have a direct impact on the benthic coral reef resources.

Plate 4-5: Benthic Substrate associated with the Proposed Ranadi Outfall.



458. The relatively high level of suspended silt and sand based substrate (refer **Plate 4-5**) located at all assessment sites and the lack of hard benthic structures (rocks, reef etc.) has a significant detrimental effect on recruitment and survival of sessile benthic marine life. This has resulted in a paucity of sessile and mobile benthic invertebrate species. Nevertheless small numbers of sedentary invertebrates were recorded, albeit in very low population densities and diversity, the majority were burrowing marine worm (polychaetes). Similarly, very low population densities and species diversity was recorded for marine flora. No sea grass was recorded.

NRH Site:

459. The proposed new sewage outfall pipe line exits the shoreline ($9^0$26'.07.5"S and 159^0 58'30."E) just outside of the western boundary of the NRH and is proposed to extend 350m directly offshore perpendicular to the shoreline (northerly direction) and will terminate approximately (09025'53.7"S 159058'18.3"E) in 14 m of water.

460. Significant foreshore alteration has taken place along the coastline directly adjacent to as well as to the west and east of the proposed outfall coastal entry location. To the east the shoreline includes reclamations for the Honiara city's main coastal road and individual/commercial property (**Plate 4-6a**). Adjacent lies several old vessels that have been grounded and are in a considerable state of disrepair (**Plate 4-6b**). To the west, the foreshore and coastal areas have been reclaimed in the past to provide shoreline protection to the NRH and includes sand extraction and piling of terrigenous deposits associated with the mouth of the nearby river (**Plate 4-6c and d**).

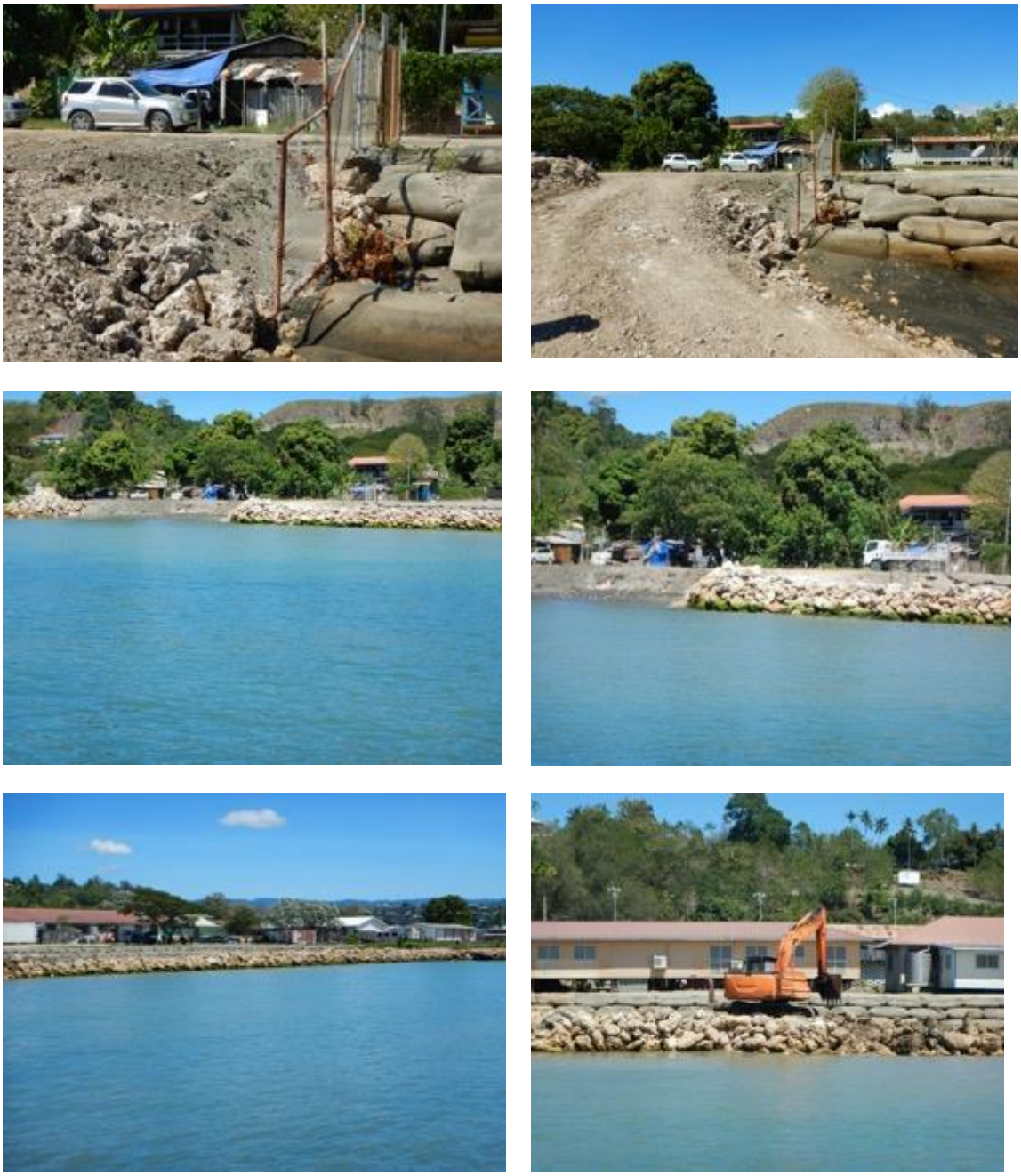
Plate 4-6: Coastal Reclamation to the East (a and b) and West (c and d) of the Proposed NRH Outfall.

461. The proposed outfall site enters the foreshore directly east of the NRH eastern boundary. It's location is situated on a previously open beach shoreline running east to west with the ocean side to the north that has been significantly altered by extensive shoreline reclamation. There are no coral reef systems nor mangroves associated with this area.

462. The site is marine with the benthic substrate dominated by both terrigenous and marine (calcium carbonate) sediments. The subtidal benthic substrate extends seawards (north) and descends gradually to a depth of 14 meters 350 meters from highwater mark at the proposed pipeline entry location. The benthic substrate consists of granular sand and finer sediment particles with the latter revealing highlight percentage levels as depth is attained and to the west. There is an absence of large size benthic substrate material (rocks, boulders etc.) throughout the assessed area.

463. The foreshore and coastal waters directly adjacent and to the east and west of the proposed outfall entry point have been significantly altered by anthropogenic activities including extensive reclamation of the original shallow water intertidal and exposed beach areas (**Plate 4-7**). The coastline associated with the proposed outfall boundary is protected by the successive development of a rock revetment seawall (calcareous limestone rock) designed to provide all year round protection from storm surge. The original NRH revetement wall during the field survey was being reclaimed by an additional extension of 50 m width along the entire shoreline by a local company.

Plate 4-7: Foreshore Environments Adjacent to the Proposed NRH outfall.



464. During periods of high precipitation, the foreshore waters exhibit considerable fluctuations in salinity and increased turbidity due to the river discharge and surface water runoff from neighboring land surfaces. In addition, the reclamation activity undertaken along the shoreline at this site during the assessment period increase turbidity significantly when machinery was in operation (**Plate 4-8**). The river is a source of significant pollution (associated with the Honiara city) including significant domestic waste (plastics and other rubbish), sewage and petrochemical products. This discharge has

a direct impact on the marine water quality associated with the inshore and offshore waters associated with the proposed outfall pipeline.

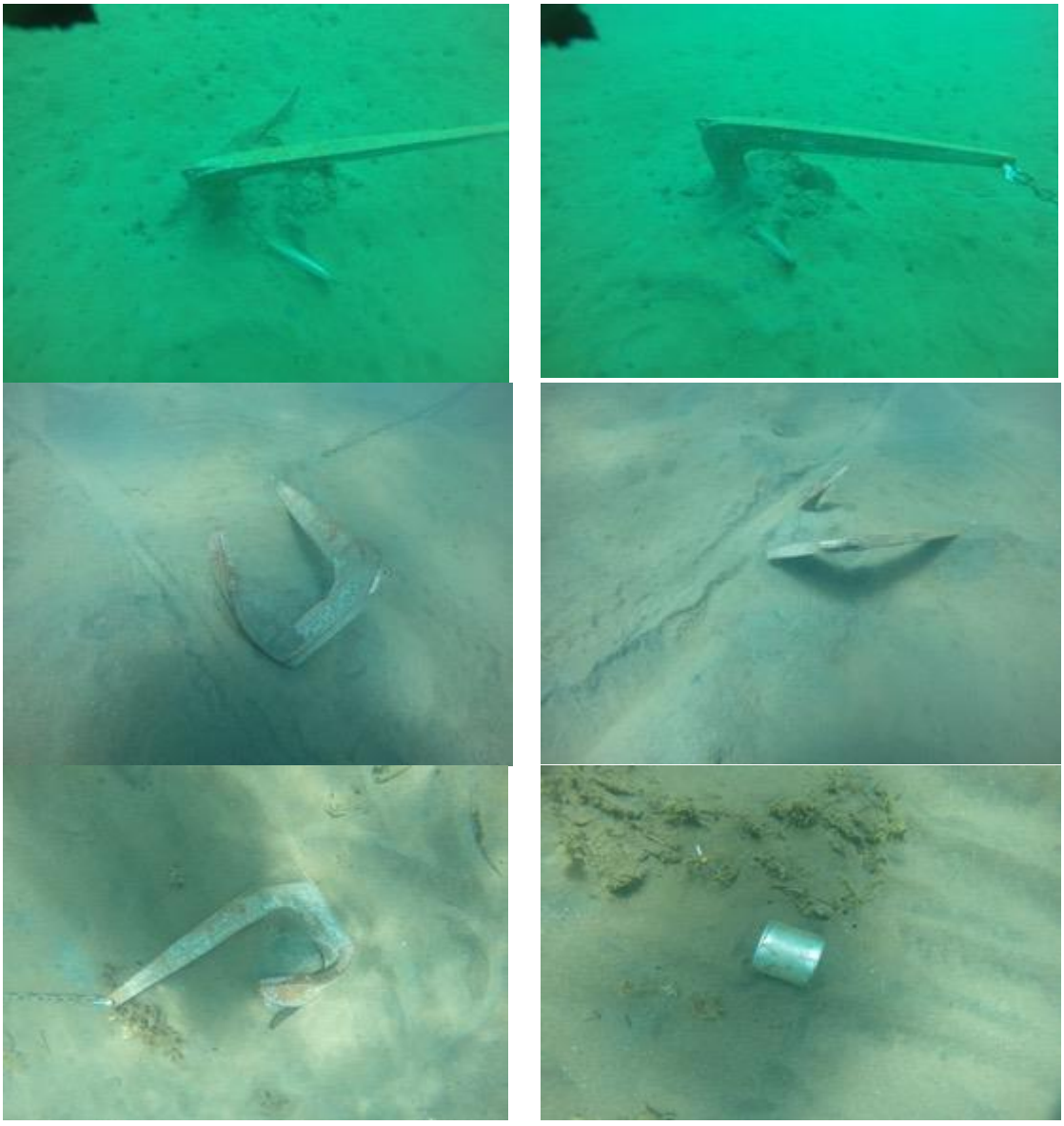
Plate 4-8: Turbidity in Shallow Water Environments during Reclamation adjacent to the Proposed NRH outfall.

465. The intertidal and subtidal marine environments located within the proposed outfall pipeline are devoid of coral reefs and associated reef benthic resource due to the inshore areas past extensive and continued shoreline reclamation activities and deposition of sediments discharged from coastal rivers and streams adjacent to the site. Similarly, mangrove trees are absent and recent anecdotal information indicates that they have not been located at this site for an extended period of time.

466. The northern shoreline, directly adjacent (west) and in front of the proposed outfall pipeline entry point location has been reclaimed and is bordered by a rock revetment breakwater. This breakwater during the assessment was being extended by approximately 50 m seaward (north) resulting in considerable reclamation of the intertidal sea floor.

467. The seabed substrate is relatively homogenous throughout the assessment site and is characterized by a bottom layer of coarse sand derived from terrigenous and coral reef origins with a thin top layer of fine sediment - silt originating from alluvial deposits **(Plate 4-9**). The sediment layer is more pronounced towards the offshore assessed areas, however fluctuations in the depth of the sediment layer and resulting water turbidity is directly related to weather conditions prevailing at any given time. The foreshore and coastal reclamation activities, including bucket dredging at the time of the assessment, significantly elevated the turbidity (and elevated suspended sediments) throughout the site. These sediments do impact the water quality associated with the subproject site and have a direct impact on the benthic coral reef resources. It is noted that no coral or river derived rubble, rocks or boulders were located at any site during the assessment.

Plate 4-9: Benthic Substrate associated with the Proposed NRH outfall.



468. The relatively high level of suspended silt and sand based substrate located at all assessment sites and the lack of hard benthic structures (rocks, reef etc.) has a significant detrimental effect on recruitment and survival of sessile benthic marine life. This has resulted in a paucity of sessile and mobile benthic invertebrate species. Nevertheless small numbers of sedentary invertebrates were recorded, albeit in very low population densities and diversity, the majority were burrowing marine worm (polychaetes). Similarly very low population densities and species diversity was recorded for marine flora. Two species of sea grass were recorded in isolated and small areas to the east of the proposed outfall pipeline, both locations are well outside the subproject's area of influence.

4.2.1.5 Key Findings

469. Key summary findings of the marine benthic assessment of the two proposed outfall pipeline benthic abiotic and biotic habitat within the direct and indirect Area of Influence is summarized below and includes:

- There are no critical habitats, ecosystems, endangered, threatened or iconic marine invertebrates, vertebrates and flora recorded at either of the proposed outfall locations.
- The foreshore and seabed substrate associated with both proposed outfall locations are relatively homogenous and similar throughout each area assessed. The substrate (sea floor) is characterized by a bottom layer of sand and alluvial soil sediment derived predominantly from terrigenous origin (rivers).
- Silt prevalence and benthic thickness appear to be relatively consistent throughout each outfall pipeline area assessed with water turbidity levels changing rapidly in shallower waters due to the prevailing weather and tidal conditions. Inshore water turbidity levels fluctuate at both site locations due to foreshore usage including vessel shoreline movement (e.g., Ranadi) and reclamation activities (both sites).
- Both proposed outfall site locations are in close proximity to large freshwater river systems which during high precipitation events result in high discharge rates have direct impacts on the water clarity, turbidity and salinity of the waters associated with both sites.
- The periodic high level of suspended sediment coupled with the significant benthic sediment layer (silt) on the sea floor has had a detrimental effect on the ability of sessile benthic marine resources to settle and survive. Thus, there are no significant benthic resources located at both sites.
- A paucity of sessile benthic invertebrate species was recorded throughout the area.
- No coral reef systems were located at either proposed outfall site.
- Isolated small hard coral colonies were located attached to the foreshore rock revetment wall at the proposed Ranadi outfall site. These species are common primary colonizing hard corals and have a wide distribution throughout Solomon Islands and neighboring nation reefs. Their presence is a direct relationship to availability of a hard surface to colonize. It is envisaged that continued small scale and localized hard coral recruitment along this revetment wall will continue if settlement conditions remain.
- Isolated colonies of soft corals including anemones (and their clown fish) were located at both sites, albeit in very low population numbers and diversity.
- Mobile invertebrates abundance and diversity were very low. They were dominated by burrowing Polychaete (marine worms) which were located at all sites assessed, albeit in low population densities. These benthic fauna resources are mobile and can adapt – survive disturbances to the benthic substrate.

470. Mobile vertebrates, including finfish were recorded in very low population and species numbers, the majority small planktivores and/or algal feeding associated with a hard structure on the sea floor (e.g. rubbish). There was a noticeable lack of predatory finfish at both proposed site locations.

- Marine sea weed diversity and population densities were very low throughout the entire area assessed for both proposed outfall site locations and were dominated by two common brown species (Padina sp. and Sargassum sp.).

- Two species of sea grass (*Halophila ovalis* and *Halodule pinifolia*) were recorded in low population densities in shallow water to the east of the proposed pipeline location at the NRH site. These populations were limited in benthic surface area inhabited and are well outside (200 plus m) of the subproject's direct or indirect area of influence and no impacts are expected. No sea grass were located at the Ranadi site.
- No mangrove trees were recorded within the subproject's direct and/or indirect area of influence at both sites.
- There were no marine mammals and/or marine reptiles (turtles) within or in close proximity to the proposed outfall location sites. A pod of dolphins were recorded to the north (500 m) of the Ranadi site moving through the waters well outside the subproject site.
- The marine benthic environment associated with the proposed outfall sites contains anthropogenic vessels and land based community derived rubbish and floating plastic was common.
- There are no marine or coastal designated marine protected areas or areas of significant biodiversity within or in close proximity to the proposed outfall sites nor do the areas possess any sites of cultural, customary or heritage significance nor any national or international endangered, endemic or protected species within and adjacent to the proposed area of influence.
- The marine benthic substrate associated with the two proposed outfall sites location due to its environmental characteristics and past extensive foreshore and intertidal reclamation activities, the benthic habitat within the proposed areas have a very low marine biodiversity and can be considered to have a very low ecological habitat and value.

471. A summary of the key marine benthic Biodiversity Conservation and Sustainable Natural Resource Management status for the Ranadi and National Referral Hospital proposed outfall pipeline using the ADB Safeguard Policy Statement Appendix 1 – Section 8 is presented below in **Table 4-12.**

Table 4-12: Key Marine Benthic Biodiversity Conservation and Sustainable Natural Resource Management Status

Outfall	Marine Ecology	Impact Summary	Biodiversity Conservation & Sustainable Natural Resource Management Status		
			Modified Habitat	Natural Habitat	Critical Habitat/ Species
Ranadi	Sea shoreline – open ocean – protected in part by adjacent islands. No coral reef, sea grass nor mangrove present. Marine coastal environment – full salinity, except surface waters during high rainfall. Small stream adjacent (east) to site, large river further east. River discharge especially during high rainfall events directly impacts environment – significant sediment deposition resulting.	Very minor ecological – resource impacts. No threats to areas marine (inshore & offshore) & coastal biodiversity. No endangered or endemic flora and fauna species present. Very small, localized site specific footprint increase in suspended sediment during pipeline deployment. Very minor potential petrochemical spillage during construction. All localized (very small area) to subproject footprint.	Yes. Extensive foreshore and inshore coastal rehabilitation and alteration. Expected to continue in the future. Adjacent to Honiara land fill.	No remaining natural habitats within or adjacent to proposed outfall– all significantly altered and degraded.	None Recorded. No critical habitats, flora or fauna species, or ecological areas of biodiversity.

Outfall	Marine Ecology	Impact Summary	Biodiversity Conservation & Sustainable Natural Resource Management Status		
			Modified Habitat	Natural Habitat	Critical Habitat/ Species
	Very limited (paucity of) benthic sessile & sedentary invertebrate communities. Sand - Silt dominated benthic substrate. Extensive foreshore & intertidal reclamation – alteration. Highly disturbed ecosystem. No MPA or other managed areas.	All impacts completely reversible and manageable. Negligible if any short or long term impacts on benthic ecological systems.			
NRH	Sea shoreline – open ocean – protected in part by adjacent islands. No coral reef, nor mangrove present. Sea grass recorded to the east (well outside subprojects area of influence 200 m +). Marine coastal environment – full salinity, except surface waters during high rainfall and river (to the west). River discharge especially during high rainfall events directly impacts environment – significant sediment deposition resulting. Very limited (paucity of) benthic and sedentary sessile invertebrate communities. Sand - Silt dominated benthic substrate. Extensive foreshore & intertidal reclamation – alteration – on going. Highly disturbed ecosystem. No MPA or other managed areas.	Very minor ecological – resource impacts. No threats to areas marine (inshore & offshore) & coastal biodiversity. No endangered or endemic flora and fauna species present. Very small, localized site specific footprint increase in suspended sediment during pipeline deployment. Very minor potential petrochemical spillage during construction. All localized (very small area) to subproject footprint. All impacts completely reversible and manageable. Negligible if any short or long term impacts on benthic ecological systems.	Yes. Extensive foreshore and inshore coastal rehabilitation and alteration. Expected to continue in the future. Adjacent to Honiara main hospital.	No remaining natural habitats within or adjacent to proposed outfall– all significantly altered and degraded.	None Recorded. No critical habitats, flora or fauna species, or ecological areas of biodiversity.

4.2.2 Terrestrial Biodiversity

472. Solomon Islands, recognized as the “Centre of Plant Diversity”, has 4,500 plant species where 3,200 are known to be indigenous. While diversity is high, endemism is low, with no endemic families and only three endemic genera. Endemism of species is not accurately known but is thought to range from ten per cent of fern species to 80% of Pandanus species. The islands with the highest rate of endemism are Santa Cruz (Temotu) and Guadalcanal. The vegetation is categorized as coastal strand vegetation, riverine forest, lowland forest, montane forest, or non-forest communities. Seasonal dry forest and grasslands can be found in parts of Guadalcanal and Central province.

473. The main groups of flora include 340 species of ferns, 277 species of orchids, 33 species of palms, 26 species of other nuts (e.g., ngali nut, cut nut and alite nut), 20 species of pandanus, 14 species of Eleocarpacae trees, and 11 species of shrubs.

474. The mountain ecosystems host some of the renowned globally endangered species particularly birds which are continually put under threat from invasive species. It is characterized by cloud forest, which has been described to descend to 1,200 m on Guadalcanal and Kolombangara, 650 m on Vangunu and Makira and 600 m on Gatokae.

475. In terms of animal species, Solomon Island has 163 species of bird (69 endemic), 14,511 species of terrestrial insects which include 130 species of butterflies (30 endemic) and 31 cicada species, 53 species of mammals (19 endemic), 80 species of reptiles and 21 species of frogs.

4.2.2.1 Terrestrial Flora

Terrestrial Flora in Solomon Islands

476. Six distinct vegetation or forest types are distinguished in Solomon Islands, which vary in magnitude from one province to another, and reflect the geological formation, ranging from acidic volcanic origin in the bigger islands to alkaline limestones in low-lying atolls. According to Whitmore (1969), the range and types of plant species present are fairly similar between islands despite their geographical spread. These are, however, affected by six factors: soil type (based on parent rock), climate (e.g. rainfall and temperature), topographical features, altitude, natural catastrophes (cyclone and earthquakes), and human activities.33

477. The six vegetation types are: lowland rainforest, hill forests, montane forests, freshwater swamp and riverine forests, saline swamp forests, and grassland and other non-forest areas.

478. Grassland and other non-forest areas: comprise predominantly non-tree species, mainly herbaceous species. Predominant species include *Imperata cylindrica*, *Dicranoptera linearis* and *Themeda australis*. Examples of commonly occurring species are *Mimosa invisa*, *Morinda citrifolia*, *Saccharum spontaneum*, *Polygala paniculata* and *Timonius timon*. Some of these species (e.g., *M. invisa*) are very common in disturbed areas.

479. Saline swamp forests are subject to tidal influence as they are found in estuaries and foreshores. Examples of species comprising this vegetation include; *Barringtonia asiatica*, *Calophyllum inophyllum*, *Casuarina equisetifolia*, *Terminalia catappa*, *Intsia bijuga*, *Inocarpus fagifer*, *Pandanus spp*., *Barringtonia racemosa* and species of mangroves.

480. Freshwater swamp and riverine forests are commonly found in poorly drained land at low altitudes with little micro-relief. Species such as *Inocarpus fagifer*, *Mextroxylon salomonense*, *Mextroyylon sagu*, *B. racemosa* are found here, although some important timber species are also present (e.g., *Terminalia brassii* and *Dillenia salomonensis*).

481. Lowland rainforests: include forests often with complex structure due to the greater number of species from upper or hill forest and patches of freshwater swamp forest. Occasional cyclones and human activities often disturb this forest type as evident in a high incidence of re-growth and secondary species. Species predominant in this vegetation include timber species such as *Campnosperma brevipetiolata, Dillenia salomonensis, Endospermum medullosum, Parinari*

33 T.C. Whitmore (1969): The vegetation of the Solomon Islands, Volume 255, Issue 800, The Royal Society

salomonensis, Terminalia calamansanai, Schizomeria serrata, Maranthes corymbosa, Pometia pinnata, Gmelina moluccana, Elaeocarpus sphaericus and *Vitex cofasus*. Most indigenous fruit trees are also found in this forest including *Canarium spp, Syzygium malaccensis, Magnifera minor, Spondius dulce, Barringtonia procera, B. edulis, Artocarpus altilis, Gnetum gnemon,* and *Burkella obovata*.

482. Hill forests: occur at 100–600 m elevation and on well-drained soils and exhibit complex structure with varying tree heights and canopy density. Some species in the lowland forest are also present here, as well as those species commonly found in the montane forest. Species forming this forest include *Pometia pinnata, Gmelina moluccana, Elaeocarpus sphaericus, Campnosperma brevipetiolata, Dillenia salomonensis, Endospermum medullosum, Parinari salomonensis, Terminalia calamansanai, Schizomeria serrata, Maranthes corymbosa,* and *Vitex cofasus.* Fruit tree species such as *Canarium spp., Gnetum gnemon* and *Artocarpus altilis* are also present.

483. Montane forests: refer to forests found generally above 600 m, on ridge tops and mountain summits, but can be found in lower elevations under harsher conditions. These are characterized by a dense and compact canopy with small lighter tree crowns. Species in this forest type include *Callophyllum kajewskii, Callophyllum pseudovitiense, Eugenia spp., Dacrydium spp., Pandanus spp., Racembambos scandens* and ferns.

484. The island of Guadalcanal has two distinctive types of forests; the lowland rainforests and seasonally dry forest not found in other provinces, in addition to grasslands. The grasslands in the north and northwest Guadalcanal appear to be the result of repeated burning preventing the re- establishment of secondary forest many decades ago.

Terrestrial Flora at Subproject Sites (Subproject Area of Influence)

485. The natural vegetation associated with the subproject area of influence has been highly modified for urban development and resembles little of the original natural vegetation and terrestrial ecosystem. There are no areas of natural or critical habitats, ecosystems, endangered or threatened flora found as most of the natural vegetation and habitats has been previously cleared for town development and urban expansions. (Refer to **Appendix 10:Terrestrial and Habitat Assessment** for detailed information.)

486. Prior to the development of Honiara, terrestrial and coastal forests dominated the area. Along the coast, Point Cruz and the Lord Howe Settlement areas to the west were mangrove swamps. Mangroves were cleared at Point Cruz and the land reclaimed to build Solomon Islands Ports, followed by the National Referral Hospital at the eastern part of Mataniko River mouth, where the Lord Howe Settlement exists today. Honiara has had much disturbance since WWII resulting to significant terrestrial disturbance to habitats and species on land and associated with the river and riparian ecosystems. The vegetation associated with the UWSSSP subproject sites is composed of scattered and degraded lowland forest and coastal vegetation. Along the narrow coastal areas strips where land is relatively flat to the ridges and hills are settlements whereas urban developments and City expansions are confined to the coastal zones.

487. The gravity and rising mains are located within the road corridor along the pipeline route in the subproject boundaries along Mendana Avenue, China Town, Kukum Highway and Ranadi. The surrounding vegetation along the pipeline corridor is secondary regrowth as it is previously cleared with no traces of original flora present. The vegetation recorded along the mains route has no significant value and none of the threatened or endangered flora was recorded. Secondary regrowth associated with the gravity and pressure mains pipeline route along the road corridor from Point Cruz,

China Town and through to Ranadi comprises of *Samanea saman* (raintree), *Terminalia catappa* (Alite), *Cocos nucifer* (coconut), *Premna serratifolia, Barringtonia asiatica* (fish poising tree), *Elaeis guineensis sp* (palm tree), *Mangifera indica* (mango), *Calophyllum inophyllum* (Koilo), *Cocos nucifera* (coconut), and *Pandanus tectorius* (pandanus), *Metroxylon sagu* (sago), *Broussonetia papyrifera* (paper mulberry), *Mangifera indica* (mango), *Leucaena leucocephala* (white lead tree), *Tabebuia rosea* (pink trumpet tree) and *Musa sp* (banana). Ornamental plants are grown along property boundaries and this includes *Pulmeria sp* (Frangipanies), *bougainvillea sp* (bouganvillia), *Hisbicus rosa-sinensis* (Hibiscus), *Ixora chinensis* (Ixora) and *Jatroha integerrima* (Peregrina). See **Plate 4-10: Typical Secondary Vegetation along Pipeline Routes** and **Figure 4-19: Vegetation Type along the Pipeline Route.**

Plate 4-10:Typical Secondary Vegetation found along the Pipeline Route: (a)Vara Creek (b) Chinatown (c) NRH (d) Kukum (c) Ranadi (d) Ranadi Landfill.

Figure 4-19: Vegetation Type Along the Pipeline Route from Point Cruz-Chinatown – Ranadi Landfill Site

Source: Basis of Design Report, Honiara Wastewater (July 2019)

488. At all the Pump Substations (PS) sites, the surrounding vegetation observed is secondary regrowth. The vegetation on the PS sites have been previously cleared for development expansions such as community hall, port jetties, land reclamations at foreshore for roads and additional land for development. Typical vegetation found at each of the PS sites are not limited to, trees such as *Samanea saman* (rain tree), *Metroxylon salomonense* (Sago) and *terminallia catappa* (Alite). Other shrubs, and herbaceous plants include and are not limited to *premna serratifolia, Macranga sp, Leucaena leucocephala (*white leadtree) and *musa sp* (banana) *Passiflora foetida* (Sweet rope), *Coccinia grandis* (l.) *Voight* (Ivy Gourd), *lepturus repens* (grass sp), *Leucaena leucocephala, Commelina benghalensis, Imperata cylindrica* and *Paspalum Vaginatum* (seashore paspalum). Ornamental plants include *Plumeria sp* (frangipany) and *Jatroha integerrima* (peregrina). The majority of vegetation that occurs on the site are highly tolerant to disturbance and no threatened or endangered flora species were present. See **Plate 4-11: Typical Vegetation at the PS Sites** and **Figure 4-20: Vegetation Type at PS sites**

Plate 4-11: Typical vegetation found at the PS Sites : (a) Market PS (b) NRH PS (c) Ranadi PS (d) Vara Creek (e) Ranadi Landfill PS (f) Naha PS

Figure 4-20: Vegetation Type at NRH sites

Source: Google Earth

489. The trees, shrubs, grasses and weeds found at the NRH Outfall Site and Ranadi Landfill sites are all secondary regrowth. At the outfall site at the NRH, the surrounding secondary vegetation has been previously cleared in the past for the construction of the NRH and staff housing. However, further clearances of the remaining secondary vegetation continue for development expansions along the coast particularly reclamation activities and site preparation for building construction.

490. The coastal strand vegetation along the NRH outfall site from high water mark and inland which are indirectly impacted consisting mainly of *Macarange sp, Barringtonia asiatica* (fish poison tree), *Annona muricata* (Soursop), *Morinda citrifolia* (noni), *Barringtonia edulis* (Cut-nut), *Jatropha curcas* (poison nut), *Premna serratifolia* (headache tree). Vines anld grasses include *Antigonon leptopus, Paspalum vaginatum, Ipomoea triloba* (littlebell, *Eleusine indica* and *Digitaria sanduinalis*. Towards the eastern side of the outfall, vegetation is dominated by *Terminallia catappa* (Alite), *Premna serratifolia* (Headache Tree) and *Impomoea littoralis*. No threatened or endangered flora were found. See **Plate 4-12: Vegetation near the NRH Outfall Site**

Plate 4-12: Vegetation near the NRH Outfall Site

491. At the Ranadi outfall site, the original vegetation associated with this area has been previously cleared paving way for industrial development and with the level of human disturbances to the area, ruderal vegetation species such as grasses, weeds and creepers typically dominate the disturbed areas overtime.

492. At the outfall pipeline route, vegetation consisted of garden mixed crops grown by the property caretaker. The garden crops include *Musa sp* (banana), (cassava) and *Abelmoschus* (slippery cabbage). At the shorefront, coastal vegetation consists of *Cocos nucifera* (coconut), *Terminallia catappa* (Alite), *Broussonetia papyrifera* (Paper mulberry, *Mangifer* indica (mango) and *Macaranga sp*, and *Senna occidentalis*. Vines comprises of *ipomoea pes-caprae* (beach morning glory), *Canavalia rosea* (beach bean), *Macroptilium atroppurpureum* (purple bush bean) and grasses such as *Thuarea involute, Eleusine indica, Brachiaria decumbens* and *Panicum maximum*. See **Plate 4-13: Vegetation near the Proposed Ranadi Outfall** and **Figure 4-21: Vegetation near Proposed Ranadi Outfall.**

Plate 4-13: Vegetation near the Proposed Ranadi Outfall

Figure 4-21: Vegetation near Proposed Ranadi Outfall

Source: Google Earth

4.2.2.2 Terrestrial Fauna

493. Solomon Islands' terrestrial fauna is extremely diverse. It is believed that the country has a greater diversity of land animals with a high level of endemism (UNDP et al., 2002). Fauna includes 223 species of birds (173 residential terrestrial species and 50 other species of shore/sea birds and visitors) including 19 species globally threatened; 52 mammals, 61 species of reptiles (25 are endemic), and 17 species of frogs.

494. There is a relatively high level of island endemism in the country. Western Province records the largest number of species (41). Choiseul and Guadalcanal Provinces have the highest rate of island endemism with six species being found on only one or two islands.

495. The forests of Guadalcanal are known to support a very high diversity of bird and vertebrate endemism. Terrestrial fauna includes a large number of birds (about 50 species) including the yellow-legged pigeon (*Columba pallidiceps*), thick-billed ground dove *(Gallicolumba salamonis*), white-headed fruit dove *(Ptilinopus eugeniae*), crested cuckoo dove (*Reinwardtiana crassirostris*), chestnut-bellied imperial pigeon (*Ducula brenchleyi*), as well as the abundant forest kingfishers. According to the Mataniko Environment Baseline Report, there are seven species of birds found in Guadalcanal that are listed as protected under the Wildlife Protection and Management Act 1998. These include: *Chalopsitta cardinalis, Geoffroyus heteroclitus, Cacatua durcopsii, Electus roratus, Micropsitta finschii, Trichoglouss haematodus* and *Halieetus sanfordi*. These species often forage at the top of the canopy and around disturbed areas and gardens.

496. The island is also known for the presence of the large Discodeles frog which is common in the grasslands and lowlands. There is also the presence of this spectacular mammal known as the Guadalcanal monkey faced bat (*Pteralopex atrata*). Also, there are 9 family of reptiles found on Guadalcanal Island, *Agamidae, Gekkonidae, Scincidae, Varanidae, Typholophidae, Boida, Acrochordidae, Colubridae* and *Elapidae* (McCoy, 2006).

497. On the Northern coast where Honiara is located, much of the land has been developed and forest cleared for Honiara's Township development. Native or original forests and ecosystems were altered severely over those early years of township development. As the northern coast of Guadalcanal Island is being developed for Honiara Township, invasion of non-native species initially invaded along the development corridors, spreading and multiplying. Biologically, these introduced invasive plants and animal species can have a great impact on naturally occurring species and can become destructive following environmental changes. The invasive species are not indigenous but can rapidly colonize an ecosystem and out competed the original species. Most of the invasive species are a serious threat to significant aquatic and terrestrial ecosystems in Solomon Islands.

498. According to the State of the Environment Report (2008) there are invasive species of fauna found which include microorganisms - *Phytophera colocasiae* (Taro leaf blight), invasive fish include *Tilapia sp* and the mosquito fish (*Gambusia affinis*). The Cane Toad (*Bufo marinus*) is also included in the list. Fire ants (*Wasmania auropunctata*) are now established within Solomon Islands but have not been noted as an invasive species

499. During the field surveys, observations on the presence of wild life and different faunal groups throughout the subproject area and proposed footprint were assessed. Along the subproject sites much of the vegetation has been degraded and modified with non-native trees and invasive grasses and vines dominating, whilst the quality of natural habitats and ecological functions are consequently on the decline and this determined the species composition, abundance and distribution of fauna.

The water bodies within the sites are highly polluted and this minimizes the ecosystem's capacity to fully support aquatic wildlife. The sandy shorelines along the NRH have been significantly altered and disturbed with ongoing reclamation activities and such minimizes the presence of organisms that burrow in sand to even survive. This is also the same for the sandy shores at the Ranadi site.

500. The terrestrial habitats found within the subproject area of influence at each PS and Outfall sites still provides habitation for birds, reptiles/lizards, amphibians, domesticated animals and other vertebrates found. On the trees, roof tops or along the paved footpath, birds such as *Acridotheres tristis* (Common Myna), *Rhipidura leucophrys* (Willie Wag Tail), and Swifts (are found to be interacting and feeding. Other vertebrates and amphibians were also found ad these include *Oryctes rhinoceros* (Coconut Rhinoceros beetles), *Anisoptera* (dragon flies), *Tettigoniidae* (Bush crickets) *Achatina fulica* (Giant African snails) and *Bufo marinus* (Cane toad). The Giant African snail is an invasive species affecting many parts of Honiara. Domesticated animals found in communities along the subproject sites include dogs, cats, rats, chickens and pigs. Other fauna observed habiting the water ways along the subproject area of influence include many unidentified species of insects (grasshoppers, moths, beetles and dragon flies and including some fish species.

501. Field observations did not find the presence of any IUCN Redlist species within the subproject area of influence.

Plate 4-14 :Terrestrial Fauna Observed at the NRH PS Site

4.2.2.3 Freshwater Ecology

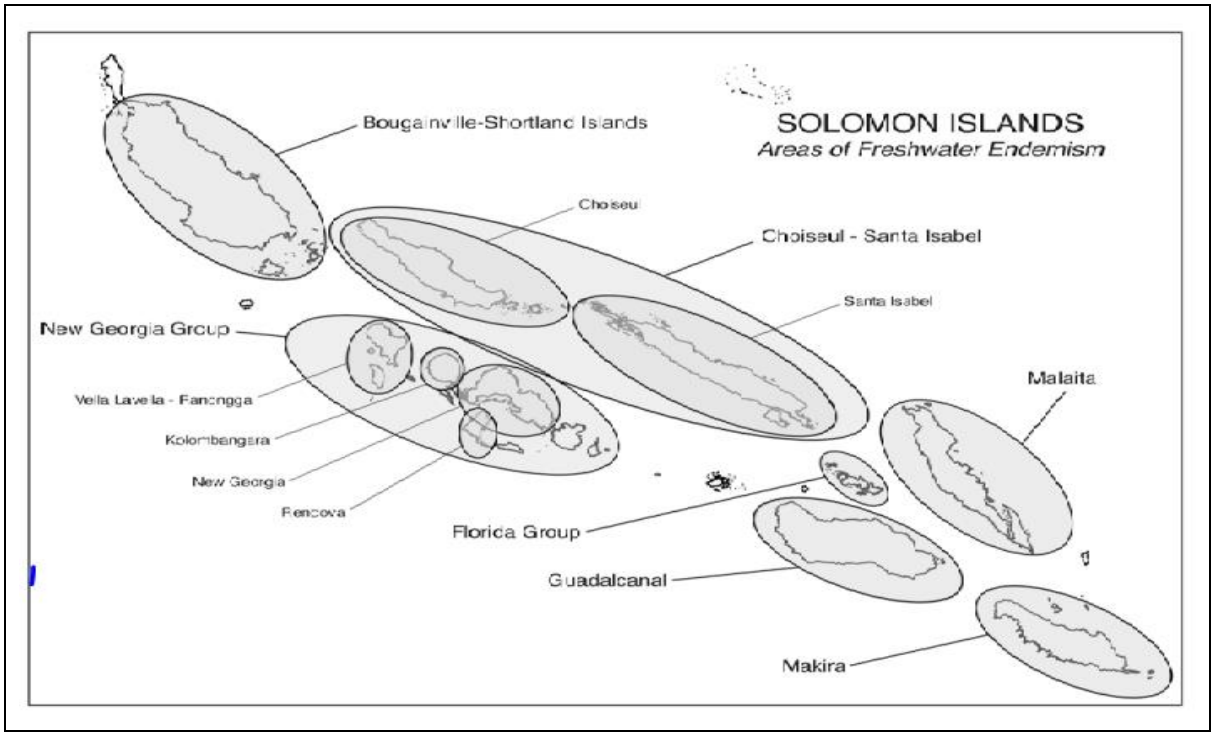
502. Solomon Island records 43 species of freshwater fish and 175 species of inland water insects (45 endemic). Freshwater biodiversity remains as the poorest amongst the classes of biodiversity but requires greater biodiversity assessment.

503. The freshwaters of Solomon Islands show a high level of biodiversity and endemism especially among the aquatic insects[34]. There are seven areas of freshwater endemism in Solomon Islands in

[34] Dan A. Polhemus, et.al (2008): Freshwater Biotas of the Solomon Islands - Analysis of Richness, Endemism and Threats, Bishop Islands Analysis of Richness, Endemism and Threats, Bishop Museum Bishop Museum Technical Report 45 Honolulu, Museum Bishop Museum Technical Report 45 Honolulu.

fishes and aquatic insects (refer to **Figure 4-22**). The 2008 survey undertaken of the freshwater ecosystems in Solomon Islands, including Guadalcanal recorded 93 species of *Heteroptera* representing 28 genera in 12 families of which 60% are endemic at the species level and at least 31 of the species collected are new to science. Sixty-three species of Odonata representing 37 genera and 12 families were recorded of which 44% are endemic at the species level and at least 1 new species was discovered. Nine described species of *Gyrinidae*, representing two genera and ten described species of *Simuliidae*, representing 2 genera were reported of which 90% of both are endemic at the species level.

Figure 4-22: Areas of Freshwater Endemism in Solomon Islands.



Source: Dan A. Polhemus, et.al (2008)

504. Attributed to their mountainous physiography, the larger islands in Solomon Islands archipelago have Gobioid fishes as the dominant freshwater fauna, represented by members of the *Gobiidae, Eleotridae* and *Rhyacichthidae* families. 43 species of fish belonging to 26 genera and 14 families were reported with no endemic species. One species of Gobiidae (*Lentipes solomonensis*) subsequently was found to be endemic through additional analysis. This species has not been found on the island of Guadalcanal.

505. According to the Rapid Coastal Assessment of Mataniko River Catchment Report (2020) the total number of freshwater fishes in Guadalcanal is 47 species from 39 genera and 23 families. As recorded during a survey on the Ngoti stream system, 11 species of fish were recorded, which represents 23% of known freshwater fish species on Guadalcanal compared to the 1% recorded in Kovi catchment. Also, there is a connectivity between the Mataniko stream and the ocean given the presence of the Giant mottled eel, Anguilla marmorata in the Mataniko stream. Eels have a catadromous life cycle where they live in freshwater but travel to the ocean to spawn after which the larvae return to the stream to settle. Six goby species and four crustacean species were also recorded in Ngoti stream. The gobies lay eggs in the stream but once eggs are hatched, larvae are transported

to the ocean and remained for up to four to twelve weeks before returning to the stream as juveniles, again proving the stream−ocean connectivity.

506. The freshwater habitats at the upper catchment of Mataniko River are dominated by riparian plants distributed along the riverbanks and along the flood plains. Much of the vegetation is still intact despite being threatened with anthropogenic activities and human settlements. The riparian vegetation at the upper catchment includes herbs, ferns, palms and trees.

507. The lower sections of the Mataniko River specifically at Tuvaruhu and Vara Creek lacks any habitats suitable for significant aquatic flora and fauna as these areas were highly disturbed by anthropogenic activities such as settlement, farming and waste disposal (sewage, household wastes etc.) and have altered the water quality and aquatic flora and fauna composition. Typical riparian vegetation found includes but not limited to *Delonix regia* (flamboyant), *bambusa sp* (bamboo), *Metroxylon salonesnse, ficus sp, Cocos nucifera* (coconut tree), *Macaranga sp*, *Musa sp* (banana), *Crytosperma merkusii* (giant swamp taro) and invasive plants species such as the *Brussonetia papyrifera* (paper mulberry tree) and *Spathodea companulata* (African Tulip Tree). River side grasses are dominating the river bank. (**Plate 4-15**)

Plate 4-15: Typical Riparian Vegetation at Tuvaruhu, Lower Section of Mataniko River

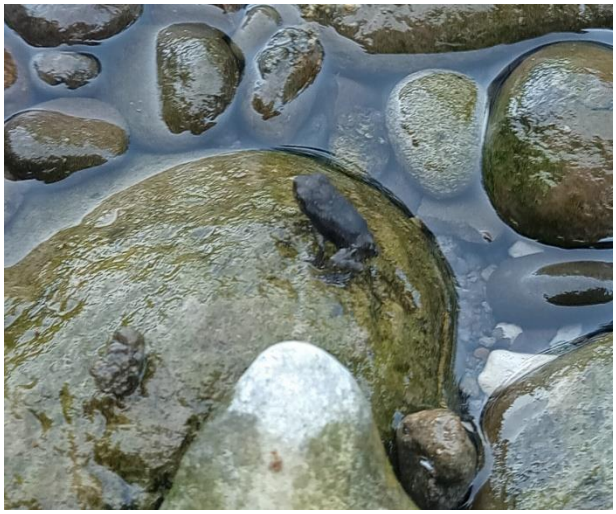
508. At the upper and lower Mataniko Bridge sites in China Town, the dominant aquatic flora is *Ipomoea aquatica* (kangkong) and is covering much of the river banks whereas vegetation at the lower bridge includes common reeds and other salt-tolerant species. Algae blooms are also occurring in this section of the river as evident in the greenish colour of the river. The anthropogenic disturbances associated with the lower reaches of the river system may have triggered or accelerated the blooms and this includes farming upstream (nutrients from fertilisers), sewage and household waste and other pollution sources such as piggery wastewater. It is a very common practice in Honiara where residents or businesses illegally dump solid wastes or wastewater into the water systems, contaminating and degrading the water quality and ecosystem. (**Plate 4-16**)

Plate 4-16: Aquatic Flora and Algal Blooms at Upper Mataniko Bridge and Estuarine Flora at Lower Mataniko Bridge, China Town.

509. Despite the river being very polluted and disturbed, freshwater fauna habitat the aquatic environment. The aquatic fauna observed include *Rinella marina tadpole* (giant marine toad), *Neurothemis sp* (Red dragonfly), *Melanoides tuberculate* (freshwater snail) and fish species such as *Khuliidai sp* (flagtail) and *Sicyopus sp* were also observed. The freshwater species live and spawn in the rivers and larvae

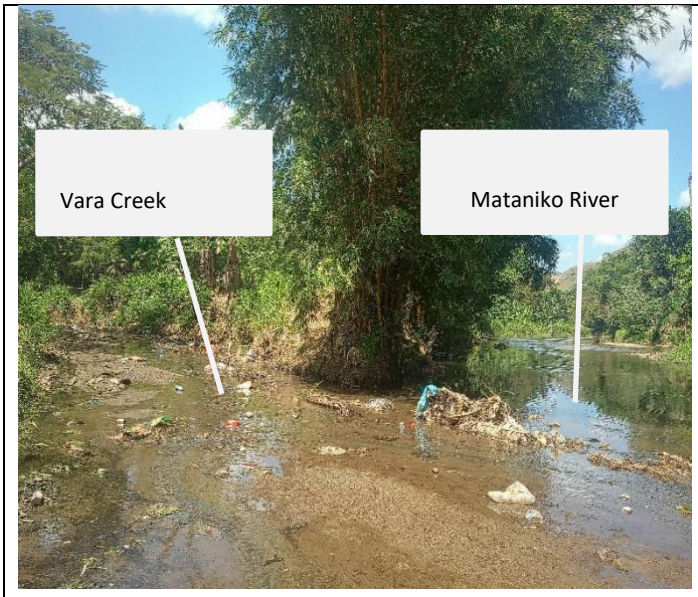
drift to the ocean to live as pelagic/oceanic marine larvae before returning to freshwater as juveniles to mature. (**Plate 4-17**)

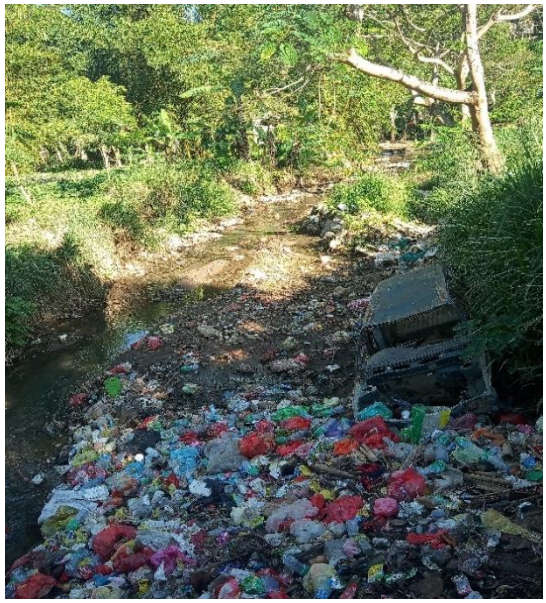
Plate 4-17: Freshwater Fauna Species found at Tuvaruhu, Mataniko River



510. The freshwater habitats at Vara Creek, Kukum Creek and the Burnscreek stream are also highly polluted and the quality of water is very poor. Vara Creek drains into the Mataniko river and the creek is also used as an illegal dump site by the settlers. (**Plate 4-18**)

Plate 4-18: Vara Creek Junction with Mataniko River.





511. Kukum Creek is east of the Naha PS and like Vara Creek, it is also very polluted. Solid wastes and sewage from households and other shops are directly dumped into this creek, (**Plate 4-19**).

Plate 4-19: Kukum Creek, Naha PS Site

512. Typical vegetation on the creek edges is mostly grass such as *Starchytapheta jamaicensis* (Blue rat's tail), *panicum virgatum* (switch grass), and *Pennisetum polystachion* (mission grass). Aquatic fauna species observed are *Rinella marina* (giant marine toad tadpoles).

513. Burnscreek stream is east of the Ranadi Landfill PS/Outfall. The stream was also polluted with untreated fecal sludge/septage being dumped at the Ranadi Landfill and leaks into the stream affecting the water quality. Aquatic flora and fauna were observed habiting the water body and it was noted the *water hyacinth* (Water lily) and *Ipomoea aquatica* (Kangkong) are the dominant aquatic flora. The fish species observed was *Kuhliidae sp* (flagtail). Settlers also farmed tilapia fish species. None of the freshwater flora and fauna species found are threatened or vulnerable. (**Plate 4-20)**

Plate 4-20: Burns Creek Stream, Ranadi Landfill Site

4.2.2.4 Rare and Endangered Species

514. There is currently little understanding of threatened and protected species knowledge in Solomon Islands. At present, there are limited regional resources directed into documenting the types of species that exist and/or are threatened in Solomon Islands. Data is often dispersed, taxonomic expertise is absent, and nomenclature and classification systems can be disputed for various species.

515. The International Union for Conservation of Nature and Natural Resources (IUCN) undertakes a global assessment to classify species at varying risk of global extinction. The 2012 IUCN Red List provides the most up-to-date collated information for Solomon Islands. It identifies and assesses the list of threatened species, which includes 245 bird species, 19 amphibians, 75 fishes, 60 plants, 75 mammals, 522 invertebrates and 6 reptiles.

516. Two species of bird have been declared Extinct in Solomon Islands – the Thick-billed Ground Dove, *Gallicolumba salamonis* and the Choiseul Pigeon, *Microgoura meeki*. A IUNC list of globally threatened fauna is provided in **Appendix 11: Red List - Globally Threatened Avifauna in Solomon Islands.**

517. Five marine turtle species are found in Solomon Islands and all are listed as protected species on the IUCN red list and include the Critical Endangered Hawksbill turtle (*Eretmochelys imbricate*); the Endangered Green turtle (*Chelonia mydas*), Olive Ridley turtle (*Lepidochelys olivacea*) and Loggerhead turtle (*Caretta carreta*); and the Vulnerable Leatherback turtle (*Dermochelys coriacea*). The identified nesting sites for turtles in Solomon Islands include Arnavon Islands (Isabel/Choiseul Provinces); Ramos Island (Malaita Province); Russell Islands (Central Province); Litoghahira (Isabel Province) and Rendova and Tetepare Island (Western Province). None of the species are recorded to nest on the beaches along the northern coastline of Guadalcanal.

518. Other protected species include cetacean (whales and dolphin species), dugong (*Dugong dugon*), crocodiles (*Crocodylus porosus*) none of which will be impacted by the subprojects scope of works. It is noted that crocodiles are reported to reside within rivers, wetland and coastal lagoonal areas associated with the northwestern and western coastal areas of Guadalcanal.

519. Solomon Islands is included in the east Melanesian Island biodiversity hotspot and as such has a high level of endemism, predominately associated with the nation's fauna. This includes 19 mammals (14 bats and 5 rats), 67 birds, 19 reptiles, 3 amphibians (frogs), 2 butterflies and 1 vascular plant.

520. Freshwater species richness and endemism among certain groups of freshwater organisms, particularly aquatic insects are provided in **Appendix 12: Areas of freshwater endemism and species endemism in Solomon Islands**.

521. Field observations along the subproject area of influence did not show any significant wildlife species and endemic or endangered species within the subproject area of influence, and no significant habitats remain in the area as it has already been developed and highly disturbed.

4.2.2.5 Protected and Conservation Areas

522. There are 17 terrestrial protected areas in Solomon Islands, two of which are located on Guadalcanal (**Table 4-13**), Mt. Popomanaseu (30,000 ha) and Lake Lauvi (200 ha) both located on the Weather Coast and well outside the subproject influenced areas. These are detailed in **Appendix 13: List of Terrestrial Protected Areas within Solomon Islands.** There are no terrestrial protected and

conservation areas plus areas of natural or critical habitats within the vicinity of the subproject area of influence that would be affected by the proposed development.

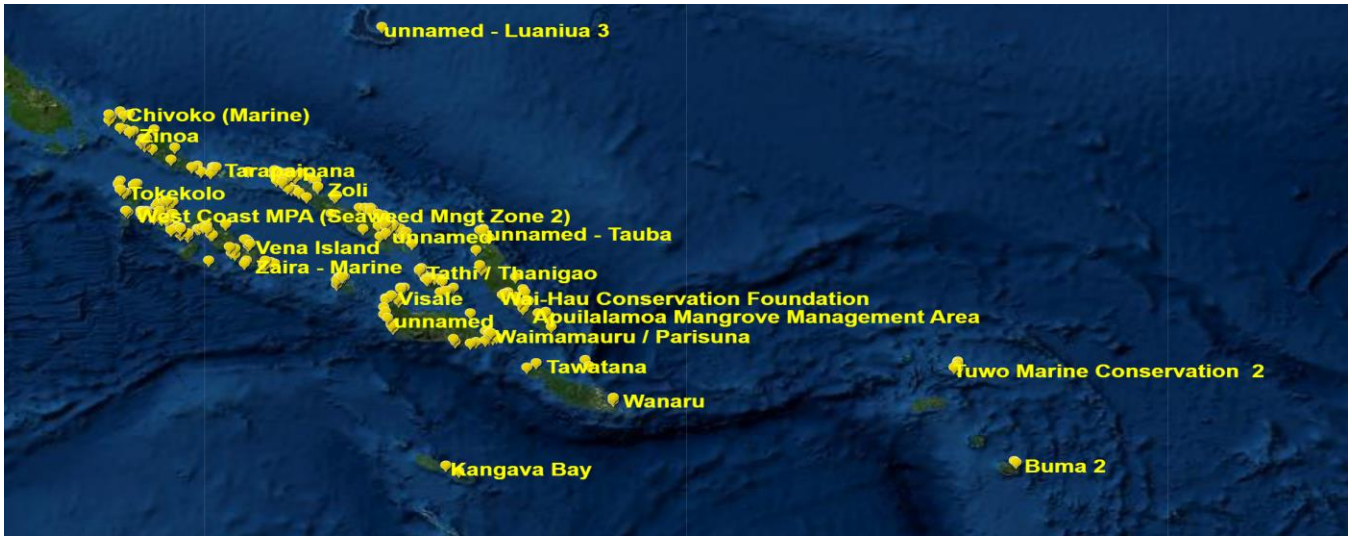
Table 4-13:Terrestrial Protected Areas

Province	No. of protected areas
Guadalcanal	2
Western	4
Choiseul	3
Isabel	3
Makira	2
Malaita	2
Temotu	1
Total	**17**

Source: MECDM (2009)

523. There are a total of 22 Marine Protected Areas (MPA) in Solomon Islands and one designated marine conservation area (Arnavon Marine Conservation Area), none of which are located along the north western coastline of Guadalcanal and as such are well beyond the subprojects area of influence. The figure below illustrates the MPA in Solomon Islands (**Figure 4-23**) and a list of names of these areas is presented in **Appendix 14: List of Marine Protected Areas within Solomon Islands.**

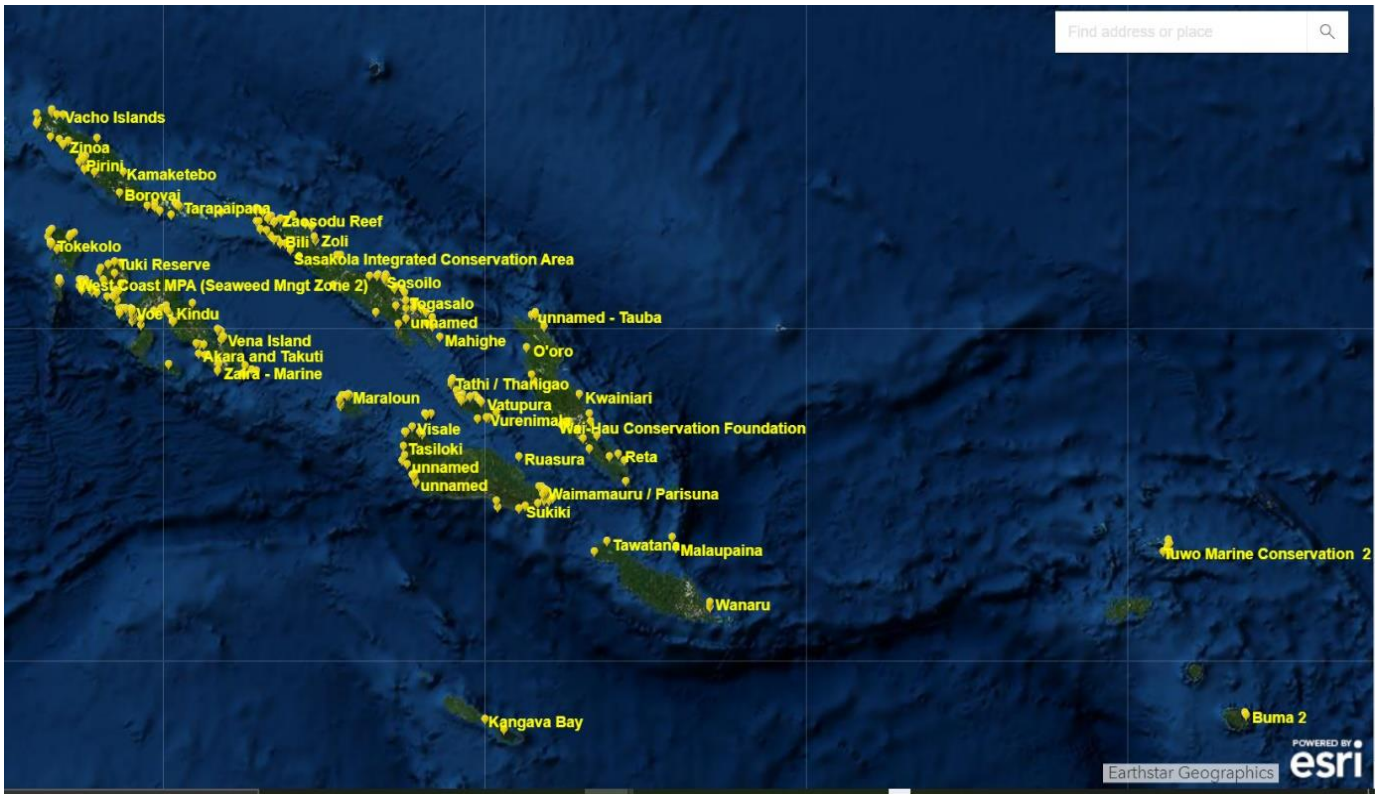
Figure 4-23: Marine Protected Areas in Solomon Islands



Source: MECDM, 2022

524. In addition, the communities of the nation have and are continuing to develop additional Marine Managed Areas (MMA) throughout the nation based principally on the traditional and community ownership that is intricately tied to land and water ownership. It is reported that in total 127 MMA are located throughout the nation (**Figure 4-24**).

Figure 4-24: Community Marine Managed Areas in Solomon Islands



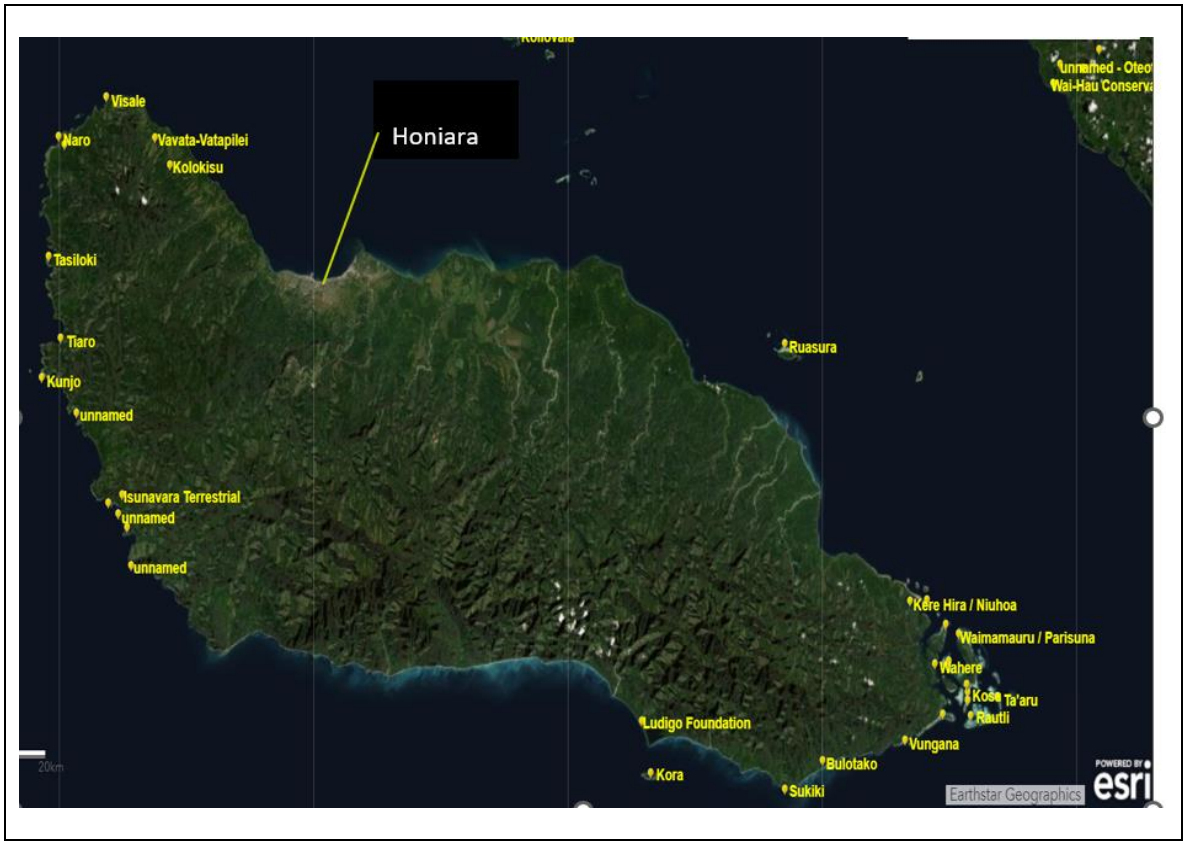
Source: MECDM, 2022.

525. MMA's are informally designated and include the customary management areas established in Roviana and Vonavona Lagoons. These two lagoons have high marine diversity and are important nurseries for bumphead parrotfish and hump head wrasse. They form part of the Bismarck Solomon Seas Ecoregion (BSSE), an ecoregion defined by the World Wildlife Fund (WWF). Additionally, a number of marine conservation areas have been established by communities in Marau Sound, Ngella, Marovo Lagoon, Tetepare, Roviana Lagoon and Gizo. Similar areas are likely to be established for marine resource management in the Shortland Islands, Russell Islands, Three Sisters Islands, Leli Island, Lau Lagoon, Suafa Bay, Langalanga Lagoon, Are'Are Lagoon and Small Malaita, Northern Isabel and Northern Choiseul.

526. The only registered MMA on Guadalcanal is located in the eastern end of the island in Marau Sound, however recently the communities located in the western end of the island have developed small MMA totaling up to about 27 which have as yet to be officially registered. These small MMA are not located anywhere near the subproject's area of influence.

527. There are no marine protect areas or critical marine habitats within the vicinity of the subproject area of influence that will be affected by the proposed development. **(Figure 4-25)**

Figure 4-25: Community Marine Managed Areas in Guadalcanal



Source: MECDM, 2022.

4.2.2.6 Critical Habitats

528. There are no critical terrestrial habitats or areas of natural habitats associated with the subproject area of influence. The subproject area of influence has previously been modified and disturbed with all levels of development including settlements, infrastructure developments and Town expansions. Flora found in the subproject area are non- native and fauna found habiting the modified environment have adapted and tolerant to the disturbances. There is no evidence of endangered flora or fauna species nor endemic species.

529. In summary, there are no critical habitats associated with the subproject's terrestrial, riparian, shoreline and coastal intertidal and subtidal marine environments

4.3 Socio-Economic Environment

4.3.1 Population Profile

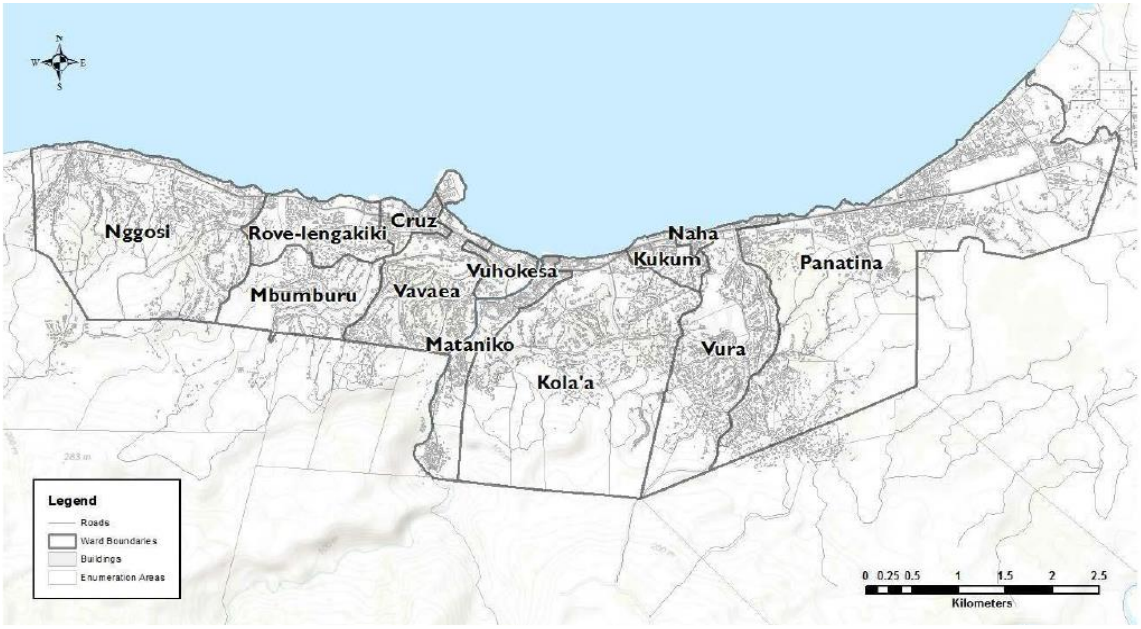
530. According to the 2009 census the population of Solomon Islands was determined as being 515,870 which is dispersed widely across the archipelago and a population growth rate of 2.3%/yr. The population has a broad-based age-sex structure. 40% of the population was found to be below 15 years of age. Moreover, in 2018, the country's population was approximately 667,044 (SIG, National

Statistic Office) with a sex ratio of 1.07 males to females, with an annual population growth rate of 2.0%, a medium age of 19.9 years, a life expectance average of 74.2 years (76.9 females, 71.6 males) and a density 22 persons per square kilometer. This reflects a sharp increase from the 17 persons per square kilometer recorded in the 2009 census. The population is thought to be doubling every 30 years, and pressure on available services and natural resources is said to be increasing dramatically. This requires Solomon Islands government to invest in for social infrastructure.

531. The estimated population of Guadalcanal in 2018 is 145,000. Based on the estimation, the population for Honiara is 86,529, with the highest number of citizens aged less than 15 years. The data provided in the Household Income and Expenditure Survey 2012/13 (HIES) indicated fluctuating population growth rates for Guadalcanal over the past two decades. The population grew rapidly, at 4.3% per year, for the inter-census period 1976-86. For the next period (1986-99) the growth rate had dropped to 1.5% due to the 1998/1999 departure of a large number of migrants from other provinces. There was a further large outflow of people in 2000, during the civil conflict, known as the 'ethnic tension' (1999-2003). The annual growth rate for the period 1999-2005 was 5.6% and since then an average growth rate of 4.4% (HIES, 2013).

532. Honiara City Council has jurisdiction over the municipal area, as shown in **Figure 4-26,** encompassing approximately 23km^2 of rugged hills and valleys rising up from the northern coastline of Guadalcanal Island. The Honiara municipal area is divided into 12 wards, each of which is represented by a single elected councilor. It is surrounded on all sides by land and ocean that falls within Guadalcanal Province's jurisdiction, within which land and near-shore marine tenure is primarily controlled by customary law.

Figure 4-26: Honiara Administrative Wards



Source: UN-Habitat (2016a)

533. As published in the last census (2009) report, Honiara City's 64,609 inhabitants represented 12.5% of Solomon Islands' total population **(see Table 4-12).** Results of the most recent census undertaken in 2020 are not available as yet. Average annual growth rates ranged from –0.9% to 4.9% for the period 1999 to 2009. The combined average annual growth rate in those wards was 2.7%. It is

generally known that with temporary migrants and informal settlers the population of Greater Honiara Area (encompassing both Honiara City Council and adjacent areas in Guadalcanal) would be in the order of 150,000.

534. Provisional results from the 2019 census (SINSO, 2019) confirm these trends, with the overall population of Solomon Islands growing by 2.7% per year from 2009 to 2019 and totaling 721,455; the growth rate of Honiara is accelerating at 5.8% per year and a total population of 130,176 almost doubling since 2009.

Table 4-14: Summary of Demographics (Solomon Island's Population Census)

Indicator	Total	Male	Female
Total Population 2019	721,455	369,252	352,204
Average annual growth rate, 1999-2009 (%)	2.7		
Population density (number of people/km2)	24		
Urban Population (2019)	184,832		
Honiara Population (2009)	64,609	34,089	30,520
Per cent urban (%)	100.0		
Average annual urban growth rate, 1999-2009 (%)	4.0		
Urban Population (2019)	130,176	67,064	63,112
Average annual growth rate, 1999-2009 (%)	5.8		

Reproduced from: SINSO. 2009, 2019.

535. The population density of Solomon Islands is 22 persons/km^2 is still considered relatively low by global standards. The Honiara population density is similar to the national average. 23.5 % of the population on Guadalcanal resides within the island's urban areas that are located on the northern side of the island along the Guadalcanal Plains.

536. Ward populations and household numbers are shown in **Table 4-15**.

Table 4-15: Ward Populations

Ward Name	Population	Average Household Size, 2009	HouseHolds
Cruz	232	6.8	34
Vuhokesa	1197	7.9	151
Mataniko	4343	7.9	550
Kukum	1835	7.4	248
Naha	356	6.6	54
Vura	9096	7.2	1263
Panatina	14, 103	6.9	2044

537. The scope of the subproject (pump stations, sewer mains and outfalls) runs through 7 wards namely Cruz, Vuhokesa, Mataniko, Kukum, Naha, Vura and Panatina. The 6 pumping stations with spillovers,

2 outfalls (NRH and Ranadi) and sewer mains (in some areas will be in the existing footprints along the main highway. A new sewer main is to be laid to connect the catchments to the two new outfalls). According to Solomon Water, the NRH will be the centre, and any sewer connections from the western end to White River will be regarded as West end and to the Eastern end to Ranadi will be East end.

4.3.2 Economic Context

538. Solomon Island's per-capita gross domestic product of US$600 ranks it as a lesser developed nation, and more than 75% of its labor force is engaged in subsistence and fishing. Most manufactured goods and petroleum products must be imported. Until 1998, when world prices for tropical timber fell steeply, timber was Solomon Islands' main export product and, in recent years, Solomon Islands forests were dangerously overexploited. Other important cash crops and exports include copra and palm oil.

539. Honiara is the economic, commercial, and administrative center of Solomon Islands. Its economic base is dominated by the services sector, including whole-sale businesses, retail stores, banks, tourism services shops, restaurants, and hotels. However, the economy is growing and the government forecasts that the construction, manufacturing, and utilities sectors will contribute more to the country's gross domestic product.

540. Domestic food consumption is supported by several markets such as the Honiara Central Market in Central Honiara. Vendors from the five surrounding provinces, namely Central, Western, Guadalcanal, Malaita, and Isabel have been selling fish in the Honiara Central Market with fish sales estimated at over AUD 2 million per annum[35].

541. The subproject is within Honiara which has a higher cost of living than the rest of the country. Using the poverty line measure, specified as the minimum expenditures needed to obtain basic food and non-food goods, a government survey in 2012-2013 reported that Honiara's poverty line per adult equivalent per year ($10,300) was almost three times that of the cheapest area in the country. This was attributed to poor infrastructures, markets not being integrated, costly transport, expensive services, and very high urban housing prices. A study conducted by ADB in 2013, stated that Solomon Islands' electricity retail tariffs are currently among the highest in the world, at $0.65 per kilowatt-hour. The Islands generate 97 percent of their electricity from diesel fuel and only 12 percent of homes are currently connected to grid power.[36]

4.3.3 Cultural Component

542. In Solomon Islands, special, sacred, or restricted sites, or 'tambu' areas represent the history, lineage and society of different clans and lines. The National Solomon Islands Museum keeps a National Tambu Site Register, which records several thousand sites in Solomon Islands. Based on information from the Register and the Honiara City Council, there are no recognized physical cultural resources within the subproject area. There is no record of visible archaeological records such as stone-faced terraces, platforms, and walls representing earlier village sites, agricultural complexes, and shrines, in the subproject areas.

[35] M. Keen and others. 2017.

[36] National Statistics Office and The World Bank. 2015

543. The proposed subproject sites do not include any areas of culture or known significant cultural interest that will be impacted by the subproject.

4.3.4 Marine Resource Utilization

544. In the marine environment, the major threats are overharvesting of marine resources, pollution from land-based sources and climate change. Threats such as high population growth, directly related to the high demands for and consumption of biological and abiotic resources, can also be regarded as a driver, as can the external demand for biodiversity goods and products and changes in people's lifestyles.

545. In Solomon Islands, marine resources are extremely important and essential to local communities. Solomon Islanders eat more fish per capita than most other nations. But poor management has led to the over-exploitation of six commercially important species and posing a great threat to communities in Solomon Islands today and, in recent decades, resultant shortages of fish have rapidly changed methods of fishing in the country's waters. In particular, the prevalence of fish poisoning and occasional blast fishing – often with dynamite – are now seriously affecting fish stocks, and the marine ecosystem as a whole. These effects are long-term too, as no natural recovery of a reef is possible when it is exposed to constant disturbance, affecting the marine environment – and therefore fish stocks – for future generations.

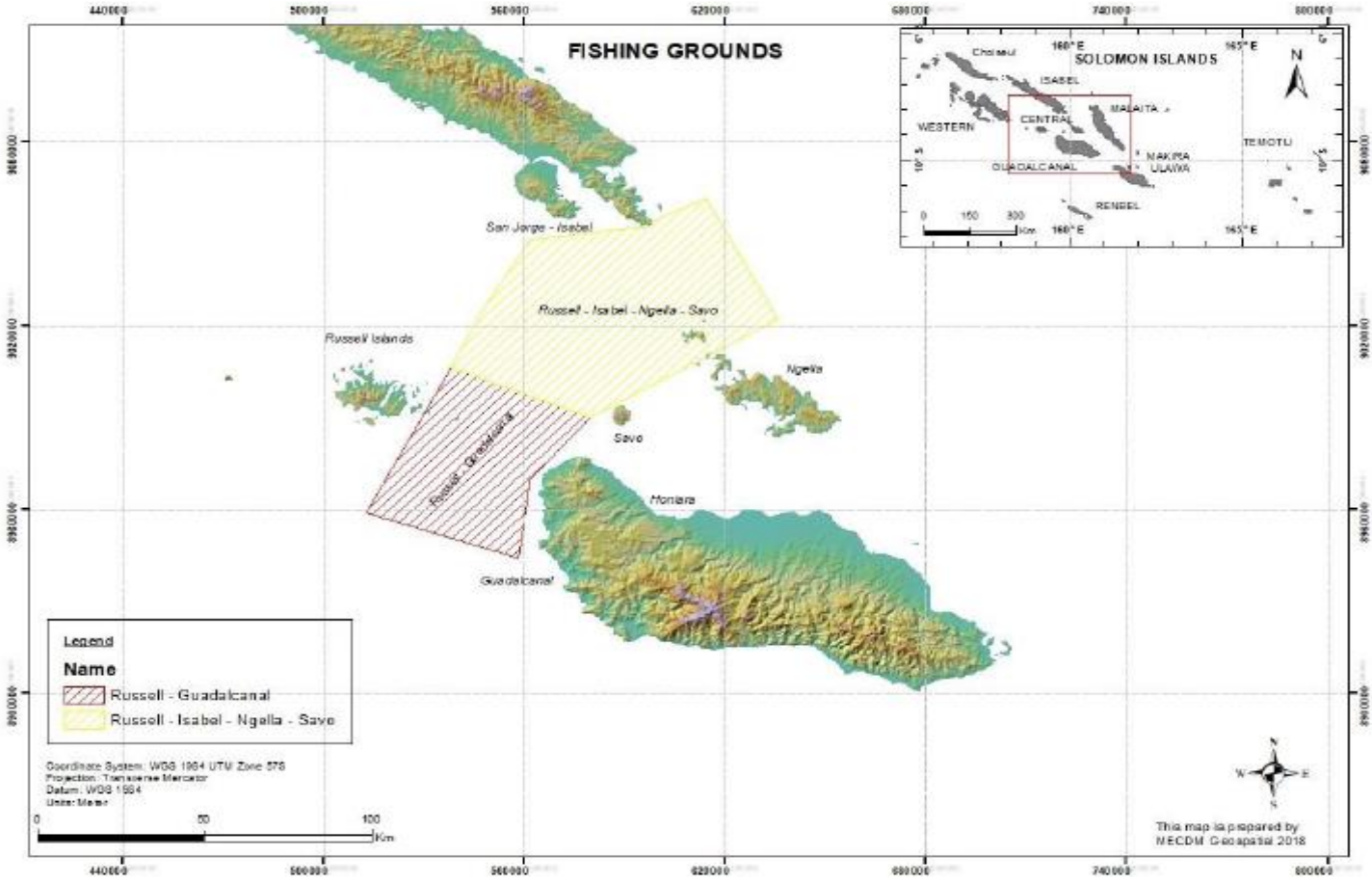
546. **Recreational Activities**: People in Honiara are commonly involved in fishing and recreational activities utilizing boats (dug-out canoes and outboard motors), kayaks, jet skis, and fishing vessels. The fishing and recreational gear includes cast nets, gillnets, fishing hand lines and diving and snorkeling gear. The operation of these activities is using the space otherwise utilized by people for swimming, surfing, sport, fishing, boating and diving. It was obvious that those that lived in informal settlements close to the coast have daily interaction with the sea. Other families usually go to the beach on weekends. However, it is to the western end of Honiara, where families spend their day out at the beach swimming, snorkeling, diving, and fishing (for fun).

547. There are a few recreational areas along the coast such as the Children's Park. The Children's Park in Rove is opposite Police headquarters and on the eastern side of the main road. The size of the area is about 50m^2, with few trees are planted in the area. Most activities occur from residential as well as hotel sites.

548. **Building Materials:** Many households in Honiara collect raw materials such as sand, gravel, coral rock, stones along the coast of Honiara for building and construction.

549. **Fishing Grounds:** In 2014, UN Habitat conducted a study for the settlements in Honiara. Three of the settlements are within the subproject area, Lord Howe Settlement and Renlau (locally known as Mamanawata) and Fishing Village. In that study, they interviewed the members about where they commonly fish and if their catch is for sale or for consumption. The result was that Lord Howe Settlement and Renlau fished in the coastal reefs and at the Mataniko River mouth whilst those from Fishing Village ventured offshore to the areas shown in **Figure 4-27** below. The shaded areas are the target Fish Aggregation Device (FAD) in Russell Islands.

Figure 4-27: Fishing Grounds for Fishers from Fishing Village.



Source: AFB/PPRC.21/27, September 2017

550. Since the Fishing Village people have to travel to the FAD, they use motorized boats. Whilst those from Renlau and Lord Howe Settlements use dug-out canoes. Methods used were the same, namely vertical line, handline, cast nets and night fishing. Fishing Village fishers used trolling while going to the fishing grounds. Both men and women from Fishing Village participated in the activity on a daily basis. For those from Renlau, most fish once or twice a week whilst from Lord Howe, the men fish three to five times a week.

551. There were distinct differences seen in the utilization of marine resources by the three settlements, some of it may be attributed to their cultural norms. The residents of Fishing Village who are originally from Malaita, venture offshore to fish, which is evident from the composition of their catch. Their target species are the pelagic species and reef fish that live in deeper water and their catch is sold to the general public. Fishing is the main source of livelihood and women are actively engaged in the commercial fishery.

552. In Lord Howe Settlement, where the residents are of Polynesian origin, the survey found that women are not encouraged to fish and the men rarely fish. The residents of Lord Howe buy salted fish from Noro cannery and value add by selling fish and chips. They also batter with Asian fishermen and exchange fruits and vegetables for fish.

553. Those from Renlau settlement fish in the Mataniko River mouth and the shallow coastal waters recipient catch is largely the smaller coastal species such as mullet and scad, and most fish just for subsistence.

4.3.5 Health and Education Status

554. **Education:** Education is not compulsory in Solomon Islands. In 2009, with respect to the population in Honiara aged 6-15 years, 86% of males and females were enrolled in school. Enrolment rates in Honiara are lower than in most other provinces. Based on the 2009 census data on the highest level of education completed, 37% of males and 32% of females 12 years and older responded that they had attended secondary education (Form 3-7); 38% and 43% of males and females completed only primary level, and 3% of males and 8% females had no schooling completed. Fifteen percent of males and 10% of females had tertiary education.[37]

555. According to the SIDHS, the majority of Solomon Islanders may have attended school at some stage in their lives, but the overall education levels are low. Overall, the school national attendance ratio is assessed to be 66% for primary school children and 34% for secondary school children. Much of the population has not completed primary school (35% of women, 34% of men). This demonstrates that education levels are low with 66% never participating in secondary school education.

556. The capital city of Solomon Islands Honiara is the main educational and administration center constitute of Schools (primary and secondary) that are privately owned, owned by the Government and the Honiara City Council. In Guadalcanal Province there are 32 ECE Schools; 74 Primary Schools; 25 Community High Schools; 3 Provincial Secondary Schools; 3 National Secondary Schools and more than 5 Rural Training Centers. These are operated by several Education Authorities, which include Guadalcanal Provincial Education Authority; Anglican Church of Melanesia; Roman Catholic Church; Seventh Day Adventist Church and South Seas Evangelical Church.

557. In overall, the primary and secondary schools can be accessed by children in the area and children also have equal access to other educational facilities which include both primary and secondary schools including early childhood education (ECE) in the city.

558. **Health:** The capital city hosts the National Referral Hospital (NRH) and about nine (9) clinics including private clinics which are not only accessed by people living within the city boundary but also accessed by people from Guadalcanal who need immediate medical attention.

559. The Ministry of Health and Medical Services is the key health provider in Solomon Islands. Health services are concentrated in urban centers with a hierarchy of facilities available ranging from nurse aide posts and rural clinics to the National Referral Hospital. Of the nine provinces in Solomon Islands, eight have a public hospital. SI has approximately 22 doctors per 100,000 of the population, but also has a strong base of nurse and midwives at 205 per 100,000. SI does not have specific data on causes of death but has identified communicable diseases including malaria and tuberculosis as important issues. Increasing prevalence of obesity due to lifestyle, diabetes, hypertension and tobacco and alcohol use has increased the rate of non-communicable diseases which will soon overtake communicable diseases as the leading burden of disease. [38]

[37] Report on 2009 Population and Housing Census for Honiara, Ministry of Finance and Treasury

[38] https://www.pacificmedicalsa.org/single-post/2017/01/23/Healthcare-Overview-Solomon-Islands

560. Demonstrating a causal link between recreational exposure to seawater contaminated with wastewater and illness is very difficult. Cabelli[39] was one of the pre-eminent researchers on this topic and managed numerous epidemiological surveys of over 10,000 people in places such as Egypt and South Africa attempting to find the link. He concluded that by far the most common illness caused by swimming in undisinfected sewage polluted water was caused by the “Norwalk type a” virus.

561. Since the presentation of his papers, Noroviruses have been adopted as the new name for Norwalk or Norwalk-like viruses. These belong to the family Caliciviridae. They are a group of non-enveloped, single-stranded RNA viruses that primarily cause acute gastroenteritis (inflammation of the stomach and/or intestines). Typically the illness lasts less than 24 hours.

562. Because of the common nature of the symptoms, it rarely goes reported and investigated leading to establishing a direct causal link with recreational water-based activities. In fact, it is reported that most people suffering from this illness do not seek medical help and assume it is related to other day-to-day activities. These include assuming it is a community-spread illness, associated with contaminated potable water or minor food poisoning. Rarely is a link established between this illness and water-based recreational activities.

563. Based on this, it is very unlikely that the health records from various clinics and hospitals would be able to regularly demonstrate a direct causal link between wastewater contamination of the water environment and patients presenting with these very common symptoms. This is further complicated by the fact that many patients do not bother seeking medical help anyway and so the event goes unreported.

564. A number of interviews were undertaken with nursing staff at clinics and hospitals. For example, the head nurse at Honiara City Council Office on September 12, 2022, stated that Water Borne Illnesses (WBIs) are rarely recorded since people traditionally do not report this to the local clinics or hospitals. People suffering from WBIs do not seek medical help, as they reportedly assume it is related to other better-known illness sources, such as contaminated potable water or minor food poisoning. As a result, they do not report the illness and often resort to herbal/home remedies for medication. This information correlates well with the international experience as described in this EIS in relation to the Norwalk virus infections in contaminated recreational waters.

565. However, the epidemiology is clear that recreating in wastewater-contaminated water bodies can result in illness. And these data have been used to determine the guideline values adopted for indicators such as *E. Coli* and *enterococci*.

4.3.6 Land-Use and Settlement Pattern

566. Honiara has a land area of 22.73 km^2. In 2012, 65% of the city’s developable land was developed, 1.5% was held by private developers, and 13.5% occupied by informal settlements (UN-Habitat. 2012). Today, commercial developments have continued along the narrow coastal strip of land with more industrial developments towards the east. More commercial building constructions are ongoing in the Chinatown area and further to the Panatina area.

[39] Von Schirnding, Yasmin; Strauss, N; Robertson, P; Kfir, R; Fattal, B; Mathee, Angela; Franck, M and Cabelli, VJ. Vol 27 10.2166/wst.1993.0343 Water Science and Technology 1993. Bather Morbidity from Recreational Exposure to Sea Water

4.3.6.1 Western Section Connection

567. **Figure 4-28: Site of Church Land Required** shows the land that will need SSEC's approval and **Table 4-13: Honiara Western Section Connections** lists the connections and land status.

Figure 4-28: Site of Church Land Required

Source: SW, Google Earth

568. **Figure4-29: Western Section of Sewerage Lines** shows the western end connectivity and where the sewerage mains will be laid, and the **Table 4-16: Honiara Western Section Connections** shows the land status and what process will be undertaken to access the land for the proposed development.

Figure 4-29: Western Section of Sewerage Lines

Source: SW, Google Earth

Table 4-16: Honiara Western Section Connections

No.	Western Section	Parcel #	Component	Area required (m2)	Type of Ownership	Landowner	Entitlements	Status
1	Sol Islands Port Authority	191-021-0032	Pipeline	3167	FTE	SIPA	Easement for Access	Easement MOU negotiation ongoing
2	Sol Islands Port Authority	191-021-0023	Pipeline	783	FTE	SIPA	Easement for Access	Easement MOU negotiation ongoing
4	Sol Islands Port Authority	191-063-0001	Pipeline	2124	FTE	SIPA	Easement for Access	Easement MOU negotiation ongoing
5	Market PS at SIPA	191-063-0001	Pump Station	106	FTE	SIPA	Acquisition - Outright Purchase	Outright Purchase MOU drafted sent
6	Honiara City Council - Hon Market/Pipeline	191-063-0001	Pump Station	534	Government	COL (User - HCC)	Access	MOU in progress for COL and HCC clerk to sign
7	South Seas Evangelical Church Sea front	191-023-186	Pipeline	207	FTE	SSEC	Easement for Access	SSEC does not agree with the pipeline going through their land. SW will make a final offer in response, and SW's Legal officer has ongoing dealings. .
8	United Church Sea front	191-023-0094	Pipeline	195	FTE	UCSI	Easement for Access	Support letter provided. Final MOU negotiated
9	Ministry of Health/NRH Pumping Station	191-031-	Pump Station	811	Government	COL (User - NRH)	Easement for Access	MHMS in support and MOU signed
10	Public access road area next to the NRH old morgue	191-031-0083	Pipeline	272	Private	Ontong Java Community Association Inc.	Easement for Access (TBC)	MOU negotiations on going
11	NRH Outfall pipeline from NRH boundary	191-082-12	Pipeline Outfall	1330	Private	Seafront Trustees	Easement for Access	MOU negotiations on going
12	Vara Creek- near the bridge	191-028-N Lot 188/v/H	Pump Station	105	Government	COL	FTE Acquisition	Approval letter from COL received. Awaiting offer letter to pay

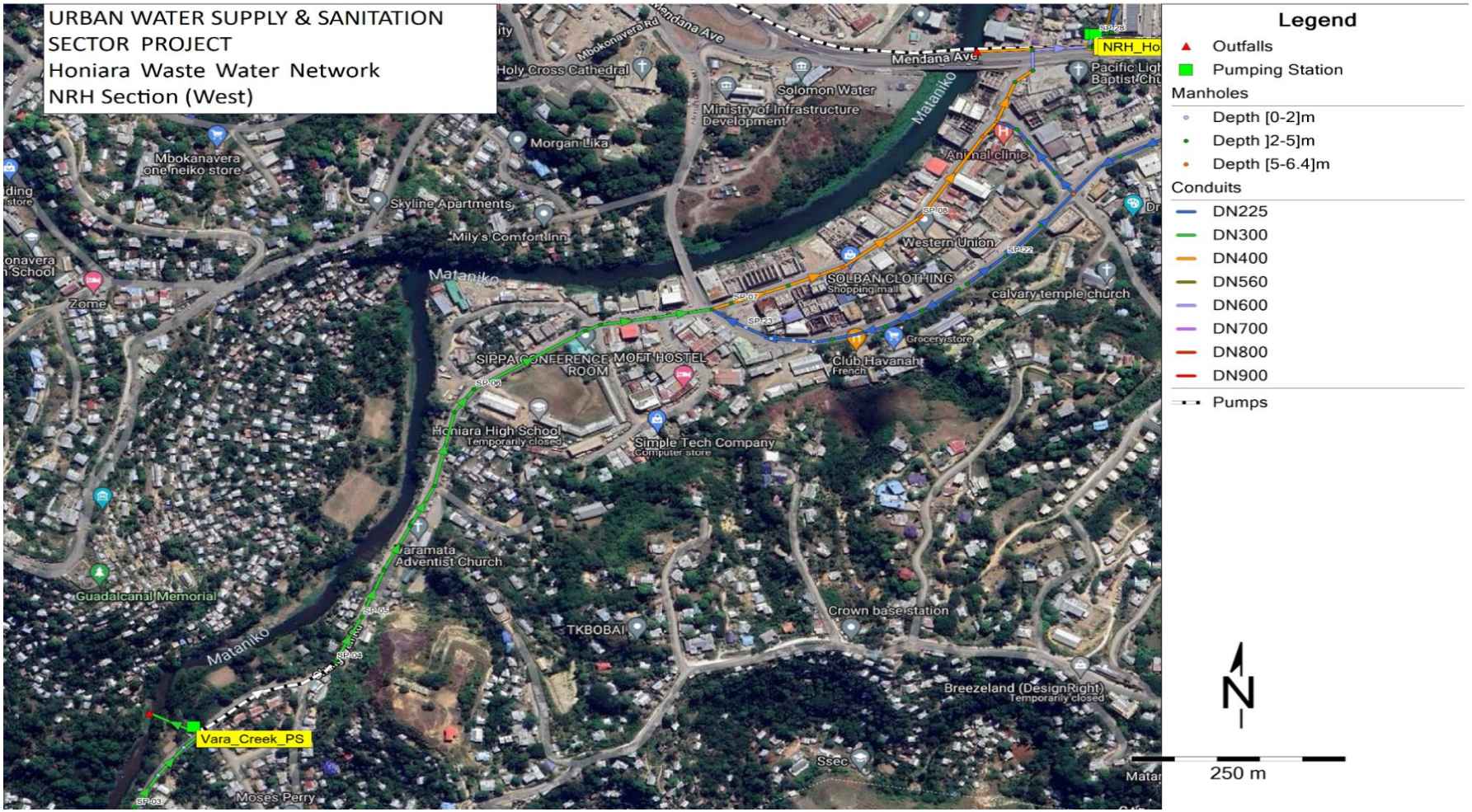
Source: SW PMU 2022

4.3.6.2 Vara Creek Pump Station and Connections

569. The Vara Creek PS will receive the Tuvaruhu catchment wastewater, and it will be connected to the NRH PS and to NRH Outfall. All the main trunks will be laid along the road corridor as shown in **Figures 4-30 and 4-31.** This will be along the road reserve. The Vara Creek PS is located on government land. Therefore, all the land that will be impacted for this proposed connectivity will be on government land. The status of the land is included in **Table 4-16: Western Section Connection.**

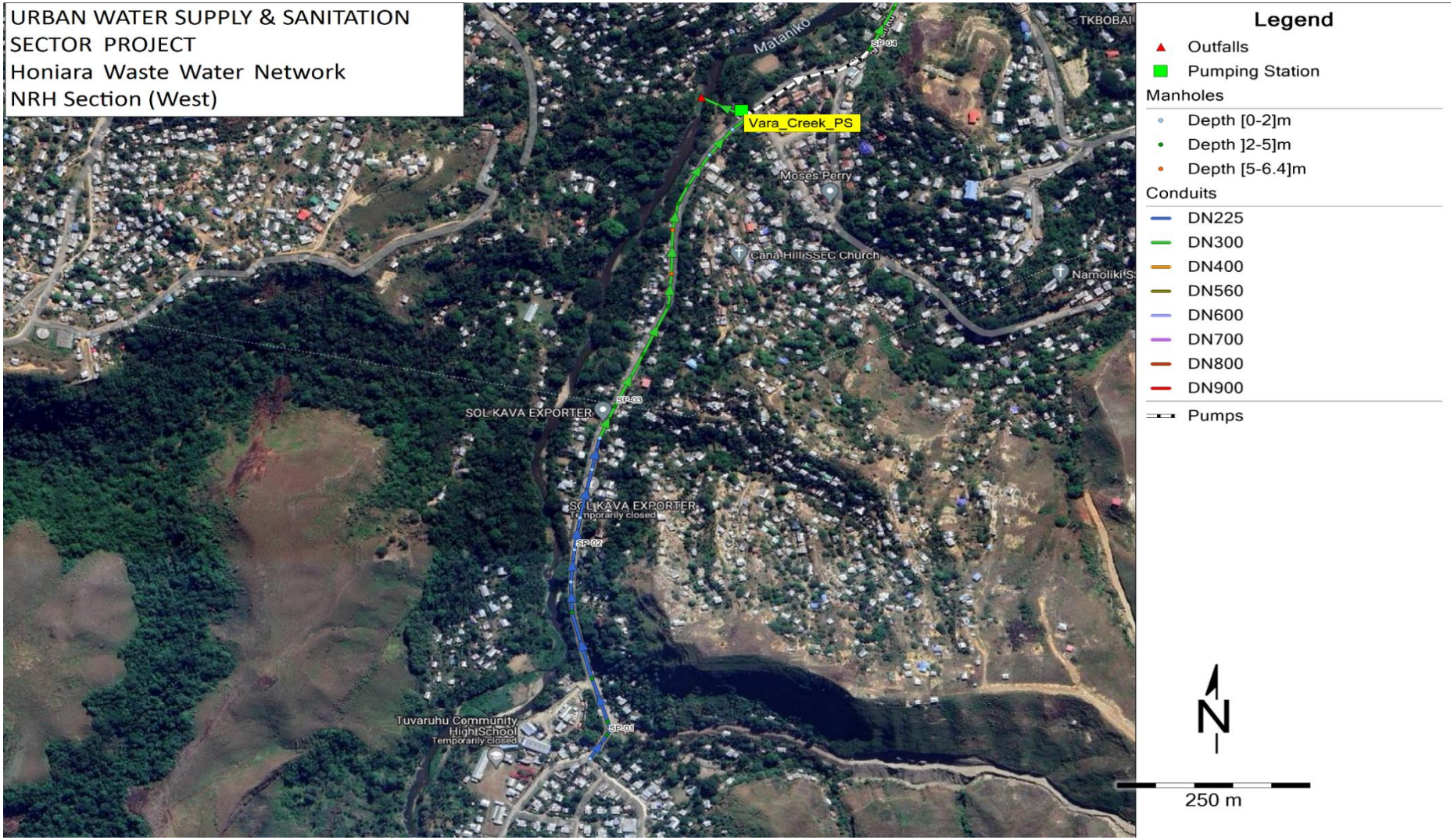
570. The Tuvaruhu main trunk will also be on the road reserve. Therefore, negotiations will involve SW, MID and CoL.

Figure 4-30: Part A- Connections from Tuvaruhu to Vara Creek PS.



Source: Suez. 2019. Basis of Design Report

Figure 4-31: Part B - Connections from Tuvaruhu to Vara Creek PS.



Source: Suez. 2019. Basis of Design Report

4.3.6.3 Eastern Section Connection

571. All the main trunks will be at the road reserve for the eastern connection. The PS will be acquired from the individual that has legal ownership of the land plot. The status of all the land that will be impacted is given in **Table 4-17.**

572. Details are shown in **Figure 4-32: Overall Eastern Section Connection**

4.3.6.4 Reclaimed Land

573. As noted in the descriptions of the NRH outfall location, extensive reclamation works were underway during the preparation of this EIS. Discussions with both the MECDM and the reclamation proponent could not resolve the land ownership status.

574. The proponent stated that he had obtained permission from the local landholders to develop the reclamation work, but doubt remains whether these are the correct traditional owners of the shore line and ocean areas immediately near the NRH hospital and to the east.

575. Discussions with MECDM confirmed they have not given any approvals or permits for this reclamation work and are actively investigating the issue. They further advised that the matter had now gone to court, and in fact the High Court, seeking a determination on the legality of the works involved. In any case, it is perplexing that a development of potentially 12 ha of reclamation of intertidal zone and seabed would not trigger the need for at least some level of environmental investigation. MECDM confirmed that there has not been any environmental investigation to date.

576. When undertaking the marine ecological study, the reclamation area was just to the west of the alignment proposed for the NRH outfall as it ran from the hospital grounds across the beach profile and into the ocean. However, this reclamation area is now being extended to the east so that the outfall will need to traverse part of this reclaimed area. It will be necessary for SW to discuss this issue with the developer and the traditional landholders to ascertain whether SW has to prepare an access agreement, such as an easement through this reclaimed area, or whether they are entitled to merely install and then maintain the outfall without any reparation or easement agreement.

Figure 4-32: Overall Eastern Section Connection

Source: Suez. 2019. Basis of Design Report

Table 4-17: Eastern Section Land Status

No	Eastern Section	Parcel #	Component	Area required (m2)	Type of Ownership	Landowner	Entitlements	Status
1	Kukum	191-037-0038	Pump Station	320	Private	KCM Properties Limited	Acquisition – Outright Purchase	Outright Purchase negotiation on going
2	Sol green / Ranadi area	192-010-009	Overflow pipe	15	Private	V Kurilau & Late R Kavichava? TBC	Easement for Access	Negotiation is subjected to confirmation of ownership
3	Sol green / Ranadi area	192-010-003	Overflow pipe	118	Private	TBC	Easement for Access	Negotiation on going
4	Sol green / Ranadi area	192-010-343	Pump Station	270	Government	COL	FTE Acquisition	Submission to Land board in progress
5	Goodwood area at Ranadi	192-010-343	Pump Station	122	Government	COL	FTE Acquisition	COL approval received
6	Goodwood area at Ranadi	192-010-0264	Outfall pipeline	22	Private	Goodwood (SI) Ltd	Easement for Access	MOU signed
7	Goodwood area at Ranadi	192-010-0185	Outfall pipeline	121	Private	Goodwood (SI) Ltd	Easement for Access	MOU signed
8	Goodwood foreshore	192-010-009	Outfall pipeline	88	Private	V Kurilau & Late R Kavichava	Easement for Access	MOU ongoing
9	GPPOL foreshore area at Ranadi	n/a	Outfall pipeline	642	Government	COL	Easement for Access	To submit to COL
10	GPPOL foreshore area at Ranadi	192-010-009	Outfall pipeline	91	Private	V Kurilau & Late R Kavichava	Easement for Access	MOU ongoing
11	GPPOL foreshore area at Ranadi	192-010-005	Outfall pipeline	359	Private	V Kurilau & R Kavichava	Easement for Access	MOU ongoing
12	GPPOL foreshore area at Ranadi	192-010-300	Outfall pipeline	448	Private	GPPOL	Easement for Access	MOU ongoing

13	GPPOL area at Ranadi in land	192-010-295	Outfall pipeline	12	Private	GPPOL	Easement for Access	MOU ongoing
14	GPPOL area at Ranadi in land	192-010-215	Outfall pipeline	290	Private	GPPOL	Easement for Access	MOU ongoing
15	Honiara City Council – Rubbish Dump site	192-010-343	Main Outfall pump station	1863	Government	COL	FTE Acquisition	Submission to Land board in progress

Source: SW PMU 2022

4.3.7 Infrastructure, Services and Built Environment[40]

4.3.7.1 Infrastructure and Services

577. Honiara became the capital city of Solomon Islands formally in 1952 with little infrastructure development. The city is located on 22.73 Km^2 of land which was acquired by the colonial administration of which 20% is unsuitable for development due to topographical and environmental limitations. Honiara is the main transport hub of Solomon Islands, connecting it to other countries through its main airport and seaport.

578. Honiara city lies along the Kukum Highway and is served by the Henderson International Airport, which was reopened in 1969 after WWII as the nation's largest airport. This was improved to receive large aircraft landings and is under the administration of the Solomon Airlines, the state-owned airline operator based at Honiara.

Figure 4-33: Honiara International Airport in relation to the Ranadi Outfall

Source: Google Earth

579. For sea transport, Point Cruz seaport is the main international seaport of entry into Solomon Islands. The port was upgraded to cater for international shipping companies and has the facility to handle 20 feet (6.1 m) containers. International shipping is generally large container vessels and non-cargo ships, such as fishing mother boats, cruise ships, naval boats, and survey ships. Another international wharf is at Noro (Western Province) servicing general cargo, bulk fuel and the fishing industry. Today the coastal shipping is locally owned, and it is used for coastal and inter-island transport, ferrying cargo and passengers throughout the islands. Local shipping operators provide passenger boat services from Honiara's main wharf at Point Cruz to the islands. The two outfalls are located towards the east of the main seaport.

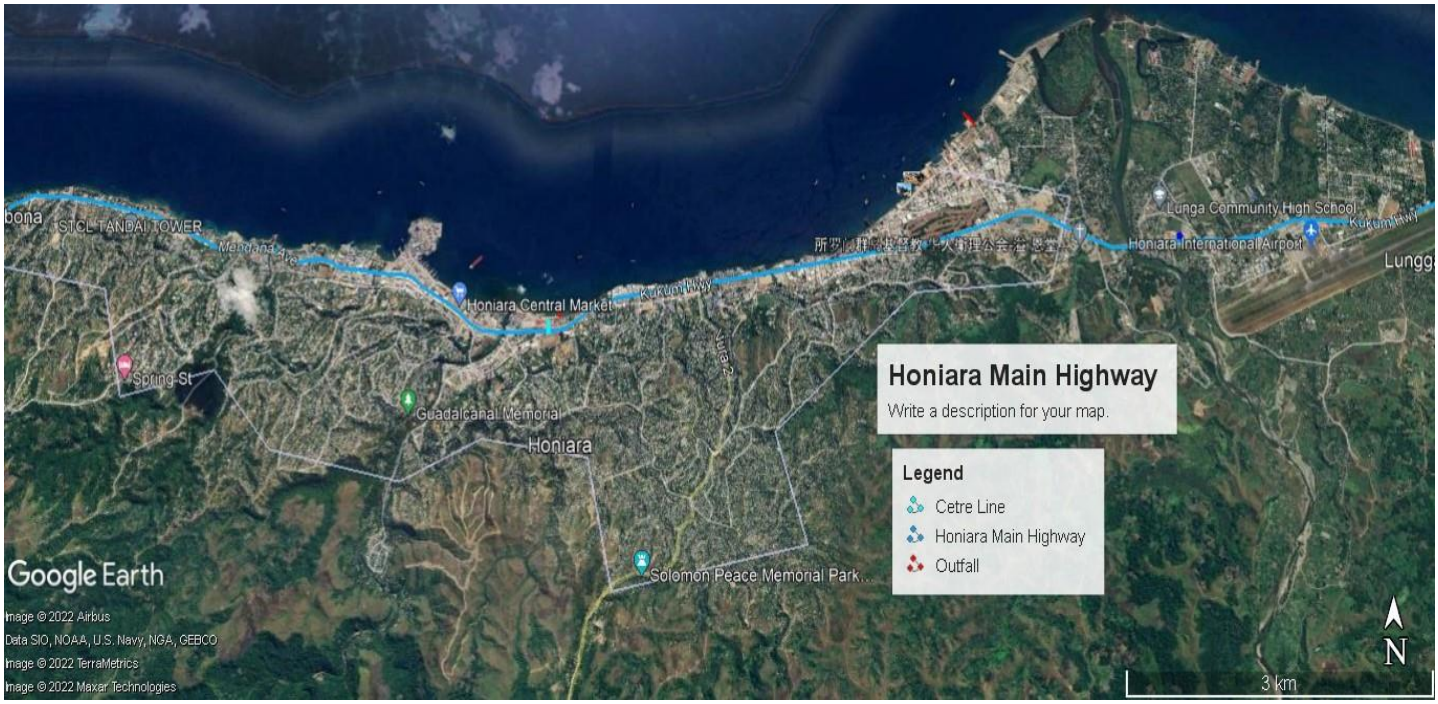
[40] Information about infrastructure and services was taken from Greater Honiara Urban Development Strategy and Action Plan (Volume I)

Figure 4-34: Honiara International Seaport in relation to NRH Outfall

Source: Google Earth

580. Roads and bridges in all the islands are in poor condition. The main road on Guadalcanal runs between Lambi (69km) in the west and Aola (79 km) in the east on the northern coastal side of Guadalcanal Island. Most of the road surface is in poor condition and needs upgrading and repair. It is estimated that there is approximately 320 km of road in North Guadalcanal. There is an existing two-way highway road that runs past the subproject site which connects the eastern end and western end of the main capital city (Honiara). The main highway also connects the international airport and seaport. Some sections of the sewer mains are within the main highway road corridor.

Figure 4-35: Honiara Main Highway



Source: Google Earth

581. The utility service lines such as Solomon water, Solomon Power and Solomon Telekom also used the road reserve to lay the service lines. Part of the service lines are laid underground, and some parts are overhead for Solomon Telekom and Solomon Power.

582. Basic urban services (water and power provision and garbage collection) vary between the formal and informal settlements. While formal residential areas are often serviced, the informal settlements are not, with a number of households resorting to illegal tapping of water pipes. Honiara city is faced with poor service delivery, lack of public sanitation, poor planning, a shortage of housing, high costs of living, environmental degradation, and a rise in informal settlements. There is still a need for the Honiara City Council to ensure the effective and equitable distribution of basic urban services to all residents of Honiara, especially those living in the informal settlement.

4.3.7.2 Built Environment[41]

583. **Transportation**: Honiara is the main transport hub of Solomon Islands, connecting it to other countries through its main airport, Henderson International Airport now known as Honiara International Airport, and its port at Point Cruz. Additional transportation networks include the highways and bridges.

584. The transportation and wharf-related activities are the transport vehicles themselves such as the canoes, OBMs, boats and ships as well as the departure or transfer areas for these vessels such as

[41] Information about infrastructure and services was taken from Greater Honiara Urban Development Strategy and Action Plan (Volume I) and the SW prepared Background Information Report 2021.

wharves, slipways, ramps, landing beaches, anchorage sites and buoys. The operation of transportation and wharf-related activities are the vessels and docks, the movement of goods and people as well as the waste produced.

585. Kukum Highway upgrading works was completed recently in 2018, funded by JICA. These also included footpaths for pedestrians and Mataniko Bridges. As part of the agreement the Mataniko Bridge was renamed 'Heiwa Bridge', meaning 'Peace' the old Mataniko Bridge renamed 'Yuko Bridge' meaning 'Friendship' and the Kukum Highway was named 'Hinode' meaning 'Rising Sun'.

Figure 4-36: Recent Kukum Upgrading Works

Source: Google Earth

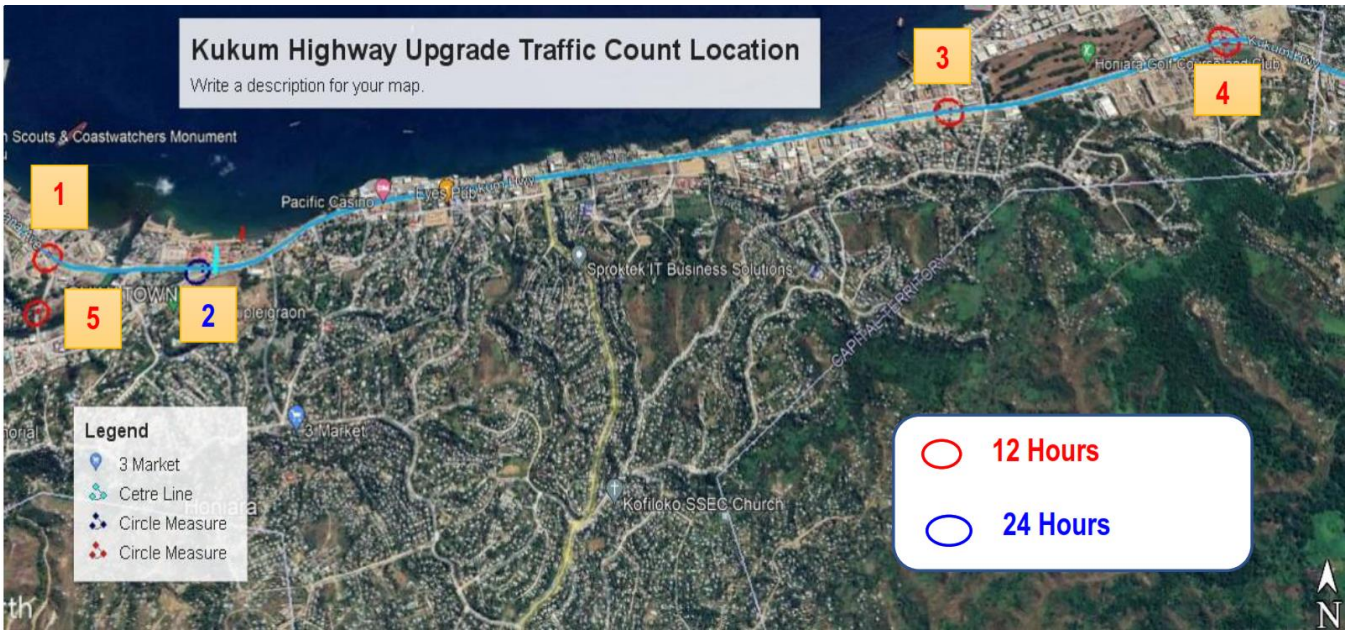
586. During the detailed engineering design for the Kukum Highway upgrading works, traffic assessment was also conducted, from which a traffic forecast was made. See below for the results from the assessment. The traffic demand forecast was conducted for the Kukum Highway Upgrade Project. **Table 4-18**Error! Reference source not found. presents the future traffic volume from 2013 to 2033. **F igure 4-37** shows the location map of traffic count stations.

Table 4-18: Future Traffic Volume (2013-2033), Passenger Car Unit PCU/day

Station No. 1	2013	2018	2023	2028	2033
1	35,336	45,996	51,329	56,824	62,432
2	44,510	50,148	55,990	62,015	68,171
3	31,453	35,639	40,002	44,545	49,233
4	21,757	24,655	27,679	30,829	34,081
5	12,851	8,266	9,222	10,206	11,210

Source: Preparatory Survey for Kukum Highway Upgrade Project in Solomon Islands, November 2014

Figure 4-37: Location Map of Traffic Count Stations



Source: Preparatory Survey for Kukum Highway Upgrade Project in Solomon Islands, November 2014

587. **Water Supply**: Honiara water supply system is managed by SW. It is composed of a large piped system supplying approximately 55% of households in Honiara (covering Honiara City Council and surrounding communities).

588. The main features of Honiara Water Supply System are as follows: (a) As of June 2019, water was supplied to nearly 60,000 people which is equivalent to ~9,600 HHs; (b) the distribution system is fed by both surface and groundwater with essentially 3 surface water sources and 8 groundwater abstraction systems a with total number of 27 boreholes; (c) the amount of supplied water is approximately ~33 MLD of which 40% is from groundwater while 60% is from surface water with Kongulai spring accounting for over 40% of the overall production; (d) SW has nearly ~295km of network pipes ranging from 15 to 300 mm from which 62% of the pipeline is PVC, 20% is PE, 13% is GI and 5% is CI/DI; (e) there are 28 District Metered Areas (DMAs) but with limited pressure regulation; (f) there is chlorine disinfection on all production systems; (g) no water treatment plant is operating; (h) there are 12 ground reservoirs in service; and (i) 16.3 ML storage which is equivalent to a half day of current production.

589. Other water sources of households not connected to SW are local spring sources, rainwater (stored in tanks), wells and rivers/streams.

590. Issues with the water supply system include intermittent water shortages and low water pressure which is experienced by about 25% of the served population resulting in insufficient water during the daytime. The water system is also highly inefficient. Non-revenue water which is the water loss due to burst pipes and leaks, scouring of mains, leaking taps, leaking reservoir tanks and illegal connections constitutes approximately 40% of the total water production.

591. Other challenges with the Honiara water supply system are the unpredictable establishment and rapid growth of informal settlements in the peri-urban area, creating another layer of complexity. Affordability, lack of tenure, illegal connections, and lack of pipe/source water capacity in some zones also complicate an already difficult situation.

592. **Water Supply in the Surveyed Areas**: Honiara City relies mostly on the Kongulai water source. **Figure 4-38** shows the main primary water source types accessed by the households. In **Figure 4-39** it is displayed by area showing most of the households accessed the Solomon Water connection. Note that the X Axis represents the number of households interviewed in each location.

593. The percentage of the household connecting to SW is high because it includes those households that shared with neighbors as they are still accessing/using that source as their primary water supply (their primary source for accessing water and not from other sources). From this survey, it was obvious that neighbors are obliged to give some money to the owner to help pay for the bills, even if the agreement between the two households is for free. The non-piped water includes spring, borehole, well, stream or river.

Figure 4-38: Primary Water Supply Source

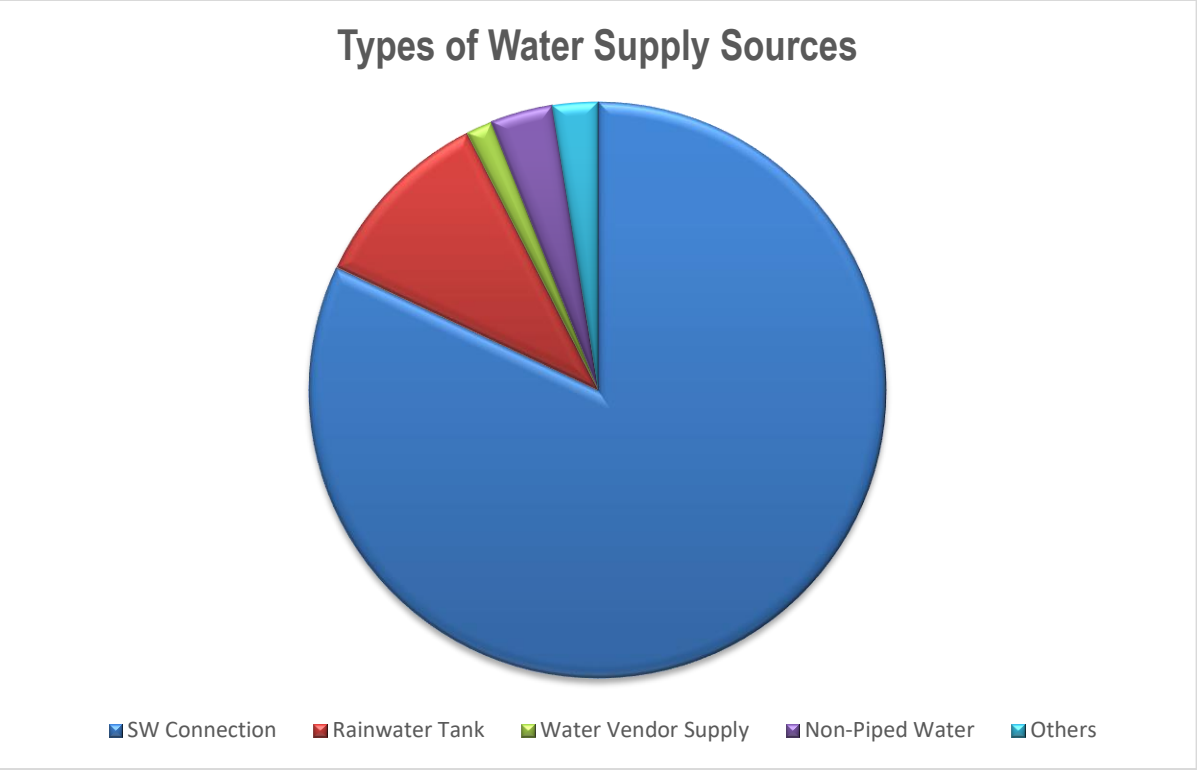
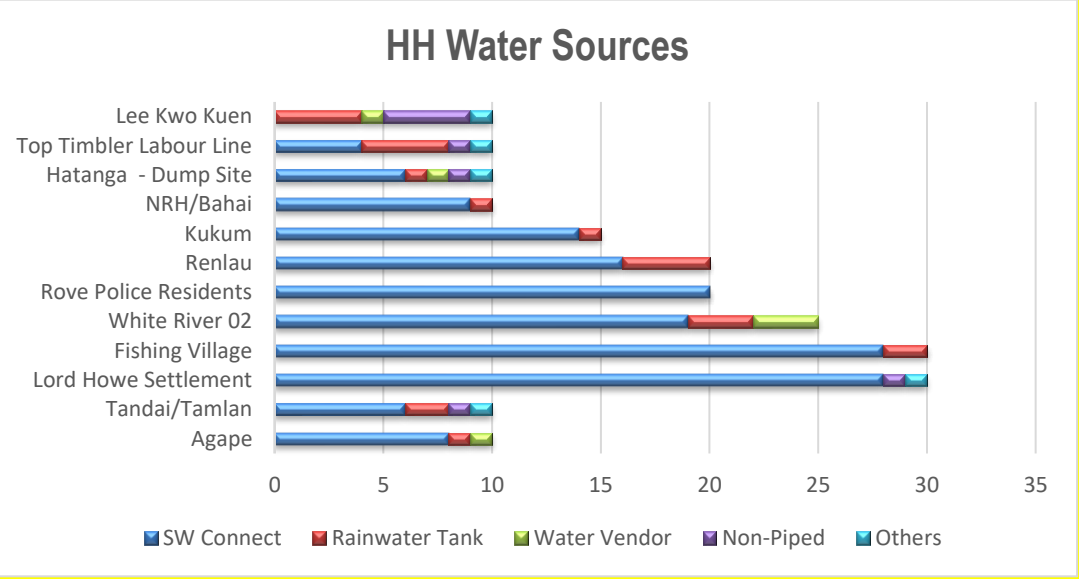


Figure 4-39: HH Accessing Water Sources



594. **Wastewater Connections and Catchments**: It is estimated that a little under 10% of the population of Honiara is connected directly to the wastewater systems with 3 areas served by Communal Septic Tanks (CSTs) at Rove, Tuvaruhu and Vara. Additionally, there are a number of non-domestic connections, particularly at Ranadi and Point Cruz. Of particular note is the hospital in Honiara which had 4 short sea outfalls directed to the foreshore (one of which was connected to the previously operating treatment facility).

595. **Table 4-19**Error! Reference source not found. below provides the existing wastewater flows.

Table 4-19: Existing Wastewater Flows (l/s)

Catchment	Area (ha)	Connections	Equivalent Population	ADWF	PDWF	PWWF
Bahai	2.7	59	413	1.0	5.6	6.8
Central Hospital	7.7	18	126	0.3	1.3	4.8
King George VI	11.7	4	28	2.2	8.6	13.9
Kukum	7.4	69	917	2.1	9.5	12.8
Mbua Valley	17.3	153	1,071	2.5	8.9	16.7
Naha	33.5	279	1,953	4.5	14	29.1
Point Cruz	43.7	138	2,411	6.0	17.5	37.1
Ranadi	10.6	36	295	0.7	2.8	7.6
Rove	5.4	64	488	1.1	5.5	7.9
Tuvaruhu	5.9	27	189	0.4	2.1	4.7
Vara Creek	42.3	255	1,785	0.7	4.8	5.6
Vura	1.9	46	322	4.4	12.9	31.9
Total	**190.1**	**1,148**	**9,998**	**25.9**	**93.5**	**178.9**

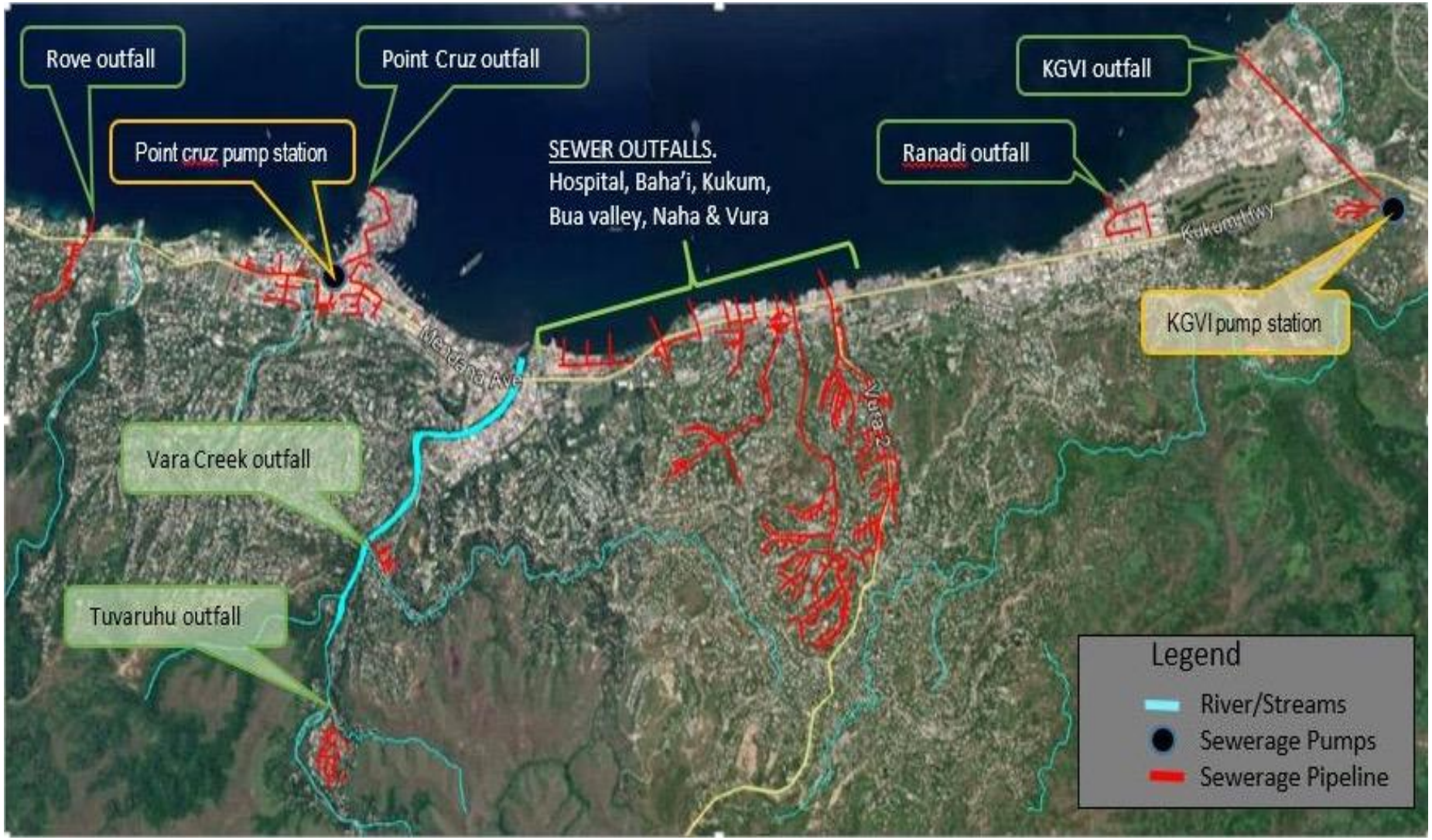
Source: Honiara Wastewater BOD, July 2019

Note:
ADWF – Average Dry Weather Flow
PDWF – Peak Dry Weather Flow
PWWF – Peak Wet Weather Flow

596. **Sanitation and Wastewater:** The Honiara sewer system consists of a number of individual collection systems generally discharging by gravity to the coast through a number of short sea outfalls (see **Figure 4-40**). Exceptions to this are the Rove, Tuvaruhu and Vara Creek systems which are pre-treated in Communal Septic Tanks (CSTs), the latter two discharging to the Mataniko River. Two pumping stations are in operation at Point Cruz and King George VI School. In other areas, individual septic tanks are installed discharging directly to drains and watercourses.

597. There a very few properly installed septic systems incorporating a properly designed, installed and maintained septic tank followed by an appropriately sited and constructed infiltration trench or bed. In addition, many septic tanks have not been maintained and are in fact badly damaged, as well as numerous simple earth closets/pit toilets.

Figure 4-40: Overview of Honiara Wastewater System



Source: Honiara Wastewater BOD, July 2019

598. **Collection and Conveyance System**: **Plate 4-21**Error! Reference source not found. provides a v isual example of the existing wastewater networks maintained and operated by SW. Two pumping stations exist on the SW networks at Point Cruz and at King George VI School.

- The Point Cruz pump station serves a major catchment upstream of the port area and conveys effluent to the Point Cruz sea outfall. There is a single 11 kW Tsurumi submersible pump discharging at 64 m^3/hr (17.8 l/s). Upstream of the pump station there is an emergency overflow which discharges excess flows to an area near the Yacht Club.
- The King George VI pump station serves primarily the school with the same name. A single 7.5kW Tsurumi submersible pump with a 24 m3/hr (6.67 l/s) is installed. The pump is suspended inside the wet well by a chain block. The area around the pump station is frequently waterlogged.

Plate 4-21: Existing Pumping Stations at Point Cruz and King George VI School

Source: Honiara Wastewater BOD, July 2019

599. Overall coverage is rather low with a total system length of a little over 36 km (<0.5 m/inhabitant). This is not surprising as less than 10% of the population is served by the public wastewater system and there is as of yet no main conveyance system linking the individual collection systems.

600. Pipe materials are predominantly pitch fiber (60%) followed by PVC (26%) and Asbestos Cement (14%). It is understood that pitch fiber was laid during the colonial period and is most likely near the end of its operational life (generally thought to be around 40 years). Pipe diameters are predominantly less than 200 mm (85%); 21% less than 150mm. Given the nature of the systems connected to these networks, it is unsurprising that this leads to blockages. Generally, in such environments minimum diameters of 150-200 mm are now required by utilities.

601. **Treatment and Disposal**: As mentioned previously there are 3 CSTs in Honiara; additionally, there is a wastewater treatment facility at the central hospital which has not functioned for many years. Disposal thereafter takes place through outfalls to both river and coastal receiving waters.

602. There are additional wastewater outfalls to the Mataniko River system such as Tuvaruhu from drains, particularly from the Chinatown region and also from the road drain running adjacent to the Hospital.

603. **Table 4-20** provides a summary of the existing 15 coastal outfalls. These as well as the two inland outfalls at Tuvaruhu and Vara Creek are shown in **Figure 4-38: Existing Outfall Locations** below.

Table 4-20: Summary of Existing Coastal Outfalls

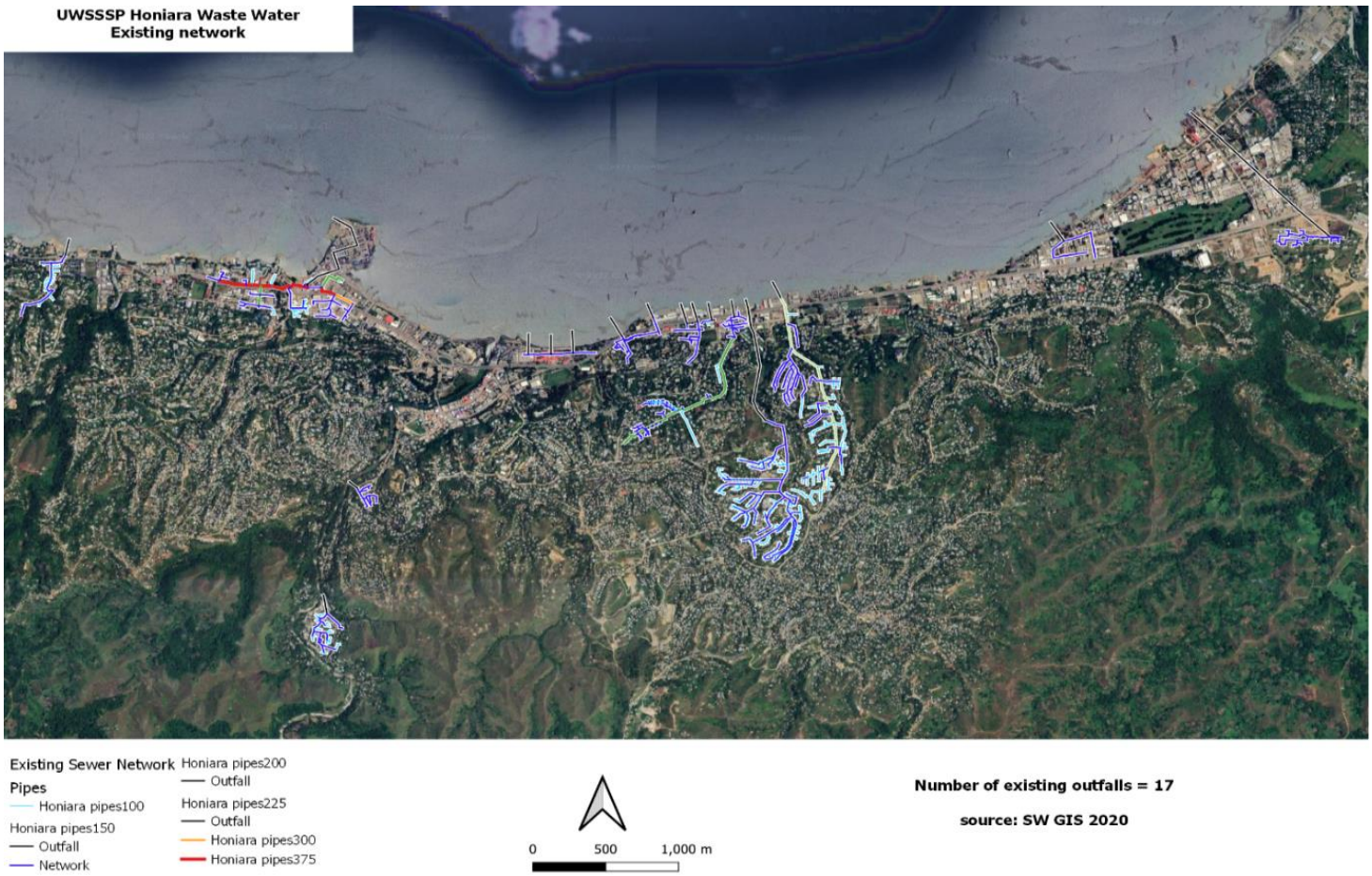
Outfall name	Year completed	Material	Diameter (cm)	Operating mode (gravity or pumping)	Non-domestic effluent
Point Cruz	1972	Concrete	225	P	X
Central Hospital 1	NA	PVC	150	G	X
Central Hospital 2	NA	PVC	100	G	X
Central Hospital 3	NA	NA	100	G	X
Central Hospital 4	2008			P	
Bahai 1	1969	AC	150	G	
Bahai 2 (Pacific Paradise)	1969	AC	150	G	
Kukum 1 (Cowboys Grill)	1968	AC	150	G	
Kukum 2	NA	PF	150	G	
Kukum 3 (Apartment)	1968	AC	150	G	
Mbua valley	1969	AC	150	G	
Naha 1-4	< 1981	AC	150	G	
Vura 1-3 (gas station)	1970	CI	200	G	X
Ranadi TGA	1975	PVC	150	G	X
KGVI	1970	PVC	150	P	X

Source: Honiara Wastewater BOD, July 2019

604. An outfall at Rove was recently refurbished and extended but is outside the UWSSSP catchment and will remain operational. Similarly, the Naha outfall was also refurbished and extended and will be integrated into the overflow system from the new Naha PS as part of UWSSSP infrastructure.

605. The figure below indicates where the existing ocean and inland outfalls are located (**Figure 4-41: Existing Outfall Locations)**.

Figure 4-41: Existing Outfall Locations



Source: Honiara Wastewater BOD, July 2019

606. The plates below (**Plate 4-22: Ranadi TGA Outfall and Plate 4-23: Tuvaruhu Discharge**) show examples of an ocean outfall and inland discharge pipe respectively. The first outfall is discharging directly onto the beach itself and would have previously been supported by what is now a number of unserviceable supports extending beyond the beach. These supports would have initially allowed the outfall to discharge beyond the surf zone.

607. At the Tuvaruhu site, the outlet pipe is discharging directly into an ephemeral creek bed which was dry at the time of sampling, and therefore was affording no dilution to the wastewater.

Plate 4-22: Ranadi TGA Outfall

Plate 4-23: Tuvaruhu Discharge

608. The hospital wastewater system consists of essentially two lines. An older line at the coastal side of the hospital and, until recently, discharging directly to coastal waters by three outfalls; a new line serving the landward side of the hospital and also connecting the former line via a pumping station. The new line adjacent to the road now overflows to the nearby stormwater drain which then discharges to the Mataniko river further to the west.

609. A major reclamation scheme recently commenced in front of the hospital. Unofficial plans indicate the total reclamation area extends some 600 m along the foreshore and occupies a total area of greater than 12 ha. Some initial reclamation work has commenced directly in front of the hospital and finishing to the east in line with where the proposed outfall will enter the ocean. Discussions with the

relevant ministries and also the project proponent yielded very different interpretations of the legality of this reclamation. The Ministry confirmed that it had not issued any permits or approvals for this reclamation work to commence. Furthermore, it is rumored that a court case has already commenced to stop this reclamation. However, at the time of drafting the EIS, a consistent picture of the legality or otherwise and the extent of the proposed reclamation could not be obtained.

610. In October 2022, reclamation was continuing and in fact expanding to the east of the first reclamation area. This second reclamation footprint is in line with the proposed NRH outfall route. Therefore, SW will need to investigate what obligations they have to obtain an easement or other access approvals through this land which may be illegally developed.

611. The plates below (**Plate 4-24: NRH Reclamation** and **Plate 4-25: NRH Outfall Pipe Inside Reclamation Area**) show the extent of the initial reclamation and one of the existing three outfalls that have been enclosed by the initial stage of reclamation works. At the time of photographing, backfilling behind the reclamation wall was ongoing. Subsequent inspections indicated this area had now been completely backfilled.

612. A new single outfall pipe now discharges outside the seaward side of the reclamation wall. Whether this one outfall is connected to any or all three of the old outfalls now within the reclamation area is unknown.

Plate 4-24: NRH Foreshore Reclamation

Plate 4-25: NRH Outfall Pipe Inside Reclamation Area

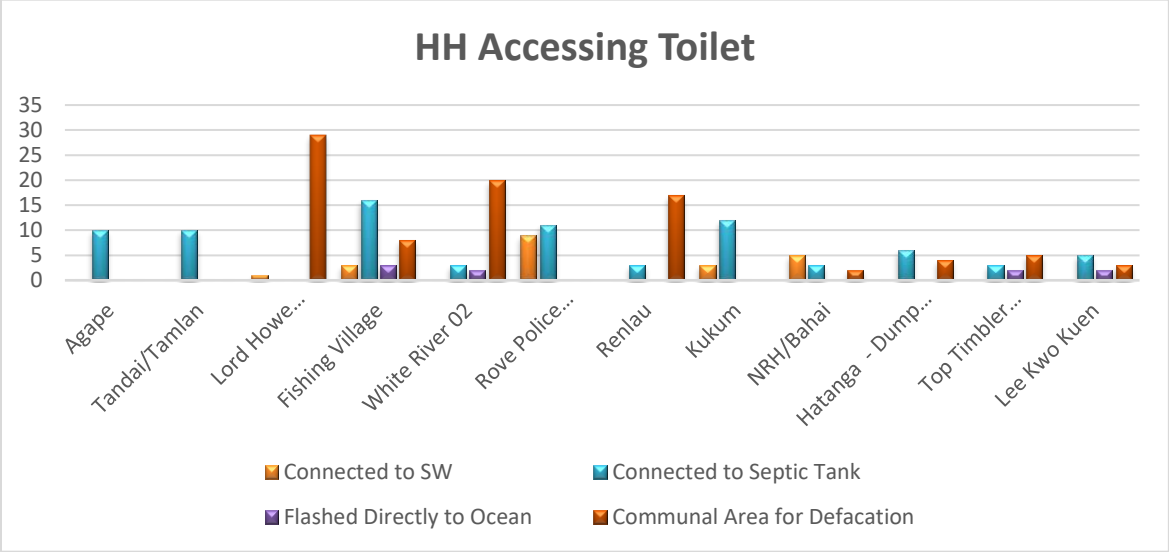
613. The wastewater system is also managed by SW which serves only about 10% of the city's population. This is limited to small parts of Honiara such as Tuvaruhu, Vara Creek, Naha and Rove. Wastewater is disposed of, untreated, through 12 outfalls along the coast and Mataniko River. Many of the outfalls are broken near the shoreline which results in near-shore pollution.

614. Residents not connected to wastewater systems may have improved on-site sanitation facilities but mainly rely on closed tanks (often intended to be septic tanks but with inadequate or no drain fields) and pits for containment. As noted above, there are many earth closets or pit toilets still in operation within the greater Honiara area as well.

615. In terms of septage collection, the city government is responsible for septage collection but the coverage and quality of services are very limited. After collection, septage is disposed of at the Ranadi solid waste dumpsite without any treatment.

616. **Sanitation in the surveyed areas:** Sanitation in Solomon Islands is an ongoing challenge, with Solomon Islands National Development Strategy 2016-2035 aligning with the global Sustainable Development Goals (SDGs) aiming to achieve water and sanitation for all (universal access) by 2030. It is estimated that by 2030, 90% of the total population should have access to clean and healthy water supply, and 76% improved sanitation in the urban area. This estimate appears optimistic when comparing the projected figures to what is actually happening on the ground. Solomon Water has a sewerage network and is currently working on improving and expanding connectivity. Only a very small number of HHs are currently connected to the SW system. Only Fishing Village, Kukum and NRH/Bahai are connected to the system. Currently in Honiara, septic tanks are commonly used, as shown in **Figure 4-42**. Agape and Tamlan/Tandai used only septic tanks. Open communal defecation is still used, especially in the informal settlements.

Figure 4-42: Sanitation Status of the HHs Surveyed



617. Lord Howe Settlement, White River 02 and Renlau have the highest proportion using open defecation. The open defecation is still used in the informal settlements because Solomon Water Sewer network does not cover their area. Also, their setting is not convenient to build septic tanks, due to overcrowding and being very close to the highwater mark. For example, in Renlau and Lord Howe Settlement they are located at Mataniko reiver mouth and also very close to the sea. In such a location a proper design and material for constructing the septic tanks and infiltration systems must be considered. Obviously proper design in such a difficult environment attracts additional cost. These communities will not have enough money to pay for such expensive systems. Thus, they rely on the less expensive systems but risk their own and the community's health.

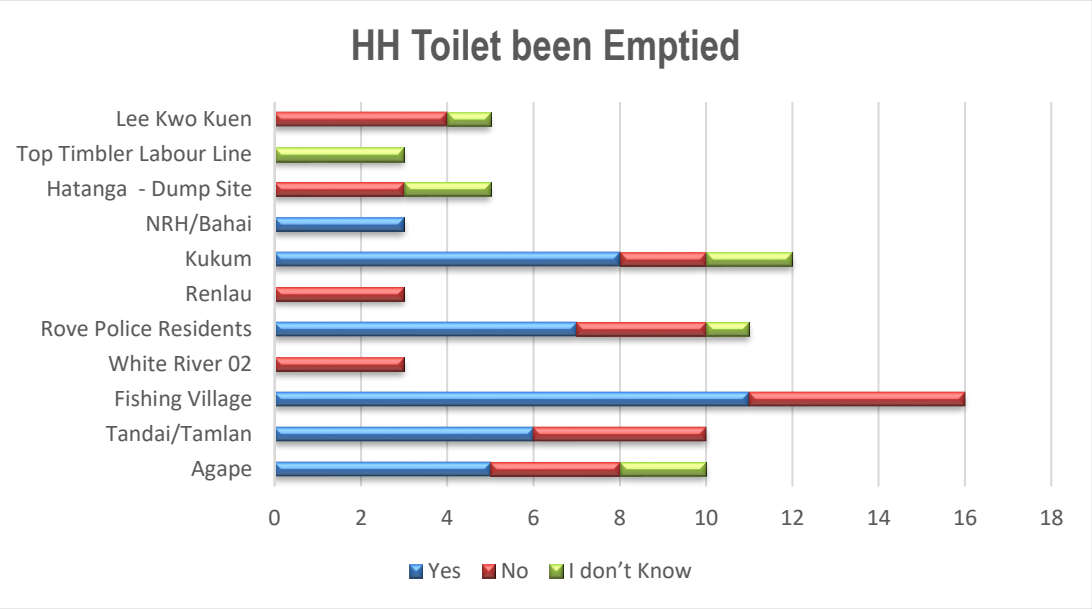
618. Whether the household is connected to the SW sewer system or open defecation, it can be classed as one system when it comes to disposal. There is no wastewater treatment plant or environmentally sustainable outfalls to manage the raw sewage entering the ocean. When a septic tank is filled, it is pumped and emptied at Ranadi Landfill. This service is provided by HCC and other private companies, and it comes with a cost.

619. Households which are connected to septic tanks were asked if the tanks have been emptied and when was the last time their tanks were emptied. The Renlau and White River 02 response was 'NO'. And the responses from the households at the Hatanga and Lee Kwo Kuen are 'NO and I DON'T KNOW'. Possibilities for such responses follow:

- The septic tanks were recently built and have not reached the operating time to be emptied;
- The septic tanks were poorly constructed, thus, causing wastewater to seep into the ground;
- The septic tank might be broken, and wastewater seeps out to the ground; and
- There was no septic tank, but wastewater flushes directly into the ocean.

620. However, overall such precincts are without adequate on-site wastewater treatment even though septic tanks are the most common means of on-site management of sanitation waste.

Figure 4-43: Septic Tanks Being Emptied



621. **Solid Waste Management**: Based on the 2009 census, around 36% of the total households of Honiara have access to formal solid waste collection services. The majority of residents not being served are from the informal settlement area.

622. The Ranadi dumpsite, located 6 km from the city, is presently the only dumpsite to serve Honiara and until 2013, it was largely uncontrolled and not constructed to modern standards. Largely as a result of work (Japan International Cooperation Agency supported), the Ranadi site is better managed, and the life of the landfill has been extended. The government of Solomon Islands plans to eventually close this dumpsite and a tentative site for a landfill has already been identified in the Henderson Area.

623. In 2022, the ADB commissioned a consulting company to undertake a solid waste management study[42] for Honiara. This is because the previous improvements in operation and management of the Ranadi landfill had faded and the site had reverted to uncontrolled dumping together with extensive areas of burning. Also, there is a significant problem with plastics waste management and as such a more sustainable holistic approach to solid waste management is being actively sought. See **Plate 4-26: Plastic Waste**

[42] ADB 2022Preparing the Honiara Sustainable Solid Waste Management Project

Plate 4-26: Plastic Waste along the Honiara Coastline

624. **Oil Spillage:** This occurs especially along the industrial site at Ranadi. Oil spillage in the natural environment presents a high risk to the marine biota. The occurrence has caused bad odor in the environment and will have direct effect on human health especially increased chronic diseases and respiratory diseases. Oil leaks from these abandoned vessels as per **Plate 4-27**.

Plate 4-27: Shipwreck Leaking Oil at Ranadi

625. **Energy / Power**: Honiara's electricity is supplied by Solomon Islands Electricity Authority (SIEA) also known as Solomon Power using several energy sources. The main power stations are in Lungga and Honiara. The two main power stations are heavily dependent on imported diesel, which, combined with transport fuel, accounts for roughly 30% of the country's goods imports by cost, and 80% of Solomon Power's expenditure (MMERE, 2014). Honiara's power supply consumes an estimated 16.2 megaliters of diesel annually. Port access and diesel storage in Point Cruz, as well as the continuing operation of the city's two power stations, is therefore critical following an extreme weather event.

626. Based on the 2009 census, 64% of the population of Honiara has access to electricity. It was estimated that the power demand is growing by 6% per annum.

627. Vuhokesa recorded the lowest rate of Solomon Power connections per household (48.0%), while Kola'a, Panatina and Vavaea all fell within the 55-65% electricity access range. It was noted during site analysis that housing constructed with traditional materials was not permitted to connect to the grid, limiting access to some customary sites along the Mataniko River, as well as a number of

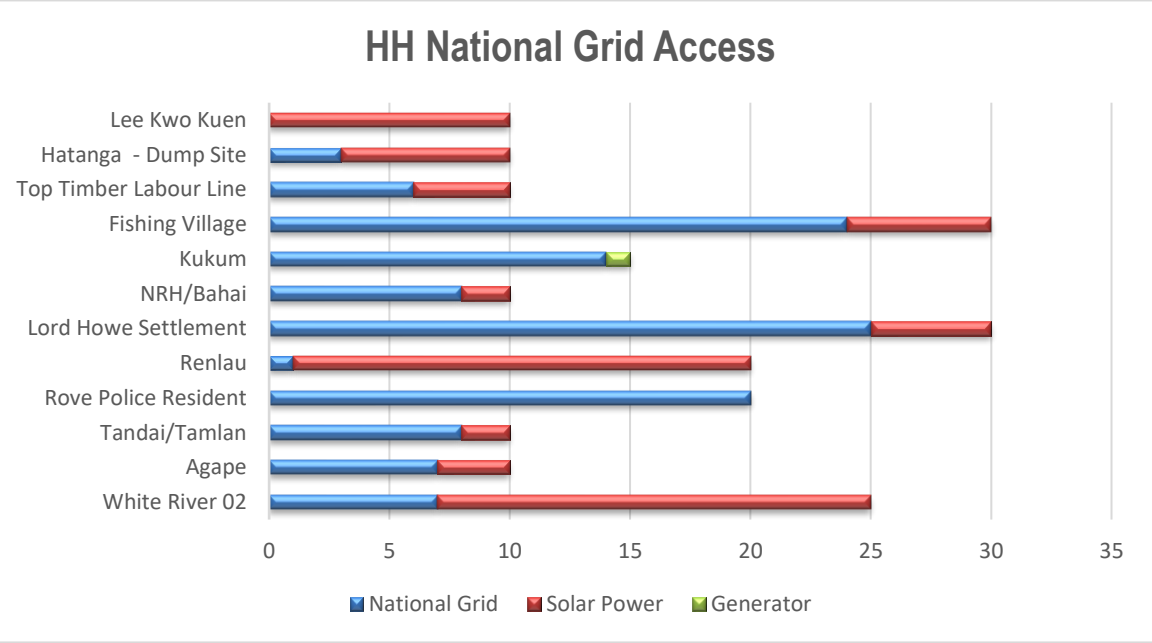
informal settlements. It was recorded that only 18% of the informal settler households are connected to SIEA.

628. Overall roughly two thirds of households in Honiara have electricity access, although a number of off-grid houses were observed to be using small solar panels to generate power for devices such as mobile phones.

629. Electricity in Solomon Islands is characterized by high cost. This is due to its geography making transmission installation expensive and high dependency on imported fossil fuels.

630. **Power in the surveyed areas**: Solomon Power has recently undertaken some upgrading and expansion work around the country mainly in the provincial headquarters and as well in Honiara. Thus, the number of metered houses accessing the national grid has increased. For the surveyed areas, all the households have access to the national grid except for Lee Kwo Kuen which has only solar power.

Figure 4-44: Households Accessing Power



631. Note that the X Axis represents the number of households interviewed in each location.

632. **Information and Communication Technology**: Cellular phone services are available in Honiara and the government reported that the majority of the population has access to the mobile services networks of either Our Telekom or Bmobile Vodafone.

633. Access to affordable, good-quality broadband internet-based services, has so far remained out of the reach of a significant proportion of the general public. The limited local infrastructure capacity is the key restriction. Significant upgrading of the local networks is required to be able to make full use of the extensive bandwidth available through the submarine fiber optical cable. Even though the local bandwidth remains very low, and regularly drops out completely, the costs remain very high providing another disincentive to wide usage.

634. **Health Services**: Tertiary health care needs are provided by the Honiara National Referral Hospital (NRH), while most primary healthcare services are provided through health facilities such as health centers, dispensaries, and aid posts. In general, malaria and tuberculosis are the major public health concerns in Solomon Islands, along with sexually transmitted infections, acute respiratory tract infections, diarrhea, viral hepatitis, dengue fever, and measles (SINSO and MOHMS. 2017).

635. In terms of coronavirus disease (COVID-19), the first case in Solomon Islands was recorded on October 3, 2020, and by October, 2021, there were 20 confirmed cases with zero deaths in Solomon Islands[43]. Solomon Islands was then in a declared state of public emergency due to the pandemic, but restrictions have now been essentially lifted and international travel recommenced. Social distancing and other methods to limit the possibility of transmission are encouraged but not enforced.

636. Solomon Islands has a high incidence of water-borne diseases. Diarrheal diseases are the sixth most common cause of death, accounting for 4% of deaths or 28 deaths per 100,000 people. The high incidence of water-borne diseases can be primarily attributed to limited access to safe water and improved sanitation and poor hygiene awareness and behaviors.[44]

637. There is an increasing demand for health services at all levels. The decision to relocate the NRH in the future is an opportunity to address a number of national health service problems, such as the limited level of provincial services resulting in many patients travelling to Honiara to seek primary and/or secondary care that ideally should be managed in their home province. Services for low-risk birthing, care for non-communicable diseases, simple surgical procedures, and other primary and secondary diagnostic and case management need to be further developed.

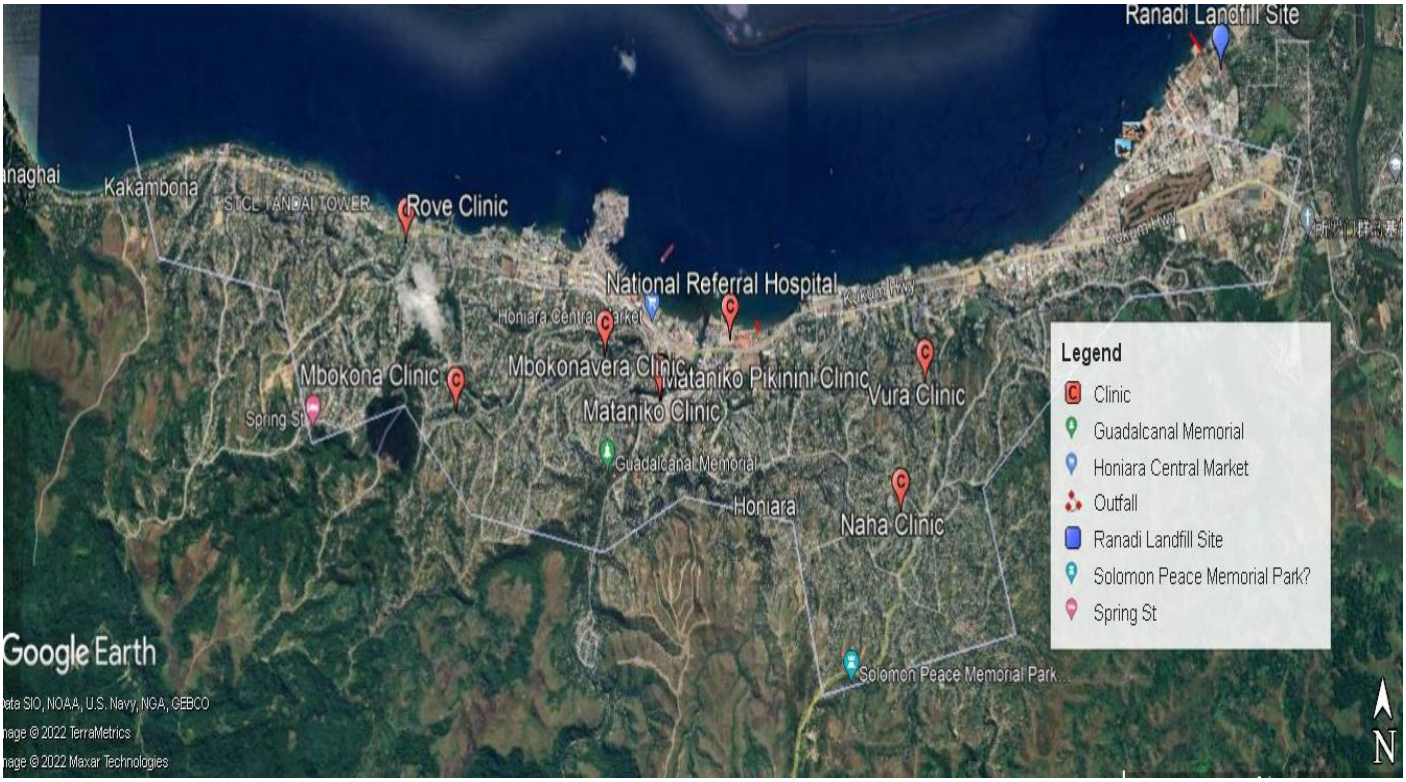
638. The suburbs' health centers provide treatment services, immunization, outpatients, prenatal and postnatal care for mothers and babies including family planning and health awareness. Major health problems are malaria, pneumonia, diarrhea, respiratory infection and various skin diseases.

639. Residents living within the proposed development site can access the National Referral Hospital, Rove, Mbokona, Mbokonavera, Mataniko Clinic, Vura Clinic and Kukum Clinic including private medical clinics.

[43] The Weather Channel

[44] Sector Assessment (Summary): Water and Other Urban Infrastructure and Services, UWSSSP

Figure 4-45: Hospital and Clinics within the Subproject Area



Source: Google Earth

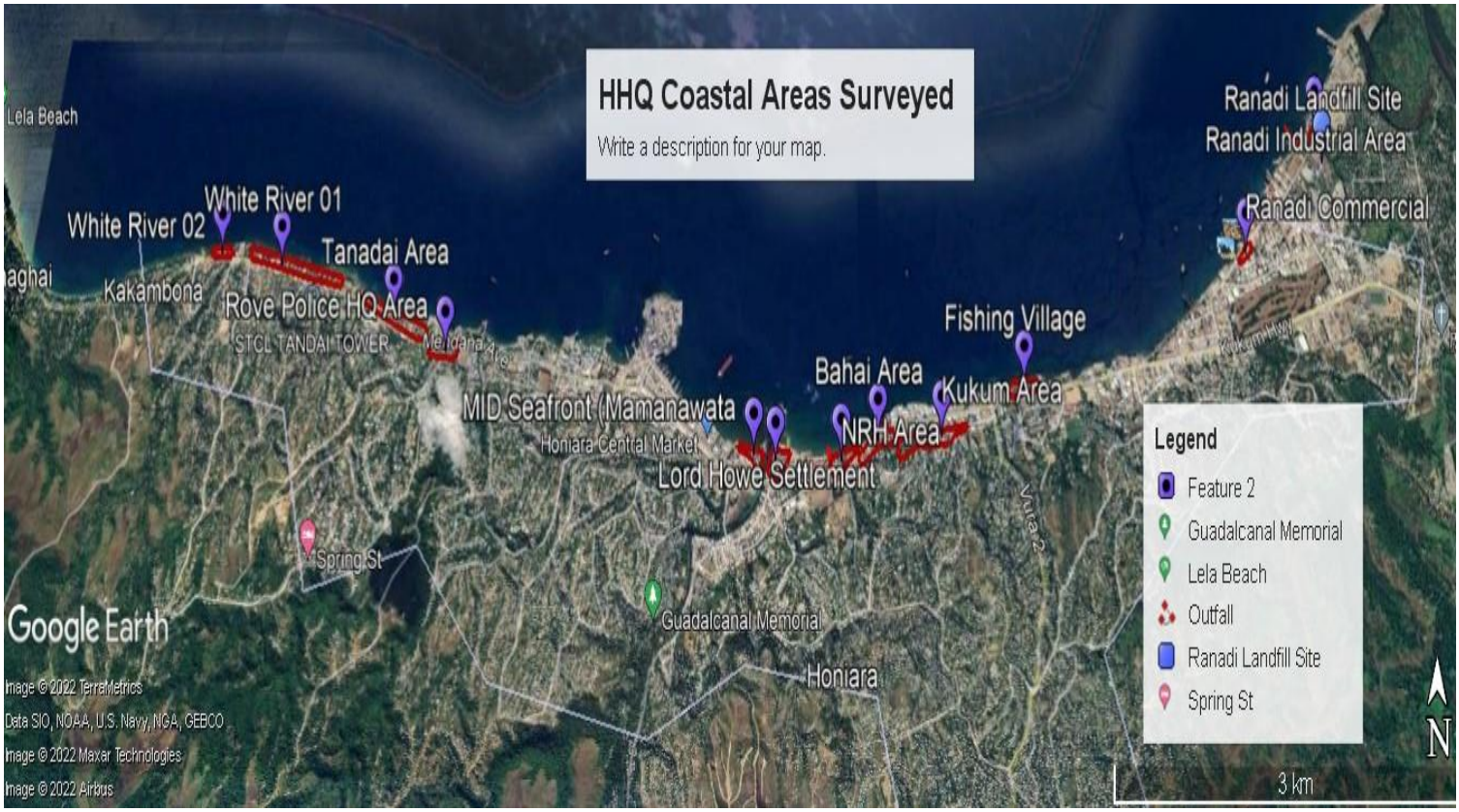
640. **Residential and Commercial Building Infrastructure**: In Honiara and other urban/rural centers, the most common form of housing is single-story timber frame construction (around 46%). Around 7% of surveyed houses are of traditional construction, and 6% are of poor construction.

641. Most government facilities and commercial and industrial developments are located in Honiara's coastal plain, as well as a few small but densely populated villages. Development on the foreshore seems to be largely unregulated as many buildings and structures encroach on it. Residential developments of single detached houses are mostly found in grassy foothills. A number of informal settlements have sprung up in the past few decades, some of which have already encroached on customary land beyond the town boundaries.

4.4 Socio-Economic Baseline of Subproject Areas

642. A number of socio-economic surveys were already conducted around the subproject sites; these consisted of the household surveys during the development of feasibility study report (FSR) and additional surveys undertaken during the detailed design phase. A study was done by EGIS EAU during the feasibility study. A total of 393 households were surveyed from 6 settlements in Honiara in July 2018 (about 10% of the total households in Honiara). The most recent household survey was undertaken during the preparation of this EIS. The communities currently residing along the coast of Honiara from Ranadi (eastern end) to White River (western end) as given in **Figure 4-46** below participated in the survey. It was conducted from 2nd to 16th August 2022. A total of 200 households were surveyed. The total population of the ward was taken and using the 30% of the population was used to get the sample population for the ward. Additional descriptions and details are in **Appendix 15: Household Survey Report. Table4-21** below shows the sample population used for the survey.

Figure 4-46: Socio-economic Survey Communities along the Honiara Coastal Strip.



Source: Google Earth

Table 4-21: Area and Sample Population for the Survey

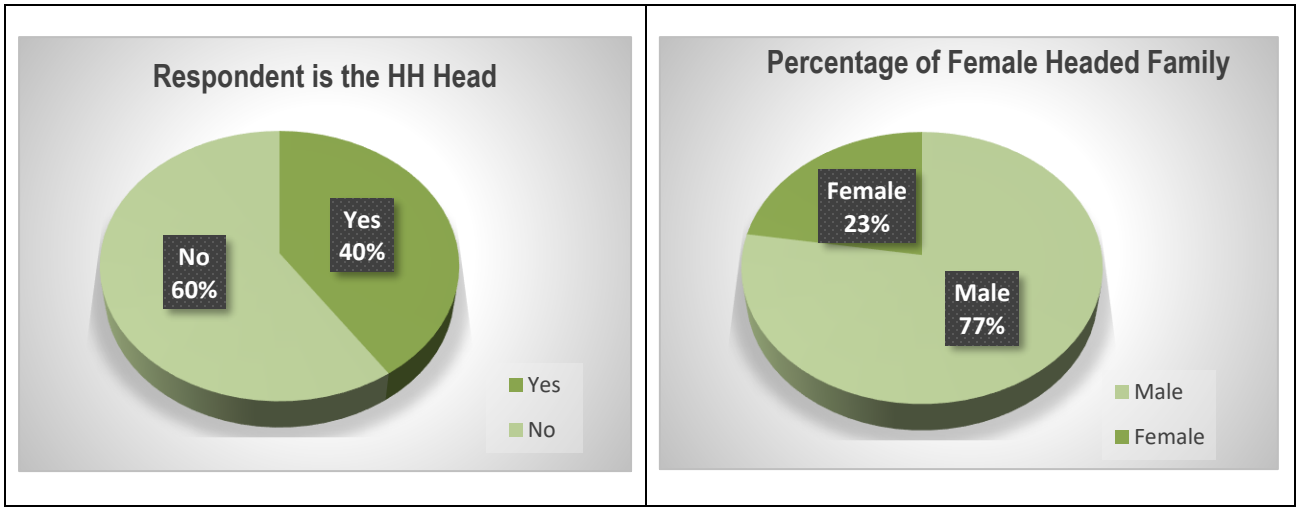
No	Area (Ward)	Sample Population
1	01 – NGOSSI – White River 02	25
2	01 – NGOSSI – Agape Area	10
3	01 – NGOSSI – Tandai/Tamlan	10
4	03 -ROVE/LENGAKIKI – Rove Police Residents	20
5	06 – VUHOKESA – Renlau	20
6	07 – MATANIKO – Lord Howe Settlement	30
7	09 – KUKUM – Kukum- Honiara 9	15
8	09 – KUKUM – NRH/Bahai	10
9	11- VURA – Fishing Village – Honiara 11	30
10	12- PANATINA – Ranadi Industrial Area	10
11	12 – PANATINA – Ranadi Commercial Area	10
12	12- PANATINA – Ranadi Dumpsite	10
	TOTAL	**200**

643. For this assessment, it has been assumed that all the communities are homogenous. The detail of the survey is attached as an appendix to this document.

4.4.1 Household Information

644. **Household head and respondents:** From the total sample population been surveyed, 40% that participated in the survey was household head. The rest of the participants were other members of the household. From the survey it recorded a total of 23% are female headed households. (See **Figure 4-47**).

Figure 4-47: Household Head is the Respondent



645. The 200 households have a total population of 1198, which a total population of 396 was between the age **of** 0 to 15years old. A total of 758 were between the age of 16 to 60 years old. And 38 people were from 60+ years. Out of the total population, a total of 7 people living with disability whereby 5 are males and 2 females. Four (4) of them have vision impairment, 1 physical disability, 1 mental health and 1 autism spectrum impairment. **Table 4-22** presents the population data.

Table 4-22: Summary of the Total Population

Age Groups	Male	Female	Total Population
0 - 15 years	273	123	396
16 - 60 years	359	399	758
60+ Years	23	15	38
I don't Know	4	2	6
Total	640	558	1198

646. **Habitat:** As shown in **Figure 4-48**, 55% of respondents described their housing as permanent and 45% as semi-permanent. This has reflected that people are trying to improve their accommodation standard. A high percentage of the semi-permanent are in the informal settlement areas. The dwellings are further categorized (owned by household head, Government Owned, Company Owned, Rented, Others). A high percentage of dwellings are owned by the household head for the surveyed areas, and lowest for rented homes. **Figure 4-49** shows the various dwelling owners for the surveyed areas.

Figure 4-48: Type of Dwelling Structure for the Surveyed Area

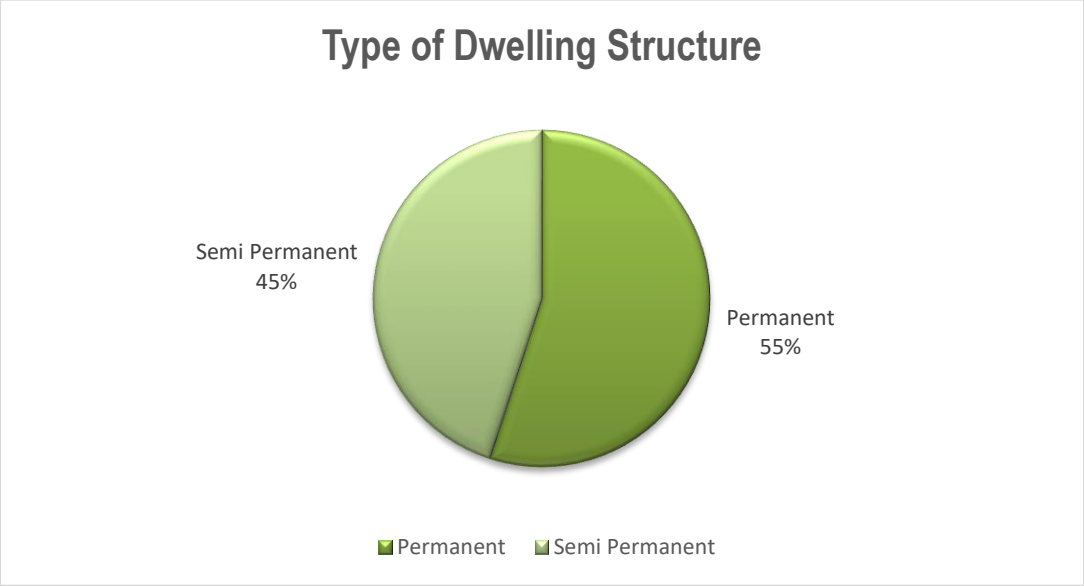
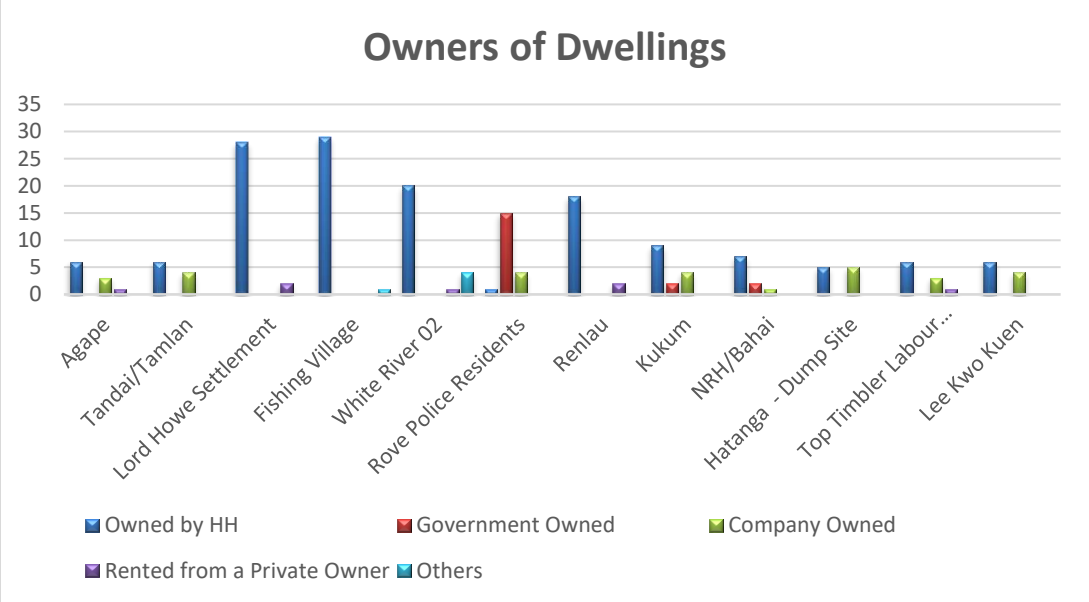


Figure 4-49: Dwelling Owners



4.4.2 Livelihood, Income and Expenditure

647. From a population of less than 20,000 at the country's Independence in 1978 it has grown rapidly to an estimated 87,000 residents in 2015, despite civil unrest disrupting rural-urban migration in the early 2000s (SINSO, 2011)[45]. Although there are a number of urban-classified townships and

1. [45] SINSO (2011) http://www.statistics.gov.sb/component/advlisting/?view=download&format=raw&fileId=413

settlements on other islands across the archipelago (such as Gizo, Noro, Munda and Auki), as well as peri-urban wards on the city fringe with Guadalcanal Province (Tandai and Malango).

648. The Household Income and Expenditure Survey 2012/13 (HIES) noted that Solomon Islands' per-capita GDP of USD$600 ranks it as a lesser developed nation, and more than 75% of its labor force is engaged in agriculture and fisheries related activities, which support around three-quarters of the total population, including almost the entire rural population. The Guadalcanal 2009 census documented that over 90% of all households grow crops, 54% raised livestock and 58% were involved in fishing for both subsistence and small-scale commercial activities.

649. Timber was Solomon Islands' main export product for decades, but the forests were dangerously overexploited. Other important cash crops and exports include copra and palm oil.

650. Honiara is the primary city, as no other cities in SI have a population of more than 10,000 persons. Honiara is the only major centre of economic activity and as such attracted increasing numbers of youth and adults from other islands seeking employment and income. Urban migration was estimated at 4%, however, the growth rate doubled by 2020.

651. The labor force in Honiara includes all persons employed and unemployed and consists of 22,962 people (13,318 males and 9,644 females). The employment population ratio for males is 44.7% and for females is 27.5% and it was very low for the population 12-19 years. The employment population ratio was the highest for people aged 30-54 and gradually decreases from then onwards. By occupation, the labor force is employed in government (33%) and private enterprises (67%).

652. Urban-Rural Economy: Honiara's economic base is dominated by the service sector, highlighting its role as the main commercial and administrative center for Solomon Islands. An increasing share of national wealth has been produced in Honiara, with a range of urban economic activities (wholesaling, retailing, banking, and restaurant and hotel related businesses). These are the main formal economic activities strengthening the viability of urban economic development and trans-shipping points for rural produce.

653. The formal sector employs just over 27 percent of city residents or 17,425 out of 64,609 people (Solomon Islands Government, 2011). Honiara City Council's internal revenue collection from all the economic activities recorded in Honiara City Council Budget 2010 was SBD $11Million.

654. The city has benefited from major infrastructure investments in recent years, making it the most attractive destination for rural-urban migration in the country. Honiara hosts many international development agencies, companies, NGOs, and government agencies and institutions that enhance service delivery to both the urban and rural populations.

655. **Informal Sector Economy**: The unorganized and unregulated informal economic activities in Honiara provide job opportunities for many without formal education. This is a vital link between the rural and urban economies with the marketing includes the selling of betel nuts, cigarettes, stationary, handicrafts and food selling along the streets in Honiara (Union Aid Abroad-APHEDA, 2009:32). The Kukum Market was the single designated area for selling betel nuts and cigarettes but was closed in 2009 due to its unhygienic state. Honiara City Council lacks the funds to upgrade the market, and this has led to an influx of street vendors in the city and the creation of a temporary market near Kukum Market site on private premises. Such activities are prohibited under the city council's by-laws, but the city council lacks the capacity and resources to effectively address this issue.

656. Honiara's main market lacks space for the numerous vendors who arrive daily from the rural areas. Thus, they display their products unhygienically on the ground, and small markets have emerged along the roadside in White River, Kola Ridge, Fishing Village and Borderline. These markets lack proper sanitation and parking areas, posing risks to people and vehicles. Both women and men are engaged in informal economic activities, but women tend to outnumber men in market sales. They work for longer hours, often in unhygienic and unsafe environments. Given the importance of the informal sector for unskilled and unemployed rural and urban dwellers, it is vital that Honiara City Council provide appropriate venues that are not congested and have the requisite sanitary facilities.

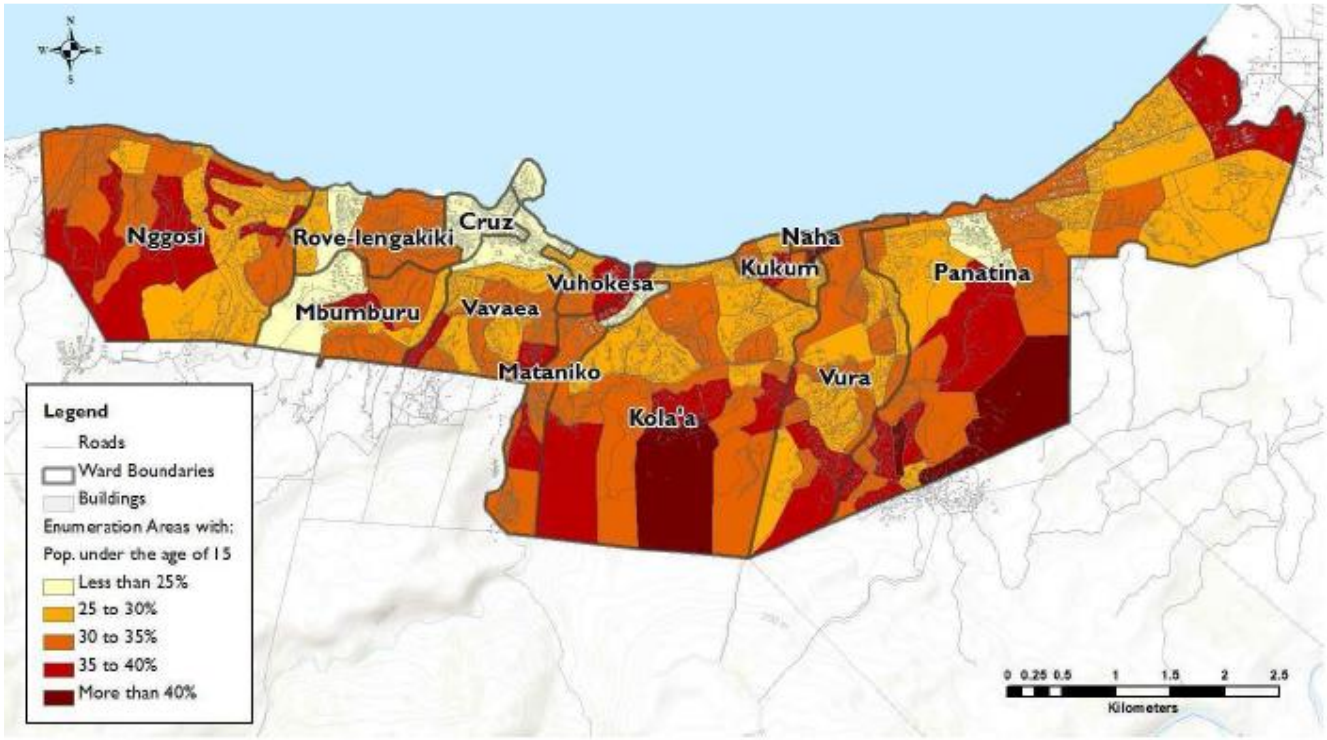
657. The economic base of the city is small and needs to be diversified for greater resilience. The challenge for the city council and the central government is to create a friendly socio-economic and political environment that will allow the formal and informal sectors to flourish.

658. **Employment:** Given the lack of formal sector jobs, the informal economy is critically important in Honiara. Research by Union Aid Abroad has revealed a hugely diverse range of informal livelihood activities undertaken by individuals and households across the city. Overall research showed almost all informal sector livelihood activities had a higher return than casual or low paid employment. The most recent poverty profiles were developed from the 2012/13 Household Income and Expenditure Survey (HIES). This work calculated Solomon Islands specific poverty lines (determining the minimum expenditure required to obtain basic food and nonfood goods) that varied across the basic needs in Honiara costs around twice as much as in the provinces, particularly due to the high cost of housing in the city. The report also noted that this effect appeared to spill over into Guadalcanal Province, which had the second highest poverty line in the country (UN-Habitat 2016, Informal Settlements Analysis – draft).

659. From the UN-Habitat 2014 study including the Informal Settlement Analysis, the pull factors of jobs, education and access to the global economy have attracted a large number of young people from the provinces to Honiara; in all, 58% of the city's population is less than 25 years old, while a third are less than 15 years of age - see **Figure 4-50.** Although the limited number of jobs available has led to high levels of youth unemployment (with associated issues such as heightened occurrences of anti-social behaviour), the concentration of educational institutions, youth groups and strong social networks provides strong capacity for engagement with an active and creative section of the community. A pilot example is the Rapid Employment Project (REP). It provides training programs and job opportunities to sectors of the community and involved productively in the development of Honiara's urban infrastructure (World Bank, 2015)[46].

[46] World Bank (2015) Solomon Islands Rapid Employment Project Implementation Status and Results Report: Sequence 7

Figure 4-50: Percentage of Enumeration Area Population less than 15 Years Old

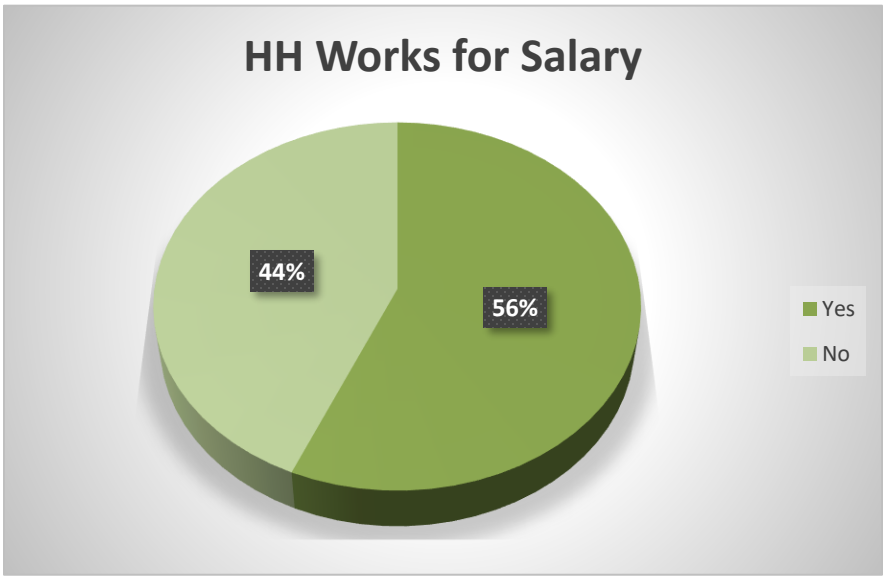


Source: Source: UN-Habitat (2016a)

660. The main economic activities in Honiara are in the services sector. Rising unemployment, poverty and high costs of living are common features in Honiara. Some residents, particularly those of informal settlements, are engaged in a range of informal economic activities (Union Aid Abroad-APHEDA, 2009).

661. From the survey, employment status of the household heads is shown in **Figure 4-51** with formal employment at 56% and the other 44% are engaged in other income activities. There is high percentage of household head working for salary for this survey. It has a high percentage because the survey was out within the Honiara Town boundary. This is supported by four (4) areas where accommodation is provided. The Rove Police Residential is government-owned, and Hatanga, Top Timber Labour Line and Lee Kwo Kuen are company-owned residential precincts. Thus, it is expected that the fraction of working-class people will be significant in this survey. Even in the informal settlements, there are working-class residents. It was unusual that unemployment is relatively low, but it can be assumed that most households within the categories of 'self-employed' and 'other' are engaged in low-income livelihoods.

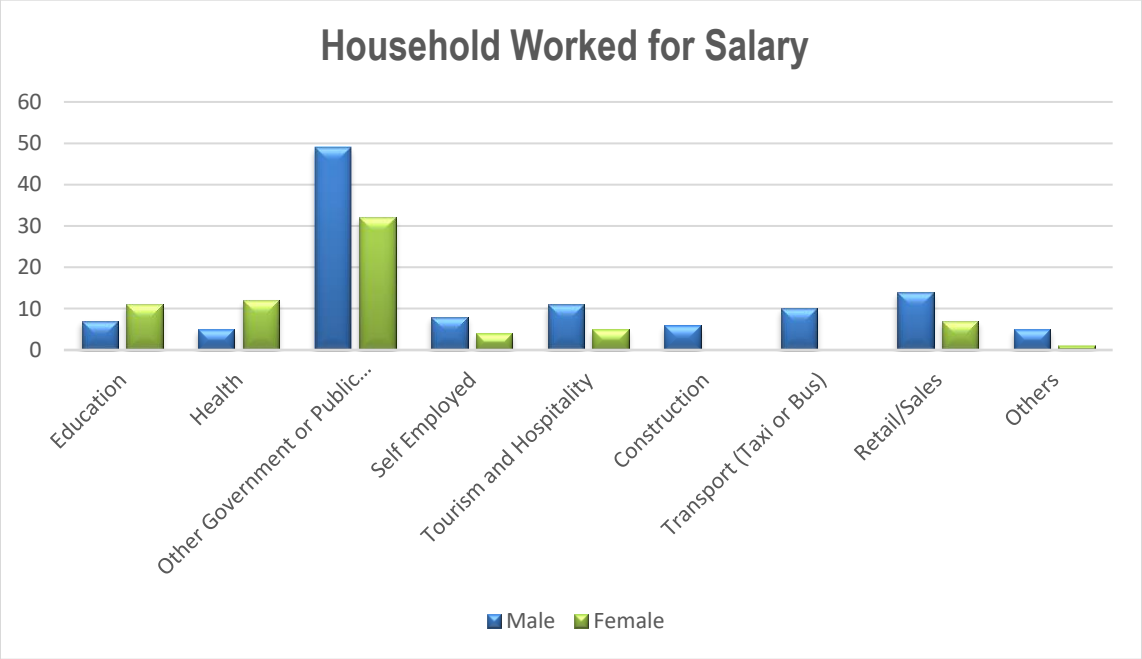
Figure 4-51: HH Works for Salary



662. The salary-based works are from various sectors (Education, health, other government offices) is shown in **Figure 4-52.** The salary-based income is paid on fortnightly or monthly basis. According to the salary-based workers, 49% are government workers, and their fortnight salary ranged from $1,500 to $5500 SBD. Apart from the household head working for a salary, there are other members in the household that also work for a salary. A total of 66 people worked for salary, 23 females and 43 males. **See Figure 4-53**

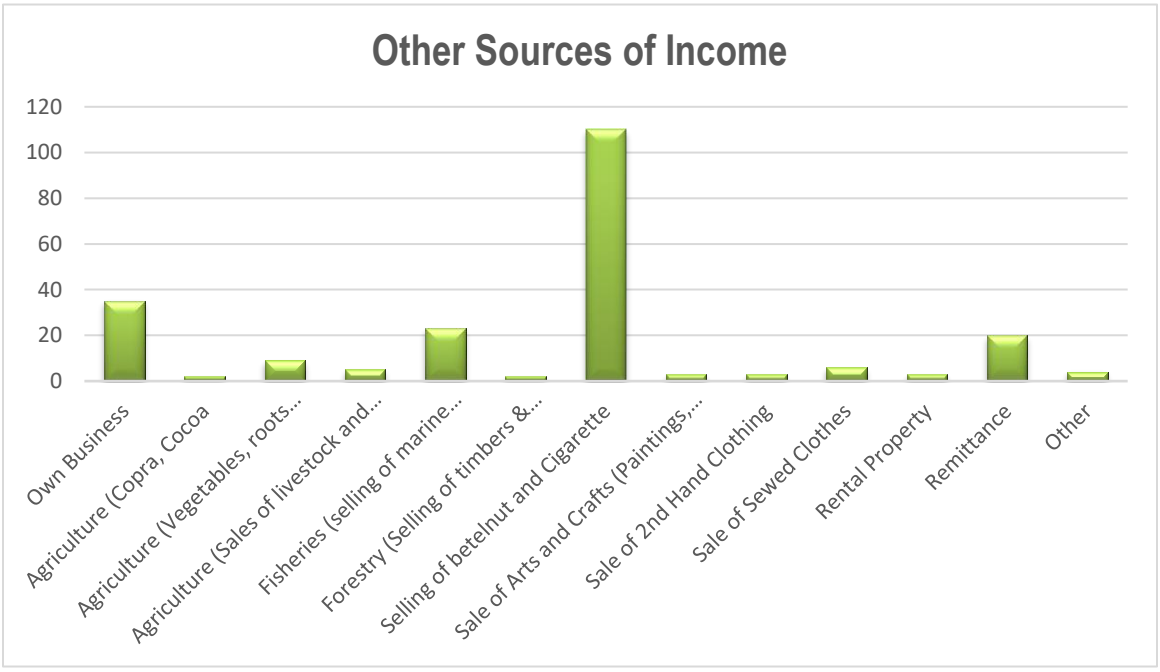
Figure 4-52: Household Head working for Salary

Figure 4-53: Total Household Members Working for Salary



663. Apart from the salary-based income, as shown in **Figures 4-52 & Figure 4-53** above, . the remaining (44%) of household heads and members also engaged in other forms of income activities. These other income source activities are given in **Figure 4-54.**

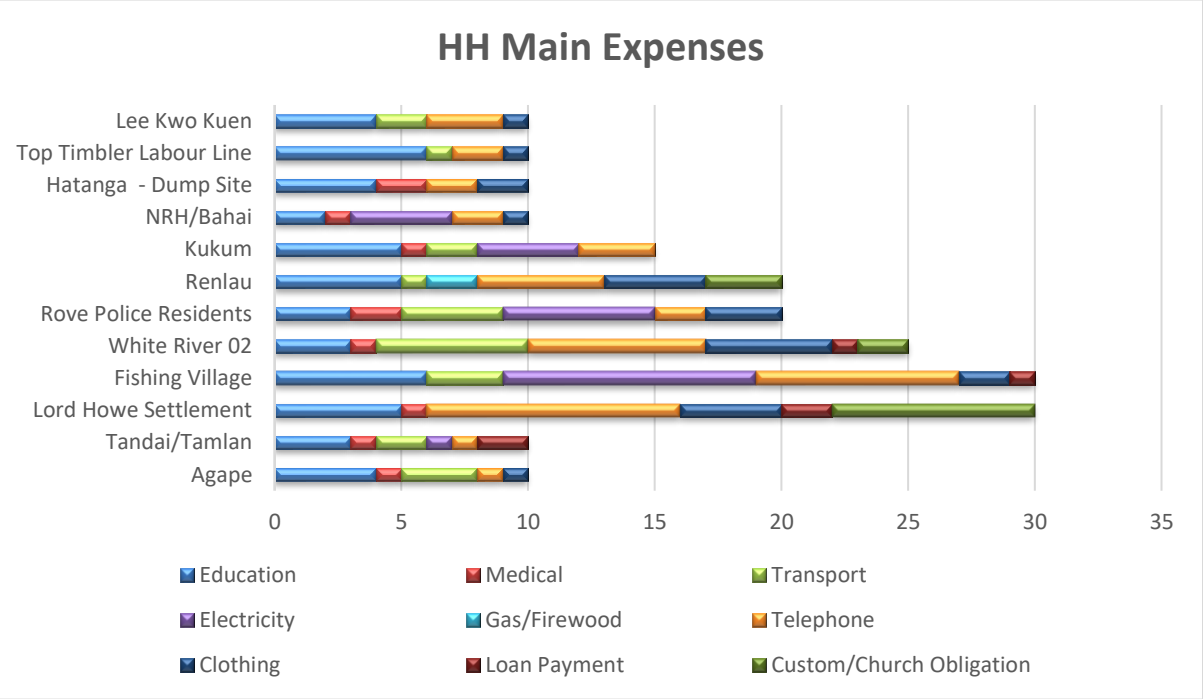
Figure 4-54: Income Source Activities



664. The living costs in Honiara are very high compared to other provincial headquarters. The main expenditures apart from food and water are categorized as education (school fees, fundraisings and

contributions), medical (medicine, to see a doctor), electricity, transportation (fuel, taxi fares/ bus fares), telephone (including internet data and phone credit), loan payment, clothing, gas/firewood, and custom and church obligations. The expenses are given in **Figure 4-55.** Note that the X Axis represents the number of households interviewed in each location

Figure 4-55: Main Expenses



665. In Solomon Islands, Poverty is measured following a Food Poverty Line (FPL), which includes a daily intake of 2,200 calories per adult per day and a Basic Needs Poverty Line (BNPL). The BNPL is the estimate of the cost of a minimum nutritional dietary intake plus the costs for non-food essential basic needs to achieve acceptable standard of living and this includes education, health, travel, transport, clothing, shelter, communication, water, sanitation and health services.

666. Honiara has a higher cost of living than the rest of the country. Using the poverty line measure, specified as the minimum expenditures needed to obtain basic food and non-food goods**, a government survey in 2012-2013 reported that Honiara's poverty line per adult equivalent per year was SDB$10,300 or $28/day** was almost three times that of the cheapest area in the country. Allowing for inflation between 2012 and 2022 of 22.5% (Statista, 2023), **the 2022 Honiara's poverty line per adult equivalent per year is SDB$12,600, or $1,050 a month or $34/day** This was attributed to poor infrastructures, markets not integrated, costly transport, expensive services, and very high urban housing prices (National Statistics Office and The World Bank. 2015).

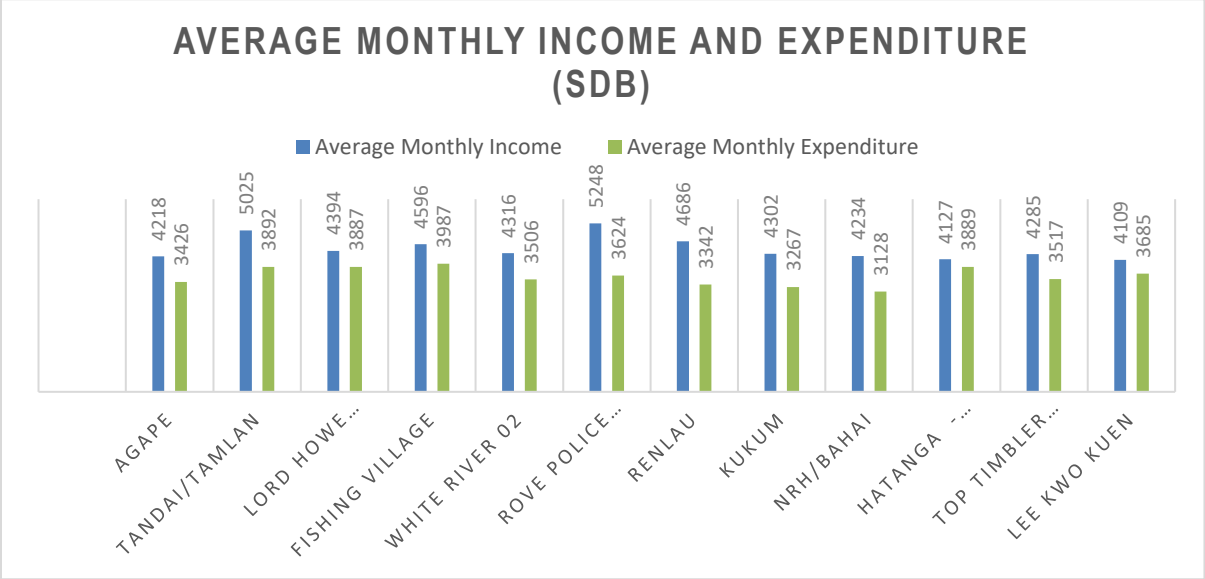
667. **Socio-economic conditions of survey households**: The average monthly income recorded per household is SBD$4461.67 and the average monthly expenditure household is SBD$3595.83. **Figure 4-56** outlines the average monthly income and expenses for each of the twelve (12) surveyed areas.

668. On an annualized basis the average expenditure for a household is $3595 x 12 months or SDB$43,140. Per adult/household would be SDB$21,570 based upon a 2-adult household or $14,380 for a three-adult household.

669. However, an annualized basis of the average income for a household is SDB$4461 x 12 months or SDB$53,532. Income per adult/household would be SDB$27,666 based upon a 2-adult household or SDB$17,777 for a three-adult household.

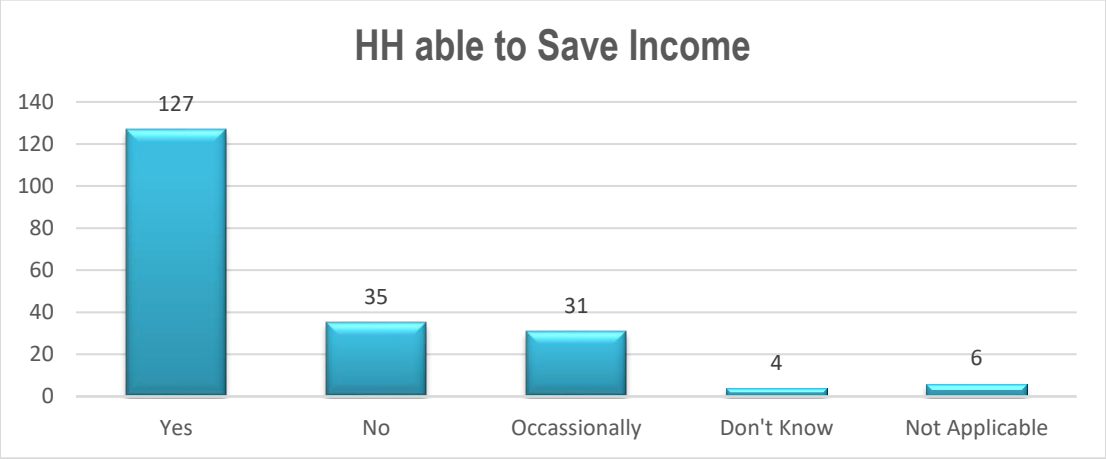
670. These values indicate that for most households, income over expenditure is just above the income over expenditure for Honiara as recorded in the national statistics report. However, this cannot be said for the entire ward, as this is just for the surveyed areas. The surveyed income over expenditure is positive, and the poverty line is not triggered for those surveyed in these communities. However, care must be taken when comparing these values because there are significant differences in the data collection methods as well as in the method used in quantifying the poverty.

Figure 4-56: Average Monthly Income and Expenditure



671. It was also noticed that amongst all the expenses, individual household members are trying to save money. This is shown in **Figure 4-57** on a monthly basis. As stated by one of the interviewees *"hem no biki bata at least savem smol samting*' meaning, '*it's not that much but at least you save something'*. The National Provident Fund (NPF) has introduced a new product (Iu Save) that is free and easy to save money using mobile phones. People can save any amount (starting with $7.00 SBD) at any time and have only certain times to withdraw. This has encouraged people to save because it is easy to save the little spare amounts that they have.

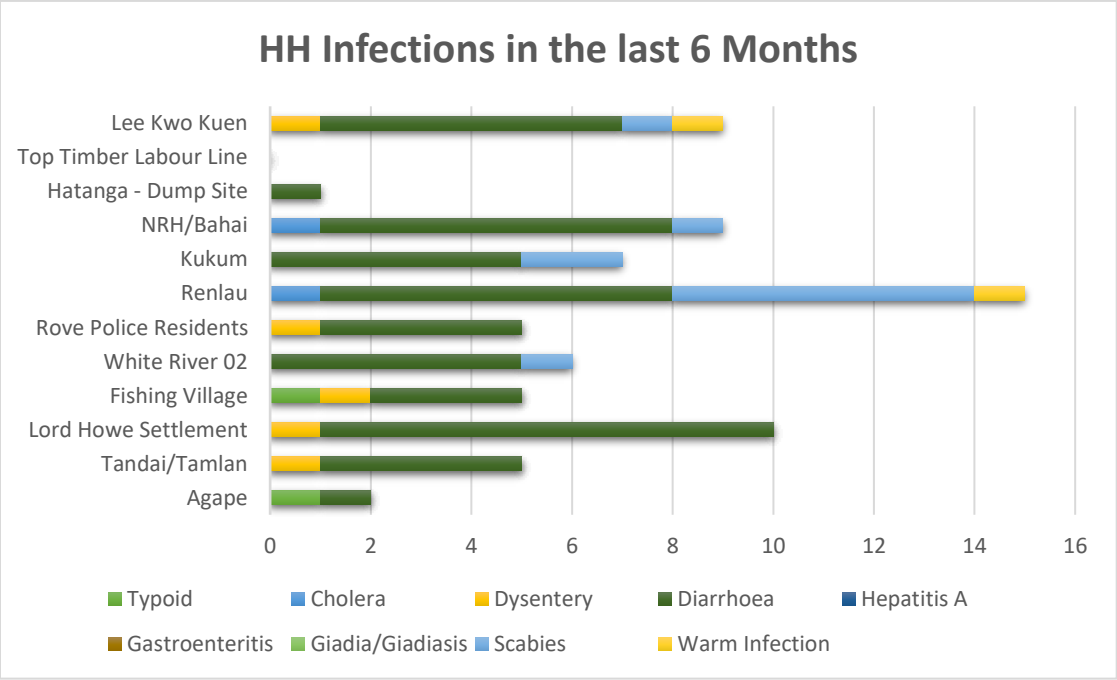
Figure 4-57: Households able to Save Income



4.4.3 Health

672. **Hygiene:** Poor hygiene is a causative factor in a number of preventable diseases such as diarrhea, typhoid, and skin diseases. Diarrhea is a common illness for more than a third of the people in Honiara, particularly in the informal settlements where poor sanitation and water supply are common. The risk of diarrheal disease increases in the annual wet season, from November to April, with risk escalating further during floods and natural disasters. From the survey, it recorded that Lord Howe Settlement has the highest record for diarrhea in the last 6 months. Renlau has the highest number of infections for the last 6 months. See **Figure 4-58** for details below. Note that the X Axis represents the number of households interviewed in each location

Figure 4-58: Incidence of Disease in Past 6 months by HHs



4.4.4 Marine

673. **Marine**: The coastline within Honiara is both natural and artificial. Within Central Honiara, the coastline is mostly artificial. For example, the whole of the Point Cruz area is reclaimed. Jetties, gabions and sea walls Have Been constructed as have ongoing reclamation works. On exception is the Mataniko River mouth, which is natural and populated with informal settlements. At the western end of Honiara beyond the subproject area of influence, the coastline is mostly natural and is backed by a narrow stretch of fringing reef covered with hard corals.

674. There are a number of activities that have also contributed to the current status of water quality. A number of these activities have been identified in the survey as an immediate significant threat/ risk for Honiara. Respondents were well aware of these activities and see them happening every day and reportedly are alarming to them. From conversations with some of the community members, they raised some related important issues, such as:

- In the past, their access to the coast and foreshore was not restricted. However, with extensive reclamation of the foreshores and the reclaimed land and new foreshore being claimed by the developer, access to the ocean is now very restricted.
- Due to the high reclamation going on along the Honiara coast, the amount of silt that floats in the sea for a long time reportedly makes the water look dirty. Respondents note that the water does not look good for swimming (unless one needs to enter in the sea to ablute).
- The amount of litter/rubbish washed onto the beach is “just unbelievable when one wakes up in the morning to see the huge piles of rubbish lying on the beachfront, which was washed ashore during the high tide and get trapped during the low tide”.

Figure 4-59: HH Responses to Coastal Activities

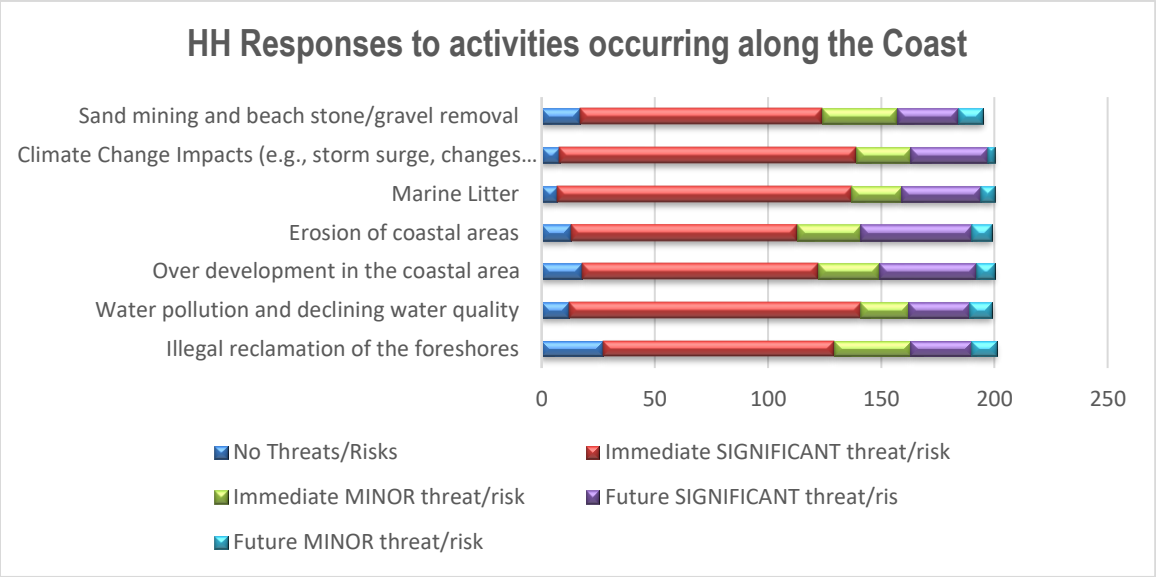
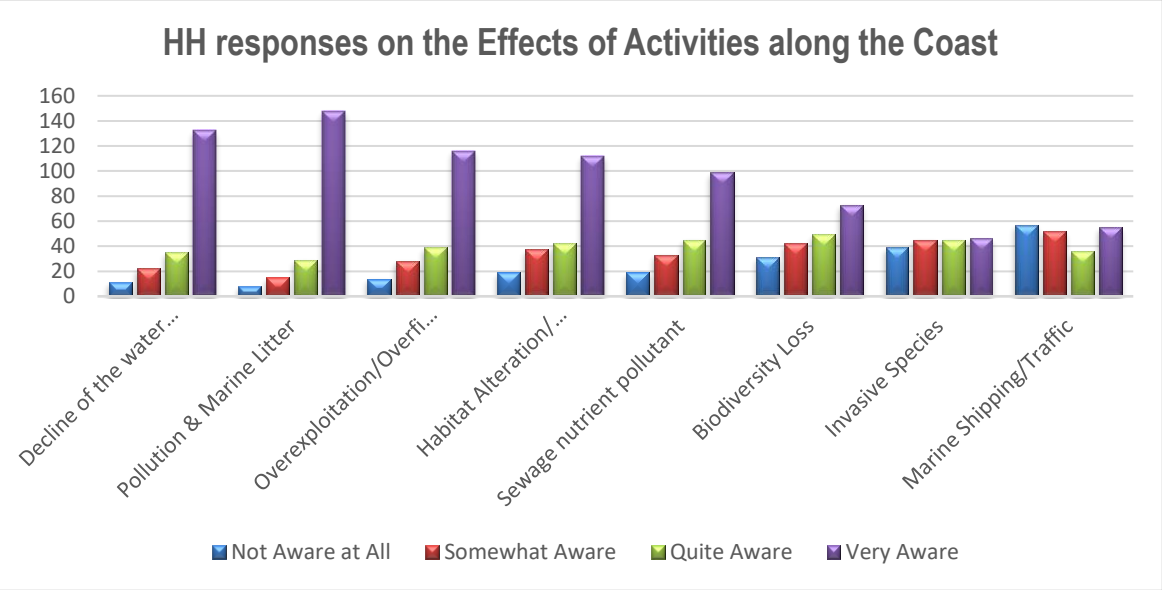


Figure 4-60: Effects of Activities along the Coast



675. This presents a clear picture showing that people are very aware of local impacts, but they feel they cannot do anything about what is happening around and in front of them. Awareness by the communities is very important, making them aware of the current status of the seafront, the water quality (if it is safe for the community to still swim in the sea), and what activities are permitted along the foreshore. For example, if they see someone doing the wrong thing, where they enquired to whom should they raise their concerns. Sometimes the community members raised their concerns when a ministry or NGOs undertake awareness education, however, they are not certain if these people really take note of their concerns. Such avenues are very vital and should be taken seriously. Such a platform can help everyone to look after our resources and use them responsibly and sustainably.

4.5 Land Use, Ownership and Settlement Pattern

676. **Land Ownership**: Most land (86%) in Solomon Islands is still held under customary tenure, where every member of the landholding entity, such as tribal, clan or family is vested with the rights to use and access it. Non-owners usually have limited rights such as right of use, easement or right of way. There is no system which allows for customary land to be surveyed and registered, it is often very difficult for outsiders to identify land boundaries and to identify who 'owns' the customary land.

677. The Commissioner of Lands has the power to administer public lands and allocate interests to others. Once land is registered, the estate title owner has indefeasibility, except for overriding public interests or when the High Court issues an order to set aside the registration because of fraud or mistake. Under the Land and Titles Act 2014, the Commissioner of Lands discretionary power can only be exercised subject to directions of the Land Board.

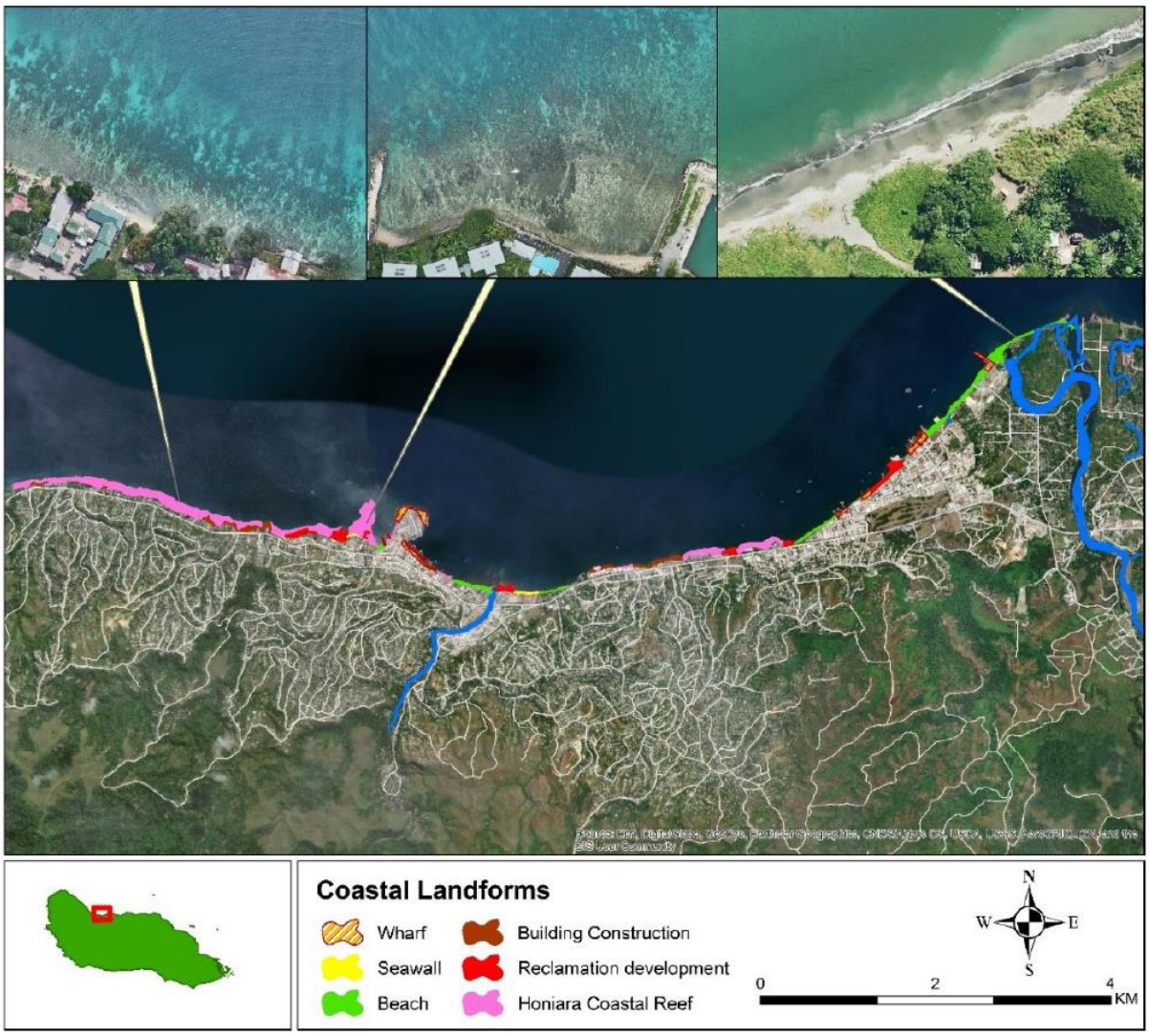
678. Guadalcanal Province unlike other provinces in Solomon Islands has no specific Provincial Capital as most of the administrative issues are administered from Honiara by the Provincial Government from the Provincial Head Office at the Kukum Highway in Honiara. This is also a contributing factor justifying why Honiara had received an influx of people from the rural areas in Guadalcanal daily for purposes of accessing banks, hospitals and clinics, shops, schools and markets to sell their produce. As found during the 2009 Census Survey, Guadalcanal has an average urban growth rate of 16.2%.

679. The main central business district of Honiara is located on the flat land of the coast. Within the greater Honiara boundary, the land is used for government facilities, education facilities and central hospital, Solomon Islands National University, commercial and business building facilities, industrial area, and residential area. Most of the residential areas occupy the hills and some reside along the valley in the south and southwest of Honiara. The eastern region of Honiara (Lungga and Henderson areas) is used for residential and cultivated for farming purposes.

680. Over the past several decades increase numbers and population settlements are located along the northern coast because of its more favorable environmental conditions and include the major economic and residential areas of the island including the island and national capital of Honiara. The living conditions of Honiara are urbanized compared to other provinces in Solomon Islands and the remote communities in Guadalcanal Province.

681. **Land Use:** Honiara is a highly developed area and does not contain areas of high biodiversity values such as other parts of Solomon Islands. However, the current marine and coastal ecosystem of Honiara still plays an important, function to the people of Honiara. The map in the **Figure 4-61** below shows the coast landforms along the coast of Honiara that refers to the remarkable change in terms of shape from natural to manmade landscape. Most of the reef system of Honiara is located at the western end from the Ports area to White River. The coastal landforms of Central Honiara are modified seawall, building, wharf, and reclamation development with limited sand located in front of Mataniko River. The landforms from the east coast of Honiara along the Ranadi to Lungga river front is tied with sandy beach and gravel and is known as an industrial zone of Honiara. There are certain landforms and coastal features of Honiara that are more vulnerable to industrial development, climate change and sea level rise.

Figure 4-61: Honiara Coastal Landform



Source: SPC, Honiara Coastal Environmental Impact Assessment, 2021.

682. For the subproject sites where the sewer lines, pumping stations and outfall locations are within the over developed areas. Mainly it will be within the road corridors except for the section where it will run in the SSEC loan. But SW continue liaise with the church and others for permission to put the underground pipe through the land. The type of land ownership and land use is discussed in Section 4.3.8 of this report.

683. **Settlement Patterns:** The Honiara city land was acquired by the government. About 65% of the land is developable land. Around 20% in unsuitable for development due to poor topography and environmental constraints. In Solomon Island Urban Profiling Report, 2012, stated that there is a housing shortage, despite about 20percent of the city's land being underdeveloped. 65% of the city's developable land was developed, 1.5% was held by private developers, and 13.5% occupied by informal settlements (UN-Habitat. 2012). Today, commercial developments have continued along the narrow coastal strip of land with more industrial developments towards the east. More commercial building constructions are ongoing in the Chinatown area and further to the Panatina area.

684. The city has 30 informal settlements located within the town boundary, and 6 have encroached on customary land. While population growth and increasing rural-urban migration are considered key to the prolific growth of informal settlement in Honiara, the lack of affordable housing and developable land for low- and middle-income earners also drives the trend. Informal settlement residents have continued to improve their homes over the years, resulting in a mix of housing quality. As a result of the housing shortage and high rental cost[47], increasing numbers of middle- and high-income earners are moving to informal settlements.

685. Approximately 35 percent of Honiara residents (22,600 persons) live in informal settlements (Solomon Islands Government, 2011). The informal settlements are unplanned and therefore lack adequate services (roads, power, sanitation, policing, water and garbage collection). Poverty and unemployment are often higher in the informal economic activities such as street vending for their livelihoods (Union Aid Abroad-APHEDA, 2009, Ministry of Lands, Housing and Survey, 2006).

686. The temporary occupation license was introduced to control illegal settlement growth on crowded land and is permitted under the Land and Titles Act and granted by the Commissioner of Lands (CoL). It allows the construction of a temporary house with basic amenities on crowded land while waiting for properly subdivided plots. The tenure of their residency is short, with an annual fee of SBD$10 (now $1000). Nominated headmen in each area are to effectively control allocation and advise the ministry accordingly. There was no survey or demarcation of plots, and people erected their dwellings at random, often as directed by the headmen of the particular area. However, this control system has suffered from weak land administration, dishonest dealings of some headmen, and uncontrolled issuing of temporary occupation licenses from the ministry (MLHS, 2006).

687. Honiara city cannot expand its boundary without purchasing from or negotiating a lease with the customary landowners. Honiara City Council and the Ministry of Lands, Housing and Survey Planners and Policymakers desire to work more closely with the Guadalcanal Provincial Authority and traditional landowners for sustainable development of land and services beyond Honiara's administrative jurisdiction and to ensure that land in the city is well planned and managed.

4.6 Physical Cultural Resources

688. Special, sacred or restricted sites, or *tambu* areas, including elements of the landscape as well as monuments, represent the history, lineage and society of different clans and lines and have local cultural as well as regional historical significance throughout Solomon Islands. Traditional medicines and resources derived from terrestrial (native and cultivated flora) and to a lesser extent marine resources play a significant role in the traditional and cultural lives of all communities. The National Solomon Islands Museum keeps a National Tambu Site Register, which records several thousand sites. Some provinces also maintain tambu site registers but due to insufficient funds and manpower, recording and registration of all sites is not systematic.

689. The earliest archaeological evidence of human settlement on Guadalcanal is at Vatuluma Posovi Poha Valley where people lived 6,400 years ago and used a cave beside the Poha River for occasional shelter. Signs of cooking fires, broken stone and shell tools, and items of jewelry such as shell rings and beads remain. In addition, archeologically sensitive areas have been identified throughout the nation including behind beaches, headlands, low ridges, rock shelters and caves, saddles in hilly areas or along traditional walking routes (UNDP *et al*., 2002).

[47] Rental for a three-bedroom executive is SBD18,000, and a two-bedroom house is SBD3,000 per month

690. The Protection of Wrecks and War Relics Act (1980) provides for protection of cultural heritage associated with the war; prohibits tampering, damaging or removing any part of a wreck or war relic unless granted a license.

691. Based on both the terrestrial and marine surveys undertaken for this subproject, there are no terrestrial nor submerged marine physical cultural resources in the subproject area.

5 Environmental and Social Impact Assessment

5.1 Significance of impacts:

692. The potential environmental and social impacts of the subproject have been identified and their significance assessed. The duration of the impacts are assessed with reference to the scope of work, the physical and socio-economic environment at the subproject site. Mitigation measures are designed to avoid and/or minimize each of the potential physical and socio-economic environment impacts. Impacts may be minor, moderate, major or negligible based on the scale of impact itself and whether it is mitigated or not.

693. The subprojects will create both common and site-specific impacts. This chapter provides a summary of these; ensuring chapters cover mitigation measures and the associated Sub-project.

5.2 Potential Pre-Construction Impacts and Mitigating Measures

694. Pre-construction considerations include climate change vulnerability; updating of ESMP based on the latest subproject design and components; integration of ESMP and development consent (DC) conditions in the bid and contract documents; update of the subproject's communications and consultation plan (CCP); grievance redress and management (GRM); identification of materials sources, materials extraction and application for BMP; biosecurity issues and potential introduction of alien invasive species; identification of sensitive receptors; cultural resources identification; land access arrangements; unexploded ordnance; and discharge of raw sewage. Actions necessary to address pre-construction considerations will be included in tender documents and construction contracts.

5.2.1 General Section

5.2.1.1 Land Access Arrangements

695. The land ownership and status of negotiations are presented in **Section 4.3.8: Land Use and Ownership.** These figures and tables also present the land title information, location and areal requirements for the mains and PS.

696. This impact addresses obtaining permanent access to lands for the proposed infrastructure either on public or private property.

697. SW has confirmed that the Resettlement Plan for the subproject is yet to be finalized and submitted to SW by SUEZ consultants, and a Due Diligence Report was not produced for the subproject sites.

698. A LARP has been prepared and approved for the Ranadi to Goodwood subproject – the first component in the schedule. The other wastewater LARPs (HNWW Eastern and Western) are yet to be completed and approved, and the aim is to have these two approved by mid-year 2023.

699. Solomon Water (SW) will use established national process to access the land needed for the subprojects. Land acquisition will be used for outright purchase of land for the PS. There will be acquisitions for two pump stations. SW will secure this through negotiated agreement under the

principle of “willing buyer and willing seller”, thus will not trigger the ADB Safeguards Policy Statement (2009).

700. In the western catchments, the main trunk sewer will mostly be laid within the road corridor, and at some will be through privately owned land. Thus, SW will consult with Ministry of Infrastructure Development (MID) for using the road right-off way. For the privately owned sections, SW will liaise with the true and rightful owners for easement access. The agreement reached will be recorded in the MOU and be signed between MID and the rightful owner. SW has identified all the key parties and stakeholders that will be affected by the proposed works and has initiated discussions .

701. The Vara Creek PS will receive the Tuvaruhu catchment wastewater, and it will be connected to the NRH PS and to NRH Outfall. All the main trunks will be buried within the road reserve. The Vara Creek PS is located on government land. Therefore, all the land that will be impacted by this proposed connectivity will be on government land and is subsequently managed by Solomon Island government.

702. The Tuvaruhu main trunk will also be within the road reserve. Therefore, negotiations will involve SW, MID and Commissioner of Lands (CoL).

703. All main trunk lines will be within the road reserve for the eastern catchment connections. The PS site will be acquired from the individual that has legal ownership of the land plot.

704. In summary, all the land associated with the Vara PS and main trunk lines will be located on government land. For the western section connectivity, all landholders apart from one namely the South Seas Evangelical Church (SSEC) have agreed with the proposed land access arrangements. Only SSEC is still pending for the trunk to run inside the church compound. For the eastern connection area, all the sewer mains will be in the road reserves. The PS will be acquired from the church that has legal ownership of the land plot.

5.2.1.2 Procurement and Environmental Management System

705. Throughout the subproject, for implementation of environmental safeguards to be effective, a robust environmental management and monitoring system will need to be established. The PMU will ensure that the ESMP is updated, as required, based on detailed design, and incorporated into the bid documents. The bid documents will also specify other environmental management requirements such as: (i) requirements to comply with applicable standards; (ii) the contractor designating a full-time environmental, health and safety officer (EHSO) and deputy EHSO and recruiting a community liaison officer (CLO) from the local community and the reporting/communication lines and channels; (iii) the monitoring and reporting requirements; and (iv) delivery of induction, training and awareness sessions for workers and the community. Prior to works commencing at each subproject site, the contractor will prepare and submit a site-specific construction ESMP (CESMP) to the PMU, the CESMP will be based on the subproject ESMP and detail the construction methodology and program to be undertaken at each site, identify the risks associated with that construction methodology and detail mitigation measures to avoid or reduce the risks. The PMU will review and clear the CESMP and advise the supervising engineer that the CESMP may be approved and no objection to commencement of works given.

706. Once works commence, the EHSO will conduct monitoring of compliance of activities with the approved CESMP and the PMU will undertake inspections and audits of the effectiveness of the contractor’s implementation of the approved CESMP. The PMU will devise the checklist to be used for the inspections and audits and will consolidate the inspection/audit findings along with summaries

of the contractor's monthly reporting. ADB and WB will undertake review missions which will report on, inter alia, overall implementation of environmental safeguard requirements.

707. As early as practicable after commencement, the subproject will operate a grievance redress mechanism (GRM) to address concerns and resolve complaints and issues raised on any aspect of the subproject and subproject implementation, building on the existing SW GRM system.

708. The CESMP will outline how the contractor will implement the relevant elements of the GRM and how and when they will provide information about construction activities and timing to the community. The contractor will be expected to provide information about the works, impacts and mitigation/control measures to the community in a timely and effective manner. The contractor's liaison and communication with the community, managed by the CLO, will be guided by the Project's CCP. Key items to be covered by the CESMP include the requirements for the contractor to set out how they will implement the relevant elements of the project's GRM. The contractor will also be required to develop a workers' Code of Conduct (CoC) to be included in individual contracts and developed based on social protocols being agreed with community leaders and representatives. The COC must specify measures to prevent incidence of SEAH, bullying and harassment.

709. The CESMP shall be in line with the ESMP and the technical specifications of the bid documents. The contractor shall not commence any permanent works under the contract prior to receipt in writing from the Engineer that the CESMP has been reviewed and approved. The approved CESMP shall become an integral part of the contract document.

710. As well as the standard content associated with professional reporting, the CESMP shall also contain, at a minimum, the following information. The CESMP must use the below listed items to be consistent with, and respond to, the ESMP and bid document, the conditions of permits and approvals from the relevant ministry departments. The document should reflect contemporary good practice; be balanced, objective and concise; and be written in a way that is easily understood by other parties. All commitments must be specific and auditable with measurable outcomes and clear timeframes. The CESMP must cover all activities within the project's area of influence. The area of influence includes the active worksites, laydown areas, construction camps, production facilities (concrete, asphalt etc.) and materials sources.

711. DECLARATION AND DOCUMENT VERSION CONTROL: person accepting responsibility for the environmental management plan – signed declaration; the document version control should be a simple system that ensures that details of all key changes to the document over time are properly recorded.

712. PROJECT DESCRIPTION: The CESMP should provide a summary of the project as this provides context for the plan. The location of all works should be summarized with a clear definition of the works' area of influence. Basic and relevant information on the environment at these locations should be summarised from the ESMF included as this helps provide the environmental context to which the CESMP applies. A schedule of intended commencement and completion dates should be provided. Activities undertaken in stages should identify each stage in the schedule.

713. OBJECTIVES: The environmental outcomes of the plan should be defined. These should be tailored to the environmental issues outlined in the CESMP.

714. ENVIRONMENTAL MANAGEMENT ROLES AND RESPONSIBILITIES: The CESMP should define the roles and responsibilities of personnel in charge of the environmental management of the project to reflect the requirements in the ESMP. The roles and responsibilities of each relevant position

should be documented, including the responsibilities of subcontractors. The names of the responsible personnel do not need to be included. Identification of the position titles, roles and responsibilities is sufficient. If the roles and responsibilities are expected to change over time the long-term variations should also be documented.

715. REPORTING: The description of reporting requirements should include: a list of required reports including where appropriate monitoring, environmental incidents, non-compliance, corrective action and auditing; a description of the standard report content; the schedule or triggers for preparing a report; who the report is provided to; and document control procedures.

716. ENVIRONMENTAL SAFEGUARDS TRAINING: All people involved with the subproject should receive relevant environmental training to ensure they understand their responsibilities when implementing the CESMP. People to be trained include those at the site/s of all subproject activities and operations, including contractors, subcontractors and visitors. The training should be tailored to the role of the individual in the subproject. The CESMP will include a list of the training needed and the plan for undertaking this training. The CESMP will also identify the resources to conduct this training (internal/external).

717. EMERGENCY CONTACTS AND PROCEDURES: The CESMP should identify the key emergency contacts responsible for managing environmental emergencies associated with the subproject and their contact details. These personnel should have the power to stop and direct works so that they can manage emergencies effectively. In addition, the plan should establish procedures for managing environmental emergencies and ensure that those procedures are implemented and maintained.

718. POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS: The potential impacts section of the CESMP should include a tabulated summary of any relevant information previously provided in the ESMP, it should also identify the km marker/chainage of the identified (an any additional) sensitive receptors. Impacts from relevant stages of the contractor works should be defined in this section and should reflect the relevant conditions of approval.

719. MANAGEMENT MEASURES: The CESMP should clearly state how the potential impacts of the works will be specifically managed based on the content of the ESMP and the measures that the contractor will undertake to implement these mitigations. The CESMP will propose management measures on the issues identified and will identify the cost involved and the party responsible for the management measures.

720. MONITORING PLAN: The CESMP must detail how the CESMP will be monitored and shall include a weekly monitoring checklist. The monitoring plan will include: what is to be monitored, how it will be monitored, the parameters (standards) that it will be monitored against, who will monitor, where will be monitored and the cost of the monitoring plan.

721. AUDIT AND REVIEW: Environmental auditing: The environmental management plan should include the schedule or triggers for auditing the implementation and effectiveness of the plan. It should address both internal and external audit requirements including who is responsible for undertaking the audits and reporting the results. CESMP review: The CESMP should specify the schedule or triggers for reviews of the plan.

722. CESMP PREPARATION AND IMPLEMENTATION: The CESMP must ensure that the person taking the action takes full responsibility for the content and commitments contained in the plan. The CESMP must be prepared and implemented by a qualified environmental practitioner (Environmental Representative) with at least 10 years-experience. Field audits of CESMP implementation must be

undertaken on at least a monthly basis by the Environmental Representative with associated audit reports certified and submitted to the Engineer.

723. CESMP COMPLIANCE: Identify the internal procedure that the contractor will follow when a non-compliance has been identified during the daily monitoring. Procedure will include notification responsibilities, rectification timeframe and reporting obligations. Procedure will also cover the process the contractor will follow when non-compliances are reported by the supervision engineer. Procedure will also identify how the contractor will action any disciplinary or training requirements following the non-compliance.

724. CESMP REVIEW AND AMENDMENT: The CESMP must be reviewed, updated and resubmitted to the Engineer for approval in response to an anticipated change of circumstances before any changes are permitted at the work sites. These circumstances include substantial design changes with environmental or social implications, changes to specific approved plans, new activities not contemplated in the subproject ESMP, or additions to the Project's area of influence. No changes will be made to the Project or the project areas until it has either been confirmed by the supervision engineer that an update to the CESMP is not needed, or the update has been made and approved by the supervision engineer. The CESMP must also be updated where it is deemed that the mitigation measures are not adequate to mitigate the environmental and social risks.

725. CESMP MANAGEMENT SUB-PLANS: The contractor must provide all sub-plans required in the ESMP as annexes to the CESMP.

726. The contractor will need to follow SW GRM system to resolve any issues or concerns raised during the construction phase. The contractor is required to:

- Have a dedicated CLO to receive the concerns/issues raised (verbally or written)
- Have a grievance box at the construction site and office
- Grievance Forms available at the construction and office site
- Grievance Register
- Conduct Awareness on how people will access the GRM and report issues and concerns

727. CODE OF CONTACT The contractor will be inducted on the potential social risks and all workers must understand fully their obligation on the code of conduct and will need to sign the COC form before commencing of work.

728. In summary, the main items to be covered in the CESMP:

- Environmental issues/the environment to be affected or impacted
- Specific mitigation control or safeguard measures, and
- Responsible institution to implement controls or safeguard measures.

729. The CESMP will implement the relevant elements of the project's GRM including:.

- Establish Institutions to deal with different types and levels of grievances

- Build Capacity to handle grievances effectively
- Create Awareness
- Implementing Steps (process of implementing a GRM involves)

730. Workers and sub-contractors will be inducted to the site and this will include awareness and training on the provisions and requirements of the CESMP and how it is to be implemented.

731. A systematic process for updating the EIS post-detailed design will be implemented by procuring additional support to ensure that the approved EIS and development consent are integrated into the bid documents; that bid documents are clear on the requirements for the successful contractor to develop and submit a construction ESMP to SW's PMU and ADB/WB for review and clearance prior to any physical works starting (including any clearing or grubbing); and, monitoring and inspections of the implementation of, compliance with, and effectiveness of, the approved CESMP. The CESMP is required to be developed based on risk assessment (or similar approach) and further development of the measures identified in the EIS and its ESMP. The CESMP must be site and activity specific and be linked to the contractor's construction program and work method statements. The CESMP must establish how the contractor intends to comply with the construction-related elements of the subprojects' communications and consultation plan and SW's grievance redress mechanism.

732. The construction supervision consultant supporting SW, will establish and support SW in implementation of an overall environmental management system, commensurate to the risks and impacts of the subproject

5.2.1.3 Access to Materials

733. Materials for this subproject will come from two different sources. The pipes themselves, associated jointing materials and geotextile fabrics will all be imported. PVC and HDPE pipes are regularly used in Honiara and given the lead time, obtaining sufficient supplies will not be difficult for the contractor.

734. Similarly for the pump stations, the pumps themselves and appurtenant fittings such as valves are all of a very standard design and relatively small size. These units will be readily available given the lead times available. Cement is readily available for making concrete for the pump stations and other hardstand areas. Electrical control systems are readily available and have been utilized in many other pump stations throughout the greater Honiara area.

735. In summary, the proposed infrastructure does not include any unusual products that will be difficult to procure or may require exceptionally long lead times.

736. One potential concern relates to the supply of bedding material to be placed around the pipes, sand and aggregate for producing concrete required for the pump stations and hard stand areas, and armor rock which may be required to protect the outfalls.

737. Standard cross-sections of the bedding material required to protect various sized pipes were obtained from the engineering consultant SUEZ. These typical sections were then used for each pipe size to determine the quantity of bedding required for each linear meter of pipe. A conservative assumption was made by assuming that all pipes should be protected against traffic loads, and therefore required more bedding material cover over the crown of the pipe. The length of each gravity sewer pipe was then applied to calculate the volume of bedding material required for both the NRH and Ranadi

components. A sample calculation made for this EIS on one of the first Ranadi stages is shown in **Table 5-1: Bedding Material Requirements- Sample Calculation** below.

Table 5-1: Bedding Material Requirements – Sample Calculation

Profile ID - Ranadi 1	SP-29	SP-30	SP-31	SP-32	SP-33	SP-34	SP-38	SP-39	SP-40	SP-41	SP-42	SP-56	
1. Network design													
Length (m)	249	287	396	181	343	347	204	289	320	386	246	197	
DN average (mm)	600	600	600	400	400	500	700	700	700	700	800	225	
Aggregate m2	0.98	0.98	0.98	0.55	0.55	0.75	1.1	1.1	1.1	1.1	1.25	0.34	
Agrregate Vol (m3)	588	588	588	220	220	375	770	770	770	770	1000	76.5	6735.5

738. Details of the rising mains were then incorporated into the calculation to determine rising main bedding requirements as well as for the overflow pipes.

739. Quantities required for armor rock to protect the outfalls were calculated based on the most conservative assumption of full outfall trench coverage with a one-meter thick armor layer two metres m wide. Obviously, the armor zone shape, in reality, would be more trapezoidal than rectangular, but the assumed two square meter cross-section would still be conservative.

740. Once the total material quantities were calculated, this was then converted to the required monthly supply rate for the processed quarry products. The consulting engineer advised that the construction period for these works at Ranadi would be between 2023 and 2025 and for the NRH catchment would be between 2025 and 2027. The consultant further advised that the actual construction period will be approximately two years for each of these catchments. Given that the successful contractor may wish to accelerate the program and have multiple working faces operating at any time, it was assumed for these calculations that the actual construction activities would be undertaken in a 12-month period, which is very conservative. This notionally applies to Ranadi being in say 2024 and NRH in 2026.

741. Based on this set of conservative assumptions, the monthly bedding, sand and aggregate requirements for NRH are 350 m³ per month and for Ranadi the average consumption rate would be 1250 m³ per month. Assuming a conservative five-day working week, this works out to less than 60 m³ of the three products combined per day. This is less than 10 truckloads per day.

742. For the armor rock, it was assumed that whilst the construction of the outfall and installation may take one or more years, it was assumed that the armor rock would be installed rapidly at the time of the lowest expected local ocean currents. Therefore the armor rock would, at the most conservative approach, be applied in say one month meaning that the requirements for armor rock at Ranadi would be 1000 m³ over one month and 700 m³ in another month for the NRH outfall as per **Table 5-2** below.

Table 5-2: Summary of Quarry Material Requirements

Total of Quarry Products Required (Cubic Metres)						Cubic metres per month		
Package	Pipe Bedding		Concrete materials		Armour Rock	Quarry processed	Quarry run	Example Year
	Gravity Mains	Rising Mains	Aggregate	Sand	Outfalls	Bedding and agrregate/sand	Armour rocks	
NRH (2025-27)	2,600	530	650	420	700	*350 m3/month*	*700 m3 in 1 month*	2,026
Ranadi (2023-25)	12,300	1,170	910	610	1,000	*1,250 m3/month*	*1,000 m3 in 1 month*	2,024
Contract terms will be 2 years for construction.								
Assume 1 year of actual construction for mains and pump stations and outfall.								
But rock armour for outfall required in 1 month to be conservative								

743. These quantities were then discussed with one of the preferred quarry suppliers for SW, namely SSS Corporation (Solomons Sheet Steel Incorporated). The supplier is fully licensed and has the

certification and permits required. Based on discussions with the quarry production management Ms. Florence Bako and the owner Mr. Jason Lee, it was concluded “that providing 1,250 m³ per month of crushed product and sand for pipe bedding and concrete production is readily manageable, and providing the 1,000 m³ of armor rock within one month is readily managed provided it is specified as being less than 300 mm in size. This is likely to be the size specification if an armor rock mat is finally adopted for protecting the outfalls. However, if larger diameter rocks are required, this would require advance notification so that the thousand cubic metres could be stockpiled over a longer production run at the quarry.”

744. Numerous quarries are serving the requirements of the greater Honiara area, and in one location alone on the Lungga River, five operators work in close proximity as shown in **Plate 5-1: Quarrying Activities.**

Plate 5-1: Typical Quarrying Activities on Lungga River.

745. Therefore, for both the imported hardware such as pipes, fittings, geotextile protective fabric, pumps and ancillaries such as electrical control systems, there will not be any availability difficulties, especially given the long lead time available.

746. Regarding the supply of local quarry products for pipe bedding, sand and aggregates for concrete and potentially for armor rock for protecting the outfalls, one of the local preferred suppliers who has all the appropriate licenses and permits has confirmed that the material rates required are readily managed and therefore new quarry facilities will not be required.

747. In general, auditing of existing operators/suppliers (and included as requirements in the CESMP) is necessary to verify operations are in compliance with CSS and any other requirements (including suppliers to have valid development consent from MECDM, BMP from MMERE and approved CESMP)

5.2.1.4 Unexploded Ordnance (UXO)

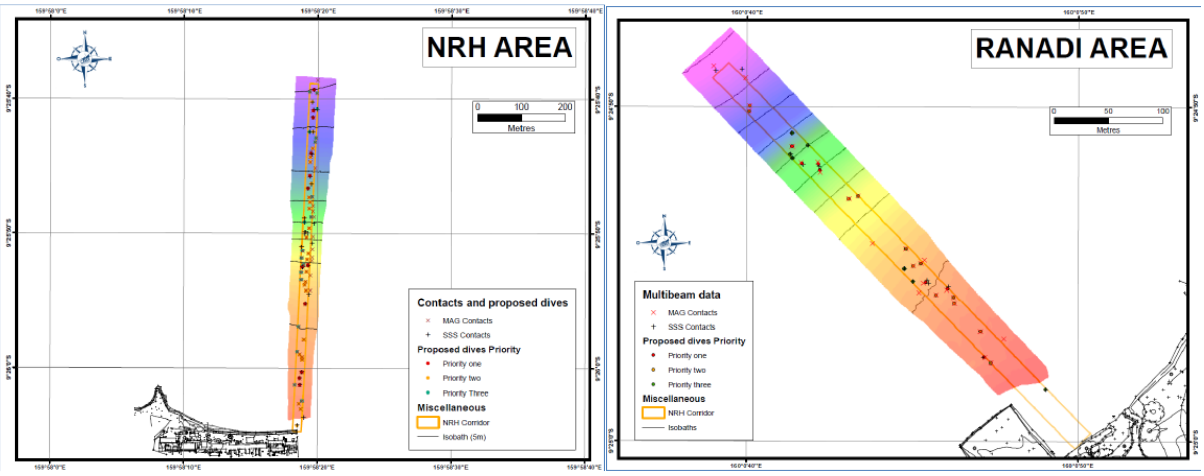
748. During WWII, the subproject site was subjected to intense battles and while this occurred over 70 years ago, it is possible that a chance discovery of a UXO may occur.

749. A survey was undertaken by Suez using Side Scan Sonar (SSS) and magnetometers to investigate possible UXO contacts in 2020. **See Appendix 16: UXO Study Area, Honiara 2020**. The surveys were along the two outfall alignments as illustrated in **Figure 5-1: UXO Surveys for NRH and Ranadi Outfalls**. This preliminary survey detected 30 contacts using SSS and 56 using the magnetometer on the NRH alignment. For the Ranadi outfall alignment, the SSS and magnetometer yielded 15 and 25 contacts respectively.

750. The report notes that these could be due to local anomalies, and some would be likely due to mental refuse being discarded overboard from ships undertaking maintenance along these alignments, or simply metals washed in from shoreline activities such as litter. Recommended diving locations were proposed by CERS/SUEZ, with priority is given to the strongest contacts yielded and also those contacts closest to the alignment route. Based on a risk assessment of the preliminary UXO survey, construction sites including the outfall routes will need to be swept for and cleared of UXOs/AXOs prior to construction.

751. Initially it was proposed that the UXO detailed assessment and clearance would be under the responsibility of the civil works contractor. However, SW has directed that the consultants must arrange for the clearance work to be done before going to tender for the civil works. Ultimately, SW will be responsible for the supervision and monitoring of the contractor.

Figure 5-1: UXO Surveys for NRH and Ranadi Outfalls



Source: UXO Study Area, Honiara 2020

752. Should UXO be discovered, the contractor is to immediately cordon off the area and arrange the evacuation of nearby residences and inform the Royal Solomon Islands Police Force (RSIPF) of the find.

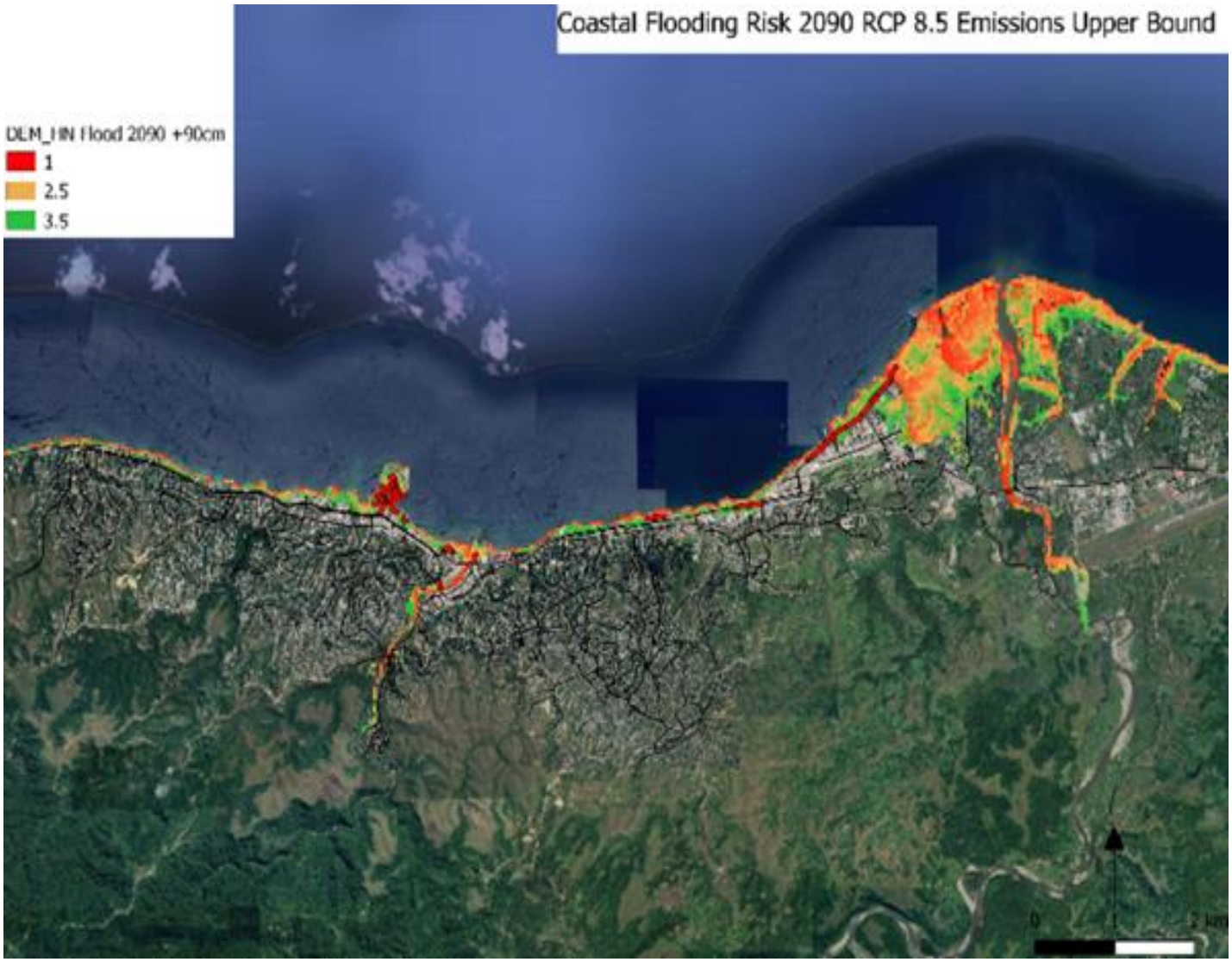
5.2.2 Pre-Construction Impacts on Physical Resources

5.2.2.1 *Climate Change Vulnerability*

753. Climate change resilience is a critical consideration because Honiara is vulnerable to the effects of climate change as the subproject sites are situated along coastal low-lying areas and riverine flood plains. Also, changes in the intensity of extreme weather events and gradual change in climate parameters such as precipitation could damage proposed wastewater facilities. Flooding could be compounded by the effects of sea level rise as well.

754. **Figure 5-2** shows the estimation of the potential impact of sea level change and wave action in 2090 using RCP 8.5 scenario. Some areas where the wastewater infrastructures is to be constructed are at risk of being flooded.

Figure 5-2: Impact of Sea Level Change + Cyclonic Wave Action at 2090 (RCP 8.5)



Source: SW Background Information Report

755. As part of mitigation measures, a hydrology and onsite flooding study was conducted during the design phase. The study described the nature of the flood hazard and the degree of flood risk for the specific sites. Results of the study have been used in designing the proposed facilities and the preparation of engineering specifications to ensure that these facilities are less vulnerable to the predicted flood events.

756. Engineering assessment on potential site erosion has been made during the design phase for each site to determine the type of erosion protection that will be appropriate using in particular information from the site-specific geotechnical studies. This applies to the sites of pumping stations, routes of sewer lines and sites of outfalls.

757. In addition, the climate-proofing measures for wastewater projects crafted by ADB are shown in **Table 5-3Error! Reference source not found.**.

Table 5-3: Climate-Proofing Measures for Wastewater Subproject

Component	Climate-Proofing Measures
Wastewater collection	▪ Prevention of sewer overflow ▪ Adjustment to operation below design capacity ▪ Relocation of flooded sewers

Source: EARF 2019.

5.2.3 Pre-Construction Impacts on Biological Resources

5.2.3.1 *Potential Introduction of Invasive and Alien Species*

758. To prevent the spread of alien and/or invasive species, imported plant, equipment and materials and the vessels that import them will be subjected to clearance procedures under the Bio-Security Act and Regulations and may require issuance of phytosanitary certificates from Biosecurity Solomon Islands. It is the importer's responsibility to ensure all machinery that arrives in Solomon Islands to be free from biosecurity risk material, such as soil, seeds, plant and animal material.

759. Construction heavy equipment i.e., bulldozers, excavators and backhoes will almost exclusively be sourced locally from Honiara or nearby areas and as such will limit any bio-security concerns focusing on plant invasive species/disease control. All machinery associated with the subproject are to be cleaned (removal of soil, seeds etc.) before entering the sites and greater Honiara.

760. The only goods expected to be imported would be mechanical and electrical equipment, and some specialist materials, all of which are expected to be new items.

761. The contractor is required to prepare and implement an invasive species management plan as part of the CESMP.

5.2.4 Pre-Construction Impacts on Socio-Economic Resources

5.2.4.1 *Sensitive Receptors*

762. The sewer lines will be installed along the road reserves within Mendana Avenue and Kukum Highway. Mendana Avenue is the main road connecting the western and eastern sides of Honiara. It

is an urban road lined on both sides with various urban developments and passes through the central business district. It connects to the Kukum Highway which is also lined on both sides with various urban developments. Kukum Highway is the main road connecting the western and central part of Honiara to the international airport at Henderson in the east.

763. Construction of sewer mains and outfalls will be conducted in close proximity to these settlements and commercial premises. Heavy plant vehicles and construction equipment may significantly increase the noise level, dust and vibration and create a nuisance for nearby sensitive receptors, pedestrians and general communities. The issue is mostly applicable along the roads reserves where the sewer mains and outfalls will be installed.

764. Sensitive receptors that will possibly be affected during the construction phase, located within 100m of the construction site, are listed in **Table 5-4** below.

Table 5-4: Sensitive Receptors in relation to Pump Stations

Infrastructure Type	Type of Sensitive Receptors	Potential Numbers of people or affected household/Business
Ports PS	Offices/commercial business	4 Buildings accommodating various shops and offices
Vara Creek PS	Residential Area	21 Households
NRH PS	Residential Area (Lordhowe Settlement	About 50 households,
NRH PS/Outfall	Hospital Ward (children's ward, TB ward, Cancer Unit, Labour, Post Natal, Pre-Natal, Gaynea, Nursery	104 patients (during time of data collection)
Naha PS	Commercial Business-	11 Commercial Business Houses
Ranadi PS	- Commercial Business	9 Commercial Business Houses
Ranadi PS/Outfall	Residents	10 Households

765. Noise monitoring has not been undertaken as part of the EIS. It is however important that the contractor undertake baseline noise monitoring as part of developing the CESMP, to clearly identify ambient levels for comparison with future levels from activities/equipment. That way noise can be controlled and monitored in order to avoid excessive noise impacts during the construction phase of the subproject.

766. Monitoring locations and parameters should be selected to best reflect likely impacts on the identified sensitive receptors listed above, and by working with the SW PMU representatives. However, initial options for locations and noise limits are listed in Section 4.1.7 - Air Quality & Noise Levels for review during project implementation.

5.3 Potential Construction Impacts and Mitigating Measures

767. The construction phase considerations are site access and clearance, including potential disruption of utilities (power and communication cables); soil erosion and sedimentation control; disposal of excavation spoils; oil and hazardous materials management; dust control; site waste management including demolition; construction noise and vibration; traffic management; community and occupational health and safety; potential social issues due to the influx of workers; potential damage to hidden archaeological and cultural assets; and removal of existing outfalls and associated beach

clean-up if required. Contractors will be required to prepare a Construction Environmental and Social Management Plan (CESMP) based on the ESMP included as part of the environmental and social assessment herein. This CESMP will reflect their construction approach and methodology to ensure appropriate environmental and social management during the construction period, including COVID-19 preparedness and response. Whilst COVID-19 restrictions were reducing at the time of preparing this EIS, new strains continue to appear so a COVID-19 contingency plan is still considered necessary.

5.3.1 Construction Impacts on Physical Resources

5.3.1.1 Soil Erosion and Sedimentation Control

768. Potential sources of sediment runoff are site clearing, ground leveling, excavations for structures' foundations, and pipe and outfall laying. Soil can be carried by runoff to the natural drainage system or to adjacent lots during rainy periods, or conveyed by ocean currents for outfall activities.

769. The installation of a marine outfall will involve pipeline trench excavation, pipeline laying, and soil cover and/or armor rock placement. Sediment generation will be due to the disturbance of the coastal foreshore land and bottom marine sediments.

770. The contractor will be required to install small interceptor dikes, pipe slope drains, grass bale barriers, silt fences, sediment traps, and temporary sediment basins to divert surface runoffs away from the exposed areas, prevent sediments from moving offsite, and reduce the erosive forces of runoff waters at all construction sites. These will include standard environmental mitigation measures associated with good engineering practice to ensure the potential impacts from the construction works are minimized, acceptable and insignificant. Such mitigation measures will include:

- Deploying silt curtain/s during all foreshore construction and redevelopment activities to reduce the dispersion of benthic substrate (silt) disturbed during construction,
- Apply mesh over any land-based stockpiles
- Ensure all equipment is properly maintained,
- Take all necessary measures to prevent leakage and accidental spillage of fuel and oil into the environment as set out in the hazardous materials section of the waste management plan (WMP).

771. Provided such measures are properly implemented, the potential impacts on the marine environment will be insignificant.

772. For all subprojects, the contractor will be required to prepare an Erosion and Sediment Control Plan (ESCP) as part of their CESMP. The geotechnical report will be provided as part of the contract documentation. This includes investigation and interpretation of onsite geology, allowing potential contractors to consider their proposed methods for site erosion control.

5.3.1.2 Disposal of Excavation Spoils

773. Construction activities for the installation of wastewater infrastructures have the potential to generate excess excavation materials.

774. Improper disposal of excavation spoil can be avoided by addressing the issue prior to the start of construction activities. The PMU will:

- Require the contractors to submit a plan for the disposal of excess excavation spoil; and
- Undertake inspection and approval of the contractors' suggested disposal sites prior to actual construction.

5.3.1.3 Storage, Use and Transportation of Oil and Hazardous Materials

775. Petrochemical based products and other hazardous materials may be used in the construction activities of the proposed subproject. Fuel, oil, grease, paints, and solvents associated with the operation of heavy equipment and vehicles may accidentally be released into the environment during construction and adversely affect water quality and aquatic life. Mitigation measures, where required, include:

- Prepare a Hazardous Substances Management Plan (HSMP) and an Emergency Response Plan (ERP) as part of the CESMP;
- Ensure all storage containers are in good condition with proper labeling; and
- Store all petrochemical products and other hazardous wastes in tightly sealed containers to avoid contamination of soil and water resources, in a secured enclosure (fenced) that has a hard floor that is bunded and roof.

776. Measures for clean-up and handling of contaminated materials will include:

- Immediate clean-up of spills,
- Oil-stained wastes and used oil to be collected and disposed of through recyclers / authorized waste handlers and disposal in authorized waste facilities;
- Ensure availability of spill clean-up materials such as absorbent pads;
- Restoration of temporary work sites will include removal, treatment, and proper disposal of oil-contaminated soils;
- Discharge of oil-contaminated water into the environment to be prohibited;
- Construction personnel designated to handle fuels/hazardous substances to be trained particularly in spill control procedures;
- All contaminated waste must be disposed of at an approved facility, and
- All loads must be covered.

5.3.1.4 Removal of Existing Outfalls and Beach Clean-up

777. The sewer outfall rehabilitation subproject will reduce the current 17 outfalls to 2 new ocean outfalls, plus retaining the recently upgraded outfalls at Naha and Rove. This is in line with SW's strategy to reduce the current number of outfalls. Consequently, there is a need to remove during the construction phase the unwanted existing outfall components and the subsequent clean-up of the beach area at these outfall locations.

778. Contractors will be required to:

- Prepare an inventory of the existing outfalls components to be removed.
- Removal and disposal plan for existing outfalls components, including the assessment if any of the wastes are hazardous and prescribe the appropriate handling and disposal for such wastes.
- Beach clean-up plan for the beach area of the existing outfalls, including the assessment of any beach portions are heavily contaminated and need to be transported to a disposal site.

5.3.2 Construction Impacts on Biological Resources

779. Construction Impacts on the terrestrial Biological Environment will be minimal. The natural ecosystem of the subproject area of influence and construction sites has been completely removed previously and as such existing flora and fauna present within the area of influence are either introduced species or secondary regrowth, which are highly tolerant of disturbances. There are no Red Listed terrestrial or aquatic species in the subproject influence area.

5.3.2.1 Terrestrial Habitat Alteration

780. Construction activities will not involve alteration of important terrestrial habitats since the sites are already highly modified. Any remaining land cleared, and not required for construction, will be seeded with grass or native plants as required as part of the revegetation program to stabilize the areas from erosion.

781. Clearing of vegetation will be minimal in the areas where sewer pumping stations and associated sewer lines will be installed as well as where outfalls will be constructed.

782. Mitigation measures include:

- Limiting vegetation clearing to areas where necessary to reduce the impact on vegetation;
- Provide temporary fencing to protect vegetation; and
- Promote restoration of damaged or destroyed vegetation by planting tree seedlings.

5.3.2.2 Marine Habitat Alteration

783. The marine assessment clearly demonstrated at both proposed outfall locations that the coastal foreshore and intertidal/subtidal marine environments within and adjacent to the projects proposed outfalls have been and continue to be significantly altered due to coastal land and shallow water reclamation and infrastructure development. This development, coupled with the exiting marine environment being dominated by high sediment deposition rates resulting from rainfall events discharging from river systems adjacent to each site, have resulted in a marine ecosystem that does not have the natural habitats to support marine biological diversity and populations. This results in a paucity of invertebrates, vertebrates and flora with no threatened, endemic or IUCN red listed species being recorded. Thus any impacts to the coastal and marine environments would be minor, very short lived and totally reversible.

784. The potential impacts of the outfall construction works on the marine biological environment include:

- Localized and temporary increased suspended sediment levels within and around the outfall footprint affecting marine habitats and associated resources during construction activities.
- Spillage/leakage of oil and other pollutants into the marine environment from plant and equipment.

785. There are no marine or coastal designated marine protected areas or areas of significant biodiversity within or in close proximity to the proposed outfall sites nor do the areas possess any sites of cultural, customary or heritage significance nor any national or international endangered, endemic or protected species within and adjacent to the proposed area of influence.

786. The marine benthic substrate associated with the two proposed outfall sites location due to its environmental characteristics and past extensive foreshore and intertidal reclamation activities, the benthic habitat within the proposed areas have a very low marine biodiversity and can be considered to have a very low ecological habitat and value.

787. Given the existing marine ecological conditions in the vicinity of the works as noted above, the potential impacts of the works on the existing marine environment are likely to be insignificant. There are no threats to the area's marine and coastal biodiversity associated with the subproject.

788. Standard environmental mitigation measures associated with good engineering practice will be implemented to ensure the potential impacts from the construction works are minimized, acceptable and insignificant. Such mitigation measures will include:

- Deploying silt curtain/s during all foreshore construction and redevelopment activities to reduce the dispersion of benthic substrate (silt) disturbed during construction,
- Ensure all equipment is properly maintained,
- Take all necessary measures to prevent leakage and accidental spillage of fuel and oil into the marine environment as set out in the hazardous materials section of the waste management plan (WMP).
- Workers (including people from outside of the area and/or who are not resource owners) will not hunt, collect or fish any marine resources. This requirement will also be included in the worker code of conduct.

789. Overall the potential impact of the works on the marine biological environment is expected to be minor, localized and overall insignificant provided standard mitigation measures associated with good engineering practice as identified above are implemented.

5.3.3 Construction Impacts on Socio-Economic Resources

5.3.3.1 Disruption of Utilities and Services

790. Proposed subprojects may disrupt the existing built environment during construction since sewer lines will be generally installed along roads in the urban area. Construction activities may affect the existing transportation, water supply system, solid waste management, electricity lines and communication lines, health services and building infrastructures.

791. Prior to construction activities, SW and the contractors will:

- Coordinate with utility providers to obtain information about the locations of the built environment;
- Coordinate with the other utility companies regarding potential disruptions;
- Make provisions to preserve the operation of current facilities; and
- Notify affected households and establishments well in advance of any disruptions.

5.3.3.2 Generation of Solid Waste Including Demolition Materials

792. Construction activities are expected to generate solid wastes including used wood materials, steel works cuttings, paint and solvents containers, used packaging materials, on-site office solid wastes, used oil from equipment, unused aggregates, and surplus earth materials. These solid wastes may cause aesthetic problems and be potential sources of contaminants for surface runoff and pollution of nearby water bodies.

793. Contractors will be required to:

- Prepare a Waste Management Plan (WMP) as part of the CESMP;
- Provide garbage bins and facilities within the subproject site for temporary storage of construction waste and domestic solid waste;
- Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporarily on-site in secure facilities with weatherproof flooring and roofing;
- Ensure that wastes are not haphazardly dumped within the subproject site and adjacent areas;
- Encourage re-use of excavated excess soil;
- Regularly dispose of wastes to an accepted disposal site (Ranadi Landfill) as approved by SW-PMU;
- Transport waste in covered or enclosed vehicles; and
- Prohibit burning of all types of wastes.

794. After completion of work activities, contractors will be required to remove construction wastes from sites, implement the required restoration of disturbed sites and ensure the proper closure of construction sites.

795. All these will be reflected in the CESMP which will contain a subproject specific waste management plan describing all waste types, amounts, disposal method, transport documentation requirements, and details of licensed waste treatment/recycling facilities for each waste stream.

796. Demolition wastes will be assessed for recycling and disposal, including the determination if any of the wastes are hazardous and prescribe the appropriate handling and disposal for such wastes.

5.3.3.3 Impacts on the Sensitive Receptors

797. Use of the most appropriate construction methodology which results in lesser disruption to the public, especially the sensitive receptors, will be required through the CESMP and method statement reviews.

798. Specific consultation will be undertaken with impacted communities and key stakeholders before and during construction activities to ensure that impacts are minimized, and community safety is ensured. This is especially important when proposing works during specific periods such as school and church hours.

5.3.3.4 Dust and On-site Air pollution

799. On-site air pollution from dust generation and use of vehicles and equipment can be expected during dry periods from activities associated with site clearing, ground leveling, and excavations for pipe laying. Intermittent episodes of localized air pollution from dark smoke emitting equipment may also occur. Wind blowing on large stockpiles of construction materials such as soil and aggregates can also produce fugitive dust.

800. Contractors will be required to:

- Conduct regular water spraying of roads, work areas and other construction-related facilities to minimize dust generation;
- Ensure construction materials stockpiles are covered or sprayed with water, as appropriate, to prevent fine materials from being blown;
- Prohibit use of equipment and vehicles that emit dark sooty emissions;
- Provide trucks transporting loose construction materials such as sand, gravel, and spoils with tight tarpaulin covers or other suitable materials to avoid spills and dust emission; and
- Prohibit burning of all types of wastes generated at the construction sites, as well as other subproject-related facilities and activities.

5.3.3.5 Construction Noise and Vibration

801. Trucks and construction equipment, which can generate noise of 80 dB(A) from a distance of 30 meters, are the potential sources of noise during construction. The issue is mostly applicable along the roads where sewer lines will be installed and the sites for pump stations and outfalls. Construction noise will largely increase the daytime ambient noise levels of the roads which can be expected to be around 60 dB(A) during peak hours, but pre-construction background noise readings will need to be undertaken by the contractor.

802. The contractor will propose a noise monitoring program as part of the CESMP at the identified monitoring locations, monitoring frequency, monitoring times and noise measurements protocols to be proposed to SW PMU for consideration.

803. Significant vibration from construction activities is not expected since sewer line installation will not involve heavy compaction activities.

804. Contractors will be required to:

- Provide prior notification to the community on schedule of construction activities;
- Whenever applicable, provide noisy equipment with noise reduction covers and silencers/mufflers;
- Position stationary equipment that produces elevated noise levels, such as diesel generators and air compressors, as far as practicable from houses and other receptors;
- Prohibit operation of noisy equipment and construction works in populated areas and where sensitive receptors are found during nighttime (19:00 – 06:00);
- If nighttime operation is required, ensure prior notification and consultation will be made with affected people and local officials, and implement suitable noise reduction measures;
- Define an acceptable noise management level based on background level at selected locations
- Conduct regular noise level monitoring (the limits near residential area are 55 and 45 dB(A) during daytime and night time, respectively),
- Locate any concrete batching plants, rock crushing plant/s, and laydown areas at a reasonable distance away from inhabited areas and sensitive receptors. Reasonable distances for each activity and receptor sensitivity will be proposed by the contractor in their CESMP, for consideration by the SW PMU.
- If noise levels still remain intrusive after relocating equipment to the maximum practicable extent, and utilizing the quietest suitable plant, then ongoing engagement with the local community will be required to explain the activities and the likely duration.

5.3.3.6 Vehicular Traffic Congestion Hindrance to Public Access

805. Construction activities and associated temporary or partial road closures may cause traffic congestion and hinder public access.

806. Managing traffic during works along Mendana Avenue and Kukum Highway will be critical given this is the main thoroughfare in the central business district. The contractor will need to undertake a survey to understand peak times and flows. Consultation will also be required with all stakeholders along Mendana Avenue and Kukum Highway and adjacent routes which could be used as diversion during construction works.

807. Temporary areas, access paths/roads and ancillary facilities will need to be carefully planned to avoid traffic congestion. Pedestrian access through and around the work sites will be controlled and managed. Traffic management and control, especially during peak traffic times, will be required to ensure safe passage of vehicles and pedestrians. Stakeholders and communities will be notified in advance of the schedule and duration of activities and the access and traffic control arrangements.

808. Contractors will be required to:

- Prepare a Traffic Management and Control Plan (TMCP) as part of the CESMP and provide traffic management personnel to direct the flow of traffic in the vicinity of the construction sites and construction-related facilities;

- Closely coordinate with local authorities for any closure of roads or rerouting of vehicular traffic;
- Provide prior notification to the community on schedule of construction activities;
- Provide traffic signs in the vicinity of the construction sites to direct motorists and pedestrians;
- Schedule construction activities with consideration to periods of heavy presence of people such as festivities, processions, parades, etc. to minimize disruption to local activities.

5.3.3.7 Occupational Health and Safety

809. Hazards to construction workers include sharp edges, falling objects, flying sparks, chemicals, noise, works on/near water as a hazard for worker safety, and various potentially dangerous situations. It is contractors' duty to protect their employees from workplace hazards that can cause injury. A clean environment is also necessary to enable the workers to maintain good health and hygiene.

810. Health and Safety will be managed in accordance with Solomon Islands Safety at Work Act 1987, and, where gaps exist, best practice will be employed. This specifically refers to the use of Australian and New Zealand standards, guidelines and codes of practice.

811. The contractor is required to have a full-time health and safety representative that will be responsible for ongoing compliance, including regular auditing and updates to subproject specific health and safety documentation. The contractor will prepare the health and safety plan to include but not limited to the following procedures listed below.

812. Contractors will be required to:

- Prepare and implement a health and safety plan (HSP), as well as an emergency response plan, as part of their CESMP;
- Ensure that a properly equipped and resourced first aid station is available at all times in areas of work;
- Provide potable water and adequate sanitation facilities including hand washing stations;
- Provide adequate clean eating areas for workers' meal breaks;
- Provide PPE suitable to tasks and activities undertaken to minimize exposure to a variety of hazards;
- Specifically, regarding safety equipment and training:
    - Trenches and excavations deeper than 1m will be barricaded or fenced off and indicated by appropriate signage.
    - Workers will be provided training specific to working in trenches, excavations and enclosed spaces.
- Provide fire-fighting equipment and fire extinguishers in workshops, fuel storage facilities, construction camps, and any sites where fire hazard and risk are present; and
- Ensure that all workers are aware of emergency response and medical evacuation procedures.

813. The contractor's health and safety plan (HSP) will provide guidance to its staff on how good work practices can be carried out on every activity in the construction site to prevent accidents to the workers and the general public. This will include emergency procedures and the required resources, clear description of responsibilities and management, specific requirements of occupational health and safety policies and regulations, training requirements, and site safety rules. The HSP is one of the inputs to the contractor's CESMP.

814. The contractor will be responsible for providing adequate knowledge to construction workers in relation to site safety. During the construction of trenches for the sewerage mains within the road corridor or private areas, and PS excavations, it is critical that access should be restricted to the construction zone through use of warning signs, temporary gates, fencing or other construction zone demarcation devices at all entry points. For the deeper and less-stable excavations, it may be necessary to have flag persons and traffic controllers stationed near the excavation to ensure absolutely no access by the public. A suitable setback from the top of the excavation edge is to be enforced using signs, construction flags, fences and sight barriers and other visual warnings to prevent machinery, vehicles and people from accidentally falling in will be incorporated into the Traffic Control and Management Plan (TCMP).

815. Given the wide variation in soil types, trench and excavation depth, water table depth, possible use of trench support systems and so on, it is inappropriate to specify a standard set-back distance from the trench or excavation to perimeter barriers. This set-back will have to be decided on a case by case basis using the criteria set out in the TCMP.

816. Appropriate PPE must always be worn, and consideration given to providing on-site storage for workers allocated PPE.

817. Considering the ongoing COVID-19 threat, the following measures will be implemented to manage risks on construction sites and in any workers' housing. The detailed guidance is provided as **Appendix 3** of this document. The WB's ESF/Safeguards Interim Note: COVID-19 Considerations in Construction/Civil Works Projects is also provided as **Appendix 3** of this document. The following reequipments may be considered as optional while the current COVID-19 situation remains stable, but will be compulsory if future outbreaks, possibly of new strains, reoccur.

- Avoid physical interaction and maintain physical distancing requirements;
- Limit the capacity of common areas;
- Regular cleaning and disinfection particularly heavily traffic areas and common areas;
- Promote good personal hygiene such as frequent hand washing with soap and water or alcohol gel;
- Provide appropriate personal protective equipment (PPE) such as face mask, face shield, etc.; and
- Monitoring of health status of workers and visitors before entering the site.

5.3.3.8 Community Health and Safety

818. The movement of construction vehicles, trench excavations, and various activities may pose hazards to the public, particularly along Mendana Avenue and Kukum Highway. Pump stations and outfall sites, including any deep excavations, may also pose hazards to the public.

819. Many of the measures to manage occupational health and safety will help mitigate the risk to the community. Contractors will be required to:

- Implement the various plans to minimize health and safety risks to the public;
- Use barriers and install signage to keep the public away from construction and excavation sites;
- Provide prior notification to the community on the schedule of construction activities;
- Provide security personnel in hazardous areas to restrict public access;
- Operate construction night lights in the vicinity of construction sites;
- Provide adequate safe passage for public, as necessary, across construction sites; and
- Ensure that any access to properties or establishments that have been disrupted or blocked by the ongoing construction activities, are reinstated as quickly as possible or alternative access is provided.
- Prepare an emergency response plan.

5.3.3.9 Construction Camp/Site Office Impacts

820. Due to the readily available accommodation close to the subproject area (Honiara CBD), a designated construction camp is not required for this subproject. The contractor will be required to adopt good management practices of the site to ensure that both physical impacts and social impacts associated with site offices and related facilities are minimized. As noted previously fuels and chemicals, raw sewage, wastewater effluent, and construction debris associated with the construction site office and storage maintenance area is to be disposed of appropriately.

821. It is expected that the contractor's office/yard will be located within a suitable location in Honiara.

822. Social impacts could include i) potential for conflict between workers from outside and local residents and communities; ii) risk of spread of communicable diseases including STIs and HIV; and iii) risk of contamination of local water sources. The proposed measures to mitigate the above risks and impacts include:

- Induction of workers on requirements of the subproject's consultation and consultation and communications plan (CCP) [48] and grievance redress mechanism (GRM) [49] and protocols established for any contact between local communities and contractor/workers;
-
- Implementation of a communicable disease awareness and prevention program targeting risk of spread of STIs and HIV.
- The contractor will put up notice boards regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restrictions;

[48] A framework CCP is being prepared for the overall project. The CCP will be further developed during the initial stage of subproject implementation.

[49] See Section 7

- The facilities will be fenced and sign-posted and unauthorized access or entry by the general public will be prohibited;
- Potable water, clean water for showers, hygienic sanitation facilities/toilets with sufficient water supply, worker canteen/rest area and first aid facilities will be provided onsite. Adequate toilet facilities will be installed. Separate toilets will be provided for male and female workers. The contractor will provide at least 2 liters of potable water per worker per day
- For unskilled activities and labor, as many local people (including women) as possible will be recruited and trained;
- Standing and open water (including puddles, ponds, drains etc.) within the office/yard will not be permitted to reduce possible disease vectors.
- At the workers accommodation including the eating, ablution and recreational areas to be regularly inspected as part of the PMU and supervising consultants monitoring and reporting activities;
- The risk of ground contamination, wastewater from contractors' workshops (if any) will be reduced by passing through gravel/sand beds or an oil separator. All oil/grease contaminants will be removed before discharging into drainage channels. Oil and grease residues will be stored, handled and disposed of as per the agreed WMP;
- To reduce the risk of ground contamination, wastewater from contractors' workshops (if any) will be passed through gravel/sand beds or an oil separator and all oil/grease contaminants will be removed before discharging into drainage channels. Oil and grease residues will be stored, handled and disposed of as per the agreed WMP;
- The contractor's facilities area will be cleaned up to the satisfaction of SW PMU and local community after use; and
- Post-construction the area will be fully rehabilitated and all waste materials will be removed and disposed to disposal sites approved by local authorities.

823. Effective implementation of the above measures will ensure that potential social impacts associated with the contractor's site office/yard will be negligible.

5.3.3.10 Potential Social Issues Due to Influx of Workers

824. Presence of workers from outside the subproject area may cause some social issues such as potential for conflict with local residents, risk spread of communicable diseases including STIs and HIV, risk of incidence of SEAH in addition to GBV and potential gender-based violence (GBV) related concerns.

825. Measures to mitigate such risks and impacts will include:

- Induction of all workers on subproject requirements regarding safeguards (including child protection), GRM and CCP requirements.
- Development of the Code of Conduct (COC) based on agreement of social protocols with community leaders and representatives (including women). COC to be inducted and workers to sign that they understand and accept the COC. The COC will also cover biodiversity protection measures (to be specified in Section 5.3.2.

- Agreement to and implementation of protocols (including code of conduct) concerning the workers contact with the local communities.
- If the contractor wishes to construct accommodation for the workers they must seek approval from the Engineer and conduct all required due diligence (including consultations and development of SEMP) and submit for review and clearance of SW, ADB and WB prior to submission to ECD for development consent and/or any commencement of works.
- Contractor to recruit an approved service provider to deliver a communicable diseases awareness and prevention program to adjacent community (prior to main worker mobilization or start of construction works) and workers. The training will be delivered throughout the subproject construction to ensure refreshers are provided.
- Contractor will employ security to ensure that access is only provided to authorized personnel and visitors. In addition to installation of physical measures (fencing, signage and gate), the contractor will implement security protocols and systems to ensure that children do not enter the works or accommodations areas.
- Priority be given to accommodating workers in existing hotels, motels, dormitories and the like and construction of a camp for workers only in the instance suitable existing accommodation is not available.
- No child labor will be employed in the subproject; the contractor must ensure that all workers are adults above the local legal age for such employment. The PMU will require the contractor to provide records of workers' age. The PMU will monitor risks of child labor and raise community awareness of the harm caused by children dropping out of school to work. These risks are considered low, as Honiara has high rates of school enrolment (89% net enrolment at primary school, National Statistics Office).
- Ensuring that sufficient water supply and temporary sanitation facilities are provided for workers at work sites in order that community infrastructure is not over-burdened.
- Security at contractor's camp and yard to control unauthorized access and prevent entry of the public (especially children).
- Handwashing facilities will be installed at all sites, and
- Workers participation in addressing GBV issues will be set in an environment where workers can openly converse about these concerns.

5.3.3.11 Potential Damage to Hidden Archaeological and Cultural Assets

826. Precautions to avoid potential damage to any archaeological and cultural assets include:

- As part of the detailed design of the sewers , any impact on identified assets (such as graves) have been avoided by re-routing the pipeline as required;
- Contractor will include the chance finds procedure in the CESMP;
- Inclusion of a chance finds procedure in the ESMP; and
- Inclusion of provisions in tender and contract documents requiring the contractors to immediately stop excavation activities and promptly inform the local authorities and Solomon Island National Museum of the presence of any previously unknown archaeological and cultural assets.

5.4 Potential Operational Impacts and Mitigating Measures

827. The key indirect operational environmental impacts associated with the subproject will be the increased volume of wastewater entering the marine environment at two specific outfall site locations. However, the operation of these two outfall systems will have an overall net positive impact on the environment within the greater Honiara area, due to wastewater being discharged offshore and not on the shoreline, significantly increased dilution achieved by discharging offshore, preventing direct public access to wastewater discharges and so on.

5.4.1 Operation Impacts on Physical Resources

828. The land-based infrastructure would include the gravity sewers and associated manholes, pump stations (PS) and rising mains. Obviously, all these items are static and will not result in ongoing physical disturbance. The six PS are all located adjacent to existing roads and ongoing access for maintenance or repairs will not result in any impacts on physical resources.

829. The outfalls traversing the foreshore and then entering the marine environment will be protected involving either anchors, armor rock mounds or an armor rock mat over the top of a buried outfall. Again, these items should only require minimal maintenance that would be accessed using a boat and commercial divers which will not result in any impact on the oceanic resource.

5.4.1.1 Natural Disaster Impacts

830. It is anticipated that there will be unforeseen events in the future due to extreme weather events. Most infrastructure is below ground or the ocean. Pump station buildings will be designed such that sensitive electrical and control systems are above flood levels.

831. SW will develop an emergency response plan in response to natural disasters. SW's staff including communities nearby will be trained on all Standard Operational Procedures (SOPs) associated with disaster management and implementation of the plan.

5.4.1.2 Generation of Site Waste

832. During operation, it is anticipated small volumes of solid and liquid waste from storage and office facilities will be generated.

833. All solid and liquid waste generated from storage and office facilities will be collected and disposed of in an approved manner and in an approved location, in accordance with local waste management by-laws or other controls. Typically this would be utilising the council solid waste collection service and connecting liquid wastes to the local sewer. Such disposal will not be permitted to cause either pollution or nuisance.

5.4.1.3 Sewage Discharges to the Sea

834. Operation of the proposed sea outfalls will greatly improve the overall environmental and health impacts of the city's sewage discharges to sea. At present, some outfalls have been broken and are continuously discharging sewage directly onto the beach. The consolidation of the outfalls from 15 shoreline and two river based outfalls, to two long ocean outfalls and retention of two recently upgraded and extended outfalls (Rove and Naha) would result in a significantly improved wastewater

management scenario. The proposed ocean outfalls will achieve much better dilution of the wastewater along the shoreline than at present.

835. Currently, the foreshore between Point Cruz and Ranadi is all Class D, which makes it unsafe for all recreational water pursuits. The proposal is between 2025 and 2050 to have Class B around Point Cruz, Class C along the foreshore and then Class D around Ranadi industrial areas. For 2050, it will be Class A around point Cruz point, Class B be between Point Cruz and Ranadi, and Class C around Ranadi industrial area. Based on the modelling results, the proposed outfall scenarios exceed these water quality bacteriological objectives for all phases at all locations, with just one area failing to meet the objectives in the short term only. This location near the NRH hospital only meets the water quality objectives 10% of the time, but just in Phase 1. This level of exceedance was considered acceptable.

836. The same model was used for the nutrient modelling, but with different input concentrations and decay rates. The results show plumes with a maximum concentration around the outfalls as expected, and a dispersion pattern essentially from East to West paralleling the shoreline. Maps of maximum concentration indicate an extensive plume for some scenarios, but these plots represent instantaneous status. The ecosystem may not have sufficient time to respond to such short nutrient elevations. Overall, as expected, higher concentrations are associated with the NRH outfall which is located in shallower waters compared with Ranadi. At Ranadi, the depth of the water column allows greater initial dilution of the plume and consequently lower surface concentrations of nutrients. The plumes from the two outfalls can intermix in some situations, for example for Phosphorus in Phase 2. Overall, nutrient modelling indicates good compliance will be achieved with the adopted water quality objectives overall.

837. Potential impacts from the outfalls on the marine physical environment would include the formation of surface slicks due to fats, oils and greases (FOGs) or other solids in the wastewater discharge. These plumes will be surfacing between 350 and 500 m offshore at the relevant diffuser locations, but would be unlikely to be visible from the shoreline. The surface slick (if any) can also reduce the oxygen transfer rate from the atmosphere into the water column. However, given that the local oceanic water is already at or near dissolved oxygen saturation concentrations, and given the mixing energy from areas outside any slick, impacts on dissolved oxygen levels in the water column would be insignificant.

838. In any case, a quarterly monitoring program will be undertaken to record any changes to the local outfalls' receiving water, and if necessary, alter the operation to suit by providing additional pretreatment at the outfall PS. The need for this intervention is considered very unlikely.

5.4.1.4 Outfall Impact on Sediment Movement

839. The outfall encasement and/or protective armor mat will be low profile to minimize the impact of wave action near the seabed. Therefore, this low profile will not have a significant impact on the longshore currents' migration of sediment. It will not act as a sediment transport barrier, particularly given that this sediment movement direction changes seasonally, and will also be affected by any short-term cyclonic conditions.

5.4.1.5 Pump Station Overflows

840. In terms of protecting both riverine and marine water resources, this could occur from short-term overflows from pump stations or associated manholes, or from the outfall discharges. Regarding the overflows associated with each of the six PS, these will only operate when a high level of wastewater is experienced within the wet well and incoming gravity sewers. The PS are all equipped with standby

pumps so if there is a pump failure from the duty unit, or the inflow rate is too high for the duty pump to control the levels within the wet well, then a standby pump will automatically start. On the rare occasions when one or both pumps fail or the inflow is extraordinarily high due to damage to the incoming sewers allowing rainwater entry, then the supervisory control and data acquisition (SCADA) system incorporated at every PS will alert the maintenance crews on a 24/7 basis.

841. The maintenance team will then be able to undertake necessary repairs to prevent, or, in the worst case, limit any resulting overflow events. However, if the wastewater level does reach the overflow pipes, then raw wastewater will be released to either the riverine or marine waters. These overflows are in some way similar to the existing outfalls which are to be removed, except that the discharges from the overflow pipes will only be very intermittent rather than continuous. Therefore, whilst there will be some short-term impact on the local water columns, this is being minimized through the standby pump configuration and SCADA systems.

842. If the overflow events are subsequently considered a local concern, then screening systems can be retrofitted on the inlet to the overflow pipes to prevent the release of gross solids, rags and other floatable material. This would significantly reduce the aesthetic impact of these very intermittent discharges but does introduce a further maintenance issue.

843. The initial development of the outfall PS will include basic screening. This will remove most of the gross solids, rags and other floatables. However, if ongoing monitoring records the formation of FOG balls or slicks incorporating solids, then the designer has included allowances for retrofitting fine screening and then grease and grit removal capabilities. This would avoid the formation of almost all slicks either due to FOG or other solids.

5.4.2 Operation Impacts on Biological Resources

5.4.2.1 Terrestrial Resources

844. It is unlikely that there would be an impact on terrestrial resources, during the normal operation of a buried pipeline, other than the recovery of cleared vegetation during trenching maintenance – repair work. There would be virtually no impact on freshwater aquatic organisms during normal operation of the pipeline. Any harm to aquatic organisms during periods of high flow and flooding would not be due to the sewer system. No mitigation is necessary

5.4.2.2 Riverine and Marine Resources

845. As noted in the previous sections on ambient water quality and ecosystems, the riverine systems near the existing outfalls are severely impacted. The subproject will replace these outfalls that have a continuous discharge with controlled overflow pipes that will only discharge very intermittently. This means that a significant improvement in the local riverine water quality, and associated biological resources, could be expected locally.

846. The biological resources along the foreshore and into the embayment have been investigated. In essence, there is very little macrobiota, either benthic or water column based. So, while the nutrient concentrations along the foreshore close to the numerous existing outfalls are elevated at present, there is little evidence of any biological impact. However, any impacts will be greatly mitigated when the nutrient concentrations along this shoreline are reduced by the diversion of flows from the existing short outfalls into the two purpose-built ocean outfalls.

847. Around the proposed outfall diffuser outlets, the marine ecological study recorded a paucity of benthic biota. No coral reefs were discovered within some 200 metres of the proposed outfall outlets, and only two very small seagrass patches were recorded at the NRH even further away from the outfall outlet. Fishers in the area utilizing small canoes were only catching very small quantities in the region of the future outfalls. Therefore, the addition of some nutrients into these offshore areas will not have measurable impacts on the local biological resources, scant as they are. In fact, it may be argued that the addition of nutrients into these depauperate offshore areas may in fact increase primary productivity through phytoplankton and nutrient cycling activity, and could lead to an improved localized biological flora and fauna resource.

848. Nutrient modelling results show plumes with a maximum concentration around the outfalls as expected, and a dispersion pattern essentially from East to West paralleling the shoreline. Maps of maximum concentration indicate an extensive plume for some scenarios, but these plots represent instantaneous status. The ecosystem may not have sufficient time to respond to such short nutrient elevations. Overall, as expected, higher concentrations are associated with the NRH outfall which is located in shallower waters compared with Ranadi. At Ranadi, the depth of the water column allows greater initial dilution of the plume and consequently lower surface concentrations of nutrients. The plumes from the two outfalls can intermix in some situations, for example for Phosphorus in Phase 2. Overall, nutrient modelling indicates good compliance will be achieved with the adopted water quality objectives overall.

849. Any biological ecosystem response to the additional nutrients offshore will not be immediate. However, it would be appropriate to undertake annual monitoring of the local benthos in the vicinity of the outfall discharge locations. This could be incorporated into the inspections proposed for the outfall diffusers as part of the physical works maintenance program.

850. Regarding the potential for utilization of marine resources, and based on the HH survey, respondents commented that they appreciate that there will be an improvement in water quality at the present outfall locations (as wastewater will be discharged further out into the ocean). The also anticipate that foul smell will be gone, and the level of pathogens reduced. However, this does not cancel out other factors contributing to the foreshore water quality. Respondents advised that there are more activities occurring near the foreshore such as the extensive ongoing reclamation, dumping of rubbish in the rivers which ended up in the ocean, contaminated runoff from developed areas, etc. Furthermore, one key issue severely limiting societal utilization of marine resources is reclamation of the seafront has very much restricted foreshore access, since the owners/developers have complete control over restricting access to the new foreshore. Furthermore the reclamation approach means there is no beach profile for pedestrian access in any case as there are seawalls associated with the reclamation areas. Historically, the seafront in almost locations could be accessed by anyone.

851. So whilst the community fully understands water quality will be improved, they still appreciate that there will be other sources of local contamination affecting foreshore water quality. Ongoing reclamation means that legal access to the foreshore is now being greatly restricted along much of the foreshore, and even if access could be obtained, there is no real beach profile available to the public as this is now submerged as a result of the reclamation seawalls being placed in deeper waters offshore.

5.4.3 Operation Impacts on Socio-Economic Resources

5.4.3.1 Noise and Odor

852. The six PS will all be equipped with submersible pumps. These pumps are located at the bottom of the concrete wet well and immersed in raw wastewater. Therefore, there will be no noise impacts from the day-to-day operation of the physical works.

853. In terms of odor, the 17 existing outfalls all currently release untreated wastewater directly to the local environment, and in some cases, above the waterline or into a dry creek bed. The removal of these discharges and replacement with two engineered outfalls and six overflow pipes (discharging only intermittently from the PS) will reduce any existing odor impacts.

854. Similarly, the wet wells at the six PS are all enclosed in a building structure with engineered vents. These physical interventions, together with the fact that the sewerage network is relatively short and therefore the sewage has not become odorous, will avoid any significant odor impacts on local receptors from the six PS.

855. The two outfall PS will be equipped with standby power generators which are contained within a generator enclosure within the overall building footprint. Therefore, on the rare occasions that these generators are actually operated, the noise impacts will be minimal and short-term.

856. The four smaller PS do not have dedicated standby generators. However mobile standby generators will be taken to the affected PS during a protracted power outage. These modern small generators have low noise ratings, will be maintained in terms of the silencers and will only operate for the shortest possible time. During the local power outages, many other residents and commercial establishments will also be starting their own standby generators, so the noise from the temporary generator at the PS will not be unique nor intrusive.

857. The PS are all equipped with the SCADA system so there is no need for external audible alarms nor flashing lights when there is a pimp failure, thereby avoiding what could be an intrusive alert system for the neighborhood. The SCADA system will allow immediate alerts to be sent to the maintenance crew without impacting the neighborhood.

858. Regular maintenance will be performed at the PS on both electromechanical assets as well as civil works. However, as mentioned above, all PS are located on or near existing roads and the maintenance vehicles and crew will not be intrusive. Programmed maintenance work such as any sanding back damaged or old painted surfaces to allow the application of new surface treatments will be done during normal working hours and not out of hours which may otherwise disturb neighboring residents.

5.4.3.2 Recreational Activities in the Marine Environment

859. Water quality monitoring results confirm that the foreshore areas in many locations and even some offshore locations failed to meet Solomon Island adopted water quality objectives for either primary or secondary contact recreation. Removal of the short outfalls and the installation of the two offshore outfalls has been extensively modelled and is predicted to significantly improve the bacteriological water quality in these areas.

860. Part of the environmental monitoring program will be to determine the real-world improvements and any adjustments required to the outfall operation or wastewater pre-treatment or even treatment, and these options can then be further investigated if required.

861. However it is extremely unlikely that any more infrastructure interventions will be required and the water quality objectives will be achieved in the timeframe presented in the modelling results above. This will lead to improved community health and safer access to the recreational and fishing grounds.

862. One of the desired outcomes from the subproject is a reduction in waterborne illness (WBI). This expected improvement in community health should lead to other benefits such as reduced sick days off work or school and reduced expenses due to doctors' visits or cost of medicines. However, it was obvious from the HH Survey that the respondents were not familiar with any of the WBIs apart from diarrhea and dysentery. Supporting this advice, there were no recorded cases in terms of WBIs at health clinics and hospital, because reportedly people did not seek medical assistance for these mild gastrointestinal illnesses, and simply used home remedies. As noted elsewhere in the EIS, this is common globally where the most common illness associated with recreating in waste water contaminated marine waters is a mild gastrointestinal illness due to the Norwalk type A virus. Globally most respondents thought this was due to drinking contaminated potable water or perhaps mild food poisoning hence the incidence of mild waterborne illness globally is grossly under-reported.

863. Given this background of no recorded WIB's at the local clinics and hospital, improvements in community health due to reduced contamination of local recreational waters will be difficult to formally quantify in the future, There may well be a reduction in general community morbidity with the commissioning of the subproject, but demonstrating this would largely have to rely on anecdotal evidence.

5.4.3.3 Ecological Status of the Marine Environment

864. The marine resource populations are currently depleted due to a very wide range of impacts – near-shore wastewater discharges, coastal reclamation and degradation, non-point source pollution, increased human population, increased fishing pressure and so on. The main driver of marine resources decline could not be attributed solely or even significantly to the existing outfalls; however the outfalls will undoubtedly be having some impact locally. Determining this quantum is not possible, however.

865. By moving the outfalls offshore and into deeper water, a wider range of marine resources will be able to utilise the nutrients compared to the current shallow water discharges. As such, over time an increase in certain resources inhabiting the area surrounding the outfalls should include a wide range of benthic organisms (feeding off the nutrients directly and/or plankton feeding off the nutrients – mainly invertebrates) which in turn support predators (wide range including fish) that feed off these organisms and so on. This could possibly create a unique ecosystem that is dependent upon nutrients discharging from the sewage outfalls.

866. These resources associated with the outfalls could in time lead to increase resource productivity – increased fish catches and possible allow commercial harvesting of sea cucumbers.

867. There should be an exclusion zone around the outfalls, at least to anchoring, so some of these resources maybe inaccessible to the community. Restricting access to the outfall sites due to anchoring limits may in time, by default, allow certain resources to grow and breed with reduced or no fishing pressure. It is probable in time that both sessile and sedentary benthic fauna, and, to a lessor degree flora (due to water depth inhibiting light penetration to the sea floor reducing and/or

precluding marine flora from surviving), will increase both biodiversity and population densities as a result of increased nutrients and subsequent and direct increase of food source. Trophic levels may well increase.

868. These fauna will progressively migrate outside the exclusion zone and become available resources.

5.4.3.4 Health and Safety Risks During Operation and Maintenance

869. Sewage spills due to accidents can threaten the health and safety of personnel. Methane gas may accumulate within the confined spaces of the structures, including gravity sewers, manholes and pump stations, and may be explosive in certain concentration ranges.

870. To reduce the operational risk and safety during operation and maintenance of wastewater system, the following measures must be implemented:

- Facility hazards identification will be conducted during the initial operation phase of the sewers, manholes and pumping stations, and updated as necessary.
- A written facility health and safety manual will be prepared, including requirements for working in live sewer systems and confined spaces access requirements

5.4.3.5 Unplanned Outages and Emergencies

871. Unplanned outages and emergencies will cause interruptions to pump station operations. Most common causes are lack of adequate backup power supplies, equipment failure and accidents.

872. To reduce the operational risk and safety due to unplanned outages and emergencies of the wastewater system:

- Identification of potential causes of unplanned outages and emergencies will be conducted during operation of the wastewater system and updated as necessary;
- Regular inspection and maintenance of the backup power supplies where present, the associated automatic transfer switch of the backup power to ensure uninterrupted operation during power failure and servicing the SCADA system;
- Regular inspection and maintenance of pumping systems and emergency backup systems to ensure that these are in good working conditions;
- Written standard operating procedures manual to be available at the facilities to provide guidance to the wastewater system's staff on how to handle unplanned outages and emergencies; and
- Regular training of wastewater system staff on how to handle unplanned outages and emergencies.

5.5 Summary

873. Implementation of the recommended actions for SW to achieve environmental compliance with SPS as identified above and as specified in the ESMP within this EIS would result in overall benefit to the surrounding environment through reduced pollution of coastal waters, reduced water-based

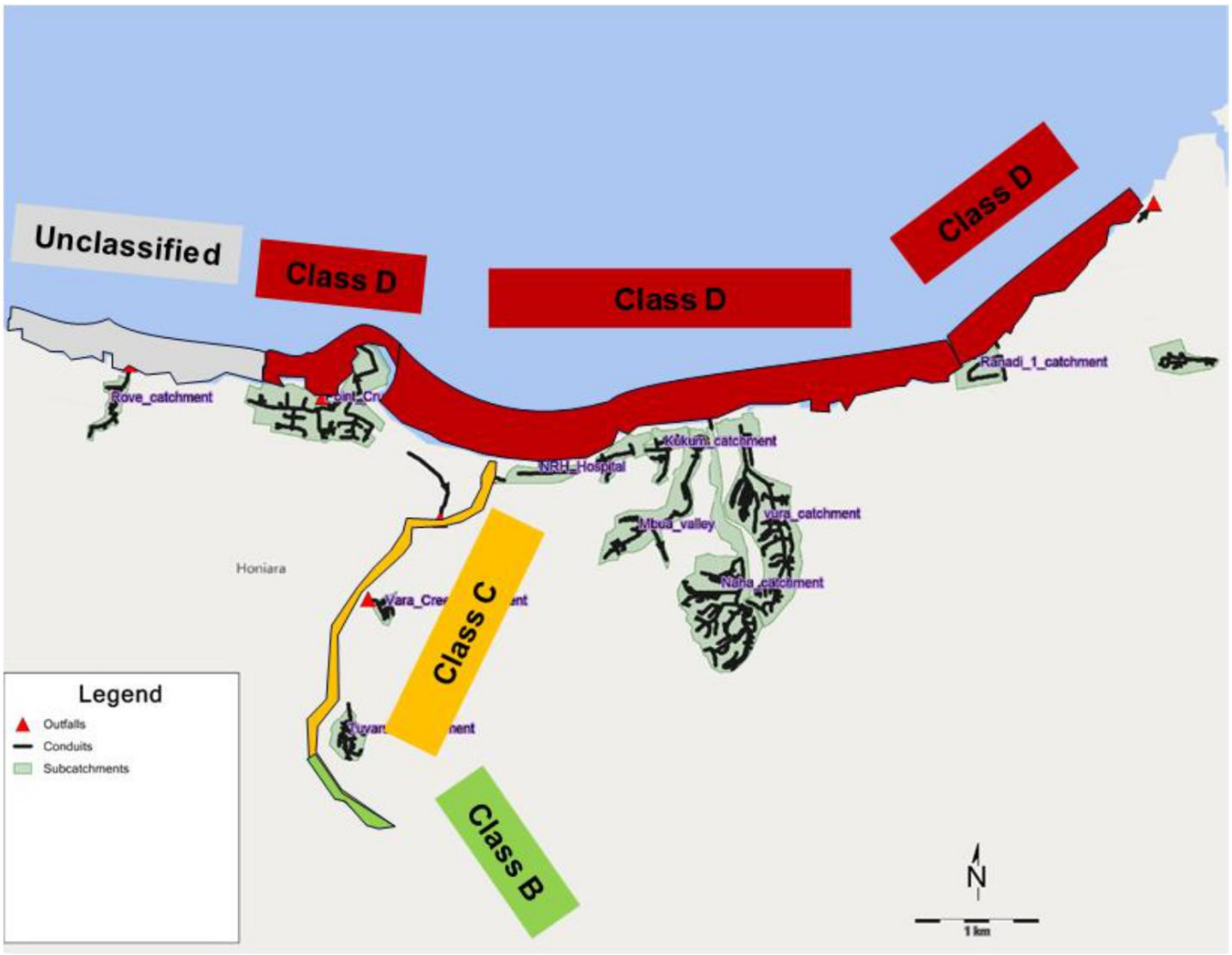
recreational health risks, improved local wastewater collection services, overall improved environmental management capacity and elevated environmental awareness of SW staff.

6 Analysis of Alternatives

6.1 Do Nothing/Without Project

874. Water quality data for the river and coastal water systems in Honiara are very limited. However, the limited data available clearly indicates that the foreshore is currently unsuitable for both primary and secondary contact recreation. This also applies to the Mataniko River and its tributaries. See **Figure 6-1: Current Water Quality Classification** based on the recreational water quality objectives adopted for recreational water quality.

Figure 6-1: Current Water Quality Classification



Source: SW Background Information Report

875. There are currently approximately 16 wastewater outfalls to the east of point Cruz, both along the ocean foreshore and within the Mataniko River system. Most discharge along the foreshore, and some are discharging directly onto the beach above high water level. So in addition to the impact on the marine water quality, there are even greater health risks associated with people coming into direct

contact with this raw wastewater exiting the numerous outfalls along the foreshore and into ephemeral watercourses.

876. The population of greater Honiara will continue to increase over time putting further pressure on the local water resources due to ever-increasing raw wastewater and both individual and community septic tank discharges. Also, there is an increasing number of informal settlement areas where wastewater is poorly managed, ranging from simple pit toilets or earth closets, through to poorly constructed septic tanks without the essential infiltration beds or absorption fields. Therefore the increasing population over time will simply exacerbate the current situation.

877. In addition to the direct exposure to raw wastewater and through aquatic contact, there is also the issue of aesthetic impact from wastewater discharges. Solomon Islands relies on tourist income and images of exposed outfalls, such as those prevalent along the greater Honiara area foreshore areas, would not be conducive to encouraging tourism.

878. In summary, the existing wastewater discharge situation presents both a health and ecosystem risk, as well as having an economic impact on tourism activities. Furthermore, these negative impacts will only worsen over time unless systemic changes are introduced.

6.2 Alternative Number of Outfalls and Location Options

879. The location, number and lengths of possible ocean outfalls have been investigated in a series of reports over four years. The first investigation[50] considered the following list of potential outfall combination options as shown in **Table 6-1: Initial Outfall Combination Options**.

[50] Urban Water Supply & Sanitation Sector Project - Honiara Wastewater Component Dispersion modelling of wastewater discharge in Honiara, Actimar Aug 2019 to Oct 2020

Table 6-1: Initial Outfall Combination Options

Scenario	Outfall	Diameter (mm)
1A	NRH 700	350
	NAHA 700	350
	RANADI 500	315
2A	NAHA 700	500
	RANADI 500	315
3A	NRH 700	500
	RANADI 500	315
4A	RANADI 500	800
3B	NRH 700	350
	RANADI 500	500
3C	NR H 500	500
	RANADI 500	315
3D	NRH 250	500
	RANADI 250	315
3E	NRH 250	350
	RANADI 250	500
3E2	NRH 350	350
	RANADI 350	500
3F	NRH 250	250
	RANADI 250	500
4F	NRH 250	350
	RANADI 250	800

Source: - Honiara Wastewater Component Dispersion modelling of wastewater discharge in Honiara, Actimar Aug 2019 to Oct 2020

880. The 3D hydrodynamic results indicated that with all the proposed scenarios, the situation along the coastline was greatly improved compared to the initial state. A 2-outfall scenario (named scenario 3) appeared to be the most efficient compared to a 3-outfall scenario, with the third outfall possibility at Naha.

881. The near-field model was then applied to confirm these first results and to compute the dimensions of the plume for each of the outfalls at different flow horizons and for different outfall length-treatment configurations. The model showed that for 2050 conditions that the shorter outfalls required wastewater treatment to provide acceptable results. For the 2025 conditions (when treatment would not be implemented), studies indicated that shorter outfalls of 250 m would not be acceptable and that outfalls of a minimum length of 350 m would be required.

882. The model demonstrated that the most critical point was to protect the area of Point Cruz, which can be reached by the plume from RH. Also, the modelling study has indicated that it would be preferable

to direct flows from Naha to Ranadi outfall rather than to the NRH outfall (even though the pumping mains would be longer). This scenario appears to be acceptable for all the considered parameters.

883. The modelling results indicate that a single outfall solution at Ranadi without treatment would be compliant in both the short and long terms (outfall of 500m length). Adding treatment at this site would enable the length of this outfall to be reduced.

884. A second study[51] further investigated a shortlisted set of options and developed capital and operating costs as well as NPVs. The selected outfall combinations together with costings are presented in **Table 6-2: Outfall Combinations and Preliminary Costings**.

Table 6-2: Outfall Combinations and Preliminary Costings

Option	Description	Outfalls				Total
		NRH Length	NRH Día	Ranadi Length	Ranadi Dia.	Cost
		m	mm	m	mm	USDM)
Scenario 3F	Two outfalls (NRH and Ranadi: Naha to Ranadi: longer outfalls)	1000	560	750	630	12.6
Scenario 3B	Two outfalls (NRH and Ranadi: Naha to Ranadi: longer outfalls)	700	500	500	500	7.7
Scenario 3E2	Two outfalls (NRH and Ranadi: Naha to Ranadi: treatment phase 2 short outfalls)	350	450	350	560	4.3
Scenario 3C	Two outfalls (NRH and Ranadi: Naha to Ranadi: treatment phase 2 medium outfalls)	500	450	500	550	6.1
Scenario 4A	One outfall at Ranadi: no treatment	Zero	Zero	500	800	5.0
Scenario 3E2>4A	Two outfalls (NRH and Ranadi: Naha to Ranadi: With all to Ranadi in phase 2 + no treatment medium outfalls)	350	400	500	800	6.6

Source: Actimar 2021. UWSSSP Project Readiness Financing – Updated Marine Impact Study

885. These costings were then further refined as per **Table 6-3: Detailed Costings for Outfall Combinations (USDM)** below.

[51] Actimar 2021. UWSSSP Project Readiness Financing – Updated Marine Impact Study

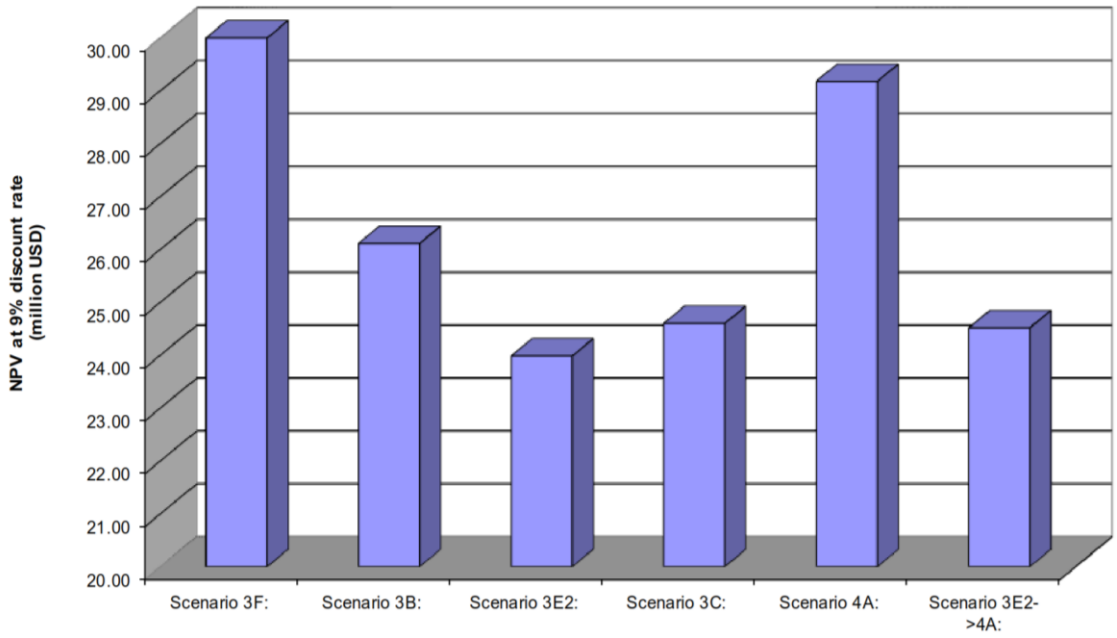
Table 6-3: Detailed Costings for Outfall Combinations (USDM)

Option	Description	Capital Cost		Annual Operating Cost at design flow		Net Present Value (million USD)			Rank by NPV for all Scenarios		
		Short Term	Long Term	Short Term	Long Term	5%	7%	9%	5%	7%	9%
Scenario 3F:	Two Outfalls (NRH & Ranadi; Naha to Ranadi; longer outfalls)	26.84	26.84	1.06	1.32	39.36	34.04	30.07	5	6	6
Scenario 3B:	Two Outfalls (NRH & Ranadi; Naha to Ranadi; longer outfalls)	22.19	22.19	1.01	1.27	34.73	29.77	26.12	4	4	4
Scenario 3E2:	Two Outfalls (NRH & Ranadi; Naha to Ranadi; Pretreatment Phase 2 ; short outfalls)	18.48	23.90	0.92	1.35	33.31	27.90	23.98	3	2	1
Scenario 3C:	Two Outfalls (NRH & Ranadi; Naha to Ranadi; Pretreatment Phase 2 ; medium outfalls)	20.61	20.61	0.97	1.24	32.88	28.11	24.60	2	3	3
Scenario 4A:	One Outfall (Ranadi), no treatment	22.71	22.71	1.32	1.69	39.55	33.58	29.18	6	5	5
Scenario 3E2->4A:	Two Outfalls (NRH & Ranadi; Naha to Ranadi; All to Ranadi P2+ No Pre-treatment; medium outfalls)	21.48	21.72	0.87	1.48	32.48	27.90	24.52	1	1	2

Source: Actimar 2021. UWSSSP Project Readiness Financing – Updated Marine Impact Study

886. This table has been summarised in **Figure 6-2: NPV Comparison** below:

Figure 6-2: Outfall Options NPV Comparison



Source: UWSSSP Project Readiness Financing – Updated Marine Impact Study, Actimar 2021

887. Clearly going immediately for a one outfall approach is not the least cost option (due to large initial OPEX costs) nor is having longer outfalls (3F).

888. Two outfall scenarios of short to medium length represent the least cost option; Scenarios 3B and 3C maintain water quality criteria (exceedance <5%); 3E2 exceeds water quality criteria in the short term (but only in 2 positions for about 10% of the time). This level of exceedance was considered acceptable.

889. Finally, a variant of 3E2 (or 3C) was proposed (3E2-4A) in which in Phase 2 there is one outfall site at Ranadi; NRH pumps to head of Naha system and then the system to Ranadi is sized for Phase 2 during Phase 1; Outfall at Ranadi sized for single outfall at 800mm diameter.

890. With this combination, Ranadi would thereafter be the long-term treatment site, although treatment may not be necessary for the long term and certainly higher forms of treatment such as activated sludge are not necessary.

891. This (3E2-4A) variant was then adopted as the preferred approach overall, with one final round of modelling to compare 350 m and 500 m outfall length options at NRH, whilst Ranadi outfall was set at 500 m long.

892. **Table 6-4: Comparison of NRH Outfall Lengths** provides the capital costs for the two options.

Table: 6-4: Comparison of NRH Outfall Lengths

Year	Option 1 Outfalls Capex 5.97M$		Option 2 Outfalls Capex 6.75M$	
2025	3E2a	350m@NRH	3Ca	500m@NRH
2035	3E2b	350m@NRH 500m@Ranadi	3Cb	500m@NRH 500m@Ranadi
2050	4A	500m@Ranadi	4A	500m@Ranadi

Source: UWSSSP Project Readiness Financing – Updated Marine Impact Study, Actimar 2021

893. The scenario described in the above table was used as the basis for the final modelling for both bacteriological and nutrient assessments. The quantitative and qualitative results indicate similar long-term results for both solutions (where only point P11 is in class B). As for the short and mid-term horizons, the water quality is improved along NRH for the second option but, improved along Point Cruz for the first. Otherwise, the differences are very small.

894. Overall, the subproject brings significant improvements in foreshore water quality. All investigated scenarios enable a very significant improvement to be made when compared with the existing situation

6.3 Alternatives and Options for Treatment

895. As part of the later modelling exercises, the option of installing treatment was considered. It is important to note the difference between pre-treatment and treatment. The current design for the two outfall pump stations includes pre-treatment such as coarse screening to prevent gross solids, rags and other floatables being discharged into the marine environment. At later stages, it is proposed to supplement this with fine screening which will also remove some of the organic load as particulates are removed. These particulates will also contain pathogens so the introduction of fine screening will slightly reduce both the oxygen demand on the marine environment and also the pathogen concentrations.

896. Consideration was also given to installing grit and grease removal facilities at the Ranadi pump station (once the NRH outfall pump station is decommissioned and all flow is directed to the Ranadi pump station and associated ocean outfall). This will provide a further marginal reduction to the biochemical oxygen demand of the wastewater and also some further small reduction in the pathogen concentrations. It will also reduce the risk of Fat, Oil and Grease (FOG) floatables forming in the ocean, and surface slicks being noticeable.

897. At this stage, consideration has not been given to installing traditional wastewater treatment such as primary settlement or secondary treatment such as biofilters or an activated sludge process. The cost of this traditional treatment, even if only primary treatment, would be significant both in terms of CAPEX and also OPEX with the need to install digesters and drying equipment for the primary settled sludge, etc.

898. As noted above, the overall approach to project development was a stepwise incremental approach, because in reality both technically and financially it needs to be stepwise. Provision has been made in the land acquisition to provide sufficient space for future wastewater treatment facilities. However these will not be provided initially, and may only be needed in later stages post 2050. In addition to

the cost savings both capital and operating, sewage treatment plants can only operate over a range of loadings and the initial flow rate is far too small to allow the development of the wastewater treatment plant without being forced to adopt a small module size and therefore cost ineffective staging approach. These additional costs will have social impacts as the charges then to be levelled on the community will be significantly increased.

899. A number of options have been considered concerning the potential future treatment scenarios, notably:

- Scenario 1: Long outfalls and independent septage treatment (biological compact treatment);
- Scenario 2:Short outfalls, independent septage treatment and wastewater treatment (implemented at a later phase eg 2035);
- Scenario 3: Short outfalls, combined septage and sewage WWTP at Ranadi site (short term) and NRH site (2035) (with digestion)
- Scenario 4: Short outfalls, combined septage and sewage WWTP at Ranadi site (short term) and NRH site (2035) (with sludge transferred to Ranadi)

900. The following table provides an estimate of CAPEX for each scenario. This estimation does not take into account the cost of the networks nor the outfall pumping stations/outfalls which are generally similar for each scenario (although Scenarios 1 to 3 willhave lower pumping station and outfall costs).

Table: 6-5: CAPEX estimates (USD) for each treatment scenario

Item	Scenario 1	Scenario 2	Scenario 3	Scenario 4
PHASE 1				
Fine screens	440,000	440,000	440,000	440,000
Septage treatment	2,192,000	2,192,000		
Combined septage and wastewater treatment			3,948,000	3.948,000
Wastewater treatment			6,353,000	
Total phase 1	2,632,000	2,632,000	8,497,000	4,388,000
Phase 2				
N H wastewater treatment with digestions			4,109,000	
NR H wastewater treatment (digestion at Ranadi)				3,698,000
Total phase 2	0	0	4,109,000	3,698,000

Source: SUEZ. Detail design update, 2019

901. Therefore, the capital cost of providing wastewater treatment alone is in the order of US$6 million for the phase under consideration, compared with US$21 million for the project without wastewater treatment.

902. For the sake of comparison, the final nutrient water quality modelling run assumed that primary treatment was installed and therefore total phosphorus would reduce from 10 mg/l to 2 mg/l. However, there would be insignificant impact on the total nitrogen concentrations. This primary treatment system could be assumed to provide a further 50% reduction in pathogens and therefore indicator organisms.

903. If the primary concern remains wastewater-sourced pathogens in the water column, then providing disinfection of the wastewater may be attractive in theory. However, in reality, it is extremely, difficult to disinfect raw wastewater. For example, if a strong oxidizing agent was to be used, such as chlorine or chlorine dioxide, these oxidants would also attack the oxygen demanding organics within the wastewater and not just the pathogens. Therefore extremely high dosage rates would be required which would not only be expensive, but also forms potential carcinogens such as trihalomethanes which should not be introduced into the aquatic environment. Alternative disinfection systems such as ultraviolet irradiation will only be effective if the wastewater is reasonably clear and the light has the opportunity to reach the pathogens. With untreated or just pretreated raw domestic wastewater, pathogens would be shielded by the organics and other particulates within the wastewater and therefore UV systems would be ineffective. Therefore disinfection alone will not be possible.

904. There are many ocean outfalls globally that discharge wastewater that has only received screening or other pre-treatment. These have been very closely monitored and have generally proven successful in both protecting marine ecosystems and also providing suitable concentrations of pathogen reduction to allow safe recreational water activities. An example would be at the premier beaches such as Bondi in Sydney, Australia. But should ongoing monitoring indicate a need for treatment, there is sufficient space at Ranadi to retrofit additional treatment stages.

905. The alternatives to ocean outfalls are effectively limited to two different approaches. One is to provide additional treatment and perhaps incorporate a dispersed treatment approach, to provide treated effluent to the city council and even citizens for irrigation of recreational areas such as parks and sporting fields. However, there are many requirements about withholding periods et cetera that would need to be applied and would add to the cost by needing to provide large wet weather storages.

906. Alternatively the treated effluent could be used in agricultural pursuits. Again there are restrictions on what sort of crops can be irrigated with treated effluent, and also various withholding periods preventing harvesting until after a certain time has elapsed following irrigation with treated effluent. There are also operational protocols that have to be followed such as not consuming any food that may have dropped from trees onto the irrigated soil et cetera. Again given the protracted wet season climate locally, there would be a need for extensive wet weather storage and it would not be unusual to require up to 90 days of wet weather storage. This would require a very large area and associated capital cost because the land has to be essentially flat for the efficient construction of wet weather holding dams.

907. Other options are even more expensive such as treating the effluent to a standard where it can be used for use in households for toilet flushing and garden watering. But this requires very expensive retrofitting of dual reticulation and very good community commitment to observing the associated potential health protocols involved if the treated effluent is mishandled. The ultimate is of course to treat the effluent so it can be consumed directly, that is direct potable reuse, but that is far too

expensive and complex, and considered completely inappropriate for the local technical-capability environment and funding sources given the very high operating costs.

7 Grievance Redress Mechanism

7.1 Purpose

908. This Grievance Redress Mechanism (GRM) is designed to deal with grievances from the public in relation to SW-managed projects at all stages of the project cycle. To date, the GRM has been delivered in English. Awareness of the GRM has been made through consultations in English and Pidgin. Documentation is currently in English but will be provided in Pidgin in future.

909. SW already has an established and well-functioning GRM and this is being implemented for the project overall and will also apply to this subproject.

910. The mechanism allows for affected parties to make known grievances as they arise and aims to provide a predictable, transparent, timely and credible process to all parties, resulting in outcomes that are fair, effective, and lasting.

911. Inward communications to SW will be filtered at the initial query stage as being project-specific or general enquiries by the customer relations team within SW. All external project communications and sites have project identifiers and unique names that allow customers to identify the potential project. Project-specific queries will be dealt with confidentially by the Community Liaison Officer and a determination made as to the nature and whether a grievance need to be raised. Generally, this will involve contacting the requestor.

912. The GRM will be highlighted to all employees of the contractor and will be included in the site induction. Where third party agreements are struck with groups or individuals, the GRM will be highlighted, and the contact details of the Project Manager will be communicated. It will be noted that this is in addition to their rights under Solomon Islands Law which is applicable in all senses.

913. The Project Managers, as the delegated authority on the contracts will be responsible for managing grievances within the PMU.

7.2 Process

914. The SW GRM is a three-stage process during any stage of which the grievance may be considered, by both parties, to have been resolved and closed off. The Grievance Log Information Sheet associated with the GRM is provided as **Appendix 17: Grievance Redress Forms.**

7.2.1 Stage 1

915. Any grievance should first be made known to the Solomon Water Project Team Manager (PTM) in charge of the project being implemented. This may initially be verbally however a monitoring form must be prepared and signed off by the party raising the grievance – support to filling in the form can be provided by Solomon Water to the aggrieved party.

916. On receipt of the Grievance Monitoring form the PTM will hold a meeting with the aggrieved party in an attempt to resolve the grievance within 5 working days of the grievance being raised. Following the discussion, the grievance may either be resolved or needs to be escalated to Stage 2.

917. A Stage 1 Grievance Outcome form should be prepared by the PTM confirming either:

- The grievance has been resolved and the means of resolution;
- The grievance has not been resolved; and outlining Solomon Water Projects Team position on the grievance.

918. Any grievance should first be made known to the Solomon Water Project Team Manager (PTM) in charge of the project being implemented. This may initially be verbally however a monitoring form must be prepared and signed off by the party raising the grievance – support to filling in the form can be provided by Solomon Water to the aggrieved party.

919. Complaints can be made through different channels, such as the traditional local practices (e.g. village chiefs), online, phone, in-person, the local GBV/Human Trafficking/CAE Service Provider, the manager(s), or the Police. Complaints should be able to be made in different ways such as online, via telephone or mail, or in person. Anonymity should be ensured if the complainant so desires it, especially about GBV/Human Trafficking/CAE.

920. The Stage 1 Grievance Outcome form should be signed by both parties and a copy provided to the party raising the grievance. This form should include the next steps in the process if they consider the issue not to be resolved.

7.2.2 Stage 2

921. If the grievance is not resolved under Stage 1, the grievance should then be referred to the General Manager (GM) of SW.

922. The GM will be provided with the Stage 1 Grievance Outcome form and a meeting arranged with the aggrieved party within 10 working days of issue of the form to discuss and try to resolve the grievance.

923. Based on the discussion the General Manager will issue a Stage 2 Grievance Outcome form confirming either:

- The grievance has been resolved and the means of resolution;
- The grievance has not been resolved and outlining Solomon Water General Manager position on the grievance.

924. The Stage 2 Grievance Outcome form should be signed by both parties and a copy provided to the party raising the grievance. This should include the next steps in the process if the issue has not been resolved.

7.2.3 Stage 3

925. If the grievance is not resolved under Stage 2 the grievance should then be referred to a three-member Grievance Tribunal[52] comprised of:

- A member of the Board of SW;

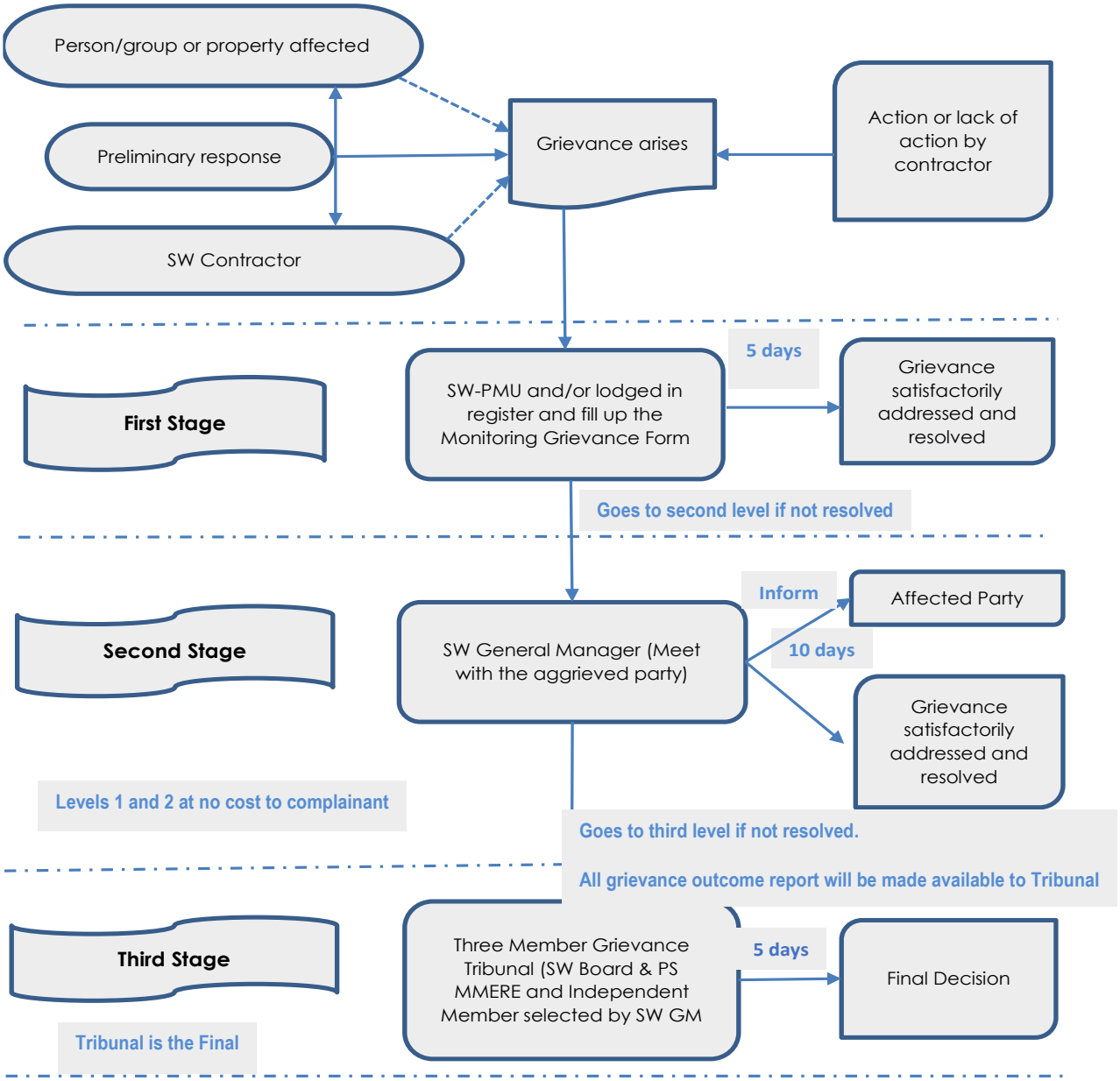
[52] The composition of the Grievance Tribunal should always ensure at least one female member and where the complainant is female should consist of two female members and one male member.

- The PS (or designate) of the MMERE;
- independent member selected by GM SW and Board Chairman.

926. All prior Grievance Outcome reports will be made available to the Tribunal; A meeting with the aggrieved party will be held within 10 working days of issue of the Stage 2 Grievance Outcome Form.

927. Within 5 working days of the Tribunal meeting a formal response will be issued to the aggrieved party outlining the Tribunal's decision on the grievance raised. The Tribunal's decision will be final.

Figure 7-1: Grievance Redress Mechanism



7.2.4 Miscellaneous

928. Whenever a grievance is resolved to the satisfaction of both parties, at whichever stage this is achieved, a written record of the agreement must be made and signed by both parties.

929. At all stages of the process the aggrieved party has the right to be represented by a third party at their own cost. The GRM nor its final decision does not affect the legal rights of the individual.

930. Provisions can be made for persons who cannot read, may have a learning disability, and/or need the written record provided in a written language other than English e.g., having it read to them, translated to a different language etc. when there is a need recognized by local community feedback.

931. SW is responsible to maintain an accurate register of grievances and the way they are dealt with.

932. SW Staff are all familiar with the GRM process and how to raise a grievance. As grievances require close out, a plaintiff must be identified. This preserves the ability to clarify and follow up grievances and agree outcomes. A SW staff member or any person may raise a grievance on behalf of someone but there must be a contact available for correspondence and close out. Solomon Water keeps private details of peoples raising grievances, the specific details of, and any details of settlements on a separate drive on their server which is accessible only to executive staff. Absolute confidentiality cannot be assured as SW encourages the raising of grievances to any officer or contract staff regardless of station.

933. Each stage in the process allows an appeal through escalation. After the SW Grievance Redress process has been completed to Stage 3, if the plaintiff is still not satisfied, they will be advised that they have legal measures available to them including the right to appeal through Solomon Islands judicial system.

934. SW Projects Team must hold a grievance review meeting at least once every 6 months to report on all grievances received and in process.

935. A Grievance Log must be maintained by the Solomon Water Projects Team and an annual report provided to the GM of Solomon Water – this should identify grievances raised (month and to date), grievances resolved (month and to date) and balance of grievances outstanding with specific actions pending. Key information to be included in the grievance log can be found in **Appendix 17: Grievance Redress Forms**, and includes the type of problem or grievance:

- Land related;
- Compensation;
- Construction;
- Resettlement site; and
- Other (specify).

936. In Solomon Islands, complaints about environmental performance of projects issued a Development Consent may also be brought to the attention of ECD of the MECDM. ECD is mandated by law (Environment Act of 1998 and the Environment Regulations of 2008) to monitor the projects issued with a development consent and address concerns, complaints, and grievances of the public regarding project performance.

8 Environmental and Social Management Plan

8.1 Introduction

937. The role of ESMP is to outline the mitigation measures to be considered during subproject implementation and operation to avoid or control adverse environmental and social impacts, and the actions deemed necessary to implement these measures.

938. Environmental assessment has determined that the subproject will have only minor negative impacts on the environment, but counteracting significant positive impacts. Social impacts are not expected to be significant with land acquisition and resettlement impacts generally avoided and residual impacts mitigated. The subproject can be implemented in an environmentally acceptable manner provided that the mitigation measures to avoid or reduce the environmental impacts will be provided. This ESMP includes: (i) implementation arrangement, (ii) mitigating measures to be implemented; (iii) required monitoring associated with the mitigating measures. It also describes the institutional roles and responsibilities during pre-construction, construction, and operation phases.

939. The ESMP contains the components crucial to effective environmental management of the subproject including: i) organizational responsibilities (for various aspects of EMP implementation); ii) consultation and information disclosure; iii) Grievance Redress Mechanism; iv) plan for mitigation of impacts (during pre-construction, construction and operation); and, v) monitoring and reporting.

940. An ESMP is developed to achieve the following objectives:

- To reflect the environmental and social issues and impacts identified during subproject preparation;
- To implement and monitor mitigation measures within the construction areas;
- To comply with the laws and regulations of the country and with international standards and best practice guidelines;
- To continuously control the changes to baseline environmental, health, safety and social conditions during pre-construction, construction and operation activities;
- To facilitate a continual review of activities based on performance data and consultation feedback; and,
- To implement corrective actions or new adaptive management programs, as required.

941. The environmental assessment of the construction, operation, and maintenance of the subproject has determined that the subproject will have an insignificant impact on the local environment. Environmental mitigation measures have been proposed to avoid or minimize environmental impacts to acceptable levels.

8.2 Institutional Arrangement

942. **MOFT & SW**: The MOFT is the executing agency for the project and SW is the implementing agency, operating through a PMU including in particular specialists associated with environmental and social safeguards.

943. **Project Management Unit:** SW has established a PMU to prepare and implement the subproject. There are seven staff in the PMU including four safeguard specialists. SW will increase numbers as required during implementation including E&S inspectors during the construction works.

944. Safeguards specialist staff within the PMU are to be assigned to undertake aspects of environmental management and oversee monitoring tasks during the development and delivery of the subproject, in an audit role. The PMU safeguards specialists will assist in all aspects of the implementation of the environmental assessment and permits as required. They will also be undertaking their own monitoring and evaluation (M&E) and capacity building of other PMU non- environmental staff and MECDM and other relevant government agencies.

945. **Construction Contractors:** The contractors undertaking the works will be responsible for ensuring that their activities comply with the environmental and social safeguard requirements and development consent conditions of the contract including the technical specifications. The Contractor's ESMP (CESMP) will be the guiding document for the implementation of this ESMP. During works, the CESMP will be reviewed and approved based on the requirements of the ESMP and will be the guiding management plan for the practical implementation of these requirements. The CESMP will contain the contractor's methodology and plan for adhering to their safeguard requirements. Additionally, the CESMP will detail how the Contractor plans to resource their team with personnel and financial resources as per the Contract. The Contractor will include the sufficient provision in their Bill of Quantities (BOQ) to ensure that the CESMP can be developed, implemented, and monitored by their Safeguard Specialist. As this role will be key personnel within the bid document, the Contractor is obliged to ensure that their BOQ item is sufficient for this person to carry out their duties as required in this ESMP and the contract.

946. The CESMP and associated sub-management plans will be developed, approved, and disclosed before the commencement of civil works. The bid documents will require that the CESMP be developed by the Contractors Safeguard Specialist and after internal review and approval, it will be subject to approval from the Supervision Engineer who will coordinate a review with the PST Safeguard Specialists. Once the CESMP has been approved, it will be disclosed by the Contractor and the PST using the same methods as required for the ESMP disclosure.

947. **Environment and Conservation Division, MECDM:** The ECD)will review the development consent applications and issue, either with or without conditions, the consents. The ECD will be invited to participate in joint inspections and audits during construction activities.

948. A summary of the environmental and social management responsibilities for the subproject is presented in **Table 8.1.**

Table 8-1: Summary of Environmental and Social Management Responsibilities for the Subproject

Project Implementation Organization	Management Roles and Responsibilities
Asian Development Bank / World Bank	▪ Review and clear EIS/ESMPs ▪ Review bidding documents ▪ Review executing agency and implementing agency's submissions for procurement of goods, equipment, works and services ▪ Conducts project review missions, midterm review mission and project completion review mission to assess project implementation progress of all outputs, compliance of project to covenants including safeguards requirements ▪ Provide environmental and social safeguards capacity building to the PMU during missions and remotely as required. ▪ Review semi-annual and annual environmental and social monitoring report

Project Implementation Organization	Management Roles and Responsibilities
Ministry of Finance and Treasury (executing agency)	▪ Guide and monitor overall project execution ▪ Financial oversight ▪ Ensure flow of funds to the implementing agency and the timely availability of counterpart funding
Project Steering Committee (PSC)	▪ Responsible for oversight and providing guidance and strategic direction to SW with respect to project implementation ▪ Ensure that the PMU is provided with the necessary resources to effectively carry out its duties and responsibilities.
Solomon Islands Water Authority (implementing agency)	▪ Responsible for overall project implementation and monitoring at the implementing agency level ▪ Ensure adequate funding available for the PMU ▪ Submit semi-annual and annual monitoring reports to ADB and WB ▪ Assist in resolving complaints brought through the Grievance Redress Mechanism (GRM) that have not been resolved at lower levels
SW Project Management Unit	▪ Responsible for overall project management, implementation and monitoring ▪ Responsible for SW's application for a Development Consent ▪ Update the EIS and ESMPs based on the detailed design and submit to ADB and WB for clearance ▪ Ensure environmental safeguard concerns are incorporated in the detailed engineering design ▪ Disclose safeguard documents, as appropriate ▪ Conduct awareness and consultations as per the CCP ▪ Submit monthly, quarterly, semi-annual, and annual monitoring report to SW Management ▪ Review and clear the CESMP of contractors ▪ Review contractor's monthly reports ▪ Implement the GRM and maintain records of complaints/grievances ▪ Ensure the contractor observes the GRM requirements ▪ Ensure contractor compliance with required resources for mitigation measures as reflected in the CESMP ▪ Issue the Community Advisory Committee guidelines to the contractor at Bid Award
PMU Environment/Social Officer	▪ Ensure EIS/ESMPs are updated based on the final detailed designs and their disclosure in locations and form accessible to the public ▪ Coordinate with the preparer of bid documents for the inclusion of EIS/ESMPs and CESMP frameworks in the bidding documents and civil works contracts ▪ Ensure required government permits and clearances acquired by SW prior to actual construction activities ▪ Establish system for monitoring environmental and social safeguards of the Project as described in the EIS/ESMPs ▪ Review, monitor, and evaluate the effectiveness of implemented mitigation measures and recommend corrective actions whenever necessary ▪ Prepare monthly environmental monitoring reports for consolidation to the semi-annual monitoring reports for SW and ADB ▪ Ensure GRM is activated prior to the start of construction ▪ During construction, conduct monthly and additional *ad hoc* site visits as necessary and coordinate with the project engineers to ensure that required environmental and social mitigation measures are implemented at the construction sites, ▪ Provide training for contractors' environment and safety officers to ensure they understand the ESMP requirements; and ▪ Coordinate with the contractors' EHSO to ensure that environmental and social awareness trainings for workers are done.
PMU Land Officer	▪ Responsible in dealing with land acquisition issues as detailed in LARP
Contractor	▪ Prepare and submit the CESMP prior to construction for review and approval of PMU ▪ Understand the ESMP requirements and allocate necessary resources for implementation

Project Implementation Organization	Management Roles and Responsibilities
	▪ Employ a full-time health and safety officer and an environmental officer as necessary to ensure compliance with all requirements concerning environmental, health, safety, social and labor regulations during construction. In addition, the archaeological findings will be handled by environmental officer in consultation with PMU land officer. ▪ EHSO also provides capacity building and training for workers on CESMP requirements as needed ▪ Implement construction activities with the required mitigation measures ▪ Conduct environmental and social monitoring as required by ESMP ▪ Act promptly on complaints and grievances concerning the construction activities by the project's GRM ▪ Submit monthly progress reports on CESMP/ESMP implementation to PMU ▪ Publish a construction notice in local media and distribute the notice to affected community members prior to the commencement of construction on-site. ▪ Establish a Community Advisory Committee (CAC) within 4 weeks of the publication of the construction notice. ▪ Hold a minimum of three (3) CAC meetings at the start, during and at the completion of construction works. ▪ Contractor's Terms of Reference for the EHSO (Secretary for the CAC) will include the role, tasks and activities described in the CAC Guidelines.
ECD	▪ Responsible for reviewing and processing of SW's application for a Development Consent ▪ Monitors construction progress for compliance with the terms of the issued Development Consent ▪ Monitors implementation of the mitigation measures and the ESMP in general
Ministry of Mines, Energy and Rural Electrification (MMERE)	▪ Responsible for processing of contractor's application for a BMP regarding mining and extraction of aggregates or gravel from rivers ▪ Monitors contractor's compliance with the terms of the issued BMP

Source: Adapted from EARF, 2019.

8.3 Environmental and Social Management Plan

949. The ESMP (including monitoring requirements) for Honiara wastewater system subprojects are presented in **Table 8.2**.

Table 8-2: Environmental and Social Management Plan for Pumping Stations, Associated Sewer Lines and Outfalls Subproject

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
PRE-CONSTRUCTION PHASE							
Cross Cutting							
Improper implementation of ESMP	Tender documents and construction contract will require the following: i. Issuance of Environmental and Social Management Plan (ESMP) to bidders. ii. Preparation of CESMP prior to construction activities. iii. Review and approval of CESMP by the PMU prior to site mobilization.	Part of contractors' bid cost	Design Consultant and Contractor	SW's PMU	CESMP	CESMP submission prior to commencement of site works	Minimal cost (part of contractor's task)
Extraction of local construction materials	The contractor will provide sufficient information about the source of construction materials to be used in the subproject. Sources such as quarries and borrow pits should be: i. Licensed. ii. Covered by required government permits. iii. Not located within 300 meters of any urban sensitive receptors. iv. Provided with drainage and sediment flow controls. v. Provided with abandonment plan such as rehabilitation using topsoil and fencing and placing of warning signs.	Part of contractors' bid cost	Contractor	SW's PMU	Government permits, license of quarries and borrow pits Operational and abandonment plan	Visual inspection of source Verification of operational and abandonment plan Weekly	Minimal cost to SW
Environmental Capacity Development	The contractor prior to mobilization will conduct orientation for its workers and subcontractors on the provisions of the CESMPs focusing of the mitigating measures to minimize impact of construction.	Part of contractors' bid cost	Contractor	SW's PMU	Number of trainings conducted, and workers trained	Attendance sheets	Part of contractors cost

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
UXO Survey Review	Measures include: i. Review the UXO clearance certification to ensure it is complete and covers all proposed working areas, including lay down locations.; and ii. Chance Find Provisions are included in the contract.	Part of Contractors' bid cost	Contractor	SW's PMU Land Officer	Survey and any remediation has been carried out by approved personnel and organizations	Certificate showing the subproject area is UXO free	Minimal cost to SW for management response
Physical Environment							
Climate change vulnerability	Climate change adaptation measures are: iii. Conduct of hydrology and onsite flooding study. iv. Engineering assessment on potential site erosion. v. Appropriate erosion protection for sewer and outfall lines will be determined.	Part of detailed design cost	Design Consultant	SW's PMU	Engineering drawings and specifications	Verification of engineering drawings and specifications	Minimal cost (part of consultant's task)
Beach water quality impacts from raw wastewater discharge to sea	Measures include: i. Conduct dispersion modelling. ii. Assessment of pathogens contaminants concentrations in nearshore areas.	Included in Detailed Design Consultant's scope and cost	Contractor	SW's PMU	Nearshore and beach water quality parameters	Dispersion modelling for detailed design of outfalls	Minimal cost (part of consultant's task)
Biological Environment							
Introduction of Alien/Invasive Species	All construction equipment (heavy plant machinery such as bulldozers, excavators, trucks, etc.)) is expected to be sourced locally. In case specialist equipment and materials need to be imported as part of the construction components (such as pumps, fittings or electronics), and including the vessels that	Part of contractors' bid cost	Contractor	PMU	Phytosanitary certificates from Biosecurity Solomon Islands	Verification of certificates	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
	import them, will be subjected to clearance procedures under the Bio-Security Act and Regulations and may require issuance of phytosanitary certificates from Biosecurity Solomon Islands.						
Socio-economic Resources							
Impacts on the sensitive receptors (churches, schools, hospitals, etc.)	Use of appropriate construction techniques which results in less disruption to public, especially the sensitive receptors. Specific consultation will be undertaken with these communities and stakeholders before and during construction activities to ensure that impacts are minimized, and community safety is ensured, especially when doing works during sensitive times, such as school and church hours.	Part of detailed design cost	Design Consultant	SW's PMU	Contractors' construction methodology Notification of affected stakeholders especially sensitive receptors	Verification of construction methodology Coordination meetings and notifications	Minimal cost to SW
Stakeholder Awareness and consultation	Develop a consultation and communication plan (CCP) to guide stakeholder consultations with the Contractor as required over the course of the subproject. Key stakeholders' engagement should be undertaken in accordance with ADB and WB requirements. Identify key stakeholders and conduct initial consultations including those affected communities and sensitive receptors for the proposed activities. Continuous awareness and consultations to keep the stakeholders updated on the latest development of the subproject.	Part of detailed design cost	Design Consultant	SW's PMU	IEE/EIS/ESMP	Verification of SEP and CCP	Minimal cost (part of consultant's task)

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Complaints due to subproject-related impacts	SW's PMU and the contractors will: i. Establish the approved subproject's grievance redress mechanism (GRM). ii. Publicize the existence of the subproject's GRM through campaigns, website, billboards, etc. iii. Ensure that the contact details are placed on notice boards and/or website.	Part of contractors' bid cost	Contractor	PMU	Consultation meetings Tender documents GRM activated with community advisory committees (CACs)	Verification of minute of meetings documents, tender documents and CAC in placed. After completion of meetings Once after preparation of tender documents prepared	Minimal cost (part of contractor's task)
Land Access Arrangements	There will be no land acquisition but instead, building wastewater infrastructure will require securing easements from identified property owners who have all provisionally agreed (pending SSEC confirmation) to provide land access/ownership for the sewers and rising mains. The 6 PS sites require land acquisition, but SW will secure this through negotiated agreement under the principle of "willing buyer and willing seller" thus will not trigger the ADB Safeguards Policy Statement (2009). These discussions are well advanced.	To be part of the subproject cost.	SW	SW	Detail design minimizes relocation	No Relocation.	Minimal by PMU

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
CONSTRUCTION PHASE							
Physical Environment							
Soil erosion and sedimentation control	Earthworks and areas to be exposed to be carefully planned; Measures to divert surface runoff away from the exposed areas and to prevent sediment from moving offsite may include: i. Small interceptor dikes. ii. Pipe slope drains. iii. Grass bale barriers. iv. Silt fence, v. Sediment traps. vi. Temporary sediment basins. vii. Replanting disturbed areas. The contractor will be required to prepare an erosion and sediment control plan as part of their CESMP.	Part of contractors' bid cost	Contractor	SW's PMU	Disturbed sites Use of appropriate sediment controls	Visual inspection of sites Verification of plans Daily during rainy periods	Minimal cost to SW
Disposal of excavation spoils and other solid wastes	The PMU will: i. Require a waste management plan as part of the CESMP. ii. Provision of garbage bins for temporary storage of waste. iii. Separate solid waste into hazardous, non-hazardous and reusable waste. iv. Regular disposal of wastes to an accepted disposal site. v. All waste to be covered when hauling. vi. inspection of disposal site prior to construction.	Part of contractor bid cost	Contractor	SW's PMU	Contractor's disposal plan	Inspection of disposal site After submission of disposal plan	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Oil and hazardous materials management	Measures for clean-up and handling of contaminated materials: i. Training on how to handle fuels/hazardous substances and how to contain spills. ii. Provision of spill clean-up materials such as absorbent pads, iii. Immediate clean-up of spills. iv. All wastes to be appropriately stored prior to disposal, in a roofed area with hardstand floor and bunded as required. v. Collection and disposal of oil-stained wastes and used oil, as well as any segregated hazardous waste, through authorized waste handlers and waste facilities. vi. Restoration of temporary work sites will include removal, treatment, and proper disposal of oil contaminated soils and any containers	Part of contractors' bid cost	Contractor	SW's PMU	Measures required to prevent accidental releases. Records of accidental releases. Measures for clean-up and handling of contaminated materials. Training records of personnel for hazardous materials;	Visual inspection of storage area; Verification of records Daily and as necessary	Minimal cost to SW
Removal of Existing Outfalls and Beach Clean-up	Measures to include: i. Inventory of the existing outfall components to be removed. ii. Preparation of removal and disposal plan for the existing outfall components. Some components may be left Insitu but decommissioned and plugged, such as Nara outfall which is encased in concrete. iii. Conduct beach and river bed clean-up of the area near the existing outfalls as may be required. iv. CESMP to provide details to ensure compliance.	Part of contractors' bid cost	Contractor	SW's PMU	Removal and disposal plan of existing outfall components Contaminated beach and riverbed materials	Visual inspection of sites Daily	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Biological Environment							
Loss of vegetation	SW's PMU and the contractors will: i. Conduct bio-physical assessments. ii. Limiting vegetation clearing. iii. Provide temporary fencing to protect retained vegetation. iv. Securing tree cutting permit. v. Promote restoration by planting trees near the subproject site.	Part of contractors' bid cost	Contractor	SW's PMU	Disturbed sites Plans and permits and clearances from relevant government agencies	Visual inspection of sites Verification of plans and permitting requirements	Minimal cost to SW
Marine bottom disturbance	Measures include provision of silt curtains or other appropriate methods during installation of outfall pipeline on foreshore and inshore environment.	Part of contractors' bid cost	Contractor	SW's PMU	Silt curtains or other appropriate methods	Visual inspection of sites Daily	Minimal cost to SW
Socio-economic Resources							
Disruption of utilities and services	SW's PMU and the contractor's will: i. coordinate with the other utility companies regarding the location of all services and note any potential disruptions ii. make provisions to preserve the operation of current facilities; and iii. provide prior notification to affected households and establishments	Part of contractors' bid cost	Contractor	PMU	Coordination with the other utility companies Notification of affected households and establishments	Verification of coordination meetings and notifications After completion of meetings and notifications	Minimal cost to SW
Waste Generation including the demolition materials	CESMP to include: i. Prepare a waste management plan as part of the CESMP. ii. Provide garbage bins and facilities within the subproject site for temporary storage of construction waste and domestic solid waste.	Part of contractors' bid cost	Contractor	PMU	Visual site inspection and implementation of the waste management plan	Weekly	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
	iii. Separate solid waste into hazardous, non-hazardous and reusable waste streams and store temporarily on-site in secure facilities with weatherproof flooring and roofing. iv. Ensure that wastes are not haphazardly dumped within the subproject site and adjacent areas. v. Encourage re-use of excavated excess soi and recyclables. vi. Regularly dispose of wastes to an accepted disposal site (e.g. Ranadi Landfill) as approved by SW-PMU. vii. Hazardous waste is to be separated into the relevant types and disposal options agreed with SW's PMU. viii. Prohibit burning of all types of wastes. ix. Solid Waste Management Plan to be completed following requirements of EIS. SWMP will be included as an appendix to the CESMP for clearance. x. At all times, the Contractor is responsible for the safe and sound disposal of all solid waste generated by the Works.				Contaminated beach and river-bed materials		
Dust and on-site air pollution due to construction activities	Interventions for air pollution from construction activities: i. Regular water spraying of roads, work areas, stockpiles and other construction-related facilities to minimize dust generation. ii. Provision of cover in storage area of construction materials, stockpiles and spoils to prevent fine materials from being blown away. iii. Prohibit use of equipment and vehicles that emit dark smoke and particulate emissions.	Part of contractors' bid cost	Contractor	PMU	Dust generation Smoke emitting equipment, Open burning of materials	Visual inspection of sites Daily	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
	iv. Provision of tight tarpaulin cover on delivery trucks to avoid spills and dust emission; and v. Prohibit burning of all types of wastes generated.						
Construction noise and vibration	Measures for construction noise and vibration: i. Prior notification to the community on schedule of construction activities especially any nighttime activities. ii. Provision of noisy equipment with noise reduction covers and well maintained mufflers/silencers. iii. Position stationary noisy equipment (genset, compressors, batching and rock crushing plant, etc.) away from houses and other receptors. iv. If possible, avoid working during nighttime (19:00-06:00). v. Require baseline noise monitoring pre-construction in addition to regular noise monitoring during construction. vi. Conduct regular noise level monitoring (the limits near residential area are 55 and 45 dB(A) during daytime and nighttime, respectively), after making allowance for background noises outside of the control of the contractor, such as local traffic noise. If noise levels are excessive, then the CESMP will identify appropriate mitigation measures, such as using quieter plant or moving any stationary plant further away from receptors. vii. If elevated noise is unavoidable, then ensure that the local receptors are advised that all practicable noise reduction measures have been implemented and advise the affected	Part of contractors' bid cost	Contractor	PMU	Noise level Normal operation schedule	Noise meter Daily / as necessary	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
	community of the proposed duration of the noisy works.						
Vehicular traffic congestion hindrance to public access	Measures for accessibility: i. Preparation of Traffic Management and Control Plan (TMCP) as part of the CESMP. ii. Coordinate with local authorities for any closure of roads or rerouting of vehicular traffic. iii. Provision of traffic signs in the vicinity of the construction sites. iv. Consideration given to schedules of festivities, processions, parades, schools churches etc. etc.	Part of contractors' bid cost	Contractor	PMU	Traffic signs in vicinity of construction sites Schedule of festivities, processions, parades, etc.	Verification of traffic management plan Visual inspection of sites Daily	Minimal cost to SW
Occupational health and safety at work sites	Measures include: i. Restrict access to the construction zone through warning signs, temporary gates, fencing or other construction zone demarcation at all entry points. ii. Utilise flag persons or other site controllers during major earthworks activities iii. Sufficient lighting for any night works iv. Implementation of a Health and Safety Plan (HSP) as part of their CESMP, incorporating the TCMP provisions for working near trenches or excavations. v. Ensure that first aid stations are always available at all work sites. vi. Provisions for working safely on/near water. vii. Provision of appropriate personal protective equipment (PPE). viii. Providing of emergency response equipment such as fire-fighting equipment, fire extinguishers, etc.	Part of contractors' bid cost	Contractor	PMU	Preparation of health and safety plan Sufficient signage and barriers provided for controlling both pedestrian and vehicular traffic as appropriate First aid station, PPE, emergency response equipment and sanitation facilities Health and safety records	Verification of health and safety plan Verification of health and safety record Visual inspection of site Daily	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
	ix. Provision of potable water and adequate sanitation facilities at all work sites. x. Provision of workers with adequate and clean eating areas. xi. Refer to Appendix for COVID measures should COVID-19 infection numbers rise again locally.				(near miss, first aid, lost time incident) Adherence to measures and ADB/WB COVID-19 guidelines if case numbers rise locally.		
Community health and safety	Measures for community health and safety: i. Use barriers and install signage at all work sites. ii. Provision of security personnel in hazardous areas to restrict public access & provide site guidance. iii. Operate construction night light in the vicinity of construction sites. iv. Provision of adequate safe passageways for the public access and crossing for all construction sites. viii. Refer to Appendix for COVID measures. ix. Advise local community of site health and safety site plans and seek feedback on appropriate mitigation measures via Community Advisory Committee meetings.	Part of contractors' bid cost	Contractor	PMU	Construction safety policy Hazards in the area Safety control such as signage, lighting, and barriers Health and safety records (near miss, first aide, lost time accident) Adherence to measures and ADB/WB COVID-19 guidelines should case numbers rise again.	Verification of construction safety policy and health and safety record Visual inspection of site Daily	Minimal cost to SW

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Potential social issues due to influx of workers	Measures include: i. Induction of the workers on community health and safety, grievance redress mechanism, and consultation and communications plan. ii. Implementation of protocols concerning the workers contact between the local communities; iii. Implementation of a communicable disease awareness and prevention program on the risk of disease spreading including STDs and HIV; iv. Provision of fence and warning signs to control unauthorized entry and prevent entry of the public v. Workers participation in addressing GBV issues will be set in an environment where workers can openly converse with about these concerns. vi. Implementation of GBV awareness training program for contractors vii. Ensure that no child labor will be employed in the subproject; ensure that all workers are adults above the age of 18 years.	Part of contractors' bid cost	Contractor	SW's PMU	Implementation of workers induction, required protocols, and disease awareness and prevention program Records of workers	Verification of records Visual inspection of site At start of work Monthly	Minimal cost to SW
Potential damage to hidden archaeological and cultural assets	Tender documents and construction contract will require an archaeological and cultural assets Plan to be prepared which includes: i. Prior research on likely presence of artefacts. ii. Site planning to avoid such artefacts. iii. Immediate stoppage upon discovery of any archaeological and cultural assets. iv. Inform the local authorities and Solomon Island National Museum about their presence.	Part of specs preparation cost	Design Consultant	PMU	Tender documents	Verification of tender documents Once after preparation of tender documents	Minimal cost (part of consultant's task)

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
OPERATIONAL PHASE							
Physical Environment							
Natural Disaster Impact (extreme weather events)	The sewers, pump stations and outfalls are designed to withstand longshore current migration of sediments and seasonal changes by short-term cyclonic conditions and flooding.	Part of SW's operational cost	SW's Operations Dept.	SW's Operations Dept. Mgt	Occurrence of longshore drift and sediment movements along the coast. Wind and flood aspects	Seasonal (Ara and koburu)	Part of SW's operational cost
Generation of waste	All the solid waste generated from the storage will be collected and properly disposed in an approved and designated location	Part of SW's operational cost	SW's Operations Dept	SW's Operations Dept. Mgt	Proper disposal No of complaint from the GRM Registry	Monthly	Part of SW's operational cost
Sewage discharges to the sea	Enhancement measures include: i. Regular monitoring and maintenance of the outfalls. ii. Regular monitoring of water quality in receiving water body. iii. Visually monitoring impacts of any overflow events to see if gross solids or rags are problematic, indicating that screens need to be installed on overflow pipes.	Part of SW's operational cost	SW's sewerage personnel for regular maintenance	SW's Operations Dept. Mgt.	Outfalls at NRH and Ranadi Biological parameters at nearshore area	Visual Inspection Quarterly water testing	Part of SW's operational cost
Biological Environment							

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Terrestrial flora damage	Replanting any damaged flora	Part of SW's operational cost	SW's sewerage personnel for regular maintenance	SW's Operations Dept. Mgt.	Remaining flora	Monthly inspections	Part of SW's operational cost
Marine ecology	Modify outfall operation such as adopting ebb-tide releases, or upgrading wastewater pretreatment or treatment if ecological impacts observed during monitoring of outfalls.	Subject to adopted strategy	SW's sewerage personnel for regular maintenance	SW's Operations Dept. Mgt.	Any benthic biota	Inspections as part of outfall diffuser inspections and maintenance	Part of SW's operational cost
Socio-economic Resources							
Health and safety risks during operation and maintenance	Mitigating measures include:. i. Identification of potential causes through facility hazards identification to be conducted during the initial operation phase of the pumping stations and updated as necessary ii. Provision of written management procedure. iii. Provision of written standard operating procedures (SOPs) as part of a written facility health and safety manual will be prepared.	Part of SW's operational cost	SW's Operations Dept.	SW's Operations Dept. Mgt	Written management procedures SOPs	Verification of management procedures, SOPs and records Weekly verification Implementation of SOPs	Minimal cost (verification of documents only)
Natural Disaster Impact	i. SW will develop an emergency response plan to natural disasters. ii. SW Staff and nearby communities will be trained on all SOPS associated with disaster management and implementation plan	Part of SW's operational cost	SW's Operations Dept.	SW's Operations Dept. Mgt	Written management procedures SOPs Number of trainings conducted	In any event of disaster daily Quarterly	Part of SW's operational cost

Activity/Environmental Impact	Proposed Mitigation Measure or Enhancement Measure	Mitigation Cost	Implementation	Supervision/ Monitoring	Aspects/ Parameters to be monitored	Means of Monitoring/ Frequency	Monitoring Cost
Unplanned outages and emergencies	Mitigating measures include: i. Identification of potential cause ii. Provision of written management procedures iii. Regular inspection and maintenance of the backup power supplies and its Automatic Transfer Switch (ATS) and SCADA systems iv. Regular inspection and maintenance of pumping systems, standby pumps and emergency backup systems v. Provision of written standard operating procedures (SOPs) vi. Regular training of staff on how to manage unplanned outages and emergencies	Part of SW's operational cost	SW's Operations Dept.	SW's Operations Dept. Mgt.	Written management procedures Records of inspection and maintenance of backup power, ATS, SCADA and pumping systems, SOPs Records on training of sewerage system staff	Verification of management procedures, SOPs and records Weekly verification Records of inspection and maintenance Implementation of SOPs	Minimal cost (verification of documents only)
DECOMMISSIONING							
Improper closure of construction sites after subproject completion	i. Site restoration and removal of all temporary facilities, excess materials, equipment, plant and excavated materials on site. ii. All dumping shall be to approved locations. iii. Replanting of disturbed sites in accordance with replanting plan.	Part of contractors' bid cost	Contractor	PMU	Disturbed sites, staging areas and workers camps	Visual inspection of sites Review and "clear" site remediation through issue of certificate when all site work is complete	Minimal cost to SW

8.4 Monitoring and Reporting

950. Environmental monitoring is an important section of an environmental impact assessment to address uncertainties pertaining to unanticipated impacts; ii) ensure mitigation measures are working; and iii) reassure the public on the progress of the development. Progressive monitoring must accompany various stages of the subproject activities (pre-construction, construction and operational phase). Environmental monitoring is required to be implemented in all phases of a project to ensure that mitigation measures are effective in reducing/managing impacts, and identify corrective actions as required; and that safeguard requirements are being complied with by the contractor and the implementing agency.

951. The Environmental Monitoring Plan (EMP) for Honiara wastewater subprojects is presented in **Table 8-3 and Table 8-4.**

952. The MP is based on the potential impacts, significance of the impacts and mitigation approaches identified during the environmental assessment.

953. The plan comprises parameters to be monitored, frequency of monitoring, authorities responsible for monitoring and cost estimates. As a requirement, the contractor will prepare a detailed CESMP based on the ESMP and as set out in the contract documents.

954. **Pre-construction monitoring**. During the pre-construction phase any gaps in the baseline data will be addressed. It is in the pre-construction phase where requirements for environmental monitoring in the construction phase can be legally required by placing specific provisions on environmental monitoring in the: (i) project specifications, (ii) bidding documents, and (iii) construction contracts. Relevant aspects of the ESMP will be incorporated in these documents. The PMU will verify if these aspects are incorporated in the said documents first during submission of the draft documents and later during submission of the final documents.

955. **Construction monitoring.** Contractors are expected to implement the relevant aspects of each project's ESMP as per their approved CESMP during execution of the construction activities as stipulated in their contracts. The contractors' CESMP will detail the monitoring plan (based on the subproject ESMP and the attached monitoring plans) with details on staff, resources, implementation schedules, and monitoring procedures (parameters, frequency etc.).

956. Compliance with the approved CESMP will be the basis for inspections and audits by PMU and the ADB and WB. The bidding document will include provisions requiring the contractor to submit their CESMP which will include a section on monitoring which should be linked to allocation of budget and staff for implementation.

957. The contractor will prepare monthly reports which will include a section on compliance with the approved CESMP, corrective actions, training and the like. This will also record any grievances lodged and project communications undertaken by the contractor. The PMU will review and consolidate information from the monthly reports of all subprojects. The quarterly progress report (QPR) prepared by the PMU will include a section on safeguards implementation summarizing the monthly reports (including training and capacity development activities).

958. A semi-annual safeguard monitoring report will be submitted to ADB and WB. This report will be based on the QPR and will include the environmental performance of each subproject/component.

Table 8-3: Environmental Monitoring Plan for Sewer Pumping Stations and Associated Sewer Lines Subproject

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
PREONSTRUCTION AND CONSTRUCTION PHASE						
PHYSICAL						
Solid and hazardous waste generation	Weight or volume of wastes generated	Weighing/log-book recording	Daily	Construction areas	Contractor; PMU	Minimal cost to SW
Soil Erosion and Sediment Control	Potential sources of Sediment runoff	Small interceptors, dikes, pipe slopes, diversion drains, grass bale barriers, silt fence, sediment traps and temporary sediment basins	Duration of construction	Construction areas	Contractor; PMU	Minimal cost to SW
Disposal of excavation spoils	Disposal Sites	Undertake inspection and approval of the contractors' suggested disposal sites prior to actual construction.	Duration of construction	Construction areas	Contractor; PMU	Minimal cost to SW
Storage, use and transportation of Hazardous Materials	Storage containers with proper labeling, waste oil, used lubricant and other hazardous wastes stored in tightly sealed containers	CESMP Compliance. Ensure storage sites are using concrete base and bunds. Spill areas cleaned and rehabilitated. Record of spills and accidents	Throughout construction phase - Weekly or after event or as required - review and approval of emergency response plan. Visual inspection of storage facilities	Construction areas	Contractor	Minimal cost to SW
Siltation of nearby surface water	Turbidity (to be calibrated against TSS for initial measurements)	Grab sampling and use of turbidity meter	Monthly	Surface water upstream and downstream near project site	Contractor; PMU	$50 per event per station

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
Air quality and noise	Dust and noise	Noise meter and handheld PM_{10} dust meter	Monthly	Project Site	Contractor; PMU	Minimal cost to SW after purchasing of meter reader
Generation of Solid Waste including Demolition Materials	• Compliance with Sediment and erosion control plan • Disposal of waste as per waste management plan	Log-book recording Inspection	Duration of construction	Project Site	Contractor; PMU	Minimal cost to SW
Removal of Existing Outfall and Beach Clean-up	Any heavily contaminated area	Inspection, Check Inventory List of all existing outfalls and beach clean-up plan	Duration of Activity	Project Site	Contractor, PMU	Minimal cost to SW
SOCIO-ECONOMIC RESOURCES						
Employment	Number of locally employed personnel	Logbook/ database registration	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW
Occupational health and safety	• No. of work-related illnesses/injuries • No. of zero incident person-hours worked	Logbook/ database registration	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW
Relation with local communities and authorities	Complaints from nearby community	Logbook/ database registration and GRM data	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
OPERATION PHASE						
Solid waste generation	Weight or volume of wastes generated	Weighing/log-book recording	Daily/Weekly	Project Site	SW's Operations Department	Minimal cost (verification of documents only)
Effluent Discharge from overflows	BOD, Fecal Coliform, *enterococci,* Ammonia, Nitrate, Phosphate, Oil and Grease	Grab sampling and laboratory analysis	Results-based during overflow events	Effluent discharge point at overflow outlet	SW's Operations Department	2,000 SID per event per station
Occupational health and safety	No. of work-related illnesses/injuries No. of zero incident person-hours worked	Logbook/database registration	Daily	Administration Office of the Project	SW's Operations Department	Minimal cost (verification of documents only)

Table 8-4: Environmental Monitoring Plan for Outfall Construction Subproject

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
PRE-CONSTRUCTION AND CONSTRUCTION PHASE						
Solid and hazardous waste generation	Weight or volume of wastes generated	Weighing/log-book recording	Daily	Construction areas	Contractor; PMU	Minimal cost to SW
Siltation of nearby surface water for on-land and near-shore construction and pipe laying	Turbidity (to be calibrated against TSS for initial measurements)	Grab sampling and use of turbidity tube	Monthly	Surface water upstream and downstream near project site	Contractor; PMU	$50 per event per station
Air quality and noise	Dust and noise	Noise meter and handheld PM_{10} dust meter	Monthly	Project Site	Contractor; PMU	Minimal cost to SW after purchasing of meter reader
Marine Water Quality and Recreational Water Quality	BOD, *enterococci*, Total Nitrogen including Organic, Ammonia, Nitrite/Nitrate, and Total Phosphorus in including Organic and Phosphate, Oil and Grease	Grab sampling and laboratory analysis	Quarterly for 1 year	Identified sampling locations (await completion of shoreline reclamation works before selecting sampling sites) but to include both outfall diffuser locations and three shoreline samples such NRH, Panatina (Marine School) and Kukum (Spice Bar)	Contractor; PMU	15,000 SID per event
Recreational Water Quality	*enterococci*	Grab sampling and laboratory analysis	Monthly except where quarterly Marine Water Quality and Recreational Water Quality is undertaken	Identified sampling locations (await completion of shoreline reclamation works before selecting sampling sites) but to include both outfall diffuser locations and three shoreline samples such NRH, Panatina	Contractor; PMU	5,000 SID per event

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
				(Marine School) and Kukum (Spice Bar)		
Benthic ecology	Benthos status	Video taken by divers when undertaking final UXO clearance	Once off	Outfall alignment	Contractor; PMU	5,000 SID
Employment	Number of locally employed personnel	Logbook/ database registration	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW
Occupational health and safety	No. of work-related illnesses/injuries No. of zero incident person-hours worked	Logbook/ database registration	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW
Relation with local communities and authorities	Complaints from nearby community	Logbook/ database registration	Daily	Administration office of the project site	Contractor; PMU	Minimal cost to SW
OPERATION PHASE						
Solid waste generation	Weight or volume of wastes generated	Weighing/log-book recording	Daily/Weekly	Project Site	SW's Operations Department	Minimal cost (verification of documents only)
Wastewater	BOD, Fecal Coliform, *enterococci*, Total Nitrogen including Organic, Ammonia, Nitrite/Nitrate, and Total Phosphorus including Organic and Phosphate, Oil and Grease	Grab sampling and laboratory analysis	Quarterly	Outfall pump station	SW's Operations Department	5,000 SID per event
Marine Water Quality and Recreational Water Quality	BOD, *enterococci*, Total Nitrogen including Organic, Ammonia, Nitrite/Nitrate, and Total Phosphorus	Grab sampling and laboratory analysis	Quarterly	Identified sampling locations (await completion of shoreline reclamation works before selecting sampling sites)	SW's Operations Department	15,000 SID per event

Concern	Parameter to be Monitored	Sampling & Measurement Plan			Responsible	Annual Estimated Cost
		Method	Frequency	Location		
	including Organic and Phosphate, Oil and Grease			but to include both outfall diffuser locations and three shoreline samples such NRH, Panatina (Marine School) and Kukum (Spice Bar)		
Recreational Water Quality	*enterococci*	Grab sampling and laboratory analysis	Monthly except where quarterly Marine Water Quality and Recreational Water Quality is undertaken. If consistently low enterococci levels are detected, then this could be reduced to quarterly unless elevated levels are detected and then monthly monitoring would be reinstituted	Identified sampling locations (await completion of shoreline reclamation works before selecting sampling sites) but to include both outfall diffuser locations and three shoreline samples such NRH, Panatina (Marine School) and Kukum (Spice Bar)	SW's Operations Department	5,000 SID per event
.Benthic ecology	Benthos status	Video taken by divers when checking outfall integrity	Annual	Outfall alignment	SW's Operations and Environment Department	5,000 SID per event
Occupational health and safety	No. of work-related illnesses/injuries	Logbook/database registration	Daily	Administration Office of the Project	SW's Operations Department	Minimal cost (verification of documents only)

9 Public Consultation and Participation

959. Public consultation, participation and information disclosure are a fundamental component of the overall planning, design, and construction of the proposed subproject.

960. The Stakeholder Engagement Plan (SEP) for the project documents the information disclosure, consultation and public participation measures to meet ADB and World Bank standards for ongoing and meaningful consultation during construction and operational works. The key stakeholders were identified in the Community Communication Plan (CCP).

961. **Table 9-1** summarizes the consultations undertaken.

Table 9-1: Consultation Summary.

Date	Venue	Male	Female	Total Participants
13th July 2018	Initial Consultation/ Information Disclosure Meeting at Start Event, Tongs Building	6	8	14
20th Feb 2019	Second Consultation/ Information Disclosure	8	7	15
21st Feb 2019	Consultation and Information Disclosure with government, CSO, NGOs and Landowners	21	3	24
4th Aug 2021	Conduct for general public at KGVI School Market area			30
6th Aug 2021	Held with Business Owners and Private sectors at Kwaimani Building, Kukum	5	3	8
22nd Oct 2021	Maromaro Market area for this residing at MFMR Office to Telekom Roundabout			35
12th July 2022	Lord Howe Settlement Area for the concept design of the PS and Outfall			52
4th Aug 2022	Community representatives, key government ministries and institutions	10	15	35

9.1 Consultations During Feasibility Study Stage

962. In July 2018, SW conducted initial public consultation activities to formally discuss the proposed subprojects with 24 stakeholders (six female and 18 male), including representatives of various civic organizations, community leaders and government officials. Stakeholders expressed support for the proposed subprojects and raised the following issues: (i) construction procedures affecting roads and the need to coordinate with other government agencies; and (ii) the need to address the procedural requirements for project implementation. The outcome of the consultation meetings was provided in Appendix 3 of the SI UWSSSP IEE and in Appendix 8 of the Background Information Report.

963. A second round of consultation was held during February 2019, which was attended by 48 stakeholders comprising local and national government, CSOs, NGOs and landowners. The outcome of the consultation meetings was provided in Appendix 6 of the SI UWSSSP IEE and in Appendix 9 of the Background Information Report.

9.2 Consultations During Subproject Implementation

964. Due to the changes in subproject components, such as not proceeding with the Point Cruz PS, SW will continue to update the identified stakeholders about changes through consultation activities. In line with this, the Project's CCP will be updated early in the subproject implementation phase. The CCP will guide the future consultation and participation activities to be facilitated and undertaken by SW.

965. Whenever necessary, stakeholder consultations will be conducted for specific issues that may arise during the design phase. Stakeholder consultations continue throughout the construction phase on an area-by-area basis to address any potential problems, particularly in resolving and mitigating subproject impacts affecting any sector of the community. These will be conducted by SW's PMU, contractors, and implementation consultants prior to commencement of construction activities. The construction consultations will address stakeholders' specific concerns related to construction activities in their area, including the scheduling of activities and the potential nuisances to the public. Records of environmental and social complaints, received during consultations, field visits, informal discussions, and/or formal letters, together with the subsequent follow-up and resolutions of issues will be kept by SW's PMU utilizing the GRM protocols.

966. Three rounds of consultation were conducted from 4th to 6th August 2021 for the sewer works. These were conducted with the market vendors along Ranadi Road and KGVI School representatives. A total of 19 people attended the public awareness meetings. The main concerns raised during the meetings were (i) subproject information to share with the communities, (ii) timeline of the subproject, (iii) safety, (iv) access for students and staff, (v) reduction of disturbance for students, (vi) coordination between developers, (vii) traffic management, (viii) risk mitigation. On 6th August 2021 a consultation meeting was held with businesses from the private sector operating within the area of the proposed sewers. There were 8 representatives from local businesses who attended the consultation meeting. The main concerns raised were (i) safety, (ii) narrow roads – risk of road shoulder collapsing into the drain (long term) and (iii) secure walkways for pedestrians.

967. Two consultation sessions took place on 22nd October 2021 with affected people within the subproject impact area from the Ministry of Fisheries to Telekom Roundabout (Ranadi). One was held at Maromaro market for the general public. The other was held at Kwaimani Conference Room for businesses houses, ministries, industries and institutions and key stakeholders along the Kukum Highway. The purpose was to disclose subproject plans to ensure people understood what is likely to happen, and also to listen to their concerns and feedback in order to improve subproject planning and implementation.

968. Ongoing meetings were held for the subproject, and discussions with Solomon Islands Port Authority were concluded as satisfactory, but consultations are still ongoing with the South Seas Evangelical Church (SSEC) which has some objections to the routing of a sewer pipe through their land.

969. Follow-up consultations were conducted on 12th July 2022 at Lord Howe Settlement. This was facilitated by SW and SUEZ on the concept design of the pumping station and outfall site. The EIS team also attended this meeting. The main concern raised during this meeting was the fear of the smell and similar occurrences that happened with the current treatment (but now abandoned) plant. They advised that their community has suffered from the smell and the amount of sewage being dumped into the river and sea. They would like to see the MoU to be signed by SW and the community so that they can also contribute to the obligations needed to be addressed or see a clear demarcation of the obligations before signing the MoU for the pumping station site. The SW CLO has recorded the minutes of the meeting. See **Appendix 18: Records of Public Consultation and Participation**.

970. An initial key stakeholder meeting was held on 4th August 2022 at Rock Haven. This was attended by community representatives, key government ministries and institutions. This was led by SW and presentations were made by SMEC and EIS Team members for the Water Supply and Sewage upgrading program for Honiara. A total of 35 participants attended. The discussion was very useful and interesting. Important issues and concerns were highlighted during the discussion which Solomon Water has taken into account as well as SMEC and EIS team for the pumping stations and outfall sites. See **Appendix 18** for the meeting details.

971. Another round of consultations will be conducted with the communities where the pumping stations will be located and also the outfall sites. This will be conducted as soon as the detailed engineering designs are confirmed and ready. However, Solomon Water and the EIS team are working closely with the design team ensuring that all the concerns raised in the previous consultations were addressed in the detailed design.

9.3 Disclosure

972. Disclosure does not equate to consultation (and vice versa) as disclosure is about transparency and accountability through the release of information about the subproject. The EIS Report will be made available on the ADB external website, MECDM website, other relevant web sites, social media sites and in hard copies at the Solomon Water Office PMU at Blums Building, Point Cruz, Honiara.

973. Further public consultation will be arranged prior to construction commencement to both alert the local residents to the possible issues and opportunities of the construction phase and to provide an opportunity for people to emphasize their concerns, as expressed above, directly to the Contractor.

974. All documents are subject to public disclosure, and therefore will be made available to the public.

975. Following clearance of the EIS from the respective authorities, the document will be posted on the government websites.

9.4 Response to MECDM Questions

976. MECDM wrote to SW on 15 January and 28 February 2022 requesting further elements be considered as part of the EIS investigations. These requests may be paraphrased as below:

- Bathymetry of the outfall route;
- Sea level risk assessment;
- Assess any impacts from the local river systems on the outfalls, including for example sedimentation and debris damage; and
- Consider the effects of littoral currents, upwelling and downwelling.

9.4.1 Outfall Route Bathymetry

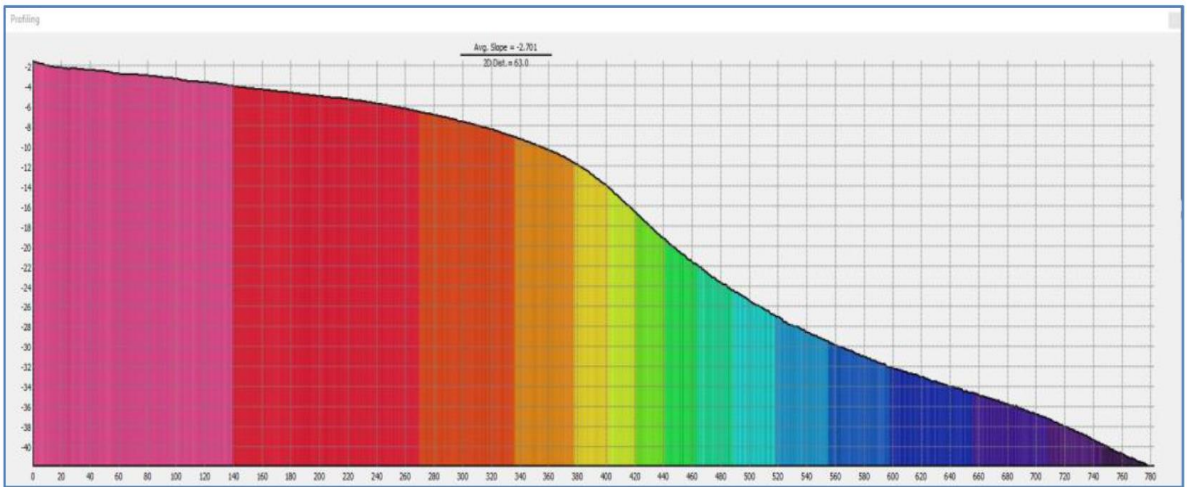
977. The outfall route bathymetry has been determined from several reports.

1. Solomon Islands International Waters Ridge to Reef project included the Honiara coastline baseline study bathymetry and hydrology assessment report, produced by GEF “Pacific International Waters Ridge to Reef regional project (SPC), Fiji, 2021”. The report noted that the Honiara coastal area has very different characteristics going from east to west. Offshore

bathymetry shows that the eastern part is much flatter and the sea floor goes to a depth of approximately 100 m extending to about 1 km from the shoreline. However, the western end of the sound is much narrower. In general, the bathymetry of Iron Bottom Sound has a raised eastern half sloping down towards the west to about 1000 m depth beyond Savo Island. The 100 to 150 m deep drop zone outside the white River Reef edge is a mini canyon that leads towards the sea floor.

2. As part of the overall subproject preparatory investigations, a preliminary UXO study report was prepared by CERES in 2020[53]. The first cross-section below shows the water depth along the proposed NRH outfall, noting that the first 30 m from the shoreline are not included because of vehicle access difficulties. For the first 330 m of the corridor, the slope is gentle at around 1.1°. Then there is a strong inflection at around 390 m from the shore with an average slope of some 6°. From approximately 410 m from the shoreline to 700 m, the slope reduces back to about 3°. Over this entire length, there are no major drop-offs. See **Figure 9-1**.

Figure 9-1: NRH Outfall Bathymetry

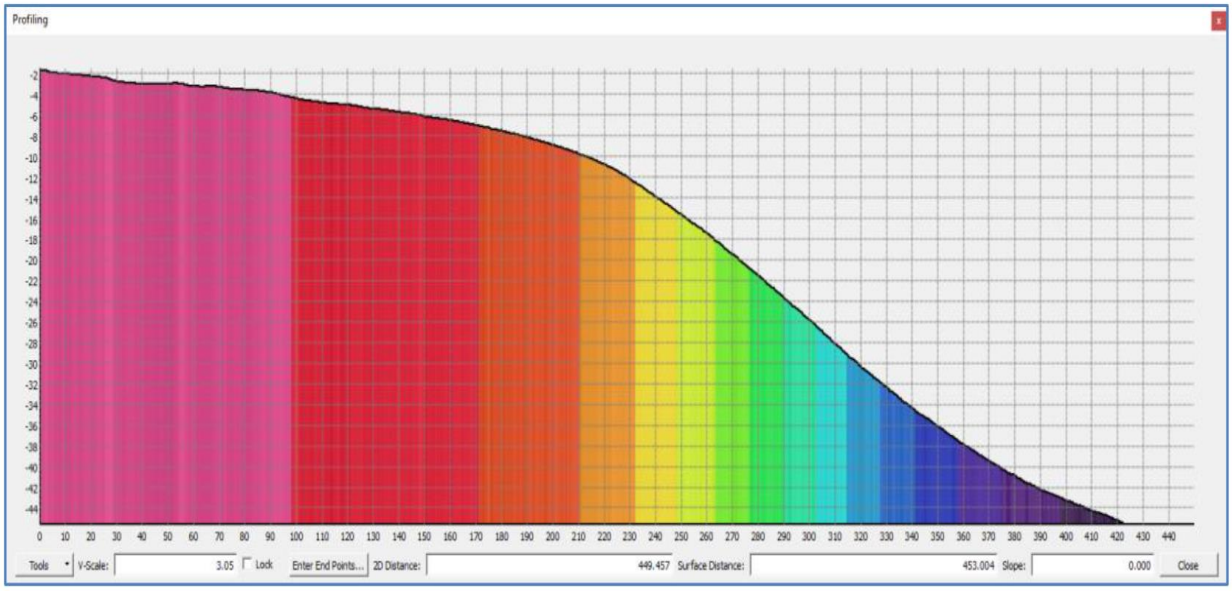


Source: CERES Consultants. 2020. UXO Study of Honiara Area

978. At the Ranadi outfall, the first 70 m are not shown again due to access difficulties by the boat. For the first 250 m of the corridor, the slope is gentle at 1.9°. Then an inflection occurs at around 290 m with an average slope of 11° until approximately 430 m. Then the slope reduces to 7° from approximately 430 to 490 m, or 560 m offshore allowing for the 70 m offshore starting location. See **Figure 9-2**.

[53] CERES Consultants. 2020. UXO Study of Honiara Area

Figure 9-2: Ranadi Outfall Bathymetry



Source: CERES Consultants. 2020. UXO Study of Honiara Area

979. A marine benthic assessment was undertaken as part of this EIS in August 2022. Formal bathymetric recordings were not made as part of the marine benthic surveys. However, a series of depth readings were undertaken at the dive points which confirm the above two studies that it is a relatively gently sloping bed profile that extends well beyond the end of the two outfalls. The water depths at the dive locations were in the order of 40 m at the 500 m mark for the Ranadi outfall and around 11 m at the end of the proposed NRH outfall. On a number of occasions, the depth sounder on the boat was utilized to track bed levels and as noted above, these were reasonably consistent going from shoreline to the end of the outfall with some minor depressions being encountered but no major drop-offs or submerged ridgelines.

9.4.2 Sea Level Risk Assessment

980. See sections on climate change and flooding at 3.1.1, 4.1.1 and 4.1.4.

9.4.3 Potential Impacts from Local Rivers on the Outfalls

981. During the marine benthic survey undertaken as part of this EIS, the seabed was investigated not only along the outfall routes but at transects on either side of both outfalls. At both the NRH and Ranadi outfalls, there was only a very small amount of litter material on the seabed. There were no large white goods nor other large items or extensive litter mounds on the seabed. This would indicate that any solid waste entering either river system is not being advected towards the outfalls. In summary, there were no large items located in any of the dive sites near the outfalls that would indicate any potential for damage from litter or other items being carried by the rivers even during high-flow flood periods.

982. Given that the depths of the outfall diffusers will be well over 10 m at NRH and closer to 40 m at Ranadi, any surface material carried during flood events would not extend to the sea floor and be able to damage the diffuser networks. Even any large trees which may be carried by the river during floods would not have branches of sufficient length to damage items at this depth from the sea floor. Such large items would be most likely trapped within the river system or the estuary mouth in any case if it had branches of this size.

983. In terms of accumulation of litter and solid waste advected by the rivers, there was only a very small amount of these items along the proposed diffuser alignments. As such, there would not be an accumulation of the smaller items that may block or otherwise hinder the ongoing operation of the diffuser ports.

984. The other possible impact from the river systems is the accumulation of sediment as a result of the highly turbid flows during major run-off events within the contiguous catchment areas. Given the ongoing land development within the catchment, these elevated sediment loads are expected to continue emanating in wet weather from the river systems.

985. Surface current movement within Solomon Islands varies in direction and magnitude over the different seasons. During the December to May wet season, westerly winds strengthen and push more waters from the north-western ern part of Solomon Islands whilst during the dry season, more waters are pushed up from the south east. In the Honiara area specifically during the dry season, the south-easterly trade winds strengthen and push more water from the east to the west. There is a relationship between the surface wind stress and ocean current movement so the dry season typically has wave action and longshore drift going from east to west. This is reversed during this wet season. However this can all change during cyclonic activities with very large, localized tide and wave activities, but these are relatively short-term events.

986. However the littoral drift is predominantly from east to west on an annual basis, so sediment being deposited in the eastern end of the bay from the river system will eventually become part of the longshore littoral currents and would be deposited further to the west. However, the changing currents at other times of the year may re-suspend and move the sediments.

987. This cyclical movement of sediment would ensure that any significant accumulations of sediment in one area, or, conversely any erosion pits, would be attenuated by this reversing longshore drift and the associated sediment movement. In terms of erosion generally in the bay area, very little ongoing coastal erosion has been observed, even within areas affected by infrastructure development such as the construction of seawalls, retention walls, wharves, and backfilled coastal areas such as reclamation sites. (Honiara Coastal Environment Baseline Assessment, comprising supplementary assessment reports of Biological and Ecological, Bathymetry and Hydrology, and Water Quality as part of the ‘Ridge-to-Reef’ (R2R) program, GEF 2021)

988. The UXO study referenced above undertook some side scan sonar and magnetometer studies to develop an initial understanding of the seabed geological profile. These initial studies indicate that there are extensive layers of heavier sand transitioning to gravel, and even massive coral and rock formations, underneath the silts and fine sand surficial layers. The UXO report recommends that more detailed geotechnical assessments are conducted along the outfall routes to confirm that the trenches proposed as one installation option for the outfalls can be readily constructed given the strength of the subgrade in these locations. Therefore it is extremely unlikely that the seabed will erode through these heavier and highly consolidated materials, exposing the diffusers and outfalls.

989. In summary, the long-term seabed stability at the diffuser locations is expected to be sufficiently robust to ensure that the diffusers are neither submerged with silt nor exposed due to significant local seabed erosion events. The diffuser ports are designed to be self-cleaning in any case, meaning that the diffuser port exit velocities are sufficient to carry away any sediment that may be deposited within the ports when the outfall pumps are not operating. So any sediment starting to accumulate near or within the ports would be borne away during the pumping cycle as the sewage exits the port diffusers.

9.4.4 Effects of Littoral Currents, Upwelling and Downwelling.

990. As noted in the above sections, local ocean currents including littoral or longshore currents are changeable and based on the seasons and the associated changing wind directions. These seasonal events have been allowed for in the full-year computer modelling which incorporates both dry and wet season currents and tidal flows.

991. On top of these long-term wind-driven and seasonal currents, there are also shorter periods of intense currents associated with any cyclonic activities when the current direction can change dramatically throughout the life of the cyclonic event.

992. The analysis of the long-term to short-term morphological evolutions and sediment dynamics in the NRH and Ranadi areas is presented in a geomorphological study[54]. It mainly shows that both sites are weakly dynamic in terms of morphological evolution. Indeed, considering a time scale of several decades, the maximum vertical variability of the seabed is assessed to reach 1 to 2 m. At an extreme event time scale (i.e. several hours to 1 or 2 days, associated with the passage of a cyclone), the maximum vertical variability of the seabed is assessed to be of the order of few centimeters when focusing on the dynamics of wave- and current-related sand ripples, while an upper bound of 0.5 m can be considered for the thickness of the seabed that can potentially be moved during storm conditions.

993. In case of cyclonic conditions, it is worth noting that the impacts of flooding-related processes on the study site morphology could be predominant compared to the latter processes, since intense flooding could presumably lead to global sediment deposition in the Honiara Bay as already seen during cyclone Namu in 1986, this sediment being then progressively sorted and moved shoreward mainly by waves.

994. Furthermore, hydro-morpho-sedimentary processes that could induce significant free spans of a pipeline laid on the seabed are assessed to be rather unlikely, partly because the general seabed morphology appears very homogeneous at both corridors (i.e. no significant seabed morphological features nor scour gradients are observed) which corroborates the weak sediment dynamics identified in both corridors areas.

995. Concerning upwelling and downwelling, these dynamic conditions can only be caused by two precursors.

996. The first is that there is significant thermal stratification, and, when the thermocline dissipates, then there will be significant vertical mixing. Discussions with representatives of the local commercial diving company indicated that in over 35 years of diving in these waters, thermal stratification and associated thermoclines had never been encountered. The water temperatures typically vary from

[54] Suez. 2022. Solomon Islands, Honiara Outfalls Project Morpho-sedimentary study at NRH and Ranadi sites Final Report V1.1

29°C to near 32°C over a depth of up to 40 or 50 m. Even on dive depths of over 100 m, the temperature has never been observed to be lower than 27°.

997. The only time commercial divers have ever encountered any stratification is the saline wedge effect following significant rainfall. This is when a freshwater epilimnion forms on top of the saline wedge underneath. The divers noted that this only remains stable for less than 24 hours when the freshwater becomes mixed through the sale l marine water underneath.

998. Therefore there is no upwelling or downwelling associated with thermal destratification events.

999. The second precursor to upwelling and downwelling is having a significant vertical structure that will cause vertical flow velocities to occur. No large wrecks were located near the diffusers based on either the marine benthic survey or the UXO investigations. Further the bathymetric studies have clearly indicated there are no major drop-offs within many hundred metres of the proposed diffuser locations. Therefore there are no large vertical structures that could result in upwelling or downwelling currents.

10 Conclusion

1000. The subproject covered in this assessment will offer benefits to Honiara by ensuring improved wastewater infrastructure and delivering high-priority elements of SW's 30-Year Strategic Plan and 5-Year Action Plan.

1001. In socio-environmental terms, the existing situation and expected outcomes can be summarized as follows:

- The existing wastewater management systems include a mixture of earth closets and septic tanks without the requisite infiltration trenches and absorption beds, currently discharging to local riverine and near-shore aquatic ecosystems.
- Existing water quality is significantly compromised, especially, near these outfalls, representing both a health risk due to elevated levels of sewage pathogens and a potential ecological risk due to elevated nutrient concentrations.
- There are no terrestrial nor marine protected areas within the area of influence nor contiguous to it.
- The marine, terrestrial and freshwater ecological assessments indicated there are no rare, threatened or endangered flora or fauna species within the area of influence.
- All subproject areas have been heavily disturbed with significant land clearing and reclamation activities undertaken. Native fauna was also absent, replaced predominantly by domestic animals.
- The marine biota survey indicated that the biota is extremely sparse along and adjacent to the proposed outfall alignments, and there was no evidence of coral reefs, extensive seagrass beds or sessile marine fauna.
- The impacts derived from the marine scope of works for both proposed outfall pipelines are expected to be very minor, localized to the immediate footprint of the works, and easily managed through standard engineering good practice mitigation measures. There are no threats to the area's marine and coastal biodiversity associated with the subproject. As such the potential impacts of the works on the marine environment are considered to be minor, temporary, mitigatable and overall insignificant.
- The proposed infrastructure will be constructed on a mix of public and private land. There are standard processes for gaining easements over public land such as road reserves and these are well underway. Only one of the private landholders is still requiring further negotiations to finalise land access.
- Community engagement has been extensive and the overall feedback is very positive about the proposed subproject.
- A grievance redress mechanism is in place.
- Alternatives to the proposed wastewater infrastructure have been reviewed and are all considered far too complex or expensive given that the proposed system will not have unsustainable socio-environmental impacts.
- The proposed sewerage infrastructure and outfalls will significantly reduce current health risks based on recreational water quality modelling in terms of primary and secondary contact recreation.

- Nutrient modelling indicates that there will be little if any negative impact on the local water column, and the additional nutrients offshore may in fact help to establish a more populous marine ecosystem.
- The overall potential impact of the works on both the terrestrial and marine biological environment is expected to be very minor, localized and overall insignificant, provided standard mitigation measures associated with good engineering practice as identified above are implemented.
- The ESMP will ensure that the preconstruction, construction and operational phases are all suitably monitored and managed. Should any unexpected impacts occur, then suitable interventions can be initiated.

1002. The environmental and social screening process has highlighted the environmental and social issues and concerns of the proposed subprojects. Based on the screening for potential environmental and social impacts and risks of the proposed subproject, there are no significant negative environmental and social impacts or risks that cannot be mitigated or managed. The ESMP prepared for each subproject will be updated and used as the basis for the preparation of the CESMP to be prepared by the contractor. Monitoring and reporting of the approved CESMP will ensure that each subproject can be implemented in an environmentally acceptable manner. There is no need for further environmental assessment. This Background Information Report will accompany the development consent application.

1003. In addition, the subproject is hereby recommended with emphasis on the following:

- Tendering process will advocate environmentally responsible procurement by ensuring the inclusion of ESMP provisions in the bidding and construction contract documents.
- Contractor's submission of a CESMP will be included in the construction contract.
- Contract provisions on the creation and operation of the community advisory committees.
- Training of SW personnel on operation and maintenance before actual operation.
- Monitoring of health and safety requirements will be given more importance during implementation to reduce risks to the public and SW personnel;
- SW will continue the process of public consultation and information disclosure during detailed design and construction phases.
- The existence of the subproject's GRM will be publicized through public awareness campaigns, billboards, public notifications, etc. GRM procedures will be disclosed to the public in consultation meetings.

11 References

A.J. Smith, J. Barber, S. Davis, C. Jones, K.K. Kotra, S. Losada, B.P. Lyons, M. Mataki, K.D. Potter, M.J. Devlin Marine Pollution Bulletin 165. 2021. Aquatic contaminants in Solomon Islands and Vanuatu: Evidence from passive samplers and Microtox toxicity assessment.

Australian Bureau of Meteorology and CSIRO. 2011. Climate Change in the Pacific: Scientific Assessment and New Research. Volume 2: Country Reports.

Asian Development Bank. 2009. Report and Recommendation of the President to the Board of Directors on a Proposed Asian Development Fund Grant and Administration of Grants Solomon Islands: Second Road Improvement (Sector) Project. Manila.

Asian Development Bank. 2018. Draft Marine Ecological Assessment – Honiara Port Development Project. Trade & Transport Facilitation in the Pacific: Regional Transport Sector Study (TA 8674-REG).

Asian Development Bank. 2020. Solomon Islands: Land and Maritime Connectivity Project – Multi-tranche Financing Facility, Road Component

Asian Development Bank. 2022. Preparing the Honiara Sustainable Solid Waste Management Project

Association of Southeast Asian Nations (ASEAN). 2008. Marine Water Quality Management Guidelines and Monitoring Manual

Australian and New Zealand Environment and Conservation Council. November 1992. Australian Water Quality Guidelines for Fresh and Marine Waters - National Water Quality Management Strategy

Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand. 2000. Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines.

Australian and New Zealand Environment and Conservation Council. 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality - National Water Quality Management Strategy

CERES Consultants. 2020. UXO Study of Honiara Area

Devlin, M., Bacon, J., Haverson, D., Graham, J., Smith, A. et al. Cefas, UK. 2018. Pacific Water Quality and Resilience Framework – Year 2 report.

Dlley, M and others. 2005. The International Bank for Reconstruction and Development / The World Bank and Columbia University. Washington, DC.Natural Disaster Hotspots - A Global Risk Analysis.

EEC Parliament and of the Council of 15 February 2006. Management of bathing water quality and repealing Directive 76/160/EEC's

Egis Eau. 2018. Lungga River Water Source Scheme - Final Feasibility Study. Solomon Islands Urban Water Supply and Sanitation Sector Project.

Environmental Policy and Planning Division, Department of Environment and Heritage Protection, Queensland Government. 2009, and updated in 2013. Queensland Water Quality Guidelines,

Environmental Protection Water And Wetland Biodiversity Policy, Environmental Policy and Planning Division, Department of Environment and Science, Queensland Government. 2019. Daintree and Mossman River Basins Environmental Values and Water Quality Objectives,

European Parliament and of the Council. 2008. Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC

Francis, S., L and Alama L. 2011. World War II Unexploded Ordnance, Retrieved at URL on 29thof October 2013 at URL:
http://www.forumsec.org/resources/uploads/attachments/documents/UXO%20final.pdf.

Hansell, J. and J. Wall. 1974. The British Solomon Islands Protectorate Volume 2. Guadalcanal and the Florida Islands. Land Resources Study 18. Quoted in Solomon Islands Government, Ministry of Environment Conservation and Meteorology. 2008. Solomon Islands State of Environment Report 2008. Honiara.

Honiara Drought Frequency Analysis Working Paper. Solomon Islands Urban Water Supply and Sanitation Sector Project. Montpellier

International Finance Corporation, Washington, DC. 2017. General EHS Guidelines: Environmental, Air Emissions, and Ambient Air Quality.

Japan International Cooperation Agency (JICA). 2006. The Study Rehabilitation and Improvement of Solomon Islands Water Authority's Water Supply and Sewerage Systems – Part B: Honiara Water Supply and Sewerage.

Japan International Cooperation Agency (JICA). 2013. The Second Preparatory Survey Report for Outline Design on the Project for Improvement of Honiara Port Facilities in Solomon Islands.

Japan International Cooperation Agency (JICA). 2014. Preparatory Survey for Kukum Highway Upgrade Project in Solomon Island

Lal, Juste-Poinapen and Poinapen, Water Science and Technology Volume 84 Number 10 – 11, 2021. Assessing the Water Quality Suva Foreshore for the Establishment of Estuary and Marine Recreational Water Quality Guidelines in the Fiji Islands

Limnol. Oceanogr., 51(1, part 2), 2006, 377–384 q 2006, by the American Society of Limnology and Oceanography, Inc. "Responses of estuarine and coastal marine phytoplankton to nitrogen and phosphorus enrichment"

Milika, S. GEF et a,l Suva, Fiji SPC, (2020) Rapid Coastal Assessment of Mataniko River Catchment Report, Honiara, Guadalcanal Island, Solomon Islands.

Ministry of Environment, Climate Change, Disaster Management & Meteorology. Solomon Islands, 2020. The National Biodiversity Strategic Action Plan 2016-2020

Ministry of Environment Conservation and Meteorology. (2008). State of the Environment Report. Honiara

McCoy M. (2006) Reptiles of the Solomon Islands, Pensoft Publishers, Moscow, USSR.

Nordlund, B. National Marine Fisheries Service. Lacey 2008. Designing Fish Screens for Fish Protection at Water Diversions.

PACCSAP, (2014). Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports 2014, Solomon Islands

Pacific Coastal and Marine Science Center (PCMSC). 2016. Preliminary Analysis of the April 2007 Solomon Islands Tsunami, Southwest Pacific Ocean. USGS. URL: https://walrus.wr.usgs.gov/tsunami/solomon07/

Pacific Community (SPC), Suva. (2020). Rapid Coastal Assessment of Mataniko River Catchment Report, Honiara, Guadalcanal Island, Solomon Islands.

Pacific Community (SPC). (2021). An Assessment of Water Quality and Biodiversity of the Mataniko Catchment, Solomon Islands. Suva, Fiji

Pacific Islands Applied Geoscience Commission (SOPAC). 2007. National Integrated Water Resource Management Diagnostic Report - Solomon Islands.

Palua Government. 2020. Palau 2020 Marine and Freshwater Quality Regulations - Chapter 2401 – 11

Pauku, R. FAO Regional Office for Asia and the Pacific. Bangkok. 2009. Solomon Islands Forestry Outlook Study.

Polhemus, D.A; Englund, R.A., Allen, G.R., Baseto, D., and Polhemus, J.T, (2008). Freshwater Biotas of the Solomon Islands – Analysis of Richness, Endemism and Threats, Bishop Museum Technical Report 45

Potential Climate Change Impacts to Water Supply and Sanitation in Honiara and Recommended Adaptation Measures. Solomon Islands Urban Water Supply and Sanitation Sector Project. Montpellier

Secretariat for the Pacific Region Environment Programme, 1996. Water Quality Protection Criteria for The South Pacific, including Standards for the Discharge of Sewage Effluent.

Sheppard, P and R. Walter. 2006. Revised Model of Solomon Islands Culture History. Research Gate.

SKM. 1995. Logan, Coomera, South Moreton Bay Wastewater Management Study.

Solomon Islands Government, Ministry of Development Planning and Aid Coordination. 2014. Rapid Assessment of the Macro and Sectoral Impacts of Flash Floods in Solomon Islands. Honiara.

Solomon Islands Government (SIG), 2009. 2009 Population & Housing Census National Report (Volume 2), Available at http://www.statistic.gov.sb/statistics/ demographic -statistics/ census. (Listed on website as Census-National Report_Vol1).

Solomon Islands National Statistics Office (SINSO). 2010. Report on 2009 Population and Housing Census – Honiara. Honiara.

Solomon Islands National Statistics Office (SINSO). 2020. Provisional Count 2019 National Population & Housing Census. Honiara.

Solomon Islands Urban Water Supply and Sanitation Sector Project, (2019). Climate Change Assessment- SOL 51271, Honiara.

Solomon Islands Water Authority. 2017. Solomon Water 30 Year Strategic Plan. Honiara.

Solomon Water. 2019. Water and Other Urban Infrastructure and Services, UWSSSP Sector Assessment (Summary)

Solomon Water. 2021. Background Information Report

South Pacific Islands Applied Geoscience Commission Technical Report 381, SOPAC, 2004. Water Quality Monitoring in Pacific Island Countries

SPREP, Apia. 2018. Ecosystem-based adaptation options assessment and masterplan for Honiara.

Suez. 2019. Basis of Design Report – Honiara Wastewater. Solomon Islands Urban Water Supply and Sanitation Sector Project

Suez. 2019. Detailed Design Report – Honiara Wastewater. Solomon Islands Urban Water Supply and Sanitation Sector Project

Suez. 2019. Detailed Design Update – Honiara Wastewater. Solomon Islands Urban Water Supply and Sanitation Sector Project

Suez. October 2021. Network design note

Suez. 2022. Dispersion modelling of nutrients in Honiara, Solomon Islands

Suez. 2022. Solomon Islands, Honiara Outfalls Project Morpho-sedimentary study at NRH and Ranadi sites Final Report V1.1

T.C. Whitmore (1969). The vegetation of the Solomon Islands, Volume 255, Issue 800, The Royal Society of London.

The Nature Conservancy, Indo-Pacific Resource Centre. Qld, Australia.2006. Solomon Islands Marine Assessment.

Trustrum, N.A., Whitehouse, I.E., and Blaschke, P.M. 1989. Flood and Landslide Hazard - Northern Guadalcanal, Solomon Islands. United Nations Technical Cooperation for Development. New York.

USEPA, Office of Water, Office of Science and Technology, Health - ecological criteria division, Washington. December 2000. EPA 822 – B – 00 – 023 Report

United Nations Human Settlement Program (UN-Habitat). 2012. Solomon Island: Honiara Urban Profile. Nairobi.

UN Office for the Coordination of Humanitarian Affairs (OCHA). 2016. Map of Major National Hazards in Asia and the Pacific. Bangkok.

US National Geospatial-Intelligence Agency. 2017. Sailing Directions (enroute) - Pacific Islands. 12th Edition. Pub.126.

Walter, R and R. Hamilton. Ecology and Society 19(4): 41. 2014. A Cultural Landscape Approach to Community-based Conservation in Solomon Islands.

World Health Organization. 2011. Guidelines for Drinking-Water Quality. 4th Edition. Geneva.