

Government of Saint Lucia

Final Environmental and Social Impact Assessment

Saint Lucia Renewable Energy Sector Development Project

September 2018

PANORAMA ENVIRONMENTAL, INC.

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Government of Saint Lucia

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Saint Lucia Renewable Energy Sector Development Project

September 2018

Prepared for:
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EXECUTIVE SUMMARY

ES.1 OVERVIEW

The Government of Saint Lucia (GoSL) proposes to conduct the Saint Lucia Renewable Energy Sector Development Project (project) within the Soufrière, Choiseul, and Laborie regions of Saint Lucia (Figure ES.2-1) to assess the feasibility of commercial development of geothermal resources in Saint Lucia. The project would initially include drilling slim-diameter and potentially full-size geothermal exploration wells to obtain information on the geothermal resource believed to underlie the area.

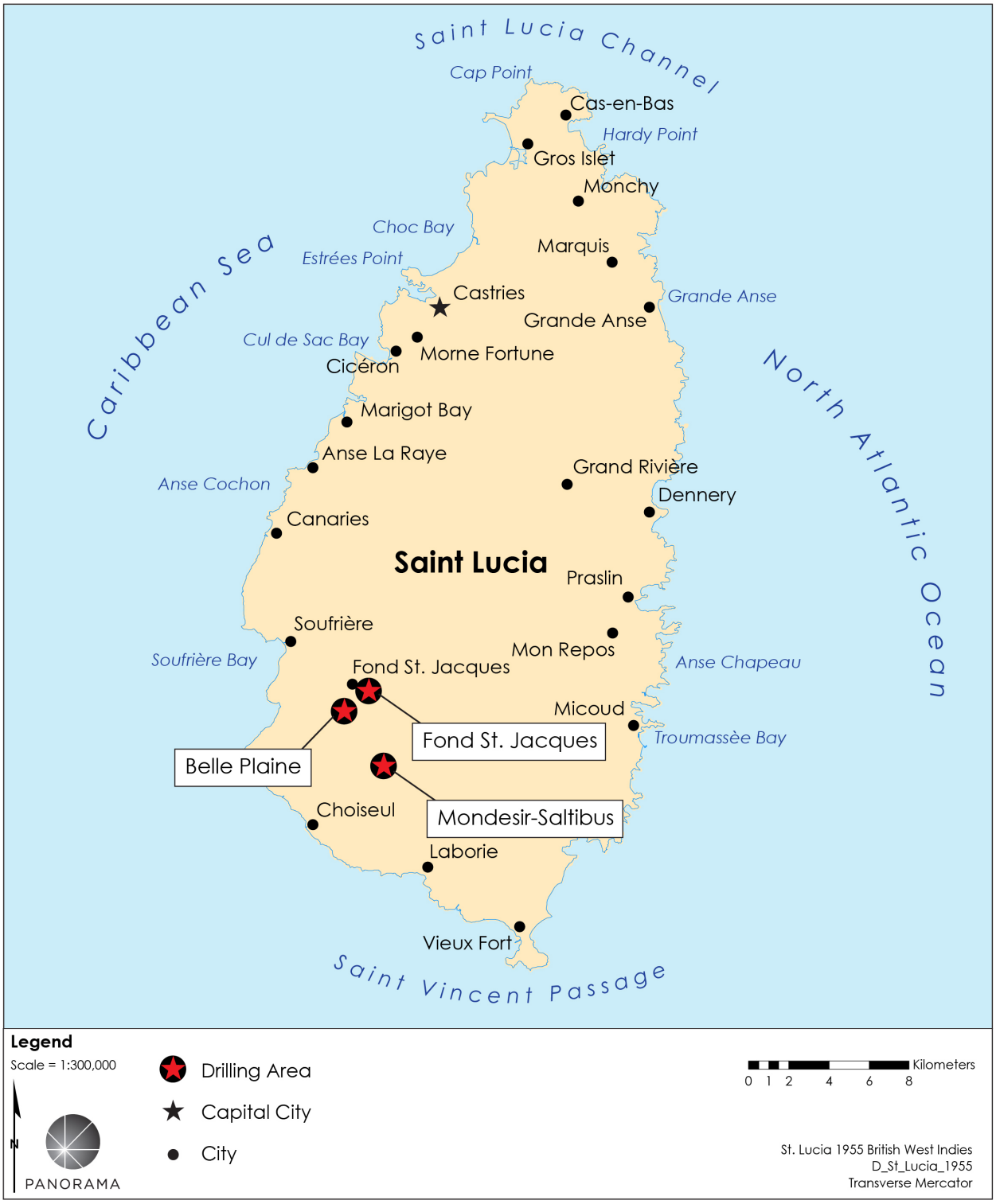
The GoSL has obtained financial assistance and technical support from a number of development partners in support of the project. To date, the World Bank has assisted Saint Lucia in accessing grant financing from the Global Environmental Facility and the SIDS DOCK Support Program for the project. Technical assistance has also been received from the Government of New Zealand and the Clinton Climate Initiative. The Environmental and Social Impact Assessment (ESIA) was prepared for the project in accordance with Government of Saint Lucia laws, World Bank Operational Policies, World Bank Environmental and Social Standards, and World Bank Environmental, Health, and Safety (EHS) Guidelines, to provide an assessment of the environmental and social risks and impacts of the project. The organization of the ESIA follows the draft World Bank Environmental and Social Framework (World Bank 2017).

This ESIA focuses on the exploration phase of geothermal development and does not address development of a power plant in the event that an economically viable geothermal resource is identified. A separate ESIA would be prepared to address potential impacts from power plant development, although much of the information presented in this ESIA could serve as a starting point for evaluation of the existing environmental conditions.

ES.2 PURPOSE AND NEED

The geothermal exploration drilling project is needed to evaluate the geothermal resource outside of the Sulphur Springs and Pitons Management Area (PMA) and determine the viability of commercial geothermal power generation in Saint Lucia. The outcome of the drilling program would provide the GoSL and LUCELEC with valuable information that will support future capital investment decisions regarding further exploration of the geothermal resource and potential development for electric power generation.

Figure ES.2-1 Project Location



Sources: (ESRI 2017, Jan Kindsay 2002)

Geothermal resource development in Saint Lucia would include the following benefits:

- Reduce consumption of non-renewable fossil fuels by providing a reliable source of clean renewable energy
- Help Saint Lucia meet its Paris Accord targets for renewable energy production
- Increase Saint Lucia's energy independence by reducing reliance on imported fossil fuels

ES.3 PROJECT DESCRIPTION

The proposed project includes drilling slim-hole wells and potentially full-size geothermal exploration wells to evaluate the feasibility of commercial geothermal development in Saint Lucia. Slim-hole wells would be drilled first. Slim-hole wells (3.78-inch bottom hole diameter) typically require less capital investment and cause less environmental and social impact than deep full-sized wells because they are drilled with smaller drill rigs on smaller well pads, drilling takes less time, and less fluid is produced. An exploratory drilling program using slim-hole wells is a cost-effective method for geothermal exploration.

Full-sized (7-inch+ bottom hole diameter) geothermal exploration wells may be drilled in Belle Plaine or Mondesir-Saltibus if the slim-hole drilling results suggest the presence of a commercial geothermal resource.

The project description and analysis in the ESIA address the possibility of drilling full-sized wells in addition to slim-hole wells to provide a range of options for the exploratory drilling program. The feasibility of drilling full-sized wells would depend on the results of slim-hole drilling, access to funds, access to sufficient workspace, and the presence or absence of environmental resources and receptors that may be impacted. The ESIA and ESMP will be updated with site-specific information once the specific locations of the exploration wells are identified, prior to the start of construction.

The project would include the following activities and components:

- Civil works and site development at three potential drilling areas
- Drilling up to four slim-holes and up to two full-size wells
- Well testing
- Well abandonment and site reclamation

ES.4 KEY PROJECT IMPACTS AND MITIGATION MEASURES

The findings presented in this ESIA identify environmental and social impacts that would result from the project. Most impacts would be temporary and focused within the drilling area during well drilling and testing. The project would not result in significant residual negative impacts

that could not be mitigated. Table ES.4-0-1 includes a list of the required mitigation plans. The contractor responsible for preparing each plan is specified.

Table ES.4-0-1 Mitigation Plans

Mitigation Plan	Mitigation Measure	Applicable to Contractor?	
		Civil	Drilling
EHS Plan	Safety-1 Health and Safety Plan	Yes	Yes
	Other measures with ESH requirements (to address in EHS Plan)		
	Water-4; Blowout Prevention		Yes
	Air-3: Air Quality Monitoring and Noxious Gas Management		Yes
	Hazards-1: Hazardous Materials Management Plan	Yes	Yes
	Fires-1: Fire Prevention and Response	Yes	Yes
	Waste-1: Waste Management Plan	Yes	Yes
	Safety-2: Personal Protection Equipment	Yes	Yes
	Safety-3: First Aid and Emergency Response Equipment	Yes	Yes
	Safety-4: Community Safety	Yes	Yes
Sediment and Erosion Control Plan	Water-1: Sediment and Erosion Control	Yes	Yes
Water Quality Monitoring Program	Water-2: Water Quality Monitoring Program	Yes	Yes
Water Extraction Strategy	Water 6: Water Extraction Strategy		Yes
Hazardous Materials Management Plan	Hazards-1: Hazardous Materials Management Plan	Yes	Yes
	Water-3: Drilling Waste and Effluent Management		
Waste Management Plan	Waste-1: Waste Management Plan	Yes	Yes
	Water-3: Drilling Waste and Effluent Management		

ES.4.1 Potential Adverse Risks Impacts

Potentially adverse environmental and social impacts that could occur as a result of the project include:

- **Soil Erosion and Water Quality.** The project would require grading roads and well pads, which could mobilize sediment and impact water quality. The drill

cuttings could contain high levels of heavy metals. Implementation of sediment and erosion control best management practices, testing drill cuttings, testing water quality on nearby streams, and implementing protective and remedial actions (if necessary) will protect water quality during drilling. Site restoration/reclamation activities will restore the well pad and avoid long-term soil loss.

- **Water Supply.** Constructing the well pads and access roads could impact water supply infrastructure, such as buried pipelines. Using water from area streams for drilling could impact downstream, water supply availability. Avoiding water supply infrastructure, and coordinating water use with the Water and Sewerage Company of Saint Lucia (WASCO) and Water Resource Management Agency (WRMA) of Sant Lucia will avoid significant impacts on water supply.
- **Air.** Geothermal testing could result in a temporary increase in carbon dioxide (CO_2) and hydrogen sulphide (H_2S) levels in proximity to the wells. Air quality will need to be monitored and emergency evacuation procedures would be implemented if CO_2 or H_2S levels exceeded standards at receptors. The risk of exceeding air quality standards is low and would most likely be attributed to an upset condition, such as a well blowout (which is rare). Any potential exceedance of air standards would be short in duration because the geothermal gases would disperse quickly after the geothermal gases are contained. The mitigation would adequately manage the risk of geothermal gas emissions.
- **Geologic Hazards.** Widening roads at sharp turns could cause a landslide if the roadway is not properly constructed. One of the drilling areas is located in an area with saturated soils. A geotechnical investigation is required prior to civil works to address the potential for induced slope stability, landslide risk, and unstable soil conditions. The risk of slope failure or subsidence would be mitigated through implementation of the geotechnical recommendations. The mitigation would adequately manage the risk from geologic hazards.
- **Noise.** Operating construction and drilling equipment would result in a temporary increase in noise in proximity to the well pads. Well drilling (and potentially well testing) would occur 24 hours a day and could result in elevated noise levels and vibrations at residences near the drilling sites. The mitigation includes installing noise control devices on the drilling equipment, noise barriers where drilling would occur within 300 meters (1,000 feet) of residences, and a mechanism to receive and respond to noise complaints. The mitigation would adequately manage temporary noise impacts.
- **Natural Habitats and Biodiversity.** The project areas would be positioned in open agricultural or previously disturbed areas absent of natural and sensitive habitats. Project noise could impact bird nesting behavior in forested habitat adjacent to the drilling areas. Mitigation includes buffers from the forested habitat and pre-construction surveys for sensitive bird species. The mitigation would adequately manage the risk to biodiversity.
- **Archaeology and Cultural Resources.** The project area contains sensitive cultural resources. Grading and excavation activities could impact archaeological and

historical resources. Mitigation includes testing for subsurface resources and archaeological monitoring during excavation and grading if the area contains subsurface resources. The mitigation would adequately manage the risk to archaeological resources.

- **Landscape and Visual Quality.** The project area is outside of the PMA and would not be in view from established tourist viewpoints. The drill rigs and equipment would have a minor and temporary impact on landscapes and views. Grading and vegetation removal could impact the landscape. Mitigation includes restoration of the well pads and revegetation after the project is completed. Implementation of site restoration would adequately manage this risk.
- **Traffic and Road Safety.** The project will include transporting large equipment to the drilling areas. Temporary lane closures may be required during equipment transport. Mitigation includes use of traffic controls and flaggers. The mitigation would adequately manage the risk on traffic and safety.
- **Utilities.** Transporting large equipment could damage low-hanging utility lines. The mitigation requires minimum clearance for overhead utilities or temporary relocation of the line. The mitigation would adequately manage the risk on utilities.
- **Fires.** Construction equipment, welding, or worker smoking could ignite a fire in brush near the work sites. Mitigation includes worker training and maintaining fire suppression equipment at the work sites. The mitigation would adequately manage the risk of wildfire.
- **Waste.** The project would generate non-hazardous waste from packaging, containers, and the worker camp. The construction equipment would also require the use of small quantities of hazardous materials, such as fuel, oils, and lubricants. Drilling will produce drill cuttings that will be tested and buried on site if non-hazardous; any hazardous drilling waste would be removed and disposed of in an appropriate facility. Produced geothermal fluids (if the well encounters the geothermal resource) would be contained in pits or tanks. Effluent (liquid waste) from drilling activities would be tested and disposed of appropriately. Mitigation includes preparation and implementation of a waste management plan and hazardous materials management plan to adequately manage the risk from solid, liquid, and hazardous waste.
- **Livelihoods and Resettlement.** The project will not require resettlement of any structures or people. Portions of the project are located in areas where active agriculture production occurs, and the project could temporarily impact the livelihoods of individual farm owners and farmworkers. Mitigation includes compensation for loss of agricultural production in accordance with the Resettlement Action Plan and Resettlement Policy Framework (Appendix E and F, respectively). The mitigation would adequately manage the impact on livelihoods.
- **Recreation.** Two potential drilling areas are located within a community recreational area. The mitigation includes avoidance of drilling within the community recreational field and use of the field as a temporary staging area only.

Avoidance of recreational areas during drilling activities will adequately manage the risk.

- **Health and Safety.** The project would expose workers to occupational hazards associated with heavy equipment, the drill rig, and potentially production of geothermal steam and hot water. Workers would also be at risk of exposure to geothermal gases including H_2S and CO_2. The mitigation includes a worker safety program and worker safety training. The mitigation would adequately manage the risk to health and safety.

ES.4.2 Potential Beneficial Impacts

The project could result in potentially beneficial social impacts through creation of temporary local jobs during construction and drilling operations. The project would provide opportunities for training and increased knowledge of geothermal exploration, drilling and testing. The project would also create good working conditions with fair employment practices in accordance with all laws and policies governing labor rights and working conditions. If the project is successful, it could lead to development of a geothermal power plant to reduce Saint Lucia's reliance on fossil fuels and reduces emissions of pollutants.

ES.5 CONCLUSIONS

All impacts associated with the project could be avoided or mitigated by implementing the mitigation measures identified in this ESIA. The project would comply with the World Bank's Environmental and Social Policy for Investment Project Financing and Environmental and Social Standards (ESS) through implementation of the mitigation measures listed in Table ES.5-1.

Table ES.5-1 Summary of Mitigation Measures

Resource	Mitigation Measure
Water Resources	Water-1: Stormwater, Erosion, and Sediment Control Water-2: Water Quality Monitoring Program Water-3: Drilling Waste and Effluent Management Water-4: Blowout Prevention Water-5: Water Supply System Protection Water-6: Water Extraction Strategy
Air Quality	Air-1: Fugitive Dust Management Air-2: Construction Emissions Controls Air-3: Air Quality Monitoring and Noxious Gas Management
Geology and Soils	Soils-1: Topsoil Preservation and Restoration Soils-2: Geotechnical Investigation
Noise	Noise-1: Noise Abatement and Community Coordination
	Noise-2: Vibration
Natural Habitats and Biodiversity	Biodiversity-1: Pre-Construction Surveys is MS-3 and MS-4 Biodiversity-2: Invasive Weed Control Biodiversity-3: Nesting Bird Avoidance and Impact Minimization
Archaeological and Cultural Resources	Cultural-1: Archaeological Testing or Monitoring Cultural 2: Pre-Construction Surveys in MS-3 and MS-4 Cultural 3: Worker Cultural Resources Sensitivity Training
Landscape and Visual Character	Landscape-1: Site Reclamation and Restoration
Traffic Circulation and Safety	Traffic-1: Traffic Control Traffic-2: Road Hazard Avoidance
Utilities and Communication Systems	Utilities-1: Protect Overhead Utility Lines
Hazards and Hazardous Materials	Hazards-1: Hazardous Materials Management Plan
Fires	Fires-1: Fire Prevention and Response
Solid Waste	Waste-1: Waste Management Plan
Livelihoods	Social-1: Agricultural Production
Working Conditions and Equality	Social-2: Working Conditions and Equality Social-3: Community Engagement and Sensitivity
Recreation	Social-4: Recreation
Worker Health and Safety	Safety-1: Health and Safety Plan Safety-2: Personal Protection Equipment Safety-3: First Aid and Emergency Response Equipment
Community Health and Safety	Safety-4: Community Safety

1 INTRODUCTION

1.1 OVERVIEW

The Government of Saint Lucia (GoSL) proposes to conduct a geothermal exploration drilling program (the project) in Saint Lucia. The project involves drilling geothermal exploration wells to evaluate the feasibility of commercial geothermal energy-fueled electric power generation. The GoSL seeks funding for the project from the World Bank. The World Bank requires borrowers to prepare an Environmental and Social Impact Assessment (ESIA) prior to approving funding in accordance World Bank Operational Protocols.

The primary purpose of the ESIA is to present a detailed analysis of the risks and impacts the project would have on the existing environmental and social conditions in the project area. Feasible mitigation measures are defined in the ESIA to avoid, minimize, or compensate for the impacts. The ESIA specifies costs of proposed mitigation measures, and their suitability under local conditions; and the institutional, training, and monitoring requirements for the proposed mitigation measures.

The GoSL contracted Panorama Environmental, Inc. (Panorama) to prepare an ESIA for the project. This ESIA was prepared in accordance with the draft World Bank Environmental and Social Framework (World Bank 2017) and is organized as follows:

- **Section 1: Introduction.** Summarizes the purpose and contents of the ESIA, previous geothermal investigations, and Pre-Feasibility Study conducted by GeothermEx and Power Engineers (2017).
- **Section 2: Legal and Institutional Framework.** Summarizes environmental and social laws that are applicable to the ESIA process.
- **Section 3: Project Description.** Describes the proposed geothermal exploration program in detail, including the specific locations, procedures, and scheduled of the project.
- **Section 4: Baseline Data/Existing Environment.** Summarizes the findings of the literature review and field studies presented in the Scoping Studies Report that was prepared for the project (Panorama Environmental, Inc. 2017).
- **Section 5: Environmental and Social Risks and Impacts.** Describes the specific risks and impacts that would result from the project.
- **Section 6: Mitigation Measures.** Provides the full text of mitigation measures that would implemented to avoid or minimize impacts, including the specific tasks, roles, and responsibilities (e.g., GoSL, civil contractor, and drilling contractor).
- **Section 7: Analysis of Alternatives.** Summarizes alternatives that were considered and screened out when developing the project description.

- **Section 8: Key Measures and Actions for the Environmental and Social Commitment Plan.** Lists the important plans and actions that would ensure implementation of the required mitigation measures and compliance with the World Bank's polices and standards.
- **Appendices A through H.** Provides additional information and documents that are an integral part of the ESIA.

1.2 SIGNIFICANT PREVIOUS GEOTHERMAL INVESTIGATIONS

Geothermal resource investigations were previously conducted in the Sulphur Springs area in the 1970s and 1980s (Barthelmy 1990). Slim-diameter geothermal wells were drilled in 1975 to 1976 and steam was encountered in four of the seven wells. Production-size geothermal wells were drilled in 1987 and 1988 at Sulphur Springs. One of the deep exploratory wells was dry and the second well encountered a high gas and acidic geothermal system (Barthelmy 1990). The productive well produced high temperature fluids but was not considered commercially viable due to the high acid content (which would corrode power plant equipment).

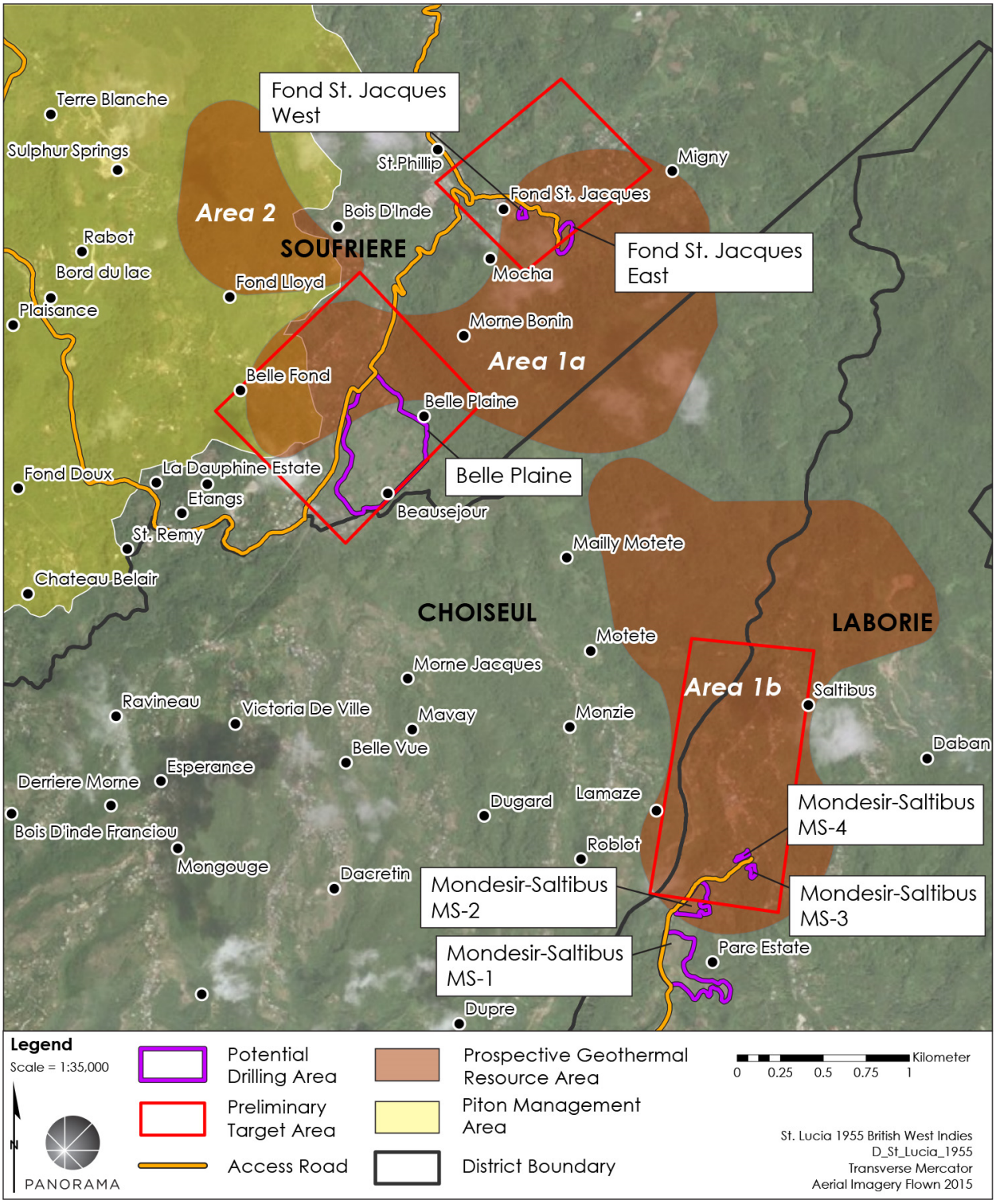
Jacobs of New Zealand (Jacobs) conducted a geoscientific study in 2015 and 2016 (Jacobs New Zealand Limited 2016) to evaluate areas of potential geothermal resource development outside of the acidic and high-gas system near Sulphur Springs. The study results suggested the presence of a geothermal resource in areas southeast of Sulphur Springs. Jacobs identified three areas with geothermal potential (Areas 1A, Area 1B, and Area 2) where further exploration of geothermal resources could be focused (Figure 1.3-1).

1.3 PRE-FEASIBILITY STUDY

GeothermEx and Power Engineers have been contracted by the GoSL to conduct a pre-feasibility study that integrates the findings of previous geothermal investigations and assists the GoSL in planning for the next phase of exploration (drilling exploratory wells). Drilling exploratory geothermal wells is necessary to verify the resource and its suitability for commercial electric power generation. GeothermEx and Power Engineers reviewed the Jacobs 2016 study (Jacobs New Zealand Limited 2016) and further refined the potential exploratory drilling area to focus on Areas 1A and 1B (refer to Figure 1.3-1). Area 2 is not desirable for initial exploration because it is located within the most sensitive area of the PMA (GeothermEx and Power Engineers 2017). GeothermEx and Power Engineers identified three resource target zones where exploratory drilling could be conducted with less cost and environmental and social effects. These areas were further refined after conducting preliminary environmental review and the final potential resource target areas were identified. Well pads may be located within the potential drilling areas shown in Figure 1.3-1.

The project drilling areas in Belle Plaine and Mondesir-Saltibus (MS-1) are positioned just outside the boundary of the areas of geothermal interest identified in the Jacobs report. Depending on the type of exploratory drilling and subsurface conditions, horizontal directional drilling techniques can be used to reach the geothermal resource area from the periphery.

Figure 1.3-1 Areas of Geothermal Exploration Interest and Potential Drilling Areas



Sources: (Jacobs New Zealand Limited 2016, GeothermEx and Power Engineers 2017)

1.4 PROJECT LOCATION AND SITE SELECTION

The project is located in the Soufrière, Choiseul, and Laborie districts of Saint Lucia. The drilling areas are located in or near Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques. The Belle Plaine and Fond St. Jacques areas would be accessed from the west via Soufrière. The Mondesir-Saltibus area would be accessed from the south via Vieux Fort.

Panorama consulted with GeothermEx to define the potential drilling areas based on accessibility/cost and reduced environmental and social conflicts. The drilling areas were identified within, or in close proximity to, the resource target zones identified in the reports by Jacobs (Jacobs New Zealand Limited 2016) and GeothermEx (GeothermEx and Power Engineers 2017). The resource target areas were then expanded in November 2017 to include additional locations in Area 1b that would only be used for slim-hole wells (due to limited available land for geothermal exploration and potential for environmental and social impacts).

The resource target areas were reduced to relatively flat and open areas where drilling would have the least logistical constraints and impacts on the local communities and still meet the desired parameters for evaluating the geothermal resource. The project could include geothermal exploration drilling on well pads in the following areas shown on Figure 1.3-1:

- Belle Plaine
- Mondesir-Saltibus (MS-1, MS-2, MS-3, and MS-4)
- Fond St. Jacques (East and West)

1.5 PROJECT NEED

The project is needed to evaluate the geothermal resource outside of the Sulphur Springs area and determine the viability of commercial geothermal power generation in Saint Lucia. The outcome of the exploration program would provide the GoSL and Saint Lucia Electricity Services Limited (LUCELEC) with valuable information that will support future capital investment decisions regarding further exploration of the geothermal resource and potential development for electric power generation.

Geothermal resource development in Saint Lucia would include the following benefits:

- Reduce consumption of non-renewable fossil fuels by providing a reliable source of clean renewable energy
- Help Saint Lucia meet its Paris Accord targets for renewable energy production
- Increase Saint Lucia's energy independence by reducing reliance on imported fossil fuels

2 LEGAL AND INSTITUTIONAL FRAMEWORK

2.1 OVERVIEW

This section provides a legal context for the ESIA, identifies Saint Lucia's legal requirements, and the World Bank's policies and guidance on environmental and social impact assessment. This ESIA has been prepared to fully comply with environmental and social legislation and procedures in Saint Lucia and with the World Bank's environmental and social safeguard operational policies. Compliance with Saint Lucia's national legislation and regulations and the World Bank's operational policies is required for Applicant's seeking financing from the World Bank.

2.2 WORLD BANK

2.2.1 Operational Policies

Applicants seeking financing from the World Bank are required to comply with the applicable bank environmental and social safeguards operational policies (OPs). A summary of the key objectives of relevant OPs are provided below.

OP 4.01: Environmental Assessment. OP 4.01 requires that an Environmental Assessment be prepared for projects submitted for World Bank funding. The Environmental Assessment must include an assessment of the risks that the project may present to the environment, identify alternatives to the project, define methods to enhance the positive impacts of the project, and define mitigation to avoid, minimize, and compensate for negative impacts of the project. The Environmental Assessment must take into account the natural environment (i.e., air, land, and water); the health and safety of the population; social aspects including involuntary displacement of peoples, indigenous peoples, and cultural heritage; and transboundary and global environmental issues. OP 4.01 requires stakeholder outreach prior to preparation of the Environmental Assessment and dissemination of information in the Environmental Assessment. All Category A and Category B[1] projects must take into account views of any

[1] Projects submitted for World Bank funding must be categorized to determine the level of environmental review necessary to analyze the environmental impacts of the project. "Projects are assigned to one of [three] categories on the basis of the nature, magnitude and sensitivity of the environmental issues" (World Bank 1999).

group that may be affected by the project. Information about the project should be disseminated prior to consultation and in a language that the group understands. Appendix C of OP 4.01 defines the requirements for a project-specific environmental management plan.

OP 4.04: Natural Habitats. OP 4.04 recognizes that the conservation of natural habitats is essential to safeguard their unique biodiversity and to maintain ecosystem services for long-term use. Natural habitats are defined as terrestrial, freshwater, coastal, and marine ecosystems, including areas that have been slightly modified by human activities, but have kept their ecological functions and majority of their biodiversity.

OP 4.09 Pest Management. OP 4.09 supports a strategy that promotes the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides. In Bank-financed projects, the borrower addresses pest management issues in the context of the project's environmental assessment. In appraising a project that will involve pest management, the Bank assesses the capacity of the country's regulatory framework and institutions to promote and support safe, effective, and environmentally sound pest management.

OP 4.11: Physical Cultural Properties. OP 4.11 emphasizes the need to protect historical and cultural heritage. Cultural resources are defined as objects, sites, physical structures, or landscapes that have historical, cultural, aesthetic, or religious importance. The OP requires that the destruction of known resources be avoided. If there are previously undiscovered resources, the OP recommends consulting national experts or institutions for the protection of the cultural heritage.

OP 4.12: Involuntary Resettlement. OP 4.12 recognizes that involuntary resettlement may cause severe long-term hardship, impoverishment, and environmental damage unless appropriate measures are carefully planned and carried out. OP 4.12 outlines the requirements for a Resettlement Action Plan (RAP) or Resettlement Policy Framework (RPF).

OP 4.36: Forests. OP 4.36 recognizes that the management, conservation, and sustainable development of forest ecosystems and their associated resources are essential for lasting poverty reduction and sustainable development. In accordance with OP 4.01, the Environmental Assessment addresses the potential impact of the project on forests.

Category A. Project that may have diverse and significant environmental impacts. Requires a full Environmental Assessment.
Category B. Project may have specific environmental impacts. Full Environmental Assessment not required, but environmental analysis is appropriate.
Category C. Project is unlikely to have significant environmental impacts. Environmental analysis is normally unnecessary.

2.2.2 Environmental, Health, and Safety Guidelines

General Guidelines

The World Bank's General Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of the environmental assessment. The General EHS Guidelines cover the following topics: Environmental, Occupational Health and Safety, Community Health and Safety, and Construction and Decommissioning.

Geothermal Power Generation Guidelines

The World Bank's *Environmental, Health, and Safety Guidelines for Geothermal Power Generation* provides specific recommendations for management of EHS issues associate with geothermal power generation (IFC and World Bank Group 2007b) The guidelines were designed to be used in tandem with *Environmental, Health, and Safety General Guidelines*, which provides guidance on common EHS issues for all industry sectors. Although this project does not include power generation, the guidelines provide recommendations for management of drillings fluids and cuttings, air emissions (i.e., H_2S), solid waste, well blowouts and pipeline failures, and water consumption and extraction. The guidelines also specify worker protection requirements for confined spaces, heat, noise, and infrastructure safety.

2.3 GOVERNMENT OF SAINT LUCIA

2.3.1 Environmental Laws

Forest, Soil and Water Conservation Act (1945 and 1983). This legislation establishes a legal framework for the management of forests and forest resources. Removal of and dealing in timber are regulated by a permit system. It establishes the guidelines for maintaining protected forests.

Saint Lucia National Trust Act (1975). The Saint Lucia Nation Trust Act of 1975 established the Saint Lucia National Trust, which is a membership organization set up to help conserve the natural and cultural heritage of sites of Saint Lucia. The objectives of the Saint Lucia National Trust include the listing of buildings, objects and monuments of prehistoric, historic and architectural interest, and places of natural beauty.

Wildlife Protection Act (1980). This act creates a legal framework for wildlife protection, conservation, and management. A Chief Wildlife Protection Officer is responsible for administration and enforcement of the Act, research and data collection.

Fisheries Act (1984). This act defines fisheries management and development, marine reserves and conservation measures, enforcement measures and other regulations applying to fisheries in the fishery waters.

Land Conservation and Improvement Act (1992). This act provides for the conservation of land in Saint Lucia and establishes the Land Conservation Board. The main functions of the Board shall be to advise the Minister responsible for Agriculture and Lands on the general supervision of land.

National Conservation Authority Act (1999). The National Conservation Authority was established in 1999 "to identify, manage, conserve, and generally provide stewardship over natural assets including beaches, coastal, protected and other declared or designated areas, in a sustainable manner and to provide ancillary amenities thereby contributing to the social and economic development of Saint Lucia."

National Physical Planning and Development Act (2001 and 2005). The objectives of this Act include ensuring that appropriate and sustainable use is made of all publicly and privately-owned land in Saint Lucia in the public interest. The act also promotes the protection and conservation of the natural and cultural heritage of Saint Lucia.

2.3.2 Environmental Policies

National Environment Policy and National Environmental Strategy (2005). In 2005, the Government of Saint Lucia approved a five-year National Environmental Management Strategy and a National Environmental Policy. The 2005 Policy, with a pending update initiated in 2014, is intended to guide implementation of national environmental goals and targets and track progress towards these goals and targets. The focus is on a clearly defined results-based operational strategy and action plan detailing specific modalities for interventions by national agencies as well as by regional and international development partners.

National Land Policy (2007). This policy is intended to guide the use, management, development and administration of land resources in Saint Lucia in order to optimize the contribution of land to sustainable development.

National Energy Policy (2010). The objective of the National Energy Policy is to create an enabling environment, both regulatory and institution, for the introduction of indigenous renewable energy to the national energy mix, thus achieving greater energy security and independence.

National Climate Change Adaptation Policy (2013). The National Climate Change Adaptation Policy provides a framework for addressing the impacts of climate change, in an integrated manner, across all key sectors. While the Policy specifically addresses climate change adaptation, it is recognized that some activities provide meaningful adaptation, as well as mitigation, co-benefits, thereby increasing resilience in the face of existing and emerging climate change impacts.

National Water Policy (2004). The goal of the policy is to sustain economic growth, human development and environmental sustainability by promoting and facilitating the use and management of freshwater resources in an efficient, sustainable, and equitable manner that is

consistent with the social, economic, and environmental needs of current and future generations as well as with the country's international obligations.

2.3.3 International Labour Convention Commitments

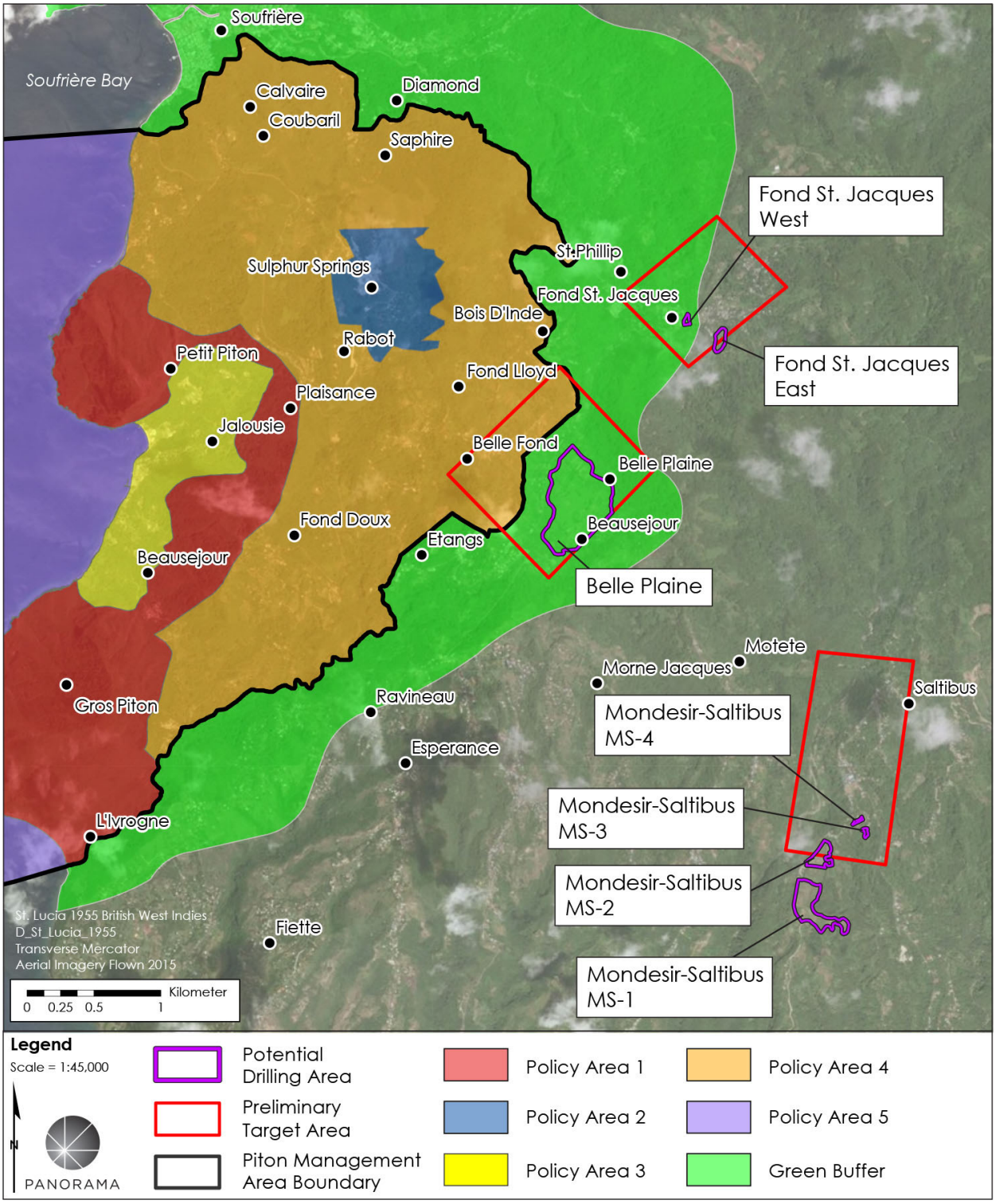
Saint Lucia is a member of the International Labour Organization. The International Labour Organization produces Conventions, which are legally binding international treaties that may be ratified by member states. Saint Lucia has ratified a total of 28 Conventions (International Labour Organization 2009).

2.4 WORLD HERITAGE DESIGNATION FOR THE PINTONS MANAGEMENT AREA

The PMA is designated as a World Heritage Site by United Nations Educational, Scientific and Cultural Organization (UNESCO) for its Outstanding Universal Value. The management of the PMA must adhere to the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO 2017). An Integrated Development Plan was prepared for the PMA and surrounding Soufriere Region that identifies policy areas and development goals to preserve the PMA and World Heritage Site designation (Hyder Consulting Limited 2008). In 2013, a study on the Limits of Acceptable Change (LAC) was prepared to identify acceptable development within the PMA policy areas, including a "green buffer" zone, as well as development that could conflict with the World Heritage Site designation (The Landmark Practice 2013). As shown in Figure 2.4-1, the potential drilling areas would be outside of the PMA policy areas, but within the green buffer zone.

The LAC study included an assessment of possible geothermal energy development within the PMA and green buffer zone. The LAC study states that "exploratory boreholes beyond the PMA are unlikely to have any effect on the PMA" (The Landmark Practice 2013). Further, the LAC study indicates that geothermal exploration, and potentially development of power plant infrastructure, may be acceptable within PMA Policy Area 2 (Sulphur Springs); however, an environmental impact assessment would be necessary to evaluate such possibilities (The Landmark Practice 2013). The LAC study also notes any power lines and support structures

Figure 2.4-1 PMA Policy Areas and Green Buffer Zone



Sources: (McElhanney Consulting Services Ltd. 2015, The Landmark Practice 2013)

associated with geothermal development could have an adverse effect on scenic views, even if they were outside of the PMA boundary; further study would be necessary depending on their location (The Landmark Practice 2013).

Further evaluation of the PMA "buffer area" will be required prior to development of geothermal resources within the PMA "buffer area". The previous evaluations of the PMA do not define activities that are allowable or excluded within the "buffer area". Further evaluation and definition of acceptable land use changes or impacts within the "buffer area" is required to determine whether future geothermal development in the "buffer area" could conflict with the PMA.

2.5 RELEVANT THRESHOLD STANDARDS

2.5.1 Effluent Discharge

The IFC and World Bank Group Environmental, Health, and Safety General Guidelines (IFC and World Bank Group 2007a) have developed guidelines for effluent discharge to waters such as lakes, streams, rivers, or the ocean. The IFC and World Bank effluent threshold standards for mining, which has similar processes to geothermal drilling, are presented in Table 2.5-1 for informational purposes. The temperature threshold standard is a differential of less than 3 degrees Celsius (C).

Table 2.5-1 Threshold Standards for Effluent Discharge

Effluent Parameter	Threshold Standards (mg/L)
Total suspended solids	50.0
pH	6 to 9
Chemical oxygen demand	150.0
Five-day biological oxygen demand	50.0
Oil and grease	10.0
Arsenic	0.1
Cadmium	0.05
Chromium (hexavalent)	0.1
Copper	0.3
Cyanide (total)	1.0
Cyanide (free)	0.1
Cyanide (weak acid dissociable)	0.5
Iron	2.0
Lead	0.2
Mercury	0.002

Effluent Parameter	Threshold Standards (mg/L)
Nickel	0.5
Phenols	0.5
Zinc	0.5

Source: (IFC and World Bank Group 2007b)

2.5.2 Soil Toxicity

The GoSL and World Bank have not developed toxicity standards for soils. The toxicity standards codified in the United States (U.S.) Code of Federal Regulation Title 40 Section 261.24 are used here because these standards underwent substantial study of impacts on human health during their adoption. Table 2.5-2 provides threshold standards for soil toxicity.

Table 2.5-2 Threshold Standards for Soil Toxicity

Pollutant	Threshold Standards (mg/L)
Arsenic	5.0
Barium	100.0
Benzene	0.5
Cadmium	1.0
Carbon tetrachloride	0.5
Chlordane	0.03
Chlorobenzene	100.0
Chloroform	6.0
Chromium	5.0
o-Cresol	4200.0
m-Cresol	4200.0
p-Cresol	4200.0
Cresol	4200.0
1,4-Dichlorobenzene	7.5
1,2-Dichlorobenzene	0.5
1,1-Dichloroethylene	0.7
2,4-Dinitrotoluene	30.13
Endrin	0.02
Heptachlor (or its epoxide)	0.008
Hexachlorobenzene	30.13
Hexachlorobutadiene	0.5

Pollutant	Threshold Standards (mg/L)
Hexachloroethane	3.0
Lead	5.0
Lindane	0.4
Mercury	0.2
Methoxychlor	10.0
Methyl ethyl ketone	200.0
Nitrobenzene	2.0
Pentrachlorophenol	100.0
Pyridine	35.0
Selenium	1.0
Silver	5.0
Tetrachloroethylene	0.7
Toxaphene	0.5
Trichloroethyleene	0.5
2,4,5-Trichlorophenol	400.0
2,4,6-Trichlorophenol	2.0
2,4,5-TP (Silvex)	1.0
Vinyl chloride	0.2

Source: (U.S. Code of Federal Regulation Title 40 §261.24 n.d.)

2.5.3 Air Emissions

The World Health Organization (WHO) maintains air quality guidelines designed to "offer guidance in reducing the health impacts of air pollution" (WHO 2005). Table 2.5-3 summarizes the WHO's threshold standards for air emissions.

Table 2.5-3 Threshold Standards for Air Emissions

Pollutant	Averaging Period	Threshold Standards (µg/m^3) [1]
Sulfur dioxide (SO_2)	Annual mean	125 (interim target 1) 50 (interim target 2) 20 (guideline)
	10-minute mean	500
Nitrogen dioxide (NO_2)	Annual mean	40
	1-hour mean	200
Particulate matter with particle size between 2.5 µm and 10 µm (PM_{10})	Annual mean	70 (interim target 1) 50 (interim target 2) 30 (interim target 3) 20 (guideline)
	24-hour mean	150 (interim target 1) 100 (interim target 2) 75 (interim target 3) 50 (guideline)
Particulate matter with particle size smaller than 2.5 µm ($PM_{2.5}$)	Annual mean	35 (interim target 1) 25 (interim target 2) 15 (interim target 3) 10 (guideline)
	24-hour mean	75 (interim target 1) 50 (interim target 2) 37.5 (interim target 3) 25 (guideline)
Ozone (O_3)	8-hour mean	160 (interim target 1) 100 (guideline)
Hydrogen sulfide (H_2S)	24-hour mean	150
	30-minute mean	7

Note:

[1] The standards for SO_2, NO_2, PM_{10}, $PM_{2.5}$, and O_3 are listed in the "WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide" (2005). The standards for hydrogen sulfide are listed in the "Air Quality Guidelines for Europe" (WHO 2000). While these standards apply to Europe, the analysis of the effects of hydrogen sulfide on human health is universally applicable; therefore, the standards in this document are applied to the proposed project.

Sources: (WHO 2000, WHO 2005)

2.5.4 Noise Exposure

The World Bank's General EHS Guidelines provides maximum noise level guidelines for project-related noise. These guidelines are generally suited for permanent noise increases, such as noise associated with land use changes and permanent point sources from a facility. The project would produce temporary noise only. Table 2.5-4 lists the World Bank's noise level guidelines by land use type. In addition to the land use guidelines, the General EHS Guidelines state that noise levels should not exceed the existing ambient noise levels by more than 3 dBA when measured at the closest noise-sensitive receptor.

Table 2.5-4 Noise Level Guidelines

Land Use	Maximum Noise Level (1-Hour L_{eq}) [a]	
	Daytime (7:00 to 22:00)	Nighttime (22:00 to 7:00)
Residential, institutional, and educational	55 dBA	45 dBA
Industrial and commercial	70 dBA	70 dBA

Note:

[a] Equivalent sound level (L_{eq}): the average A-weighted sound (dBA) level during a defined period of time.

Source: (IFC and World Bank Group 2007a)

Table 2.5-5 lists occupational noise exposure limits and required hearing protection worker exposure.

Table 2.5-5 Occupational Noise Exposure Limits and Required Hearing Protection

Sound Level (dBA)	Maximum Permitted Exposure (Hour/Day)	Required Hearing Protection
80	16	--
85	8	Class C
90	2	Class C/B
100	1	Class B
105	0.5	Class B
110	0.25	Class A
115	0.125	Class A
>115	0	Class A

Source: (Kiama 2016)

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3 PROJECT DESCRIPTION

3.1 OVERVIEW

This section describes the drilling areas, project components, and activities that would be undertaken during implementation of the project.

3.2 POTENTIAL DRILLING AREAS

The project would involve geothermal exploration drilling in the three areas shown on Figure 1.3-1. The geothermal exploration program would include drilling slim-diameter wells to obtain information on the geology and temperature gradient in the area. Deep geothermal wells may eventually be drilled with larger drilling rigs if the initial drilling is successful. The approach for selecting the specific locations of exploration wells, including their depth and diameter, would depend on a range of factors such as access to funds, land accessibility, environmentally and culturally sensitive areas, identification of feasible well pad locations, and eventual power plant development potential. The potential drilling areas shown on Figure 3.2-1, Figure 3.2-2, and Figure 3.2-3 include more land than would be needed during the geothermal exploration program. Larger areas were identified to provide flexibility for selecting suitable drilling sites. The ESIA and ESMP will be updated with site-specific information once the specific locations of the exploration wells are identified, prior to the start of construction. The ESIA will be provided to key stakeholders, including the IUCN, after it has been updated and at least 60 days prior to construction.

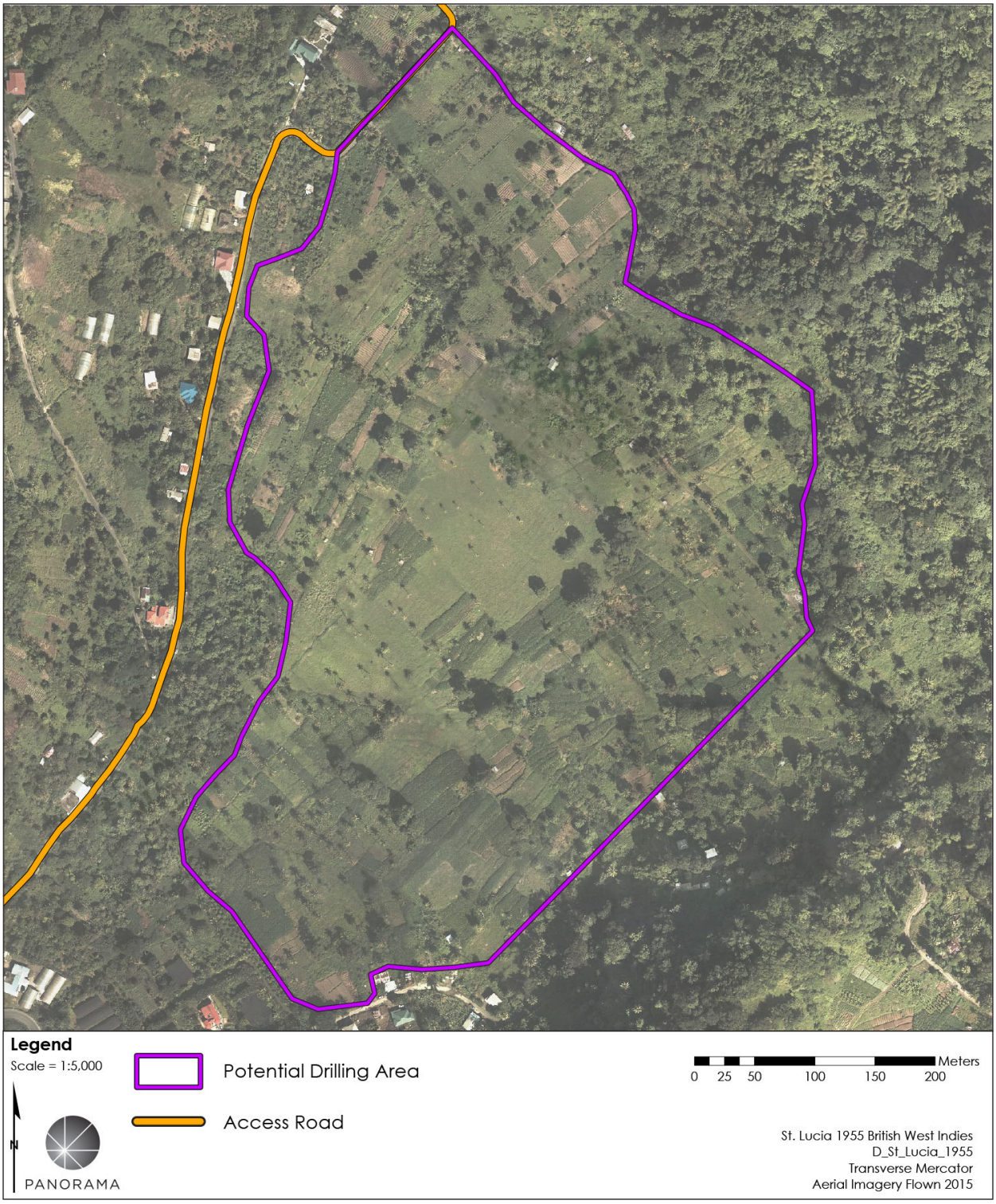
3.2.1 Belle Plaine

Belle Plaine has the most logistically favorable conditions for drilling and the fewest constraints of the three potential drilling areas due to the availability of flat open agricultural land near established roads (refer to Figure 3.2-1). The total area where project activities could be located is approximately 26.3 hectares (65.1 acres); however, only a small percentage of the total area would be needed (well pads require 0.1 to 1.6 hectares [0.25 to 4 acres]).

3.2.2 Mondesir-Saltibus

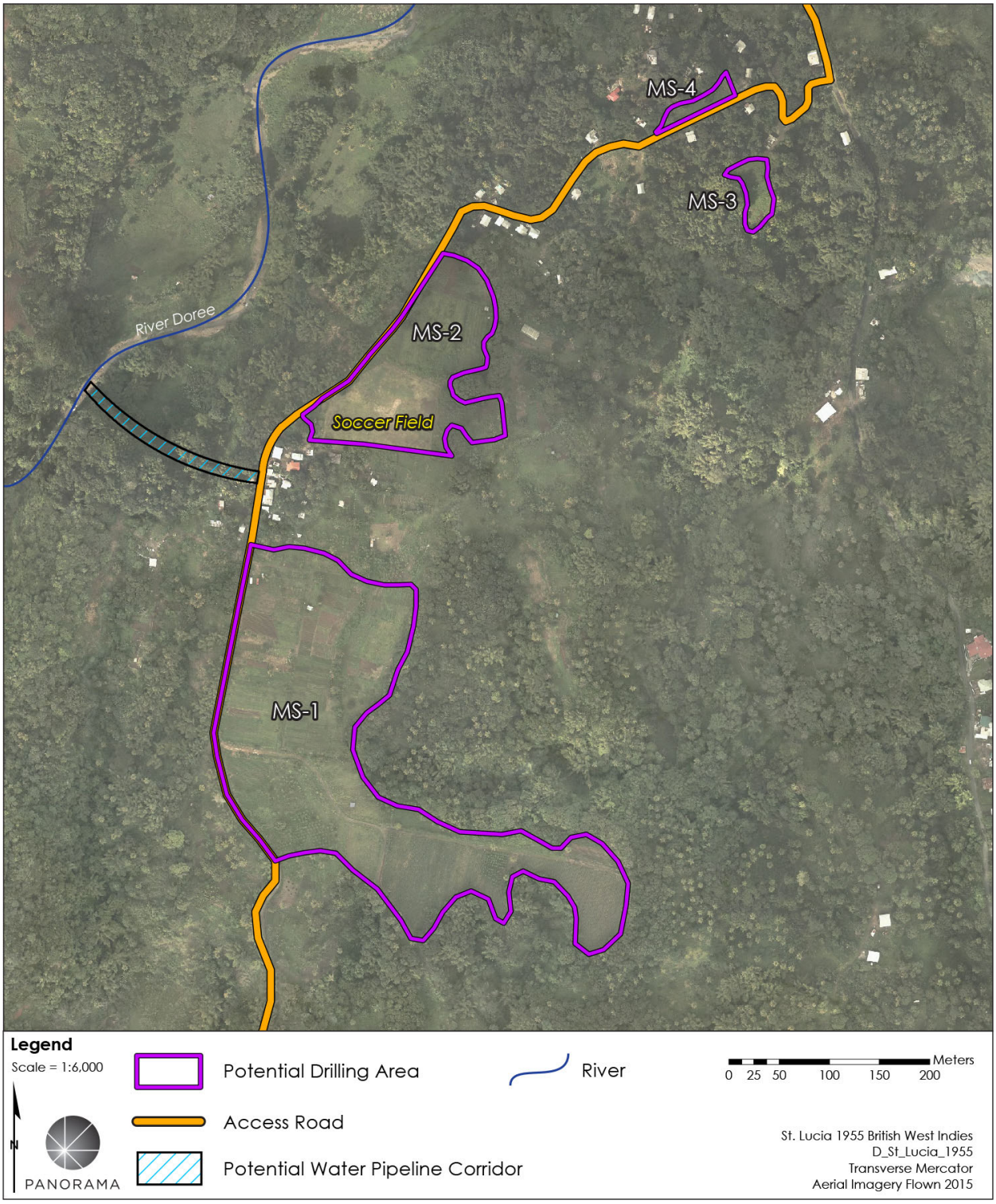
Two medium-sized areas (MS-1 and MS-2) and two small-sized areas (MS-3 and MS-4) may be suitable for drilling in the vicinity of Mondesir-Saltibus. These areas are shown on Figure 3.2-2. MS-1 is approximately 6.5 hectares (16.1 acres) and is located on flat and open government-owned farmland. MS-2 is approximately 2.1 hectares (5.3 acres) and includes a soccer field and agricultural area within government-owned land. MS-3 and MS-4 are approximately 0.1 hectare (0.3 acre) and 0.2 hectare (0.5 acre), respectively. MS-3 is located adjacent to two residences on private property. MS-4 is located on a small private parcel adjacent to the road and has several

Figure 3.2-1 Potential Drilling Area near Belle Plaine



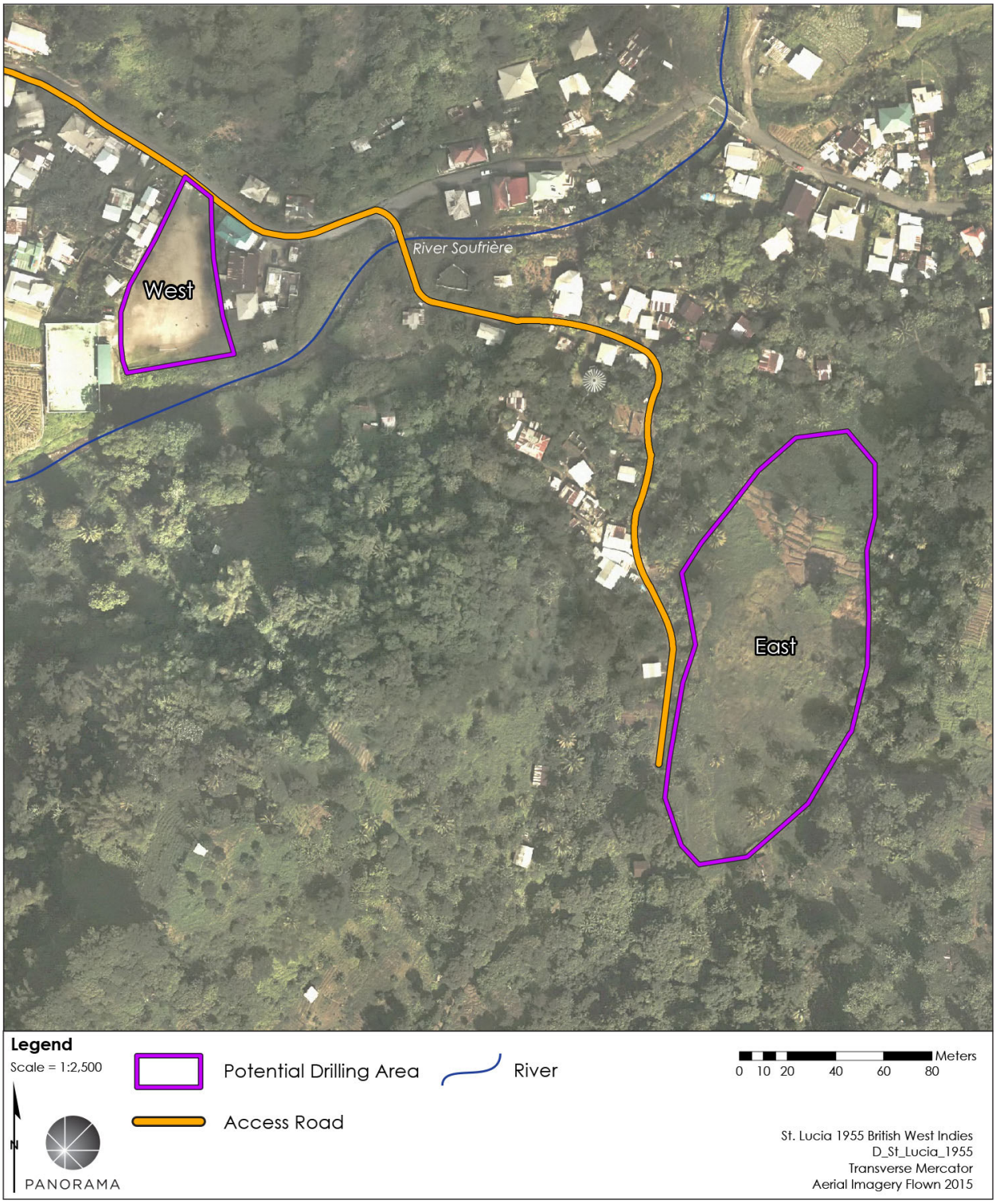
Source: (McElhanney Consulting Services LTD 2015)

Figure 3.2-2 Potential Drilling Areas near Mondesir-Saltibus



Source: (McElhanney Consulting Services LTD 2015)

Figure 3.2-3 Potential Drilling Areas Near Fond St. Jacques



Source: (McElhanney Consulting Services LTD 2015)

residences nearby. Either slim-hole or full-sized well drilling may occur at MS-1 and MS-2. Due to the limited space, geothermal exploration at MS-3 and MS-4 would be limited to slim-hole well drilling.

3.2.3 Fond St. Jacques

There are limited locations that may be suitable for drilling within the Fond St. Jacques target area due to the density of residential development, steep terrain, and absence of flat and open areas to construct well pads. Two small areas that may be suitable for slim-hole wells within the Fond St. Jacques target area are shown on Figure 3.2-3. The western area is approximately 0.24 hectare (0.6 acre), is surrounded by residences, and is located on an unpaved parking area adjacent to the river. The eastern area is approximately 1.1 hectares (2.7 acres) and is located in an agricultural area near a residential community.

3.3 PROJECT COMPONENTS

3.3.1 Drilling Strategy

The drilling strategy for the initial exploration phase will consist of drilling slim-hole wells in the resource target areas to evaluate sub-surface conditions and determine if there are indications of presence or absence of a commercially developable geothermal system.

The well drilling results will be evaluated before determining the next drilling location and well design. If the slim-hole drilling program indicates there may be a commercial resource, full-size geothermal wells could be drilled in Belle Plaine or the MS-1 and MS-2 areas. Full-size wells will not be drilled at Fond St. Jacques or the MS-3 and MS-4 areas due to an absence of flat open areas and the presence of residences in close proximity to the drilling area making access with a large drill-rig economically infeasible during this initial exploration stage. The deep geothermal wells would be used to further test and prove the presence of a commercial geothermal resource.

3.3.2 Site Development, Civil Works, and Supplies

Equipment and Material Sources

Equipment and materials will be sourced locally, if available. It is expected that some equipment and materials would have to be shipped to Saint Lucia from nearby countries (most notably Central, South and North American countries). Shipped equipment and materials would be transported out of Port Vieux Fort and Hewanorra International Airport to the south, or Soufrière Bay to the West. Existing infrastructure at Port Vieux Fort and Hewanorra International Airport could accommodate project needs and is the preferred method of obtaining large equipment and materials for the project.

Soufrière Bay does not have a commercial seaport that could accommodate project needs; therefore, a temporary ramp consisting of a docking station with setup for loading and unloading boats and trucks would be constructed on the beach to unload and load equipment

from the vessel. The decision whether to build this infrastructure will be based on logistic ease and economic value.

Access Roads

The equipment and materials would be transported from the ports to the exploration target areas using a network of existing paved and unpaved roads, as well as new access roads within the drilling target areas. Existing roads may also be improved at areas with tight turning radius by increasing the width to accommodate the turning radius for vehicles and drilling equipment, and by reinforcing unpaved roads leading to the Fond St. Jacques and Mondesir-Saltibus drilling target areas, if necessary. The use of the existing roads for project equipment and materials would not result in a change to the existing uses of the roads. Access roads within the drilling target areas would be constructed as needed by removing trees and vegetation, grading, installing fill dirt, and/or installing gravel. If necessary, retaining walls along access roads would be installed or replaced where widening is required to accommodate the drill equipment turning radius consistent with engineering requirements. Fill material and gravel used for access roads would be purchased from local suppliers or shipped to the island from other CARICOM Countries. The anticipated volume of fill material and gravel is expected to be minor, given that the well pad locations would be chosen at sites close to existing roads. During the process of selecting well pad locations, the cost of new roads in the drilling target area and any road improvements to accommodate the turning radius of the drilling equipment would be evaluated further by GoSL's Department of Infrastructure. A unit cost estimate (i.e., cost per kilometer of new road) would be used to estimate the expected total cost for accessing well pads.

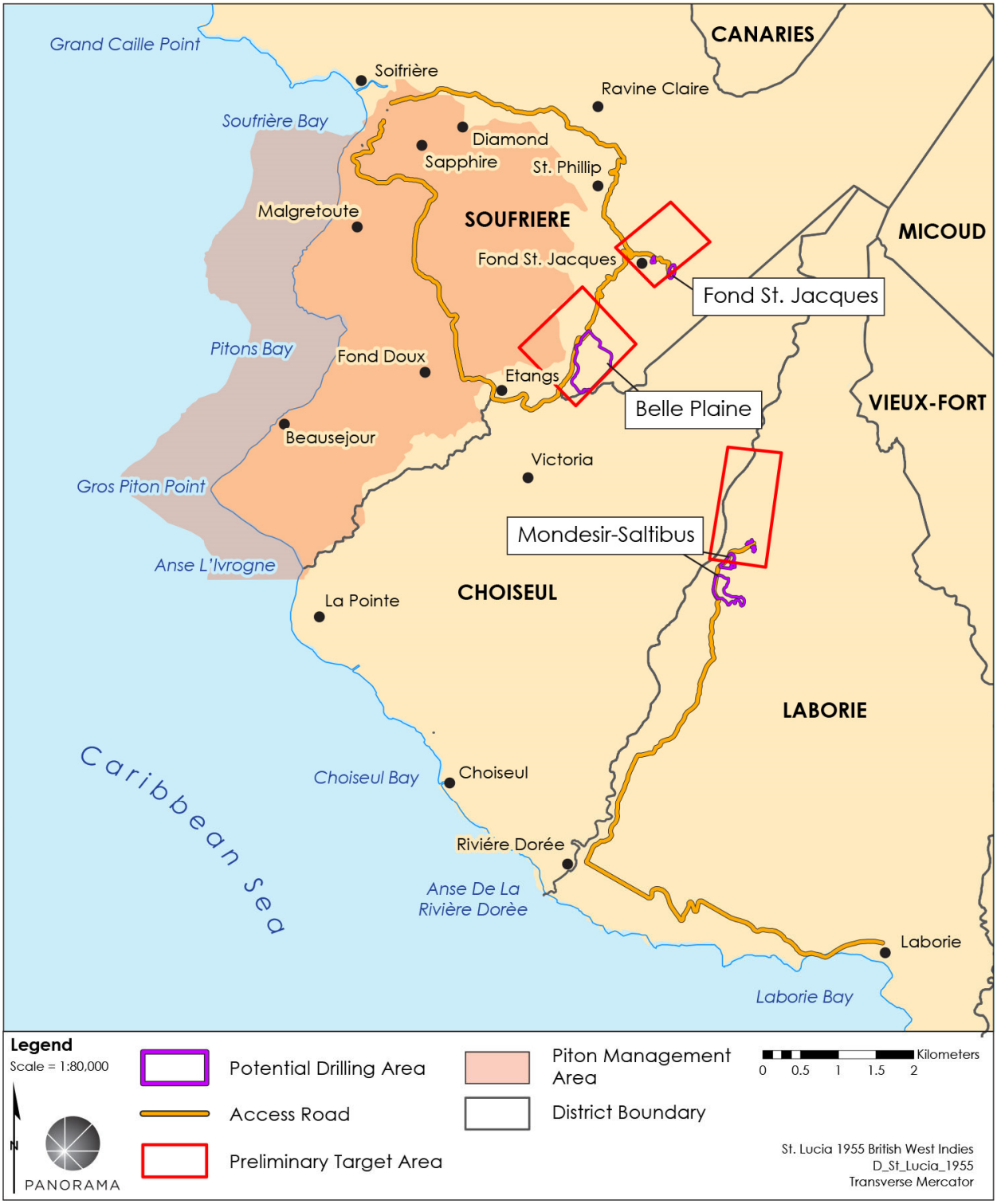
Access roads within the drilling target areaswould be established with a width of approximately 4 to 6 meters (about 13 to 20 feet). Construction of new access roads would occur immediately before well pad development. A drilling rig capable of completing the slim-hole wells (e.g., a Boart Longyear LF230 diamond coring rig) is approximately 3 meters (about 10 feet) wide. Existing bridges and culverts would be reinforced or replaced, if necessary. Temporary or permanent drainage crossings to reach to well pad would be installed as needed to accommodate equipment access. These crossing could include bridges, culverts, steel plates, and rock. Temporary crossing materials would be removed from drainage crossings following construction. The primary access road network is shown on Figure 3.3-1.

Equipment and Material Storage

Equipment and material storage sites would be developed near each drill pad or as close as possible if space is limited. The total space needed at each location would be approximately 0.1 to 0.2 hectare (0.25 to 0.5 acre). If necessary, storage sites would be cleared of vegetation and graded prior to use. Gravel and drainage materials may also be installed to facilitate all weather access. Equipment and materials at the storage sites would be transported to and from well pads and other project sites, as needed.

If necessary, a security fence and lighting would be installed around the storage sites, and security guards may be stationed at the sites.

Figure 3.3-1 Primary Access Roads



Source: (ESRI 2017, ACP-EU Natural Disaster Risk Reduction Program 2016)

Workers' Camp

If required, a worker camp would be established in the Belle Plaine/Fond St. Jacques area and another worker camp could be established in the Mondesir/Saltibus area to house the construction workforce during exploration activities in each area. A worker camp would not be required for slim-hole drilling due to the small number of workers that would be required to construct the smaller wells. The worker camp would house up to 50 workers and would include separate sleeping and bathing facilities for men and women, safe food and drinking water, air conditioning, first aid and medical facility, water storage, generators for electricity, and access to communication networks. Transportation from the worker camp to the project site will be provided. The IFC/EBRD (European Bank for Reconstruction and Development) guidance note on Workers Accommodation: Processes and Standards will be used as guidance in establishing any worker camps.

If necessary, a security fence and lighting would be installed around the worker camp, and security guards may be stationed at the camp.

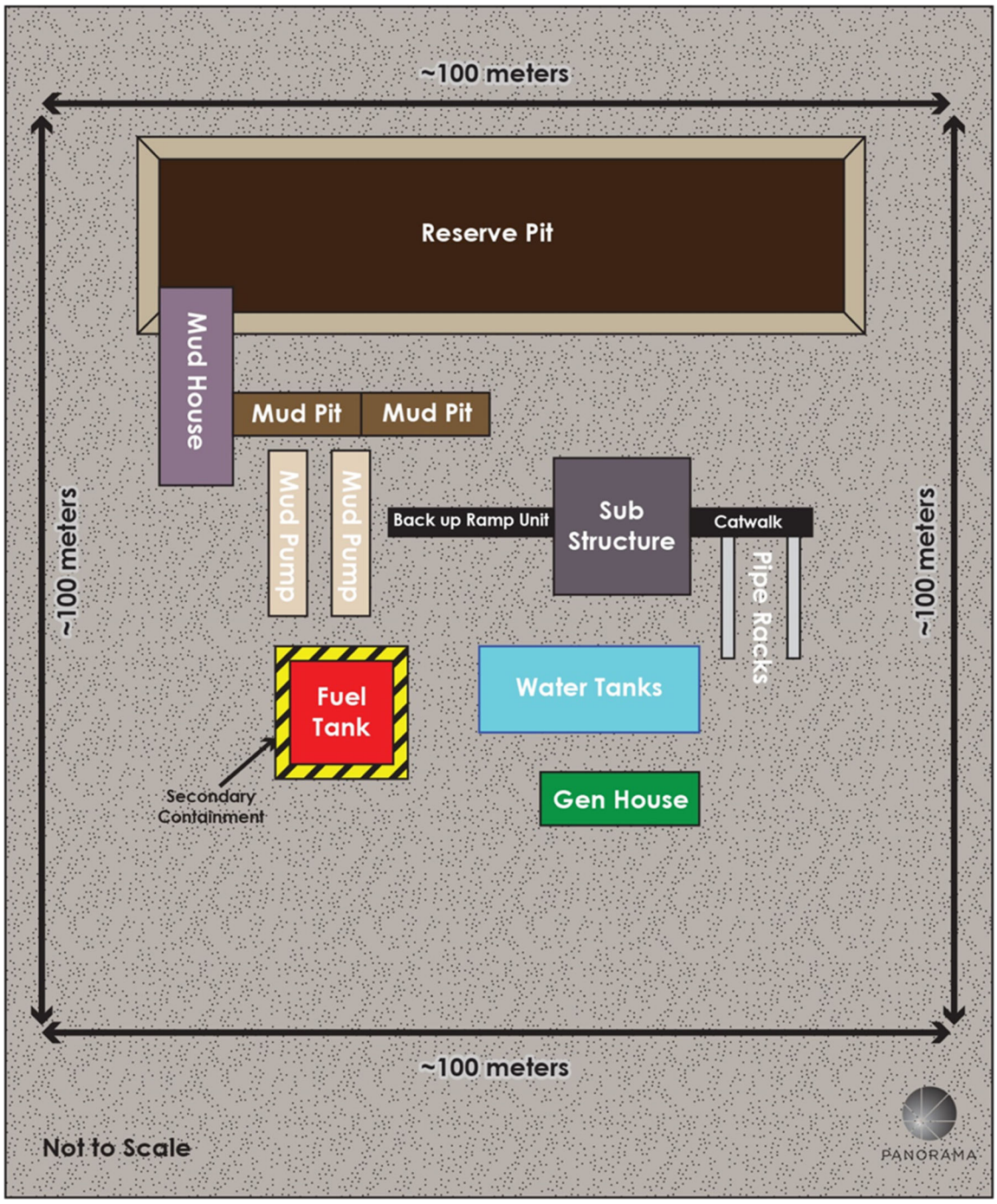
Well Pads

Well pads would be developed at each drilling location where the drilling equipment and materials would be positioned. A well pad for a slim-hole well is typically much smaller than a full-sized well (approximately 40 by 30 meters or 0.1 hectare [0.25 acre]). Well pads for full-sized (deep) wells are generally 100 by 100 meters or approximately 0.8 to 1.6 hectares (2 to 4 acres) in size. Well pads generally include the equipment and components listed below; however, slim-hole well pads would include fewer and/or smaller components than full-sized wells. The differences between full-sized wells and slim-hole wells are described further in Section 3.3.3

- Drill rig
- Well head
- Blowout prevention equipment
- Power supply engines
- Fuel tanks
- Accumulator
- Pipe racks
- Drilling mud tanks
- Drilling mud pumps
- Water storage tanks
- Water supply pipelines
- Mixing tanks
- Reserve pit
- Office space
- Storage space
- Fire-fighting equipment
- Parking space

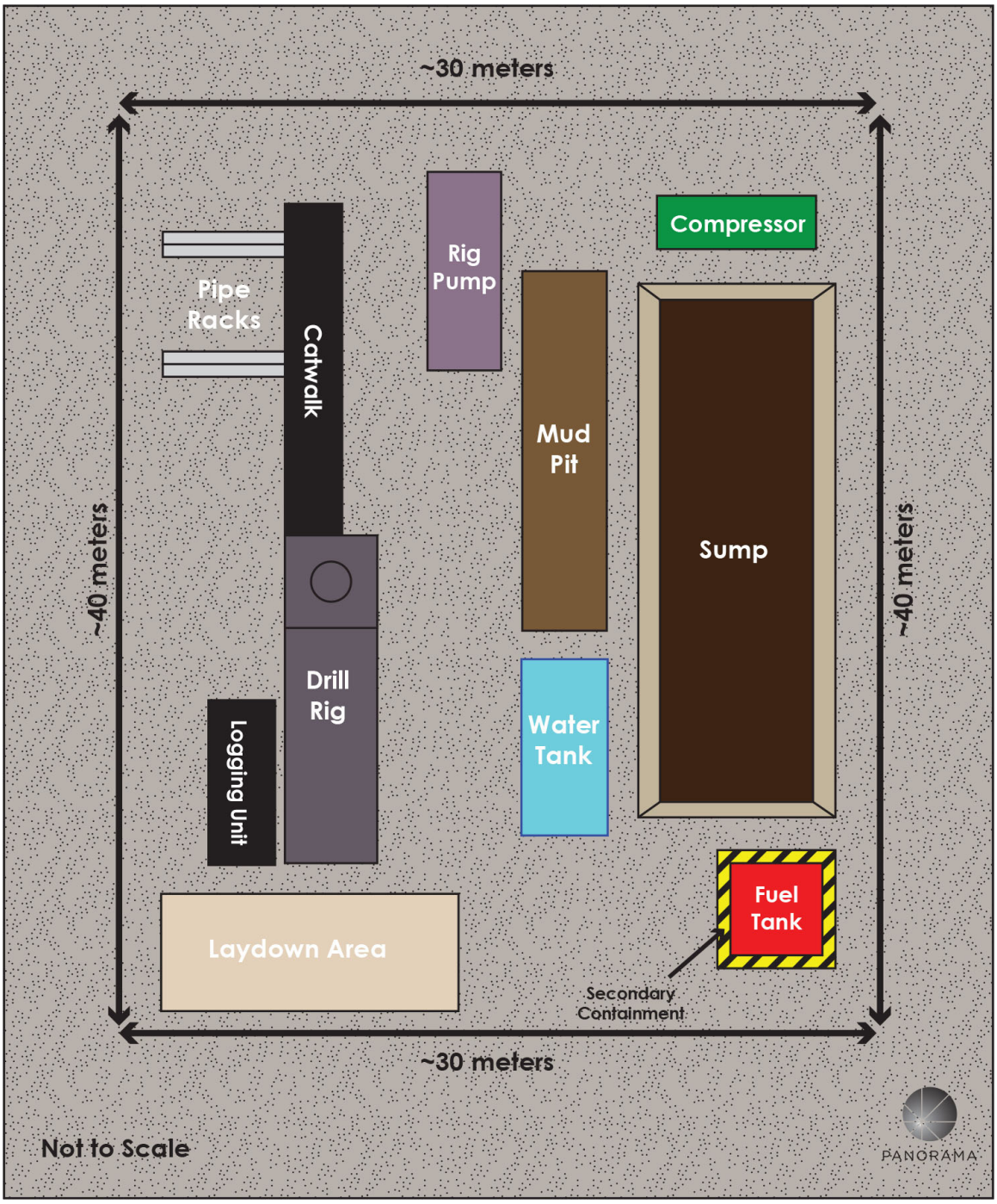
Well pad development would include removing vegetation (including trees). The ground surface would be prepared by grading, compacting soil, and installing a layer of gravel. Gravel used for the well pads would be purchased from local suppliers. The typical layouts of a full-sized well and slim-hole well are show on Figure 3.3-2 and Figure 3.3-3, respectively.

Figure 3.3-2 Typical Layout of a Full-Sized Well Pad



Source: (Maurer Engineering Inc. 1998)

Figure 3.3-3 Typical Layout of a Slim-Hole Well Pad



Source: (Maurer Engineering Inc. 1998)

3.3.3 Well Drilling

As described in Section 3.3.1, the proposed project includes drilling exploratory slim-hole wells at the potential drilling areas; however, the option for drilling full-sized wells is also included. For comparison purposes, Table 3.3-1 lists some of the key differences between slim-hole wells and full-sized wells.

Table 3.3-1 Comparison of Potential Drilling Operations

Component	Slim-hole Wells	Full-sized Wells
Well Pad Dimensions	40 x 30 meters (0.12 hectare) (130 x 100 feet; 0.3 acre)	100 x 100 meters (0.2 hectare) (330 x 330 feet; 0.5 acre)
Drill Rig Dimensions	12 x 4 meters (40 to 13 feet) [a]	20 x 10 meters (66 to 33 feet) [b]
Minimum Access Road Width	4 to 5 meters (12 to 16 feet)	6 to 7 meters (18 to 24 feet)
Well Diameter at Depth	3.78 inches	7 inches
Target Depth	1,200 to 2,000 meters (4,000 to 6,600) feet)	2,000 to 3,000 meters (6,600 to 9,850 feet)
Estimated Water Demand during Drilling	3 to 5 liters per second (up to 45 days)	20 to 30 liters per second (up to 90 days)
Drilling Materials	• Drilling mud/fluid • Casing • Cement	• Drilling mud/fluid • Casing • Cement
Drill Cuttings/Waste Storage	• Tanks or lined sumps	• Lined sumps
Drilling Period	30 to 45 days (up to 24 hours per day)	30 to 90 days (up to 24 hours per day)
Geothermal Resource Testing	• Temperature gradient • Potential for injectivity and production testing	• Injectivity and production testing
Testing Period	30 days (up to 24 hours per day)	30 to 90 days (up to 24 hours per day)

Notes:

[a] Dimensions for the anticipated drill rig (Boart Longyear LF230 or similar).

[b] Approximate dimensions for a conventional drill rig.

Sources: (GeothermEx and Power Engineers 2017)

The exploration slim-holes are planned to be drilled using a combination of rotary and diamond coring drilling techniques. A diamond coring rig that is equipped to rotary drill is the ideal rig type to complete these wells. The wells are planned to reach a total depth of 1,200 to 1,500 meters (approximately 4,000 to 5,000 feet), with the option to drill to 2,000 meters (in HQ or NQ core diameter). The deepest cemented casing string will be set to approximately 750 meters depth (approximately 2,500 feet). A blowout-preventer (BOP) would be installed above the 7-inch casing, which will be set to a depth of approximately 250 meters (approximately 820 feet). If full-sized exploration wells are drilled, they would be

approximately 48 inches in diameter at the top of the well and narrow (telescope) to approximately 7 inches at the bottom of the well.

Examples of drill rigs for a slim-hole well and full-sized well are shown on Figure 3.3-4 and Figure 3.3-5, respectively.

Drilling would require water to cool the drill and wash drill cuttings from the drill bit.[2] The final volumes required will be defined after selection of the drilling rig and hydraulics calculations are completed.

Wells would be drilled using water and non-toxic drilling mud. Variable concentrations of non-toxic additives (drilling fluid) would be introduced to the drilling mud as needed to prevent corrosion, increase mud weight, and prevent mud loss. Additional drilling mud would be mixed and added to the mud system as needed to maintain the required mud quantities.

All drill cuttings and drilling fluid would be discharged to a reserve pit or tank. After drill cuttings settle, the drilling fluid would be disposed of in a shallow well or open reserve pits. Drill cuttings would be left in the reserve pit if found to be non-toxic after testing. The volume of cuttings produced from each exploration slim-hole well is estimated to be approximately 21 cubic meters (approximately 70 cubic feet). The final sump dimensions would be designed to handle all cuttings and mud that is not re-circulated.

An exploration well may need to be re-drilled or worked-over if problems occur that prevent completion of the well. Potential problems may include mechanical malfunctions, difficulty setting the casing, or limited permeability, productivity, or injectivity. The well may be re-drilled by re-entering and re-drilling the existing well bore, or moving the drill rig to a different location on the well pad and drilling a new well through a new conductor casing. Each well will be equipped with a well head and operating valve.

3.3.4 Geothermal Resource Testing

Testing for the presence or absence of an exploitable geothermal reservoir will be conducted after each well is completed. Depending on the final depth and characteristics of each well, these tests would include downhole temperature measurements, injection testing or production testing. Temperature-gradient measurements will be completed periodically for weeks after completion, after the drilling rig is off the location.

[2] Drilling operations for the deeper sections of each well require relatively small amounts of water flow, whereas the larger hole diameters near surface require significantly more water flow for hole cleaning.

Figure 3.3-4 Example Well Pad and Drill Rig for a Slim-hole Well



Source: (Boart Longyear 2017)

Figure 3.3-5 Example Well Pad and Drill Rig for a Full-sized Well



Source: (n.d. 2017)

Wells that encounter elevated temperature and permeability at depth may be completed with a slotted liner. Short-term production and/or injection tests may be completed to assess sub-surface conditions. This testing will occur immediately upon completion of the well, and will require the drill rig to remain on site.

If deep exploration wells are drilled and successfully encounter the geothermal reservoir, well and reservoir testing would be conducted to analyze characteristics of the resource. One or more initial short-term flow tests would occur at each exploration well, and one or more long-term flow tests will occur after the completion of all wells to assess the productivity of the geothermal reservoir and to sample the geothermal fluid. One or more short-term tests will be conducted to test any shallow reservoir transected by the slim-hole wells.

The well bore would ideally be cleared of all residual drilling mud and drill cuttings prior to conducting a well production test. Air may be injected to facilitate the well to flow. The geothermal fluids would be allowed to flow from the exploration well into an atmospheric separator, where temperature, pressure, flow rate, and chemical composition are monitored. The separated water would be discharged to tanks and steam would be released to the atmosphere through a silencer. The silencer may be a rock muffler or a larger diameter pipe. An injectivity test may also be performed by injecting the extracted geothermal fluid back into the exploration well. A long-term flow test may be performed, if warranted, to measure the flow temperature, pressure, and chemistry over time. The decision to conduct a long-term flow test will depend on wellbore conditions, benefits from the data obtained, and casing integrity.

3.3.5 Well Abandonment and Site Reclamation

The commercial potential of each exploration well would be assessed after testing. The well will not be abandoned if it is determined to have long-term use as a production well, monitoring well, or injection well. Equipment would be removed and the site cleared of excess material. The wellhead will remain in place for future testing, monitoring, or production.

If a well is not determined to have commercial potential, monitoring of the well may continue or the well may be abandoned. Well abandonment typically involves plugging the well bore with enough cement to ensure that fluid in the reservoir would not flow into different aquifers; the casing would remain in place. Any wellhead equipment would be removed from the well, and a metal cap would be welded to the casing.

The well pad sites would then be graded as necessary to restore the sites to the approximate original topography.

3.4 WATER DEMAND

The project would require fresh water for the workforce and to support well pad compaction and well drilling. Potable water would be obtained from WASCO or a local vendor. Estimated water use during well drilling is provided in Table 3.3-1.

Water for drilling at Belle Plaine would either be piped in from the adjacent Migny River or tributaries, piped in from local water tanks, or trucked in from other local sources as approved by WASCO. If necessary, a water well would be developed to provide water for the well drilling.

Water for drilling at Mondesir-Saltibus would be piped in from the River Doree or tributaries downstream of WASCO's main raw water intake. Depending on the specific location of the well pads, either a temporary water pipeline would be installed between the raw water sources and well locations along the road and water access corridor (as shown on Figure 3.2-2), or the water would be transported via a small water truck from the river to the well pad. The final decision will be based on logistics and economics. Water could also be piped in from local water tanks or trucked in from other sources.

Water for drilling at Fond St. Jacques would either be piped in from the Soufrière River or tributaries downstream of WASCO's three raw water intakes, piped in from water local tanks, or trucked in from other sources.

3.5 EROSION AND SEDIMENT MANAGEMENT

Best Management Practices (BMPs) for erosion and sediment control would be developed during the project design. BMPs would be used to stabilize loose soil and control sediment. Typical BMP materials installed on construction sites include fiber matting, hydroseed, mulch, straw wattles, silt fencing, rock bags, and hay bales. Typical BMP procedures implemented on construction sites include wetting loose, dry soil during ground disturbance; preventing soil track-out onto paved roadways; and covering truck loads when transporting soil.

3.6 HAZARDOUS MATERIAL MANAGEMENT

Hazardous materials, such as fuels, oils, and lubricants for construction equipment, would be stored in the designated storage area. Used oil would be gathered and stored in tanks at the storage area until it could be transported off site and disposed of at a facility that can accept hazardous materials. A roof would be installed over a portion of the storage area to protect construction materials from the rain. Wells would be drilled with water and non-toxic drilling mud. Hazardous materials would be transported, handled, and stored in accordance with applicable laws of Saint Lucia, World Bank General EHS Guidelines Section 1.5 (2007a), and World Bank EHS Guidelines for Geothermal Power Generation Section 1.1 (2007b).

3.7 WASTE AND EFFLUENT DISPOSAL

All drill cuttings and drilling fluid would be discharged to the reserve pit or tanks. Drill cuttings would be left in the reserve pit. Fluids and solids would be tested to determine the chemical composition and identify any materials that may be hazardous. Any drill cuttings that exceed the toxicity threshold for hazardous waste would be treated as hazardous waste and disposed of off-site.

Latrines for workers would be constructed on the project site and would be maintained in a clean condition. A septic tank system would be installed to manage the wastewater from the worker camp.

Trash would be maintained in covered receptacles at the well pads, storage area, and worker camp. Non-hazardous waste would be disposed of at an authorized landfill in either Vieux Fort or Castries.

3.8 SCHEDULE AND WORKFORCE

The anticipated project schedule and workforce are summarized in Table 3.8-1. The anticipated work hours for project activities are summarized in Table 3.8-2.

Table 3.8-1 Anticipated Workforce and Schedule

Activities	Schedule	Workforce
Access Establishment and Site Development	0 to 3 months	Up to 50
Well Drilling (per well)	1 to 3 months	Up to 50
Well Testing (per well)	0 to 3 months	Up to 50
Well Abandonment and Pad Reclamation	1 month	Up to 50
Grand Total	**2 to 10 months**	**Up to 50**

Table 3.8-2 Anticipated Workhours per Day

Activities	Hours
Access Establishment and Site Development	7:00 to 19:00
Well Drilling	24 hours
Well Testing	24 hours
Well Abandonment and Pad Reclamation	7:00 to 19:00
Note: Proposed workhours would be the same on weekdays and weekends for all activities.	

4 BASELINE DATA/EXISTING ENVIRONMENT

4.1 OVERVIEW

A comprehensive scoping studies report was prepared for the project prior to development of the ESIA to obtain and evaluate information about the existing environmental and social conditions within the project influence area. This section summarizes the baseline/existing conditions that may be at risk or impacted by the project based on the results of the Scoping Studies Report. The complete Scoping Studies Report is provided in Appendix C. The Scoping Studies Report provides additional detail on baseline data and conditions in the project area including the data sources, study methods and data gaps.

4.2 ENVIRONMENTAL CONDITIONS

4.2.1 Water Resources

Water Supply

Surface Water Resources

The Belle Plaine drilling site is located within the Choiseul/Trou-Barbet watershed. The Choiseul and Trou Barbet rivers flow through or adjacent to the potential drilling area from south to north. The drilling area drains to the east and north within the valley. Storage tanks that are used to contain runoff water are present in the potential drilling area. Water in Belle Plaine area is primarily managed for agricultural activities. Streams along the western flank of the valley contained minimal flow during field investigation during the rainy season and these streams likely run dry for portions of the year. No springs or ponding of surface water was observed within the valley.

The Mondesir-Saltibus sites are located within the Doree and Balembouche watersheds. The rivers are located to the west and to the east of the potential drilling area. The river located to the west of the potential drilling area maintains perennial flow. There is limited water supply infrastructure other than cemented roadside drainage ditches and pipes that supply water to the population.

The Fond St. Jacques potential drilling areas are located within the Soufrière watershed. The river borders the Fond St. Jacques drilling area. The river supplies water to a local water storage tank that serves as the primary water source for the Fond St. Jacques community. Buried pipelines convey water from the water storage tanks to the community. Two springs are located in the foothills on the southeastern flank of the potential drilling areas. The water that comes

from these springs is stored in tanks (see Figure 4.2-1) and supplies the adjacent communities of Fond St. Jacques and Soufrière with freshwater.

Community members in Fond St. Jacques/Belvedere indicated that the spring water is extremely important to them as a "back-up" water supply, particularly during public water shortages and natural disasters, such as Hurricane Tomas when WASCO's supplies had been damaged. Some individuals indicated that their spring water supplies are piped alongside WASCO's pipelines and into their households. One respondent reported that since Hurricane Tomas, spring water, instead of WASCO's water, was now piped to the household for domestic purposes (except drinking).

A household survey conducted in 2017 indicated that the majority of households in all the affected communities use mainly public pipe-borne water supplied by WASCO as their primary source of water for domestic purposes, which is generally considered good quality and reliable. Rainwater harvesting tanks/containers were also used by most households. Spring water was generally used for other non-drinkable domestic purposes and farming in all the communities. A few households also reported using a combination of public standpipe, spring, and river water.

Figure 4.2-1 Water Storage Infrastructure in Fond St. Jacques



Source: (Appendix E, Scoping Studies Report 2017)

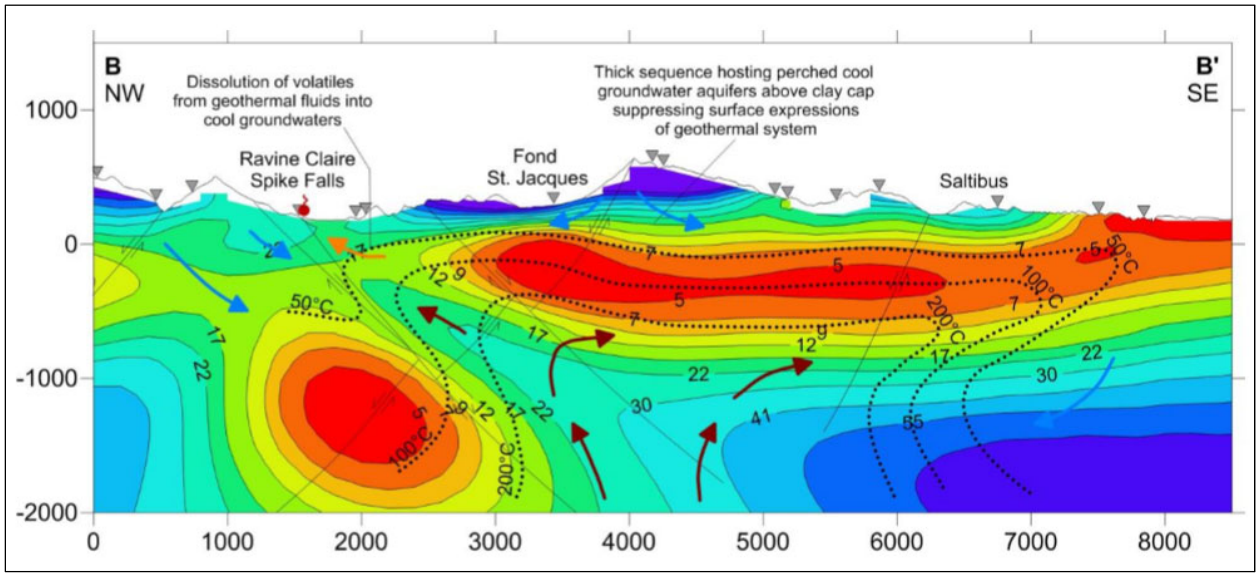
Groundwater

No groundwater investigations have been performed in the project area and there is no reported use of groundwater resources for water supply in the area. Rainwater runoff from topographically high areas, including the mountains surrounding Belle Plaine and Fond St. Jacques, recharge groundwater aquifers in the valleys. The groundwater aquifers in the project areas are expected to be limited in size and volume due to the volcanic nature of the geology in the project areas and the small basin and alluvial area that could contribute to the groundwater system. Groundwater aquifers typically occur in areas with underlying sedimentary soils; volcanic bedrock is not conducive to groundwater storage.

Geothermal Resource

The geothermal aquifer is naturally separated from the groundwater aquifer by aquitards, which limit infiltration and cross-contamination of geothermal resources with surface water or shallow groundwater resources. Jacobs (Jacobs New Zealand Limited 2016) developed a conceptual hydrogeological model of the area of influence (shown in Figure 4.2-2). The conceptual model shows the presence of a clay layer, which suppresses surface expression of the geothermal system. The cool groundwater aquifer is perched above the clay layer. The hydrothermal alteration appears to occur at relatively shallow depths just at or below sea level. Surface manifestation of the geothermal resource occurs along fractures where there is upflow, such as in the vicinity of Ravine Claire Spike Falls.

Figure 4.2-2 Schematic Conceptual Hydrogeologic Model



Source: (Jacobs 2016)

Water Quality

The water quality of Saint Lucia's rivers has declined considerably in recent years due to an increase in agriculture, especially banana cultivation. Research carried out by the River Surveillance Monitoring Project (Lloyd et al. 1996) concluded that the variable that most affects Saint Lucia's ecosystems is the intensification of agriculture in combination with deforestation near water sources. Recent water quality studies conducted by the WRMA (Water Resources Management Agency of Saint Lucia 2010-2016) in the Fond St. Jacques and Saltibus areas indicate the presence of coliform in the local drinking water supply; however, water from both sites is within the range of what is allowed by the WHO for inorganic constituents. The Draft Water Resource Sampling and Monitoring Plan, included as an appendix to Appendix C: Scoping Studies Report details the water resource sampling and monitoring approach to be implemented during project construction. Sampling at location(s) upstream of the project during construction would provide baseline data about water quality conditions in the area.

4.2.2 Air Quality

Project Area Ambient Air Quality

Ambient air quality was measured for a 20-day period in the vicinity of the project. Low ambient concentrations of nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), and hydrogen sulfide (H_2S) were measured near the project areas. The 20-day average concentrations were well below the World Health Organization (WHO) Guidelines. WHO guidelines specify 10-minute maximum concentrations of 500 $\mu g/m^3$ for SO_2, a 1-hour average of 40 $\mu g/m^3$ for NO_2 and a 30-minute average of 7 $\mu g/m^3$ for H_2S.

Naturally Occurring Geothermal Emissions

Geothermal systems may contain gases that are potentially hazardous to human health. The most common gases in geothermal systems include: carbon dioxide (CO_2) and hydrogen sulphide (H_2S). People visiting Sulphur Springs and other areas of fumarolic activity with uncontrolled naturally occurring emissions in Saint Lucia are at the greatest risk for exposure to geothermal gas emissions (Jan Lindsay 2002). There have been reports of people and animals dying from CO_2 inhalation associated with geothermal systems in the Caribbean, including Saint Lucia (Jan Lindsay 2002).

Ambient concentrations of SO_2 and H_2S at Sulphur Springs were substantially higher than concentrations in the project vicinity. H_2S concentrations at Sulphur Springs were 29.24 $\mu g/m^3$, which exceeds WHO guidelines of 7 $\mu g/m^3$. It should be noted that the WHO guidelines are for annoyance, with potential eye irritation likely caused when concentrations reach 150 $\mu g/m^3$ or above. A 20-day SO_2 average concentration of 292 $\mu g/m^3$ was measured at the Sulphur Springs site. This average SO_2 concentration was below WHO guidelines and in line with concentrations measured during the University of West Indies Study, which showed monthly average concentrations ranging from 177 to 623 $\mu g/m^3$ between April and December 2014. The higher concentrations measured at this site are representative of emissions at the fumarole where there is venting of the geothermal gases.

4.2.3 Geology and Soils

Belle Plaine is located in a wide, flat valley surrounded by steep mountains. Geologically, this area is characterized by pumiceous, pyroclastic flow deposits. The soil is used for agricultural production, including bananas, cocoa, and coconuts.

Mondesir-Saltibus is located on a large raised field with water systems nearby. The geology of the area is composed of pyroclastic flows containing pumiceous and andesitic deposits. The outcrops of these units can be found along the road cuts on the eastern side of the main road adjacent to the area. Mondesir-Saltibus soils are suitable for agriculture and the area is widely used for growing bananas, cocoa, coconuts, and other vegetables, especially toward the hillsides. Roadside drainages were observed in the area.

Fond St. Jacques is located in a depression surrounded by steep mountains. The geology of the area is composed of block and ash flow deposits that possess a high permeability, through which several freshwater springs emanate. It is evident that this area has extensive agricultural activity located on both flat and mountain slopes; crops include bananas, coconuts, and cocoa, among others. Soils in the Fond St. Jacques east potential drilling area are saturated due to shallow groundwater and spring flows. Soil erosion is the most severe environmental problem in Saint Lucia and affects the water supply and agricultural productivity. An agricultural study of soils showed that the loss of soil cover is very high as a result of high storm intensity (Cox, Sarangi and Madramootoo 2006). More than 90 percent of annual soil erosion is generated in short periods of hours or days (Norville and King 2001). The greatest contributors to erosion issues in Saint Lucia include:

- Loss of vegetation cover in watersheds
- Lack of proper soil conservation practices
- Inappropriate land use, and degradation of soils

Factors that contribute to the degradation of soil quality in Saint Lucia include:

- Loss of nutrients or imbalances in the soil
- Overfertilization
- Use of pesticides and herbicides
- Disposal of both human and natural waste
- Waterlogging in flat areas

4.2.4 Noise

Existing daytime ambient noise levels were measured in the project area of influence. The documented noise levels were consistent with a rural environmental where the noise sources are predominantly natural (e.g., wind, water, wildlife, and farm animals). Other noise sources included mobile (e.g., traffic) and stationary sources encountered along roadways. Table 4.2-1 provides the average and the extreme high and low noise levels measured at representative locations near each potential drilling area during daytime hours. Ambient noise levels at night are typically lower than during the daytime (approximately 10 A-weighted decibels[3] [dBA] less).

There are numerous residents living in the vicinity of the potential drilling areas, which are considered noise-sensitive receptors. Residences within 304.8 meters (1,000 feet) of the potential drilling areas are shown on Figure 4.2-3 through Figure 4.2-5.

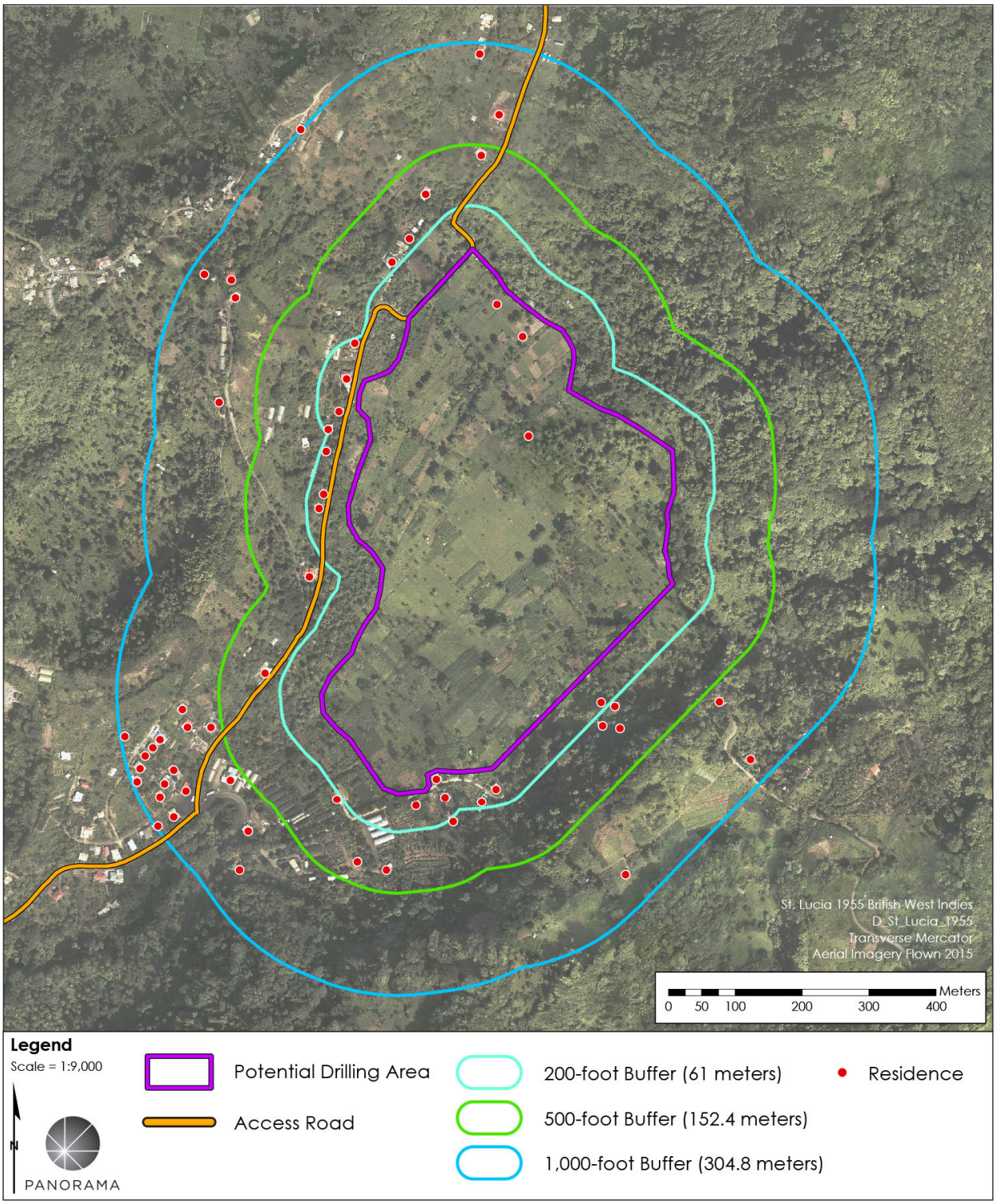
Table 4.2-1 Existing Daytime Ambient Noise Levels

Area of Impact	Average (dBA)	Range (dBA)	Extreme Noise Sources during Measurements
Belle Plaine	45 - 60	30 - 88	The high noise measurement at Belle Plaine was recorded within 20 meters from a running diesel engine flatbed 4 axle truck that was idling throughout the duration of the noise measurement.
Fond St. Jacques	45 - 71	38 - 105	The high noise level was measured in the courtyard of the Fond St. Jacques primary school at the end of the school day at approximately 15:00 when children were present and yelling and interacting with the microphone equipment from a short distance.
Mondesir-Saltibus	43 - 60	30 - 120	A large diesel engine truck on the main N-S road near the noise monitoring station passed by during the recording.

Source: (Dewhurst Group 2017)

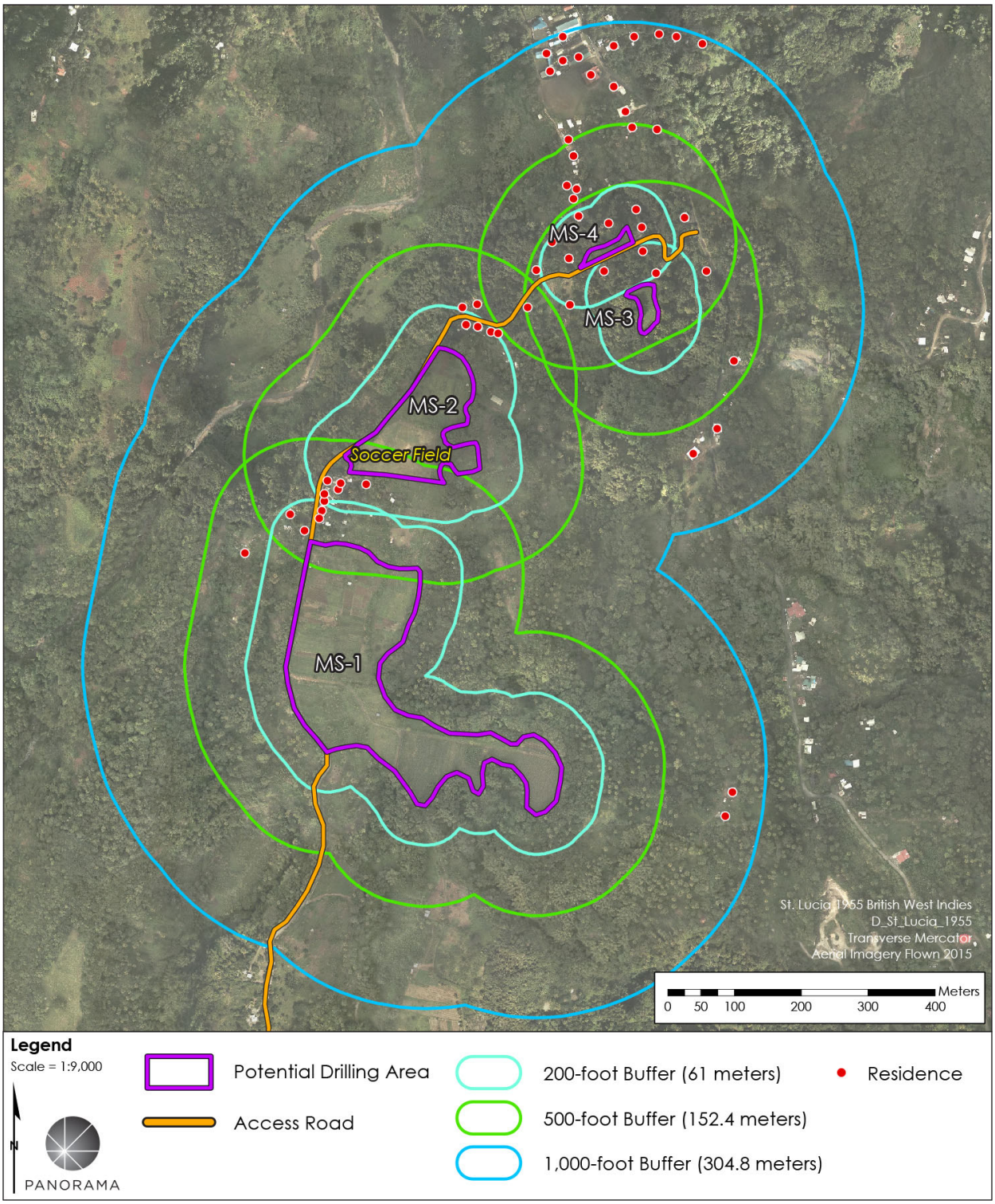
[3] The A-weighted sound level (dBA) is a noise measurement that deemphasizes the very low- and very high-frequency components of the sound, which reflects how the human ear perceives sound.

Figure 4.2-3 Residences near Potential Drilling Areas at Belle Plaine



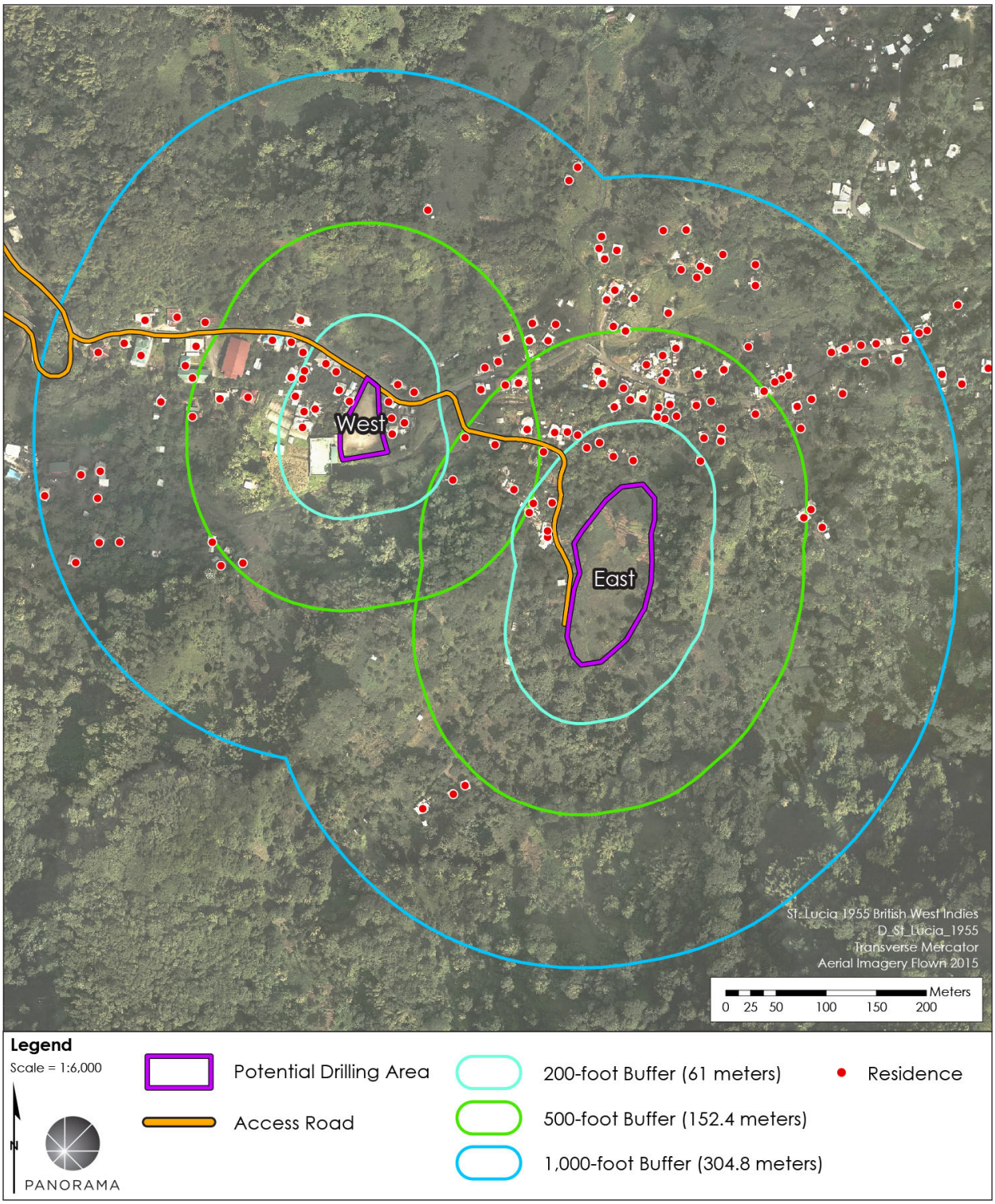
Sources: (McElhanney Consulting Services Ltd. 2015, Panorama Environmental, Inc. 2017, ECMC, Ltd. 2017)

Figure 4.2-4 Residences near Potential Drilling Areas at Mondesir-Saltibus



Sources: (McElhanney Consulting Services Ltd. 2015, Panorama Environmental, Inc. 2017, ECMC, Ltd. 2017)

Figure 4.2-5 Residences near Potential Drilling Areas at Fond St. Jacques



Sources: (McElhanney Consulting Services Ltd. 2015, Panorama Environmental, Inc. 2017, ECMC, Ltd. 2017)

4.2.5 Natural Habitats and Biodiversity

Flora and fauna species observed within the project area of influence are provided in the Scoping Studies Report (Appendix C). No endangered or priority floristic, mammalian, herpetofauna, or insect species were encountered during surveys of the project areas and adjacent area of influence. Several endangered and priority birds were encountered in the forest habitat adjacent to Belle Plaine and Mondesir-Saltibus (see discussion below).

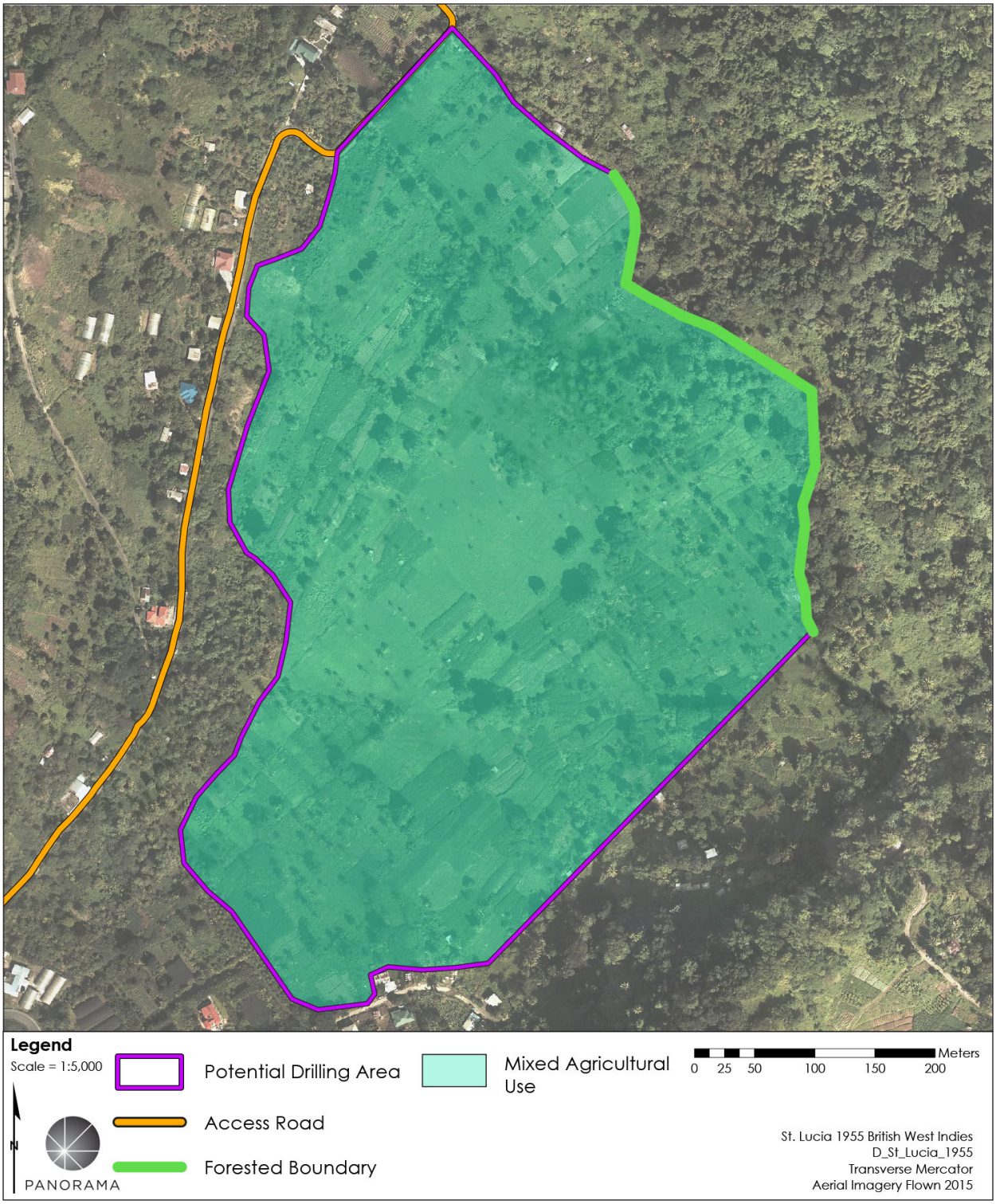
Vegetation Communities/Habitat Characteristics

The dominant land use/vegetation types in each drilling area are shown on Figure 4.2-6 through Figure 4.2-8. The dominant vegetation types and habitat characteristics of each project area are summarized in Table 4.2-2, below. The drilling areas were characterized by a lack of native habitats or vegetation communities. Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques East areas are subject to widespread agricultural production. The Fond St. Jacques West area has been developed/disturbed and generally lacks natural vegetation or habitat. Native forest habitat occurs along the border of the Belle Plaine and Mondesir-Saltibus project areas. Vegetation surveys have not been completed within the MS-3 or MS-4 sites, but the sites appear disturbed from agricultural use or adjacent residential uses.

Fauna

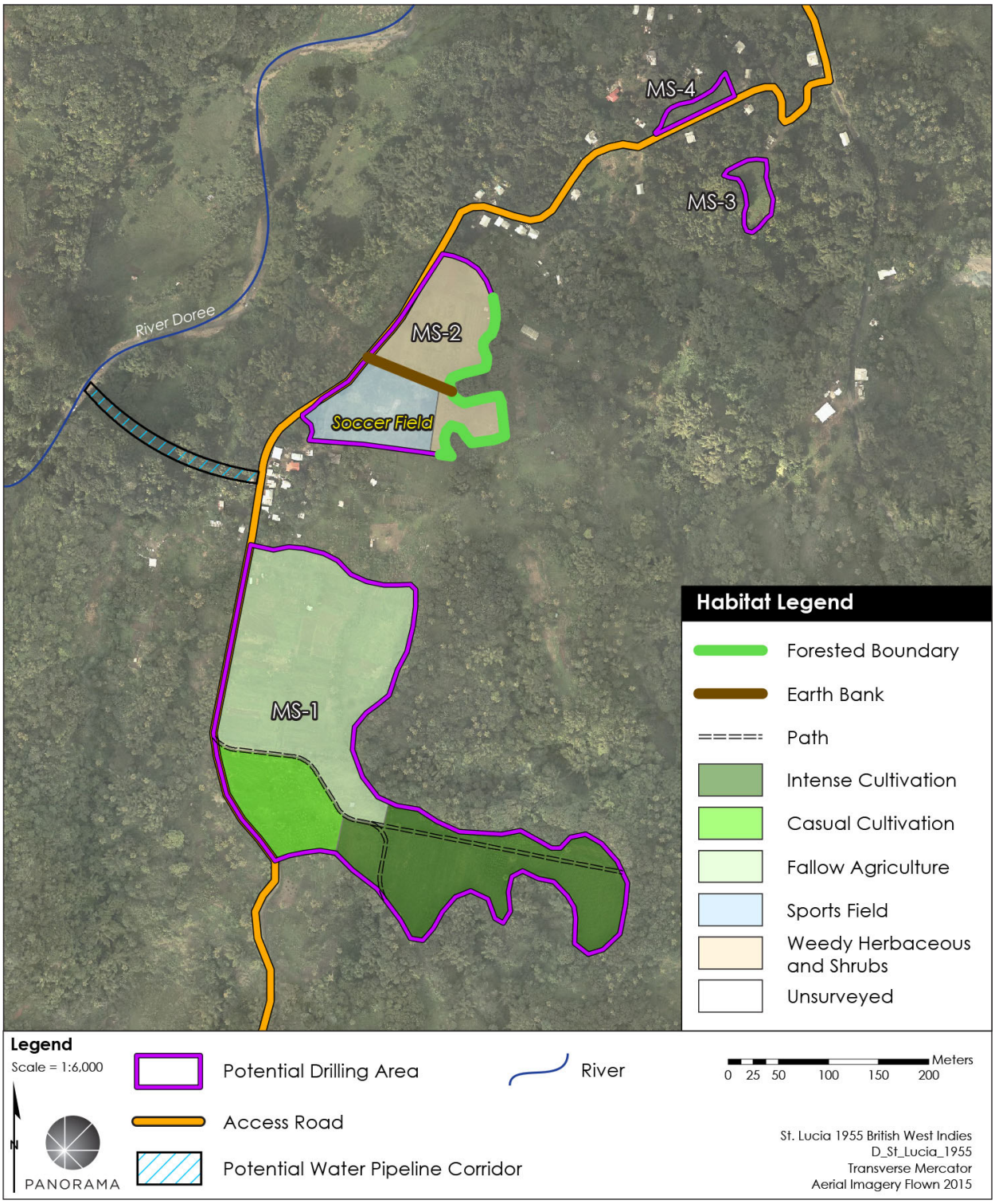
Table 4.2-3 provides a summary of the common faunal species documented in each project area and surrounding area of influence (i.e., habitat areas within approximately 300 meters [1,000 feet] of the potential drilling sites). The drilling areas were characterized by a lack of native habitats. Belle Plaine, Fond St. Jacques East and West, and MS-2 were very similar in composition of faunal community with many of the same bird, mammalian, herpetofauna, and insect species due to similar habitat conditions within and surrounding the drilling areas. The drilling areas were characterized by a lack of suitable habitat; however, the surrounding forested edge provides natural habitat for bird species. Fauna surveys were not completed within MS-3 or MS-4, but the areas are expected to have similar fauna species to MS-1 and MS-2 due to the proximity of the areas.

Figure 4.2-6 Belle Plaine Habitat/Land Use



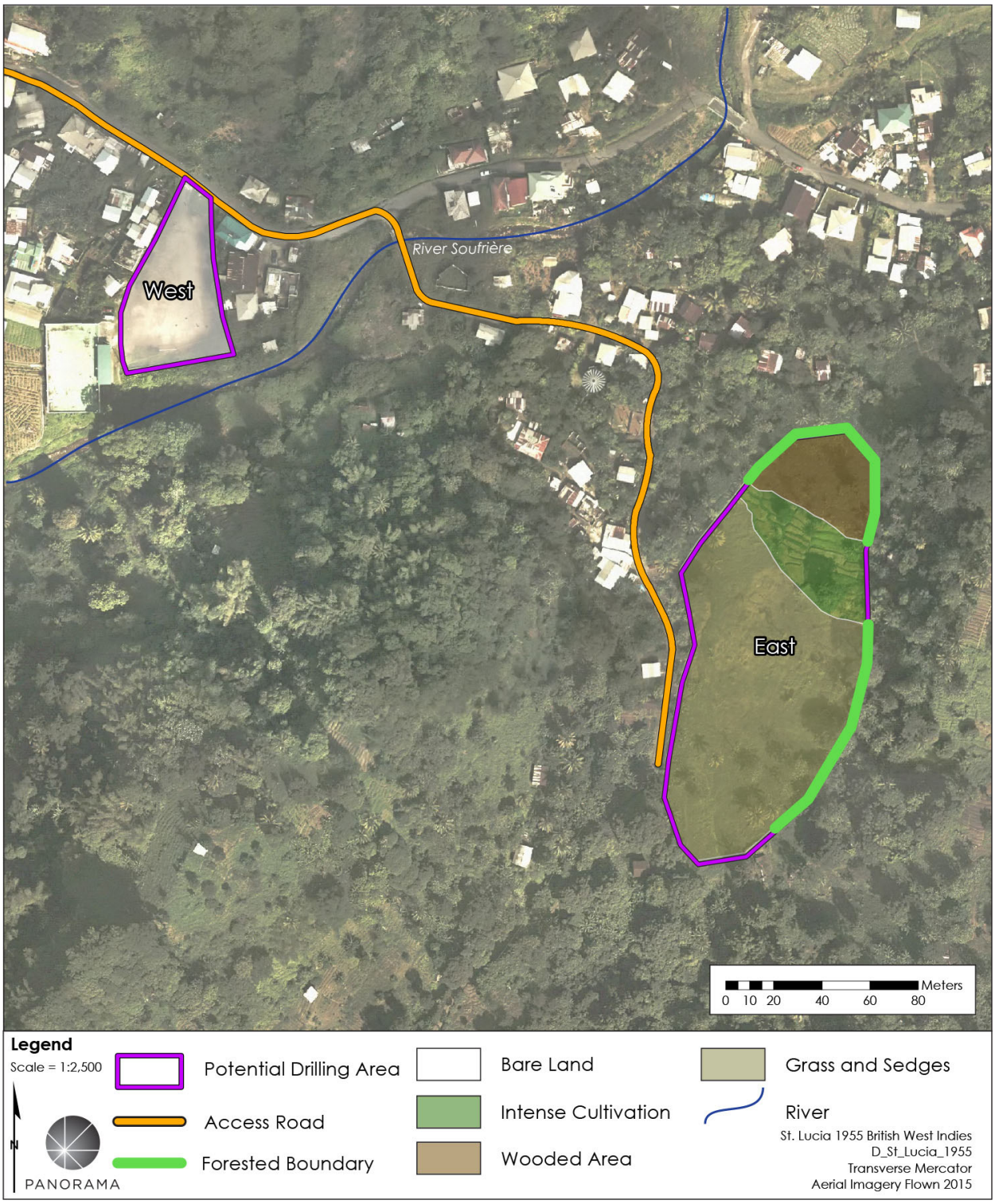
Sources: (McElhanney Consulting Services Ltd. 2015, Graveson 2017)

Figure 4.2-7 Mondesir-Saltibus Habitat/Land Use (MS-1 and MS-2 Only)



Sources: (McElhanney Consulting Services Ltd. 2015, Graveson 2017)

Figure 4.2-8 Fond St. Jacques Habitat/Land Use



Sources: (McElhanney Consulting Services Ltd. 2015, Graveson 2017)

Table 4.2-2 Habitat and Dominant Floristic Species by Area

Area Name	Description of Vegetation/Habitat Conditions	Dominant Vegetation
Belle Plaine	The Belle Plaine area has been cleared of all natural forest and replaced by agriculture. The area was previously intensively farmed with bananas and is now largely abandoned with open herbaceous areas punctuated by remnant *Musa* cultivars (bananas and plantains) and mature fruit trees. Small plots with a market gardening type of agriculture are located in small areas. Cows graze on the site and several substantial wall houses are under construction in the area. The area is bordered on the western side by a steep forested hill	The area is covered predominantly by weedy flora of grasses, herbs and shrubs. The majority are native species, but many are naturalized species. Widely spaced throughout the open areas are cultivated fruit trees including *Erythrina poeppigiana,* Gmelina and pines, and mahogany. There are also many clumps of Musa cultivars (bananas and plantains). A few ornamental trees occur on the site including Ficus bejamina, Bougainvillea, Saman trees and *Heliconia wagneriana* which have become naturalized.
MS-1	The MS-1 area is a formerly intensive agricultural area that is now limited to sparse cultivation. There are many common weedy herbs and shrubs found on the site.	The area is dominated by herbs and shrubs including *Andropogon bicornis, Urena lobata* and *Ipomoea tiliacea* along with grasses such as *Andropogon bicornis, Cenchrus purpureus, Chloris ciliata* and *Eragrostis pilos.* Additional cultivated vegetables and fruit trees are present.
MS-2	The MS-2 area is a formerly intensive agricultural area that is now limited to sparse cultivation. There are many common weedy herbs and shrubs found on the site.	The area is dominated by herbs and shrubs including *Andropogon bicornis, Urena lobata* and *Ipomoea tiliacea* along with grasses such as *Andropogon bicornis, Cenchrus purpureus, Chloris ciliata* and *Eragrostis pilos.* Additional cultivated vegetables and fruit trees are present.
MS-3	The site is located approximately 90 meters (300 feet) southwest of the Saltibus/Parc Estate road junction. The surface is roughly rectangular with dimensions approximately 100 meters (330 feet) by 60 meters (200 feet). The topography is flat with very good surface features and is not under dense vegetation. The existing land use is agricultural and residential (two houses); the immediate surrounding land use is agricultural.	Similar to MS-1 and MS-2 (no biological surveys have been completed in the area).

Area Name	Description of Vegetation/Habitat Conditions	Dominant Vegetation
MS-4	The site is located approximately 100 meters (330 feet) west of the Saltibus/Parc Estate road junction. The surface is a trapezoid with dimensions approximately 60 meters x 20 meters (200 x 66 feet). The topography is generally flat with no drainage and is adjacent to the Parc Estate road. The existing land use is agricultural; the immediate surrounding land use is agricultural and residential.	Similar to MS-1 and MS-2 (no biological surveys have been completed in the area).
Fond St. Jacques West	Fond St. Jacques west is a small cleared site with a river on the lower end of the site. There is almost no vegetation on the site.	The area is developed/disturbed and generally lacks vegetative cover.
Fond St. Jacques East	The Fond St. Jacques east area is very swampy and most of the site is saturated. The area is covered by an herbaceous flora of mainly grasses and sedges, with some weedy shrubs and scattered fruit trees. The area is bordered by some large trees except where it forms a boundary with the road. There are patches of cultivated dasheen (*Colocasia esculenta*), a crop that thrives in swampy conditions. Cows graze in the area.	The area is dominated by the grass *Paspalum paniculatum* and large areas covered by the sedge *Fuirena umbellata.*

Sources: (Panorama Environmental, Inc. 2017)

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Table 4.2-3 Faunal Species and Conditions in the Area of Influence

Area Name	Birds	Mammals	Herpetofauna	Insects
Belle Plaine	A total of 36 species were detected in the Belle Plaine area and surroundings. The majority of the detected species are resident species, with the exception of two, the Sand spotted sandpiper and the barn swallow. Five endemic birds occurred in the area; two of the Saint Lucian endemics were uncommon for the site. Nine priority species were found occurring in the forested area adjacent to the site, four of which are classified as endangered species of birds. The priority species observed include: • Saint Lucia Parrot (*Amazona versicolor*) • Saint Lucia Black finch (*Melanospiza richardsoni*) • Saint Lucia Oriole (*Icterus laudabilis*) • House Wren (*Troglodytes aedon mesoleucus*) • Saint Lucia Warbler (*Dendroica delicata*) • Saint Lucia Pewee (*Contopus oberi*) • Lesser Antillean Saltator (*Saltator albicollis albicollis*) • Lesser Antillean Flycatcher (*Myiarchus oberi sanctaeluciae*) • Grey trembler (*Cinclocerthia gutturalis macrorhyncha*)	Mongoose (*Herpestes suropuntatus*) was recorded in the area. Mongoose was introduced to Saint Lucia and is classified as invasive wildlife. Two species of bats were observed in the study area including: • Fruit bats (*Monophyllus plethodon*) • Insectivorous bats (*Bracyphyllus cavernum*) These species are not considered endangered.	Five reptile species were recorded in the study area, including the endemic Saint Lucia anolis lizard (*Anolis luciae*). Other reptiles included: • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Butterflies, dragonflies, and bees were common insects observed in the study area. Common butterfly species included: • Southern great white • White peacock • Common long tail skipper • Tropical chequered skipper • Ocola skipper • Fiery skipper • False barred sulphur • Spreadwing skipper • Caribbean buckeye • Southern broken dash • Hannos blues
MS-1	A total of 20 species of birds were recorded in the MS-1 study area. The bird species encountered were very similar to Belle Plaine and Fond Saint Jacques East, owing to the similar biodiversity and rich ecotone in the forest edge surrounding the potential drilling sites, which provide an ideal habitat. Four of these species are classified as priority species, two of which are Saint Lucia endemic species: Saint Lucia pewee (*Contopus oberi*) and Saint Lucia warbler. Both Saint Lucian endemics were common for the site, which is consistent at the national level.	None	Three reptile species were recorded in the study area, including: • Saint Lucia anolis lizard (*Anolis luciae*) • Common House Gecko (*Hemidactylus mabouia*) • Slipperyback Skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Very few insects were observed and none were identified to a species level.
MS-2	A total of 15 bird species, which include two priority species,the Saint Lucia warbler and Lesser Antillean saltator, were observed in the MS-2 study area. The Saint Lucia warbler (*dendroica delicata*), is classified as endemic to Saint Lucia, but is considered of *Least Concern* in accordance with the IUCN Red List Category & Criteria (2016)	None	None	
Fond St. Jacques West	There were very few faunal species on the Fond St. Jacques West site due to the lack of vegetation to provide habitats for these species. Bird species encountered included: • Carib grackle • Lesser Antillean bull finch • Common ground dove • Zenaida dove These species are very common on the island and are adapted to open areas.	None	None	None

Area Name	Birds	Mammals	Herpetofauna	Insects
Fond St. Jacques East	A total of 29 bird species were detected in the Fond St. Jacques east area. The majority of the detected bird species are resident species. Five Saint Lucia endemic species were observed during surveys. Three priority species were observed including: • Saint Lucia parrot (*Amazona versicolor*) • Saint Lucia black finch (*Manospiza richardsoni*) • Saint Lucia oriole (*Icterus laudabilis*)	Seven mammal species were recorded in the study area. These include, the small asian mongoose (*Herpestesou ropuntatus*) the opossum (*Didelphis marsupialis*), rats, and mice. All species are introduced to Saint Lucia and are classified as alien invasive wildlife. Two species of bats, a fruit bat (*Monophyllus plethodon*) and an insectivorous bat (*Bracyphyllus cavernum*) were found in this study area. These species are not considered endangered.	Three reptile species were recorded in the study area including • Saint Lucia anolis lizard (*Anolis luciae*) • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*) One amphibian, the cane toad (*Rhinella marina)* was encountered in the study area. The habitat is ideal for this species, which is considered an invasive species.	Butterflies, dragonflies, and bees were the most common insects observed in the study area. Dragonfly species were the most common insect group. The presence of a wet surface provides ideal habitat for the majority of dragonfy species.

Sources: (Panorama Environmental, Inc. 2017)

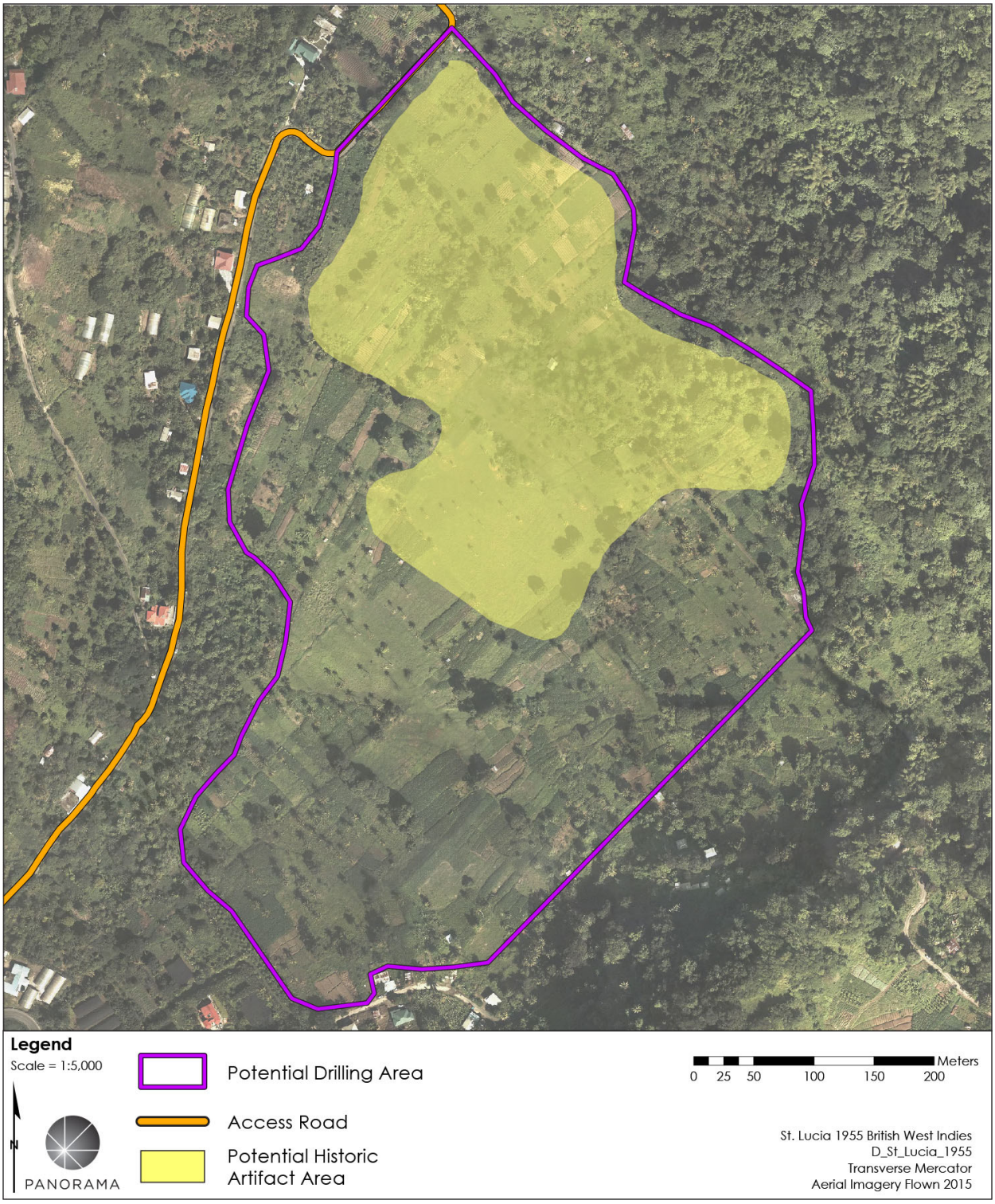
4.2.6 Archeological and Cultural Resources

The areas of Belle Plaine and Mondesir-Saltibus contain significant amounts of both prehistoric and early colonial artifacts. Areas within Belle Plaine and Mondesir-Saltibus that are highly sensitive for historical and prehistoric resources are shown on Figure 4.2-9 and Figure 4.2-10. The potential drilling area at Belle Plaine is located on or near the locations of two early plantations, Rabot Estate and Belle Plaine Estate. There is a strong likelihood that the potential drilling area at Mondesir-Saltibus is within the eighteenth and early nineteenth century slave village at Parc Estate, one of the largest plantations and slaveholdings in Saint Lucia. Both the Belle Plaine and Mondesir-Saltibus potential drilling areas have the potential to shed new light on significant aspects of Saint Lucian cultural heritage, especially issues of slavery and plantation life in early Saint Lucia. The archaeological study of slavery and plantation life in Saint Lucia is lacking, and the evidence from these sites may provide important insights into the daily lives of enslaved peoples who lived and worked on Saint Lucian estates. Belle Plaine may also offer new information about the lives and material conditions of plantation owners and their families in the early colonial era.

The drilling areas at Fond St. Jacques have been heavily developed or located in a historically swampy area where settlement is unlikely. No archeological artifacts were identified at these areas during pedestrian surveys. For these reasons, the drilling sites at Fond St. Jacques are not considered sensitive archeological sites.

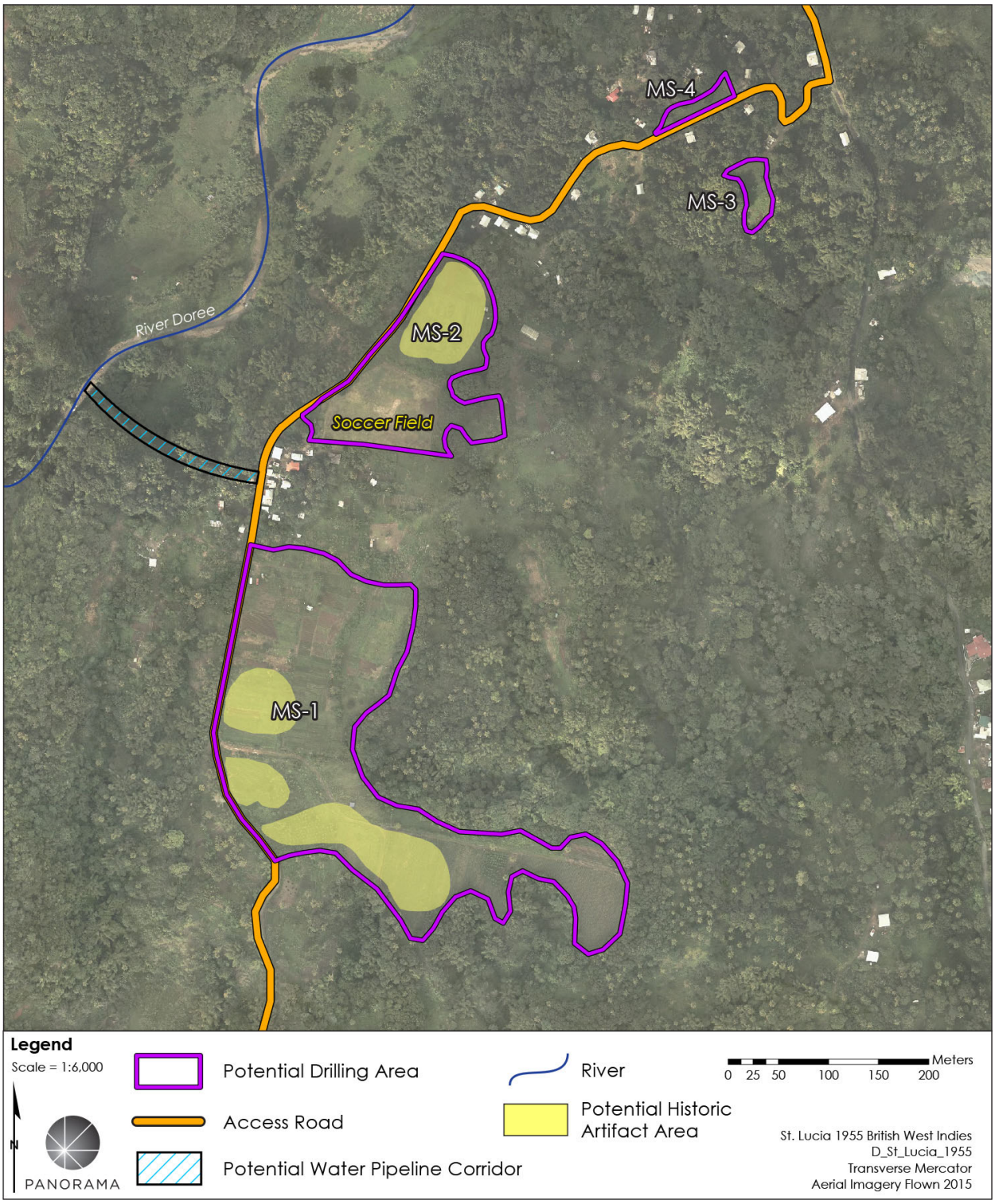
A fairly sizeable amount of prehistoric Amerindian materials were observed during pedestrian surveys at Belle Plaine and Mondesir-Saltibus. There is a potential for subsurface Amerindian resources due to the age of these resources. The discovery of Amerindian materials adds to the ever-growing database of Amerindian archaeological sites in Saint Lucia, as well as the broader Caribbean.

Figure 4.2-9 Belle Plaine Historically Sensitive Areas



Sources: (McElhanney Consulting Services Ltd. 2015, Smith 2017)

Figure 4.2-10 Mondesir-Saltibus Historically Sensitive Areas (MS-1 and MS-2 Only)



Sources: (McElhanney Consulting Services Ltd. 2015, Smith 2017)

4.2.7 Landscape and Visual Character

The visual resources and landscape within the Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques east sites are typical of agricultural areas in Saint Lucia and provide views of trees, row crops, and fallow agricultural fields as shown on Figure 4.2-11, Figure 4.2-12, and Figure 4.2-15. An open grass soccer field is present within MS-2 and an unpaved recreational area is present in Fond St. Jacques west as shown on Figure 4.2-13 and Figure 4.2-14, respectively. There are no scenic vistas or viewpoints in proximity to the drilling areas. The drilling areas are only visible within the valley surrounding the potential drilling area due to the steep surrounding hillslopes and topography. The drilling areas are not visible from any key viewpoints in the PMA referenced in the Limits of Acceptable Change Report (The Landmark Practice 2013).

Figure 4.2-11 Belle Plaine Active Farmland



Source: (Appendix E, Scoping Studies Report 2017)

Figure 4.2-12 Mondesir-Saltibus Fallow Area



Source: (Appendix E, Scoping Studies Report 2017)

Figure 4.2-13 Mondesir-Saltibus Sports Field



Source: (Appendix E, Scoping Studies Report 2017)

Figure 4.2-14 Fond St. Jacques West



Source: (Appendix E, Scoping Studies Report 2017)

Figure 4.2-15 Fond St. Jacques East



Source: (Appendix E, Scoping Studies Report 2017)

4.2.8 Geohazard and Natural Disaster Vulnerability

Hurricanes and Tropical Storms

Saint Lucia faces a constant threat from hurricanes and other tropical storms; hurricanes have historically been the most common hazard to impact Saint Lucia (Government of Saint Lucia 2006). Hurricanes are also the primary cause of widespread slope failure (Government of Saint Lucia 2006). Recent climate change predictions indicate a future increase in hurricane activity and extreme rainfall events in the region, including an increase in associated landslide failure (Brian Lovelock 2016). According to the World Bank, Saint Lucia has an average annual loss from hurricanes of US $9.5 million (0.7 percent of the GDP), and a probably maximum loss from hurricanes of US $382 million (27.2 percent of the GDP) over a 250-year return period (2016). Saint Lucia has a high vulnerability to impacts from hurricanes in all categories.

Flooding Hazards

Flooding is a risk in Saint Lucia, particularly flooding associated with hurricanes and tropical depressions. The main areas at risk for flooding in Saint Lucia are narrow zones along river valleys and in the Soufrière Valley. The Global Facility for Disaster Reduction and Recovery produces a national flood hazard map for Saint Lucia, as part of the Caribbean Handbook on Risk Information Management project (2017). The only flood hazard area identified within the potential development areas is located along the stream corridor through Fond St. Jacques and within a small portion of the Mondesir-Saltibus drilling area as shown in Figure 4.2-16.

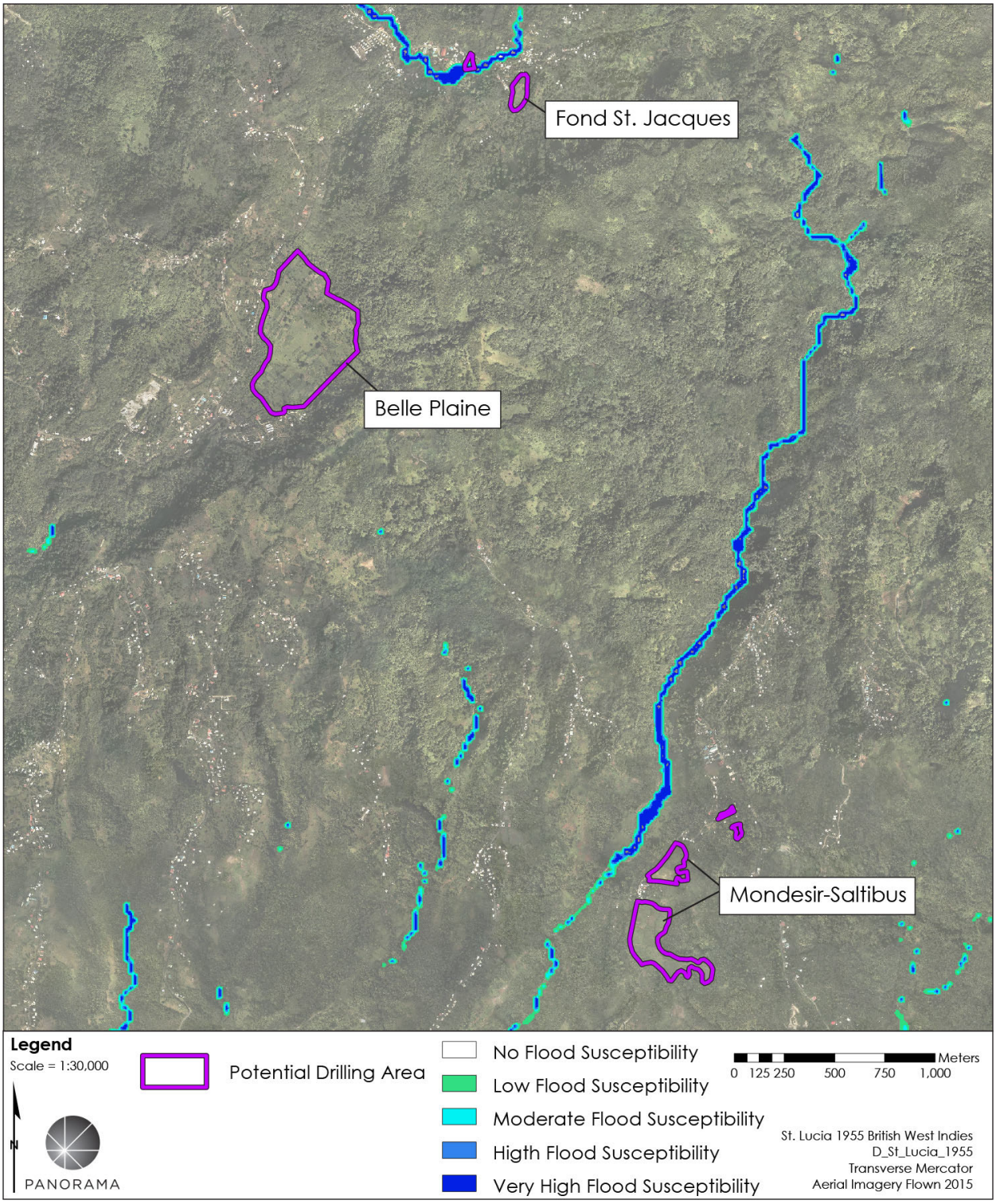
Landslides

Numerous damaging landslides have been documented in Saint Lucia; the causes of the most significant landslides have been attributed to events including hurricanes, tropical storms, and poor farming practices (i.e., mass rainforest canopy removal). Research indicates that the majority of landslides in Saint Lucia are shallow failures of the soil mass at depths of 2 meters (7 feet) or less; the most common landslide types are debris flows; and earth flows, rockfalls, rock slides, and slumps also occur, but are less frequent (Brian Lovelock 2016). Most slumps and rotational failures observed are associated with disturbed slopes such as road cuts or unplanned housing developments involving construction, earthworks, and vegetation changes (The University of the West Indies 2017). Roads in Saint Lucia are often susceptible to new slumps and slope failures due to redirected or inadequate drainage, exposed soils, over steepened cut slopes, and/or the removal of support at the toe of slopes (Brian Lovelock 2016).

Seismicity and Earthquakes

There are no known active faults within the project drilling areas, and there is a relatively low potential for major earthquakes to cause substantial damage in Saint Lucia. According to the World Bank, Saint Lucia has an annual average loss from earthquakes of US $2.6 million (0.2 percent of the GDP), and a probably maximum loss from earthquakes of US $148 million (10.5 percent of the GDP) over a 250-year return period (2016). These values are less than half of those estimated for loss from hurricanes. Saint Lucia is considered to have a moderate vulnerability to impacts from seismicity and earthquakes in all categories.

Figure 4.2-16 Flood Hazard Areas



Sources: (McElhanney Consulting Services Ltd. 2015, ACP-EU Natural Disaster Risk Reduction Program 2016)

Volcanic Eruptions

Approximately one third of Saint Lucia is within a moderate, high, or very high volcanic hazard zone identified on volcanic hazard maps used by the GoSL (Jan Lindsay 2002). The drilling areas at Belle Plaine and Fond St. Jacques are in a 'very high hazard zone.' The drilling area at Mondesir-Saltibus is in a 'high hazard zone.'

4.3 SOCIAL CONDITIONS

4.3.1 Population and Affected Communities

The project area spans three contiguous districts, Soufrière, Choiseul, and Laborie; however, the communities and people potentially affected by the project are located in Soufrière and Laborie. The project drilling areas would be located within or adjacent two community settlements in Soufrière and two community settlements in Laborie. The communities that could be affected by project activities and population estimates from 2010 are listed in Table 4.3-1.

Table 4.3-1 Population and Unemployment Rates of Affected Communities

Affected Communities	Population (2010)			Unemployment Rate (2010)
	Females	Males	Total	
Belvedere [a]	221	252	473	12.1 %
Belle Plaine [a]	47	54	101	23.9 %
Parc Estate [b]	45	54	99	30.6 %
Gayabois [b]	31	42	73	23.3 %
Total	344	402	746	12.1 % – 23.3 %

Notes:

[a] Belvedere and Belle Plaine are in Soufrière. Belvedere is the community within the Fond St. Jacque area where drilling could occur.

[b] Parc Estate and Gayabois are in Laborie. Gayabais is about 1,126 meters (0.7 miles) south of the Mondesir drilling areas.

Source: (Central Statistics Office 2011, Panorama Environmental, Inc. 2017)

4.3.2 Gender

Poverty

OECS countries are categorized as having a high human development, however, they experience a poverty rate fluctuating between 18% and 38%, are in financial debt and have low economic growth (Gandini 2013). The incidence of poverty is slightly higher among men (29%) than among women (25%), while that among female-headed households (21.2%) is about the same as among male-headed households (22%). According to 2010 census data, 41% of households are headed by men and 27% by women. Households with single parents, both female and male, and with three generations are particularly at risk of being poor (Ranjitsingh 2016).

Education

Women are less likely than men to have no formal education completed (46% versus 50%) and are more likely than men to have a diplomate/certificate or degree (5% and 4 % versus 4% and 3%, respectively) (Budlender n.d.). At all education levels, female mean earnings are below male mean earnings, with the largest gap found among those with a school-leaving certificate, followed by those with a university degree (Budlender n.d.). This suggests that women are not getting the same monetary return to further education as men.

Health

Low maternal mortality, high percentages of prenatal care and of births attended by skilled staff is characterizing the whole sub-region, with St. Lucia reported to have maternal, childcare, and reproductive health services at all health centers (Gandini 2013). Despite these advancements, teenage pregnancy is a mjor concerns and has consequences both for mother and child's health. HIV/AIDS is one of the most urgent health concerns in the region, affecting both men and women's health. Although the Caribbean has had a steep decline in new infections since 2001, te region is still highly affected by the epidemic. Women aged 15 to 24 are three to six times more likely to contract HIV/AIDs than young men, as a result of poverty and gender roles and practices (Gandini 2013).

Participation in the Labor Market

The employment rate for population aged 15-plus years is 63% for males and 43% for females, with a total employment rate of 53%.[4]Women are less likely (49 percent versus 69 percent) than men to want to work (labor participation rate). Among those who want to work, they are more likely to be unemployed (12 percent versus 8 percent) (Budlender n.d.). Table 4.3-2 provides a breakdown of employment by gender (aged 15-plus years) for various industries.

Table 4.3-2: Gender Breakdown by Industry

Industry	Male	Female	Total
Agriculture	16%	6%	12%
Manufacturing	4%	6%	5%
Construction	21%	1%	12%
Trade	5%	13%	9%
Hospitality	5%	7%	6%
Transport	8%	2%	6%
Services	29%	36%	32%
Administration/Social Security	5%	9%	7%

[4] Employment rates include those who report having done employment-related work over the past seven days, the international standard period for asking about employment.

Industry	Male	Female	Total
Educational/Social Services	2%	11%	6%
Other	5%	9%	7%
Total%	100%	100%	100%
Total Number	34655	26856	61511

Source: (Budlender n.d.)

Decision-Making Spaces

Participation in decision-making spaces is deeply entrenched in gender norms, with men holding the majority of public and private decision-making positions. In the last decade, Latin America and the Caribbean have progressed toward women in high governmental positions. St. Lucia has had considerable change in increase women's parliamentary participation, from 0% in 1990 to 17% in 2012, putting the country closest of the OECS countries to meeting upper middle class and Latin America and Caribbean averages (22 and 25 percent, respectively) (Gandini 2013). Gendered roles are most obvious in the differentiation of cabinet positions held by men and women, where women area more likely to sit in social or cultural-related cabinets rather in economic or political cabinets (Gandini 2013).

Gender-Based Violence

In the Eastern Caribbean, the gender-based violence is deeply embedded in social norms, traditional roles, and cultural values. Men that follow the traditional role of being a man are more likely to engage in partner abuse or sexual coercion, and women who subscribe to the traditional role of femininity are more likely to accept abuse (Gandini 2013). Violence and abuses are increasing among the sub-region with 40 to 50% of women experiencing some form of domestic violence; which is more likely perpetrated by persons close to them (Gandini 2013). Although St. Lucia had established its law against domestic violence in 1994, there are cases of domestic violence in close proximity to law enforcement bodies, and yet no action is taken, likely due to violence being handled as a private issue, typical in many other Caribbean and Latin American contexts (Gandini 2013).

4.3.3 Employment, Livelihoods, and Income

Economic activity and employment in Saint Lucia are driven by three main sectors: tourism (hotels), construction, and agriculture. Tourism is the single largest economic activity in the country, and is primarily concentrated in the north (Gros Islet) and south (Soufrière). In 2016, tourism accounted for approximately 8 percent of the gross domestic product (GDP) in Saint Lucia. The contribution of tourism to GDP has generally increased over the past 10 years, whereas the contribution of agriculture has gradually decreased to approximately 2 percent in 2016.

The total unemployment rate in Saint Lucia has remained above 20 percent since 2009, with one report in 2016 that showed signs of improvement. The declining contribution of the agriculture industry, the 2008 global financial crisis, and slowed economic growth are likely the main

reasons for poor job prospects and overall weak employment trends. Table 4.3-1 above lists the unemployment rates from a 2010 census for communities that could be affected by the project. Table 4.3-3 lists the results of a household employment survey conducted in 2017 for the affected communities. The unemployment rates recorded during the household field survey were higher than those recorded during the 2010 census (refer to Table 4.3-1). Respondent were generally unwilling to provide information on income. From the data obtained, Belle Plaine reported the highest income levels, followed by Belvedere. Mondesir had the lowest income level, reporting monthly household incomes ranging from less than $500 to $1,000.

Females consistently experienced a higher rate of unemployment, countrywide, and at the district and settlement levels. This gender disparity appears to have persisted; whereas the overall unemployment rate for 2016 was estimated at 21.3 percent, unemployment rates for females remained typically higher at 22.9 percent compared to 16.2 percent for males. The difference between the average unemployment rate of females and males decreases as the highest education level attained increases (Government of Saint Lucia 2016a) .

Crop and livestock production are the most productive sub-sectors in the agricultural industry. Banana production, which are produced mainly for export, has been on a downward trend. Other crops are produced mainly for domestic consumption and are sold to local supermarkets and hotels. A cocoa revitalization project was implemented to increase production of cocoa particularly in Soufrière. The last two agricultural censuses have shown a substantial decrease in agriculture lands and production in Soufrière and Laborie.

Water resources in Saint Lucia are primarily used for domestic, commercial, and agricultural purposes. Water is typically extracted from raw water intakes on rivers and river tributaries, and then treated in nearby communities to meet the potable supply requirements. In some communities, notably Belvedere and Fond St. Jacques, water from spring sources is also used (refer to Section 4.2 for further details on water resources).

Table 4.3-3 Household Employment Rates of Affected Communities

Household Respondents	Belle Plaine	Belvedere	Mondesir
Full-time employment	38 %	22 %	18 %
Part-time employment	None reported	6 %	None reported
Self-employed	62 %	39 %	39 %
Unemployed	None reported	33 %	43 %
Total	100 %	100 %	100 %
Expected a loss of land from the project would affect their employment or income	*50 %*	*64 %*	*57 %*

Source: (Panorama Environmental, Inc. 2017)

4.3.4 Education

The affected communities fall within two school districts (#7 and #8), which have a total of 17 primary and 3 secondary schools. All 20 of these schools are exceeding their capacity (Ministry of Education 2014). The Saltibus Combined Primary School and the Piaye Secondary Schools serve the Parc Estate and Gayabois communities. They are located approximately 0.8 and 8 kilometers (0.5 and 5 miles) away, respectively. The Fond St. Jacques Primary School and the Soufrière Comprehensive Secondary Schools serve the communities of Belvedere and Belle Plaine. These schools are located approximately 0.8 and 5 kilometers (0.5 and 3 miles) from Belvedere, and approximately 3 and 8 kilometers (2 and 5 miles) from Belle Plaine, respectively.

Based on the results of a household field survey, approximately 54 percent of the household populations attained primary level education; 28 percent were educated at the secondary level and 9 percent were educated at the tertiary level (community college).

4.3.5 Health and Disease

The affected communities span two health regions (#5 and #6) that contain a total of eight health care facilities. Soufrière Hospital is the main primary care health facility serving the communities of Fond St. Jacques, Belvedere, and Belle Plaine. There are two other health centers in Soufrière that provide general services including visiting specialist and pharmacist services. The Fond St. Jacques health center is less than 5 kilometers (3 miles) from the Belvedere community and the Etangs Health Centre is approximately 5 kilometers (3 miles) from Belle Plaine. The Soufrière Hospital currently functions as a polyclinic or non-hospital referral facility and is not equipped to provide a high level of acute care.

Secondary level medical care for Fond St. Jacques and Belle Plaine communities is available at Victoria and St. Jude Hospital, both of which are about 45 kilometers (28 miles) away. The residents of Mondesir (Parc Estate and Guyabois), have access to the Saltibus health center, which is approximately 5 kilometers (3 miles) away. The St. Jude Hospital is about 30 kilometers (18 miles) from Mondesir and is available for secondary level medical care to the Parc Estate and Gayabois communities.

The Ministry of Health reported that for 2014, the infant mortality rate (annual infant deaths under 1 year old per every 1,000 live births) was down to 17 and the average life expectancy had decreased to 74.4 years. Excluding maternal and reproductive conditions, injuries, road accidents, and non-communicable diseases (e.g., hypertension, heart disease, and cancer) were the most common causes of illnesses and death in Saint Lucia. In 2013 and 2014, mortality due to non-communicable diseases accounted for 58 percent of premature deaths and 73 percent of total preventable deaths. In recent years, there has been a significant increase in the number of suicides in Saint Lucia. The majority of the cases are due to mental health illnesses or substance abuse problems such as alcohol and the use of illicit drugs (Saint Lucia 2015).

The gradual rise in the numbers of persons testing positive for HIV or dying of AIDS is of great concern, although the disease is not yet a significant cause of illness and death in Saint Lucia. The annual HIV/AIDS surveillance report by the Ministry of Health for 2014 reveals that the

number of cases per 100,000 persons of HIV infection is 35. The number of new cases of HIV infection stabilized between 2005 and 2010, increased again between 2011 and 2013, and fell slightly in 2014 compared to 2013. At the end of 2014, there were 674 persons living with HIV out of the total 1029 cases recorded on the national register; males accounted for 50 percent. The majority of diagnosed cases live in the north (e.g., Castries, Babonneau, and Gros Islet) where roughly 55 percent of the population resides. About 34 percent of persons living with HIV in Saint Lucia are enrolled under the Ministry of Health's treatment program.

4.3.6 Land Ownership and Housing

The primary form of land tenure in the Belle Plaine area is family-owned land followed by leased, and privately-held land based on information obtained from the Land Registry Titling Project (LRTP) maps and Government of Saint Lucia Land Registry. Among the three communities, private ownership of lands was highest in Belle Plaine, whereas family-owned land was the main form of land tenure in Belvedere. Leasing, primarily from Government/Invest Saint Lucia, was the predominant form of land tenure in Mondesir, specifically MS-1 and MS-2.

Belle Plaine's respondents reported the highest percentage (80 percent) of family-land used for farming. In the Belle Plaine community cluster, members of a family comprising many siblings declared ownership of over 80 hectares (200 acres) of land, which is currently being used to grow a variety of crops for sale. These lands have already been sub-divided and titles are currently being prepared. In Belvedere, family-owned land was the main form of tenure reported for both housing and farming.

The houses in the three communities are all detached/individual structures mostly built from masonry (concrete/block-wall) or a combination of masonry and wood. The Belle Plaine community had the highest proportion of houses constructed out of a combination of masonry and wood materials. A higher percentage of wooden houses was observed in Belevedere and Mondesir. All the houses surveyed in the Belle Plaine community reported having septic tank toilet facilities whereas 18 percent and 36 percent in Belvedere and Mondesir, respectively, had pit latrines.

4.4 CUMULATIVE DEVELOPMENT

According to the Saint Lucia Ministry of Physical Planning, no other projects have been proposed in the project area of influence.

4.5 DATA GAPS FOR FUTURE DEVELOPMENT

As previously stated, this ESIA focuses on the exploration phase of geothermal development and does not address development of a power plant in the event that a commercially viable geothermal resource is identified. A separate ESIA would be prepared to address potential impacts from power plant development, although much of the information presented in this

ESIA could serve as a starting place for evaluation of environmental conditions. Potential data gaps for preparing an ESIA that addresses future power plant development are summarized as follows:

- Clear policy guidance from the PMA Development office on levels of acceptable geothermal development within PMA policy areas and green "buffer zone" (refer to Section 2.4)
- Baseline data for specific power plant development areas
- An assessment of environmental and social risks and impacts associated with construction, maintenance, and operation of the power plant
- Additional data on ambient air quality conditions and wind speed/direction in the potential area of drilling to support dispersion modeling of air emissions from a future development phase
- An aquifer test to support a more detailed hydrologic model and assessment of potential use of groundwater resources in the future development area
- Data on surface water discharge rates and water quality; long-term monitoring of surface water resource flow rate and water quality in proximity to the future development area is recommended

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5 ANALYSIS OF ALTERNATIVES

5.1 OVERVIEW

This section describes alternatives that were considered when developing the proposed project. The alternatives include different locations for exploration activities within the geothermal resource area. Each alternative would avoid at least one significant impact, but would include different or greater impacts of their own. Project alternatives, including a "without project" alternative, are described below, including their pros and cons as well as potential differences in mitigation.

5.1.1 Approach to Definition of Potential Geothermal Exploration Areas

Jacobs conducted geophysical investigations in the Soufrière and Choiseul regions to assist the GoSL in defining areas for geothermal resource exploration outside of Sulphur Springs (2016). Jacobs identified three target areas for geothermal resource investigation. These target areas spanned a large area to the east of Sulphur Springs.

5.1.2 Refinement of Drilling Areas to Minimize Impacts

GeothermEx/POWER Engineers and Panorama Environmental, Inc. conducted reconnaissance surveys of the three target resource areas defined by Jacobs. GeothermEx/POWER and Panorama considered key environmental and social constraints when defining the geothermal resource target drilling areas considered in this ESIA. These constraints included:

- Stable and relatively flat topography within the drilling area
- Drill rig transport/access via the existing road network
- Access to water supply
- Avoidance of existing homes/structures
- Avoidance of native habitats
- Avoidance of the PMA Policy Areas

5.1.3 Drilling Strategy

GeothermEx/POWER Engineers considered potential environmental and social conflicts when developing the drilling strategy. The drilling strategy specifically focuses on small diameter wells in order to minimize the time required to complete the wells and the area needed for the well pads. The strategy also identifies Fond St. Jacques and MS-3 and MS-4 as areas that would only be suitable for slim-hole wells to minimize community disruption and social impacts.

5.2 ALTERNATIVES CONSIDERED BUT REJECTED

5.2.1 Alternative 1: Alternate Drilling Areas

Rural and Mountainous Areas

The proposed project drilling areas are located in flat and open areas to avoid communities as much as possible, and limit the amount of tree removal and grading that would be required to establish access roads and well pads. Nearly all of the flat and open areas in the areas of geologic interest for drilling (based on the Pre-Feasibility Study (GeothermEx and Power Engineers 2017, Jacobs New Zealand Limited 2016) are used for agriculture production and have greater residential density. Areas north of Mondesir-Saltibus with potentially more attractive geophysical indications are in more rugged terrain that would require extensive road building and substantial cut and fill for well pads.

An alternative to the proposed project would be to move the project drilling areas away from the flat and open areas, where residences and farmland are located, to more rural areas that have steeper slopes and would have much greater road and pad construction costs. The pros and cons of this alternative are summarized as follows:

Pros

- Avoids direct impacts to farmland and livelihoods
- Reduces impacts on adjacent residents (e.g., noise, air quality, livelihoods, and traffic circulation)
- Reduces some public safety concerns (e.g., geothermal gas emissions, hot fluids, heavy equipment, etc.) for nearby residences

Cons

- Greater impacts associated with grading, ground disturbance, and vegetation disturbance
- Greater risk of erosion and sediment transport
- Greater impacts on habitat for wildlife and nesting birds
- Potential for causing landslides and mudslides
- Potentially greater visual impacts
- Longer construction period
- Greater construction costs

This alternative would require similar mitigation to the proposed project; however, mitigation to compensate farm owners and farmworkers for a loss in livelihoods would not be needed. Additional mitigation would be needed to address the risks and impacts from working on slopes. The civil works costs would be substantially greater.

Pitons Management Area

The proposed project does not include drilling areas within the PMA policy area boundary, which was intentionally avoided to:

- Avoid risks and impacts to the PMA World Heritage Site
- Avoid conflicts with tourism

- Uphold the GoSL's preservation commitments

An alternative to the proposed project would be locate one or more of the drilling areas within the PMA, which is closer to Sulphur Springs and surface manifestations of the geothermal resource and farther from residential areas. The pros and cons of this alternative are summarized as follows:

Pros

- May reduce direct impacts on farmland
- Reduces impacts on adjacent residents (e.g., noise, air quality, livelihoods, and traffic circulation)
- Reduces some public safety concerns (e.g., geothermal gas emissions, hot fluids, heavy equipment, etc.) for nearby residences if pads are sited farther from residences

Cons

- Impacts in the PMA
- Could affect the PMA's designation as a World Heritage Site
- Greater impacts on tourism
- Greater impacts on habitat for wildlife and nesting birds
- Visual impacts in the tourist area
- Closer to known area of high-acidity geothermal fluids identified during previous drilling investigations
- Possible impacts to surface manifestations of the Soufriere volcanic area

This alternative would require similar mitigation to the proposed project; however, mitigation to compensate farm owners and farmworkers for a loss in livelihoods might not not be necessary. Additional mitigation would be needed to address impacts to visual resources, tourism, the PMA, and to preserve the World Heritage Site designation.

5.2.2 Alternative 2: Reduced Drilling Sites

The drilling areas in Fond St. Jacques are in close proximity to residences. An alternative to the proposed project would be to avoid drilling in Fond St. Jacques, which is in very close proximity to residences, and only drill wells in the Belle Plaine and Mondesir-Saltibus areas, except MS-4 which is also close to residences. The pros and cons of this alternative are summarized as follows:

Pros

- Reduces direct impacts on farmland and livelihoods
- Reduces impacts on adjacent residents (e.g., noise, air quality, livelihoods, and traffic circulation)

Cons

- Reduces exploration study area
- No subsurface data would be collected for the northern extent of the geothermal interest areas
- Fond St. Jacques is within the area that was defined as the

- Reduces some public safety concerns (e.g., geothermal gas emissions, hot fluids, heavy equipment, etc.) for nearby residences
- Reduces construction costs
- Reduces mitigation costs

resource target area resulting from geophysical assessment

This alternative would require similar mitigation to the proposed project; however, some mitigation procedures for construction noise and community health and safety may not be needed. Additional mitigation would be needed to address impacts on the PMA and to preserve the World Heritage Site designation. No additional mitigation would be needed.

5.2.3 Alternative 3: "Without Project" Alternative

The World Bank Environmental and Social Framework states that a "without project" alternative should be addressed in the analysis of alternatives section. A "without project" alternative considers if the project was not implemented and no exploration drilling occurred at all. The pros and cons of this alternative are summarized as follows:

Pros

- Avoids all impacts

Cons

- No information would be obtained about the feasibility of developing the geothermal resource
- Geothermal development would not occur and energy use in the region would continue as it is now

No mitigation would be required under this alternative.

6 ENVIRONMENTAL AND SOCIAL RISKS AND IMPACTS

6.1 APPROACH TO IMPACT ANALYSIS

The IFC Performance Standards on Environmental and Social Sustainability states that the environmental and social risks and impacts section should take into account all relevant environmental and social risks and impacts of the project, including the environmental and social risks and impacts specifically identified in PS 2 through PS 8, as well as any other environmental and social risks and impacts arising as a consequence of the specific nature and context of the project.

The primary purpose of an ESIA is to predict the impacts resulting from a project and identify measures to avoid, reduce, or compensate for adverse impacts. Impacts can be direct, indirect, or induced, as defined in Table 6.1-1.

Table 6.1-1 Types of Impacts

Type of Impact	Definition
Direct	Impacts that result from a direct interaction between the project and a resource/receptor (e.g., between disturbance of a plot of land and the habitats on that plot of land that are affected).
Indirect	Impacts that follow from the direct interactions between the project and its environment as a result of subsequent interactions within the environment (e.g., impacts on bird population levels as a result of construction noise impacts on bird breeding behavior).
Induced	Impacts that result from other activities (which are not part of the project) that happen as a consequence of the project (e.g., increased spending in the local economy due to increased worker employment).

6.1.1 Step 1: Predict Impacts

Potential project impacts are predicted and quantified to the extent possible. The magnitude of impacts on resources (e.g., water and air) or receptors (e.g., people, communities, wildlife species, habitats) is defined. Magnitude is a function of the following impact characteristics:

- Type of impact (i.e., direct, indirect, induced)
- Size, scale, or intensity of impact
- Nature of the change compared to baseline conditions (i.e., what is affected and how)
- Geographical extent and distribution (e.g., local, regional, international)
- Duration and/or frequency (e.g., temporary, short-term, long-term, permanent)

Magnitude describes the actual change that is predicted to occur in the resource or receptor. The magnitude of an impact takes into account all the various impact characteristics in order to determine whether an impact is negligible or significant. Some impacts can result in changes to the environment that may be immeasurable, undetectable, or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and are characterized as having a negligible magnitude. In determining the magnitude of impacts on resources and receptors, embedded controls (i.e., physical or procedural controls that are incorporated into the proposed project) are taken into consideration. For example, the magnitude of impacts on stream water quality from ground disturbance take into consideration the effectiveness of proposed sediment and erosion control measures that would be applied during construction.

In addition to characterizing the magnitude of impact, the sensitivity of the impacted resource or receptor is characterized by its sensitivity to change, vulnerability, importance, and quality, as applicable. Resource sensitivity includes local, national, and international scale considerations, such as abundance or scarcity of a physical resource, as well as sensitivity to the specific project activities that are proposed. Human receptor vulnerability is also considered. Resource and receptor sensitivity are designated as low, medium, or high.

6.1.2 Step 2: Evaluate Impacts

The significance of a potential project impact is evaluated by considering the magnitude of the impact in combination with the sensitivity/vulnerability/importance of the impacted resource or receptor. The assignment of a significance rating facilitates decision-makers and stakeholders to understand how much weight should be given to the issue in their process. In the case of beneficial impacts, the significance is assigned as positive or beneficial.

Significance was assigned for each impact using the matrix shown in Table 6.1-2. This matrix applies universally to all resources or receptors.

Table 6.1-2 Risk and Impact Significance Matrix

Risk and Impact Magnitude	Resource or Receptor Sensitivity [a]			
	Very Low	**Low**	**Moderate**	**High**
Very Low	Negligible Impact	Negligible Impact	Negligible Impact	Negligible Impact
Low	Negligible Impact	Negligible Impact	Less than Significant Impact	Potentially Significant Impact
Moderate	Negligible Impact	Less than Significant Impact	Potentially Significant Impact	Significant Impact
High	Less than Significant Impact	Potentially Significant Impact	Significant Impact	Significant Impact

Note:

[a] Resource or receptor sensitivity collectively refers to characteristics including sensitivity to change, vulnerability, importance, and quality, as applicable.

The levels of impacts are defined using the following terms:

- **Negligible Impact.** A negligible impact is one where a resource or receptor (including people) would not be affected by a particular activity, or the predicted effect is deemed to be imperceptible or is indistinguishable from natural background variations.
- **Less than Significant Impact.** A less than significant impact is a minor impact is where a resource or receptor would experience a noticeable effect, but the impact magnitude is sufficiently low (with or without mitigation) and/or the resource or receptor is of low sensitivity. In either case, a less than significant impact must be sufficiently below applicable standard threshold limits.
- **Potentially Significant Impact.** A potentially significant impact is a moderate impact that meets applicable standards but comes near the threshold limit. The emphasis for such moderate impacts is to demonstrate that the impact has been reduced to a level that is as minor as reasonably practicable so that the impact does not exceed standard threshold limits and become significant.
- **Significant Impact.** A significant impact is one where an applicable standard threshold limit would or could be exceeded, or if a highly valued or very scarce resource would be substantially affected.

In addition to the risks and adverse effects, the proposed project may include positive effects. Some of the positive effects from the proposed project are described in the impact evaluation, such as the potential for generating temporary jobs during exploration activities; however, the impact evaluation primarily focuses on the adverse impacts.

6.1.3 Step 3: Evaluate Mitigation

After predicting and evaluating the impacts, the ESIA process involves evaluating mitigation measures that could be implemented to avoid, reduce, or compensate for the impacts, as necessary and to the extent reasonably feasible. A mitigation hierarchy from the World Bank Environmental and Social Framework was used in which preference is always given to avoid or minimize the impact before considering other types of mitigation (i.e., observe, remedy, compensate, offset). The hierarchy of mitigation measures includes:

1. **Anticipate and Avoid Impacts.** Remove the source of the impact (i.e., avoid the specific action or resource area).
2. **Minimize Impacts.** Reduce the magnitude of the impact, where the impact cannot be completely avoided.
3. **Compensate or Offset Impacts.** Where significant residual impacts would remain after exhausting avoidance and minimization options, provide compensation or offsets for the impact, where technically and financially feasible.

6.1.4 Step 4: Evaluate Residual Impacts

Residual impacts are the impacts that are predicted to remain after mitigation has been implemented based on the effective outcomes. The significance of residual impacts are rated in the same way as impacts before mitigation (e.g., less than significant, potentially significant, and significant), but includes assumptions on how mitigation would reduce the impact magnitude or otherwise address sensitivity characteristics, thereby reducing its overall significance.

6.2 ENVIRONMENTAL RISKS AND IMPACTS

6.2.1 Water Resources

Sensitive Resources

Two intermittent streams flow through or adjacent to the Belle Plaine drilling area, two rivers flow adjacent to the Mondesir-Saltibus drilling areas, and two rivers flow near the Fond St. Jacques drilling area. The Fond St. Jacques drilling area is also located near water storage infrastructure and springs, which supply drinking and non-drinking water to the local community. The rivers and water resources near the proposed drilling areas are important water supply sources for the communities near the project area and downstream. These resources are very important to the local communities and considered highly sensitive.

Potential Risks/Impacts and Magnitude

Water Quality

Civil Works

The project would involve construction of new access road segments, expansion of existing access roads, and construction of well pads. Grading and vegetation clearing activities during the civil works phase of the project could destabilize soil and result in erosion or sedimentation during rain events. Erosion and sedimentation that reaches the drainage network has the potential to degrade surface water quality.

Well Drilling and Testing

Geothermal fluid could be produced during the geothermal drilling and testing at the Belle Plaine and Modesir-Salitbus wells. Drill cuttings and fluids produced during drilling, and produced geothermal fluids could contain high levels of the following heavy metals, which commonly occur in geothermal resources:

- Arsenic
- Boron
- Cadmium
- Chromium
- Nickel
- Mercury
- Zinc
- Uranium
- Radium
- Gross alpha and beta

Drilling waste and any geothermal fluids would be collected in tanks or reserve pits at the drilling sites. Fluids would be allowed to evaporate or, or they would be reinjected into the well.

If the reserve pits were improperly constructed or maintained, fluids in the pits could be flow into the drainage network, which could degrade water quality downstream from the drilling areas. Incidental leaks or spills of hazardous materials could also contaminate nearby waterways if the materials are not properly contained.

There is a risk that the geothermal drilling and testing operations could result in a release of geothermal fluids to surface waters. While unlikely, a well blowout could result in an uncontained discharge of geothermal fluids that could flow to surface water. Well blowouts are typically caused by improper well construction or lack of BOP equipment. Well BOP equipment will be installed on all wells.

Civil Works and Well Drilling

Earth moving equipment (e.g., graders and dozers) and drill rigs require the use of oil, grease, hydraulic fluids, and other chemicals. Leaking construction equipment, drill rigs, or improperly stored hazardous materials could result in a discharge of hazardous materials to nearby rivers during rain events. The transport of hazardous materials to waterways has the potential to degrade water quality downstream of the work area.

Surface pollution upgradient of springs or well drilling within connected aquifers could impact water quality for the springs at Fond St. Jacques. These springs are likely surface manifestations of ground water collection from upslope area, and the potential drilling areas are located downgradient from the springs; however, the potential for underground connectivity between spring sources and aquifers that may be encountered during drilling cannot be known without further study or monitoring.

Reclamation

Reclamation would involve earth moving activities that would have a potential to cause erosion prior to vegetation establishment. The equipment used during reclamation would also require small quantities of hazardous materials (e.g., oil, grease, and hydraulic fluid).

Water Supply

Civil Works

Construction equipment and grading could directly damage water supply systems (i.e., pipes, intakes, tanks, and ditches) that are both above ground or buried. In particular, the buried pipelines and water supply infrastructure in Fond St. Jacques could be damaged during well pad and access road construction. Effects to the water supply system would have an adverse effect on water supply in the community if not promptly repaired.

Water would be required for dust control during road and well pad construction. The volume of water required for dust control would be minimal and would not noticeably affect the availability of water in the region.

Well Drilling

The project would require fresh water for drilling, worker needs (e.g., drinking, washing, and sanitation), and dust control. Drilling water would be extracted from the Doree River and Migny River, including their tributaries, or other WASCO water supply tanks and piped or carried by truck to the well sites. Water extraction would occur downstream from WASCO's raw water intakes to avoid substantial impacts on the main water supply; however, the downstream water supply could be affected. If feasible, a water well could also be bored in the Belle Plaine area to supply drilling water.

The volume of water required during well drilling would vary depending on the type of well (e.g., slim-hole or full-sized well) and the subsurface conditions and rock/fracture permeability, which are currently unknown. Higher permeability rocks with numerous open fractures would require more water during drilling. The water requirements specified in Section 3.4 reflect the maximum potential water demand assuming highly permeable rock is encountered with high water losses. The volume of water required for well drilling could exceed the volume of water that is available in local streams. Therefore, the project could substantially reduce the water supply for users downstream of river extraction points or those relying on water tanks that may be used by the project.

Installation of a water well in the Belle Plaine area would not affect the water supply in the area because there are no existing uses of groundwater resources in the Belle Plaine area.

Reclamation

Water use would be limited during reclamation and would be used primarily for dust control.

Flooding

Civil Works and Well Drilling

The project area in Belle Plaine is located within a 100-year flood plain. Table 6.2-1 below provides the approximate hydraulic flow rates for each of the project areas using the rational method.

Table 6.2-1 Estimated Hydraulic Flow Rates

Project Area	Catchment	Area (ha)	Top Elevation (m)	Slope	Runoff Coefficient	Intensity (mm/hr)		Runoff (m3/s)	
						5-yr	10-yr	5-yr	10-yr
Belle Plaine	L'Ivrogne	910	698	0.065	0.15	62	85	24	32
	Sub-L'Ivrogne	251	249	0.036	0.15	82	115	9	12
Mondesir-Saltibus	Doree	1095	570	0.055	0.15	50	70	23	32
	Sub-Doree	736	548	0.058	0.15	68	90	21	28
Fond St. Jacques	Soufrière	1556	520	0.071	0.15	62	85	40	55
	Sub-Soufrière	226	240	0.14	0.15	108	215	10	20

The minimal surface recontouring to construct a well pad would not measurably effect runoff in any of the effected drainages. The well pads are small in size and would remain largely pervious so that they would not concentrate downstream flow or cause any increase in downstream flooding.

Reclamation

The project site would be returned to pre-existing contours and vegetation types during site reclamation. Reclamation of the site would have no impact on flood intensity off site.

Impact Significance and Mitigation

The significance of each impact on water resources and mitigation measures that would be applied are summarized Table 6.2-2.

Table 6.2-2 Summary of Potential Water Resource Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Water Quality	Sediment Discharge	High	Moderate	**Significant**	Water-1 Water-2	Negligible to Less than Significant
	Drilling Waste	High	Moderate	**Significant**	Water-3	Negligible
	Geothermal Fluid Discharge	High	High	**Significant**	Water-4	Negligible to Less than Significant
	Hazardous Material Discharge	High	Moderate	**Significant**	Hazards-1	Negligible
	Underground Spring Contamination	High	Moderate	**Significant**	Water-2	Negligible
Water Supply	Damage Water Supply Infrastructure	High	Moderate	**Significant**	Water-5	Negligible
	Water Use (Dust Control)	High	Very Low	Negligible	--	--
	Water Use (Well Drilling)	High	High	**Significant**	Water-5 Water-6	Less than Significant
	Groundwater Well	Low	Low	Less than Significant	--	--
Flooding	Well Pad Construction	Moderate	Low	Negligible	--	--

6.2.2 Air Quality

Sensitive Receptors

Residential dwellings are located in proximity to the drilling areas in Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques; occupied dwellings are considered sensitive receptors. Sensitive receptors within 305 meters (1,000 feet) of the drilling areas are shown on Figure 4.2-3 through Figure 4.2-5. Elderly individuals and people who may be more sensitive to air quality were documented in the communities surrounding the drilling sites. The residences are therefore considered highly sensitive to air quality impacts.

Potential Risks/Impacts and Magnitude

Equipment Emissions and Fugitive Dust

Civil Works and Well Drilling

Well pad construction for slim wells would require leveling and compaction to create a stable surface for the truck mounted drill rig. The full-size wells could require soil excavation, grading, and vegetation removal, which could create sources of fugitive dust. Travel over unpaved access roads during civil works and well drilling operations could create fugitive dust, which could impact air quality and visibility. Access road improvements may require vegetation removal and grading with heavy equipment which could also produce fugitive dust. Fugitive dust could settle onto adjacent agricultural products or could cause visible dust plumes that would be noticeable to people living or working in the area.

Both the civil works and well drilling construction phases would require the use of heavy diesel-powered equipment. The equipment exhaust would result in emissions that would temporarily degrade air quality in the immediate vicinity of the equipment. The duration of construction in a single area would be limited to approximately 2 to 6 months, depending on the size of the wells. Equipment emissions would dissipate rapidly in the atmosphere and would not result in a substantial increase in any air pollutant at sensitive receptors.

Reclamation

The air quality effects of reclamation would be similar to those of civil works but likely short in duration (less than one week) during site recontouring. Reclamation activities would stabilize the site to avoid long-term emissions of fugitive dust.

Geothermal Gas Emissions

Well Drilling and Testing

Well drilling and flow testing could result in the release of geothermal steam if the resource is encountered. The geothermal emissions may include water vapor, carbon dioxide, and hydrogen sulphide (H_2S). Small amounts of boron, arsenic, mercury, and bicarbonate may be entrained in geothermal steam and emitted during drilling and testing. These gases occur naturally at the surface manifestations of the geothermal resource at Sulphur Springs.

Well flow testing would only occur if the geothermal resource was encountered, and would not occur at Fond St. Jacques east site to minimize risks to the population due to proximity to

sensitive receptors. Fond St. Jacques would only include temperature gradient holes. Flow testing would involve venting steam to the atmosphere and could emit H_2S, boron, arsenic, mercury, and bicarbonate. The geothermal resource is usually encountered at the latter phase of drilling—the last 10 to 15 days. H_2S is the constituent of primary concern in geothermal emissions because it can cause health effects at elevated levels. The H_2S concentration measured at Sulphur Springs is characteristic of the anticipated H_2S concentrations anticipated during venting of the geothermal resource. H_2S concentrations at Sulphur Springs were 29.24 $\mu g/m^3$ during air quality monitoring in September 2017 (refer to Appendix C). Local receptors within 100 meters (328 feet) may smell a "rotten egg" odor if H_2S is present in the steam.

It is not feasible at this stage of the project to conduct air dispersion modeling to predict H_2S levels at receptors because (1) the precise location of the well pads and relative distance to receptors is not defined, (2) the chemistry of the geothermal resource in the potential drilling areas is not known, and (3) there is no data on the wind speed and direction in the project areas. The air quality at Sulphur Springs where the geothermal resource naturally vents to the atmosphere indicates that the project could produce H_2S concentrations in excess of WHO guidelines for annoyance. Any emissions from the geothermal drilling and testing, including a potential blowout, would disperse quickly in the atmosphere. The air quality risk from geothermal testing would be moderate due to quick dispersion rates, the short duration of drilling and testing activities, and limited volume of fluid that could be produced. The temporary venting of geothermal steam during resource testing would not cause any adverse health effects and is not expected to exceed WHO H_2S thresholds for eye irritation.

Impact Significance and Mitigation

The significance of each impact on air quality resources and mitigation measures that would be applied are summarized in Table 6.2-3.

Table 6.2-3 Summary of Air Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residences and Community Members	Fugitive Dust	Moderate	Low	Less than Significant	Air-1	Negligible
	Equipment Emissions	High	Low	**Potentially Significant**	Air-2	Negligible
	Geothermal Gas Emissions	High	Moderate	**Significant**	Air-3 Water-4	Negligible to Less than Significant

6.2.3 Geology and Soils

Sensitive Resources

The potential drilling areas in Belle Plain, Mondesir-Saltibus, and Fond St. Jacques include active agricultural uses. Productive topsoil is important to agricultural production and topsoil is considered a highly sensitive resource to the community. The project area in Fond St. Jacques

and the access roads to the drilling sites are located within areas that are prone to landslides and slope failure. The risk of landslides is high in areas where access road grading may be required.

Potential Risks/Impacts and Magnitude

Erosion and Topsoil Loss

Civil Works

Soil erosion is a severe environmental problem in Saint Lucia and affects the water supply and agricultural productivity. Access road and well pad grading and vegetation clearing activities could cause soil erosion and loss of topsoil. Gravel would be installed at work areas and access roads, where necessary, to facilitate all weather access for vehicles and equipment. Substantial erosion could affect slope stability and lead to sediment transport. Substantial topsoil loss could affect agricultural land and crop production.

Well Drilling and Testing

Well drilling and testing activities would be conducted within the stabilized well pad. Well drilling and testing activities would not disturb nearby areas or cause loss of topsoil. Geothermal fluid spills from the sump (if used) could cause erosion of topsoil in steep areas. Most well pads would be located on relatively flat areas, reducing the risk of runoff and erosion.

Reclamation

Reclamation would involve recontouring of the site to pre-existing conditions. The removal of gravel could temporarily destabilize the soil and cause soil erosion; however, the reclamation activities would provide long-term stabilization of the site and involve replacement of topsoil to minimize or avoid effects from topsoil loss.

Landslides, Mudflows, and Unstable Soil Conditions

Civil Works

The access roads leading to the potential drilling areas require passage through steep mountainous terrain with tight turns. Access roads may need to be expanded in areas where the turning radius is insufficient to accommodate large construction equipment. Expansion of the access road along steep slopes could cause slope instability if the road expansion is not properly designed to address soil and slope conditions.

The potential drilling area in Fond St. Jacques east is located in an area that is known to contain saturated soils. Construction of the well pad and access road could create an unstable work area if the well pad was not properly engineered and constructed to address saturated soil conditions.

Well Drilling

The slopes surrounding the Belle Plaine, Fond St. Jacques and MS-3 and MS-4 areas are prone to landslides and potential mudflows. Landslides could affect the drilling sites depending on the location and extent of slope failure. Due to the short duration of drilling activities, drilling

activities could be timed to avoid periods when there is a risk of substantial rainfall and landslide or mudflow.

Reclamation
Reclamation would return the sites to the pre-construction conditions and would not increase the potential effects related to landslides, mudflows, and unstable soil conditions.

Seismicity
Well Drilling and Testing
There is no causal link between exploratory geothermal drilling and induced seismicity. The exploration drilling program would not exert pressure on a known fault system or induce seismicity.

Reclamation
Reclamation activities would have no effect on seismicity.

Impact Significance and Mitigation

The significance of each impact on geology and soil resources and mitigation measures that would be applied are summarized in Table 6.2-4.

Table 6.2-4 Summary of Geology and Soil Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Topsoil	Erosion (Civil Works)	High	Moderate	**Significant**	Water-1 Soils-1	Negligible to Less than Significant
	Erosion (Well Drilling)	High	Very Low	Negligible	--	--
Slope/Soil Stability	Destabilization Slopes/Soil (Civil Works)	High	High	**Significant**	Soils-2	Negligible to Less than Significant
	Destabilization Saturated Soils	High	Moderate	**Significant**	Soils-2	Negligible
	Destabilization Slopes/Soil (Well Drilling)	High	Low	Less than Significant	--	--
	Induced Seismicity (Well Drilling)	Moderate	--	Negligible	--	--

6.2.4 Noise

Sensitive Receptors

Noise sensitive land uses can include residential areas, schools, and places of worship. No schools or places of worship are located in proximity to the drilling areas. Residences are

located in the vicinity of all three of the potential drilling areas, the closest of which are near the Fond St. Jacques west and MS-4 site. Residences within 305 meters (1,000 feet) are shown on Figure 4.2-3 through Figure 4.2-5. Residents are typically most sensitive to noise at night, when noise can interfere with sleep. The noise sensitivity for receptors in proximity to the drilling sites is considered high because the project could involve drilling and testing activities at night.

Potential Risks/Impacts and Magnitude

Civil Works

The project would temporarily generate noise during construction activities from the operation of motorized vehicles (e.g., trucks and bulldozers) and stationary equipment (e.g., generators, compressors, pumps, etc.). Civil works activities would occur during daytime hours. Typical noise levels from civil works activities are listed in Table 6.2-5.

The noise levels in Table 6.2-5 are based on a reference distance of approximately 15 meters (50 feet), and the noise level would change with distance. Noise levels attenuate (decrease) at an average rate of approximately 6 dBA per doubling of distance from a source. Conversely, noise levels increase by approximately 6 dBA when distance is reduced by half. For example, if noise from a bulldozer is 85 dBA at a distance of 15 meters (50 feet), the adjusted noise level would be 79 dBA at 30 meters (100 feet) and 91 dBA at 7.5 meters (25 feet).

Table 6.2-5 Typical Noise from the Proposed Activities

Activity	Predicted Noise Levels (dBA) at Distance [a]								
Meters (Feet)	3.8 (13)	7.6 (25)	15.2 (50)	30.5 (100)	61.0 (200)	152.4 (500)	304.8 (1,000)	609.6 (2,000)	1,524.0 (5,000)
Civil Works	96	90	84	78	72	66	60	54	48
Well Drilling (Large Rig)	93	87	81	75	69	63	57	51	45
Well Drilling (Small Rig)	83	77	71	65	59	53	47	41	35
Well Clean-Out	93	87	81	75	69	63	57	51	45
Well Flow-Testing	96	90	84	78	72	66	60	54	48

Note:

[a] Estimated noise levels are given for various distances from the noise-generating sources. These noise levels do not account for the topographical barriers, trees, vegetation, and manmade structures through the project area that would absorb or deflect sound waves, thereby reducing noise levels.

Sources: (U.S. Department of Interior, Bureau of Land Managment 1995)

Well Drilling

The project drilling areas are generally located in areas that are characterized as residential, rural residential, and mixed-use agricultural land. The World Bank's guidelines for noise in

residential areas (refer to Section 0), when measured at the nearest sensitive receptor, are as follows:

- ≤ 55 dBA during daytime hours (7:00 and 22:00)
- ≤ 45 dBA during nighttime hours (22:00 and 7:00)
- ≤ 3 dBA increase above existing ambient levels (all periods)

The World Bank's guidelines are generally suited for permanent noise increases, such as noise from permanent facility or frequent operation activity. Infrequent and temporary construction noise typically exceeds these guidelines; however, the guidelines can indicate a potential noise impact for construction noise that is relatively long-term (more than a few weeks or months). All noise associated with the well drilling and testing phase would be temporary and limited to the 2 to 6 months in any area.

Residences (sensitive receptors) are located in proximity to the boundary of potential drilling areas, especially at Fond St. Jacques west and MS-4, as shown on Figure 4.2-3 through Figure 4.2-5. Construction activities at 15 meters (50 feet) from the project would temporarily exceed the World Bank's guidelines for permanent noise. Temporarily exceeding the guidelines would not be a significant impact on its own; however, the project could generate substantial temporary noise that could impact adjacent residents and workers, depending on the noise characteristics (i.e., overall level, difference between existing ambient noise, duration, frequency, and timing), receptor location (i.e., separation distance and intervening vegetation, topography, and structures), and receptor sensitivity.

Daytime drilling noise could result in adverse community reaction if a well is drilled adjacent to a home in Belle Plaine or MS-4 areas. Most other drilling areas would allow 50 meters (160 feet) or more buffer from residences.

Nighttime drilling noise could cause adverse community reaction and potentially sleep disturbance. Noise above 45 dBA during nighttime hours is likely to cause sleep disturbance. Noise levels could exceed 45 dBA up to 300 meters (1,000 feet) from the well pad. Indoor noise levels with the windows closed would be attenuated and less than outdoor noise levels. Procedures should be implemented to position well pads as far from receptors as feasible, and to reduce equipment noise levels to the greatest extent possible.

Drilling may also cause periodic vibration that could be felt up to approximately 10 meters (30 feet) from the drill rig depending on ground conditions. Vibration attenuates rapidly over distance, and any vibration would be temporary and short-term. Vibration is not expected to affect any structures due to the rapid attenuation of vibration with distance. Though no damage is expected as result of vibration caused by drilling, mitigation is included to provide to ensure that property owners would be properly compensated to repair any damage caused by the project.

Reclamation

Site recontouring and reclamation activities would produce temporary noise from use of large equipment, similar to the equipment that would be used for the civil works phase. Noise during reclamation would be very short in duration (a few days). Reclamation activities would take place during daytime hours. The noise impact would be similar to large truck noise, which is part of the ambient environment.

Impact Significance and Mitigation

The significance of each impact on noise sensitive receptors and mitigation measures that would be applied are summarized in Table 6.2-6.

Table 6.2-6 Summary of Noise Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Residences	Daytime Noise (Civil Works)	Moderate	Moderate to High [a]	**Significant**	Noise-1	Less than Significant
	Daytime Noise (Well Drilling and Testing)	Moderate	Moderate to High [a]	**Significant**	Noise-1	Less than Significant
	Nighttime Noise (Well Drilling and Testing)	High	Moderate to High [a]	**Significant**	Noise-1	Less than Significant
Structures	Vibration (Well Drilling)	High	Low	Less than Significant	Noise-2	Negligible

Note:

[a] Magnitude would be high at Fond St. Jacques west and moderate at other locations.

6.2.5 Natural Habitats and Biodiversity

Sensitive Resources

The project area consists of disturbed and agricultural production areas. No natural habitats are present and no sensitive or critical natural sites occur in the areas that would be directly affected by the project activities. There are no rare, endangered or protected species present, and no areas of high biological diversity or endemism. No endangered or vulnerable plant, mammal, lizard, reptile or insect species are known to occur in the area. The sensitivity of biological resources within the drilling area is low.

Priority bird species occur in the forested areas adjacent to the drilling areas in Belle Plaine and Mondesir-Saltibus. The sensitivity of forested areas adjacent to the project area is moderate.

Potential Risks/Impacts and Magnitude

Direct Impacts on Habitat and Species (Civil Works)
Access road grading and well pad construction in agricultural areas or disturbed habitats would not have an adverse impact on natural communities or biodiversity because no natural communities occur in the area. Wildlife would tend to avoid areas of noise and human activity.

Biological surveys of the proposed drilling areas did not identify sensitive biological resources within any drilling site (refer to Appendix C). Well pad construction and access road grading within the surveyed drilling areas would not directly affect any natural habitats or sensitive species because the potential drilling areas are agricultural or barren areas with no suitable habitat for sensitive biological resources.

Biological surveys have not been completed at MS-3 or MS-4. MS-3 and MS-4 were defined as agricultural and residential disturbed areas during reconnaissance surveys, and the areas have a low potential for sensitive biological resources. While it is unlikely that sensitive biological resources could occur in the MS-3 or MS-4 areas, it is not possible to fully rule out the potential for sensitive species in the MS-3 or MS-4 areas because the areas have not been surveyed. If rare plants or sensitive biological resources occur in the MS-3 or MS-4 area, well pad construction and access road grading would adversely impact these resources.

Indirect Impacts on Habitat and Species (Civil Works and Well Drilling)
Invasive Weeds
Construction equipment, vehicles, and drill rigs can carry mud and invasive weed fragments or seeds on the vehicle and equipment tires or undercarriage. Invasive weeds could be introduced to the project area and surroundings through imported construction equipment and drill rigs. Invasive weeds can outcompete native vegetation and cause loss of habitat and potentially increased risk of wildfire. The potential drilling areas in Belle Plaine and Fond St. Jacques are located in proximity to the PMA. Introduction of invasive weeds was identified as a threat to the biological diversity of the PMA (The Landmark Practice 2013). The introduction of invasive weeds could adversely impact native habitats surrounding the potential drilling areas.

Noise
Heavy equipment used during civil works and well drilling activities will produce noise levels that exceed the ambient noise conditions in the area (refer to Section 6.2.4 for predicted noise levels). Noise from heavy equipment and the drill rig could disturb wildlife and interrupt bird nesting behavior. Several priority bird species were documented in the forested buffer near the drilling areas during planning surveys (refer to Appendix C). An intermittent increase in noise could potentially cause nest abandonment if birds are nesting in the vicinity of the drilling area. Disturbing nesting behavior or causing nest abandonment could adversely impact bird populations. Drilling noise levels would be fairly constant over the drilling period. Drilling noise is not expected to cause nest disturbance because any species nesting in the vicinity of the drilling area would be accustomed to the constant noise level; however, drilling noise could cause birds to avoid habitat in proximity to the drilling areas.

Worker Behavior
Workers could attract wildlife to the construction area if they were to feed wildlife or improperly store food waste. Attracting wildlife to the work area could put wildlife in danger or injury or mortality from heavy equipment or vehicles.

Reclamation
Reclamation activities would return the well pads to the preconstruction state. Drill pads would be revegetated to match pre-construction conditions. Reclamation activities would not adversely affect biodiversity or natural habitats.

Impact Significance and Mitigation

The significance of each impact on natural habitats and biodiversity and the mitigation measures that would be applied are summarized in Table 6.2-7.

Table 6.2-7 Summary of Natural Habitats and Biodiversity Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Rare Species	Unknown Resources in MS-3 or MS-4	Very Low to High	Moderate	**Significant**	Biodiversity-1	Less than Significant
Natural Habitats	Introduction of Invasive Weeds	High	Low	**Potentially Significant**	Biodiversity-2	Negligible
Priority Birds	Nesting Disturbance	High	Moderate	**Significant**	Biodiversity-3	Negligible
Wildlife	Attracting Wildlife	Low	Moderate	**Potentially Significant**	Waste-1	Negligible

6.2.6 Archeological and Cultural Resources

Sensitive Resources

Belle Plaine and Mondesir-Saltibus contain an abundance of historical and Amerindian resources. These drilling areas are considered highly sensitive for archaeological and cultural resources. Fond St. Jacques has low sensitivity for archaeological and cultural resources; no historical uses are known to occur in the area.

The MS-3 and MS-4 sites have not been surveyed for archaeological and cultural resources. These areas could contain sensitive archaeological and cultural resources, similar to the MS-1 and MS-2 areas, which were previously surveyed.

Further study of the areas that would be impacted at these drilling sites is necessary before any grading or ground disturbing activities occur to gather information about the sites and evaluate their significance. A qualified archeological monitor should also be present to collect and evaluate any artifacts that may be encountered during grading at the Belle Plaine and Mondesir-Saltibus drilling areas. Mitigation measures are identified in Section 7 to address

sensitive archeological sites that may be present at the Belle Plaine and Mondesir-Saltibus drilling areas.

Potential Risks/Impacts and Magnitude

Civil Works

The project would involve grading and ground disturbance in the Belle Plaine and Mondesir-Saltibus areas, which are known to contain archeological resources. Grading, vegetation removal, and excavation activities have the potential to displace or destroy archaeological or cultural resources that may contain important information about Saint Lucia's history. There is also a potential for workers to take artifacts that may be uncovered, which could result in the loss of important historical resources.

Well Drilling

Well drilling activities would occur within the graded and disturbed well pad that would be constructed during the civil works phase. No archaeological or cultural resources would be disturbed by well drilling activities.

Reclamation

Reclamation activities would occur in the areas disturbed by civil works activities. Reclamation activities would not cause effects to cultural resources.

Impact Significance and Mitigation

The significance of each impact on archaeological and cultural resources and the mitigation measures that would be applied are summarized in Table 6.2-8.

Table 6.2-8 Summary of Archaeological and Cultural Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Historical and Amerindian Resources	Damage or Relocate Resources	High	Moderate	**Significant**	Cultural-1 Cultural-3	Negligible to Less than Significant
	Unknown Resources at MS-3 and MS-4	Very Low to High	Moderate	**Significant**	Cultural-2	Negligible to Less than Significant

6.2.7 Landscape and Visual Character

Sensitive Resources

There are no scenic vistas within the project area. The potential drilling area within Fond St. Jacques and Belle Plaine are located within the buffer area for the PMA. Landscapes and viewsheds in the PMA buffer are considered to have a moderate or high sensitivity to visual effects.

Potential Risks/Impacts and Magnitude

Civil Works

The removal of vegetation from access roads and well pads and the grading of well pads will have a temporary impact on the landscape and scenery in areas adjacent to project sites. Substantial vegetation disturbance could have a minor but long-term impact on visual quality if the well pad and access roads with vegetation that contributes to scenic quality were not revegetated following project activities.

Well Drilling

The presence of tall drill rigs and construction equipment would contrast with the natural landscape and temporarily degrade the visual quality near drilling areas. The drill rigs would only be in place for up to 6 months during drilling and testing. Trees, dense vegetation, and topography in the area would partially screen the drilling activities from views, such as those from the primary access roads. The project areas are not visible from any of the key viewpoints in the PMA that were considered in the Limits of Acceptable Change report (The Landmark Practice 2013).

Reclamation

Reclamation activities would be short-term and not have an adverse effect on the landscape or visual character of the area. Reclamation activities including site recontouring, revegetation, and trash removal would restore the site to pre-construction conditions to avoid any long-term impacts on the landscape.

Impact Significance and Mitigation

The significance of each impact on landscape and visual quality and the mitigation measures that would be applied are summarized in Table 6.2-9.

Table 6.2-9 Summary of Landscape and Visual Quality Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
PMA Buffer Zone	Vegetation Removal and Grading	High	Moderate	**Significant**	Landscape-1	Negligible to Less than Significant
	Visible Construction Equipment	Moderate	Low	Less than Significant	--	--
Views from Adjacent Roads and Residences	Vegetation Removal and Grading	Low to Moderate	Low	Less than Significant	--	--
	Visible Construction Equipment	Low to Moderate	Low	Less than Significant	--	--

6.2.8 Traffic Circulation and Safety

Sensitive Resources

The roads that would be used to access the drilling areas are used by community members and potentially tourists; traffic volume on the roads leading to the drilling area is generally low. The existing road network to Belle Plaine and Fond St. Jacques is paved and the road to Mondesir-Saltibus is unpaved. The road that would be used by construction equipment to access the drilling areas is the primary access road to each community.

Potential Risks/Impacts and Magnitude

Road Expansion (Civil Works)

The project may require expansion of roadways at sharp turns where the turning radius is inadequate to support large equipment access. Expansion of the roadway could require temporary lane or road closures. Temporary road closures could disrupt the traffic circulation, may cause prolonged wait times during traffic control, and traffic detours to maintain community access. Road work could also create temporary traffic safety hazards during construction, or permanent hazards if improperly designed.

Large Vehicle/Equipment Transport (Civil Works and Well Drilling)

The project would involve operating large trucks on public roads to transport construction equipment and materials. Traffic controls, such as pilot vehicles and flaggers, may be necessary to safety maneuver large trucks through narrow roads and sharp turns. Temporary lane and road closures may also be necessary where access roads are constructed for the project. Traffic controls would temporarily impact traffic circulation for infrequent and short periods during construction, which would not be significant. Temporary lane and road closures lasting more than a few hours could significantly disrupt traffic circulation, depending on the location and duration of the closure.

Reclamation

Site reclamation would require temporary travel of large construction equipment on area roads during site recontouring and revegetation. Reclamation activities would be very short in duration (a few days) and would be conducted off area roadways within the well pad area. Reclamation would require little or no heavy equipment travel on area roads.

Impact Significance and Mitigation

The significance of each impact on traffic circulation and safety and the mitigation measures that would be applied are summarized in Table 6.2-10.

Table 6.2-10 Summary of Traffic Circulation and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Traffic Circulation	Lane and Road Closures	Moderate	Moderate	**Potentially Significant**	Traffic-1	Negligible
	Transport of Large Equipment	Moderate	Moderate	**Potentially Significant**	Traffic-1	Negligible
Community Members	Traffic Safety	High	High	**Potentially Significant**	Traffic-1	Negligible
	Road Hazards	High	High	**Potentially Significant**	Traffic-2	Negligible

6.2.9 Utilities and Communications Systems

Sensitive Resources

Low-hanging utilities, including communication cables and electrical distribution lines, are located along area roads that would be used to access project sites as well as near the drilling areas.

Potential Risks/Impacts and Magnitude

Civil Works, Well Drilling, and Reclamation

The project would involve operating large trucks and equipment on area roads to access the work area. Low-hanging utilities and communications systems could be damaged in areas where there is inadequate clearance for large equipment to pass. Damage to utilities and communication systems could result in service interruptions to communities that are served by the utility lines.

Impact Significance and Mitigation

The significance of each impact on utilities and communication systems and the mitigation measures that would be applied are summarized in Table 6.2-11.

Table 6.2-11 Summary of Utility and Communication System Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Utility and Communication Lines	Damage to Low-Hanging Utility Lines	Moderate	Moderate	**Potentially Significant**	Utilities-1	Negligible

6.2.10 Hazards and Hazardous Materials

Sensitive Receptors

The communities living near the drilling areas are at risk of hazards from construction operations. Sensitive receptors include residents near the drilling sites and community members who may use the roads or recreational facilities near the drilling areas. No schools are located in proximity to the drilling areas.

Workers would also be exposed to hazards and hazardous materials (refer also to Section 6.3.6 for worker health and safety and community health and safety).

Potential Risks/Impacts and Magnitude

Hazardous Material Use (Civil Works and Well Drilling)

Operation of construction equipment would involve the use of hazardous materials, such as fuels, oils, lubricants, and other chemicals. Wells would be drilled with water and non-toxic drilling mud; however, materials extracted during the well drilling and testing process (e.g., cuttings and geothermal fluid) could be hazardous and contain toxic elements, such as heavy metals.

Hazardous materials, including potentially hazardous waste, would be transported, handled, and stored in accordance with applicable laws. If hazardous material and waste were not managed correctly, or if incidental leaks or spills occurred, the project could contaminate soil and water quality. Contaminating soil and water quality could affect drinking water for local communities, natural habitats, and agricultural production.

Geothermal Fluid Discharge (Well Drilling)

Although unlikely, well drilling could result in an unanticipated release of geothermal gasses and fluid if a well blow out occurred. An uncontrolled release of geothermal fluid could expose people near the well to air contaminants as described in Section 6.2.2, water quality contaminants (see Section 6.2.1), and/or very high temperature fluid, which may be hazardous to community members and workers.

Reclamation

Reclamation would use equipment similar to that used in construction. Site clean-up and restoration would have minimal use of hazardous materials and the risk would be low.

Impact Significance and Mitigation

The significance of each impact on hazards and hazardous materials and the mitigation measures that would be applied are summarized in Table 6.2-12.

Table 6.2-12 Summary of Hazards and Hazardous Materials Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members and Workers	Hazardous Material Discharge	High	Low	**Potentially Significant**	Hazards-1	Negligible
	Geothermal Gases and Fluid, and Well Blowout	High	Low	**Potentially Significant**	Water-3 Water-4 Air-3	Negligible

6.2.11 Fires

Sensitive Receptors/Resources

Uncontrolled wildfires can result in substantial damage to property, as well as injury or death. Wildfires can also result in substantial damage to natural habitats and biodiversity. The drilling areas have a low to moderate risk of wildfires during the dry season or periods of drought.

Potential Risks/Impacts and Magnitude

Civil Works and Well Drilling

The project would have a low potential for causing fires during civil works and well drilling operations. The use of heavy construction equipment and welding could create sparks, which could potentially ignite a wildfire in nearby brush. Workers who smoke could also cause a wildfire if their cigarettes were not properly extinguished or smoking occurred in areas with dry vegetation.

The project would involve operating large trucks and equipment near low-hanging utility lines, including power lines. Live power lines could cause electrocution and fires.

Well Testing

Geothermal testing would not pose a significant risk of fires because gases that are typically emitted from geothermal systems are not combustible.

Reclamation

Reclamations activities would consist of trash removal, site recontouring, and revegetation. Reclamation activities would be conducted within the well pad, which would be free of vegetation. The risk of fire from site reclamation would be very low.

Impact Significance and Mitigation

The significance of fire impacts and the mitigation measures that would be applied are summarized in Table 6.2-13.

Table 6.2-13 Summary of Fire Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members, and Natural Habitats and Biodiversity	Fire from Workers Smoking	High	Low	**Potentially Significant**	Fire-1	Negligible
	Fire from Vehicle or Equipment Ignition	High	Low	**Potentially Significant**	Fire-1	Negligible
	Fire from Contact with Live or Low-hanging Power Lines	High	Low	**Potentially Significant**	Fire-1 Utilities-1	Negligible

6.2.12 Solid Waste

Sensitive Resources

The drilling areas are located within and near land used for agricultural production or recreational activities, and other residential activities. The presence of trash or waste in these areas could degrade the existing environment, attract wildlife, and affect existing land uses, such as agricultural land.

Potential Risks/Impacts and Magnitude

Civil Works and Well Drilling

The project would generate non-hazardous solid waste from worker subsistence (i.e., food trash, water bottles, etc.) and from miscellaneous construction waste, such as material packaging and containers. If the waste was not contained and disposed of properly, the surrounding environment could be degraded by litter.

Well Drilling and Testing

The geothermal well drilling and testing process would produce drill cuttings that would be stored on site in sumps or tanks and would not require disposal at the landfill unless the cuttings require treatment as hazardous materials.

Reclamation

Site reclamation would include site clean-up and restoration. The wellhead, if no longer needed, would be removed and recycled. Trash would be hauled away. Limited quantities of waste would be produced during site reclamation.

Impact Significance and Mitigation

The significance of solid waste impacts and the mitigation measures that would be applied are summarized in Table 6.2-14.

Table 6.2-14 Summary of Solid Waste Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers and Community Members	Construction Waste and Debris	Moderate	Low	**Potentially Significant**	Waste-1	Negligible

6.3 SOCIAL RISKS AND IMPACTS

6.3.1 Livelihoods

Sensitive Receptors

The potential drilling areas in Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques east are under agricultural production. The livelihoods of farm owners and workers could be impacted, if the project causes a reduction in agriculture production.

Potential Risks/Impacts and Magnitude

Direct Impact on Livelihoods (Civil Works and Well Drilling)

The project would temporarily disrupt agricultural production where well pads and access routes would be located on land that is currently used for agricultural production. Depending on the location of the well pads and access roads, the project could impact farms with annual row crops or crop trees that have longer maturing and yield periods (i.e., bananas, coconuts, cocoa, avocados, mangoes, and citrus). Construction of the well pads would remove that area from agricultural production for the life of the well pad. The area would be lost to agriculture for a few months to 1 year if:

- The slim-hole well testing results do not show promising increase in temperature at depth and the well is not suitable for monitoring
- The slim-hole well geology does not indicate the presence of a geothermal resource
- The slim-hole well (if it is designed to penetrate the geothermal resource) does not show adequate temperature, permeability, and fluid and the well is not suitable for monitoring
- The full-size well does not encounter a geothermal resource with adequate temperature, permeability, and fluid flow and the well is not suitable for monitoring

Unsuccessful wells would be plugged, abandoned, and the well pad restored. A well that may be suitable for monitoring or further study may retain the wellhead requiring up to 5 square meters (16 square feet) of permanent impact, with the majority of the well pad revegetated and restored. Monitoring could continue at a restored well pad.

Short-term impacts could occur through well drilling and restoration (approximately 2 to 10 months) where annual row crops are present. Where mature crop trees could not be avoided, the impact would occur for a longer period (up to several years) until the new trees matured

and reached the same production levels. Impacts on agriculture production and compensation are discussed further in the Section 6.3.3, Resettlement.

Wells that are successful, encounter a geothermal resource, and are designated for further drilling or testing may be removed from agricultural production for several years to up to 30 years or more if a power plant is built.

The graded well pad and access road could result in the long-term loss of agricultural productivity if the well pad site was not properly restored to pre-construction conditions with productive topsoil.

The project has the potential to create temporary construction jobs for local community members during the civil works and drilling phase. Although the extent of job opportunities and hiring is unknown at this time, providing local communities with job opportunities would be a positive impact.

Indirect Impacts on Livelihoods

Geothermal Emissions (Well Testing)

Geothermal emissions may result in some geothermal steam particulates landing on nearby crops. Some crops are sensitive to boron and could be affected if geothermal steam particulate settle on the crops. Leaf injury must be severe to cause reduced crop quality and yields. Long-term use of irrigation water containing more than 0.5 ppm of boron can reduce yields of bean, onion, garlic, and strawberry; 0.7 ppm can reduce yields of broccoli, carrot, potato, and lettuce; and 2 ppm can reduce yields of cabbage and cauliflower. The amount of boron that would be deposited on crops would be low because the droplets settle out close to the emission point and land on the well pad and the testing would be short duration (days). Impacts to agricultural production and required compensation are described in detail in the RAP (Appendix E).

Water Supply and Topsoil Loss

The project could also deplete the water supply or degrade water supply systems used for agriculture (refer to Section 6.2.1) and could cause loss of topsoil due to erosion (refer to Section 6.2.3); these project impacts have the potential to adversely affect agricultural production.

Reclamation

Reclamation would restore the sites to agricultural production and would avoid long-term impacts from loss of productive use of the land. The reclamation process would likely require local labor, which would also have a positive impact on livelihoods.

Impact Significance and Mitigation

The significance of impacts on livelihoods and the mitigation measures that would be applied are summarized in Table 6.3-1. The RAP and RPF also identify measures to reduce or avoid impacts (refer to Section 6.3.3).

Table 6.3-1 Summary of Livelihood Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers	Short-term Loss of Livelihood	High	High	**Significant**	Social-1 Soils-1 Landscape-1	Negligible
	Long-term Loss of Livelihood	High	Low	**Potentially Significant**	Social-1 Soils-1 Landscape-1	Negligible
Community Members	Temporary Construction Jobs	--	--	Positive	--	--

6.3.2 Tourism

Sensitive Receptors/Resources

Tourism is the primary economic activity in the project region. The protection of the tourist industry and tourist resources is a top priority for the GoSL and community stakeholders.

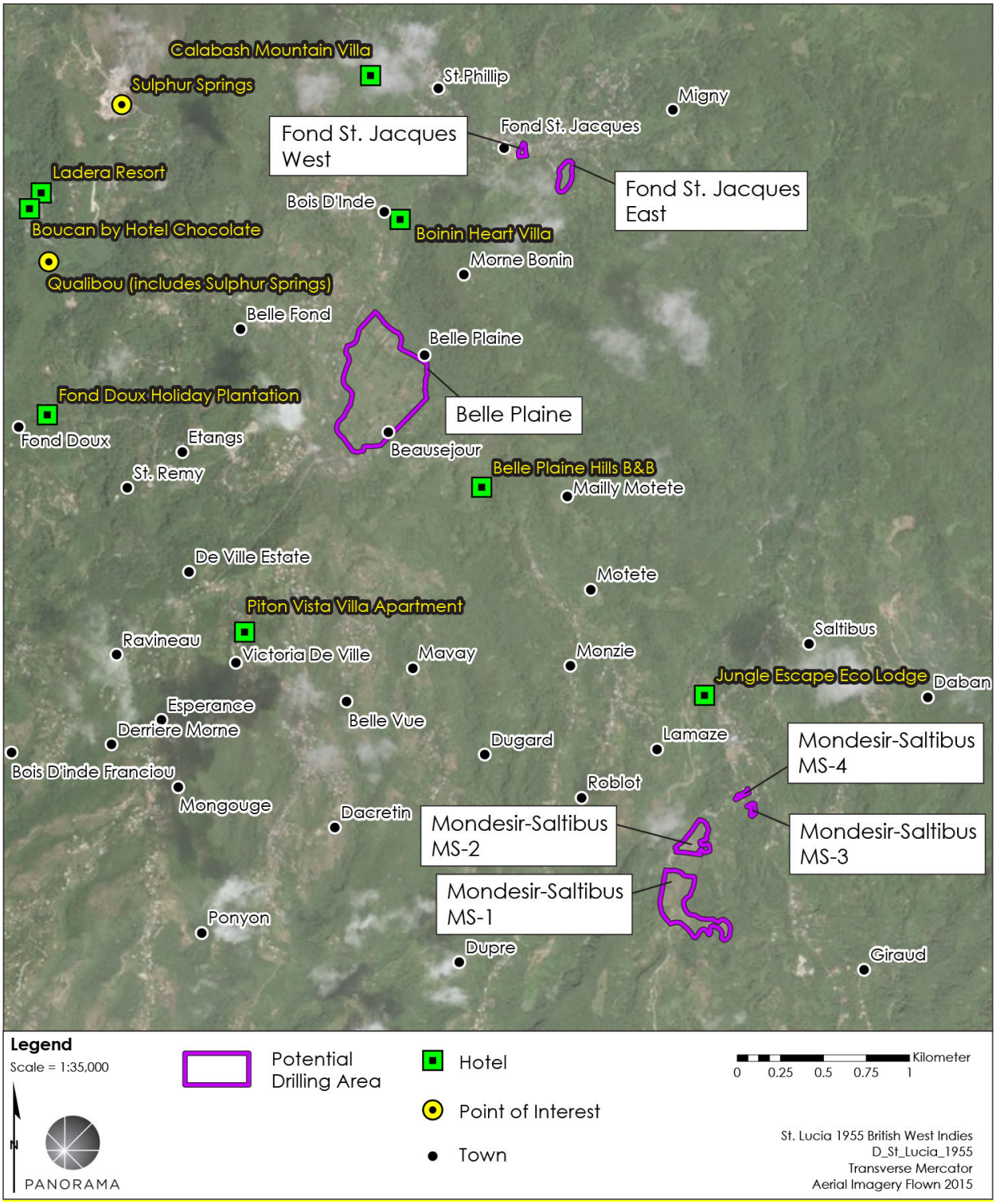
No tourist destinations, such as hotels or popular places of interest, are located in close proximity to the potential drilling areas. The closest tourist destinations are located approximately 0.6 kilometer (2,000 feet) from the drilling areas as shown on Figure 6.3-1. Intervening topography and dense vegetation would restrict views of the drilling areas and project activities.

Potential Risks/Impacts and Magnitude

The large truck traffic could have a minor effect on tourist traffic near Soufrière or other port of entry for heavy equipment (refer to Section 6.2.8).

Temporary construction noise (refer to Section 6.2.4), landscape impacts (refer to Section 6.2.7) could affect tourists in a similar manner as local residents; however, the project would not displace tourism activities or the livelihoods of those working in the tourism industry. The geothermal drilling could be of interest to tourists and could be a positive impact, bringing tourists to the area that may increase spending in the local community.

Figure 6.3-1 Tourist Destinations in the Project Vicinity



Sources: (ESRI 2017, McElhanney Consulting Services LTD 2015)

Impact Significance and Mitigation

The significance of impacts on tourism and the mitigation measures that would be applied are summarized in Table 6.3-2.

Table 6.3-2 Summary of Tourism Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Tourism	Visual	High	Very Low	Negligible	--	--
	Noise	High	Very Low	Negligible	--	--
	Traffic	High	Very Low	Negligible	--	--

6.3.3 Resettlement

Sensitive Receptors

No structures are located within the potential drilling areas where well pads will be sited. Agricultural land uses in the project area could be temporarily displaced during civil works and well drilling activities.

Potential Risks/Impacts and Magnitude

Direct Impacts (Civil Works and Drilling)

Resettlement refers to the potential displacement of people or existing land uses. Figure 4.2-3 through Figure 4.2-5 show sensitive receptors in the potential drilling areas. It is not anticipated that the project would require direct resettlement of communities or residences because there are adequate open spaces within the drilling areas to build the well pads. A slim-hole well pad is approximately 40 by 30 meters (0.1 hectare or 0.25 acre). Well pads for full-sized (deep) wells are generally 100 by 100 meters (330 by 330 feet) or approximately 0.8 to 1.6 hectares (2 to 4 acres) in size. The well pad siting goal is to reach the geologic targets, and avoid drilling in close proximity to residences if possible. The actual locations will be sited based on these factors as well as access and surface conditions.

Inadvertent travel off of access roads or outside of designated work areas could expand the area of impact on livelihoods and the area requiring compensation for loss. This impact is addressed in the RAP and RPF.

Indirect Impacts

It may be necessary, for safety reasons or to avoid substantial noise disruption (refer to Section 6.2.4), to temporarily vacate residents in close proximity to well pads during construction and/or drilling, such as during potential emergency situations (addressed in Section 6.3.6). Any evacuation of residents would be very short in duration (a few hours) and would not cause resettlement.

The project would temporarily impact agricultural land during construction and restoration as described in Section 6.3.1.. Impacting food supply and the livelihoods of farm owners and

farmworkers could cause indirect resettlement. Resettlement without appropriate compensation would be a significant impact.

A RAP was developed to address anticipated resettlement for the project (displacement of agricultural land uses) (provided in Appendix E). In addition, a RPF was developed to address the potential for unanticipated resettlement issues that may arise (provided in Appendix F).

Impact Significance and Mitigation

The significance of impacts on resettlement and the mitigation measures that would be applied to reduce the impact are summarized in Table 6.3-3.

Table 6.3-3 Summary of Resettlement Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Farmers	Displace Agricultural Production	High	Moderate	**Potentially Significant**	RAP RPF	Negligible
Community	Emergency Evacuation	High	Very Low	Negligible	--	--
Farmers	Travel Outside Approved Work Areas	High	Moderate	**Potentially Significant**	Social-1	Negligible

6.3.4 Working Conditions and Equality

Sensitive Receptors

Women are vulnerable to sexual harassment and abuse and should be afforded special considerations and protection. Religious minorities, ethnic minorities, or economically disadvantaged communities are also vulnerable to discrimination and disproportionate impacts. In the workplace, these groups can also be vulnerable to unequal job opportunities, unequal pay, and workplace harassment. Poor labor and working conditions can result in worker exploitation and abuse.

Potential Risks/Impacts and Magnitude

The project would comply with applicable laws and policies governing labor rights and working conditions. The project would also incorporate World Bank EHS Guidelines and policies relevant to working conditions and equality to ensure and safe and equitable environment for all workers.

Impact Significance and Mitigation

The significance of impacts on working conditions and equality and the mitigation measures that would be applied are summarized in Table 6.3-4.

Table 6.3-4 Summary of Equality and Working Conditions Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community members	Harassment from workers	Moderate	Moderate	**Potentially Significant**	Social-2	Negligible
Workers	Workplace harassment	Moderate	Moderate	**Potentially Significant**	Social-2	Negligible

6.3.5 Recreation

Sensitive Resources

There is a soccer field within the potential drilling area identified for Mondesir-Saltibus (refer to Figure 3.2-2) and a recreational area in Fond St. Jacques west (refer to Figure 3.2-3). There are few soccer fields in the region and the field is important to the surrounding communities.

Potential Risks/Impacts and Magnitude

The recreational areas could be physically impacted by construction activities if access roads and well pads were positioned within the soccer field, and soccer games could be prevented if the field was occupied by project equipment. The soccer field and games could be affected for between 2 to 10 months during construction through restoration, depending on the extent of well drilling and testing. Physically disturbing the soccer field and losing access to the playing field could result in an adverse community effect.

Impact Significance and Mitigation

The significance of impacts on recreation and the mitigation measures that would be applied are summarized in Table 6.3-5.

Table 6.3-5 Summary of Recreation Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members	Temporary Loss of Recreational Areas	High	Moderate	**Significant**	Social-4	Less than Significant

6.3.6 Labor Influx

Sensitive Resources

The potential drilling areas and worker camp are located near communities with limited housing resources.

Potential Risks/Impacts and Magnitude

The project could attract locals from surrounding communities seeking possible employment opportunities which could temporarily increase community population and housing demand for the duration of construction (approximately 6 to 9 months). The majority of workers without

available housing would be provided housing at the worker camp, and the project would not involve long-term jobs; therefore, it is unlikely that people seeking work would permanently migrate to communities where project activities would occur.

Impact Significance and Mitigation

The significance of impacts on labor influx and the mitigation measures that would be applied are summarized in Table 6.3-6.

Table 6.3-6 Summary of Labor Influx Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Local communities	Labor Influx	High	Low	Less than Significant	--	--

6.4 HEALTH AND SAFETY

6.4.1 Worker Health and Safety

Sensitive Receptors

Workers would have the greatest potential for health and safety risks as a result of the geothermal exploration activities because workers would be directly engaged in the geothermal exploration process.

Potential Risks/Impacts and Magnitude

The project would expose the labor workforce to hazards during construction that pose a risk of bodily injury or death. The primary hazards that may be encountered during construction can be generally categorized as either occupational or environmental. Typical occupational hazards associated construction include working with moving machinery and motorized equipment, working at heights or in confined spaces, open holes and trenches, repetitive motions, falling objects, exposure to heat (i.e., hot weather, fluids, or objects), fires, loud noises, and hazardous materials (refer to Environmental and Social Impacts Section 6.2). Less common occupational hazards that may be encountered during geothermal drilling and testing include exposure to potentially harmful geothermal gases, hot geothermal fluids and drilling materials, and hazards associated with a potential well blowout.

Environmental hazards in Saint Lucia that may be encountered during construction include hurricanes and tropical storms, landslides, earthquakes, volcanic eruptions, and flooding. Workers could also be exposed to biological hazards in the environment such as those associated with dangerous or infectious insects, animals, and plants.

If proper safety precautions were not taken, then workers could be exposed to very high levels of noise that could result in hearing damage. Hearing damage can occur from exposure to moderate noise levels (85 to 100 dBA) over a few weeks, or exposure to high noise levels (>100 dBA) for shorter periods (refer to Table 2.5-5). The frequency of exposure plays a large

role in the risk of hearing damage. Workers must wear proper hearing protection when noise levels exceed 85 dBA (refer to Table 2.5-5).

Refer to Section 6.4.2 below for a discussion of potential risks associated with disease.

Impact Significance and Mitigation

The significance of impacts on worker health and safety and the mitigation measures that would be applied are summarized in Table 6.4-1.

Table 6.4-1 Summary of Worker Health and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Workers	Occupational Hazards	High	High	**Significant**	Safety-1 Safety-2 Safety-3	Less than Significant
	Noise	High	High	**Significant**	Noise-1	Less than Significant
	Geothermal Gases	High	High	**Significant**	Water-4 Air-3	Less than Significant
	Disease	High	Moderate	**Potentially Significant**	Safety-1	Negligible

6.4.2 Community Health and Safety

Sensitive Receptors

The project could expose the local community members to the same hazards as workers; however, the risk of such hazards would generally be reduced with distance from project areas. Community members who are living or using property adjacent to the well pads and access roads would be exposed to the greatest risk of hazards.

Potential Risks/Impacts and Magnitude

Community Hazards from Civil Works and Drilling Activities

The public would generally be restricted from entering well pads where the hazards are greatest; however, the public could still be exposed to hazards at the periphery of work areas or within access roads. Hazards to the community would include moving vehicles and equipment, hazardous materials, open holes and trenches, fires, potentially harmful geothermal gases, and hazards associated with a potential well blowout.

Disease

The project would involve bringing foreign workers to Saint Lucia. Foreign workers could expose people in Saint Lucia to new diseases, and vice versa. The risk of transferring diseases between workers and the local population would not be significantly different that the same risk between tourists and the local population. The project workforce would be limited to approximately 50 people at any given stage of construction, some of whom may be hired from

the local population. Bringing up to 50 foreign workers to Saint Lucia would have an insignificant effect on the local population compared to the tourist industry; however, workers could be exposed to new diseases in the region or experience an injury or medical emergency.

Impact Significance and Mitigation

The significance of impacts on community health and safety and the mitigation measures that would be applied are summarized in Table 6.4-2.

Table 6.4-2 Summary of Community Health and Safety Impacts and Mitigation

Resource/ Receptor	Impact	Sensitivity	Magnitude	Pre-Mitigation Significance	Mitigation Measure	Residual Significance
Community Members	Construction Hazards	High	Low	**Potentially Significant**	Safety-4	Negligible
	Noise	High	High	**Significant**	Noise-1 Social-4	Less than Significant
	Geothermal Gases	High	Moderate	**Significant**	Water-4 Air-3	Negligible
	Disease	High	Low	Less than Significant	--	--

6.5 CUMULATIVE IMPACTS

There would be no cumulative impacts because no other projects have been proposed in the project area of influence

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7 MITIGATION MEASURES

7.1 OVERVIEW

This section identifies the mitigation measures that would be implemented to address the risks and potential impacts described in Section 6. Mitigation measures for the project are separated into three categories: environmental, social, and health and safety; however, elements of some mitigation measures are applicable to more than one category.

Mitigation measures were designed to avoid or reduce impacts to less than significant levels. In addition to the full text of the mitigation measures, the following elements are provided for each measure:

- The issue or potential impact being mitigated identified in Section 5
- The parties responsible for implementing the described requirements
- The general timing when implementation is required

The construction contractors (e.g., civil and drilling) would have the primary responsibilities for implementing the mitigation requirements; however, the GoSL's Project Coordination Unit (PCU) would also be responsible for implementing some requirements where specified. The PCU would be responsible monitoring, documenting, and reporting implementation of the mitigation measures. These roles and responsibilities are described in detail in the ESMP.

7.2 ENVIRONMENTAL MITIGATION MEASURES

Table 7.2-1 Environmental Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
Water Resources			
• Water Quality • Erosion and Topsoil Loss • Landslides and Mudflows	**Water-1: Stormwater, Erosion, and Sediment Control** At least 30 days prior to construction, the contractor shall prepare a sediment and erosion control plan for GoSL review that details the procedures for sediment and erosion control, BMPs that would be applied to the site including the location of all BMPs, and procedures for monitoring and maintenance of all BMPs. The sediment and erosion control plan shall include procedures for implementation of sediment and erosion control following industry standards as provided in Erosion and Sedimentation Control: Best Management Practices Manual, December 2016, Department of Transportation of Montana. BMPs and drainage systems shall be designed to accommodate rapid rainfall events that can be expected in the region. The following procedures shall be described in further detail in the sediment and erosion control plan and implemented to prevent soil loss, erosion, and sediment transport in project areas: • Project activities shall be scheduled to avoid the heaviest rain season, to the extent possible. • Soil disturbance shall be limited to the minimum amount necessary. • All disturbed areas shall be stabilized as soon as possible (i.e., covered, compacted, or secured with BMP materials). • Project traffic shall be restricted to designated areas. • Pipelines shall be monitored for leaks and any leaks shall be repaired immediately. • Sediment shall be controlled and prevented from leaving disturbed project areas. All BMPs shall be properly inspected and maintained on a frequent basis to ensure they are functioning properly.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Water Quality	**Water-2: Water Quality Monitoring Program**	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	The drilling contractor shall implement a water quality monitoring program to ensure the project does not cause or substantially contribute to a condition that exceeds acceptable water quality standards. Water quality sampling, as described in Appendix F: Water Resources Sampling and Monitoring Plan to the Scoping Studies Report (Appendix C) shall occur prior to the start of project activities to determine the baseline contaminant levels, and then every few weeks during project activities in the area, in order to determine if the project is reducing water quality. Samples shall be taken upstream and downstream in potentially affected waterways. If it is determined that the project is reducing water quality, the drilling contractor shall make the appropriate adjustments to the construction activities to correct the problem. If the water supply becomes unsafe to drink, safe water shall be supplied to the affected communities and workers. Water quality monitoring and any necessary supplemental water supply shall continue until the water conditions are safe and returned to pre-project conditions. A Draft Water Quality Monitoring Program is provided in Appendix F of the Scoping Studies Report. In the unlikely event that water quality is impacted for a long-term basis (longer than project activities are occurring), long-term water treatment and/or supply systems shall be installed that provide safe water to those affected at pre-project constituent and flow levels, while also considering seasonal fluctuations.	• Drilling Contractor	• During Construction
• Water Quality • Hazardous Materials	**Water-3: Drilling Waste and Effluent Management** The drilling contractor shall incorporate specific procedures for managing drilling waste and effluent into the Hazardous Materials Management Plan and the Waste Management Plan. All drilling muds, fluids, and cuttings shall be tested for water quality parameters before discharging such fluids into the environment or disposing the materials into landfills, to ensure contaminant levels in waste water do not exceed acceptable standards and are disposed of properly in accordance with the Waste Management Plan. Water quality parameters that may be sampled include: pH, Temperature, Boron, Bicarbonate, Calcium, Chloride, Sulfide, Iron*, Fluoride, Copper, Cadmium, Mercury, Lead, Chromium (hexavalent* and total), Nickel, Arsenic, Vanadium, and Silver. Geothermal fluid shall also be tested for the following radiological elements: Radium 226/228 (combined), gross alpha (adjusted), and uranium. Fluid that exceeds acceptable standards shall be contained and/or disposed of in accordance with applicable laws and policies. Note: Elements marked with an asterisk (*) require testing within 24 hours due to	• Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	short hold times. If it is not feasible to transport the samples to a certified lab within the specified hold times, testing shall be conducted on site. Reserve pits for drilling materials shall be maintained in proper functioning order with a minimum of 0.5 meter (1.6 feet) of freeboard at all times. If foams are applied to the drilling fluid, the drilling contractor shall cover any reserve pits containing drilling cuttings or line the downwind perimeter of the reserve pits with hay bales or equivalent to prevent the foam from being transported offsite via wind. Drilling fluids, mud, and spoils shall be stored in either storage tanks or reserve pits adjacent to the wells. Drilling fluids shall be reused to the extent feasible to conserve freshwater.		
• Water Quality • Geothermal Emissions • Hazards	**Water-4: Blowout Prevention** All drill rigs used during the exploration program shall be equipped with blowout prevention (BOP) equipment to prevent blowout if the geothermal resource is encountered. The GoSL shall require that the drilling contractor or the drilling supervisor have experience in geothermal drilling. Drillers shall receive proper training for response to blowouts, should one occur. The drilling contractor shall prepare and implement a Well Blowout Prevention and Containment Plan. At a minimum, the plan shall address the following: • Proper use of BOP equipment that meets industry standards • Specific procedures for preventing and controlling an incidental blowout, such as using a blowout preventer stack and stocking material for quelling the blowout • Training requirements for all workers that may be exposed to a well blowout • Staffing requirements to ensure qualified individual(s) who are certified in well control and blowout response are present during all drilling operations • Blowout documentation and cleanup procedures	• PCU • Drilling Contractor	• During Construction
• Water Supply	**Water-5: Water Supply System Protection** Public and private water supply systems (i.e., pipes, intakes, tanks, and ditches) shall be identified and marked for avoidance prior to initiating project activities that could damage such systems. If water supply systems are inadvertently damaged, they shall be repaired immediately. Water shall be supplied to the affected community members if the water supply is interrupted.	• PCU • Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction • After Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	The PCU will consider the community benefit of leaving water supply systems that are developed for the project (i.e., pipes, intakes, tanks, and wells) after exploration drilling is complete.		
• Water Supply	**Water-6: Water Extraction Strategy** The drilling contractor, in conjunction with the PCU, shall develop a strategy for obtaining water that does not disrupt the water supply for domestic and agricultural users. Water extraction for the project, including the locations of water pipelines and tanks, shall not deplete water reserves below levels that are required to supply the community. The PCU and drilling contractor shall consult with Water and Sewerage Company of Saint Lucia (WASCO) and Water Resource Management Agency (WRMA) of Saint Lucia to ensure communities are supplied with adequate water during extraction. Where water is extracted from rivers, the project intake systems shall be designed to limit impacts on sensitive aquatic habitat and wildlife, and screen barriers shall be installed to prevent impingement and entrapment of wildlife. Intake areas and potential hazards where pipelines cross roadways shall be clearly marked with signs and/or flagging.	• PCU • Drilling Contractor	• Before Construction • During Construction
Air Quality			
• Air Quality	**Air-1: Fugitive Dust Management** The following procedures shall be implemented where dry exposed soils are located in project areas: • Water shall be applied to active construction areas to prevent visible dust, to the extent that water is readily available. Water shall not be over applied so that it creates runoff that leaves the site. As an alternative to water, chemical stabilizers or surfactants may be applied to disturbed areas, being careful to not allow overspray on nearby vegetation. • Vehicle speeds shall not exceed 25 kilometers (15 miles) per hour on unpaved surfaces. • Inactive areas shall be covered or otherwise stabilized to reduce the potential for wind transporting dust. Disturbed areas shall be stabilized and restored once project activities are completed.	• Civil Contractor • Drilling Contractor	• During Construction
• Air Quality	**Air-2: Construction Emissions Controls**	• Civil Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	The construction contractors shall be responsible for ensuring all vehicles and equipment are properly operated and maintained according the manufacturer's specifications, and equipped with appropriate emission control devices (i.e., catalytic converters, etc.). Malfunctioning equipment shall be repaired immediately or removed from the site.	• Drilling Contractor	
• Worker Health and Safety • Community Health and Safety	**Air-3: Air Quality Monitoring and Noxious Gas Management** The drilling contractor shall be responsible for managing risks to workers and local communities from potentially harmful geothermal gas emissions (e.g., hydrogen sulphide, carbon dioxide, boron, arsenic, mercury, and bicarbonate) during well drilling and testing. At a minimum, the following procedures shall be implemented during drilling and testing activities: • Well drilling or testing that could cause the release of potentially harmful geothermal gases shall not occur where the public could be put at undue risk. An appropriate geothermal gas hazard zone shall be established around well sites based on the risk of gas release from the drilling and testing activities that would occur. The hazard zone shall be marked with signs and communicated to the local community members. If occupied structures would be located within a hazard zone, the drilling site must be relocated or drilling activities shall be limited to techniques that would not release unsafe levels of geothermal gases, such as surface coring. • Minimize the potential for gas release by using properly weighted drilling mud to keep the well from flowing or by implementing other well head abatement measures. • Install gas detection and monitoring devices during well drilling and testing activities, that are equipped with alarms that would be trigged if gas concentrations reach unsafe levels. • Autonomous respiratory equipment shall be provided in enclosed areas of the drill rig. • The Health and Safety Plan shall specify safety procedures for potential exposure to geothermal gases and emergency response. The drilling contractor shall implement an air quality monitoring program to monitor air quality during well drilling and testing for signs of unsafe levels of potentially harmful geothermal gases using automated detection and alarm systems. If unsafe gas levels are detected, the area shall be evacuated and properly trained workers wearing appropriate PPE shall attempt to stop the release by injecting hydrogen peroxide, capping the well, or another suitable method.	• Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
Geology and Soils			
• Topsoil Loss	**Soils-1: Topsoil Preservation and Restoration** Where grading occurs within farmland, topsoil shall be separated and stockpiled during the construction period. The topsoil stockpile shall be secured with plastic and BMP materials. Following construction, the topsoil shall be applied evenly to the site during the restoration process. The topsoil shall be properly compacted and stabilized to prevent erosion and sediment transport.	• Civil Works Contractor	• Before Construction • During Construction
• Unstable Slopes and Saturated Soils	**Soils-2: Geotechnical Investigation** The civil works contractor shall complete a geotechnical investigation prior to initiating civil works activities for access road expansion or well pad construction in Fond St. Jacques. The contractor shall implement all recommendations contained in the geotechnical investigation.	• Civil Works Contractor	• Before Construction • During Construction
Noise			
• Noise	**Noise-1: Noise Abatement and Community Coordination** Construction noise and the associated effects shall be reduced or minimized, to the extent possible, by implementing the following procedures: • Select quieter equipment and construction activities, whenever feasible; • Ensure motorized vehicles and equipment are equipped with the greatest possible noise reduction parts, such as mufflers, silencers, insulators, and enclosures; • Locate access roads and well pads as far from sensitive receptors as feasible; • Limit civil work activities to daytime hours (7:00 to 18:00), to the extent feasible; • Avoid civil works during sensitive morning, evening, and nighttime periods, to the extent feasible; • Notify and coordinate with residents adjacent to project areas prior to construction to inform them of the possibility of temporary noise disruption, and how to report noise complaints; • Install acoustic barriers between stationary equipment and sensitive receptors located within 300 meters (1,000 feet); • Use a rock muffler or other effective, industry standard silencer during well testing; • Notify community members at least 24 hours prior to conducting well tests;	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	• Implement a Noise Complaint Program to record and respond to noise complaints during construction.		
• Vibration	**Noise-2: Vibration** Structures within 100 feet of drilling activities will be documented with photographs prior to construction and after the completion of drilling to assess and record any pre-construction cracking and any post-drilling cracking. If any structural damage as evidenced by new post-drilling cracking is documented during the photo survey that could have been caused by the drilling activity, homeowners will be compensated to repair the damage that was incurred as a result of the project.	• Drilling Contractor	• Before Construction • After Construction
Natural Habitats and Biodiversity			
• Biodiversity	**Biodiversity-1: Pre-Construction Surveys in MS-3 and MS-4** The GoSL shall conduct surveys for rare plants and priority or endemic wildlife species prior to civil work activities in MS-3 and MS-4. If any rare plants or sensitive wildlife species occur in the drilling area, the sensitive resource shall be fenced and no activities will be allowed within 15 meters (50 feet) of the resource.	• PCU	• Before Construction
• Natural Habitats	**Biodiversity-2: Invasive Weed Control** All equipment shall arrive at the work site clean and free of caked mud and plant material. Any weeds encountered in the work area during post-construction site restoration monitoring shall be removed using mechanical equipment or by hand. No herbicides shall be applied to the site.	• Civil Works Contractor • Drilling Contractor	• During Construction
• Nesting Birds	**Biodiversity-3: Nesting Bird Avoidance and Impact Minimization** Well drilling activities shall be scheduled outside of the prime bird nesting season (April to June) to the extent feasible. If well drilling occurs during the prime nesting bird season, well pads shall be positioned at least 75 meters (250 feet) from the forested areas where suitable nesting habitat for priority bird species may be located. Prior to well drilling during the nesting season, a qualified biologist shall survey potentially suitable nesting habitat for priority species birds. If active nests are identified, a qualified biologist shall monitor the nesting birds responses to the loudest level of construction noise for an appropriate duration. If the nesting birds show signs of disturbance that could result in nest failure, all work activities that disturb the birds shall be temporarily halted and visual and acoustic barriers shall	• Civil Works Contractor • Drilling Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	be erected between the nesting location and work areas. Installation of any visual and acoustic barriers shall be overseen and approved by the qualified biologist.		
Archaeological and Cultural Resources			
• Archeological and Cultural Resources	**Cultural-1: Archaeological Testing or Monitoring** The contractor shall either conduct subsurface archaeological testing prior to grading and earthwork. If the results of the subsurface testing indicate the presence of subsurface archaeological resources, archaeological monitoring shall be conducted during grading and earthwork in the drilling area. In the event of an unanticipated discovery of an archaeological resource in any area where archaeological monitoring is not being conducted, work within 15 meters of the resource will halt, and an archeological monitor will be contacted to investigate the find. The procedures for site evaluation defined under archaeological monitoring below will be followed for any unanticipated discovery of archaeological resources. *Archaeological Testing*. Prior to ground disturbing activities in Belle Plaine and Mondesir-Saltibus, a qualified archeologist shall conduct subsurface archaeological testing, site recording, and artifact recovery in previously undisturbed areas that would be significant impacted by project activities (e.g., grading deeper than 6 inches and drilling). The testing shall include a series of 50 cm shovel test pits at 10-meter (30-foot) intervals within the immediate areas that would be affected. *Archaeological Monitoring*. During grading activities in Belle Plaine and Mondesir-Saltibus that are greater than 6 inches in depth, a qualified archeological monitor shall be present. The archeological monitor shall observe grading activities and collect any artifacts that may be unsurfaced. If the archeological monitor determines that a sensitive archeological site may be present, work shall be redirected until the site can be evaluated for its significance. If the site is determined to be significant or if the site evaluation efforts would be extensive, project areas that pose a risk to the site may be relocated away from the site to avoid potential delays to project activities. Alternatively, special protection measures may be implemented to continue project activities while preserving possible site features, as determined appropriate by the archeological monitor.	• Civil Works Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Archeological and Cultural Resources	**Cultural-2: Pre-Construction Surveys in MS-3 and MS-4** The GoSL shall conduct surveys for archeological and cultural resources prior to civil work activities in MS-3 and MS-4. If any sensitive resources are identified, the resources shall be evaluated to determine appropriate treatment or avoidance procedures. If the sites contain resources or if inadvertent discoveries are made during construction, the testing and monitoring provisions detailed in Cultural-1 shall be implemented, as determined necessary by the archeologist and GoSL.	• PCU	• Before Construction
• Archeological and Cultural Resources	**Cultural-3: Worker Cultural Resource Sensitivity Training** Workers shall be properly trained on identifying potential archeological and cultural resources that could be uncovered during construction, including procedures for reporting potential discoveries to the archeological monitor. If potential resources are discovered, they must be left in place or turned over to the archeological monitor for proper record keeping and cataloging.	• PCU	• Before Construction • During Construction
Landscape and Visual Character			
• Landscape and Visual Character • Waste	**Landscape-1: Site Reclamation and Restoration** The following reclamation and restoration activities shall be completed following construction: • Prior to construction the contractor shall take photos of the well pad and access roads to document pre-construction conditions. • The contractor shall restore grades on site to match pre-construction conditions. • The proper restoration of the site shall be documented by the contractor in a post-construction report containing pre- and post-construction photos. • The drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes shall be dismantled upon completion of the exploration phase and removed from the project site. • Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the well tests shall be dismantled after completion of the tests and the temporary treatment facilities and pipes shall be removed from the project site. • The drilling fluid and mud reserve pits, and any water supply sumps shall be filled in, and graded to match the surrounding area. • The worker camp and storage area, including all aggregate and materials and any latrines, shall be dismantled and removed from the site. The worker	• Drilling Contractor	• After Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	camp and storage area shall be resurfaced as necessary to match the surrounding area. • Heavily compacted areas should be appropriately de-compacted to facility quicker vegetation regrowth.		
Traffic Circulation and Safety			
• Traffic Circulation • Community Health and Safety	**Traffic-1: Traffic Control** Informational signs shall be posted where lane and road closures could substantially disrupt traffic circulation at least 7 days prior to the closure. Proper traffic controls shall be in place during closures to minimize impacts on traffic circulation and for traffic safety, such as signs, flaggers, and temporary barriers. Local traffic laws and speed limits shall be followed at all times. Appropriate safety precautions shall be taken when transporting large equipment on public roadways, such as using a pilot car.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Community Health and Safety	**Traffic-2: Road Hazard Avoidance** If road work occurs on public roadways, the civil works contractor shall design the modifications in accordance with applicable road and traffic safety laws. The project shall not degrade road safety or create a new road hazard. Any damage to the existing road condition caused by the project shall be repaired. The designs for any road modifications shall be submitted to the GoSL for review and approval prior to conducting the work.	• Civil Works Contractor	• Before Construction • During Construction
Utilities and Communication Systems			
• Utilities and Communication Systems	**Utilities-1: Protect Overhead Utility Lines** The construction contractors shall identify and mark any overhead utility and communication lines that hang over access roads and work areas to ensure the lines are not inadvertently damaged during construction. A minimum of 5 feet of clearance shall be maintained between construction equipment and low-hanging lines. If the minimum clearance cannot be maintained, the construction contractors shall work with the applicable system providers to temporarily disconnect or reposition the lines for the duration of construction.	• Civil Works Contractor • Drilling Contractor	• Before Construction
Hazards and Hazardous Materials			
• Water Quality	**Hazards-1: Hazardous Materials Management Plan**	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Hazardous Materials • Worker Health and Safety • Community Health and Safety	The construction contractors shall prepare and implement a Hazardous Materials Management Plan. The Hazardous Materials Management shall identify proper management procedures for all hazardous materials and wastes that may be encountered during construction, including handling, labeling, transporting, and storing procedures. In addition, the Hazardous Materials Management Plan shall address the following: • Non-toxic and biodegradable produces will be used whenever possible. • Hazardous materials shall be transported and stored in appropriate containers with clearly visible labels. Hazardous materials shall be stored at least 100 feet from any downgradient drainage or within secondary containment cable of containing its entire volume. • Stormwater flows shall be directed away from hazardous material storage areas. • Equipment and work areas shall be regularly inspected for signs of leaks and spills. Spill containment and cleanup kits shall be available wherever hazardous materials are being used or stored. Any incidental spills or leaks shall be contained and cleaned up as soon as it is safe to do so. Any contaminated soil shall be collected and disposed of in an appropriate land fill. • Equipment refueling and maintenance shall be limited to designated areas at least 30 meters (100 feet) from any downgradient drainage. All workers shall receive training on proper handling and storage of hazardous materials, as well as spill response and cleanup procedures, prior to working on the project site.	• Drilling Contractor	• During Construction
Fires			
• Wildfire Ignition	**Fires-1: Fire Prevention and Response** The risk of fires shall be evaluated for each project site based on the activities that would occur, environmental conditions, and presence of ignitable or combustible materials in the area. If the activities pose a risk of igniting a wildfire, appropriate fire prevention and response equipment shall be available at each active site, such as shovels, axes, fire extinguishers, and dedicated water tanks. All workers shall be trained on proper fire prevention and response procedures prior to working on the site.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Any smoking on site shall be restricted to barren areas away from ignitable or combustible material. Smoking waste shall be fully extinguished and disposed of appropriately.		
Solid Waste			
• Water Quality • Hazardous Materials • Waste	**Waste-1: Waste Management Plan** The construction contractors shall prepare and implement a Waste Management Plan. At a minimum, the plan shall address the sources of waste; waste minimization, reuse, and recycling opportunities; and waste collection, storage, and disposal procedures. The Waste Management Plan should distinguish between solid and liquid waste, as applicable, and include procedures for addressing waste that may be hazardous to health and the environment. In addition, the Waste Management Plan shall address the following: • All food waste shall be contained in covered bins and disposed of on a frequent basis to avoid attracting wildlife. • Trash bins shall be accessible at all locations where waste is generated. • The project area shall be kept clean and free of litter and no litter shall be allowed to disperse to the surrounding area. • Solid waste shall be removed from the site and transported to a municipal landfill. • Waste shall not be dumped or buried in unauthorized areas or burned. • Human waste associated with the worker camp and latrines shall be properly contained and disposed of. The construction contractors shall ensure all workers receive training on proper disposal of all waste prior to working on the project site.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

7.3 SOCIAL MITIGATION MEASURES

Table 7.3-1 Social Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Livelihoods	**Social-1: Agriculture Production**	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	Impacts to active farmland should be avoided to the extent possible. The locations of access roads and well pads should be positioned away from active agricultural areas, as feasible. The limits of all access roads and well pads shall be clearly identified and marked, if necessary, to ensure impacts from ground disturbance are limited to approved properties and work areas. If active farmland cannot be avoided, crops with long maturing periods (i.e., bananas, coconuts, cocoa, avocados, mangoes, and citrus) should be avoided to the greatest extent possible. Where farmland and crops are impacted by the project, farm owners and farmworkers should be compensated for the loss in pay and agriculture production for affected growing seasons in accordance with the Resettlement Action Plan and Resettlement Policy Framework. Male and female farm owners and farmworkers shall be compensated for impacts to agriculture production equally.	• Drilling Contractor	• After Construction
• Working Conditions and Equality	**Social-2: Working Conditions and Equality** Employment opportunities created by the project shall be equally available to men and women. If locals are hired for construction jobs, job postings and/or notices shall be disseminated that foster participation from women and men. The GoSL shall include a preference for hiring from the project region in the civil works contract. The construction contractors shall provide safe and equal working conditions and comply with the World Bank's social policies regarding age, gender, ethnicity, and religious equality. Workers shall be provided with: • Information on their rights regarding safety and payment prior to working on the site • Gender-specific latrines at each project area that are maintained in a sanitary condition with adequate capacity • Gender-specific sleeping quarters at the worker camp • Clean drinking water at all times • Adequate training for their position Violence, sexual harassment, discrimination, and drug abuse shall not be tolerated. Workers engaging in such activities shall be dismissed immediately. Any concerns and complaints regarding workplace or community harassment shall be addressed with respect and due diligence by a grievance and redress committee designated by the GoSL; women shall be appointed to the grievance	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	and redress committee. Workers and community members who issue concerns or complaints shall be protected from retaliation. Prior to working on the project site, all workers shall receive equality and harassment awareness training, for both workplace and community relations, in conjunction with other social trainings for the project.		
• Working Conditions and Equality • Noise • Community Health and Safety	**Social-3: Community Engagement and Sensitivity** **Pre-construction Meeting.** Prior to the start of construction activities, the PCU shall hold a public meeting for the affected communities to explain the project activities, schedule, possible inconveniences that may be experienced during construction, and safety considerations associated with drilling operations (refer to Health and Safety-4). The affected communities shall be informed of how they can submit complaints about the project should they arise. **Informational Signs.** The PCU shall install an informational sign at the entrance of each project area to inform the public about the project, construction schedule, and important information about health and safety related to project activities, such as evacuation areas in the event of an emergency. The sign shall include procedures and contact information for submitting complaints about the project to the Community Liaison Officer (CLO). **Community Complaints.** Complaints that relate to the requirements set forth in the ESIA shall be recorded and addressed as set forth in the Stakeholder Engagement Plan, and the underlying issue shall be corrected, to the extent feasible. **Worker Sensitivity Training.** The PCU shall prepare a social and community sensitivity training that would be provided to all workers. The training shall be designed to inform all workers of the local customs, traditions, and community considerations for each area affected by the project. The construction contractors shall be responsible for providing the social and community sensitivity training to all workers prior to initiating work.	• PCU • Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Recreation	**Social-4: Recreation** Avoid project activities (i.e., drilling, staging, or storing material) in recreational areas such as playing fields where feasible to minimize disruption to the communities in the drilling areas. Any use of recreational fields for material staging shall be coordinated with the community.	• Civil Works Contractor • Drilling Contractor	• During Construction

7.4 HEALTH AND SAFETY MITIGATION MEASURES

Table 7.4-1 Health and Safety Mitigation Measures

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
• Fires • Worker Health and Safety • Community Health and Safety	**Safety-1: Health and Safety Plan** The construction contractors shall prepare and implement a Health and Safety Plan that addresses the applicable risks and prevention procedures applicable to each contractor's work. At a minimum, the Health and Safety Plan shall address hazards that may be encountered during construction, including prevention and response procedures, for the following topics: • General occupational hazards that may be encountered (e.g., moving machinery and motorized equipment, working at heights or in confined spaces, repetitive motions, falling objects, exposure to heat, loud noises, and hazardous materials, protective clothing); • Unique occupational hazards associated with drilling activities (e.g., exposure to potentially harmful geothermal gases, hot geothermal fluids and drilling materials, and hazards associated with a potential well blowout); • Minimum training requirements for operating vehicles, equipment, and machinery, in accordance with applicable laws and industry standards; • Fire prevention and response procedures, including compliance with the with relevant policies in the GoSL's Wildfire Management Plan; • Natural hazards that may be experienced during construction (e.g., hurricanes and tropical storms, landslides, earthquakes, volcanic eruptions, and flooding), including designated response procedures and evacuation areas for each project area that are consistent with the GoSL's natural hazards and emergency response plans; • Biological hazards in the environment (e.g., dangerous or infectious insects, animals, and plants); • Disease risk and prevention (i.e., HIV/AIDs, etc.); • Community safety considerations (e.g., traffic, harmful geothermal gases, and unsafe areas); • Emergency preparedness and response procedures, including the locations of hospitals and medical services in the region in the event of an injury or medical emergency.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	The construction contractors shall provide all workers with training on the contents of the Health and Safety Plan prior to working on the site. Refresher trainings shall be given on an occasional basis and before beginning work in new project areas.		
• Worker Health and Safety	**Safety-2: Personal Protective Equipment** The construction contractors shall supply all workers with Personal Protective Equipment (PPE) and any required training, and ensure workers use the proper PPE during all work activities. At a minimum, PPE for workers shall include: • Safety headgear • Steel toed boots • Safety glasses or impact-resistant eye protection • Ear protective devices • Harnesses for workers operating at heights • Respirators • Gloves • High visibility clothing or vests • Other specialized protective equipment for the drilling, welding, etc. Employers should make sure that each employee demonstrates an understanding of the PPE training as well as the ability to properly wear and use PPE before they are allowed to perform work requiring the use of the PPE. All PPE shall be properly fitted for each worker, including body size and gender, and workers shall be trained in the proper use of PPE, prior to working on the project site.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Worker Health and Safety	**Safety-3: First Aid and Emergency Response Equipment** The construction contractors shall provide first aid training to all workers prior to working on the project. The construction contractors shall ensure all project sites are equipped with first aid and emergency response equipment. The drilling contractor shall ensure that adequate safety equipment is located at drilling sites and maintained in good working order, such as firefighting equipment, protective suits, respirators, and other breathing apparatuses.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Community Health and Safety	**Safety-4: Community Safety** Communities that may be exposed to hazards from drilling activities (communities within 500 meters of well pads) shall be informed of the risks and provided information regarding emergency preparedness and response. If and where	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Responsible for Implementing	Timing of Requirements
	necessary at drilling areas, alarms shall be installed for major emergencies that could require evacuation, such as a well blowout or geothermal gas emission. Evacuation procedures during an alarm shall be communicated to community members during the Pre-construction Information Meeting and on applicable display panels (refer to Social-3). The construction contractors shall install temporary signs and fences around all unsafe areas to prevent members of the public from entering the areas. If installing fences is not feasible, the area shall be clearly identified as unsafe with signs and flagging.		

8 STAKEHOLDER ENGAGEMENT AND COMMUNITY CONSULTATIONS

8.1 PROJECT STAKEHOLDERS

Project stakeholders include individuals, groups, organizations, and institutions interested in and potentially affected by the project as well as those having the ability to influence the project, either positively or negatively. The primary stakeholders are comprised of persons that are directly or indirectly affected by the project impacts and other community individuals and groups. The secondary stakeholders are the institutional (the government agencies, non-profit, community-based) organizations and other people who have an interest in the project including potential beneficiaries (such as consumers for the geothermal energy). Table 8.1-1 presents a brief analysis of the various stakeholders of the project.

Table 8.1-1 Project Stakeholders

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
Potential receptors – those ultimately affected (directly or indirectly) by the project (positively or negatively) due to the project's impacts	Interested and affected parties in the project's area of influence	Primary key stakeholders (individuals and groups) High stake, but low influence
Project Affected Persons	Residents, landowners and farmers/ farm workers, agricultural squatters near the exploratory drilling sites in target communities	Primary key stakeholders (individuals and groups) High stake, but low influence
Other Affected Persons	Vulnerable persons (women, children, disabled); local community advisory groups; parliamentary representatives; drive-in, drive-out workers and fly-in, fly-out workers	Primary stakeholders Advocates/supporters Blockers/critics
Other Stakeholders in Soufriere, Laborie & Choiseul districts	Project Affected Communities Local private businesses, schools, hoteliers; tour operators The unemployed (potential workforce seeking employment) Local recreational users including national & foreign tourists	Primary stakeholders Advocates/supporters Blockers/critics
National and local NGOs & CBOs/Regulators/organizations (Legal mandates)/ interest groups	Soufriere Regional Development Foundation; Fond St. Jacques Development Foundation; Laborie Development Foundation; Saint Lucia National Trust; Saint Lucia Archaeological	Secondary key stakeholders Advocates/supporters Blockers/critics

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
	& Historical Society, International Union for Conservation of Nature (IUCN), UNESCO	
Government/Institutional/ Authorities/supporting organization (Legal mandates)/facilitators	Government Departments/Ministry of: • Agriculture, Fisheries, Physical Planning, Natural Resources & Co-operatives • Economic Development, Housing, Urban Renewal, Transport & Civil Aviation • Education, Innovation, Gender Relations & Sustainable Development • Equity, Social Justice, Empowerment, Youth Development, Sports & Local Government • Finance, Economic Growth, Job Creation, External Affairs & the Public Service • Health and Wellness • Infrastructure, Ports, Energy and Labor • Tourism, Information, and Broadcasting • Soufriere Town Council	Secondary stakeholders Advocates/Supporters
Customer/Client/ Implementing Agency/Implementer	Renewable Energy Unit, Department of Sustainable Development; Ministry of Sustainable Development, Energy, Science, and Technology	Secondary project partners/ Advocates/ Supporters
Project Sponsor/Fiduciary Support/facilitator	Project Coordination Unit (PCU), Department of Planning and National Development; World Bank	Secondary Advocates/Supporters

8.2 STAKEHOLDER ENGAGEMENT DURING PREPARATION OF THE ESIA

8.2.1 St. Lucia Government Consultations

The GoSL and Panorama have conducted stakeholder engagement activities during the preparation of this ESIA. A meeting was held with stakeholders on the 8th of August, 2017 at the Finance Administrative Center and was attended by the following government stakeholders:

- Jacqueline Francois, Budget Analyst
- Leca James, Social Research Officer
- Werner Houson, Physical Planning Officer
- Danna Jr. Charles, Social Planning Officer
- Timothy Ferdinand, Department of Tourism and Broadcasting
- Annette Rattigan-Leo, Agriculture CSDEO
- Barrymore Felicien, Agriculture DPS

Judith Ephraim and Panorama staff member Susanne Heim conducted follow-on meetings on 11 August 2017 with the Departments of Physical Planning, Land Survey, and Land Registry. These meetings were attended by:

- Mrs. Magdalene Fontenelle, Physical Planning
- Mr. David Alphonse, Physical Planning
- Ms. Jeanelle Fevrier-Popo, Physical Planning
- Werner Houson, Physical Planning
- Mr. Phillip Hippolyte, Survey
- Mr. Luther Goddard, Deputy Chief Surveyor

8.2.2 Local Agency Consultations

The GoSL and Panorama conducted a site visit with local stakeholder representatives on 9 August 2017. The site visit included travel to Sulphur Springs where previous geothermal exploration had been completed and the three target areas for geothermal exploration including the Belle Plaine, Fond St. Jacques, and Mondesir-Saltibus area. Panorama presented a PowerPoint presentation on the geothermal exploration and development process and ESIA procedures and scope at the Soufrière Regional Development Foundation Office after completion of the site visit. The site visit and meeting in Soufrière were attended by the following local stakeholder representatives:

- Augustine Dominique, Manager, PMA Office
- Michael Bobb, General Manager, SMMA
- Craig Henry, Saint Lucia National Trust
- Franklin Solomon, Operations Manager-SRDF
- Shem Jean, Projects-SRDF
- Vicky Romael John Augustin, Road Builder in Choiseul

8.2.3 Community Meetings

The GoSL and ESIA contractor conducted community meetings and presented the proposed geothermal exploration project in each of the local communities (Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques) in August and September 2017. Community comments were obtained during each meeting and subsequent surveys were conducted with community members. Notes from each of the community meetings are provided in the Scoping Studies Report (Appendix C).

8.3 COMMUNITY CONSULTATION ON DRAFT ESIA

Community consultations on the draft ESIA were conducted with the potentially affected communities in Belle Plaine on March 13, Soufriere (for the Fond St. Jacques community) on March 14, and in Parc Estate for Mondesir-Saltibus on March 12. An additional public consultation meeting was held with stakeholders in Castries on March 15. The majority of invitees from the Fond St. Jacques community elected not to attend the community consultation in Soufriere, despite transportation arrangements, citing that a community consultation was

held in Fond St. Jacques in August 2017. The invitees were surprised that Fond St. Jacques, a potential drilling site, was not included as a venue for a community consultation. Detailed information on issues raised during each of these consultations and responses to comments and questions is provided in Appendix H: Community Consultations Response to Comments. The key issues raised during the community consultations were:

- Potential for blowout incidents and other safety risks
- Seismic activity resulting from exploration drilling
- Community members not properly informed of the project
- Feasibility of agricultural land restoration
- Success rate of the project
- Use of alternative sites or alternative technologies
- Food security
- Hydrogen sulphide emission during drilling and air quality
- Construction of alternative renewable energy (wind and solar)
- Reduction in electricity bills
- Noise and vibration effects
- Effects of drilling on tourism
- Potential for landslides and flooding in Fond St. Jacques
- Impacts to water quality
- Impacts on water supply
- Changes to Rabot Lake from past geothermal exploration
- Impacts to recreational areas in Fond St. Jacques
- Job opportunities

8.4 COMMUNICATIONS AND OUTREACH CAMPAIGN

Separate from the ESIA, the GoSL intends to engage a communication consultant to increase public awareness for geothermal exploration and the proposed project.

8.5 STAKEHOLDER ENGAGEMENT PLAN

A Stakeholder Engagement Plan has been prepared for the project (refer to Appendix G). The Stakeholder Engagement Plan defines key stakeholders, the timing for interaction with each stakeholder group prior to, during, and after geothermal exploration activities, and the approaches to reach stakeholders. Stakeholder engagement will be ongoing throughout the project life. Additional stakeholder consultations will be held prior to geothermal drilling,

8.6 GRIEVANCE REDRESS

Project-related grievances will be addressed according to the grievance redress procedures outlined in the Stakeholder Engagement Plan (SEP) in Appendix G. It is anticipated that grievances will likely focus on resettlement issues and inconveniences associated with drilling.

The mechanism for grievance redress will include:

- Provision for the establishment of a Grievance Redress Committee
- A reporting and recording system
- Procedure for assessment of the grievance
- A time frame for responding to the grievances filed

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APPENDIX A LIST OF ESIA PREPARERS AND CONTRIBUTORS

APPENDIX A LIST OF ESIA PREPARERS AND CONTRIBUTORS

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Hydrologist/Hydrogeologist	Warren Dewhurst, Dewhurst Group

APPENDIX B REFERENCES

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Government of Saint Lucia

Scoping Studies Report

Saint Lucia Renewable Energy Sector Development Project

July 2018

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Government of Saint Lucia

Scoping Studies Report

Saint Lucia Renewable Energy Sector Development Project

July 2018

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1 INTRODUCTION

1.1 OVERVIEW

The Government of Saint Lucia (GoSL) proposes a geothermal exploration program to test the geothermal resource and evaluate the feasibility of commercial geothermal power production in Saint Lucia. The geothermal exploration is proposed within the Soufrière, Choiseul, and Laborie regions of Saint Lucia (Figure 1). The geothermal exploration program would include slim-diameter wells to obtain information on the geology and temperature gradient in the area. Deep geothermal wells may be drilled with larger drilling rigs if the initial drilling is successful.

The World Bank requires preparation of an Environmental and Social Impact Assessment (ESIA) in accordance World Bank Operational Protocols prior to approving funding for the geothermal exploration activities. GoSL contracted Panorama Environmental, Inc. to prepare an ESIA for the geothermal exploration program. The Panorama team includes geologists, geothermal experts, resource-specific specialists, and local ESIA and social experts.

The ESIA process includes documentation of baseline environmental and social conditions in order to evaluate potential project impacts. This Scoping Studies Report was prepared by Panorama Environmental, Inc. to document the results of the baseline environmental and social studies conducted by our team members in the potential geothermal exploration areas.

1.2 PROJECT AREAS

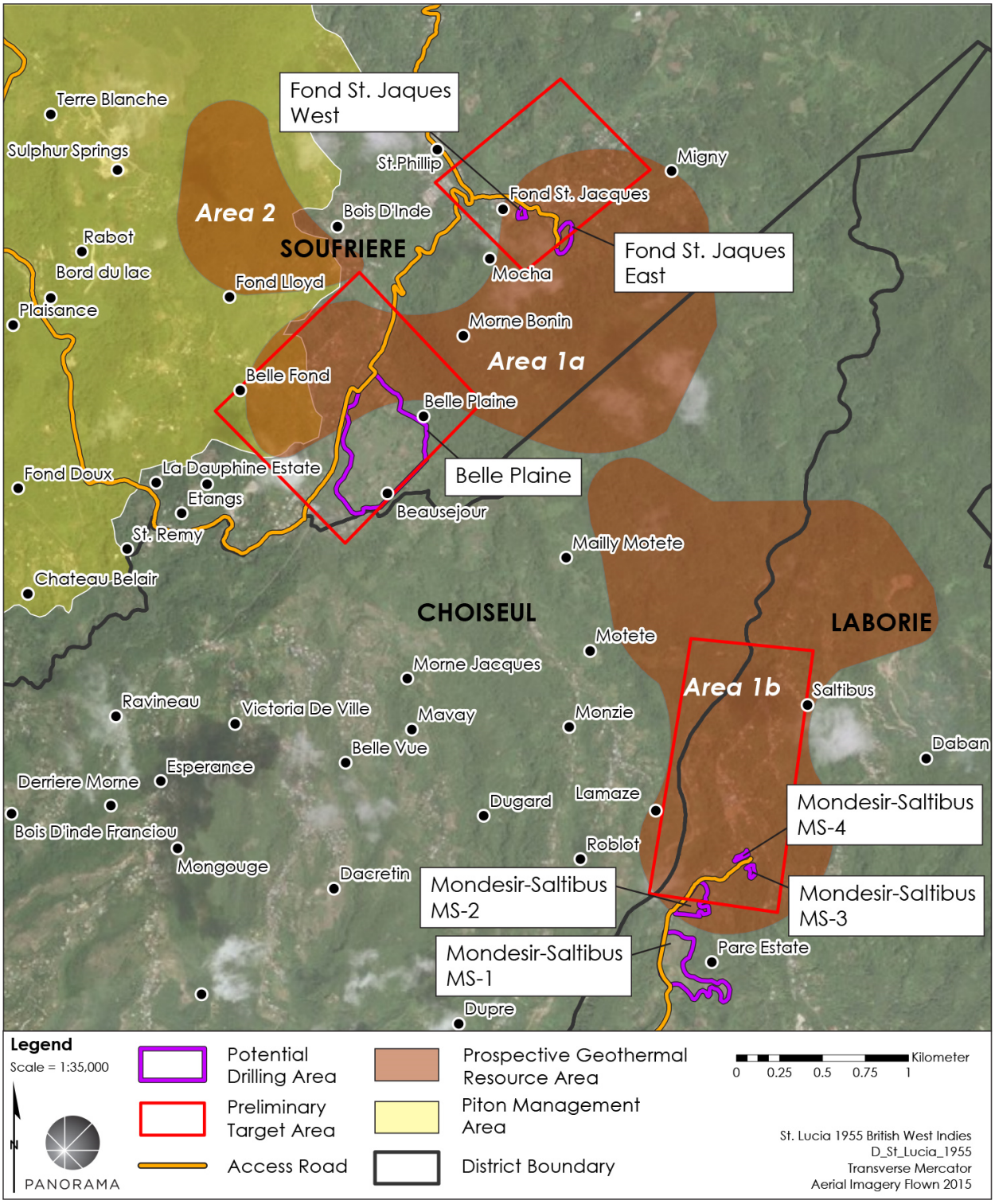
Jacobs New Zealand Limited conducted integrated geoscience investigations in 2015 and 2016 to assess the geothermal resource suitability of Soufrière Volcanic Zone. The results of the investigations and recommendations are presented in the *Soufrière Geothermal Resource - Integrated Exploration Report* (JACOBS - Lovelock & Ussher, 2016). The report authors identified three resource target areas for geothermal exploration to further analyze the suitability for power generation.

The resource target areas were refined by the pre-feasibility contractor, GeothermEx and POWER Engineers, in collaboration with Panorama Environmental, Inc., in order to focus the field baseline data collection. The target areas that were the focus of the baseline data collection activities are shown on Figures 1.1-1 and include:

- Belle Plaine (26.3 hectares [65.1 acres])
- Fond St. Jacques (1.3 hectares [3.3 acres])
- Mondesir-Saltibus (9.0 hectares [22.2 acres])

The 1,200-square-meter (m^2) to 8,400-m^2 (12,917-square-foot [ft^2] to 90,417 ft^2) well pads would be located within the larger study areas.

Figure 1.1-1 Potential Drilling Areas



Source: (McElhanney Consulting Services LTD, 2015)

1.3 SUMMARY OF SCOPING STUDIES

The scoping study requirements are defined the Terms of Reference (TOR) and Panorama's contract with GoSL. Table 1.3-1 provides an overview of the required scoping studies in the TOR and the location of the scoping study results in this report.

Table 1.3-1 TOR Requirements and Scoping Study Reference Location

TOR Requirement	Scoping Study Section(s)
1) Necessary desk reviews of existing reports, maps and field investigations to support the environmental and social assessments;	3.1.1; 3.2.1; 3.3.1; 3.4.1; 3.5.1; 3.6.1; 3.7.1; and 3.8.1
2) Surveys of Water Quality, Groundwater and Hydrology including surface water features and groundwater resources;	3.1.1.2 and 3.1.1.3
3) Literature study of the hydrogeological environment for the project area of influence;	3.1.1.2 and 3.1.3
4) Identify sampling sites based on potential water abstraction sources and potential receptor sites within the project area of influence and agreed to by GoSL and the technical consultant for the pre-feasibility study;	Appendix F
5) A desktop study of published maps including soil classification and land evaluation, soil investigations, soil sampling of locations suspected of contamination through visual assessment;	3.2.1 and 3.2.2
6) A description of water uses and users in the project area of influence and an assessment of surface water and groundwater use and availability	3.1.1.4 and 3.7.2.6
7) A data collection plan for field sampling and streamflow measurements to reflect seasonal variations, that should include: a. Existing hydrological information; b. Flood risk assessment (localized); c. Analysis of physical and chemical parameters (dissolved oxygen, temperature, conductivity, pH, turbidity, TSS, nitrogen, organic material, BOD5, COD, heavy metals, hydrocarbons, sulphur, iron, manganese, uranium, radium, gross alpha and beta) in representative streams/rivers under base flow and seasonally variable conditions. d. Measuring of stream flow (velocity, discharge) at key points under base flow and seasonally variable conditions.	Appendix F
8) Develop a conceptual model of hydrogeology in the project area of influence, specifically focusing on hydraulic interconnections of surface water and springs with groundwater in both the shallow and deep systems;	3.1.3.2
9) Undertake GIS Constraints Mapping highlighting key environmental and social receptors that may influence the topographical survey work and exploratory drilling, using existing data coverage where available, for the following: • Rivers and surface water features; • Significant environmental/ecological features (protected areas such as national parks, conservation areas, UNESCO sites, viewsheds and aesthetic features, wetlands); • Habitat mapping; • Land use mapping;	GIS database to be transmitted electronically 3.1.1; PMA layer in GIS 3.5.2; 3.7.2.9 3.8

TOR Requirement	Scoping Study Section(s)
• Erosion potential; • All sensitive receptors (houses, schools, hotels, communities, touristic sites); • Archaeological/Cultural heritage constraints mapping (over and above PMA requirements). • Areas of high natural hazard potential (landslide, flood, seismic, volcanic)	Sensitive receptors layer in GIS 3.6.2; 3.8
10) Undertake a baseline noise monitoring survey at representative locations/sensitive receptors in the project area of influence including households, hotels, roads and tourism viewpoints, as well as nearby communities which could be affected by noise emissions during drilling. Baseline noise monitoring should be performed in accordance with international standards for noise monitoring and should include daytime and nighttime monitoring at a range of representative dates/times;	3.4.2 and Appendix B
11) Undertake baseline ambient air quality monitoring at potential air quality sources (e.g. surface manifestations) and potential receptor sites within the project area of influence including households, hotels, roads, tourism, viewpoints and potential drilling sites. Baseline air quality monitoring should be performed in accordance with international standards and methodologies for air quality monitoring, taking into account the possible characteristics of the steam from potential geothermal development. Specific tasks to include:	3.3.2 and Appendix A
12) Describe the existing biological, terrestrial and aquatic environment with focus on the flora and fauna (mammals, migratory and resident birds, amphibians and reptiles) and overall biodiversity of the areas to be impacted, based upon existing information and field work (as needed)	3.5.2 and Appendix E
13) Identify important sites and species including local variations and biological diversity "hot spots", including areas of high endemism;	3.5.1 and 3.5.2
14) Prepare habitat mapping of the project area of influence supported by field verification/ walkover surveys to determine the presence or absence of key species, including endangered, threatened, or other protected species;	3.5.2; 3.5.3; and Appendix E
15) Identify designated sites of archaeological importance in the project area of influence;	3.6.2
16)Consult with key archaeological bodies and institutions in St. Lucia and conduct informal community interviews to identify potential grave sites or other unique natural features or tangible objects that embody cultural values, such as Amerindian terraces, sacred graves, rocks, lakes, waterfalls and other forms of non-tangible cultural heritage;	3.6.1 and 3.6.2
17) Perform non-intrusive verification walk-over at any identified potential sites of direct impact in the area of influence to verify any localized risks and issues.	3.6.2
18) Review of existing information and baseline data on the following areas: a. Population and demographic movement; b. Economic environment, livelihoods, employment and labour implications;	3.7.1

TOR Requirement	Scoping Study Section(s)
c. Use of natural resources and agriculture; d. Community organization and local institutions; e. Access to social services and infrastructure; f. Community health, safety and security, including HIV/AIDS prevalence; g. Poverty and vulnerable groups; h. Equity and potential issues related to social conflict; i. Lifestyle, culture and recreation.	
19) Perform field verification survey. The survey should entail identifying occupants that are likely to be affected in the project area of influence, the profile and standard characteristics of these occupants, baseline information on livelihoods and standards of living of the occupants, an understanding of the severity of the impact loss, information on vulnerable groups or persons for whom special provisions may have to be made	3.7.2
20) Prepare map of land ownership and use, supported by desk based profile of the land owners or users (for monitoring livelihood restoration), or land use rights transfer procedures.	3.7.2.9
21) Stakeholder analysis. The study will include an identification and mapping of relevant stakeholder organizations, groups and individuals who have an interest in the project areas or geothermal development in St. Lucia.	3.7.2.9; Appendix C and GIS database
22) Review the geohazard and natural disaster vulnerability of the area of interest, in the context of existing risk to the population and the project infrastructure, and any additional risk imposed by the project activities. Specific tasks may include:	
a. Review of seismic monitoring network and historical data	3.8.2
b. Volcanic hazard analysis based on the University of the West Indies (UWI) studies	3.8.4
c. Potential for increased seismic activity due to drilling or fluid reinjection	4.8.1
d. Vulnerability of population and infrastructure to landslides, floods, high winds, and fire	4.8.1
e. Health and safety precautions and emergency response plans for workers during drilling	4.8.1 and 4.8.2
f. Evacuation plans and contingency plans for potentially affected populations	4.8.2
g. The potential for hydrogen sulfide (H2S) releases and strategy for mitigation measures.	4.3.1, 4.3.2, 4.8.1 and 4.8.2

1.4 USE OF THIS REPORT

This Scoping Studies Report has been prepared on behalf of GoSL to support the assessment of baseline conditions for the ESIA. The Scoping Studies Report also defines the area of influence for the ESIA and provides an initial qualitative assessment of the potential impacts of the project with recommendations for mitigation where impacts are likely significant.

1.5 APPROACH TO ESIA

The literature review and field surveys allowed the Panorama team specialists to identify the existing site conditions, identify data gaps, and understand the resources that could be affected by the geothermal exploration program. The TOR and Inception Report for this ESIA guided the definition of the study methodologies, which are presented in Chapter 2. Chapter 3 presents the results of the literature review and field studies. The data in this chapter defines the areas of influence. Chapter 4 provides an overview of the effects to the resources and identifies recommendations for the mitigation measures that will avoid or reduce significant effects. Chapter 5 provides conclusions and a summary of the scoping studies results.

2 METHODOLOGY

2.1 WATER RESOURCES

2.1.1 Literature Review

Panorama team members from Dewhurst Group L.L.C. (DG) conducted a literature review of existing information related to the water resources in Saint Lucia in accordance with TOR Tasks 1.1, 1.2, 1.3, and 1.6. DG reviewed existing reports and water resource data provided by entities such as the Division of Sustainable Development (DSD) and the Water & Sewerage Company, Inc. (WASCO). DG obtained additional information through online sources. The results of the literature review are presented in Section 3.1

2.1.2 Field Investigation

DG conducted a visual assessment of the streams in the target drilling areas on 7 September 2017. The conditions during the field survey are provided in Section 3.1.2. The visual assessment of water resources included the following process:

1. Identification of existing water sources in the area
2. Determination of the use of water resources and their condition
3. Identification of associated infrastructure

2.1.3 Data Analysis

DG analyzed the information obtained as part of the literature search and field investigation to define water resources within the drilling target area. The data were also used to develop a sampling and data collection plan for future study in accordance with TOR Tasks 1.4 and 1.6. DG also prepared a conceptual hydrogeologic model in accordance with TOR Task 1.8.

The results of the analysis are presented in Section 3.1.

2.2 GEOLOGY AND SOILS

2.2.1 Literature Review

DG reviewed available geological and scientific information relevant to the geothermal project in accordance with TOR Task 1.5, with special emphasis on the volcanic zone of Soufrière. Datasets include geology, geochemistry, water analysis, geophysics (magnetotelluric, magnetic, seismic, gravity surveys), temperature, and Light Detection and Ranging (LiDAR) data. Data were obtained primarily from DSD, WASCO, and online reports. Key studies included:

- Geochemical analysis of fluids by British wells in the 1970s (Bath 1976)

- Studies conducted in the 1980s by Los Alamos National Laboratories (LANL) for the Saint Lucia government (Goff and Vuataz 1984)
- Exploration work conducted by Aquater as part of UN/USAID-funded geothermal exploration campaign in the 1980s, including a hydrogeochemical survey in 1984 (Gandino, Piovesana and Rossi 1985) and subsequent discharge testing of well SL-2 in 1988 (Rivera 1990)
- Various recent chemical studies of the Lesser Antilles archipelago (JACOBS - Lovelock and Ussher 2016)

2.2.2 Field Investigation

DG conducted a visual assessment of the geology and soils of the target drilling areas on 7 September 2017. The visual assessment included an evaluation and documentation of the following conditions:

- Geological context
- Land use
- Condition of facilities (deposits, etc.)

2.2.3 Data Analysis

DG analyzed the data obtained through the literature search and field investigation in order to determine the basic geological setting. The literature review yielded limited information regarding soil contamination; however, land use and agricultural practices were considered in determining areas of potentially contaminated soils.

The results of this analysis are presented in Section 3.2.

2.3 AIR QUALITY

2.3.1 Literature Review

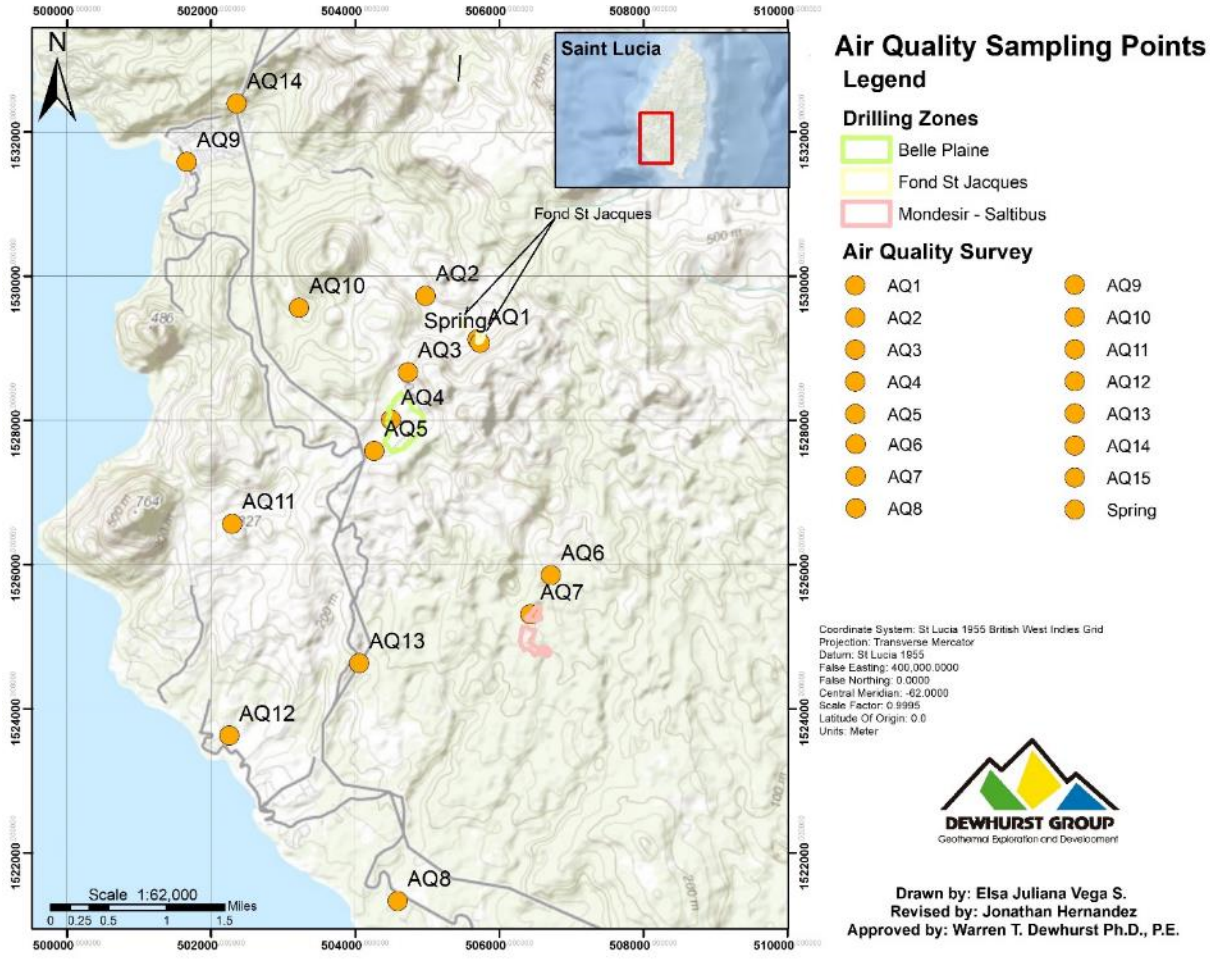
DG obtained and collated existing data on climate in the vicinity of the target drilling areas including wind direction and rainfall in accordance with TOR Task 1.11. Existing climate data and reports were obtained from a meteorological station at Hewanorra International Airport and Caribbean Environmental Health Institute (Caribbean Environmental Health Institute 2006). Air quality data contained in the *Geochemical Monitoring of Sulphur Springs* (Joseph E. , 2004) were reviewed to define ambient air quality conditions.

2.3.2 Field Investigation

DG conducted baseline ambient air quality monitoring in accordance with TOR Task 1.11. The baseline ambient air quality monitoring program included air quality monitoring at 15 air quality monitoring stations near sensitive receptors including households, hotels, tourist sites, and schools around the target drilling areas and near access roads. The sampling points are shown on Figure 2.3-1. Air quality sampling was conducted primarily on the west side of the

target drilling areas because the wind primarily blows in an east–west direction. A control point was also installed in Rodney Bay (at the northern end of the Island) and outside the area of

Figure 2.3-1 Air Quality Sampling Locations



interest. The air-quality survey sheets and photos from the air-quality field survey are included in Appendix A - Air Quality Data.

DG installed air-quality diffusion tubes to passively sample sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and hydrogen sulfide (H_2S). Diffusion tubes measurements were obtained between 6 September and 25 September 2017. Diffusion tubes were installed in trees, light posts, and walls (in lieu of trees or light posts), at heights over to 2 meters (6.6 feet) above ground. Diffusion tubes were secured with zip ties, so that they could not be easily removed by passers-by. Some diffusion tubes were saved, unused, as "blank tubes" to verify the laboratory's analysis; these tubes should not show any percentage of gases when analyzed in the laboratory.

2.3.3 Data Analysis

Air quality sampling data was analyzed in the laboratory by Ormantine USA Ltd., Inc. The existing air quality data and air quality data obtained in the field were evaluated to define the baseline air quality conditions in the vicinity of the target drilling areas.

The results of this analysis are presented in Section 3.3.

2.4 NOISE

2.4.1 Literature Review

DG reviewed the geothermal drilling noise surveys that were conducted in 1987 during the previous geothermal investigation in Saint Lucia. The 1987 survey included noise measurements and house-to-house contact and questionnaires (Associates in Rural Development - Dullin and Hannah 1987).

2.4.2 Field Investigation

2.4.2.1 Noise Survey Timing

DG conducted a baseline noise survey in the target drilling areas and vicinity between 5 September and 7 September 2017. The noise survey was conducted in accordance with TOR Task 1.10. Noise level observations were obtained during daylight hours. Weather conditions during the noise survey were primarily clear with rain showers and an easterly breeze in the late afternoons. Noise observations were avoided during periods of heavy rain and/or significant wind.

2.4.2.2 Noise Survey Locations

Baseline noise sampling locations were located adjacent to the air quality monitoring stations to maximize the use of time available in the field. Noise levels (e.g., observations of sound pressure) were taken at a total of 13 unique locations referred to as NS1 through NS13 as shown in Figure 2.4-1, with multiple readings at sites closest to the target drilling areas. Belle Plaine has three sites with two of those sites having repeat observations at different time periods. Fond St. Jacques has two sites, both with repeat observations at different time periods. Mondesir-Saltibus (Parc Estate) has three sites, two of which have repeat observations at different time periods.

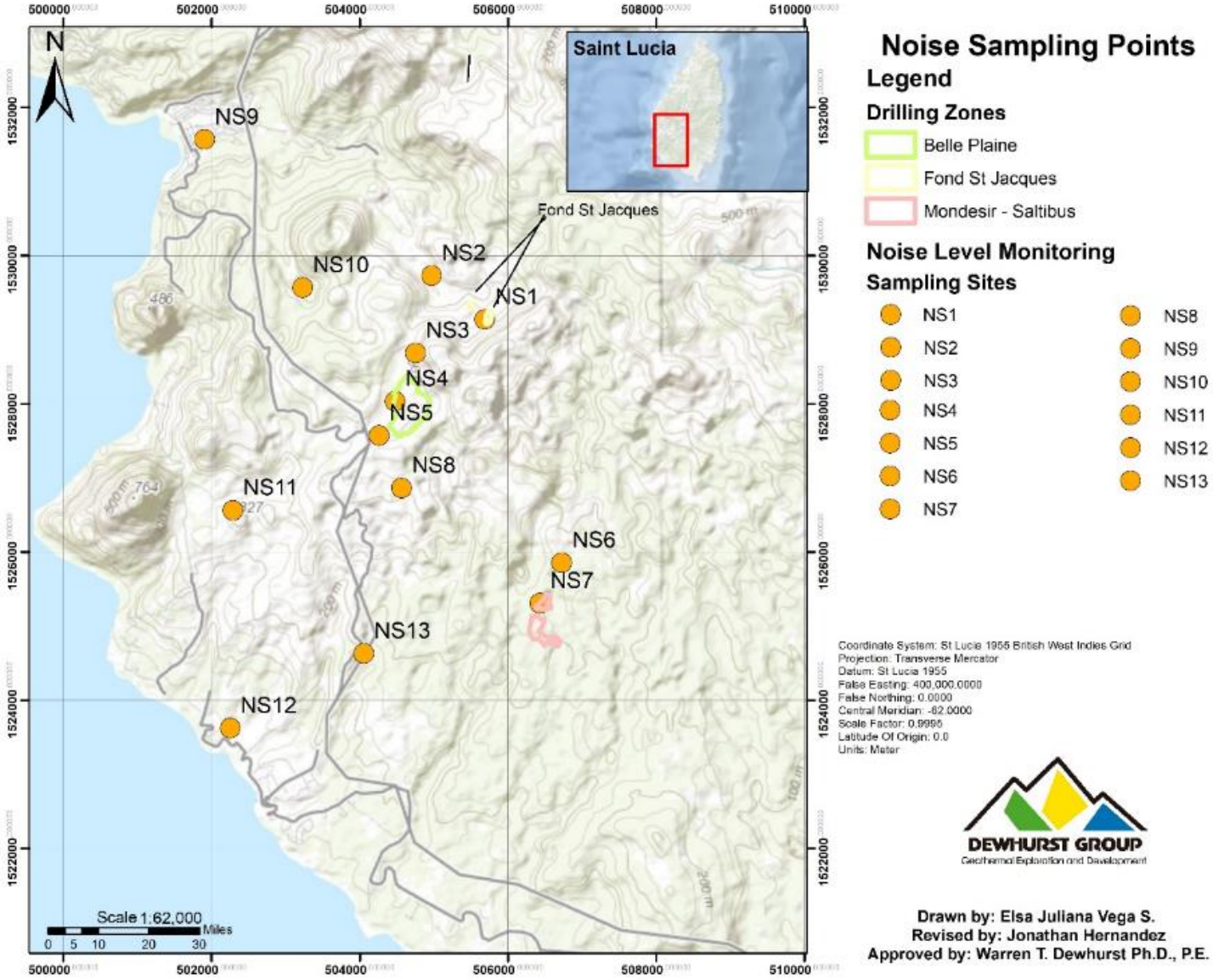
The noise monitoring locations are described in All sound-level meters were calibrated with the REED R8090 Sound Level Calibrator prior to the survey and subsequent to monitoring. The REED R8090 conforms to standard IEC 60942 Class 2. The noise level equipment used to conduct the field survey is identified in Table 2.4-2.

Table 2.4-1. Photos of the noise monitoring locations and data sheets are provided in Appendix B – Noise Monitoring.

2.4.2.3 Noise Survey Instrumentation and Method

Noise measurements were obtained in "A" weighted decibels (dBA), which is equivalent to sound heard by humans with an approximate frequency response of 31.5Hz to 8KHz. The noise level survey was conducted using Type 2 sound-level instruments with an accuracy of +/- 1.5 dBA and precision (resolution repeatability) of 0.1 dBA. Data was logged using a "fast" recording setting to produce 30 data points per minute.

Figure 2.4-1 Noise Sampling Locations



All sound-level meters were calibrated with the REED R8090 Sound Level Calibrator prior to the survey and subsequent to monitoring. The REED R8090 conforms to standard IEC 60942 Class 2. The noise level equipment used to conduct the field survey is identified in Table 2.4-2.

Table 2.4-1 Noise Monitoring Locations Description

Site Name	X (mE)	Y (mN)	Elevation (m ASL)	Description of Area
NS1	505697,59	1529120,83	298	**St. Jacques** - Drill Site in the field by small structure near unpaved road in the area
NS2	504975,66	1529721,89	250	**St. Jacques** - Primary School Yard near the main road in the area
NS3	504733,32	1528664,69	400	**Belle Plaine** - LUCELEC Generator near the main road in the area
NS4	504497,87	1528007,49	337	**Belle Plaine** - Drill Site Field near the main unpaved road in the area
NS5	504262,91	1527572,65	362	**Belle Plaine** - Greenhouse near the bend on a main Island paved road
NS6	506717,32	1525848,05	292	**Saltibus** - Primary School between local school and the Community Center
NS7	506428,84	1525305,34	261	**Saltibus** - Parc Estate Drill Site (Near a commercial establishment) and soccer field
NS8	504588,74	1521330,67	45	**Saltibus** – At the corner of the local access road (to Parc Estate) corner with Main Road
NS9	501662,68	1531580,77	-6	**Soufrière** – Fire Station Flagpole taken from within southern edge of parking lot
NS10	503220,76	1529558,78	223	**Sulphur Springs** – southern side of main walkway 5m due south of NS10
NS11	502289,70	1526560,38	225	**Union Vale** – About 15m from the main paved road/bridge and within vegetation
NS12	502251,56	1523623,93	53	**Old Mill** - Light Pole # SEQC04444 near main paved road in the area
NS13	504053,18	1524628,25	219	**D'Quitoin** - Off main road - terrace farm - high side/scarp side of the highway

Note:

[a] Sites in Bold represent the target drilling areas.

[b] GPS measurements taken on site with Trimble GEOXH Serial #5138477832.

[c] Projection: Transverse Mercator. Datum: Saint Lucia 1955

Table 2.4-2 Noise Level Survey Equipment

Instrument	Model number	Manufacturer	Serial number
Sound-level meter	MLM02	TACKLife®	17277243
Sound-level meter	MLM02	TACKLife®	17277252
Sound-level meter/logger	SD-4023	REED®	H339634
Sound-level calibrator	R8090	REED®	160324199
Tripod with bracket	BC Master	N/A	N/A
GPS Unit	GeoExplorer 3000 Series GeoXH™	Trimble®	5138477832

Each sound-level meter contains an approximately 13-millimeter (mm) electret condenser microphone. The REED SD-4023 Sound Level Meter/Logger was used to obtain a noise/time series. The MLM02 Sound Level Meters were used for spot observations of low and high sound levels. All three meters were mounted to a tripod with a leveled ball head and proprietary mounting bracket. The mounting bracket permitted the simultaneous use of all three meters. The meters were positioned at an elevation of 1.5 meters (4.9 feet) above ground level (AGL). The MLM02 meters were used to augment time-series observations and to obtain supplemental observations at secondary locations. Observations at these secondary locations was used to characterize "spot" sound levels throughout the areas of impact. Measurements were made over a 15-minute observation period. Time-series measurements and low and high readings were obtained simultaneously. Both high and low sound levels were recorded during monitoring periods.

Key noise level terms are provided in Table 2.4-3.

Table 2.4-3 Noise Definitions

Term	Definition
Ambient	Approximation of the steady-state sound-pressure level in the absence of measurement fluctuation
Continuous	Noise produced without interruption.
High Levels	Absolute maximum values observed above ambient level. High levels may be naturally or culturally induced.
Intermittent	Noise produced on a discontinuous basis (e.g., cyclical equipment, or isolated events such as passing vehicles or aircraft).
Impulse	Brief and abrupt noise of short duration (typically less than one second), the sound pressure of which is significantly higher than the background.
Low Levels	Absolute minimum values observed above 30 dBA but less than ambient level.
Tonal	Noise which contains a clearly audible tone (i.e., a distinguishable, discrete, or continuous note, such as a whine, hiss, hum, screech, etc.).

2.4.3 Data Analysis

Noise data were analyzed to define average daytime ambient noise levels, peak or high noise levels, and minimum noise levels in the community surrounding the project area. Existing stationary and mobile noise sources (e.g., generators and trucks) in proximity to the noise measurement location are described to address variability in the ambient noise levels.

The results of this analysis are presented in Section 3.4.

2.5 BIOLOGICAL RESOURCES

2.5.1 Literature Review

Existing reports and data on flora and fauna in the target drilling areas and vicinity were reviewed by biologists Roger Graveson and Adam Touissant in accordance with TOR Task 1.12.

2.5.1.1 Flora

The floristic literature review included review of Mr. Graveson's records from more than 25 years of experience conducting biological studies in Saint Lucia. The following sources were reviewed:

- Flore Illustree des Phanerogrames de Guadeloupe et de Martinique
- Flora of the Lesser Antilles. (Leeward and Windward Islands), volumes 1-6 (Howard 1974-1989)
- The Classification of the Vegetation of Saint Lucia, National Forest Demarcation and Bio-Physical Resource Inventory Project Caribbean – Saint Lucia (Graveson 2009)
- A Systematic Vademecum to the Vascular Plants of Puerto Rico (Axelrod 2011)
- Plants of Saint Lucia (Graveson 2017)

2.5.1.2 Fauna

Reports on wildlife of Saint Lucia and the target drilling area that were reviewed prior to conducting field studies include:

- Birds of the West Indies (Raffaele et al. 2003)
- Important Bird Areas on Saint Lucia (Anthony & Dornelly 2008)
- Status and Conservation of Saint Lucia Birds (Toussaint et al. 2009)
- Species Accounts, Distribution, Abundance, Ecology, Conservation and Management of St. Lucia's Native and Introduced Wild Mammals (Clarke 2009)
- Biodiversity Assessment of Saint Lucia's Forests, with Management Recommendations (Daltry 2009)
- Field Guide to the Birds of Saint Lucia (Toussaint n.d.)

2.5.2 Field Investigation

A field investigation of the target drilling areas was conducted to define the biological resources in accordance with TOR Task 1.12 and 1.14. Flora and fauna surveys were conducted in early

September 2017. The weather was sunny and dry with temperatures reaching 32 degrees Celsius (°C) (90 degrees Fahrenheit [°F]) during surveys. Flora and fauna surveys were conducted from dawn until early afternoon.

2.5.2.1 Methodology of Flora Study

The target drilling areas were surveyed visually for floristic species by walking around each site. All species observed during the field investigation were documented to enable identification of threatened, endangered, or protected plant species and any areas of high biodiversity and/or high endemism within the survey area.

2.5.2.2 Methodology of Fauna Study

Faunal species within the target drilling areas were documented using an initial site reconnaissance survey and point count surveys. The reconnaissance survey was conducted within the target drilling areas to ground-truth the environmental conditions and establish locations for point count stations.

Twenty-five point count stations were randomly established within the target drilling areas. The survey was conducted by standing at each point station, while scanning in all directions to detect (see and/or hear) as many bird and other faunal species as possible. For each species, the number of individuals detected was noted. Surveys were initially conducted for 10 minutes at each point count station, starting at the surveyor's arrival at the survey point. A 10-minutes survey period was selected to make the data from this survey comparable with data from previous bird surveys. The surveyor then repeated the count of faunal species for an additional two minutes whilst "pishing" (imitating a generalized alarm call) to draw birds in towards the surveyor.

The point count stations were monitored between the hours of 5:30 and 11:30 AM and between 3:30 and 6:30 PM. Point count monitoring was conducted by A. Toussaint, an expert naturalist who possesses great skills and experience identifying by sight and sound birds and other faunal species on Saint Lucia. A pair of binocular was used to aid in the detailed identification of birds and other fauna. Field records were made for all fauna species sighted or heard at each point count station. Photographs were also taken at each point count station using a Canon EOS 7D Mark II camera with Canon EF 400 mm 1:5.6 Lens.

2.5.3 Data Analysis

2.5.3.1 Flora Data Analysis

Habitat mapping (TOR Task 1.13) was not conducted within the target drilling areas because of the absence of native habitat. The target drilling areas are dominated by agricultural vegetation and no native habitats were observed within the target areas. Native forest habitats occur within along within the buffer to the drilling target area; however, this vegetation would not be removed or directly impacted by the project. Land use (e.g., sports field) was indicated on the maps where applicable. Plant species observed were entered into an Excel database and analyzed for the presence of endangered, threatened, or other protected species.

2.5.3.2 Fauna Data Analysis

Records from the point count stations and records from previous studies of the target drilling area and vicinity conducted in the last 5 years were compiled and wildlife lists were prepared. These lists were then compared to information available on endemic, endangered, and protected species in order to identify species of biological importance, if any, present in the target drilling areas and to determine if there were any biodiversity "hotspots".

The results of the biological resources data analysis are presented in Section 3.5.

2.6 ARCHEOLOGICAL AND CULTURAL RESOURCES

An archaeological investigation was undertaken by Dr. Fredrick Smith, Director or Archaeology and History at St. Nicholas Abbey, Barbados West Indies in accordance with TOR Tasks 1.15, 1.16, and 1.17.

2.6.1 Literature Review and Consultations

Dr. Fredrick Smith reviewed published literature on archaeological resources within Saint Lucia. Dr. Smith also spoke with local landowners, farmers, and members of the surrounding villages to gain insights into archaeological findings and gather oral traditions about the sites being investigated during the field surveys. Dr. Smith also spoke at two community forums, including 1) the Region 6 Farmer's Field Coop in Belle Plaine and 2) the Saltibus School. In addition to meeting and speaking with members of the communities near the proposed drilling areas, Dr. Smith met with heritage stakeholders in Saint Lucia.

2.6.2 Field Investigation

2.6.2.1 Field Survey and Data Collection Methods

A pedestrian survey was conducted in the potential drilling areas in Belle Plaine, Fond St. Jacques, and Mondesir-Saltibus (MS-1 and MS-2 only) to identify cultural resources, such as archaeological sites, modified landscapes, ruins, petroglyphs, and other heritage resources that might be impacted by road or well pad construction or geothermal drilling. Surveys were conducted through the process of field walking and visual inspection of artifacts found on the ground surface. Visual inspection was supplemented by the collection of artifacts, referred to as surface collecting. Artifacts collected from each location were placed in bags and labeled with contextual information about their location of recovery.

The main objective of the pedestrian surveys and surface collections was to gain a general knowledge of the location of possible archaeological resources in the potential drilling areas. These methods do not allow for an in-depth understanding of the full potential of archaeological resources; however, they provide information about the chronology and function of different areas of a site. Surface collecting was an appropriate method for this initial phase of survey. It is dependent upon the visual discovery and identification of artifacts on the ground surface.

Much of the potential drilling areas was relatively clear of brush as they were being used for agriculture purposes. The cultivated fields created favorable conditions for finding cultural materials. Plowing and planting break the ground surface and pull lower layers of soil and any artifacts contained therein up to the surface. Plowing and planting drastically move objects vertically but do not greatly alter their horizontal position. Collecting and recording concentrations of artifacts on the surface of fields is an effective means of identifying areas of human occupation and use. Analysis of subsurface stratigraphy was conducted of the road cuts at the Belle Plaine and Mondesir-Saltibus sites, which showed a rich organic layer atop culturally sterile clays. This rich organic layer is the result of human activity, and in both areas, it contained evidence of human occupation and use in both prehistoric and historic periods. Archaeologists typically refer to these rich organic layers as plowzone. All of the artifacts collected during the surveys were washed, catalogued, and photographed at L'Haut Resort in Soufrière.

2.6.2.2 Field Survey Dates

All field surveys were conducted by Dr. Fredrick Smith, Archaeologist. The field survey of the Belle Plaine area commenced on 2 September 2017. Dr. Smith returned to the site for a second survey several days later to reassess the extent of archaeological deposits. Dr. Smith conducted a field investigation of the Fond St. Jacques area on the afternoon of 2 September 2017. Surveys of the Mondesir-Saltibus area were conducted on 3 and 4 September 2017. Gifta Jongué, a community liaison, joined the field survey in Mondesir-Saltibus area to help explain the survey efforts to members of the local community.

The results of the archaeological field survey are provided in Section 3.6.

2.6.3 Data Analysis

The results of the historical and archaeological resource investigation were reviewed to define areas that have a high abundance of resources and data gaps. Section 4 includes recommendations to address these data gaps prior to ground disturbance.

2.7 SOCIO-ECONOMIC ENVIRONMENT

2.7.1 Literature Review

ECMC staff, Egbert Louis and Theresa Louis, reviewed socio-economic reports and data provided by the DSD and other Saint Lucia government and international firms/non-governmental organizations in accordance with TOR Task 1.18. Information reviewed included:

- Population and Housing Census 2010 (Government Statistical Department 2010)
- 2014 - 2025 Mid-Year Population Projections (Government Statistical Department Saint Lucia 2014)
- Analysis of the Saint Lucia Labour Market Needs Assessment Survey 2012 (St. Catherine 2013)
- Economic and Social Review of the Economy (Government of Saint Lucia 2016a)

- Local Economic Development Strategic Plan (Government of Saint Lucia 2016b)
- National Environmental Summary (United Nations Environment Programme 2010)
- Education Statistical Digest 2014 (Ministry of Education 2014)
- National Health Strategic Plan (Regional Health Services n.d.)
- St Lucia Biennial Chief Medical Officer Report 2014-2016 (Ministry of Health and Wellness 2016)
- Saint Lucia National Report submitted in accordance with paragraph 5 of the annex to Human Rights Council Resolution 16/21 (UN Human Rights Council 2015)
- Saint Lucia Annual Surveillance Report for 2014 (Ministry of Health 2015)
- Trade Adjustment and Poverty in Saint Lucia – 2005/06, Volume I: Main Report (Kairi Consultants 2007)
- A "Basic Needs" Index for Saint Lucia at the level of Small Areas for the 2010 Population and Housing Census (Director of Statistics 2011)
- Human Development Report 2016 (United Nations Development Programme 2016)
- Budget, Fiscal Space and Child Well-being Analysis for Children in Saint Lucia (UNICEF 2016)
- Saint Lucia Social Protection Policy (Government of Saint Lucia 2015)
- Final Report on Gender Aware Beneficiary Analysis of Saint Lucia's Public Assistance Programme (Xavier 2015)
- The Changing Nature of Poverty and Inequality in the Caribbean: New Issues, New Solutions (Caribbean Development Bank 2016)

The results of the literature review were verified through the field investigation and socio-economic survey as described below.

2.7.2 Field Investigation

The field investigation was conducted by Panorama team and ECMC in accordance with TOR Task 1.19 and included:

- Field observations
- Community consultations
- Land ownership and use survey

The *Public Consultation Report* included as an appendix to the *Project Inception Report, Geothermal Resource Development Project, Environmental and Social Impact Assessment* (Panorama 2017) prepared for this project provides detailed information on the stakeholder meetings.

The field investigation methods are described below.

2.7.2.1 Field Observations

Panorama, ECMC, DSD, and stakeholder representatives conducted a reconnaissance field tour of the proposed project sites on 3 August 2017. ECMC noted the general socio-economic environmental setting and the existing infrastructure during the field tour.

ECMC conducted a second reconnaissance field investigation on 9 September 2017, to define the number of households within the target areas for geothermal exploration and confirm the land use in the target areas. ECMC documented observations and took photographs during each reconnaissance field investigation.

2.7.2.2 Consultations

A public meeting was held in each affected community (i.e., Belle Plaine, Fond St. Jacques, and Mondesir-Saltibus). Project information was shared with the affected stakeholders and other interested community members during the public meetings. ECMC also documented stakeholder concerns, identified potential impacts, and discussed potential avoidance and mitigation options that will be considered in the project design and ESIA. Community meetings were held between 31 August and 3 September 2017. The notes of public consultation meetings are provided in Appendix C - Public Consultation Questionnaire and Notes.

For each community, surveys were conducted for a sample of the cluster of households near (within about 800 meters [2625 feet]) the target areas for exploration drilling. The purpose of the survey was to collect baseline socioeconomic information from a representative group of potentially affected stakeholders and to solicit their comments and opinions. A list of households was not available; therefore, in view of the time and budget limitations, 10 households in each cluster were randomly selected through house-to-house visits in each of the three communities. In most cases, the respondents (head of household) were present. Where the head of the household was absent, responses were sought from the next responsible adult.

A semi-structured questionnaire was designed to gather the baseline socioeconomic information from households. In developing the questionnaire, several questions were first generated by team members, then reduced and formatted. A few questionnaires were then pretested during the community consultation exercise. The questionnaire was designed to capture aspects of the households' socioeconomic situation including age, gender, family size, education, occupation, income, and land ownership. Respondents were informed about the proposed exploratory drilling and the ESIA process prior to administering the questionnaires.

Individual face-to-face interviews were used to administer the questionnaires for all households except one. A telephone interview was used for one respondent in Belle Plaine who worked in another district. In cases where the head of the household was absent, responses were sought from the next responsible adult.

The interviews were conducted during 5 to 11 September 2017 by Theresa Alexander-Louis who was assisted by the Community Liaison Officer, Ms. Gifta Jongué. The final version of the questionnaire used is attached as Appendix C – Public Consultation Questionnaire and Notes.

2.7.2.3 Land Ownership and Use Survey

ECMC conducted a land ownership and land use assessment to provide information on the ownership and use of lands that are likely to be affected by the project. The assessment included review of Saint Lucia Government land records, existing land legislation, and administrative practices with respect to land acquisition.

The land ownership and use survey was designed to identify potentially affected persons with legal title to land, as well as non-titled persons (family-land tenants, and informal dwellers on privately and publicly owned lands).

A reconnaissance field visit was conducted on 9 September 2017 to physically establish the number of households within the proposed drill site envelope and to confirm the existing land uses (residential, agricultural or commercial) of the communities within the potentially affected areas.

2.7.3 Data Analysis

The data obtained from the literature search and field survey were analyzed in accordance with TOR Tasks 1.20 and 1.21. Responses to the survey questions were coded and transferred from the questionnaires into a spreadsheet for the socio-economic survey. The data entry was checked for accuracy and the data was analyzed using simple database tools. Tables were used to present data.

The Land Registry and Titling Project (LRTP) map sheets and aerial photographs of the proposed location of the drill sites were used to evaluate land use impacts. The aerial imagery was used to provide information on buildings and other structures within the potential drilling areas. The legal identification (i.e., block and parcel number) was established for parcels that are wholly or partially within the boundaries of the potential drilling areas.

The ownership of each parcel on the LRTP map sheet was validated through a record search at the Government Land Registry. The type of land use and legal status of the potentially affected stakeholder was established in cases where the number of land users were more than the number of the sub-divided parcels. Where the boundaries of the proposed drilling sites were near existing or proposed roads as shown on the maps, the configuration and boundaries were realigned to allow the roads to form the proposed drilling site boundary. Similarly, where only a sliver of a parcel was contained within the proposed drilling site boundary, the boundary was realigned to omit that parcel entirely.

The results of this analysis are presented in Section 3.7.

2.8 COMMUNITY RISK ASSESSMENT

2.8.1 Literature Review

Panorama reviewed the geohazard and natural disaster vulnerability of the area in accordance with TOR Task 1.22. The island of Saint Lucia is exposed to multiple natural hazards and

potential adverse natural events that make its population, infrastructure, and economy vulnerable. The major natural hazards that can be anticipated in Saint Lucia include the following geohazard and natural disaster categories:

- Seismicity and earthquakes
- Landslides and slope instability
- Volcanic eruptions
- Geothermal gas emissions
- Hurricanes and tropical storms
- Floods
- Fire
- Health and safety
- Evacuation plans and contingency plans for potentially affected populations

The primary literature reviewed to identify the risk and vulnerability of geohazards and other natural disasters in Saint Lucia included the following:

- Country Hazards and Risk Profiles (United Nations Office for Disaster Risk Reduction n.d., The World Bank 2016, The University of the West Indies 2017)
- Saint Lucia Landslide Inventory Map (Global Facility for Disaster Reduction and Recovery 2017)
- Saint Lucia Landslide Susceptibility Map (Global Facility for Disaster Reduction and Recovery 2017)
- Natural Hazard Mitigation Plan (Government of Saint Lucia 2006)
- Saint Lucia National Flood Plan (Government of Saint Lucia 2006)
- Earthquake Contingency Plan (Government of Saint Lucia 2007)
- Landslide Response Plan (Government of Saint Lucia 2008)
- Hurricane Response Plan (Government of Saint Lucia 2002)
- Volcanic Eruption Response Plan (Government of Saint Lucia 2009)
- Soufrière Geothermal Resource - Integrated Exploration Report (Jacobs New Zealand Limited 2016)
- Volcanic Hazard Assessment for Saint Lucia, Lesser Antilles (Jan Lindsay 2002)

2.8.2 Field Investigation

DG conducted a visual assessment of the geology and soils of the target drilling areas on 7 September 2017. The existing conditions were also reviewed on aerial photographs.

2.8.3 Data Analysis

The existing risk levels were evaluated for each of the natural hazard categories using the data resources described above, and given a general rating of low, moderate, or high. The existing impact vulnerability of regionally applicable populations, infrastructure, or significant economic contributors (i.e., businesses, farms, and tourist attractions) were also evaluated and

rated in this manner. Project factors associated with drilling exploration and future geothermal power plant development were then analyzed to determine if they could:

- Change the existing risk levels;
- Change the existing vulnerability level; or
- Place project workers or project infrastructure at undue risk.

The results of this analysis are presented in Section 3.8.

3 RESULTS

3.1 WATER RESOURCES

The following section contains information pertaining to TOR Tasks: 1.2, 1.3, 1.6, and 1.8. The area of influence includes surface waters downstream of the project area and any water supply infrastructure that could be impacted by the project.

3.1.1 Literature Review Results

3.1.1.1 Watersheds

Regional

Saint Lucia is divided into 37 watersheds (Figure 3.1-1) that are characterized by steep topography due to the geotectonic nature of the island. Within these watersheds, 20 to 25 water catchments are used for domestic water supply (AGRICO Ltd. 2001). Most of the water consumed or used on the island comes from runoff from catchment areas in the upper reaches of seven catchments (also known as watersheds), which have headwaters mainly in the mountainous south-central region (Thomas-Louisy 2014). The most important rivers of the country are Cul de Sac, Canelles, Dennery, Fond d'Or, Piaye, Doree, Canarias, Roseau, Marquis, and Troumassee River (Food and Agriculture Organization of the United Nations, 2015).

Watersheds in the Project Area

The Belle Plaine drilling site is located within the Choiseul/Trou-Barbet watershed. The rivers flow through or adjacent to the potential drilling area from south to north. The drilling area drains to the east and north within the valley.

The Fond St. Jacques drilling site is located within the Soufrière watershed. The river borders the Fond St. Jacques drilling area. Water flows from east to west in the valley.

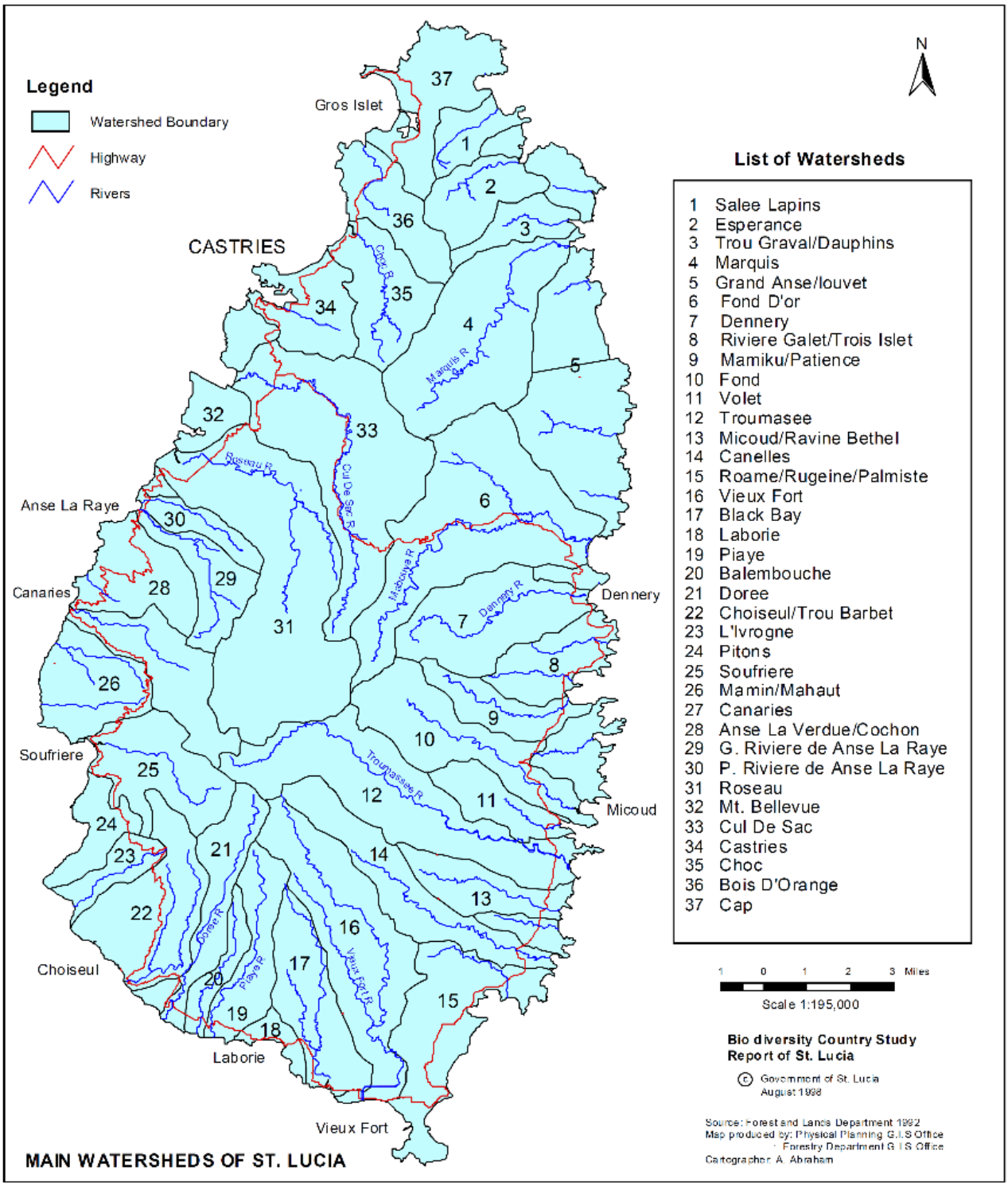
The Mondesir-Saltibus sites are located within the Doree and Balembouche watersheds. The rivers are located to the west and to the east of the potential drilling area. The river located to the west of the potential drilling area maintains perennial flow. The northern drilling area drains to the southwest and the southern drilling area drains to the southeast.

3.1.1.2 Groundwater

Regional Groundwater

Research conducted in the northwest of Saint Lucia in the 1960s indicated that there are good groundwater reserves. The exploration of groundwater began in Saint Lucia by drilling 14 wells in Union (in the northwestern region of the country). Of these wells, only two wells were reported to have produced 7 liters per second (l/s) (Norville and King 2001).

Figure 3.1-1 Saint Lucia Watersheds/Catchments



Source: Forest National Report on Integrating the Management of Watersheds and Coastal Areas in Saint Lucia, 2001

In the Soufrière area near the volcano, pyroclastic deposits are likely to bear good quality water. In addition to the geological context, tectonics have played a fundamental role in Saint Lucia, generating saltwater entrapments in some alluvial plains, especially in the west. These alluvial plains contain productive aquifers. The groundwater resources of Saint Lucia are restricted to the lower alluvial plains with reserves that could be suitable for small-scale uses.

The circulation of groundwater in volcanic islands is linked to more permeable horizons, normally with limited extension and with fault systems. According to the reported geochemical studies by (Aquater 1982), it is possible to say that a large portion of the infiltrated water flows into the sea through shallow aquifers.

The sources of water catchment are relatively small and are characterized by steep terrain with a fast rate of runoff and limited percolation.

Groundwater in the Project Areas

The project areas are located in the southwest region of Saint Lucia and no information about groundwater exploration is available. Most of the rainfall flows to the sea (west) with very little percolation or storage as groundwater due to Saint Lucia's rugged topography, and absence of intermediate collection points such as ponds and lakes (Jacobs 2016).

3.1.1.3 Water Quality and Chemistry

Regional Water Quality

Water quality depends on weather conditions and water uses. In dry times, the quality of the water worsens due to the minimal dilution of the existing chemical constituents in the streams. In times of flooding, the increased water volume helps to dilute the chemical pollution present. Even when such dilution is an advantage, flooding or wet periods cause other issues such as loss of soil surface cover, and increase in sediment load, clogged water-supply systems, causes and water-supply service suspension for habitants. In general, topographically higher areas are contaminated mainly by agricultural activities, while lower lands are polluted by domestic activities (Norville and King 2001).

The water quality of Saint Lucia's rivers has declined considerably in recent years due to an increase in agriculture, especially banana cultivation. Research carried out by the River Surveillance Monitoring Project (Lloyd et al., 1996) concluded that the variable that most affects Saint Lucia's ecosystems is the intensification of agriculture in combination with deforestation near water sources.

Project Area Water Quality

WASCO carried out chemical water studies from 2010–16 in Saltibus, and from 2010–17 in Fond St. Jacques (available data). For Saltibus, WASCO divided the studies into two parts: Upper Saltibus Raw Water (2010–13) and Upper Saltibus Treated Water (2013–16). In Fond St. Jacques, WASCO divided the analytical studies into four parts: Lower Fond St. Jacques Raw Water (2012–16), Lower Fond St. Jacques Treated (2010–17), Upper Fond St. Jacques Raw (2011–16),

and Upper Fond St. Jacques Treated (2010–17). Water quality sampling data in the project areas is provided in Appendix D – Water Quality Sampling and Stream Flow.

The analytical reports for both localities (Fond St. Jacques and Saltibus) included many physical chemical parameters as reported in Appendix D:

- pH
- color
- turbidity
- appearance
- odor
- conductivity
- dissolved oxygen
- residual chlorine
- total alkalinity as calcium carbonate ($CaCO_3$)
- total hardness as $CaCO_3$
- calcium hardness as $CaCO_3$
- magnesium hardness as $CaCO_3$
- chlorides as Cl
- fluorides as F
- free ammonia as NH_3
- nitrates as NO_3
- phosphates as P_2O5 and PO_4
- sulphate as SO_4
- silica as SiO_2
- free carbon dioxide
- nonfilterable residue
- total iron as Fe
- copper as Cu
- Manganese as Mn,
- aluminum as Al,
- total coliform
- fecal coliform
- Streptococci

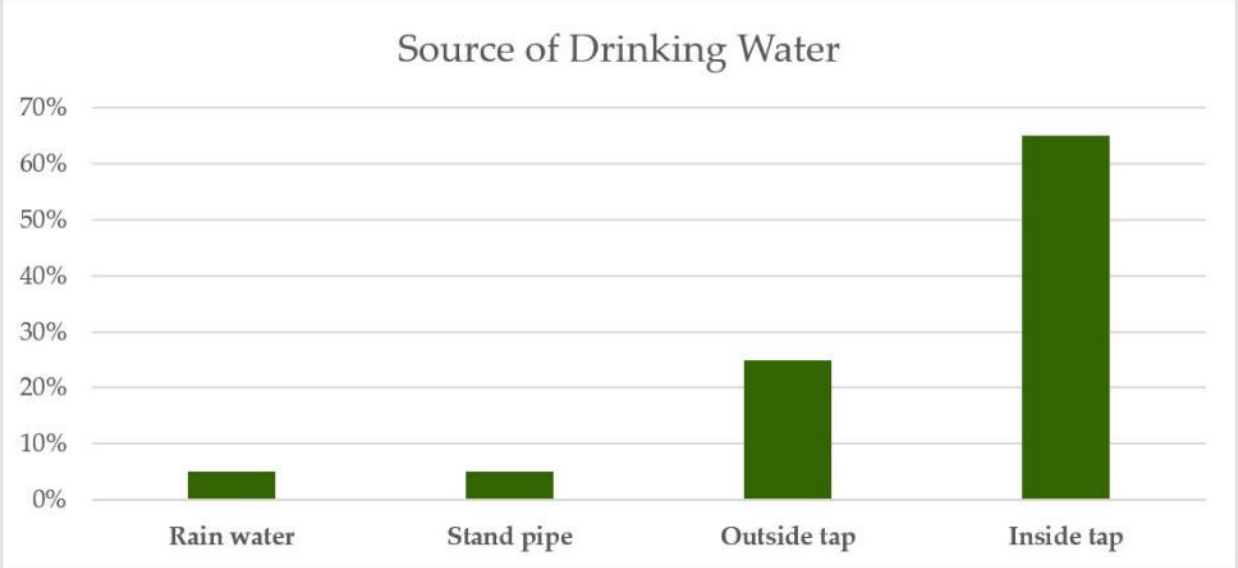
The World Health Organization (WHO) Guidelines for Drinking-Water Quality (World Health Organization 2017) state that "Water intended for human consumption should contain no fecal indicator organisms." Coliform is present within treated waters in Fond St. Jacques and Saltibus according to WASCO water quality analysis reports. Water from both sites is within the WHO allowable range for inorganic constituents.

3.1.1.4 Water Use and Supply

Access to Water

A survey of access to drinking water found that most residents are connected to the public supply (91 percent), with around 66 percent having a private tap inside their home and 25 percent having their tap on the outside (Caribbean Environmental Health Institute 2006). A minority of residents (around 8 percent) use standpipe and rainwater as their primary drinking-water sources. Around 90 percent of residents surveyed have regular water access, while 10 percent indicated intermittent supply (Figure 3.1-2).

Figure 3.1-2 Access to Drinking Water



Source: (CEHI, 2006)

Water Availability

The irregular distribution of rainfall tends to be problematic in the drier period of February to April in the absence of adequate collection and storage facilities (Norville and King 2001). In the dry season, available water comes from river base flows as well as from limited rainfall. The Island tends to experience periods of drought, especially in the southern region, when the stream flows tend to fall below known historic base flows. As a result, the entire residual flow of the sub-catchment is used for water supply, leaving the downstream segment completely dry.

The major concerns with respect to watershed management are uncontrolled agricultural intensification, poor agricultural practices, inappropriate land use, and direct and/or indirect discharge of untreated effluent into waterways (Norville and King 2001). Vieux Fort's water-supply system suffers from water-quality problems, resulting in the intake having to be relocated to the upper reaches of the watershed (ibid). Doing so, however, significantly reduces the available dry-season water supply. Such problems mainly result from inadequate public education and participation in conservation efforts.

Only a small portion of the public received a 24-hour supply of potable water in 2001 (Norville and King 2001). Water service reliability and access have improved in Saint Lucia due to implementation of the northern Water Supply Infrastructure Improvement Project funded by the World Bank and upgrading of the Hill 20 Raw Water Transmission Pipeline together with the new pumping system at Talvern, funded by CDB (WASCO, 2009). The improved water treatment capacity at Grave in Vieux Fort and upgraded intake at Woodlands in Vieux Fort also improved the water supply capacity to serve an additional 20,000 people (*ibid*). Collectively these water supply upgrades have substantially improved the reliability of water supply in Saint Lucia.

The northwestern region is essentially the main tourism belt of Saint Lucia as well as the region of preferred settlement. Around 60 percent of the population resides in the north and the current distribution network is unable to meet the growing demands of this region. In the southern region, the water-supply situation is even more critical (Table 3.1-1). There, raw-water

Table 3.1-1 Water Availability and Supply by Catchment Areas

River and catchment	Catchment area (km^2) from GIS	% Total area in use	Average base flow (l/s)	Average dry season base flow (l/s)	WASCO demand (l/s)
Marquis	30.55	100	240	150	53
Found d'Or	40.12	100	470	225	17 < 25
Dennery	19.25	100	270	137	8 < 10
Fond	18.00	100	285	150	8
Troumasse	32.43	100	285	150	8
Cannelles	16.83	100	300	150	13
Vieux Fort	28.99	100	480	250	75
L'Ivrogne	5.56	100	95	65	10
Soufrière	15.73	100	440	200	8
Canaries	24.24	100	300	175	8
Anse La Raye	8.91	100	175	87	5
Roseau	48.08	100	1050	550	14
Cul de Sac	38.8	100	500	237	25
Choc	13.55	100	100	50	10

Notes:
km^2 square kilometer
l/s = liters per second

Source: Modified from Norville and King, 2001

as well as treated-water storage facilities are inadequate to meet growing demand, especially in the dry season. The southern region of Saint Lucia has the most critical water supply needs because the area has been targeted for extensive development, which depend heavily on the availability of a reliable supply of water (Norville and King 2001).

Saint Lucia is viewed as a water-rich island; however, the drought of 2001 was a reminder that the country is susceptible to droughts. Awareness that drought conditions will reoccur on Saint Lucia spurred the creation of the Water Management Plan for Drought Conditions.

Water in the project area (southern Saint Lucia) is supplied by surface water intakes situated in the upper reaches of the watershed. Water supply is more critical in the southern portion of Saint Lucia (Norville and King, 2001). "…Research concluded that the most significant environmental variable affecting the reduction of diversity of the macro invertebrate (biological)

community of Saint Lucia's streams is the intensification of agriculture in combination with deforestation in the vicinity of the water supply stream intakes. This invariably leads to major deterioration in water supply quality and continuity" (Lloyd et al., 1996 in Norville and King, 2001).

Water Supply

Saint Lucia's water requirements are met through an integrated network of river intakes, treatment plants, transmission pipelines, and distribution systems. These system components are under the operation and control of WASCO. Saint Lucia uses four major potable water supply systems including Roseau Dam and Hill 20 in the north and Grace and Beausejour in the south. Water is supplied to the treatment plants through both gravity- and pump-conveyance systems. These systems treat and then disinfect the raw water in filtration plants.

Groundwater investigations in the 1960s indicated good reserves of groundwater, but due to water quality associated with hardness, salinity, and iron content, these reserves have never been exploited (Norville and King 2001).

Water Use

Water-use estimates from the Water and Sewerage Authority are provided in Table 3.1-2. WASCO does not track water use for agriculture. The WASCO currently allows farmers to withdraw water from raw-water mains for irrigation; farmers also irrigate using water drawn directly from rivers, and some small property holders use the domestic water supply.

Water outages are a common occurrence on Saint Lucia and hotels must truck in water; therefore, WASCO's water-use estimate for hotels does not reflect total hotel consumption.

Table 3.1-2. WASCO Estimated Use of Water Supply

Category	Percentage (%)
Domestic	90
Commercial	3.6
Government	5.64
Hotels	0.19
Boats/Ships	0.17
Agriculture	-
Total	**100**

Source: Modified from (Singh and Clouden 1999)

Water Treatment

Saint Lucia has two sewage systems. The first is a primary sewage collection and disposal system in the city of Castries, which serves approximately 15 percent of the greater Castries population and covers the business area. The second is a sewage system, which includes collection, treatment, and disposal facilities and is located in Rodney Bay on the north end of Saint Lucia, primarily serving residential areas and hotels.

Most of the residents of Saint Lucia use individual on-site systems (pit latrines, septic tanks, and soak ways) for sewage treatment and disposal. Grey water is generally discharged to open drains and has the potential to spread disease since it contains fecal coliforms (Government of Saint Lucia 2009a). "With the exception of areas in the north, all other areas are supplied by surface water intakes located in the upper reaches of the watershed within which these are located. Treatment at the Dennery, Canaries, Micoud and Anse-la-Raye intakes comprise slow sand filtration combined with chlorination while for all the others minimal sedimentation and chlorination is the only treatment provided." (Norville and King, 2001).

Water Use and Availability in the Project Area

Water is typically extracted from run-of-the-river intakes and treated to meet the potable supply requirements in nearby communities. Water from a local spring source is also used as a potable water source for the local community in Fond St. Jacques. Several factors could affect the water supply for a geothermal exploration project. Discussions with Mr. Jim King of WASCO indicated the potential for industrial water wells for large scale use in construction, as well as established tariffs to provide certainty when budgeting the project. In addition, WASCO has pre-approved contractors locally to transport water into on-site storage facilities in order to minimize impact on natural water sources. The only water supplies that may be available near the project area include streams near the drilling areas; however, water availability within the streams could be affected seasonally.

3.1.1.5 Stream Flow Conditions

Stream Flow Monitoring

In 1980, a water-monitoring network was established in 10 Saint Lucia watersheds. The number of monitoring stations by type are summarized in Table 3.1-3. All stations were discontinued for reasons such as shifting of the channel away from gauges, washing away of some gauges by Tropical Storm Debbie in 1995, and a lack of specialized local professionals (Flether-Paul n.d.).

Flow Rate Data

The Water Resources Management Agency of Saint Lucia provided stream flow data for 30 watersheds from 1985 to August 2017. The stream flow measurements were obtained during the dry and wet season. These data are provided in Appendix D. This information was not consistently obtained in a manner that allows for calculation of peak discharge under a 1 in a 100-year event; however, the data were analyzed to describe variability in stream flow conditions during the wet and dry seasons.

Table 3.1-3 Water Monitoring Stations in Saint Lucia

Type	Streamflow	Rainfall
Recording	2	25
DCP loggers	0	13
With telemetry	0	0
Manually read	0	6

Spot measurements	12	
Total	**14**	**44**

Source: Fletcher-Paul, w.d

Seasonal Flow Rate in the Project Area
The project areas drain to four watersheds:

- Choiseul/Trou Barbet (Belle Plaine)
- Soufrière (Fond St. Jacques)
- Doree (Mondesir-Saltibus)
- Balembource (Mondesir-Saltibus)

There is no stream flow measurements data for the Belle Plaine watersheds during the wet season. The Choiseul River downstream of the Belle Plaine area had a measured flow rate of 0.027 cubic meters per second (m^3/s) during the dry season in 2014.

The Soufrière River downstream of the Fond St. Jacques project area had a measured average wet season flow rate is 0.47 m^3/s and an average dry season flow rate of 0.42 m^3/s. These flow rates indicate the potential for low seasonal variability in stream flow in the Fond St. Jacques area.

The Doree watershed (Mondesir-Saltibus) has an average wet season flow rate of 0.44 m^3/s and an average dry season flow rate of 0.22 m^3/s indicating that the flow is seasonally affected. Stream flows are expected to be perennial in all area streams.

3.1.1.6 Drought Susceptibility

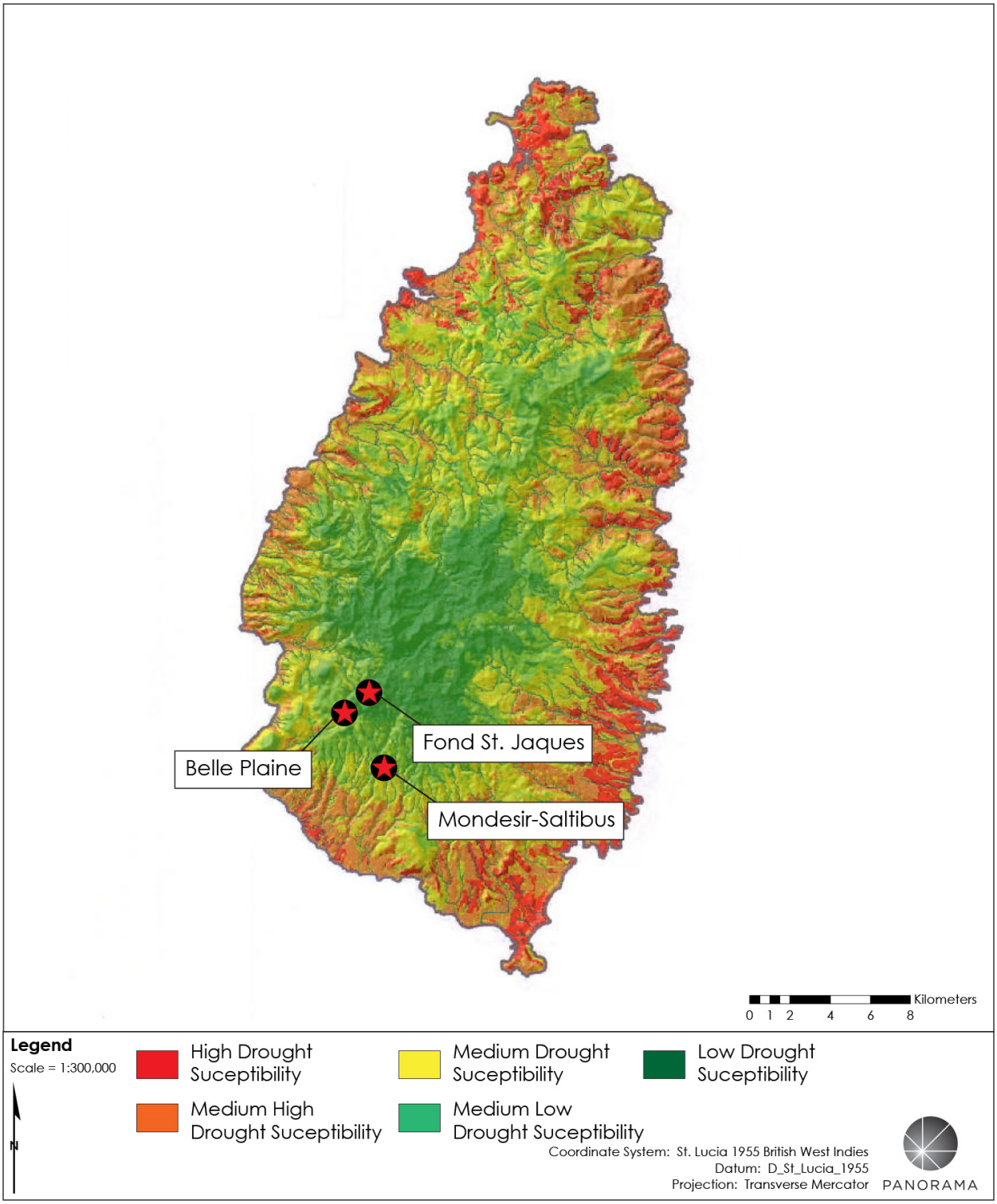
Drought Susceptibility Map
The Government of Saint Lucia produced the Drought Susceptibility Map under the Government of Saint Lucia Disaster Management Project II (Government of Saint Lucia, 2009). The Drought Susceptibility Map is based on:

- Annual water balance
- Flow accumulation
- Mean annual temperature
- Soil drainage
- Moisture supply capacity

In the map, drought susceptibility is given five orders, with red representing "High Susceptibility" and green representing "Low Susceptibility" (Figure 3.1-3).

Project Area Drought Susceptibility
The project areas are located in a region of classified as medium-low susceptibility to drought. Areas downstream of the project and along the coast are characterized as medium to medium-high drought susceptibility.

Figure 3.1-3 Drought Susceptibility Map



Source: (GOSL 2009)

3.1.1.7 Flood-Risk Assessment

Regional

Flooding is a risk in Saint Lucia, particularly flooding associated with hurricanes and tropical depressions. The Saint Lucia National Flood Plan (Government of Saint Lucia 2003) identifies five types of flooding:

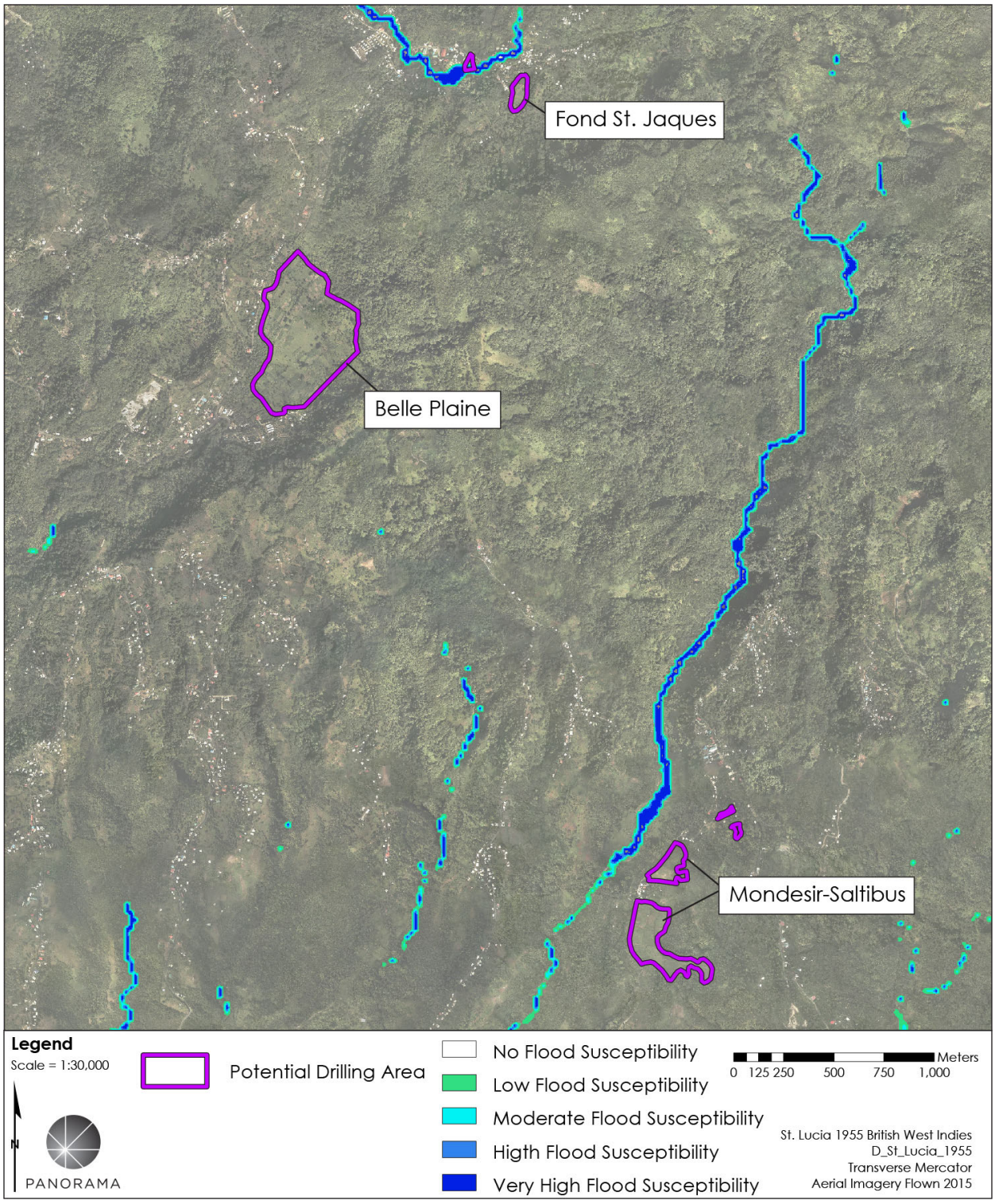
- **Flash floods**. Flash floods are the result of heavy rainfall over a relatively small drainage area. Flash floods carry highly destructive flood waves and are most common in mountainous areas or in steep places that have streams flowing through narrow canyons.
- **Riverine floods**. Riverine floods occur when a large amount of rain falls in river systems with tributaries that drain large areas containing many independent river basins. Riverine floods may last a few hours or many days, depending on the intensity, amount, and distribution of rainfall.
- **Land-based floods**. Some states are subject to relatively large amounts of rain in relatively short periods of time. Land-based floods can result, especially when such sudden rains are combined with steep terrain, porous soil, river basins, siltation, compromised (e.g., deteriorated, insufficient, or blocked) drainage systems, and unregulated deforestation of upland areas.
- **Coastal/tidal floods.** Coastal/tidal floods occur during high tides, hurricane rains, storm winds (which create a "suction effect" of reduced atmospheric pressure along a coastline), and tsunami waves produced by earthquakes or volcanic eruptions at sea.
- **Ponding.** Ponding results from a slow build-up of water in depressions, sinks, and areas with clay-base soil and slow percolation rates. Ponding may persist for many days because of poor drainage.

Flood hazard maps are used to define flood risk/susceptibility. Precipitation initially results in runoff in developed areas (e.g., roads and paved surfaces). Areas of clay soils with little vegetation and forested areas also contribute to runoff. The average Saint Lucia runoff from a 1 in 5-year event is 15 percent, increasing to 20 percent from a 1 in 50-year event. All major valleys in Saint Lucia are capable of creating floods, which is a danger for settlements along riverways (Jetten 2016).

Project Area Flood Risk

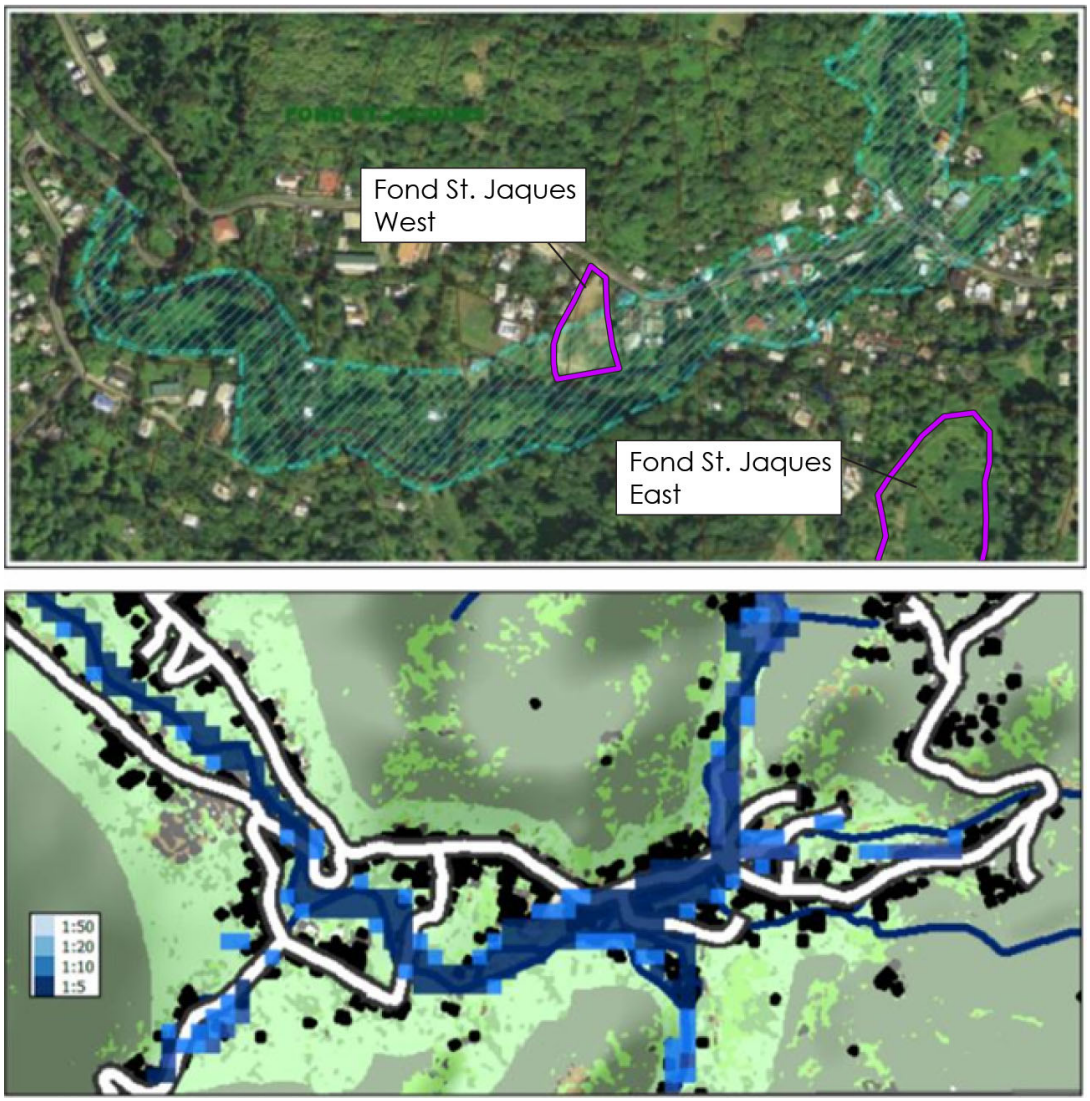
The flood-hazard assessment for the is shown in Figure 3.1-4. Fond St. Jacques has a greater risk of flooding due to the presence of steep terrain and narrow valley surrounding the river (Figure 3.1-5). Only the southwestern segment of MS-2 is located in the flood plain. The Belle Plaine area and the remainder of the Mondesir-Saltibus areas are not located in flood-prone areas and no flood risk mapping has been conducted for these areas.

Figure 3.1-4 Flood Risk Areas



Source: GFDRR 2016

Figure 3.1-5 Fond St, Jacques 2013 Flood-Hazard Assessment (top) and National Flood-Hazard Image (bottom)



Source: (Jetten 2016)

3.1.2 Field Survey Results

3.1.2.1 Belle Plaine

No water resources were identified within the drilling target area in Belle Plaine. Two streams have been identified in proximity to the drilling area. One stream flows towards the project area from south to north along the western edge of the valley. The stream may supply irrigation water to the site intermittently. The second stream is downgradient of the project and flows around the potential drilling area along the eastern border of the site. The potential drilling area generally drains toward the north and east. Storage tanks that are mainly used for runoff water were observed during field surveys. Water use in Belle Plaine is primarily managed for agricultural activities. Several greenhouses are located at the southern edge of the valley and just south of the potential drilling area. Streams along the western flank of the valley contained minimal flow during field investigation and these streams likely run dry for portions of the year. No springs or ponding of surface water was observed within the valley. There is limited potential for groundwater storage in the area due to the small size of the basin and surrounding drainage area.

3.1.2.2 Fond St. Jacques

Surface water resources in the Fond St. Jacques area includes two water courses. One of the water courses is a third-order stream that flows across the area from northeast to southwest and contains few visible floating solids. The second water course is a first-order stream flowing from southeast to northwest that has a considerable amount of visible floating solids and associated residues. These streams do not provide water to the local community. The water courses could not be accessed during field surveys due to recent rainfall and unsafe access conditions (i.e., loose slippery soils).

An unpaved road provides access from the main access road to the Fond St. Jacques East area. The Fond St. Jacques East area is characterized by a shallow water table (e.g., swamp like conditions) with an intermittent canopy of vegetation. A chain of steep hills bound the valley to the east of the potential drilling area. Dense vegetation and a stream are located south of the Fond St. Jacques East area. The stream supplies water to a local water storage tank that serves as the primary water source for the Fond St. Jacques community. Buried pipelines convey water from the water storage tanks to the community.

Two springs are located in the foothills on the southeastern flank of the potential drilling areas. The water that comes from these springs is stored in tanks (see Figure 3.1-6) and supplies the adjacent communities of Fond St. Jacques and Soufrière with freshwater. The water storage tanks are located approximately 40 meters (130 feet) west of the foothills and 25 meters (80 feet) from the local access road.

The main storage tank (Figure 3.1-6, left) is made of concrete and most of its volume is installed underground. This unit is connected to the spring by means of a pipe buried at shallow depth. The relative distance between the spring and the storage tank ranges from 8 to 10 meters (25 to

Figure 3.1-6 Water Storage Tanks in Fond St. Jacques Area (left and top right) Crops that use surface water (bottom right)



30 feet). An irrigation system was observed at the base of the foothills during field investigation filled.

Two plastic water storage tanks, which collect surface water, were observed in proximity to the drilling area. These plastic water storage tanks are used primarily for agricultural purposes (Figure 3.1-6). The water storage tanks have an estimated capacity of 189 liters (50 gallons) based on visual assessment.

3.1.2.3 Mondesir-Saltibus

The Mondesir-Saltibus area is primarily used for agricultural production including bananas, cocoa, coconuts, and vegetables. Water in the area is primarily used for agricultural production.

The primary water sources in the area include a third-order stream flowing in a north-northeast to south-southwest (NNE–SSW) direction, and a secondary, first-order stream flowing in a north-northwest to south-southeast (NNW–SSE) direction. Due to the high vegetation cover and the steep topography, only the valleys through which these streams flow were identified visually. The recent rains and slippery soil conditions during the field investigation prohibited any access and assessment of the water courses near the potential drilling areas. There is limited water supply infrastructure other than cemented roadside drainage ditches and pipes that supply water to the population.

3.1.3 Conceptual Hydrogeological Model

3.1.3.1 Regional Hydrogeological Conditions

Shallow groundwater aquifers within Saint Lucia are fed primarily by streams and river recharge. Deeper groundwater aquifers are limited in extent due to the low permeability and existence of aquitards (clay layers) created from hydrothermal alteration.

The deeper groundwater aquifers are expected to contain high levels of heavy metals, including manganese, due to the volcanic nature of the region. The geothermal aquifer is naturally separated from the groundwater aquifer by aquitards, which limit infiltration and cross-contamination of geothermal resources with surface water or shallow groundwater resources.

The overall geology of St. Lucia (due to volcanic activity and provenance) provides limited sedimentary basins, such as sandstone or limestone, which are common for groundwater basins. The steep topography along with fracture networks and streams lend to drainage as opposed to ponding and groundwater storage.

Preliminary assessments identified three main catchment areas, or sources of groundwater, on Saint Lucia associated with the surface features:

1. Grande Riviere du Vieux Fort,
2. Troumassée River, and
3. A third, slightly smaller catchment area associated with Anse la Reye.

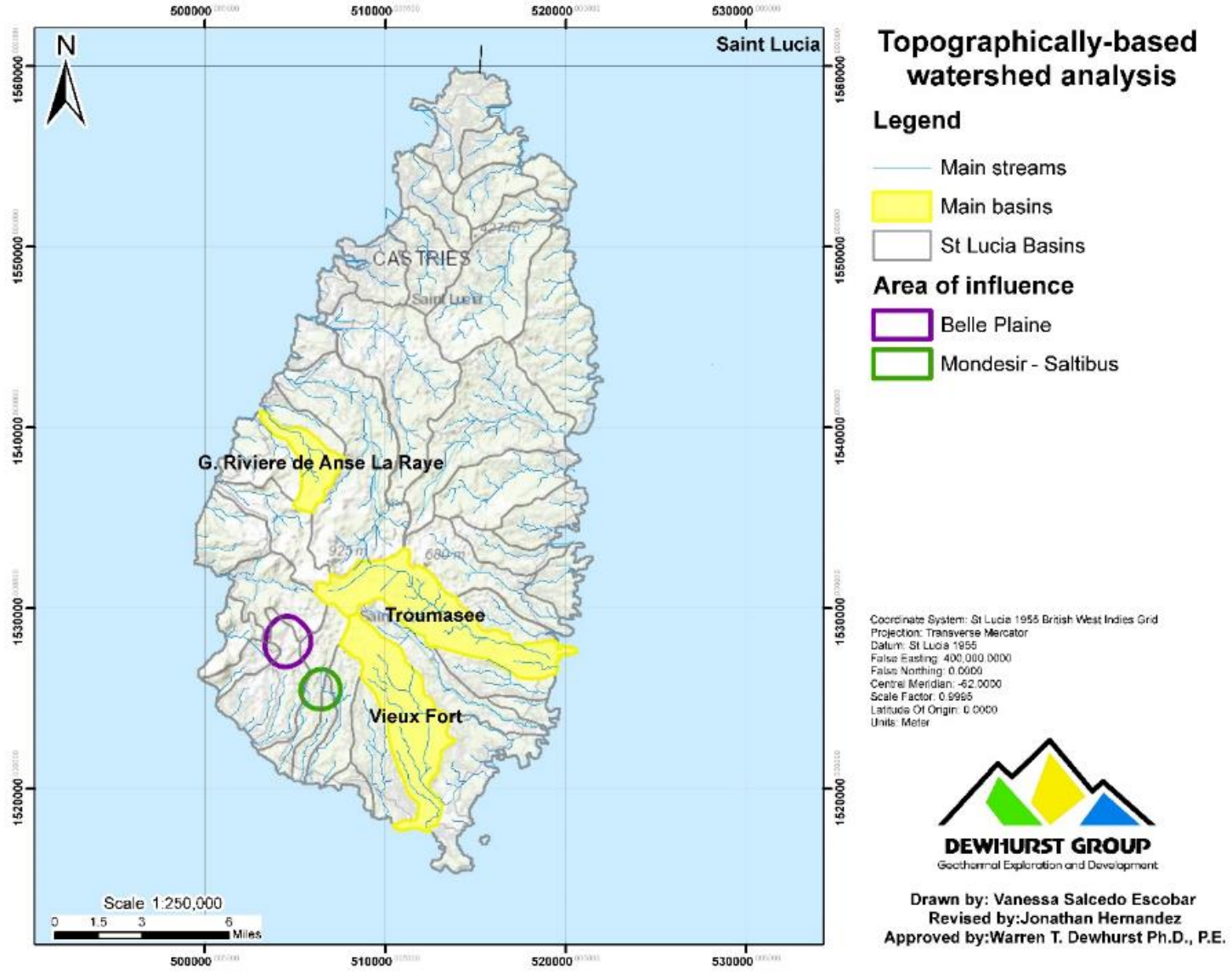
The surface area within each catchment is provided in Table 3.1-4 and Figure 3.1-7. None of these sources of groundwater are within the areas of influence for the project.

Table 3.1-4 Summary of Major Catchment Areas

Catchment Name	Surface Area (approximate) km^2
Grand Riviere du Vieux Fort	27
Troumassée River	29
Anse La Reye	5.8

Previous hydrogeological studies document the presence of structural controls possibly associated with the Qualibou Depression through which many of the surface hydrothermal manifestations occur in New Jerusalem, Cresslands, Spike Falls, and Diamond. All of these manifestations are in the deposits of blocks and ashes at the base of the Qualibou Depression. This geologic unit could serve as the aquifer that controls the shallow outflow of fluids from the Sulphur Springs, with manifestations of this outflow breaching the surface where vertical permeability structures are intersected (JACOBS - Lovelock and Ussher 2016).

Figure 3.1-7 Saint Lucia Groundwater Basins



Source: After Morgan, 2007

A study carried out in 1986 (Flynn et al., 1998) indicates that the fractured and jointed lavas can serve as transmissive aquifers. There may be an impermeable zone over the geothermal resource consisting of altered old rocks of basaltic composition and andesitic pyroclasts that are composed mainly of clays.

3.1.3.2 Hydrogeological Environment/Conceptual Hydrogeological Model

Groundwater Resources/Storage in the Project Area

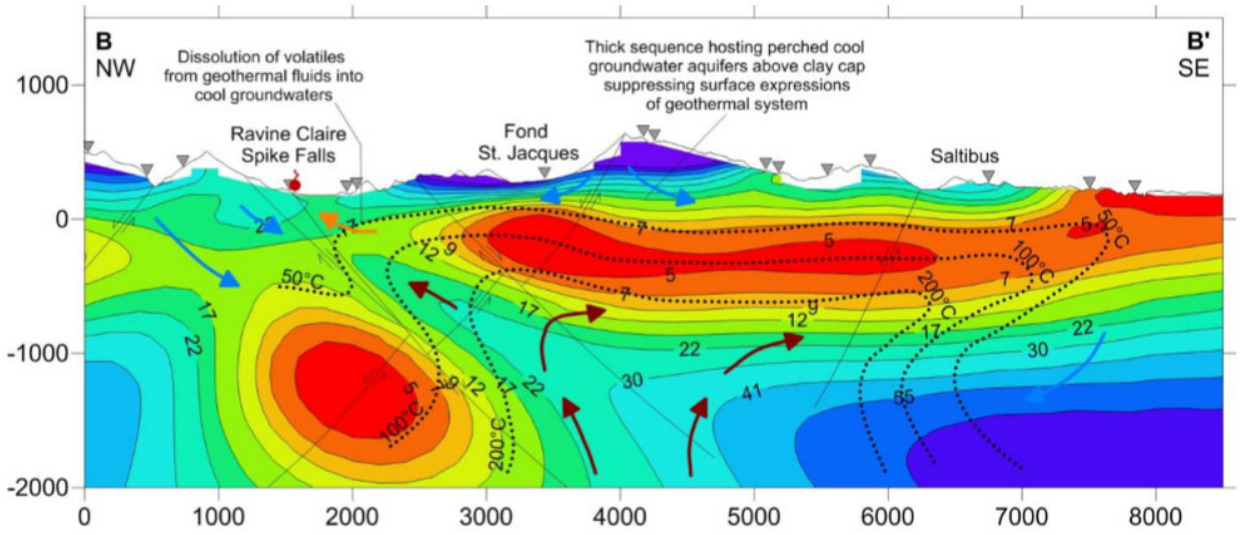
Rainwater runoff from topographically high areas, including the mountains surrounding Belle Plaine and Fond St. Jacques, recharge groundwater aquifers in the valleys. The groundwater aquifers in the project areas are expected to be limited in size/volume due to the volcanic nature of the geology in the project areas and the small basin and alluvial area that could contribute to the groundwater system. Groundwater aquifers typically occur in areas with underlying sedimentary soils; volcanic bedrock is not conducive to groundwater storage.

Belle Plaine is located in a valley. Runoff from the surrounding mountains could contribute to groundwater recharge in the Belle Plaine Valley. The Belle Plaine drainage area is limited in size resulting in limited potential for groundwater recharge and storage. Mondesir-Saltibus is located on a hill slope where some shallow groundwater may occur due to proximity to nearby streams and stream recharge. The topography of the Mondesir-Saltibus area is not expected to support substantial groundwater resources because groundwater would runoff the hill slope rather than collect in the area. There is currently no data available to support the presence of cool groundwater in either Belle Plaine or Mondesir-Saltibus. A perched groundwater aquifer was observed in the Fond St. Jacques drilling area where a spring discharges from the hill slope.

Jacobs of New Zealand (2016) developed a conceptual hydrogeological model of the area of influence (shown in Figure 3.1-8) using the results of the seismic study (refer to Section 3.2.1 and Figure 3.2-1). The conceptual model shows the presence of a clay layer, which suppresses surface expression of the geothermal system. The cool groundwater aquifer is perched above the clay layer. The hydrothermal alteration appears to occur at relatively shallow depths just at or below sea level. Surface manifestation of the geothermal resource occurs along fractures where there is upflow, such as in the vicinity of Ravine Claire Spike Falls.

Fond St. Jacques shows evidence of perched cool groundwater aquifers above the clay cap, which suppresses surface expressions of the geothermal system (Jacobs 2016). This perched cool groundwater aquifer was observed during field investigation. A spring and and shallow groundwater/saturated soils were observed at Fond St. Jacques. The presence of a perched groundwater aquifer/spring indicates that the clay caps of the geothermal system are a factor in groundwater storage, providing high impermeability at lower depths, allowing for storage within the subsurface—likely within fracture networks as opposed to porosity. Similar scenarios of groundwater storage above geothermal clay caps could exist in Belle Plaine and Mondesir-Saltibus; however, no subsurface investigation has been conducted in these areas.

Figure 3.1-8 Schematic Conceptual Hydrogeologic Model



Source: Jacobs, 2016

Potential Mixing of Groundwater and Geothermal System

Recent geophysical studies (JACOBS - Lovelock and Ussher 2016) of the project area indicate the presence of a geothermal upflow zone between Belle Plaine, Fond St. Jacques, and Mondesir–Saltibus (Parc Estate), with a northwest - southeast trend. The Jacobs (2016) study also concludes that the outflow of deep geothermal fluids starts from this zone of upflow and moves toward zones topographically lower, west and southeast of the zone of interest. The outflow of shallow steam-heated waters occurs east of Fond St. Jacques. No heated springs were observed in the project areas indicating that the water resources in the project area are isolated from the geothermal system by an impermeable layer.

Water quality sampling and analysis was conducted on the shallow groundwater system in the vicinity of Sulphur Springs (Aquater 1982). The water quality analysis indicates that, except for tiny admixtures of geothermal steam causing geochemical anomalies for ammonia, boron, and carbon dioxide, no extensive mixing of shallow water with either the underlying reservoir brine or its steam takes place. This condition strongly suggests that impervious or self-sealed rocks intervene between the geothermal reservoir and the surface.

3.1.4 Data Gaps

The water quality and geology field investigation took place in Saint Lucia during the end of the summer months and encountered conditions that limited access. Safety is always prioritized over data acquisition during field surveys. The steep terrain and rainfall during the field visits provided hazardous conditions at times restricting access to area streams and other water bodies. The best possible visual assessment was made in good faith, and provided within this report. Other hazards included livestock and other wildlife on private property, such as the farm lands of the Belle Plaine drilling site. Fond St. Jacques also contained livestock as well as

swampy terrain that made passage difficult to the east, and to the west of the site. Mondesir-Saltibus is bounded by rivers, which were visually assessed in the field; however, access to the rivers was not possible due to previous rain and steep topography.

A detailed conceptual hydrogeological model for the area of interest could not be developed at this time due to the absence of key data on the aquifers in the area of interest. The current conceptual model is based on assumptions and inference from the remote sensing data. The conceptual model is speculative and additional data would be required to validate the conceptual hydrogeological model including:

- The geometry of the hydrogeological units and their hydraulic properties (e.g., hydraulic conductivity, storage coefficient, and porosity)
- Piezometrics, temporal variability, direction of groundwater flow, and hydrochemical characteristics and variations
- The recharge and discharge mechanisms of the system
- Classification of aquifers
- A preliminary water balance
- The hydraulic interconnections of surface water and springs with groundwater, in both shallow and deep systems

The preliminary hydrogeological model of the area of influence was developed using topographical data, field investigation, and the results of the magnetotelluric data. Very little is known about the recharge, size, and volume of the shallow cold water aquifer(s) or the deep geothermal reservoir. Geological features within Saint Lucia suggest that the host rock for the deep geothermal reservoir under the clay cap could be heavily fractured lava flows that appear to have structural control in the location of the thermal manifestations. The extent and specific locations of underground connectivity and permeability among the shallow aquifer and deep geothermal reservoir remains uncertain.

3.2 GEOLOGY AND SOILS

The following section contains information pertaining to TOR Task: 1.5. The area of influence includes all soils within the potential drilling area and area of civil works because the exploration areas would only affect soils within the drill sites and areas where grading is conducted.

3.2.1 Literature Review Results

Saint Lucia is volcanic in origin, with rocks that vary in age between the Tertiary and the Quaternary era. The geology of Saint Lucia is divided into three categories (JACOBS - Lovelock and Ussher 2016):

- Eroded basalts and andesites;
- Dissected centers of andesites; and

- Extensive deposits of pyroclastic flows, lava flows, phreatic and phreatomagmaticcraters, domes, and flows of rock and ash from the volcanic center of Soufrière.

Some sedimentary units are located in the northeast section of Saint Lucia formed by the erosion of coral reefs of the lower Miocene.

It is believed that the volcanic activity of the Island's southwestern sector began in the Pleistocene. Structures such as craters and domes have been identified. Surface geothermal manifestations such as fumaroles and hot mud pools are active along faults. The most interesting thermal features are found in the Sulphur Springs area, which is located near the caldera. Other notable locations with geothermal manifestations are located in the north, including Spike Waterfall and Piton falls.

The Qualibou caldera is located in the southwest of Saint Lucia. This main feature was initially identified in 1964 and was formed between 40,000 and 300,000 years. Studies by (Aquater, 1985) concluded that the caldera collapsed 300,000 years ago, while (Goff and Vuataz 1984) estimated the collapse at 100,000 years ago. Subsequent to this collapse, volcanic eruptions that formed domes and deposits of ash filled the caldera. Figure 3.2-1 shows the geology of the Qualibou caldera, which is bounded to the NW and SE by NE-striking normal faults (JACOBS - Lovelock and Ussher 2016).

Saint Lucia is located in an archipelago of volcanic islands, which was formed by the collision of the North American and South American plates under the Caribbean plate (Lindsay 2013) . The data support the notion that the Qualibou Depression is (or has recently been) situated in an extensional regional-stress regime with the principal horizontal stress oriented NW–NNW. Intra-arc environments are known to be favorable settings for geothermal development. The data are consistent with a model of recent magmatic and geothermal activity in the Terre Blanche-Belfond region. The prospective region to the south of the Qualibou Depression is controlled by a NW-striking accommodation zone, with additional secondary permeability perhaps provided by the interaction with large NE-striking structures and faults (JACOBS - Lovelock and Ussher 2016).

3.2.1.1 Geochemistry

Geothermometric calculations of reservoir temperatures from H_2/Ar - CH_4/CO_2 gas ratios give a range of 190–300°C, generally consistent with temperature calculations of 292°C on fluids obtained from borehole sampling (UNRFNRE 1989), and 280°C as estimated from gas geothermometers (GI 1991). The most recent geochemical studies have shown that the geothermal water has not reached chemical equilibrium with the host lithology; geothermometry data are therefore considered unreliable.

3.2.1.2 Water Analysis

Samples of the geothermal reservoir indicate that they are low-chloride, high-boron waters, with a presence of amorphous silica and a relatively low discharge rate, all of which would

indicate a vapor-dominated system. The silica content indicates subsurface temperatures exceeding 180°C (Goff, F. and Vuataz, F. 1984).

3.2.1.3 Geophysics

The following geophysical studies have been carried out in the area of interest:

- Magnetotelluric Surveys
- Seismic surveys
- Magnetic surveys
- Gravity surveys
- Temperature surveys
- LiDAR

The results of these geophysical surveys are discussed below.

Magnetotelluric Surveys

The magnetotelluric/audio magnetotelluric (MT/AMT) resistivity surveys indicate that the northern and northeastern part of the Qualibou Depression has intermediate resistivity values and few clear structures. The survey results are consistent with a resource that was hydrothermally altered in the past, but subsequently cooled, and is not currently thermally

active. Resistivity patterns indicate that the Sulphur Springs system is confined to a relatively small area, but may extend up to 1 kilometer (km) (0.6 mile) to the east and southeast of the thermal area. It is plausible that large NW-striking faults in this region (i.e., those along the Migny River valley and those offsetting drainage to the west of Saltibus) are controls of geothermal upflow (Jacobs, 2016).

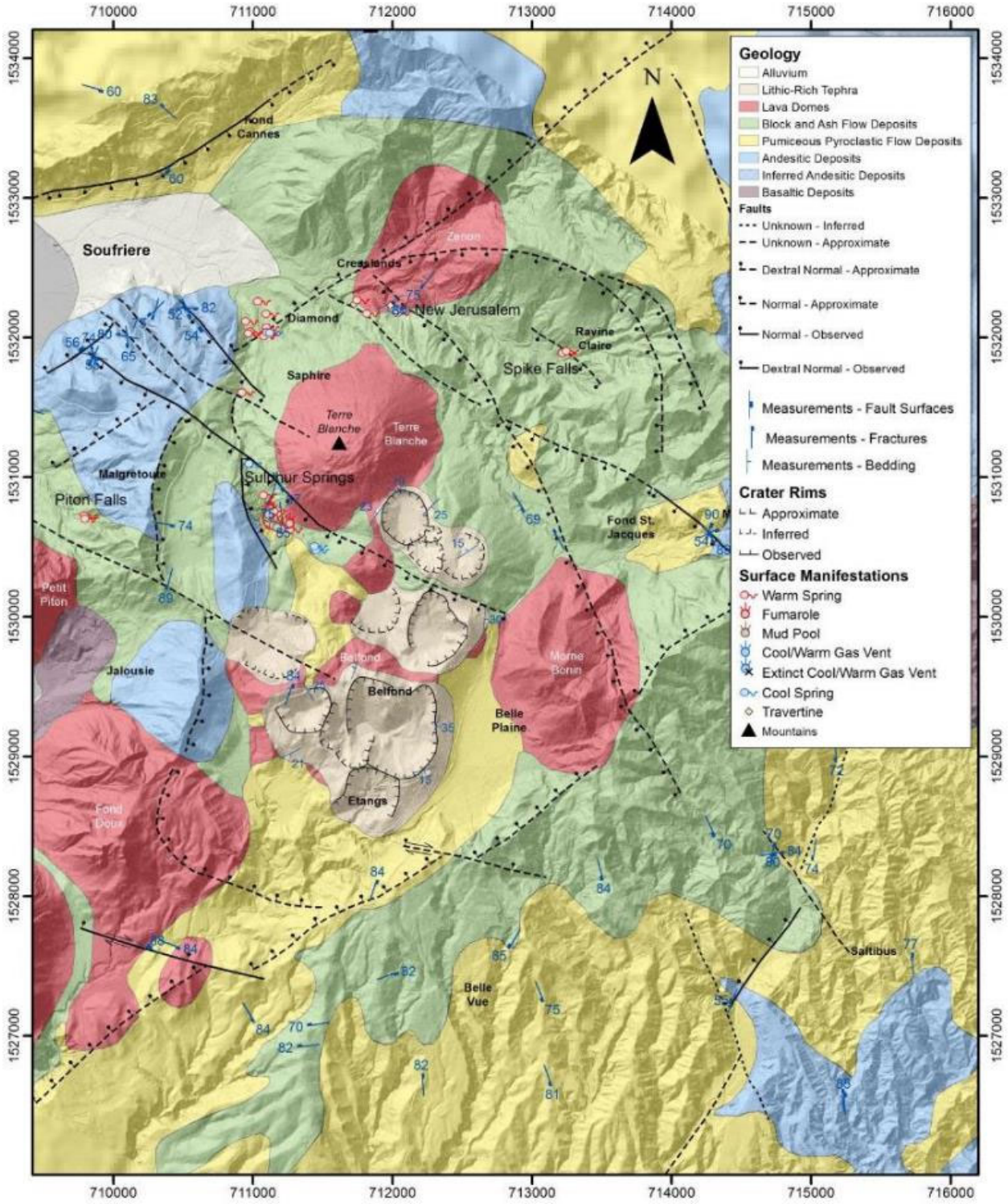
Seismic Survey

(Aspinal, Michael and Tomblin 1976) performed a microearthquake survey at Qualibou caldera. The seismic records are characterized by emergent P-waves and missing or attenuated S-waves, characteristics that denote the presence of fluid bodies (magma or water) at depth. Analysis of the data indicates that the attenuating medium occurs at depths less than 2 km (1.2 miles), extending from Sulphur Springs to the north caldera wall; thus, these researchers conclude that a geothermal system occupies this zone. The distribution of known hot springs inside the caldera is coincident with the attenuating zone (JACOBS - Lovelock and Ussher 2016).

Magnetic Survey

An aeromagnetic survey was performed in previous studies, and is considered extensively within the Jacobs report (JACOBS - Lovelock and Ussher 2016). The strongest feature of the aeromagnetic anomaly map is the broad zone of low magnetic strength surrounding Sulphur Springs and extending over the area encompassing the lower-elevation warm springs and extending further NE into the high terrain west of Mt. Gimie, located approximately 3 km (1.5 miles) northeast of the Fond St. Jacques area. These features may be indicative of a widespread area of hydrothermal alteration that may be caused by some alteration associated with the

Figure 3.2-1 Geological Map of the Qualibou Depression and Surroundings



Source: Jacobs, 2016; Lindsay et al., 2013; and Wohletz et al.,1986

outflows of warm condensate fluids at quite shallow depths from the Sulphur Springs area (Jacobs New Zealand Limited, 2016).

Gravity Survey
(GENZL, 1992) suggests that the most prominent anomaly may be due to a NE-trending down-faulted depression that has been in filled with denser volcanic material. Lindsay et al. (2003) suggest that the gravity high points could be due to the presence of a denser intrusive body which counts against caldera collapse where infill material would comprise less dense pyroclastics.

Temperature Survey
Seven shallow geothermal wells and two deep geothermal wells (SL-1 and SL-2) were previously drilled near Sulphur Springs. SL-2 encountered a geothermal resource and reached a temperature of about 260°C; SL-2 reached a depth of 1408 meters (4619 feet) and showed a very high geothermal gradient (220°C/1000m). Figure 3.2-2 illustrates the different temperatures and depths of each well.

Measures of Deep Resistivity in the Qualibou Caldera
A dipole-dipole resistivity study was made along the N-S trend, through the Qualibou Caldera north of Ruby to the north of Victoria Junction (stations near Sulphur Springs). An apparent low resistivity value was found below the Belfond area indicating that geothermal waters occur at a depth of 600 to 900 meters below ground surface, and locations with low resistivity (<10 ohm-m) corresponded to hot springs. A very low resistivity zone (1ohm-m) was found below the Etangs area, which may be associated with thermal upwelling along a fault zone, perhaps associated with the boiler. Below the Sulphur Springs area, a zone of relatively high resistivity (40-150ohm-m) was found, suggesting the presence of a very hot field of dry steam below Sulphur Springs (Aquater 1982).

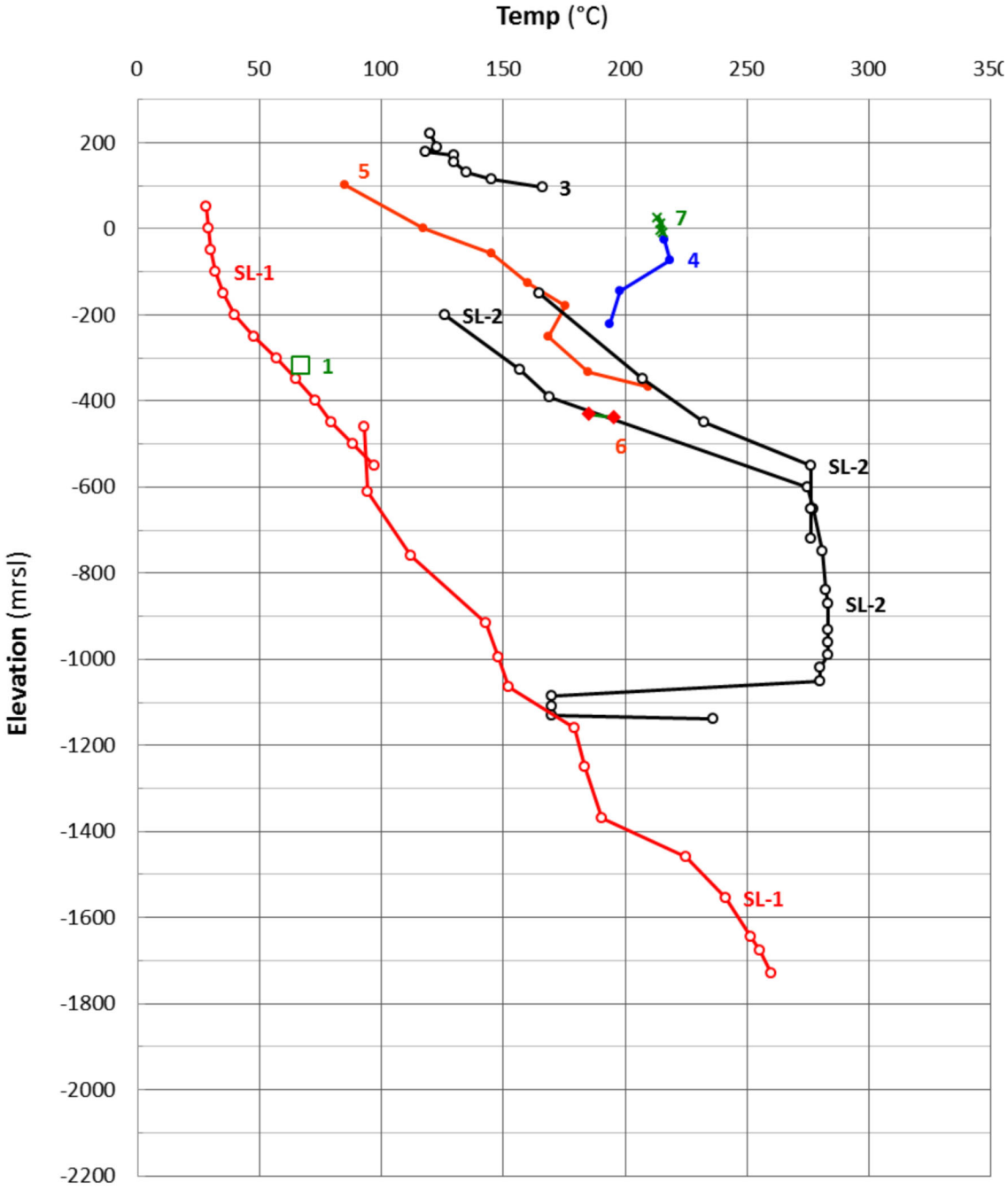
LiDAR
In 2016, McElhanney Consulting Services Ltd. carried out a LiDAR survey with orthophotos in the Soufrière region, covering an area of approximately 75 km^2. The LiDAR data were used to create a digital elevation model (DEM) from the contour data. DG used the DEM data to analyze streams and rivers for the various catchments and their potential flow order (i.e., 1, 2, and 3).

Hydrogeochemical Studies of the Qualibou Geothermal System
Hydrogeochemical data suggest the presence of a geothermal reservoir beneath Sulphur Springs, divided into three layers:

1. An upper zone of condensed steam
2. A two-stage intermediate zone
3. A lower-brine zone

Chemical analysis of Sulphur Springs fluids indicates the presence of an acid-sulphate system, of low pH, high concentrations of SO_4 (sulfate), low Cl (chloride), temperatures of 24°C, and pressures of < 32 ba (barye). These conditions suggest a vapor-dominated system. Gas

Figure 3.2-2 Measured Temperature for Geothermal Exploratory Wells in Saint Lucia



Source: Jacobs 2016

geothermometry for this area indicates a reservoir temperature of 280°C (Goff and Vuataz 1984). The complex brine chemistry suggests a fluid that is not in equilibrium. A detailed conceptual model of the southwest of Saint Lucia is show in Figure 3.2-3.

Heat Origin

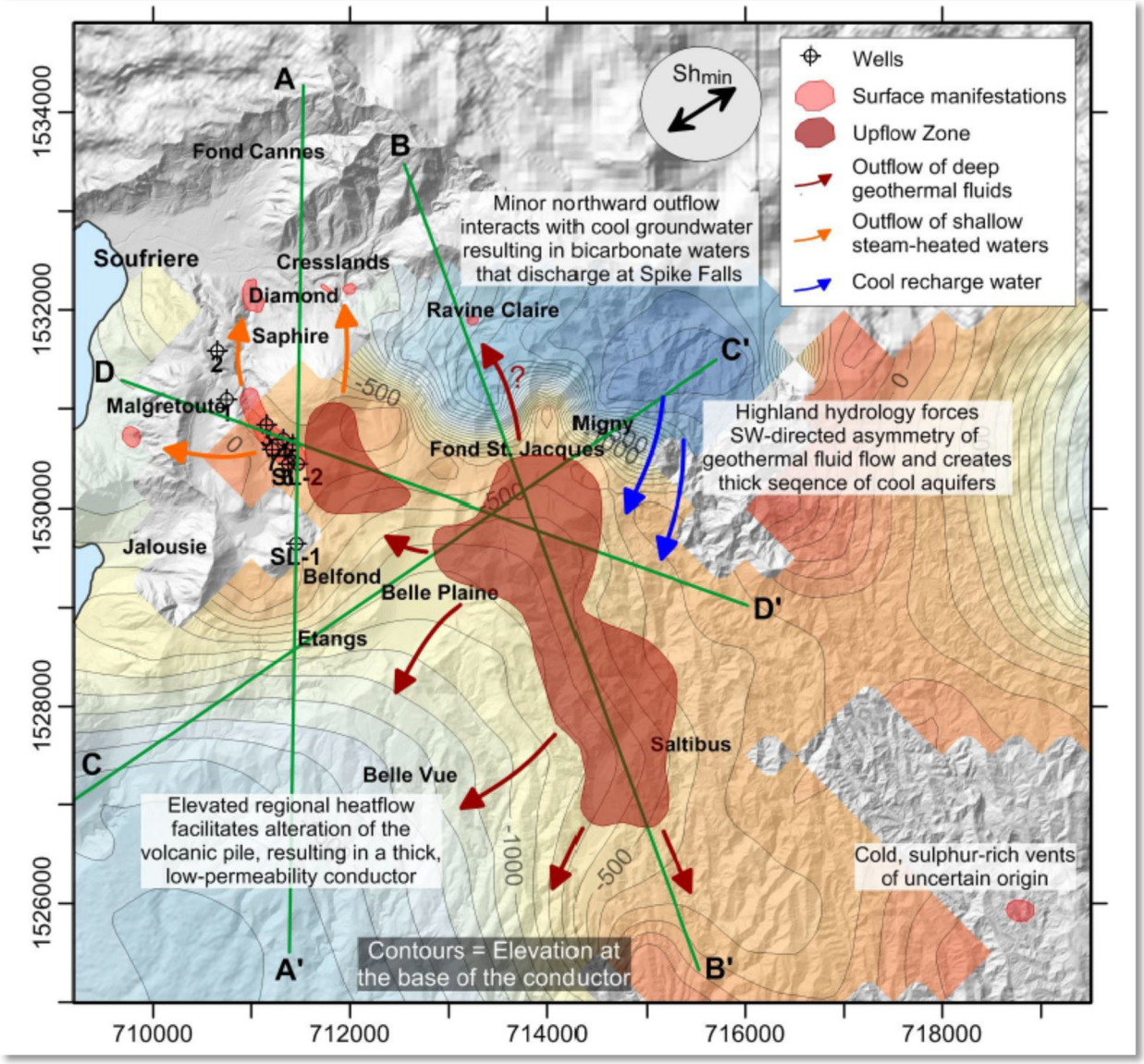
The natural heat of the geothermal resource comes from the cooling of a shallow magmatic chamber below the Sulphur Springs area, the same as the Terre Blanche and Belfond dacitic eruptions of 15 to 20 thousand years ago (JACOBS - Lovelock and Ussher 2016).

3.2.1.4 Soils

Soil Types

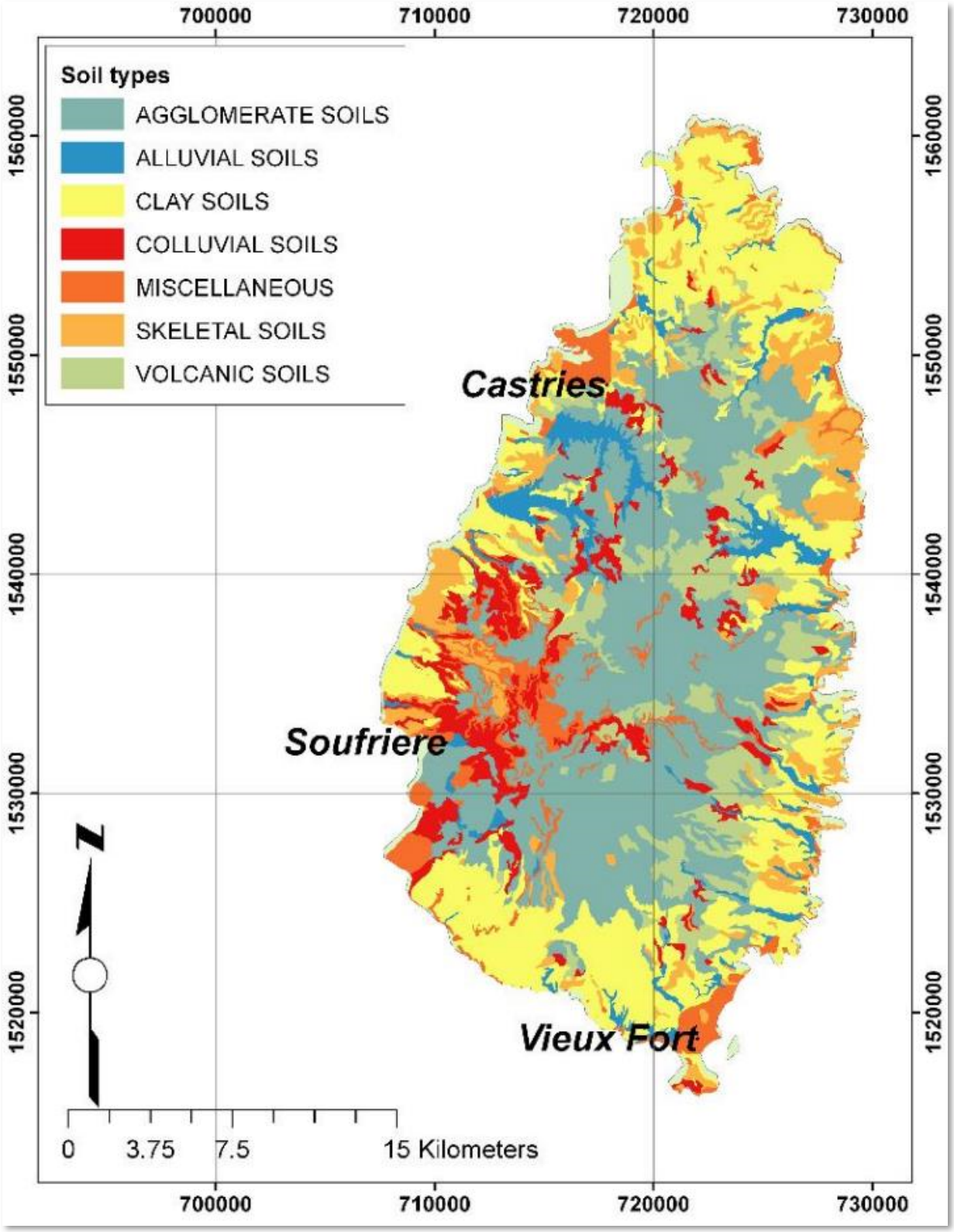
The Soil Atlas of Latin America and the Caribbean generally classifies soil in Saint Lucia as a Cambisol, between Vertic Cambisol (CMvr) and Eutric Cambisol (CMeu). The soil texture class ranges from fine to very fine; the soil has a 30 to 45 percent average grain size of sand without gravel content. The soils are moderately well drained (Gardi 2015). The soils of Saint Lucia are generally kaolinite clays in the center of the Island and montmorillonitic clays in the coastal areas that tend to be drier (Cox, Sarangi and Madramootoo 2006). Microorganisms and plant degradation are the main agents that allow the fertility of the soil, which is typical of tropical soils. The soils are particularly acidic, and generally low in phosphorus (Gonzales and Zak 1994). The high concentration of clayey tropical soils is the result of weathering of the volcanic rocks combined with weathering of soils in river valleys, sedimentation and over-sedimentation, erosion, landslides, and other soils actions. Distribution of primary soil types is illustrated in Figure 3.2-4 (Quinn 2012).

Figure 3.2-3 Conceptual Geothermal Model (Cross sections are shown as green lines)



Source: Jacobs, 2016

Figure 3.2-4 Soil Types in Saint Lucia



Source: (Quinn 2012)

Erosion and Soil Loss

A study of agricultural soils showed that the loss of soil cover is very high as a result of high storm intensity (Cox, Sarangi and Madramootoo 2006). The impact energy of the raindrops during heavy rains breaks the surface energy of the soil aggregates; sediment flow then runs to the macropores and creates a sealing that reduces the percentage of infiltration and generates rapid erosion. The high rate of erosion generates loss of soil fertility and sedimentation of the water systems that are essential in agricultural productivity, especially in the lower valley (Food and Agriculture Organization 2000). According to Saint Lucia's *Initial National Communication on Climate Change* (Tulsie 2001), the following factors relevant to erosional processes are considered major threats to the agricultural sector:

- Loss of vegetation cover in watersheds
- Lack of proper soil conservation practices
- Inappropriate land use, and degradation of soils

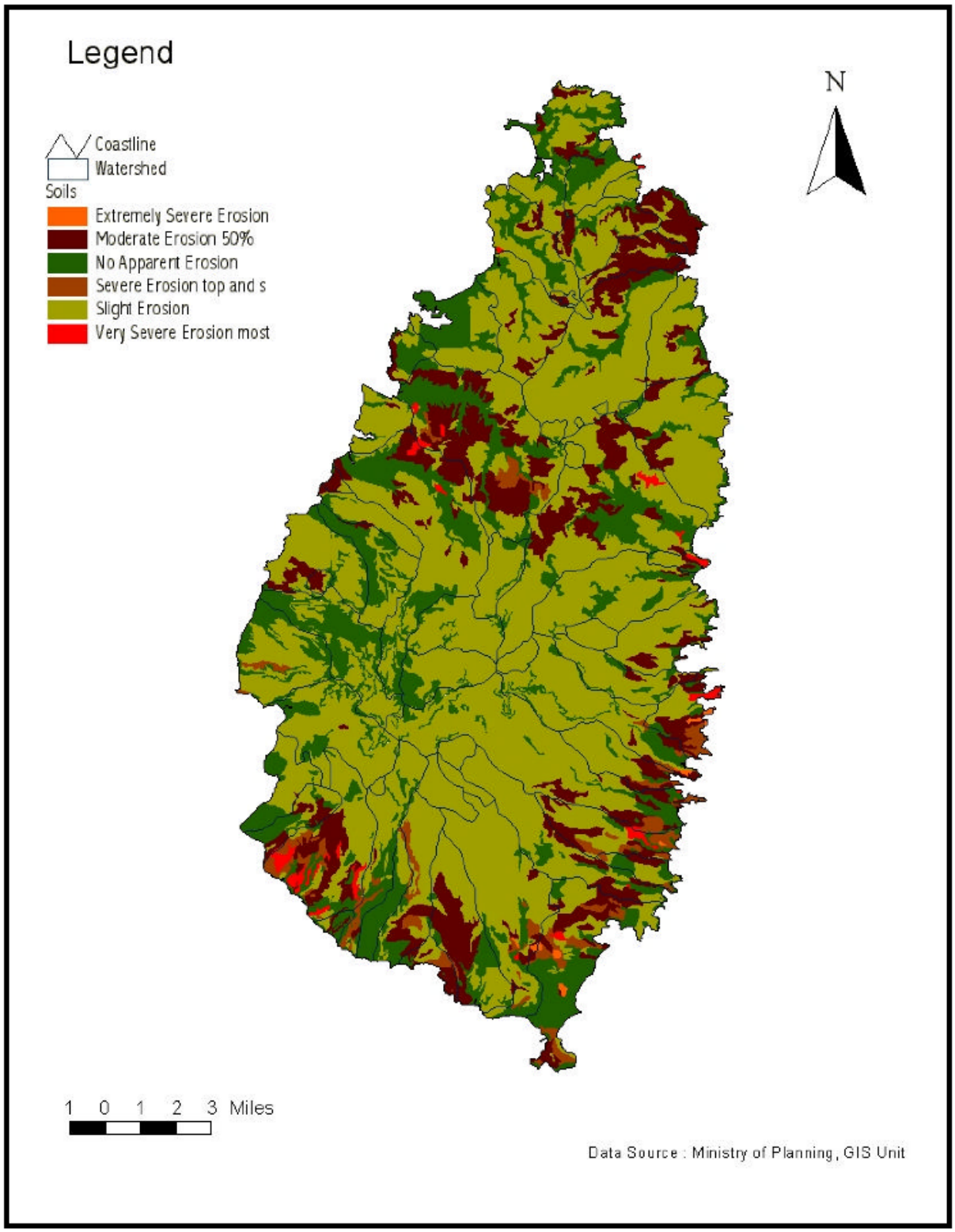
Figure 3.2-5 shows the different levels of erosion throughout Saint Lucia, indicating that the coastline is most susceptible to erosion. The agricultural sector is also very vulnerable to erosion (Reisdorff 2008).

Erosion is the most severe environmental problem in Saint Lucia. Erosion results in chain reactions (e.g., loss of plant land and nutrients, runoff concentration, flooding, and damage to infrastructure) that generate direct and indirect impacts on the economy, tourism, infrastructure, and food supply. More than 90 percent of annual soil erosion is generated in short periods of hours or days (Norville and King 2001). Soil erosion also degrades water quality by causing sedimentation in waterways.

The following factors also contribute to degradation of soil quality in Saint Lucia (Norville and King 2001):

- **Loss of nutrients or imbalances in the soil.** On lands with some degree of inclination, soil tends to lose nutrients by surface runoff, causing agricultural workers to over-feed nutrients.
- **Overfertilization.** Acidification of the soil by overfertilization, which causes pH to drop to values between 4.6 and 5.0.
- **Use of pesticides and herbicides.** The CEHI indicates that the use of pesticides does not affect degradation, however monitoring is needed to evaluate the impact.
- **Disposal of both human and natural waste**.
- **Waterlogging in flat areas**. Waterlogged soils pose problems for agricultural production.

Figure 3.2-5 Erosion



Source: Saint Lucia Department of Physical Planning, 2017

3.2.2 Field Survey Results

Agricultural production was observed in each of the three project areas. Potential sources of soil contamination that are associated with the observed land use include:

- Potential fertilization and acidification of the soil
- Potential application of pesticides and/or herbicides
- Potential disposal of waste

No soil contaminants or application of herbicides or pesticides was observed during the field investigation.

3.2.2.1 Belle Plaine

Belle Plaine is located in a wide, flat valley surrounded by steep mountains. Geologically, this area is characterized by pumice pyroclastic flow deposits. The soil is used for agricultural production, including bananas, cocoa, and coconuts. The area is also used for livestock grazing (cattle and goats). There are no structures associated with water management, but small agricultural shacks for the farm workers are located between the crop rows.

3.2.2.2 Fond St. Jacques

Fond St. Jacques is located in a small valley surrounded by steep mountains. The geology of the area is composed of block and ash flow deposits that possess a high permeability, through which several freshwater springs flow. It is evident that this area has extensive agricultural activity located on both flat and mountain slopes; crops include bananas, coconuts, and cocoa, among others. Some structures are associated with water management, as seen in Figure 3.1-6.

The area around and within the potential drilling area is a shallow, moist valley with scattered vegetation. Saturated soil conditions were observed during field investigation; however, the field investigation was conducted during the rainy season and it cannot be determined whether saturated soil conditions persist year-round due to the nearby spring, or if the saturated soils are a seasonal condition that was reflective of recent rains.

3.2.2.3 Mondesir-Saltibus

Mondesir-Saltibus (Parc Estate) is located on a plateau with water systems nearby. The geology of the area is composed of pyroclastic flows containing pumiceous and andesitic deposits. The outcrops of these units can be found along the road cuts on the eastern side of the main road adjacent to the area. Mondesir-Saltibus is widely used for growing bananas, cocoa, coconuts, and other vegetables, especially toward the hillsides. Some structures associated with water management, such as roadside drainage, were observed in the area.

3.2.3 Data Gaps

No data were available on soil contaminants in the project areas. Potential sources of soil contamination and methods to address any contaminated soils are addressed in Section 4. See Section 3.1.4 regarding field survey limitations due to inclement weather conditions.

3.3 AIR QUALITY

The following section contains results pertaining to TOR Task 1.11. The area of influence for the air quality analysis is areas within approximately 1 km (0.5 mile) of the drilling target areas because air emissions would dissipate over this distance.

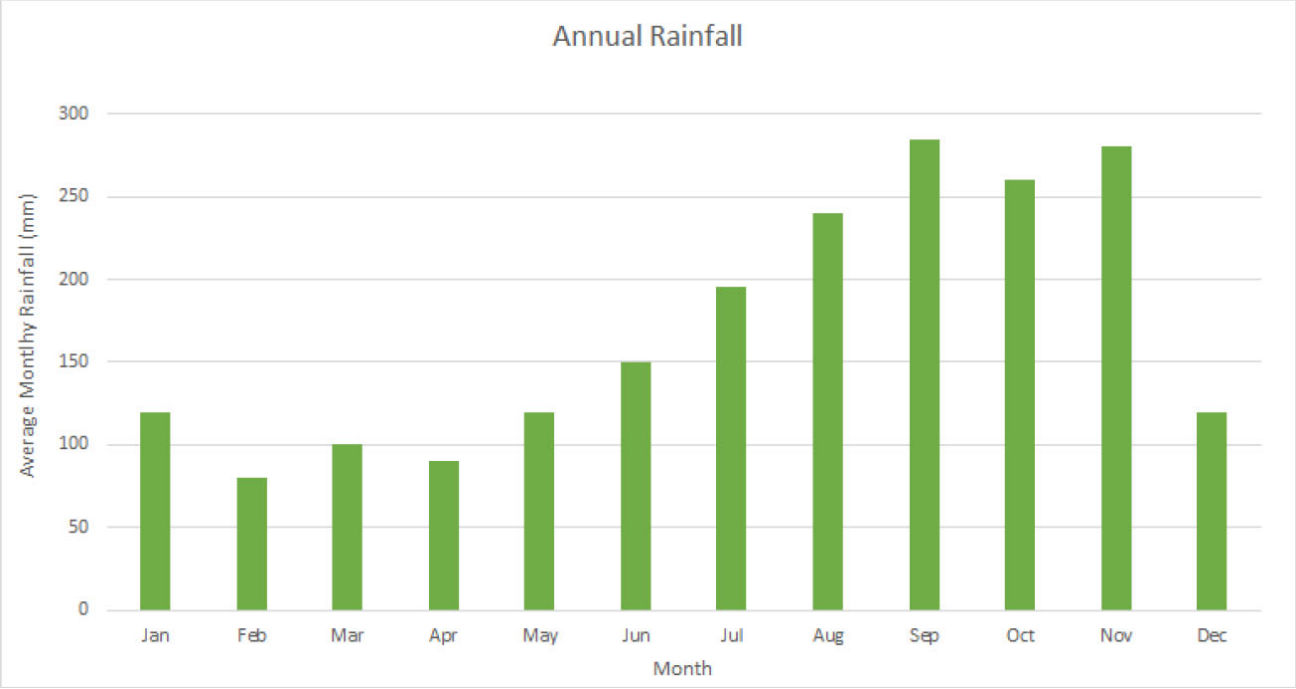
3.3.1 Literature Review Results

3.3.1.1 Precipitation

Saint Lucia's climate is tropical maritime. Most precipitation occurs during August and November; mean annual precipitation ranges from 1,500 mm (59.1 inches [in]) over the coastal areas to approximately 3,800 mm (149.6 in) in the interior of the Island (Caribbean Environmental Health Institute 2006). The average annual rainfall is shown in Figure 3.3-1. The drought seasons are between December and April. Saint Lucia is vulnerable to hurricanes, especially in late summer months.

The average daytime temperatures are between 26°C to 32°C, with an average relative humidity around 75 percent.

Figure 3.3-1 Annual Rainfall (Vieux Fort Town, Le Resource, La Retraite, La Tourney, Black Bay, Laborie, Savannes Bay, Augier, Grace, and Joyeux)



Source: Caribbean Environmental Health Institute - CEHI, 2006

3.3.1.2 Meteorological Conditions

Meteorological data from the Hewanorra International Airport for the period of March to December 2014 is presented in Table 3.3-1. This representative dataset shows that the rainy season occurs during the months of July to November. It should also be noted that hurricanes are active this season. The average temperature is 27°C, with a wind direction that runs approximately E-W, with relative humidity at approximately 77 percent.

Table 3.3-1 Meteorological Data March–December 2014 (Hewanorra International Airport)

Month	Wind direction (°s from true North)	Wind speed (knots)	Average temperature (°C)	Average rainfall (mm)	Relative humidity (%)	Average hours of sunshine
March	88.2	15.36	26.4	38.0	73	8.5
April	95.5	16.08	27.2	40.7	73	10.0
May	93.2	15.32	27.6	25.0	74	9.4
June	90.3	17.16	28.3	65.2	76	8.5
July	89.6	16.14	28.1	107.0	77	8.9
August	91.8	13.41	28.0	164.6	81	7.8
September	92.3	11.77	28.3	169.7	79	8.8
October	92.1	9.36	28.1	154.9	80	8.4
November	89.2	14.38	27.8	245.4	80	8.4
December	80.6	12.36	27.2	21.8	76	9.8

Source: (Joseph and Beckles 2015)

3.3.1.3 Air Quality Monitoring

The University of the West Indies completed a study of ambient sulfur dioxide (SO_2) concentrations within and around the Soufrière Volcanic Center to measure emissions from the geothermal hot springs and fumaroles (Joseph et al, 2015). Diffusion tubes were used to collect SO_2 samples at various sites in and around the Volcanic Center. Samples were collected from April to December 2014 to obtain results during different climatic conditions.

The results of the University of West Indies study indicated that "during the dry season period of April to July 2014 concentration at sites closest to the main vents at [the Volcanic Center], which are routinely used by staff and visitors, frequently exceeded the WHO 10-minute AQG for SO_2 of 500 $\mu g/m^3$. However, for sites that were more distal to the main venting area, the average monthly ambient SO_2 did not exceed the WHO 10-minute AQG for SO_2 of 500 $\mu g/m^3$ during the entire monitoring period. The measured concentrations and dispersion patterns of ambient SO_2 at [the Volcanic Center] appear to be influenced by rainfall, proximity to the fumarolic vents, altitude (local topography), local atmospheric circulation and plume dispersion, and anthropogenic sources."

The SO_2 concentrations at the Sulphur Springs site are not representative of the SO_2 concentrations in the project areas because the SO_2 from the springs is expected to disperse at the distance of the project areas. During the ESIA field study a set of NO_2, SO_2 and H_2S diffusion sampling tubes were installed at the same position as the site 6 samples taken during the University West Indies study to evaluate whether there is any relationship between air quality in the project area and air quality at Sulphur Springs. These results are presented in section 3.3.2 below.

3.3.2 Field Survey Results

The results of the SO_2, NO_2 and H_2S diffusion tube sampling over a 20-day period in the project vicinity are provided in Appendix A. The 20-day average concentration results indicate low ambient concentrations of NO_2, SO_2, and H_2S at all sites with the exception of Sulphur Springs. The 20-day average concentrations were well below the World Health Organization (WHO) Guidelines. WHO guidelines specify 10-minute maximum concentrations of 500 $\mu g/m^3$ for SO_2, a 1-hour average of 40 $\mu g/m^3$ for NO_2 and a 30-minute average of 7 $\mu g/m^3$ for H_2S.

The Sulphur Springs site was installed next to the main hot spring area within the Soufrière Volcanic Center. The results from the Sulphur Springs site showed significantly higher concentrations of SO_2 and H_2S. H_2S concentrations exceed WHO guidelines of 7 $\mu g/m^3$. It should be noted that the WHO guidelines are for annoyance, with potential eye irritation likely not caused until concentrations reach 150 $\mu g/m^3$ or above. A 20-day SO_2 average concentration of 292 $\mu g/m^3$ was measured at the Sulphur Springs site. This average SO_2 concentration was below WHO guidelines and in line with concentrations measured during the University of West Indies Study, which showed monthly average concentrations ranging from 177 to 623 $\mu g/m^3$ between April and December 2014. The higher concentrations measured at this site should be excluded when evaluating baseline conditions for proposed drilling sites because they are not representative of ambient conditions away from the hot spring area and closer to population centers.

3.3.3 Data Gaps

Ambient air quality monitoring was conducted over a three-week period during the rainy season. Sample tubes at 3 of the 15 sampling locations (Fond St. Jacques, Castries base station and the Soufrière Fire Station) were affected by vandalism or lost due to storms; these data are therefore unavailable for analysis; however, data from other locations were consistent and it is expected that air quality at these stations would be similar to locations other than Sulphur Springs. The air quality data also represent a snap-shot in time and the data could be somewhat affected by seasonal weather conditions such as tropical storms during the monitoring period.

Fine particulate matter <10 microns (PM_{10}) data were not be collected at the time of field survey because PM_{10} cannot be collected with diffusion tubes and rain conditions would have affected the results. PM_{10} measurements should be collected during the dry season when the agricultural fields could generate dust emissions Recommendations regarding future air quality monitoring are provided in Section 4.3.2.

3.4 NOISE

The following section contains results pertaining to TOR Task 1.10. The noise area of influence includes areas within 1 km (0.5 mile) of the drilling sites because drilling noise would attenuate over this distance.

3.4.1 Literature Review Results

Noise monitoring took place during drilling of SL-1 and SL-2 geothermal exploration wells with dosimeter readings around the pumping stations on a regular basis to create iso-decibel maps (Associates in Rural Development - Dulin and Hannah, 1988). Infrastructure and drilling operations were heard within a 1 km (0.5 mile) radius of the drilling sites based on resident surveys (Associates in Rural Development - Dulin and Hannah, 1988). Mufflers were recommended, but not used during operations, resulting in high noise levels during drilling (Associates in Rural Development - Dulin and Hannah, 1988).

3.4.2 Field Survey Results

Noise levels measured in the project area of influence are provided in Table 3.4-1. The highest maximum peak noise level (119.5 dBA) was recorded at NS8-A. The high peak noise level was caused by a passing dump truck approximately 20 meters (65.6 ft) from the data logger. The lowest noise level (30.0 dBA) was measured in the Belle Plaine area near the local generator when the generator was not running.

The noise data was generally consistent during the monitoring period with the exception of intermittent interruptions such as traffic, children, wildlife, livestock, and light rainfall. The weather conditions did not substantially affect the noise monitoring results because noise monitoring was not conducted during periods of heavy rain or high winds. Peak noise measurements and causes for the peak measures are noted in this section as well as on the graphs found in Appendix B - Noise Monitoring.

The noise levels documented in the project area of influence are consistent with a rural environmental where the noise sources are predominantly natural (e.g., wind, water, wildlife, and farm animals). Other noise sources included mobile (e.g., traffic) and stationary sources encountered along roadways.

Table 3.4-2 provides the extreme high and low noise levels measured within each area of influence during daytime noise surveys. Noise levels at night are lower than during the daytime due to reduced vehicle activity.

Table 3.4-1 Noise Monitoring Results

Date	Site	Time Start (HH:MM:SS)	Time End (HH:MM:SS)	Min (dBA)	Max (dBA)	Average (dBA)	Mean (dBA)	Std. Dev.
5-Sep-17	NS1	10:40:58	10:56:06	38.1	58.5	44.9	44.9	2.0
5-Sep-17	NS2	11:18:30	11:34:02	43.5	91.2	63.7	63.4	5.9
5-Sep-17	NS3	11:49:08	12:04:58	30.0	81.1	48.4	48.1	5.2
5-Sep-17	NS4	12:29:09	12:44:29	32.9	67.0	44.5	44.3	4.7
5-Sep-17	NS5	13:03:25	13:19:03	44.7	80.1	55.6	55.3	5.7
5-Sep-17	NS6	15:12:19	15:27:31	42.7	85.3	58.4	58.1	5.7
5-Sep-17	NS7	15:52:09	16:07:35	43.1	84.5	52.9	52.7	4.1
5-Sep-17	NS8	16:43:57	16:59:03	46.0	109.3	59.6	59.2	7.1
5-Sep-17	NS9	17:50:42	18:06:06	58.5	90.7	63.1	62.9	4.3
6-Sep-17	NS10	11:25:43	11:44:21	41.2	79.1	52.0	51.9	3.4
6-Sep-17	NS11	12:27:01	12:45:57	37.1	86.0	48.3	48.2	4.1
6-Sep-17	NS12	13:36:13	13:50:59	36.0	85.0	48.2	48.1	3.7
6-Sep-17	NS13	14:20:27	14:35:45	32.0	85.0	52.1	51.5	8.2
7-Sep-17	NS8-A	10:22:57	10:39:59	30.9	119.5	49.9	49.1	9.9
7-Sep-17	NS7-A	11:05:56	11:22:20	30.2	69.7	42.6	42.4	4.3
7-Sep-17	NS1-A	14:22:12	14:42:40	32.4	68.8	46.6	46.3	5.2
7-Sep-17	NS2-A	14:59:42	15:16:10	41.0	104.7	70.7	70.3	7.2
7-Sep-17	NS3-A	15:28:35	15:44:27	51.0	88.0	60.2	60.2	1.6
7-Sep-17	NS4-A	15:56:20	16:13:28	30.8	71.8	46.3	46.1	4.7

Notes:

dBA = A-weighted decibel scale.

Sampling times are GMT-4. Sites followed by "-A" are repeat measurements at the same location. GPS measurements taken on site with Trimble GEOXH Serial #5138477832

Table 3.4-2 Extreme Noise Levels by Project Area

Area of Impact	Noisiest/ Quietest	Site	Ambient Avg. (dBA)	High (dBA)	Low (dBA)
Belle Plaine	Noisiest	NS3-A	60.2	88.0	51.0
Belle Plaine	Quietest	NS3	44.5	64.7	30.0
Fond St. Jacques	Noisiest	NS2-A	70.7	104.7	41.0
Fond St. Jacques	Quietest	NS1	44.9	46.0	38.1
Mondesir-Saltibus	Noisiest	NS8	59.6	119.5	46.0
Mondesir-Saltibus	Quietest	NS8	42.6	65.0	30.2

The high noise levels shown above are attributed to the following factors:

- **NS2-A**. The high noise level was measured in the courtyard of the Fond St. Jacques primary school at the end of the school day at approximately 3:00 PM when children were present and yelling and interacting a short distance from the microphone equipment.
- **NS3-A.** The high noise measurement at Belle Plaine was recorded within 20 meters of a running diesel engine flatbed 4-axle truck that was idling throughout the duration of the noise measurement.
- **NS8.** A Large diesel engine truck on the main road near the noise monitoring station passed by during the recording.

3.4.3 Data Gaps

Noise monitoring was conducted during daylight hours exclusively. Night time transportation was not available and night time field work was not advisable due to security reasons. During the data acquisition, rain was noted within the noise data and may have had a minor effect on the recorded ambient noise levels.

3.5 BIOLOGICAL RESOURCES

The following section contains results pertaining to TOR Task: 1.12, 1.13. and 1.14. The area of influence includes the drilling sites and a 300-meter (1,000-foot) buffer for consideration of potential noise effects on birds. Biological surveys were not conducted within MS-3 or MS-4; recommendations for future surveys of these areas are provided in Section 4.5, below.

3.5.1 Literature Review Results

Numerous biological resource investigations have been conducted for the PMA, which is located to the west of the Belle Plaine and Fond St. Jacques areas. The steep slopes of both Pitons and Piton Mitan are home to a rich and unique flora. Gros Piton is one of the few areas left in the Caribbean where native dry and moist forest remains more or less unmodified. Roger Graveson has recorded 254 indigenous flowering plant species on the Pitons (this excludes common weedy herbaceous plants and plants only found on the flatter areas between and

around The Pitons and alien plant species) including three Saint Lucian endemic, twenty-two Lesser Antillean endemics and thirty-five Caribbean endemics. Forty-six plant species are only found in the PMA. Many species are extremely rare throughout their Caribbean range. Two new indigenous tree species were discovered during surveys of the PMA by Melvin Smith, *Crateva tapia* and *Erythroxylum oxycarpum*. Two endangered species, *Tradescantia zebrina* and *Callisia fragrans*, recently established in the PMA and threaten the biological diversity of the PMA. The PMA is listed as an Important Bird Area and is recognized for its diversity of avian species (Tha Landmark Practice 2013).

3.5.2 Field Survey Results

Flora and fauna species observed within the project area of influence are listed in Appendix E – Flora and Fauna Species Observations and Photographs, Tables E-1 through E-8. Photos of each project area and the surrounding habitat are also provided in Appendix E.

3.5.2.1 Vegetation Communities/Habitat Characteristics

The dominant land use/vegetation types in each drilling area are shown on Figures 3.5-1 through 3.5-3. The dominant vegetation types and habitat characteristics of each project area are summarized in Table 3.5-1, below. The drilling areas were characterized by a lack of native habitats or vegetation communities. Belle Plaine, Fond St. Jacques East, and the Mondesir-Saltibus areas are subject to widespread agricultural production. The Fond St. Jacques West area has been developed/disturbed and generally lacks vegetation or habitat. Native forest habitat occurs along the border of the Belle Plaine and Mondesir-Saltibus project areas.

3.5.2.2 Fauna

Table 3.5-2 provides a summary of the common faunal species documented in each project area and surrounding area of influence (i.e., habitat areas within approximately 300 meters [1,000 feet] of the potential drilling sites). The drilling areas were characterized by a lack of native habitats. Belle Plaine, Fond St. Jacques East and West, and MS-2 were very similar in composition of faunal community with many of the same bird, mammalian, herpetofauna, and insect species due to similar habitat conditions within and surrounding the drilling areas. The drilling areas were characterized by a lack of suitable habitat; however, the surrounding forested edge provides natural habitat for bird species.

Figure 3.5-1 Belle Plaine Habitat/Land Use

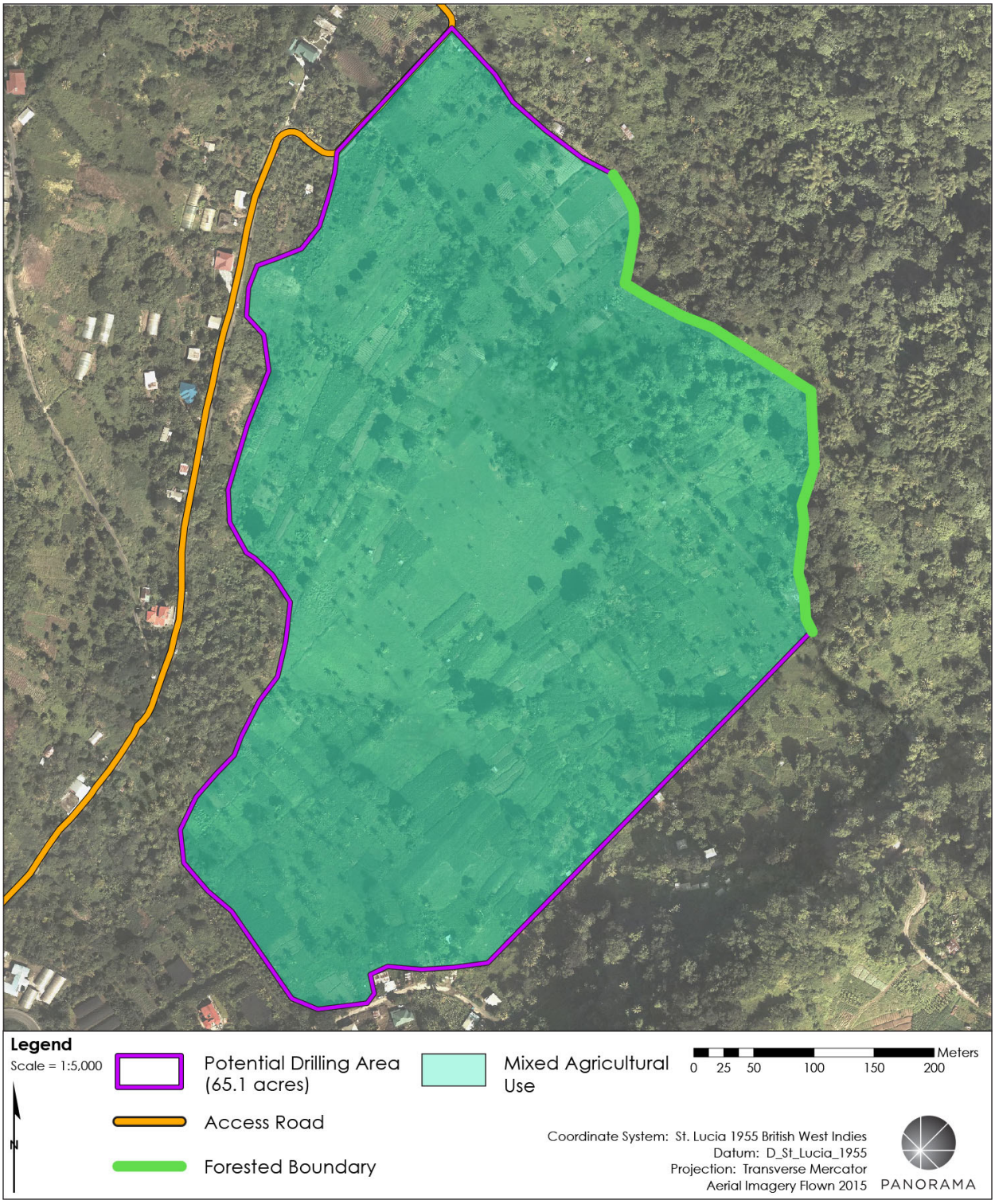


Figure 3.5-2 Fond St. Jacques Habitat/Land Use

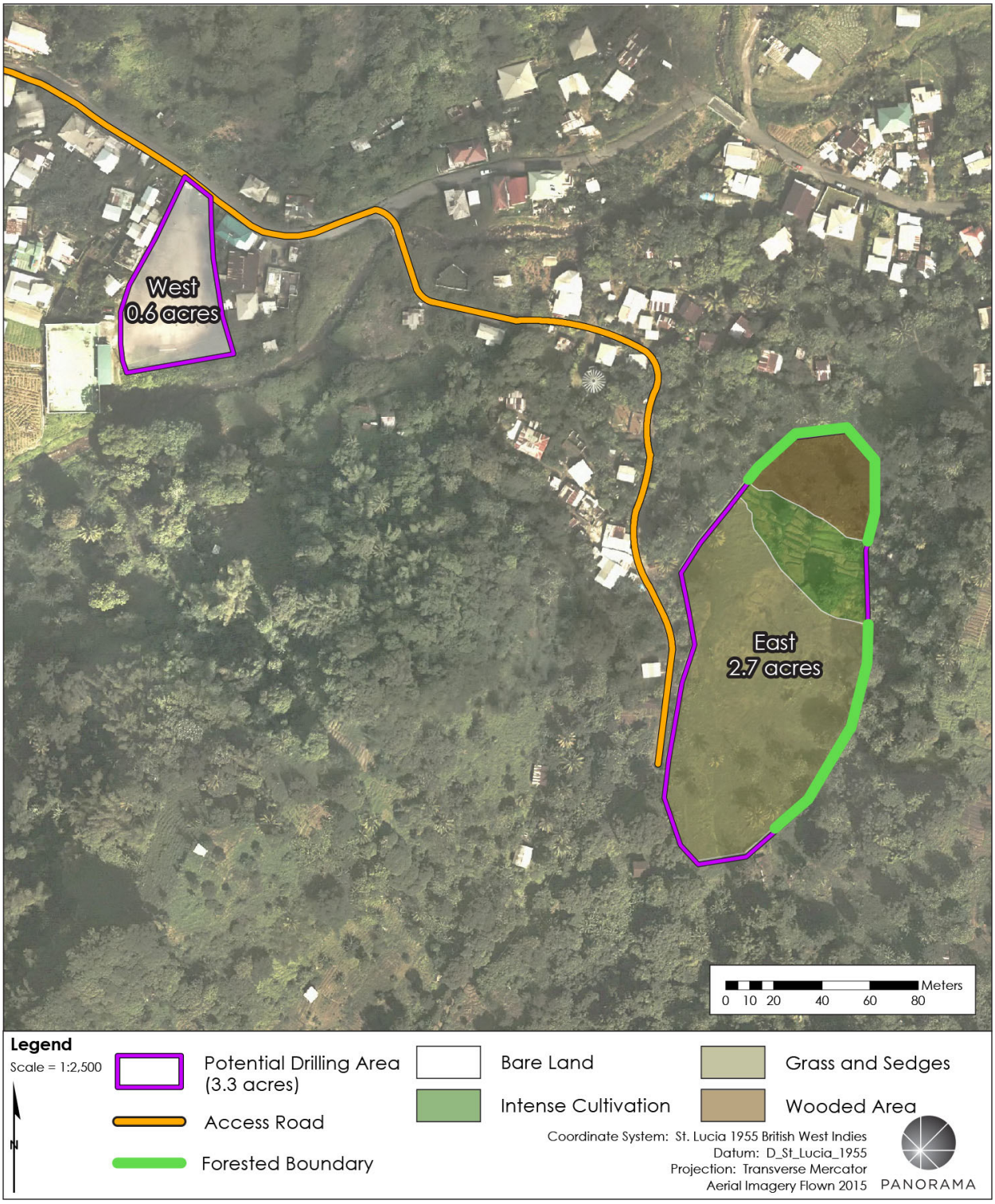


Figure 3.5-3 MS-1 and MS-2 Habitat/Land Use

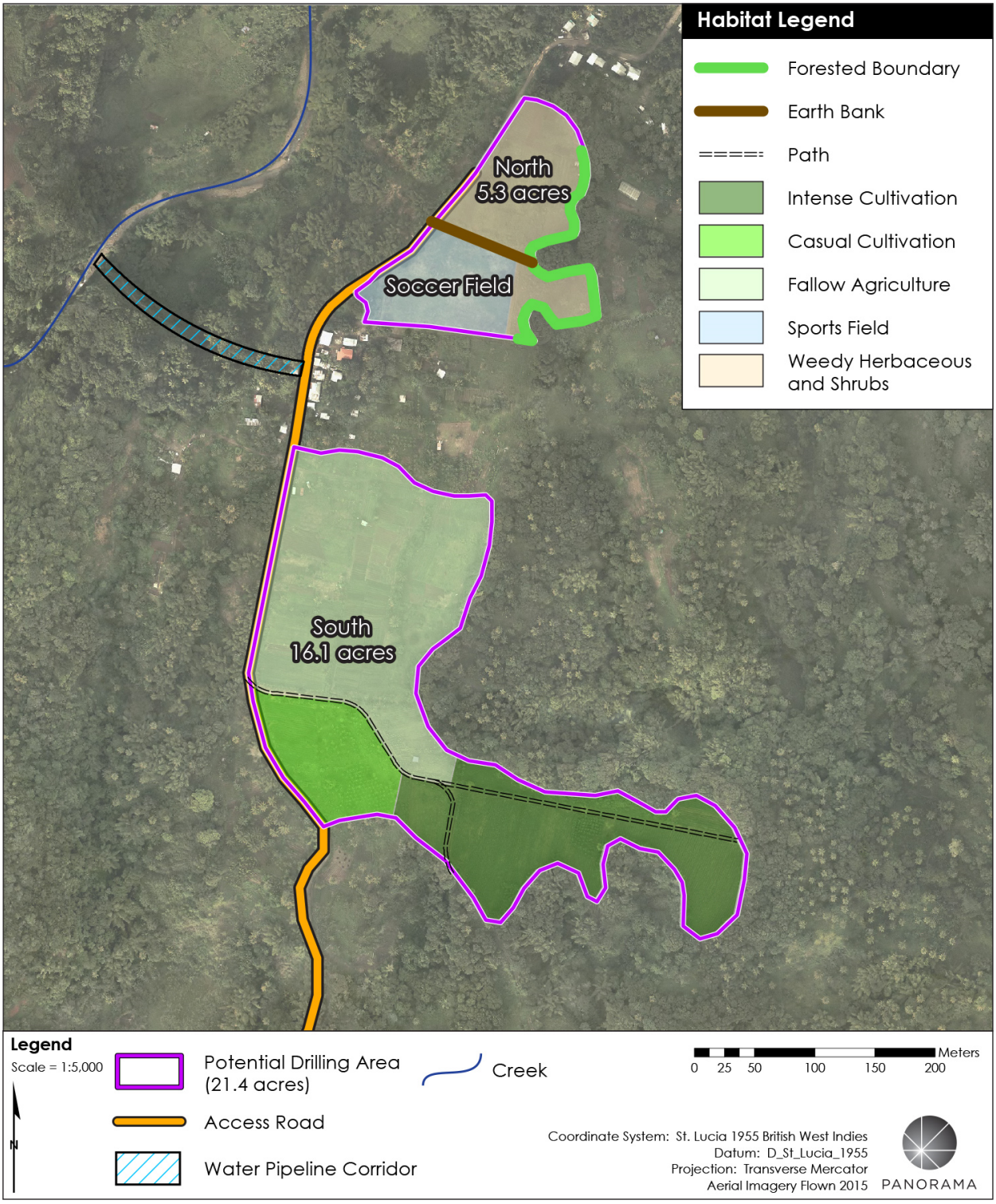


Table 3.5-1 Habitat and Dominant Floristic Species by Area

Area Name	Description of Vegetation/Habitat Conditions	Dominant Vegetation
Belle Plaine	The Belle Plaine area has been cleared of all natural forest and replaced by agriculture. The area was previously intensively farmed with bananas and is now largely abandoned with open herbaceous areas punctuated by remnant *Musa* cultivars (bananas and plantains) and mature fruit trees. Small plots with a market gardening type of agriculture are located in small areas. Cows graze on the site and several substantial wall houses are under construction in the area. The area is bordered on the western side by a steep forested hill	The area is covered predominantly by weedy flora of grasses, herbs and shrubs. The majority are native species, but many are naturalized species. Widely spaced throughout the open areas are cultivated fruit trees including *Erythrina poeppigiana,* Gmelina and pines, and mahogany. There are also many clumps of Musa cultivars (bananas and plantains). A few ornamental trees occur on the site including Ficus bejamina, Bougainvillea, Saman trees and *Heliconia wagneriana* which have become naturalized.
Fond St. Jacques West	Fond St. Jacques west is a small cleared site with a river on the lower end of the site. There is almost no vegetation on the site.	The area is developed/disturbed and generally lacks vegetative cover.
Fond St. Jacques East	The Fond St. Jacques east area is very swampy and most of the site is saturated. The area is covered by an herbaceous flora of mainly grasses and sedges, with some weedy shrubs and scattered fruit trees. The area is bordered by some large trees except where it forms a boundary with the road. There are patches of cultivated dasheen (*Colocasia esculenta*), a crop that thrives in swampy conditions. Crows graze in the area.	The area is dominated by the grass *Paspalum paniculatum* and large areas covered by the sedge *Fuirena umbellata.*
MS-2	The MS-2 area is a formerly intensive agricultural area that is now limited to sparse cultivation. There are many common weedy herbs and shrubs found on the site.	The area is dominated by herbs and shrubs including *Andropogon bicornis, Urena lobata* and *Ipomoea tiliacea* along with grasses such as *Andropogon bicornis, Cenchrus purpureus, Chloris ciliata* and *Eragrostis pilos.* Additional cultivated vegetables and fruit trees are present.
MS-1	The MS-1 area is a formerly intensive agricultural area that is now limited to sparse cultivation. There are many common weedy herbs and shrubs found on the site.	The area is dominated by herbs and shrubs including *Andropogon bicornis, Urena lobata* and *Ipomoea tiliacea* along with grasses such as *Andropogon bicornis, Cenchrus purpureus, Chloris ciliata* and *Eragrostis pilos.* Additional cultivated vegetables and fruit trees are present.

Table 3.5-2 Faunal Species and Conditions in the Area of Influence

Area Name	Birds	Mammals	Herpetofauna	Insects
Belle Plaine	A total of 36 species were detected in the Belle Plaine area and surroundings. The majority of the detected species are resident species, with the exception of two, the Sand spotted sandpiper and the barn swallow. Five endemic birds occurred in the area; two of the Saint Lucian endemics were uncommon for the site. Nine priority species were found occurring in the forested area adjacent to the site, four of which are classified as endangered species of birds. The priority species observed include: • Saint Lucia Parrot (*Amazona versicolor*) • Saint Lucia Black finch (*Melanospiza richardsoni*) • Saint Lucia Oriole (*Icterus laudabilis*) • House Wren (*Troglodytes aedon mesoleucus*) • Saint Lucia Warbler (*Dendroica delicata*) • Saint Lucia Pewee (*Contopus oberi*) • Lesser Antillean Saltator (*Saltator albicollis albicollis*) • Lesser Antillean Flycatcher (*Myiarchus oberi sanctaeluciae*)	Mongoose (*Herpestes suropuntatus*) was recorded in the area. Mongoose was introduced to Saint Lucia and is classified as invasive wildlife. Two species of bats were observed in the study area including: • Fruit bats (*Monophyllusplethodon* • Insectivorous bats (*Bracyphylluscavernum* These species are not considered endangered.	Five reptile species were recorded in the study area, including the endemic Saint Lucia anolis lizard (*Anolis luciae*). Other reptiles included: • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Butterflies, dragonflies, and bees were common insects observed in the study area. Common butterfly species included: • Southern great white • White peacock • Common long tail skipper • Tropical chequered skipper • Ocola skipper • Fiery skipper • False barred sulphur • Spreadwing skipper • Caribbean buckeye • Southern broken dash • Hannos blues

Area Name	Birds	Mammals	Herpetofauna	Insects
	• Grey trembler (*Cinclocerthia gutturalis macrorhyncha*)			
Fond St. Jacques West	There were very few faunal species on the Fond St. Jacques West site due to the lack of vegetation to provide habitats for these species. Bird species encountered included: • Carib grackle • Lesser Antillean bull finch • Common ground dove • Zenaida dove These species are very common on the island and are adapted to open areas.	None	None	None
Fond St. Jacques East	A total of 29 bird species were detected in the Fond St. Jacques east area. The majority of the detected bird species are resident species. Five Saint Lucia endemic species were observed during surveys. Three priority species were observed including: • Saint Lucia parrot (*Amazona versicolor*) • Saint Lucia black finch (*Manospiza richardsoni*) • Saint Lucia oriole (*Icterus laudabilis*)	Seven mammal species were recorded in the study area. These include, the small asian mongoose (*Herpestesou ropuntatus*) the opossum (*Didelphis marsupialis*), rats, and mice. All species are introduced to Saint Lucia and are classified as alien invasive wildlife. Two species of bats, a fruit bat (*Monophyllus plethodon*) and an insectivorous bat (*Bracyphyllus cavernum*) were found in this study area. These species are not considered endangered.	Three reptile species were recorded in the study area including • Saint Lucia anolis lizard (*Anolis luciae*) • Common house gecko (*Hemidactylus mabouia*) • Slipperyback skink, known as Zandoli tarre (*Gymnopthalmus pleei*) One amphibian, the cane toad (*Rhinella marina)* was encountered in the study area. The habitat is ideal for this species, which is considered an invasive species.	Butterflies, dragonflies, and bees were the most common insects observed in the study area. Dragonfly species were the most common insect group. The presence of a wet surface provides ideal habitat for the majority of dragonfy species.
MS-2	A total of 15 bird species, which include two priority species,the	None	None	An abundance of butterflies was found on this

Area Name	Birds	Mammals	Herpetofauna	Insects
	Saint Lucia warbler and Lesser Antillean saltator, were observed in the MS-2 study area. The Saint Lucia warbler (*dendroica delicata*), is classified as endemic to Saint Lucia, but is considered of *Least Concern* in accordance with the IUCN Red List Category & Criteria (2016).			study site, belonging to eight (8) species, none of which found are known to be endangered or of concern. The common species include: • Southern great white • Caribbean buckeye • White peacock • Common long tail skipper • Tropical chequered skipper • Fiery skipper • False barred sulphur • Southern broken dash
MS-1	A total of 20 species of birds were recorded in the MS-1 study area. The bird species encountered were very similar to Belle Plaine and Fond Saint Jacques East, owing to the similar biodiversity and rich ecotone in the forest edge surrounding the potential drilling sites, which provide an ideal habitat. Four of these species are classified as priority species, two of which are Saint Lucia endemic species: Saint Lucia pewee (*Contopus oberi*) and Saint Lucia warbler. Both Saint Lucian endemics were common for the site, which is consistent at the national level.	None	Three reptile species were recorded in the study area, including: • Saint Lucia anolis lizard (*Anolis luciae*) • Common House Gecko (*Hemidactylus mabouia*) • Slipperyback Skink, known as Zandoli tarre (*Gymnopthalmus pleei*)	Very few insects were observed and none were identified to a species level.

3.5.2.3 Endangered and Priority Species

No endangered or priority floristic, mammalian, herpetofauna, or insect species were encountered during surveys of the project areas and adjacent area of influence. Several endangered and priority birds were encountered in the forest habitat adjacent to Belle Plaine and Mondesir-Saltibus. Description of each species status and presence in the project area of influence are provided in Table 3.5-3. These species are also among the suite of sixteen "priority bird species" listed in the 2009 Status and Conservation of Saint Lucia Birds (Toussaint et al. 2009).

Table 3.5-3 Endemic and IUCN Listed Birds

Species Name	Endangered or Priority Status	Threats	Status in Project Area
Saint Lucia Parrot *Amazona versicolor*	Vulnerable, according to the IUCN Red List Category & Criteria Priority Listed in Saint Lucia	Major threats to the parrot includes urban sprawl and agriculture, increasing pressure on the forest and resulting in habitat loss. Selective logging of mature trees may significantly reduce breeding sites (Juniper and Parr 1998), and hurricanes, hunting and trade pose further threats.	The Saint Lucia parrot was encountered in two of five study areas, Belle Plaine and in Fond Saint Jacques East. Birds were heard and seen flying in small groups and as single individuals. No evidence of individual nesting or roosting was observed. There was only one case of a perched pair of birds near the Fond Saint Jacques East area. It appears that the adjacent forested areas and the ecotones provide very important foraging habitat.
Saint Lucia Oriole	Near Threatened, according to the IUCN Red List Category & Criteria Priority Listed in Saint Lucia	The Saint Lucia Oriole is susceptible to brood parasitism by the shiny cowbird (*Molothrus bonariensis minimus*, a species found in both sites where the Oriole occurs, which are predominantly in cleared areas and hence likely to increase with increasing human impacts on the landscape (Keith 1997). Keith (1997) also mentions the possibility of harassment by the bare-eyed thrush (*Turdus nudigenis nudigenis*), sighted at both sites mentioned. Secondly, it has been speculated that the oriole may also be susceptible to secondary poisoning from agrichemicals.	A total of five oriole were found across study sites at the edge of agriculture areas at Bell Plaine and Fond Saint Jacques East. The general habitat at these two sites appears to be very favorable for the oriole, due to the prevalence of abandoned agricultural plantations.
Saint Lucia black finch	Endangered, according to IUCN Red List	The decline in habitat through clearance for agriculture, urban and tourism	The Saint Lucia black finch were found in two of the five study areas, Belle Plaine and Fond St

Species Name	Endangered or Priority Status	Threats	Status in Project Area
	Category & Criteria Priority Listed in Saint Lucia	development can impact its range. This species has a broad habitat range. However, the total population level remains extremely low.	Jacques east. The black finch was encountered only four times in two study areas.
Saint Lucia wren	Least Concern, according to IUCN Red List Category & Criteria Priority Listed in Saint Lucia	While common in the Americas, the Saint Lucia population is very small with birds rarely seen and with extremely limited range. Threatened by habitat lost, wildfires, predation by alien invasive species including by mongoose and brood parasitism by the shiny cowbird.	The Saint Lucia wren was encountered in one of the five study areas, Belle Plaine.
Saint Lucian warbler	Least Concern, according to IUCN Red List Category & Criteria Priority Listed in Saint Lucia	Habitat modification may threaten populations due to limited habitat range within riparian areas.	The Saint Lucia warbler was found in four of the five study areas. It was more common in the forest habitat of Belle Plaine and Fond Saint Jacques East and less common in the agricultural area in the Mondesir-Saltibus area
Lesser Antillean saltator	Least Concern, according to IUCN Red List Category & Criteria Priority Listed in Saint Lucia	No known threats	The lesser Antillean saltator occurred in four of the five study areas, absent only in Fond St Jacques West.
Gray trembler	Least Concern, according to IUCN Red List Category & Criteria Priority Listed in Saint Lucia	Highly endemic species limited to Saint Lucia and Martinique. Population is currently stable.	Grey trembler occurs in three of the five study areas. They were encountered around forests edges, woodlands, scrubs and agricultural areas.
Saint Lucia pewee	Least Concern, according to IUCN Red List Category & Criteria Priority Listed in Saint Lucia	No known threats	The Saint Lucia pewee was encountered in three of the five study areas: Belle Plaine, Fond Saint Jacques East and MS-1.

3.5.3 Data Gaps

The biological resources survey was conducted over a one-week period in early September in between a period of tropical storms. The results of the fauna survey may be affected by seasonal use of the project sites and surrounding forested buffer. Other wildlife species may use the site seasonally. Recommendations for pre-construction surveys are provided in Section 4.

3.6 ARCHEOLOGICAL AND CULTURAL RESOURCES

The following section contains results pertaining to TOR Task: 1.15, 1.16, and 1.17. The area of influence includes all areas that may involve grading or soil disturbance during exploration activities.

3.6.1 Literature Review and Consultation Results

There is a long tradition of archaeological research in Saint Lucia beginning in the mid-twentieth century. Among the more renowned Caribbean archaeologists to conduct investigations in Saint Lucia was (McKusick 1960), whose research in the 1950s identified distinct Amerindian pottery traditions on the island, which helped refine Irving Rouse's (Rouse 1992) elaborate cultural sequencing for the broader Caribbean region.

In the 1970s, Ripley Bullen, Adelaide Bullen, and Eric Branford conducted extensive archaeological investigations at the Giraudy site in the quarter of Vieux Fort, which shed new light on the settlement patterns and subsistence strategies of the Amerindians peoples of Saint Lucia dating back to the earliest Saladoid occupations around A.D. 150 (Bullen 1973).

In the 1980s, a group of Austrian archaeologists from the University of Vienna conducted a series of archaeological surveys in southern Saint Lucia, which added new insights into the cultural practices of indigenous peoples of the island (Friesinger 1986).

Perhaps the most extensive and detailed archaeological analysis of Saint Lucia's archaeological assets was conducted in the early 2000s by an international group of Caribbean archaeologists from Holland and the United States, including Corrine L. Hofman, Menno L.P. Hoogland, and William F. Keegan (Hofman, Hoogland and Keegan 2004). Working with local members of the Saint Lucia Archaeological and Historical Society, the international team identified and inventoried numerous archaeological sites, conducted extensive tests on known sites, and recorded ethnographic and ethnohistorical information that supported archaeological findings and interpretations (Hofman and Bright 2004, Hofman, Hoogland and Keegan 2004, W. C. Keegan 2003, Keegan, Hofman and Hoogland 2004).

The archaeological studies conducted by these professionally trained researchers have been augmented by the important contributions of self-trained experts and avocational archaeologists from Saint Lucia, including Reverend Charles Jesse (Jesse 1968), a founding member of the Saint Lucia Archaeological and Historical Society, who published the first systematic inventory of Amerindian archaeological sites in the island in 1960. Other Saint Lucians, such as Robert Devaux and Winston Phulgence, are among the aficionados and

collectors who have helped save archaeological sites and materials from destruction by development. Moreover, Archaeological Secretary Laurent Jean Pierre and First Vice President Francis Pappin of the Saint Lucia Archaeological and Historical Society, as well as Bishnu Tulsie, Director of the Saint Lucia National Trust have done much to raise local awareness of Saint Lucia's archaeological resources. Despite the pioneering and insightful research of these notable Caribbean scholars and resident collectors, Saint Lucia has not received the same level of archaeological attention as other parts of the Caribbean, especially the nearby Windward Islands of Barbados and Martinique, where ongoing archaeological research programs have been regularly pursued for many decades. Moreover, the archaeological studies in Saint Lucia have focused exclusively on prehistoric archaeological sites.

Archaeological Secretary Laurent Jean Pierre and First Vice President Francis Pappin of the Saint Lucia Archaeological and Historical Society highlighted the challenges of protecting heritage resources and developing ongoing archaeological research programs. I met with Margo Thomas, the Director of the Saint Lucia Archives, who has published extensively on heritage issues in the island. She noted the absence of resources for heritage assessments, but was pleased to see a growing appreciation for heritage assets in Saint Lucia. Bishnu Tulsie, the Director of the Saint Lucia National Trust discussed the need for greater structure and government support for heritage protection. I also met with members of the Ministry of Education, including Deputy Permanent Secretary Michelle Charles, about heritage education initiatives and the potential for developing long term heritage education efforts in Saint Lucia. These discussions provided important insights into the challenges and opportunities that may result from the geothermal project.

3.6.2 Field Survey Results

The archaeological and cultural resource investigation field survey results are described by drilling target area below. Areas within Belle Plaine and MS-1 and MS-2 with a higher sensitivity and density of historic resources are shown on Figure 3.6-1 and Figure 3.6-2. Recommendations for archaeological monitoring and survey within sensitive areas and MS-3 and MS-4 are provided in Section 4.6, below.

3.6.2.1 Belle Plaine

Historic Resources

Ceramics

The pedestrian survey of Belle Plaine revealed a sizeable amount of early colonial ceramics. These included a piece of late seventeenth- or early eighteenth-century English tin-enamel glazed earthenware (delft), as well as what appears to be a piece of seventeenth century French tin-enamel glazed earthenware (faience). The site also contained a large number of English refined earthenware ceramics dating from the last quarter of the eighteenth century to the mid-nineteenth century. Among the refined earthenware ceramics were creamware and numerous shards of blue and green shell-edge pearlware. There was a paucity of imported and locally made low-fired unglazed coarse red earthenware ceramics, which are frequently found in plantation settings.

Figure 3.6-1 Belle Plaine Historically Sensitive Areas

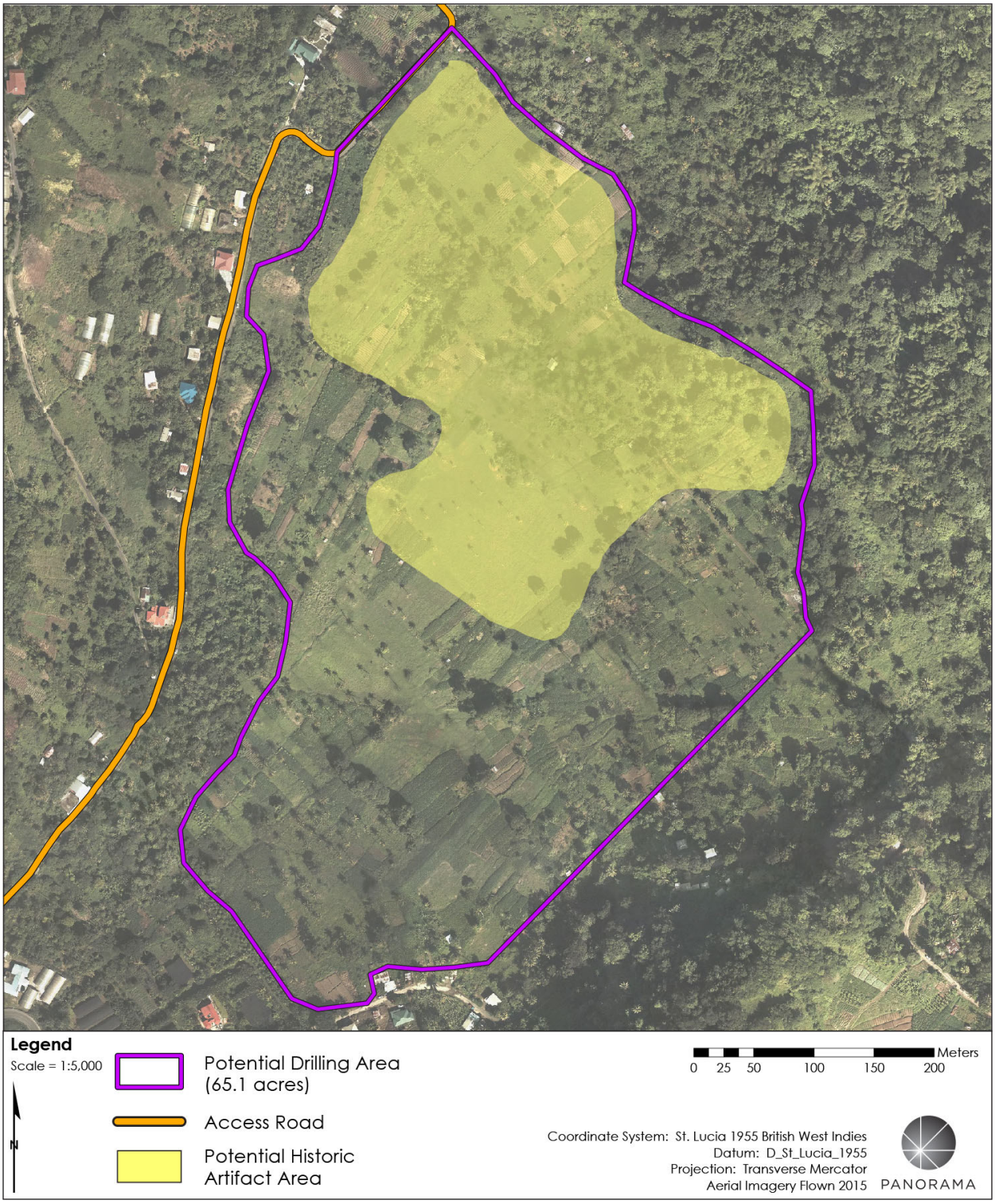
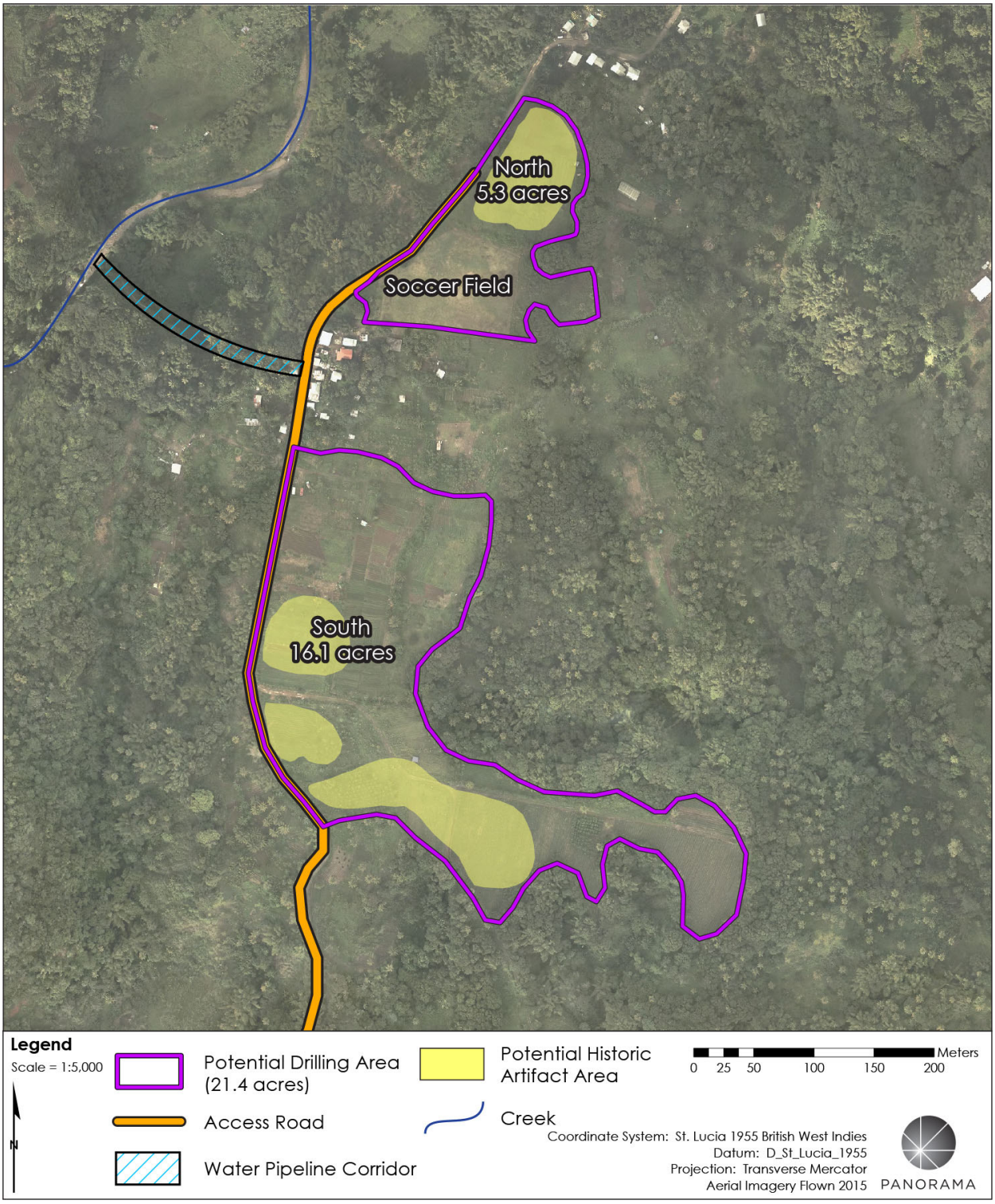


Figure 3.6-2 MS-1 and MS-2 Historically Sensitive Areas



The sizeable amount of refined ceramic types indicates an extensive amount of domestic activity at the site in the eighteenth through the mid-nineteenth centuries. The almost complete absence of either imported or locally made coarse red earthenware ceramics at the site may be an indication of the relative wealth of the inhabitants. Coarse red earthenware pottery is often found in association with industrial practices, such as a sugar making, or the domestic sites of enslaved peoples. The near absence of coarse red earthenware ceramics and the heavy presence of refined earthenware at Belle Plaine, therefore, suggest that individuals who deposited the materials were of a relatively wealthy socio-economic standing, such as a planter and his family.

Rabot Estate

The potential drilling area at Belle Plaine is located on or near the locations of two early plantations, Rabot Estate and Belle Plaine Estate. In 1795, British military forces, along with French Royalist planters in Saint Lucia, attempted to oust the French Republican-inspired "brigands" from their strongholds in Choiseul and Soufrière. The brigands were a company of former slaves, freed people of color, and French republican soldiers whose aim was to institute French Republican ideals of liberté, égalité, fraternité in Saint Lucia. They were known as the L'Armée Française dans les Bois, but they were more commonly called "brigands." In April of 1795, British and French Royalist forces attempted to destroy L'Armée Française dans les Bois. The brigands lay in wait for the British and French Republican forces in Belle Plaine. The conflict that ensued that April was known as the Battle of Rabot, and it was a major brigand victory that served as a symbol of brigand resilience and a rallying cry of against British colonial rule. The victory would sustain the spirits of brigand forces for many years. Local farmers called the large and well-maintained stone structure near the potential drilling site "Rabot," and it may have been the location of Rabot Estate's great house (the home of the planter and his family) during the early colonial period. Rabot remained a productive estate well into the nineteenth century. At the time of slave emancipation in 1834, Rabot was a sugar-producing estate owned by Colonne Doufsard. It had around 46 enslaved workers on the estate and the factory had a watermill. It remained a sugar-producing estate well into the nineteenth century. In the 1890s, however, the estate was abandoned when global overproduction of sugar, especially European beet sugar, glutted world markets and led to a sharp decline in sugar prices.

Belle Plaine Estate

Belle Plaine Estate was a coffee estate owned by Antoine Taurin Bernard Drivon in the 1820s and 1830s. The number of enslaved peoples on the estate ranged from between 65 and 102. In the later nineteenth century, Belle Plaine was also a sugar estate producing about 50 hogsheads of semi-refined muscavado sugar annually in its cattle-driven mill. However, as with the nearby Rabot Estate, Belle Plaine fell victim to declining sugar prices and it was abandoned by 1896 (Hamsen, Ellis and Devaux 2014).

The refined historic-period ceramic materials recovered during the pedestrian survey at Belle Plaine are likely from the planter's family in the great house, a manager's dwelling, or some

other domestic high-status residence or outbuilding associated with Rabot Estate and/or Belle Plaine Estate.

Prehistoric Resources
A few sherds of Amerindian pottery were recovered at the Belle Plaine site. Most of these were small undiagnostic pieces. One relatively thick, flanged bowl rim fragment with a deep incised design was recovered at the site. Another ceramic sherd recovered at Belle Plaine was a finger notched bowl rim. These were thick, unpolished pieces that are most likely associated with the Suazan Troumassoid phase of Amerindian settlement dating to between A.D. 750 and A.D. 1150.

3.6.2.2 Fond St. Jacques

Fond St. Jacques West
The Fond St. Jacques western target area is small and located along a river. The area had been used as a helipad rescue site during the evacuation of residents after tropical storm Tomas, which caused severe flooding and landslides in the area in 2010. The area was heavily disturbed and land was built up for the construction of the helipad. Any potential archaeological deposits have likely eroded away into the river or are buried under the many meters of backfill that were used to construct the helipad. No cultural material was recovered during the pedestrian survey of this area.

Fond St. Jacques East
The Fond St. Jacques eastern target area is located in an area known to local residents as a "swamp." The ground was saturated by a local spring making it unlikely that humans ever settled or occupied the area. No cultural material was recovered during the pedestrian survey of this area. A stone masonry water tank and pumping station were located along the western edge of the potential drilling area, but it does not seem to carry any historical significance.

3.6.2.3 Mondesir-Saltibus

Both MS-1 and MS-2 contained an extensive array of historic and prehistoric archaeological materials. The areas surveyed were under extensive agricultural cultivation at the time of field survey, and farmers were employing the same mounded-earth (conuco) agricultural techniques seen in Belle Plaine. The cleared fields made the pedestrian survey and surface collection easy.

Historic Resources
The artifacts from this area included a wide variety of mid- to late eighteenth-century and early nineteenth-century ceramic types. These artifacts included refined English earthenware ceramics, such as creamware, shell-edge pearlware, and annular-decorated whiteware. Several pieces of stoneware, including a possible tankard, were recovered, along with fragments of early colonial black glass bottles. The most striking difference from Belle Plaine was the large number of low fired, coarse red earthenware ceramics from the early colonial period. These included both imported and locally made varieties of earthenware. Some pieces were industrial wares used in sugar manufacturing, while others were domestic wares, such as locally made bowls and cooking pots known as *kannawis*.

The archaeological assemblage is consistent with the village sites of enslaved peoples found throughout other parts of the Caribbean (Smith 2008, Smith and Bergman 2014, Smith and Bassett 2016, Smith 2017, Smith Forthcoming). In fact, the area was once part of Parc Estate (*La Parc*). Parc Estate was one of the earliest and largest sugar estates in Saint Lucia. It appears on the Jacques Nicolas Bellin map of St Lucia in 1763 and on the Thomas Jefferys map of Saint Lucia in 1775. By the time of emancipation in 1834, Parc Estate was divided between multiple owners who produced cocoa, coffee, and sugar. It had 176 enslaved workers, making it one of the largest slaveholdings in Saint Lucia.

Some of the older farmers from the community with whom the cultural resources specialist spoke believed that the area was once the village for enslaved peoples from Parc Estate. The farmers had also heard of a burial ground in the area, but were not certain of its location. One of the farmers introduced me to his uncle, who was an elderly farmer from the community. Many years ago, the man had found a silver coin while cultivating his fields, which were located within the potential drilling area. The coin depicted a crown on one side and a lion on the other. It had a date of 1779. Although he had sold the coin to a local collector, many members of the community confirmed his discovery. The date of the coin, which was likely British, fits very well with the mid-to late eighteenth century dates of the refined earthenware ceramics recovered from the site.

A long cart road cut along the southern boundary of the potential drilling area revealed the subsurface stratigraphy of the area. It consisted of a rich organic plowzone of dark brown silty clay ranging from 20 cm to 50 cm below the natural ground surface. A wide variety of imported and locally made historic period ceramics were present in this rich organic layer. That organic layer sat atop a subsoil layer of sterile clays that predated human occupation of the island.

Prehistoric Resources

A few sherds of Amerindian pottery were recovered during the pedestrian survey of MS-1 and MS-2, indicating an Amerindian presence at the site. The pottery fragments were small and lacked any distinguishing marks, but the thickness and coarseness of the pottery hint at a Suazan Troumassoid tradition. Several pieces of worked jasper were also recovered during the survey, and these too were likely associated with pre-colonial Amerindian peoples.

An earlier archaeological survey in 2004 noted the presence of prehistoric Amerindian materials at Parc Estate, at the nearby village of Gayabois, and at the nearby Saltibus School (Hofman et al 2004). These sites were dated to the later Suazan Troumassoid period. The Jasper may have come from local outcrops or it may have been collected in other islands and brought to Saint Lucia. In 2004, archaeologists had searched the Saltibus region for jasper sources (ibid; 51-53). Jasper was used by Amerindian peoples of the Caribbean to produce a variety of different tools for cutting, scraping, and splitting. There is evidence of extensive Amerindian activity in prehistoric times in the proposed drilling areas at MS-1 and MS-2.

3.6.3 Data Gaps

The pedestrian surveys conducted for this Scoping Studies report did not include any subsurface investigation (i.e., shovel test pits). Recommendations for further investigation are provided in Section 4.

3.7 SOCIO-ECONOMIC ENVIRONMENT

The following section contains results pertaining to TOR Task: 1.18, 1.19, 1.20, and 1.21. The socio-economic area of influence includes the communities of the potential drilling areas.

3.7.1 Literature Review Results

3.7.1.1 Population and Demographic Profile

The mid-year population of Saint Lucia for 2016 was estimated at 173,966 persons (Government Statistical Department Saint Lucia 2014), reflecting a 0.7 percent growth over the previous year. The latest population and housing census (Government Statistical Department 2010) indicated that about 55 percent of the population resided in two of the country's ten census or administration districts, Castries (the capital) and Gros Islet, both located in the northwestern part of the country. There were an estimated 58,891 households in 2010 with an average household size of 2.8 persons; a significant decline from the 3.3 persons for the previous census.

Females accounted for roughly 51.4 percent of the population. The working age population (15-64 years) represented 71.6 percent of the population. Dependents (people younger than 15 or older than 64 years) comprised 28.4 percent of the population; almost 9.0 percent fall within the age group of 65 years and over. Population trends indicate that this elderly group will form an increasingly larger proportion of the population over time.

The project area spans three contiguous districts or quarters, Soufrière , Choiseul, and Laborie; however, the communities and people potentially affected by the project are located in Soufrière and Laborie. As indicated in Table 3.7-1, the 2010 census estimated that for 2010, these two districts accounted for a total of 15,173 persons, 8,472 in Soufrière and 6,701 in Laborie.

Table 3.7-1 Demographic Profile of Soufrière and Laborie

Demographics	Soufrière	Laborie	Saint Lucia
Population in	8,472	6,701	165,595
Population under 15 years of age	2,296	1,627	43,041
Percentage Females	49.48	50.11	50.36
Percentage Males	50.52	49.89	49.64
Total private dwellings	**2,886**	**2,189**	**58,920**
Population density per square kilometer	1,124	1,189	2,062

Source: (Central Statistics Office 2011)

Between the 2001 and 2010 censuses, Soufrière recorded a 10.7 percent increase in population. Conversely, Laborie experienced the largest decrease (-9.0 percent) in the country. In Soufrière, females accounted for about 49.5 percent of the population, whereas for Laborie, the figure is slightly higher at 50.1 percent, in line with the country's average. Population densities for both districts were well below the national average of 2,062 persons per square km, with Soufrière recording the lowest density island-wide.

The project-affected communities include four settlements, two each located in Soufrière and Laborie. The Belvedere community includes individuals who may be affected by the Fond St. Jacques area and the Parc Estate and Gayabois communities include individuals who may be affected by drilling in Mondesir-Saltibus. Based on the last population census, the two settlements in Soufrière (Belvedere and Belle Plaine), had an estimated 574 persons accounting for approximately 6.8 percent of Soufrière's total population. The two settlements in Laborie (Gayabois and Parc Estate) had 172 persons, which represents only 2.8 percent of Laborie's total population. Table 3.7-2 presents the estimated population of each affected community based on the 2010 Census.

Table 3.7-2 Population of the Affected Communities

Population (2010)	Females	Males	Total
Soufrière			
Belvedere	221	252	473
Belle Plaine	47	54	101
Total	**268**	**306**	**574**
Laborie			
Parc Estate	45	54	99
Gayabois	31	42	73
Total	**76**	**96**	**172**

Source: (Central Statistics Office 2011)

3.7.1.2 Economic Environment, Livelihoods, Employment and Labour Implications

Economic activity and employment in Saint Lucia are driven by three main sectors: tourism, construction and agriculture. Tourism (hotels) accounted for almost 7.8 percent of the gross domestic product (GDP) of Saint Lucia in 2016. Tourism is the single largest economic activity in the country and it is mainly concentrated in the north (Gros Islet) and south (Soufrière). The contribution of tourism to GDP has generally increased over the past 10 years, whereas agriculture's share has gradually declined to 2.0 percent in 2016. Agriculture currently accounts for 11 percent of the total employment.

The unemployment rate remains persistently high at over 20 percent since 2009. However, the most recent Economic and Social Review (Government of Saint Lucia 2016a) reported that the labour market showed signs of improvement. The unemployment rate fell from 24.1 percent in 2015 to 21.3 percent in 2016 largely due to construction as well as the accommodation and food

services sectors. The unemployment rate among youth (15 to 24 years) remains high, reaching a peak of 43 percent in 2016. The declining contribution of the agriculture/banana industry, the 2008 global financial crisis and downturn in economic growth are likely to be some of the main reasons for poor job prospects and overall weak employment trends.

In Soufrière, tourism, followed by agriculture and fisheries are the main economic activities with most of the job openings and new employees being in the accommodation and food service sectors (St. Catherine 2013). Soufrière has several tourist attractions, notably the Pitons a UNESCO World Heritage Site; the Sulphur Springs (drive-in volcano, hot springs); and high-end hotels, such as the multiple award winning Jade Mountain Resort.

Laborie depends on fishing and agricultural production. Data for 2016 (Government of Saint Lucia 2016a) indicates that Laborie has gradually increased fish landings and now accounts for twice the quantity of fish landed in Soufrière. In addition, quarrying/mining by Wilrock Ltd which provides a significant level of employment opportunities in the community. Laborie also has a small tourism sector that comprises a few guest houses within the village and rural areas such as Banse (Government of Saint Lucia 2016b).

Several communities in Soufrière are afflicted by high unemployment, although the unemployment rate recorded in 2010 (Government Statistical Department 2010) for Soufrière was lower (18.6 percent) than the national average of 20.6 percent. The project affected community of Belle Plaine had an unemployment rate of 23.9 percent, albeit less than the Palmiste community which is close to the urban area and had the highest rate (31.8 percent) in Soufrière. Belvedere had a moderate rate of 12.1 percent unemployment. Crop production was a significant form of livelihood in Belvedere. The lowest unemployment rates in Soufrière were recorded in the Sulphur Springs' community (3.5 percent) and Fond Gens Libre (7.3 percent), two areas with tourism-related economic activities.

In Laborie, the average unemployment rate was 8 percent higher than Soufrière's, with rates as high as 48.7 percent along the Laborie/Vieux Fort highway. Unemployment rates in Parc Estate and Gayabois were 30.6 percent and 23.3 percent respectively. Crop production was the main form of livelihood in these two communities.

Females consistently experienced a higher rate of unemployment, countrywide, and at the district and settlement levels. This gender disparity appears to have persisted; whereas the overall unemployment rate for 2016 was estimated at 21.3 percent, unemployment rates for females remained typically higher at 22.9 percent compared to 16.2 percent for males. However, it was found that the difference between the average unemployment rate of females and males decreases as the highest education level attained increases (Government of Saint Lucia 2016a).

3.7.1.3 Use of Natural Resources and Agriculture

Forests

The total land area of Saint Lucia is about 616 square kilometers (238 square miles). About 56 percent of the natural forests are found in forest reserves and 43 percent on private lands

(United Nations Environment Programme 2010). Forest reserves cover about 7,690 hectares (19,002 acres). The Forestry Department is responsible for managing the forest and water resources in Saint Lucia. The Forest, Soil and Water Conservation Act allows for private landowners to enter into agreements with the Government for the management of private lands as forests for conservation purposes, and for private landowner to be compensated accordingly.

Agriculture

The last (2007) agricultural census estimated 12,223 hectares (30,204 acres) to be under agricultural production of which 1,503 hectares (3,714 acres) were under forest and woodland cultivation. Several species of forest trees, particularly mahogany and Blue Mahoe are grown for timber.

Crop and livestock production are the most productive sub-sectors in the agricultural industry. Banana production, which has been on a downward trend, is exported to the United Kingdom and other Caribbean markets. Other crops, fruit and tree crops, roots and tubers as well as vegetables and condiments are produced mainly for domestic consumption and are sold to local supermarkets and hotels. A cocoa revitalization project was implemented to increase production of cocoa particularly in Soufrière. Hotel Chocolat, a luxury chocolate firm located on an old cocoa estate in Soufrière has been promoting the production of cocoa beans.

Soufrière and Laborie recorded a substantial decrease in the area of agricultural lands between the last two agricultural censuses. Soufrière had 455 farms operating on 603 hectares (1,490 acres) while Laborie had 769 farms on 737 hectares (1,820 acres) and the total number of farms in Saint Lucia was 9,972 in 2007. The 2007 census recorded an increase in abandoned banana farms and lands in fallow/resting and a general improvement in the distribution of farm land ownership and an increase in family-lands ownership.

Water Resources

Water resources in Saint Lucia are used mainly for domestic, commercial, and agricultural purposes. The John Compton (Roseau) dam, built in 1995 is the largest water supply with a reservoir capacity of 2.6 million cubic-meters serving the north of the Island. Water is typically extracted from run-of-the-river intakes and treated to meet the potable supply requirements in nearby communities. In some communities, notably Belvedere-Fond St. Jacques, water from spring sources is also used (refer to Section 3.1.1 and 3.1.2 for further details on water resources).

3.7.1.4 Community Organization and Local Institutions

There is a strong tradition of community oriented organizations in Saint Lucia. Several cooperative credit unions, farmers association, mothers' and fathers' groups, youth and sports groups, and other faith-based organizations operate throughout the country. Both Soufrière and Laborie have development foundations – organizations aimed at promoting and facilitating local development initiatives. The community of Fond St. Jacques also has a Development Committee.

The Ministry of Equity has established community/resource centers all over the country. These are public facilities where community members gather for meetings, activities, and other social events. Many of these centers serve as training and emergency shelters. There are community and resource centers in Fond St. Jacques and Laborie that are available to the potentially affected communities.

3.7.1.5 Access to Social Services

Housing and Infrastructure

Based on the 2010 Census, almost 70 percent of Soufrière's households had flushable toilet facilities (linked to a septic tank) and 93 percent used electricity as the main source of lighting; both indicators were higher than the national average. However, 73 percent used public (WASCO's) piped borne water and 72 percent used gas/LPG as fuel for cooking - both were below the national average[1].

Approximately 63 percent of the households in Laborie had flushable toilet facilities (linked to a septic tank) and 94 percent used electricity as the main source of lighting; these indicators were consistent with the national average. About 77 percent of Laborie households used public piped water; this was below the national average but higher than Soufrière's. Although 80 percent of Laborie's household used gas as fuel for cooking, the use of charcoal and wood was higher (11.8 percent) compared to (7.8 percent) and countrywide (5.4 percent).

Education

Primary level education is compulsory for all children between the ages of 5 to 11 years in Saint Lucia. For the past 10 years, primary school enrolment has been steadily declining partly due to a persistent decline in the school-aged population. For the 2013/14 academic year, there were about 97 public schools operating throughout the country, 74 of which were primary and 23 secondary. These schools are organized by eight school districts.

The project affected communities fall within school districts numbers 7 and 8, which have a total of 17 primary and three secondary schools. All 20 schools serving the affected areas have excess capacity[2]. The Parc Estate and Gayabois settlements have access to the Saltibus Combined (primary) school which is about 0.8 km (0.5 mile) away, and the Piaye Secondary schools, which is about 8 km (5 miles) away from the community. The communities of Belvedere and Belle Plaine have access to the Fond St. Jacques Primary (0.5 to 3.2 km [2 miles] away) and the Soufrière Comprehensive Secondary schools, (4.8 to 8 km [3 to 5 miles] away).

Medical Care

Public health care services in Saint Lucia are provided by a network of facilities that comprises 33 health/wellness centers, two general hospitals (Victoria and St. Jude Hospitals), two district

[1] Population and Housing Census 2010; Source: Government Statistical Department, Saint Lucia
[2] Education Statistical Digest 2014, published by the Ministry of Education

hospitals and one polyclinic (in Gros Islet). The health centers provide primary (non-emergency) health care and are dispersed throughout the Island's eight health regions. The health sector policy is that each health center should serve a population within a maximum of 4.8 km (3 miles). Public secondary level (acute) health care is provided by two general hospitals. The largest, Victoria Hospital, is a public hospital located in Castries. St. Jude is a quasi-government facility in Vieux Fort in the south of the Island. A third secondary level health care facility, Tapion Hospital, is privately owned and located in Castries. The National Mental Wellness Centre and a Drug Rehabilitation Centre are the only mental wellness centers in Saint Lucia and both public institutions are located in Castries. Both facilities provide in-patient care and follow-up consultations.

At health centers, routine medical care by a nurse is available 5.5 days per week up to 4:30 PM, after which medical care is available at the hospitals (Regional Health Services n.d.). Doctors are available on selected days and hours. Specialized clinics are held weekly for the management of diabetes, hypertension, birth control, psychiatric disorders and sexually transmitted diseases including HIV. More specialized medical care is available as outpatient services at the general hospitals and medication is accessible at several public health care facilities at a subsidized price to the general public.

The project-affected communities span two health regions (numbers 5 and 6) that contain a total of eight health care facilities. Soufrière Hospital is the main primary care health facility serving the communities of Fond St. Jacques/Belvedere, and Belle Plaine. There are two other health centers in Soufrière that provide general services including visiting specialist and pharmacist services. The Fond St. Jacques health center is less than 4.8 km (3 miles) from the Belvedere community and the Etangs Health Centre is approximately 4.8 km (3 miles) from Belle Plaine. The Soufrière Hospital currently functions as a polyclinic or non-hospital referral facility and is not equipped to provide a high level of acute care. Secondary level medical care for Fond St. Jacques and Belle Plaine communities is available at Victoria and St. Jude hospital, both of which are about 45 km (28 miles) away.

The residents of Mondesir (Parc Estate and Guyabois), have access to the Saltibus health center, which is approximately 4.8 km (3 miles) away. The St. Jude Hospital is about 29 km (18 miles) from Mondesir and is available to the Parc Estate and Gayabois communities for secondary level medical care.

3.7.1.6 Community Health, Safety and Security, and HIV/AIDS Prevalence

Community Health

The Ministry of Health reported that for 2014, the infant mortality rate (deaths per 1000 of the population) was down to 17 and the average life expectancy had decreased to 74.4 years, with females having a higher expectancy (78.7 years) than males (70.3 years) (Ministry of Health and Wellness 2016). Apart from maternal and reproductive conditions, injuries and road accident, non-communicable diseases (including diabetes, hypertension, heart disease and cancer) were the most common causes of illnesses and death in Saint Lucia. Elderly females (65 years and over) were more affected by hypertension whereas older males (45-64 years) were more affected

by diabetes. Females (25-64 years) also accounted more for cancer but the majority of injuries and mental illness were recorded for adult males. In 2013-2014, mortality due to non-communicable diseases was 58 percent of premature deaths and 73 percent of total preventable deaths. In recent years there has been a significant increase in the number of suicides in Saint Lucia. The majority of the cases are due to mental health illnesses or substance abuse problems, such as alcohol and the use of illicit drugs (UN Human Rights Council 2015).

Safety and Security

Indications are that the crime rate has increased in recent years. In May 2017, the Royal Saint Lucia Police Force (RSLPF) reported (St. Lucia Times 2017) that crime in 2016 had increased by two percent over the previous year. The RSLPF indicated that "This rate was the highest experienced over the past four years." It was further reported that for 2016, there were increases in almost all the major crime categories (murders, sexual offences, firearm offences, offences against property, drug offences and summary offences), except crimes against the person (which recorded a slight decrease when compared to 2015). The north of the Island accounted for 40 percent of the total crimes reported in 2016.

An analysis of data obtained from the Central Statistical Office of Saint Lucia revealed that 17,968 crimes were reported for 2016. The major crimes, "crimes against the person" (murder, assaults, wounding etc.); sexual offences; crime against property (robbery, burglary etc.); and firearm offences represented almost 50 percent of all crimes. The official number of reported murders (Royal Saint Lucia Police Force n.d.) for 2016 was 33, of which 30 percent had been cleared up compared to 28 murders in 2015 with a clearance rate of 57 percent. Information obtained on Royal Saint Lucia Police Force indicates that for 2017, a total of 11,454 crimes were reported and accepted; 25 were murders with 68 percent being cleared up (Royal Saint Lucia Police Force n.d.).

In terms of the geographical distribution of crimes, the 2010 Population and Housing Census indicated that of the number of households who recounted being victims of crimes[3], house-breaking represented the largest proportion (66 percent) of crimes at both the national and district levels. The north of the Island accounted for the majority (66 percent) of all households affected, while Soufrière and Laborie accounted for 2.8 percent and 3.2 percent of house-breakings, respectively.

Currently, there are a total of 13 police stations in Saint Lucia with 5 located in the southern half of the island. Soufrière and Laborie have police stations, both within 9.7 and 16 km, (6 and 10 miles) respectively of the communities potentially affected by the project.

[3] Reported and not reported to the police

HIV/AIDS Prevalence

The gradual rise in the numbers of persons testing positive for HIV or dying of AIDS is also of great concern even if the disease is not yet a significant cause of illness and death. The annual HIV/AIDS surveillance report by the Ministry of Health for 2014 (Ministry of Health 2015, Ministry of Health and Wellness 2016) reveals that the prevalence/incidence (number of cases per 100,000 persons) of HIV infection is 35. During 2005 and 2010, the number of new cases of HIV infection had stabilized, but increased again during 2011-2013. The number of new cases of HIV/AIDS in 2014 fell to 61 compared to 63 in 2013. Males, accounted for the majority (62 percent) of these newly diagnosed cases. About two-thirds of the newly diagnosed cases were in the 25- to 49-year old age group, and twice as many males as females had been diagnosed with HIV/AIDS.

Overall, at the end of 2014, there were 674 persons living with HIV out of the total 1029 cases recorded on the national register; males accounted for 50 percent of the cases. About 34 percent of persons living with HIV are enrolled under the Ministry of Health's treatment program.

The majority (81 percent) of the newly diagnosed cases are not recorded by health region or location. For 2010-2014, about 75 percent of newly diagnosed cases lived in the north (Castries, Babonneau and Gros Islet) where almost 55 percent of the population reside. For the 5-year period (2010-2014), HIV/AIDS incidence increased in the north as well as in Micoud, Soufrière and Laborie, as compared with the previous period (2005-2009). In 2014, the incidence in Soufrière was 0.9 whereas Laborie was 0.6.

3.7.1.7 Poverty and Vulnerable Groups

The findings on Poverty and Inequality in Saint Lucia (Central Statistical Office of Saint Lucia 2017)indicates an alleviation in the Island's poverty during the past 10 years. In 2016, it was estimated that 25.8 percent of the population was considered poor, almost 4 percent less than in 2006 (Kairi Consultants 2007). The poverty gap had reduced from 9 percent in 2006 to 7.5 percent in 2016. Although the decline was most noticeable in the rural areas, poverty in Saint Lucia remains a rural phenomenon. Approximately 41 percent of the rural population were poor in 2016, compared to 23 percent for the urban population. Soufrière and Laborie both recorded a significant decline in poverty levels during the 10-year census period. In 2016, it was estimated that approximately 25.5 percent of Soufrière's population were poor, compared with almost 42.5 percent in 2006. Likewise, 23.4 percent of Laborie's population were poor in 2016; a significant improvement from 42.1 percent in 2006.

In 2010, Soufrière and Laborie scored similar poverty levels (13.78 and 13.80 points respectively) out of a maximum of 30 for the "Basic Needs" Index (a proxy for poverty levels) (Director of Statistics 2011). The Belvedere community, although not the poorest, was found to have a higher level of poverty (11.94 points) than Belle Plaine (16.71 points). The highest level of poverty in Laborie was recorded in Parc Estate (10.64 points) while Gayabois was less poor with 12.35 points.

Children make up a substantial (22.5 percent) proportion of those who are in the poorest wealth quintile (UNICEF 2016). The Findings on Poverty and Inequality by the Central Statistical Office of Saint Lucia estimated that the disparity in poverty levels between poor male and poor female household heads in Saint Lucia had worsened from 1.8 percent in 2006 to 9.3 percent in 2016. There was also a gap in employment income between men and women across both poor and non-poor groups.

The Ministry of Education provides assistance in the form of bursaries and the School Feeding Program to needy students in public primary schools. School District 7, which includes Soufrière and Laborie, recorded the highest (79 percent) proportion of students benefiting from the Program (Government of Saint Lucia 2015).

There are other social protection programs, such as the Public Assistance Program (PAP) that are designed to address critical vulnerabilities. The PAP provides aid to almost 3,300 persons who have been deemed needy. The assistance includes monthly cash transfers and waivers on medical care, mainly to vulnerable groups – the elderly, and to a lesser extent, persons with disabilities. In April 2015, PAP provided support to 364 persons in Soufrière (about 11 percent of the total registered needy persons in Saint Lucia) and 329 in Laborie (Caribbean Development Bank 2016).

3.7.1.8 Equity and Potential issues related to Social Conflict

Data on equity or social conflict in Saint Lucia is not readily available at the national or district levels. Information from the Caribbean Development Bank (Caribbean Development Bank 2016) indicates that the level of inequality in Saint Lucia has been declining overall. In 2015, the shares of the wealthiest 20 percent of the population decreased; however, it was estimated that at least one third of the population are multidimensional deprived. Factors used in calculating multidimensional deprivation are poor health, lack of education, inadequate living standard, lack of income, disempowerment, poor quality of work, and threat from violence.

Another measure of inequality is the Inequality-adjusted Human Development Index (IHDI) - an average measure of basic human development achievements in a country. The IHDI value for Saint Lucia is 0.618 for 2015, placing the island in the high (or relatively good) category (Caribbean Development Bank 2016). The highest IHDI was reported for Norway (0.898) and the global average is 0.557.

The Gender Inequality Index (GII) on the other hand reflects gender-based disadvantage in three dimensions: reproductive health, empowerment and the labour market. In 2015, Saint Lucia scored a GII value of 0.354, ranking it 74 out of 159 countries which also places the country in the high GII category. An analysis (by Julie V. Xavier, PhD) on gender beneficiary of Saint Lucia's PAP indicated there are systemic barriers that operate against female beneficiaries and applicants.

Lifestyle, Culture and Recreation

The "kweyol" or patois language forms part of the traditional Saint Lucian culture and lifestyle, and is more prevalent in the rural areas. "Jounen Kweyol" is one of the largest cultural events

that takes place throughout all communities; it is an annual celebration of International Creole Day which is held in October and provides the occasion to support the culture of Saint Lucia as well as a form of recreation. Other cultural activities are the flower festivals (the Lawòz and Lamagwit) which are held in August and October, respectively. These two cultural festivals are promoted at schools, as well as Quadrille – a traditional local dance.

Carnival and Calypso celebrations are held in July each year. Most of the events (Calypso Monarch, Soca Monarch, Panorama/Steel Pan and Carnival Queen competitions) are held in Castries and culminate in the two-day parade. Some communities, including Soufrière town and Fond St. Jacques host their own carnival festivities. Laborie's "Freedom Mas" is a family oriented activity held on Emancipation Day - August 1. Laborie Development Foundation hosts other cultural events such "Festèn Labowi" a fish festival in June and Kolasyon Nwèl, Christmas celebrations in December.

Creole music is played by chak-chak bands that use a violin, guitar, banjo and locally made African style drums (called taboos). Quadrille is danced to the music. "Country and Western" music/dance is also popular throughout the island, especially in the rural areas. This genre of music, reportedly introduced to locals by U.S. military workers who came to build airports in Saint Lucia during the Second World War. Both Soufrière and Laborie have beaches where community members and their families visit for swimming, picnics, and relaxation, especially on weekends and holidays.

"Sou-sou" and "koudmen" are two cultural forms of economic and social collaboration among community members, particularly the poor in rural areas. "Sou-sou" remains popular particularly among poorer women throughout the country. It is a West African form of rotating savings was reportedly brought to Saint Lucia by African slaves. The sou sous operates through an informal group/savings club comprising a small group of people. This form of savings is believed to have diminished with the growth of credit unions. For "koudmen" (lending a hand), community members assist each other by working for free on projects – typically house construction or farm work.

3.7.2 Field Survey Results

This section provides the results of the field verification surveys conducted by ECMC in the potentially affected communities.

3.7.2.1 Age and Gender

The ages of respondents ranged from 20 to 85 years; the youngest being a female from Belvedere and the oldest, a male from Parc Estate. Table 3.7-3 provides a summary of the age and gender distribution of the respondents. The majority of respondents (59 percent) were males.

Table 3.7-3 Age and Gender of Respondents in the Affected Communities

Community	Age Range	% Females	% Males
Belvedere	20-80	55	45
Belle Plaine	25-71	22	78
Mondesir	25-85	46	54

Reported household sizes ranged from 1 to 15 persons. The higher end of the spectrum comprised households with extended families. These types of households were more prevalent in Belvedere and Mondesir settlements. The largest household was an extended family in Parc Estate. It was reported that this settlement basically comprises 7 to 8 families living in separate or extended family households. The average size of all the households surveyed was 3.5 persons.

Males account for roughly 60 percent of the total household population. The working age group (15 to 64 years) was the largest proportion of the population (69 percent). Three disabled (mentally challenged) males, both in the 50 to 55 years age group, are accommodated in households in Belvedere. One physically disabled male was identified in Gayabois. Dependents (residents younger than 15 or older than 64 years) accounted for about 31 percent of the household population with persons 65 years and over representing 13 percent. The youngest (1.5 years) household member was recorded in Belvedere and the oldest was an 89-year-old male in Parc Estate.

3.7.2.2 Education

Approximately 54 percent of the household populations attained primary level education; 28 percent were educated at the secondary and 9 percent at tertiary (community college) levels. Around 9 percent had no schooling; these individual comprised older (73 to 89 years old) persons who live in Belvedere and Mondesir. Belle Plaine's population had the highest proportion of tertiary and secondary level schooling. Respondents in Mondesir had the lowest percentage of tertiary and secondary schooling. The Mondesir community also had the highest percentage of residents with no schooling. Table 3.7-4 summarizes the responses regarding the level of schooling in the affected communities.

Table 3.7-4 Education levels in the Affected Communities

Schooling	Belle Plaine	Belvedere	Mondesir
Tertiary (%)	24	5	4
Secondary (%)	47	23	21
Primary (%)	29	64	61
None (%)	-	9	14
Total (%)	**100**	**100**	**100**

3.7.2.3 Employment, Livelihoods and Income

Based on the survey results, 36 percent of the total working household population are unemployed. A large proportion (39 percent) reported being self-employed, primarily as farmers. The main type of farming practiced is crop production, especially root crops (dasheen and sweet potatoes) followed by vegetables (cucumbers, cabbages, melons and tomatoes). Subsistence cattle, sheep, and goat rearing was also being undertaken by a few households (mainly in Belle Plaine and Belvedere).

In Belle Plaine, 62 percent of the household population were self-employed in farming. Around 50 percent of Belle Plaine's respondents indicated that their employment would likely be negatively affected by loss of land to the project. Compared with Belvedere and Mondesir, full-time employment was relatively higher in Belle Plaine, with 38 percent of household population working in the private or public sector. A few respondents of Belle Plaine also reported being retirees from overseas. Unemployment in Belle Plaine was not reported by any of the households interviewed.

Conversely, 33 percent of the households' working population surveyed in Belvedere (Fond St. Jacques) was unemployed; 39 percent self-employed in farming and 22 percent were employed full-time. Among the three communities, Belvedere had the widest range of livelihoods comprising hotel work, construction, small business/shop owner, and Government work. The majority (64 percent) of Belvedere's respondents were of the view that their livelihoods would likely be negatively affected by loss of land to the project compared with 50 percent in Belle Plaine.

Table 3.7-5 summarizes the employment status of household members in the affected communities.

Mondesir reported the highest level (43 percent) of unemployed persons. Self-employment was around 39 percent and full-time employment, the lowest at 18 percent. About 57 percent of Mondesir's respondents were of the view that their employment would likely be negatively affected by loss of land to the project.

Respondents were generally unwilling to provide information on income. From the data obtained, Belle Plaine reported the highest income levels, followed by Belvedere. Mondesir had the lowest income level, reporting monthly household incomes ranging from less than $500.00 to $1,000.00.

Table 3.7-5 Employment Status of Household Population in the Affected Communities

Employment Status	Belle Plaine	Belvedere	Mondesir
Full-time (% of households)	38	22	18
Part-time (% of households)	*	6	*
Self-employed (% of households)	62	39	39
Unemployed (% of households)	*	33	43
Total (%)	**100**	**100**	**100**
Percentage who perceived employment affected due to loss of land to the project (%)	50	64	57

Notes:
*None reported

3.7.2.4 Land Ownership and Land Use

The respondents indicated that the primary form of land tenure was family-owned land followed by leased, and privately-held land. Among the three communities, private ownership of lands was highest in Belle Plaine, whereas family-owned land was the main form of land tenure in Belvedere. Leasing, primarily from Government/Invest St. Lucia, was the predominant form of land tenure in Mondesir.

Belle Plaine's respondents reported the highest percentage (80 percent) of family-land used for farming. In the Belle Plaine community cluster, members of a family comprising many siblings declared ownership of over 81 hectares (200 acres) of land, which is currently being used to grow a variety of crops for sale. These lands have already been sub-divided and titles are currently being prepared. In Belvedere, family-owned land was the main form of tenure reported for both housing and farming. Leasing from Government/Invest St. Lucia was the primary form of land tenure in Mondesir. Some respondents in Mondesir claimed that they had acquired lands from the Danes' Project in the 1990's. Table 3.7-6 presents the land ownership and use reported by respondents in the affected communities.

Table 3.7-6 Land Ownership Pattern in the Affected Communities

Land Tenure/ Use	Belle Plaine	Belvedere	Mondesir
Housing			
Family (%)	75	89	31
Privately held (%)	25	*	15
Leased/Gov't (%)	*	11	54
Total (%)	**100**	**100**	**100**
Farming			
Family (%)	80	75	25

Privately held (%)	20	*	*
Leased/Gov't (%)	*	25	75
Total (%)	**100**	**100**	**100**

Note:
*None reported

3.7.2.5 Housing Facilities

The houses in the three communities are all detached/individual structures mostly built from masonry (concrete/block-wall) or a combination of masonry and wood. The Belle Plaine community had the highest proportion of houses constructed out of a combination of masonry and wood materials. A higher percentage of wooden houses was observed in Belvedere and Mondesir. All the houses surveyed in the Belle Plaine community reported having septic tank toilet facilities whereas 18 percent and 36 percent in Belvedere and Mondesir, respectively, had pit latrines. Table 3.7-7 shows the type of housing facilities in the sample of households in the affected communities.

In all the potentially affected communities, every house in the sample stated that electricity is their main form of lighting; however, electricity was not used as fuel for cooking. The majority of households used either gas (LPG) or a combination of LPG and charcoal as fuel for cooking. The use of charcoal and wood was reported more frequently in Mondesir and Belvedere.

Table 3.7-7 Type of Housing Facilities in the Affected Communities

Type of Housing	Belle Plaine	Belvedere	Mondesir
Outer walls			
Masonry (%)	33	45	54
Masonry/wood (%)	40	18	15
Wood (%)	17	36	31
Total (%)	**100**	**100**	**100**
Toilet Facilities			
Septic tank (%)	100	82	64
Pit Latrines (%)	-	18	36
Total (%)	**100**	**100**	**100**

3.7.2.6 Water Supplies and Quality

The survey indicated that the majority of households in all the affected communities use mainly public pipe-borne (WASCO's) water as their primary source of water for domestic purposes. A few households in Mondesir reported using public standpipe as their main source of water. Overall, the quality of WASCO's water was rated as good and generally reliable. Rainwater harvesting tanks/containers were also used by most households. Spring "sous" water was

generally used for other non-drinkable domestic purposes and farming in all the communities. A few households in Mondesir also reported using a combination of public standpipe, spring, and river as their sources of water.

Some households were of the perception that spring water was a better and a more natural source of water than the public-piped water, which they believe contains too much chlorine. This view was expressed more frequently in Belvedere where 36 percent of respondents reported using only spring water. It should be noted that a spring is located near the target drilling area; WASCO's water storage tank is also within close proximity to the affected households. Belvedere's respondents indicated that the spring water is extremely important to them as a "back-up" particularly during public water shortages and natural disasters such as Hurricane Tomas when WASCO's supplies had been damaged. Some respondents indicated that their spring water supplies are piped alongside WASCO's pipelines and into their households. One respondent reported that since Hurricane Tomas, spring water, instead of WASCO's water, was now piped to the household for domestic purposes (except drinking).

3.7.2.7 Community Perceptions

In all the communities surveyed, the majority of respondents were of the opinion that the natural environment in their communities was either very good or good. They treasured their community mainly because it was peaceful and quiet. Both Belle Plaine and Mondesir respondents also valued the "pristine" environment and low crime/burglary.

The majority of respondents in all communities surveyed complained about the poor conditions of their roads. Road upgrading and employment opportunities were the most frequent suggestions for improving all communities. The lack of internet services was also identified as a problem in Mondesir. Some residents of Belvedere expressed the need for more support from each other in their community. Others were of the view that the hurricane had destroyed part of their community and now it is "quieter." One respondent was pleased that cable television and internet services had been recently extended further into the community.

Belle Plaine's respondents could not recall the names of any specific community group in their community. A few respondents from Belvedere mentioned that a Fond St. Jacques Youth Group exists; however, persons from their household were not members. Other older respondents recalled there had once been a mothers' and fathers' groups in Fond St. Jacques. In comparison, Mondesir reported having two sports' teams: a women's cricket team and a men's football team. Sporting activities are usually held on the playing field in Parc Estate. A masonry structure/bar "M L Hide Away" located near the playing field is used by the community for recreational purposes.

3.7.2.8 Perceptions of the Project

The majority (75 percent) of respondents from Belle Plaine had some knowledge about the project's history compared with 36 percent for Belvedere, and 42 percent for Mondesir. Overall, respondents had heard that the project was not successful and had to be terminated. Respondents who had heard about this current phase of the project had done so from the radio,

television, and the recent community meetings. Some residents of Belle Plaine had heard about the project from the poster (at the Belle Vue Farmers' Cooperative) or had overheard from a friend.

For all the communities surveyed, the increased noise, especially at night, and the possible health hazards from the drilling were the most frequent concerns reported about the project. Belle Plaine's respondents were extremely concerned about the noise, loss of farmland/livelihoods, and health hazards – *"the heat that would be generated from drilling is too dangerous."* Belvedere respondents were worried about the noise, displacement of homes/residents, and health hazards *"fumaroles, gas leaks and possible radiation into the atmosphere."* In addition to the noise, Mondesir's respondents were concerned about the possible loss of the playing field, loss of croplands, and *"hazardous materials exposed to the atmosphere."*

Few respondents in Belle Plaine envisaged any likely advantages or benefits of the project to their household or the community. Respondents suggested that the project should provide alternative locations or livelihoods for displaced residents and farmers to ensure that the negative effects on their community are minimized. Conversely, some of Belvedere's respondents were of the view that the project might generate employment in their community and *"make Belvedere a landmark."* In order to maximize the benefits and minimize the negative effects, the respondents recommended that their roads should be widened/upgraded; health hazard prevention/mitigation systems introduced in the community; employment opportunities be provided and residents kept informed about the project.

The Mondesir respondents were hopeful that the project would create employment in the community and provide their households with electricity from the project and at a lower rate than LUCELEC. The respondents advised that project should protect the playing field or provide another one nearby; the roads should be improved and health hazard prevention/mitigation systems should be provided in the community to ensure that the project's benefits are maximized and the negative effects minimized.

When asked if they would be seeking a job from the project, the majority of respondents from Belvedere and Mondesir responded "yes," compared with "No" for Belle Plaine. Some of possible jobs mentioned were labourer, mason, road construction/maintenance worker, plant manager, and supervisor.

3.7.2.9 Land Ownership and Use Survey

Belle Plaine

The area of the proposed drill site in Belle Plaine is estimated as 26.3 hectares (65 acres) and is part of an 81-hectare (200-acre) tract of family lands. In recent years, this plot of land has been undergoing a sub-division exercise and smaller parcels are currently being titled to heirs of the original owners.

The site straddles Blocks 0428B and 0427B. A copy of the most recent LRTP map sheet suggests that there are 29 parcels and most likely an equivalent number of persons who own the land

within the proposed drilling site. These parcels appear to be farm lands, some of which are under active cultivation, while the remainder appear to be fallow. Some of the owners of the sub-divided parcels have their residences on the opposite side of road, which essentially borders the site.

A parcel of land (Block 0427B Parcel 123), occupied and owned by the Bellevue Farmers' Cooperative shares part of the drilling site. It is likely that other owners of the lands which are part of the proposed drilling site are part of, or sell their produce to the Cooperative.

A preliminary profile of the ownership and use of the lands that fall within the proposed drilling site is presented in Table 3.7-8.

The combined LRTP map sheet and aerial photograph shown in Figure 3.7-1 indicate that some parcels on the western side of the proposed drilling site will be split into varying proportions by the boundary lines. This potential division significantly reduces the size of affected parcels, thereby reducing the viability of the entire parcel for agricultural purposes.

Belvedere/Fond St. Jacques

Two separate sites have been identified for drilling in the Belvedere/Fond St. Jacques community. The smaller site, which is near the center of the Fond St. Jacques community is being used for recreational purposes by the community. The other site is in Belvedere, about 0.5 kilometer uphill from the first site; it is located at the base of a forested hill which is likely to be at the boundaries of the rain forest. The site is cultivated with a few tree crops scattered on lands which may best be described as being in fallow. A noteworthy feature of the site is WASCO's water storage tank which is being supplied from the nearby spring. The lands occupied by WASCO as a reserve is approximately 256 square meters (2,755 square feet).

The proposed drilling site comprises five parcels; two of which form the majority (2 hectares [5 acres]) of the site, with one of these parcels extending to the adjacent block and hillside. Two other parcels are slivers of the drilling site and are located along the boundaries. The fifth parcel is the land on which WASCO's spring water intake is located.

A preliminary profile of the ownership and use of the lands that fall within the proposed drilling site in Fond St. Jacques is presented in Table 3.7-9. The combined LRTP map sheet and aerial photograph for the proposed drilling sites in Fond St. Jacques is shown in Figure 3.7-2

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Table 3.7-8 Preliminary Profile of Land Ownership and Use – Belle Plaine Drilling Area

Block	Parcel	Area (m²)	Land Ownership and Use
0427B	193	2,152	This parcel is family lands owned by heirs of the original owners. Only a small portion of this parcel falls within the site and should be omitted.
	190	28,000	These 5 parcels are fully within the proposed drill site. These are family lands owned by the heirs of the original owners. The lands appear to have been recently subdivided and allocated to family members. All lands are under active farming.
	188	10,571	
	191	28,708	
	189	26,260	
	156	21,437	
	155	6,781	These 5 parcels are family lands owned by the heirs of the original owners. The lands appear to have been recently subdivided and allocated to family members. All lands are under active farming These areas are smaller than the average as the boundaries of the site do not extend to the road. If the site is used for the proposed project, the owners will not have any access to or use of the rest of the land.
	154	9,374	
	157	2,596	
	158	2,234	
	159	1,225	
	123	22,491	This parcel is fully within the proposed site and is part of lands used by the Belle Vue Farmers' Cooperative for farming. The parcel is most likely owned by the Cooperative.
	103	3,334	These are portions of narrow parcels which fall within the envelope of the proposed site. These parcels are family lands owned by the heirs of the original owners and the lands are being used for farming.
	104	4,532	
	105	4,699	
	106	3,834	
	107	12,601	These 10 parcels are fully within the proposed drill site and are family lands owned by the heirs of the original owners. The lands appear to have been recently subdivided and allocated to family members. The lands are being used for farming.
	108	12,425	
	109	5,444	
0428B	126	5,393	
	127	9,562	
	128	9,580	
	129	9,625	
	130	9,701	
	124	10,188	
	125	30,576	
	117	2,236	These are slivers of family owned lands within the proposed boundaries for the proposed drill site.
	121	394	
	122	251	

Figure 3.7-1 Parcels within the Potential Drilling Area in Belle Plaine

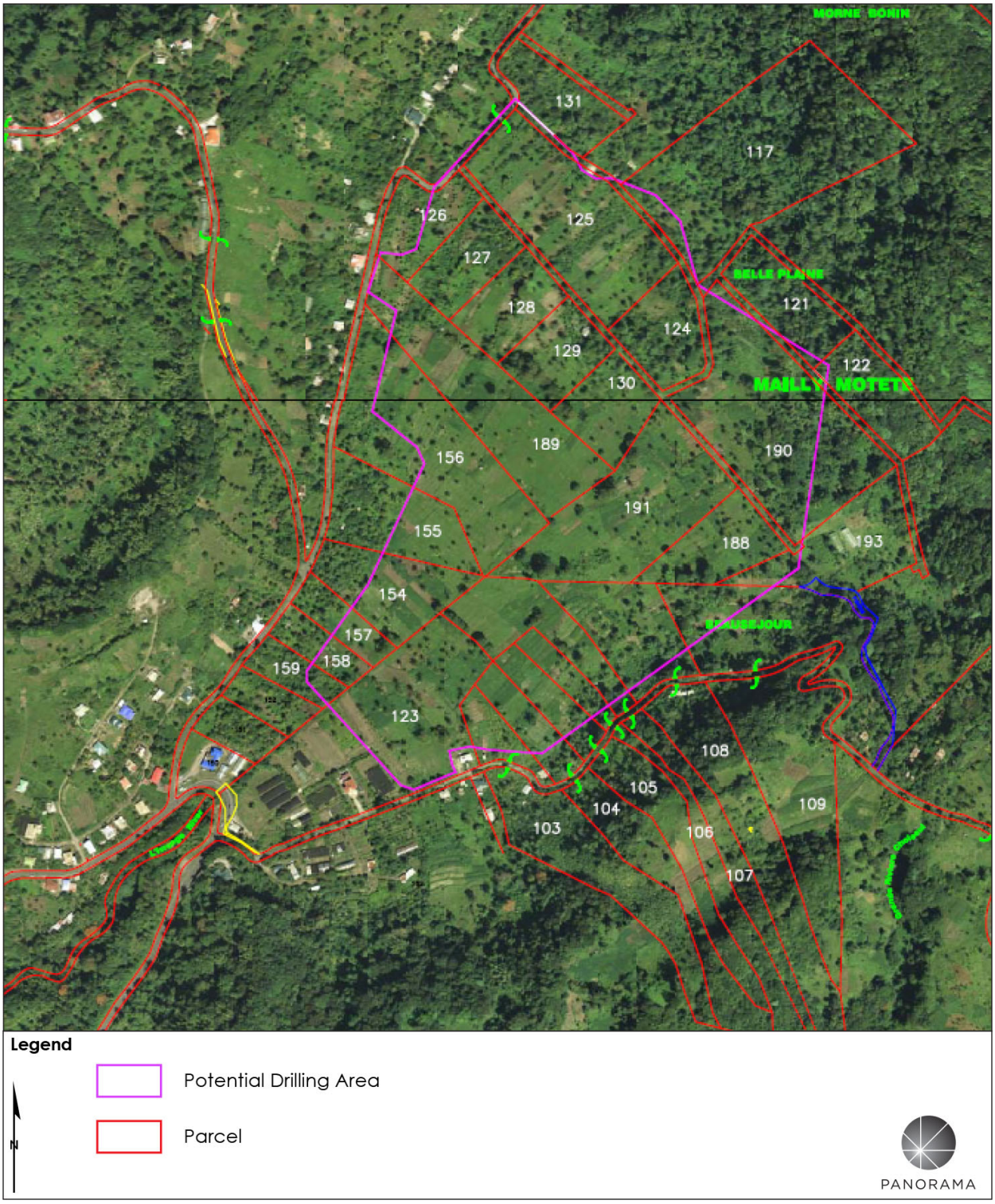
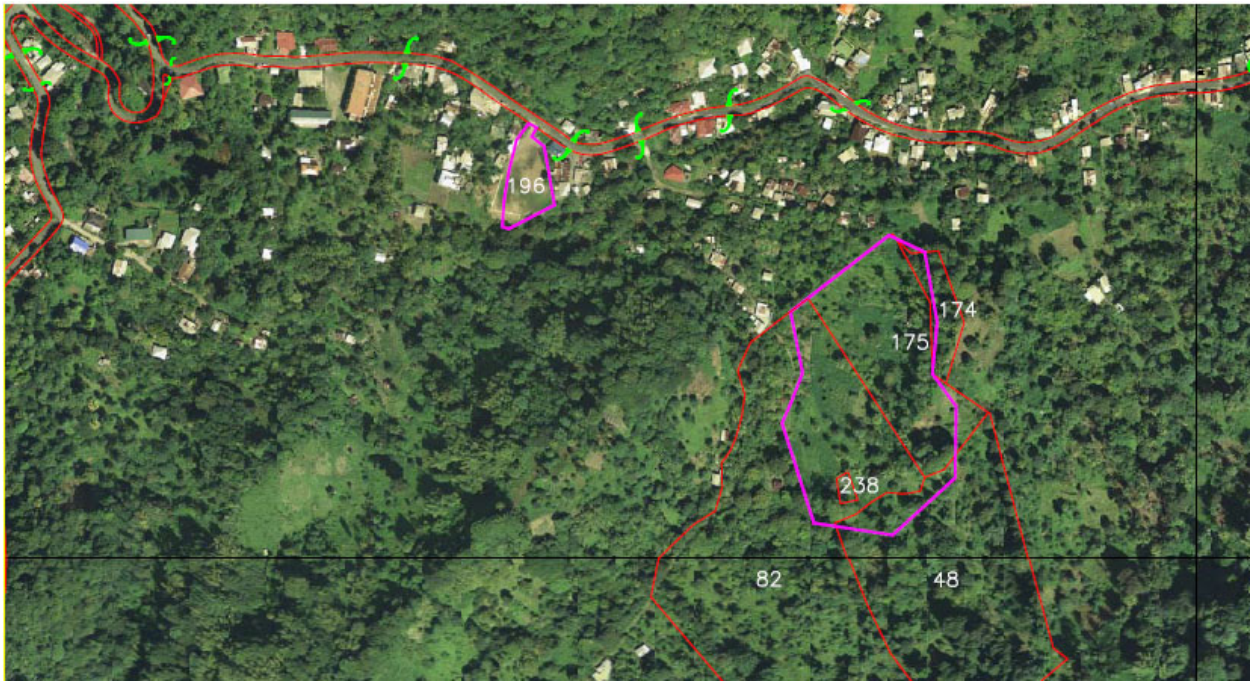


Table 3.7-9 Preliminary Profile of Land Ownership and Use – Fond St. Jacques Area

Block	Parcel	Area (m^2)	Land Ownership and Use
0429B	196	1,897	This parcel is currently being used as a playing field. It is Government owned.
	174	556	This parcel forms part of the proposed drilling site and is privately owned.
	175	10,584	This parcel is under agricultural production and is privately owned
	238	255	This parcel is within the proposed drilling site and is owned by WASCO. It is being used for spring water intake and water storage
0428B	82	9,762	This parcel is under minimal agricultural cultivation and is privately owned.
	48	1,786	This is a peripheral portion of the potential drilling area; it is privately owned

Figure 3.7-2 Parcels within the Potential Drilling Area in Fond St. Jacques



Mondesir

The proposed project area in Mondesir includes four potential drilling sites. MS-2 (2.5 hectares [6 acres]) is near the Parc Estate community and MS-1 is closer to Guyabois; MS-3 and MS-4 are closer to Saltibus and include small sites that would only be suitable for slim-hole wells. MS-1 and MS-2 are being used for agricultural and or recreational purposes. MS-2 is being used for farming and as a playing field. Although the nearest communities (Parc Estate and Gayabois) comprise about 15 to 20 houses clustered between the two segments, the playing field is comparable in size to a standard playing field; therefore, the likely users would also come from the adjacent communities of Saltibus to the north and Balca to the South.

MS-1 is approximately 7.3 hectares (18 acres) and is cultivated with temporary crops such as pineapples, sweet potatoes and vegetables. Information from residents in the community suggested that the lands were earmarked for relocation of farmers who would have been displaced as a result of a major hotel development proposed in the southeast of Saint Lucia. The current level of farming does not reflect intensive cultivation.

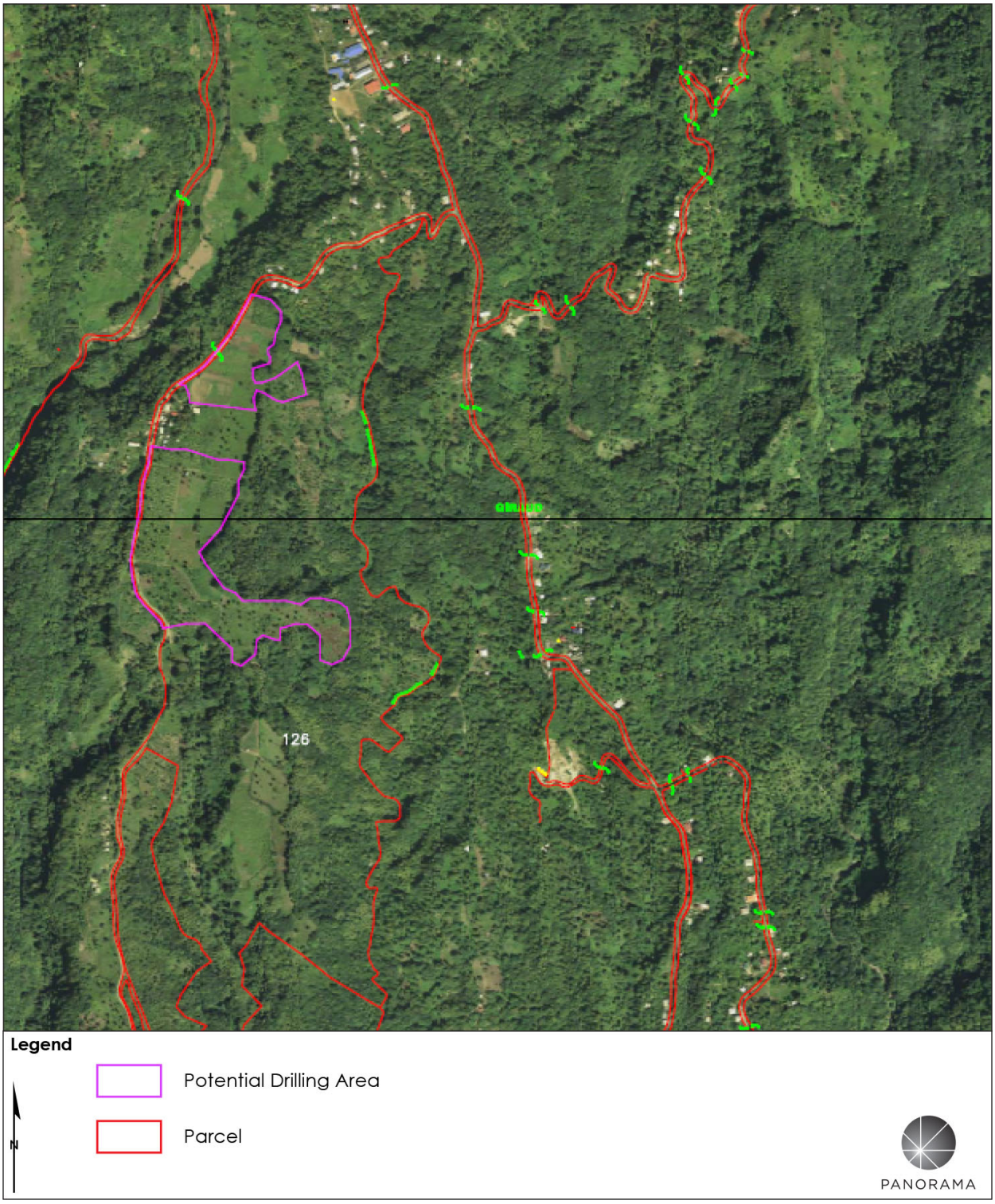
The MS-1 and MS-2 area straddles two blocks (0624B and 0625B); however, both potential drilling sites are located on one large portion of land, legally demarcated as Block 0624B Parcel 140 and is owned by the Crown (Government). MS-3 and MS-4 are located within small residential properties. Table 3.7-10 provides the land ownership for parcels within Mondesir-Saltibus

Table 3.7-10 Preliminary Profile of Land Ownership and Use – Mondesir-Saltibus Area

Block	Parcel	Area (hectares)	Land Ownership and Use
0624B	140	9.7 ha	Crown (Government) in agricultural use
0625B	71		Private land owned by heirs of the original owners; a portion of the parcel is also in a private pedestrian right-of-way
	52	3.6 ha	Privately held parcel
	105	2.3 ha	Privately held parcel
	100	0.70 ha	Crown (Government) in agricultural use

The combined LRTP map sheet and aerial photograph for MS-1 and MS-2 is provided in Figure 3.7-3.Some of the users within MS1 and MS-2 reported having lease agreements with Invest St. Lucia – the quasi-government institution responsible for management of these Crown lands. Comments from other users suggest that portions of the lands are owned by the residents; however, evidence of these claims was not found during our research conducted at the Government Land Registry.

Figure 3.7-3 Parcels within the Potential MS-1 and MS-2 Drilling Areas



3.8 COMMUNITY RISK ASSESSMENT

The following section contains results pertaining to TOR Task 1.22. The area of influence includes areas that could be affected by any slope failure induced by the project or areas exposed to geothermal gas emissions from the project.

3.8.1 Overview

Table 3.8-1 summarizes the results of the literature review and existing natural hazards risk and impact vulnerability ratings for the project region. A description of the findings for each natural hazard category are provided in the sections below.

Table 3.8-1 Existing Natural Hazards Risk and Impact Vulnerability Ratings

Natural Hazards	Risk Rating	Impact Vulnerability Ratings		
		People	Infrastructure	Economy
Seismicity and earthquakes	Low	Moderate	Moderate	Moderate
Landslides and slope stability	High to Low	High	High	High
Volcanic eruptions	Low [a]	High	High	High
Geothermal gas emissions	Low	High	--	Low
Hurricanes and tropical storms	High	High	High	High
Flood hazards	Moderate [a]	High	High	High

Notes:

[a] The risk rating pertains to the area of influence for potential exploration and development areas.

Sources: (Jacobs New Zealand Limited 2016, Jan Lindsay 2002, United Nations Office for Disaster Risk Reduction n.d.)

3.8.2 Seismicity and Earthquakes

Frequent moderate seismicity occurs in the Lesser Antilles island arc because of the crustal plate subduction process and associated volcanic activity (Jacobs New Zealand Limited 2016). The distribution of earthquake activity in the Eastern Caribbean varies, with high levels of seismicity commonly recorded near Antigua, and the lowest levels in the area from Grenada to Saint Lucia (Jacobs New Zealand Limited 2016). In the last 100 years, periodic swarms of shallow earthquakes have been reported in Saint Lucia considered to be triggered by a larger tectonic earthquake (Jan Lindsay 2002). Two substantial earthquakes that caused significant damage in Saint Lucia have been recorded, a magnitude (M) > 7.0 earthquake in 1906 and a M 7.5 to 7.75 in 1953 (Jacobs New Zealand Limited 2016). A more recent M 7.3 earthquake occurred in 2007 off the coast of Martinique, which resulted minor damage to some structures and significant damage to at least one structure (Office of the National Emergency Management Organisation Prime Minister's Office 2008).

Jacobs New Zealand Limited (2016) uses the probabilistic peak ground acceleration (PGA) values listed Table 3.8-2 for the design model to assess earthquakes with a moderate or greater potential to result in structure damage. These assumptions indicate that earthquakes with a moderate or greater potential to result in ground shaking are not expected to occur frequently.

Table 3.8-2 Peak Ground Acceleration

Return Period (years)	PGA (% g)	Perceived Shaking	Potential Structure Damage
475	0.20 – 0.25	Very Strong	Moderate
975	0.30 – 0.35	Very Strong/Severe	Moderate/Moderate to Heavy
2,475	0.45 – 0.50	Severe	Moderate to Heavy

Source: (Jacobs New Zealand Limited 2016)

The potential for ground surface rupture to occur across these faults is largely unknown (Jacobs New Zealand Limited 2016). No faults are known to be active, yet the reconnaissance geological mapping suggests the majority of the fault traces display offsets of Quaternary age (Jacobs New Zealand Limited 2016). There are no records of earthquakes with epicenters on faults in the study area that exceeded a magnitude that would likely result in ground surface rupture (≥M5) (Jacobs New Zealand Limited 2016). The potential for ground surface rupture to occur on known faults in the study is considered low; however, further study would be necessary prior to development to avoid siting structures within 200 meters of any identified fault traces to allow for uncertainties where fault traces are poorly constrained in the landscape and or concealed by vegetation and younger geological deposits (2016).

According to the World Bank, Saint Lucia has an annual average loss (AAL) from earthquakes of US $2.6 million (0.2 percent of the GDP), and a probably maximum loss from earthquakes of US $148 million (10.5 percent of the GDP) over a 250-year return period (2016). These values are less than half of those estimated for loss from hurricanes. Saint Lucia is considered to have a moderate vulnerability to impacts from seismicity and earthquakes in all categories.

3.8.3 Landslides and Slope Stability

The steep slopes and deep soils found on many of the Caribbean islands, including Saint Lucia, are naturally prone to landslides (Jacobs New Zealand Limited 2016). The combination of Saint Lucia's volcanic geology, wet tropical climate, and the rapid decomposition of bedrock in humid conditions has resulted in deeply weathered and relatively weak clayey tropical soils (Jacobs New Zealand Limited 2016). Weak clay-rich soil associated with areas of hydrothermally altered ground are highly susceptible to slips where any topographic gradient exists (Jacobs New Zealand Limited 2016). High-intensity or high-duration rainfall events commonly trigger landslides and slope failures in Saint Lucia, and earthquake-induced landslides have also been documented (Jacobs New Zealand Limited 2016). Numerous damaging landslides have been documented in Saint Lucia; the causes of the most significant

landslides have been attributed to events including hurricanes, tropical storms, and poor farming practices (i.e., mass rainforest canopy removal).

Research indicates that the majority of landslides in Saint Lucia are shallow failures of the soil mass at depths of 2 meters (6.6 feet) or less, the most common landslide types are debris flows, and earth flows, rockfalls, rock slides, and slumps also occur, but are less frequent (Jacobs New Zealand Limited 2016). Most slumps and rotational failures observed are associated with disturbed slopes such as road cuts or unplanned housing developments involving construction, earthworks, and vegetation changes (The University of the West Indies 2017). Roads in Saint Lucia are often susceptible to new slumps and slope failures due to redirected or inadequate drainage, exposed soils, over steepened cut slopes, and/or the removal of support at the toe of slopes (Jacobs New Zealand Limited 2016).

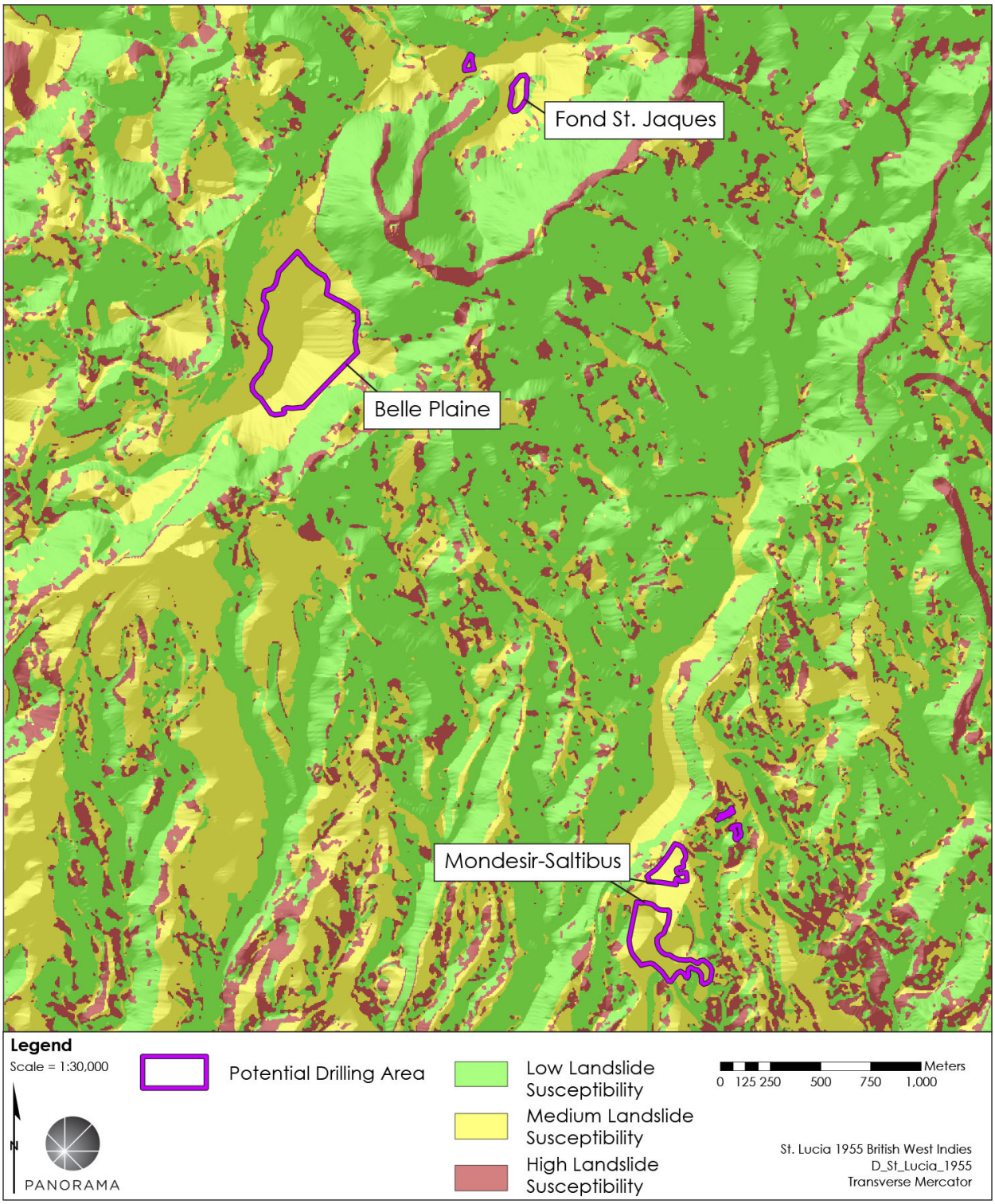
Jacobs New Zealand Limited (2016) conducted a review of numerous studies and mapping for documented landslide locations, susceptibility, and hazards, which indicate that most slopes in the potential development areas have a high susceptibility to landslides (Global Facility for Disaster Reduction and Recovery 2017, Global Facility for Disaster Reduction and Recovery 2017). Areas of landslide susceptibility are mapped on Figure 3.8-1. Jacobs New Zealand Limited also identified several additional landslides in the landscapes that were not documented.

3.8.4 Volcanic Eruptions

The Seismic Research Unit of the University of the West Indies assessed volcanic hazards in Saint Lucia following an increase in shallow earthquakes in 2000. The results of the assessment were published in the *Volcanic Hazard Assessment for Saint Lucia, Lesser Antilles* (Jan Lindsay 2002). The Soufrière Volcanic Zone is the primary focus of the assessment because it displays the youngest volcanic activity on the island and is considered the most likely location of future eruptions. The assessment authors present the following four future eruption scenarios:

1. A steam or hydrothermal eruption from the Sulphur Springs area. This type of event would be the most likely, but the impact would be relatively small (e.g. boulders ejected up to 200 meters [656 feet] from the vent) and would only affect the directly surrounding area for a short timeframe (i.e., days).
2. A small explosive magmatic eruption in the Belfond area forming an explosion crater. This type of event may produce large amounts of ash and projectile rock, but is unlikely to produce pyroclastic flows or lahars. It would be expected to last for a few weeks or months.
3. An effusive magmatic dome-forming eruption within the Qualibou Caldera. This type of event may generate dome collapse pyroclastic flows, pyroclastic surges, considerable airfall, and has a high risk of corresponding lahars being generated.
4. A large explosive magmatic eruption from within the Qualibou Caldera or from the Central Highlands area. This type of event is the least likely and worst-case

Figure 3.8-1 Areas of Landslide Susceptibility



scenario. It may generate large column-collapse pyroclastic flows, basal surges, significant airfall, and has a high risk of corresponding lahars in heavy rainfall events.

Pyroclastic flows and surges down the major valleys (eruption scenarios 3 and 4), and subsequent secondary hazards such as lahars, are the most significant volcanic hazard to personnel and infrastructure developments; however, these events are very unlikely to occur as no recent volcanic activity has been reported in Saint Lucia.

Figure 3.8-2 illustrates the combined hazard zones for three most likely eruption scenarios (1, 2, and 3) from the volcanic hazards assessment report. The worst-case scenario (4) was not taken into consideration in the map because it is considered the least likely to occur (Jan Lindsay 2002). The GoSL's Volcanic Eruption Response Plan (2009) incorporates the same hazards map (Figure 3.8-2) from the volcanic hazards assessment "for planning evacuation scenarios and in-long-term land-use planning in Saint Lucia" (Government of Saint Lucia 2009); however, no land use policies or planning strategies are identified in the plan due to the low likelihood of volcanic activity. Approximately one third of Saint Lucia is within a moderate, high, or very high volcanic hazard zone. The potential development areas near Belle Plaine and Fond St. Jacques are in a 'very high hazard zone.' The potential development area near Mondesir-Saltibus is in a 'high hazard zone.'

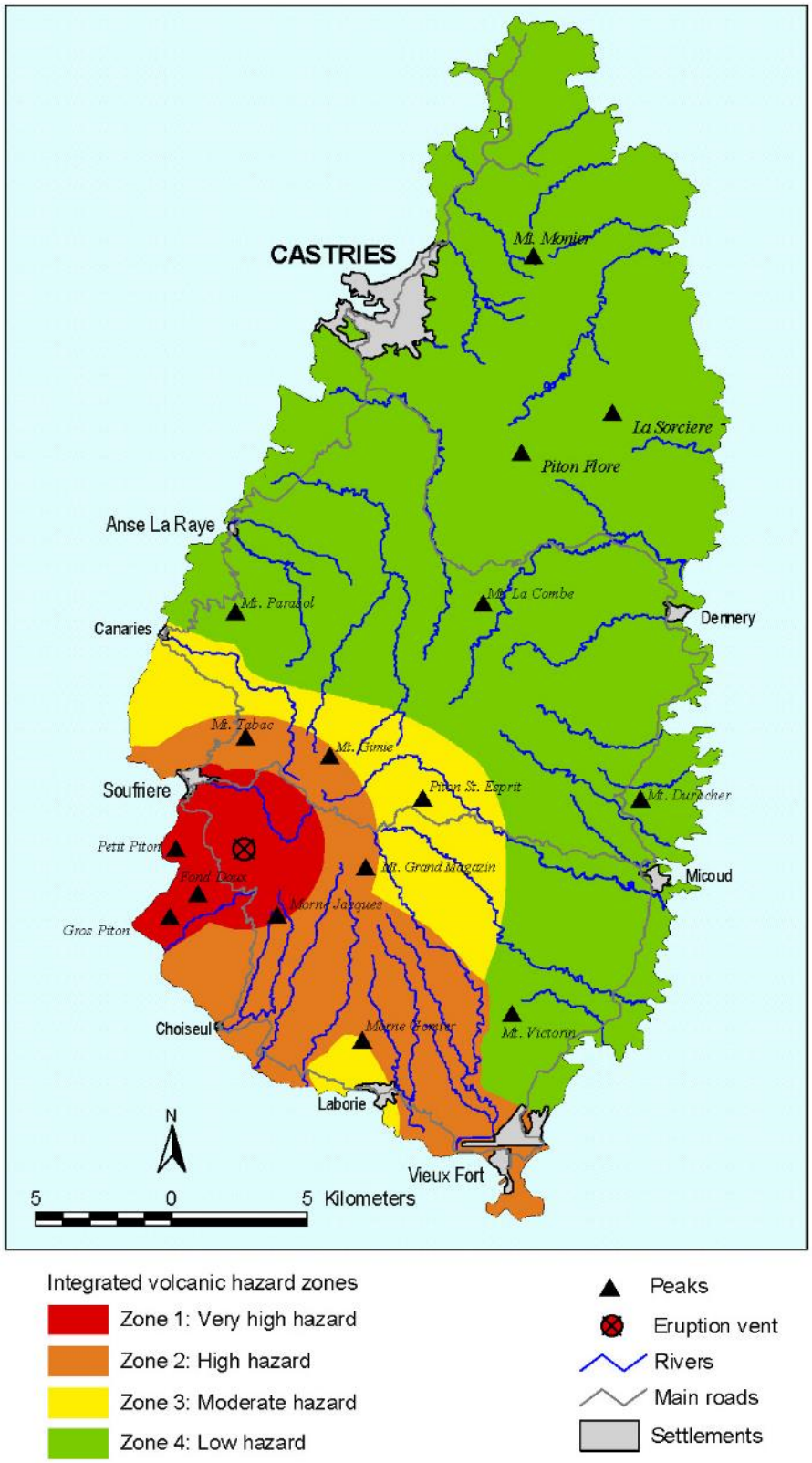
3.8.5 Geothermal Gas Emissions

Geothermal systems contain gases that are potentially hazardous to human health. The most common gases in geothermal systems include: carbon dioxide (CO_2), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), and carbon monoxide (CO). People visiting Sulphur Springs and other areas of fumarolic activity in Saint Lucia are at the greatest risk for exposure to geothermal gas emissions (Jan Lindsay 2002).

CO_2 is an extremely dangerous gas. If inhaled at low levels, it can cause rapid breathing, increased heart rate, headaches, sweating, dizziness, muscular weakness, and drowsiness (Jan Lindsay 2002). At concentrations of 11 percent or more, it can result in unconsciousness in a minute or less, and at concentrations of 20 percent or more, it can cause almost instantaneous death (Jan Lindsay 2002). CO_2 tends to accumulate in hollows in the ground because it is heavier than air, and poses a risk of suffocation to people and animals because it is invisible and has no taste or smell (Jan Lindsay 2002). There have reports of people and animals dying from CO_2 inhalation associated with geothermal systems in the Caribbean, including Saint Lucia (Jan Lindsay 2002).

SO_2 is a gas that has a characteristic pungent odor. It can cause inflammation and burning of the eyes and respiratory tract, and make breathing difficult (Jan Lindsay 2002). When SO_2 is released into the atmosphere, it reacts with air and water particles to form sulfuric acid (H_2SO_4), a constituent of acid rain which can corrode metal, which causes destruction of vegetation and severe irritation to the eyes, nose, and throat (Jan Lindsay 2002). If SO_2 is inhaled, H_2SO_4 is formed in the upper respiratory tract, which over time may cause erosion of the teeth, and chronic irritation of the eyes, nose, throat and lungs (Jan Lindsay 2002).

Figure 3.8-2 Integrated Volcanic Hazard Zones (Eruption Scenarios 1, 2, and 3)



Source: (Jan Lindsay 2002)

H_2S is an extremely toxic gas that has a very strong and unpleasant smell, like rotten eggs. Inhalation of low concentrations of H_2S causes headaches, fatigue, dizziness, excitement, diarrhea, and irritation of the eyes and upper respiratory tract; and is extremely detrimental to the sinus and respiratory system (Jan Lindsay 2002). Inhaling large quantities of H_2S results in paralysis of the respiratory system and death. H_2S is heavier than air and can accumulate in low-lying areas, like CO_2.

3.8.6 Hurricanes and Tropical Storms

Hurricanes have been historically the most likely hazard to impact Saint Lucia; Saint Lucia faces a constant threat from hurricanes and other tropical storms (Government of Saint Lucia 2006). Hurricanes and tropical storms involve extremely high winds and heavy rains that place high levels of stress on buildings, facilities, and people. Hurricanes are also the primary cause of widespread slope failure (Government of Saint Lucia 2006). Recent climate change predictions indicate a future increase in hurricane activity and extreme rainfall events in the region, including an increase in associated landslide failure (Jacobs New Zealand Limited 2016). According to the World Bank, Saint Lucia has an AAL from hurricanes of US $9.5 million (0.7 percent of the GDP), and a probably maximum loss from hurricanes of US $382 million (27.2 percent of the GDP) over a 250-year return period (2016). Saint Lucia has a high vulnerability to impacts from hurricanes in all categories.

3.8.7 Flood Hazards

Inland flooding from heavy rainfall, often associated with hurricanes and tropical storms, is also a significant natural hazard in Saint Lucia. The risk and intensity of flooding in urban areas has increased in recent years due to an increase in development of impervious surfaces, inadequate storm drainage, and inappropriate garbage disposal that blocks storm drains (Government of Saint Lucia 2006). The loss of natural vegetation can also contribute to runoff and flooding problems in both urban and rural environments. Flooding in Saint Lucia has been attributed to tens of thousands of dollars in damage (Government of Saint Lucia 2006).

The Global Facility for Disaster Reduction and Recovery produces a national flood hazard map for Saint Lucia, as part of the Caribbean Handbook on Risk Information Management project (2017). The main areas at risk for flooding in Saint Lucia are narrow zones along river valleys and in the Soufrière Valley. The only flood hazard area identified within the potential development areas is located along the stream corridor through Fond St. Jacques and within a small portion of the Mondesir-Saltibus drilling area as shown in Figure 3.1-4.

4 IMPACTS AND RECOMMENDATIONS

4.1 WATER RESOURCES

4.1.1 Potential Impacts

4.1.1.1 Water Quality

The geothermal exploration project will involve drilling of slim hole wells and potentially full-size geothermal wells to test the geothermal resources. The equipment used during geothermal testing will require use of hydraulic fluids and materials that could contaminate the soil, surface water, or groundwater if the hazardous materials were spilled or not properly stored.

The rock cuttings extracted during drilling geothermal wells could also contain high levels of heavy metals that are potentially hazardous to human health. The geothermal fluid is expected to contain high levels of heavy metals and gases, and could contaminate water resources if the fluid were released to the surface or groundwater. Accidental spill or overflow of the drilling sump could also contaminate soils or surface water.

4.1.1.2 Water Supply

The geothermal drilling operations will use 5 to 30 liters per second of water during well drilling. Water will be obtained from streams near the drilling areas in Fond St. Jacques and Mondesir-Saltibus. A water storage tank would be used to contain water for drilling operations.

Water availability is a key concern to the local community and the streams in the Fond St. Jacques area could run dry during the dry season or periods of drought. Drilling operations in proximity to the spring and WASCO water storage facilities in Fond St. Jacques will need to avoid damage to any water containment or storage infrastructure.

4.1.2 Recommended Water Resource Mitigation Measures

Table 4.1-1 below lists the recommended water resource mitigation measures with the applicable location(s) and timing for implementation.

Table 4.1-1 Water Resource Mitigation Measures

Location	Timing	Recommendation
All areas where hazardous materials will be used or encountered	Develop plan prior to drilling; implement plan during drilling operations	GoSL shall require the drilling contractor to provide a drilling-fluids plan that includes procedures for fluid containment, contingency measures for spills and leaks, and emergency procedures.
Each drill site	During drilling operations	Only non-toxic drilling fluids, such as bentonite drilling mud and other inert additives, shall be allowed as part of the drilling contractors' preliminary drilling plan to protect surface water and groundwater during drilling and testing of the geothermal resource.
Each well	During drilling operations	All cased well segments shall have fully cemented annular volumes except for the production zone. Casing and cementing protect and isolate susceptible geologic formations from any contamination from geothermal production fluids and gases, and maximizes production enthalpy from the reservoir.
Each drill site	During drilling operations	A large sump lined with impermeable high-density polyethylene shall be used to maintain excess drilling fluids on site.
Each drill site	During drilling operations	Drilling muds shall be stored in mud tanks or in lined sumps with sufficient freeboard to prevent overflow (approximately 1 meter).
All work areas	Prior to civil works and throughout drilling operations	Sediment and erosion control best management practices shall be implemented to prevent soil erosion and sedimentation to downstream water bodies.
Vehicle fueling areas and drill sites	During civil works and drilling operations	No vehicle fueling or drilling operations shall be conducted within 15 meters (50 feet) of any surface water resources including creeks, springs, or any public water storage area. Secondary containment shall be provided around the drill rig where any drilling operations are conducted within 300 meters (1,000 feet) of any surface water resources.
Upstream and downstream of drilling areas	During drilling operations	GoSL shall require the drilling contractor implement a water quality sampling and monitoring program (see Appendix F) during drilling operations.
Water storage tanks	Prior to and during drilling operations	The water storage tanks for drilling operations shall be filled during periods when there is surplus water in area streams; the project water use must not affect water downstream water supplies. GoSL shall consider dedicating water storage tanks and water supply infrastructure to the community at the completion of the geothermal exploration activities.
Existing water infrastructure	During civil works and drilling operations	Water containment and storage infrastructure in proximity to drilling operations shall be protected from drilling equipment and site preparation activities. The location of the underground water pipeline at Fond St. Jacques shall be defined prior to drilling operations and drilling operations shall be located to avoid impacts on any water supply infrastructures including buried pipelines.

Location	Timing	Recommendation
Fond St. Jacques East	Drilling operations	Any drilling operations in Fond St. Jacques east shall be conducted downgradient/downstream of area springs
All locations requiring water supply	Water supply	Saint Lucia's approved water supply contractors and industrial water access procedures shall be followed for supply of water to the drilling areas.

4.2 GEOLOGY AND SOILS

4.2.1 Potential Impacts

4.2.1.1 Site Stabilization

Soil behavior pre, during and post drilling operations is an important factor to consider along with weather that can worsen certain soil conditions. Both Fond St. Jacques and Mondesir-Saltibus require transport through unpaved access roads. Depending on the contractor´s rig size, the road turning radius may need to be expanded to accommodate drilling equipment. The road expansion could encounter areas of steep slope, which could result in slope or soil instability. The Belle Plaine site has access via a paved and well-maintained backroad, although there are some instances of blind curves, the main obstacle in soil behavior may be the construction of a well pad within the agricultural land that is well irrigated, of dense use, and within a drainage basin that creates moist and unconsolidated soils. The drilling site within Fond St. Jacques east is located within an area with shallow groundwater and seepage from a nearby spring. The soils may be saturated and require treatment prior to heavy equipment access. The pre-drilling operations of infrastructure for roads, pads, and sumps must account for ´wet season´ conditions for usage and deterioration; conversely, the ´dry season´ conditions are equally important to study for execution of construction operations under maximized sunlight and minimal rainfall.

During drilling operations, subsidence is one of the major concerns due to equipment weight and presence of unconsolidated sediments. Post-drilling operations have limited risk with regards to landslide or unstable soil conditions other than the deterioration over time of the in-place structures (roads, pads, sumps, etc.). Pressure cap build up and formation fracture can occur if there is a build-up of geothermal pressure at the surface.

Productive top soil within the drilling area could be lost as a result of site grading during civil works. The project could also cause off-site erosion or sedimentation due to site grading activities.

4.2.1.2 Soil Contamination

Drill cuttings removed during drilling operations could contain high levels of the following heavy metals due to exposure to the geothermal resource:

- Arsenic
- Boron
- Mercury
- Zinc

- Cadmium
- Chromium
- Nickel
- Uranium
- Radium
- Gross alpha and beta

4.2.2 Recommended Mitigation Measures

Table 4.2-1 below lists the recommended geology and soils mitigation measures with the applicable location(s) and timing for implementation.

Table 4.2-1 Geology and Soil Mitigation Measures

Location	Timing	Recommendation
Roadway Expansion	Before Road Work	The contractor shall conduct a geotechnical investigation of areas of roadway expansion and implement all geotechnical recommendations. The geotechnical investigation shall address potential for landslides and slope failure in areas where roadways will be expanded.
Well Pads	Before pad construction; compaction testing during construction	The contractor shall conduct a geotechnical investigation in accordance with international standards and implement geotechnical recommendations for shallow groundwater and unconsolidated sediments to protect against subsidence. The geotechnical study shall address at a minimum: fracture gradient (via tr-axial or catalog), porosity, compaction, water table, grain size and grain size Subsurface coring or coring logs from previous and close-by areas (CPT) shall be incorporated into the geotechnical investigation as needed. Well pads and areas supporting heavy drilling equipment shall be compacted to a minimum of 90%
Each drill site	Before construction of pad; during reclamation	Stockpile topsoil that is removed during grading of well pads; reapply topsoil during site reclamation
Each drill site	During drilling operations	Sample drill cuttings for the following heavy metals an raidonuclides: • Arsenic • Boron • Cadmium • Chromium • Nickel • Mercury • Zinc • Uranium • Radium • Gross alpha and beta If the sample exceeds toxicity thresholds for any heavy metal, the drill cuttings shall be treated as hazardous waste and either be capped with 1 meter (3 feet) of clean fill material or transported to a landfill that is authorized to accept hazardous waste.
Each drill site	During civil works and drilling operations	Sediment and erosion control best management practices shall be implemented to prevent soil loss on and off-site. Drainage plans shall account for potential heavy rains in the design of pads, roads, sump and other areas where heavy machinery will be located or used
Exploration wells	Post-construction	Monitor wellhead pressure at any wells that are not plugged and decommissioned and depressurize when needed.

4.3 AIR QUALITY

4.3.1 Potential Impact

4.3.1.1 Fugitive Dust

Grading of access roads and well pads could generate emissions of fugitive dust (PM_{10}). The potential dust emissions could affect air quality and visibility in the neighboring communities.

4.3.1.2 Geothermal Gases

Geothermal fluids are known to contain the following gases, or constituents in gases, which are potentially hazardous to human health at high concentrations:

- CO_2
- H_2S
- Boron
- Arsenic
- Mercury

These gases occur naturally in the geothermal resource and the geothermal gases could be released during geothermal testing. Residential areas are located directly adjacent to the Fond St. Jacques west and east drilling sites. These residents could be exposed to high levels of gases if geothermal testing were conducted in the area or if a blowout occurred during drilling.

4.3.2 Recommended Mitigation

Table 4.3-1 below lists the recommended air quality mitigation measures with the applicable location(s) and timing for implementation.

Table 4.3-1 Air Quality Mitigation Measures

Location	Timing	Recommendation
Each drill site	During drilling operations	Conduct air quality monitoring for PM_{10}, CO_2, and H_2S at locations near the drill sites prior to and during geothermal testing activities. If emissions exceed thresholds corrective actions shall be implemented including potential temporary cessation of geothermal testing until air quality levels are below St. Lucia and international air quality thresholds.
Each drill site	During civil works and drilling operations	Apply water to exposed soil surfaces (including drill pads and access roads) during the dry season to control fugitive dust emissions.
All wells	Prepare plan before drilling operations	The drilling contractor shall prepare an emergency evacuation and response plan to address contingencies and procedures in case of well blow-out, loss of control, or other emergencies,
All work areas	Before drilling operations	Implement safety procedures to protect workers and community members from potentially harmful geothermal gases.

4.4 NOISE

4.4.1 Potential Impact

Slimholes would be drilled using a small geothermal drill rig that is capable of reaching up to 2,000 meters (6,562 feet) below ground surface (bgs). Slim holes would be drilled 24 hours per day. Full-size geothermal test wells would be drilled using a large geothermal drill rig and constant drilling, 24-hours per day.

Drilling slim holes would cause a temporary increase in the daytime and nighttime ambient noise level in proximity to the drill rig; the increase in noise could affect people who live in proximity to the drilling. Drilling at night could affect sleep. The level of impact would depend on the proximity of the drill rig to residences.

Drilling full-size geothermal test wells would cause a temporary increase in ambient noise levels. The increase in noise levels from the constant drilling for up to 3 months could be significant.

4.4.2 Recommended Mitigation

Table 4.4-1 below lists the recommended noise mitigation measures with the applicable location(s) and timing for implementation.

Table 4.4-1 Noise Mitigation Measures

Location	Timing	Recommendation
Wells	During project design	Locate deep geothermal wells 150 meters (500 feet) or more from the nearest residence or sensitive noise receptor to the extent feasible.
Areas in Proximity to Well Pad	Prior to drilling	Educate nearby residents about the anticipated noise level and methods to reduce noise levels. Encourage residents near drilling areas to stay in other areas at night to avoid drilling noise.
Each drill site	During drilling operations	Equip all vehicles and equipment with proper noise-reduction parts, such as mufflers, silencers, insulators, and enclosures.
Each drill site	During drilling operations	Install acoustic barriers such as hay bales where drill rigs are located within 100 meters of sensitive receptors.
Each drill site	During drilling operations	Establish a contact person for neighbors to call regarding excessive noise. Install additional noise attenuation measures if noise levels exceed standards.

4.5 BIOLOGICAL RESOURCES

4.5.1 Potential Impact

The geothermal exploration would not directly impact any sensitive plants or habitats because no sensitive plant species or habitat occur within any of the drilling areas. Drilling locations consist of disturbed land or agricultural areas.

The target drilling areas in Belle Plaine and Mondesir-Saltibus are located adjacent to a forested area that provides suitable habitat for birds including Saint Lucia priority species. Noise from geothermal drilling operations could impact bird nesting behavior. Wildlife could also be injured if they were to enter a geothermal drilling site and become trapped in equipment or excavated area. The exploration could indirectly impact sensitive habitats through introduction of invasive plant species to the drilling sites.

4.5.2 Recommended Mitigation Measures

Table 4.5-1 below lists the recommended biological resource mitigation measures with the applicable location(s) and timing for implementation.

Table 4.5-1 Biological Resource Mitigation Measures

Location	Timing	Recommendation
Each drill site	During drilling operations	Enclose the well pad within temporary exclusion fencing to prevent wildlife from entering the work site.
Belle Plaine and Mondesir	Project design	Locate wells at minimum of 75 meters (250 feet) from the forested edge in the Belle Plaine and Mondesir-Saltibus areas and avoid drilling during the peak of bird nesting season (April to June) to the extent feasible. If drilling must take place April to June, conduct a survey to locate bird nests within 30 meters (100 feet) of the drill rig. Install noise barriers to protect the nesting birds, if needed.
Each drill site	Prior to construction	Retain a wildlife biologist to conduct surveys of the drilling site and surrounding 75 meter (250 feet) area prior to construction activities. If any priority species are identified in the area of direct impact, no activities shall be conducted in the area until the priority species leaves the area.
All areas	Civil works and drilling operations	Contain waste within covered containers.
All work areas	Civil works and drilling operations	Clean vehicles and equipment prior to arrival on site to avoid introduction of invasive plants. No pets shall be allowed on the site.
All work areas	Civil works and drilling operations	Implement a worker training program that includes worker training to recognize priority species that could occur in the area and identify measures to avoid those species.

Location	Timing	Recommendation
All work areas	At the completion of construction in each area	The contractor shall remove all construction equipment, supplies, and debris from all work sites including any staging yards and drill areas, and restore all well pads to match undisturbed conditions. Prior to construction the contractor shall prepare a restoration plan that describes the methods for restoration of the well sites and a reference site in an undisturbed area that can be used to define the target restoration conditions. A pre-construction report shall also be filed by the contractor to document the site conditions prior to project disturbance.

4.6 ARCHEOLOGICAL AND CULTURAL RESOURCES

4.6.1 Potential Impacts

The drilling target areas in Belle Plaine and Mondesir-Saltibus include areas that contain historic and pre-historic resources. Areas with a higher sensitivity for cultural resources are shown on Figure 3.6-1 and Figure 3.6-2. Grading of well pads and access roads and drilling geothermal wells could disturb or destroy historical resources in Belle Plaine or Mondesir-Saltibus areas.

4.6.2 Recommended Mitigation

Table 4.6-1 below lists the recommended archaeological and cultural mitigation measures with the applicable location(s) and timing for implementation.

Table 4.6-1 Archaeological and Cultural Resource Mitigation Measures

Location	Timing	Recommendation
Belle Plaine and Mondesir	Prior to project implementation	Retain a qualified archaeologist to conduct shovel test pit investigation to evaluate the potential for subsurface resources in Belle Plaine and Mondesir-Saltibus areas
Grading and excavation areas	During civil works	Avoid grading and drilling operations within historically sensitive areas to the extent feasible. If avoidance is not feasible, a qualified archaeologist shall survey the area (if not previously surveyed) and conduct subsurface testing. Resources should be catalogued and evaluated for their significance.
Belle Plaine and Mondesir	Civil works	Retain a qualified archaeologist to conduct archaeological monitoring during vegetation removal and grading operations in historically sensitive areas and MS-3 and MS-4. Collect and archive any resources that are encountered during archaeological monitoring.
All	Prior to civil works	Conduct worker training to relay the type of resources that might be encountered, procedures to follow if resources are discovered, sensitivity of resources, and the importance of protecting the resources.

4.7 SOCIO-ECONOMIC ENVIRONMENT

4.7.1 Potential Impacts

The project would create temporary job opportunities during civil works and drilling operations, which would have a beneficial impact on employment. Many of the jobs during drilling operations will require specialized skills and workers would come from the international market for specialized jobs. For non-specialized jobs, the project can create an equal employment opportunity for men and women.

The project will involve use of expensive machinery and equipment, which could attract vandalism or theft to the area.

The potential drilling areas include areas that are under agricultural production. Drilling operations could result in temporary loss of livelihood for farmers in the area. Disturbance of playing fields could disrupt the community.

Other key community concerns included noise, geothermal gas emissions, and water supply impacts. These issues, and mitigation measures to reduce the effects, are addressed above under noise, air quality, and water resources, respectively.

4.7.2 Recommended Mitigation

Table 4.7-1 below lists the recommended socio-economic mitigation measures with the applicable location(s) and timing for implementation.

Table 4.7-1 Socio-Economic Mitigation Measures

Location	Timing	Recommendation
Well Pads and access roads	Prior to project implementation	Compensate farmers for temporary loss of livelihood from the geothermal exploration in accordance with the Resettlement Action Plan and Resettlement Policy Framework
Drilling areas and worker camps	During project implementation	Provide fences and security around staging and material storage areas and at worker camp(s) for community safety and to protect from vandalism or theft.
All	Civil works and drilling operations	Comply with the World Bank's social policies regarding age, gender, ethnicity, and religious equality; provide equal employment opportunities for non-specialized labor categories.
All	Civil works and drilling operations	Develop a grievance redress process with an assigned community liaison to address community and worker complaints during project implementation.
Fond St. Jacques and Mondesir-Saltibus	Civil works and drilling operations	Avoid project activities (i.e., drilling, staging, or storage) in recreational areas such as playing fields where feasible to minimize disruption to the communities in the drilling areas.

4.8 COMMUNITY RISK ASSESSMENT

4.8.1 Impact Analysis

4.8.1.1 Seismicity and Earthquakes

Seismicity typically occurs naturally; however, surface and subsurface human activities can also induce seismicity. Geothermal drilling operations are not known to cause seismicity and the drilling operations do not involve any actions that are suspected of inducing seismicity. The geothermal exploration and testing would not increase pressure within a known fault system. Geothermal exploration activities including slim-hole drilling and exploration well construction and testing would not induce seismicity.

The existing risk of earthquakes in the area is considered low. The risk to workers and equipment during geothermal exploration activities would not be considerable.

4.8.1.2 Landslides and Slope Stability

The primary transport roads and potential development areas have a high risk of landslides and slope failure. Activities that destabilize slopes in these areas, such as constructing new roads, expanding existing roads, grading, or removing vegetation could increase the risk of landslides and slope failure. Poor drainage and stormwater runoff practices can also increase the risk of landslides and slope failure.

The drilling areas in Belle Plaine and Mondesir-Saltibus are in areas with low susceptibility to landslides and clearing vegetation or grading for well pads would not impact slope stability because the drilling area is located on flat areas that are stable.

The east Fond St. Jacques potential drilling area is located at the bottom of a slope that exhibits signs of recent landslide; this potential drilling area is susceptible to landslide or mudflow from adjacent hill slopes.

4.8.1.3 Volcanic Eruptions

As stated in Section 3.8.4, approximately one third of Saint Lucia is within a moderate, high, or very high volcanic hazard zone (refer to Figure 3.8-2); however, the risk of a volcanic eruption is considered low. The potential development areas near Belle Plaine and Fond St. Jacques are in a very high hazard zone, and the potential development area near Mondesir-Saltibus is in a high hazard zone.

The project would no effect on the volcanic eruption risk or vulnerability. The geothermal system that is the target of the geothermal exploration drilling project is a result of the volcanic activity in the region. Drilling wells and any future development of the geothermal resource would not change the potential for volcanic eruption.

The risk to workers and equipment from the volcanic hazard during exploration drilling would not be considerable. The risk is similar to other areas in Saint Lucia.

4.8.1.4 Geothermal Blow-outs and Gas Emissions

Well blow-outs (uncontrolled release of geothermal fluids) are a rare occurrence but are a potential hazard. The risk of a blow-out is reduced or eliminated by use of a blow-out preventer and by using drilling personnel who are very experienced with drilling geothermal wells.

Potentially harmful geothermal gases naturally occur in the region (e.g., CO_2, SO_2, H_2S, and CO), such as at Sulphur Springs. There are no known sources of geothermal emissions currently in the project areas.

Geothermal gases could be encountered during well drilling and testing. Steam and hot water produced from the geothermal well could burn employees or animals. If not properly vented. Vented steam could also damage nearby crops and vegetation. Wells should be vented through a silencer to avoid direct venting to vegetation.

Uncontrolled emissions would pose a hazard to workers and adjacent community members who could be exposed to geothermal gases (emitting from well locations. H_2S, which has a rotten egg odor, is the gas of primary concern in geothermal fluids. Workers will be protected by using H_2S monitors at the drill rig to alert workers to dangerous levels of H_2S. The community would be protected by maintaining a buffer between the drilling location and residents. Blow-out preventers and experienced drilling crews would reduce or eliminate the risk of blow-outs and uncontrolled release of gases.

4.8.1.5 Hurricanes and Tropical Storms

Hurricanes and tropical storms present a risk to worker safety and drilling operations. Project activities associated with exploration drilling should be scheduled to avoid the hurricane season (approximately June through November), to the extent possible, to avoid putting workers at significant risk of hurricane and tropical storm hazards.

If the hurricane season cannot be avoided, the relevant policies of the GoSL's Hurricane Response Plan should be adopted to protect workers. Any development associated with the project should comply with the GoSL's Engineering Guidelines for Incorporating Climate Change into the Determination of Wind Forces on Buildings and Other Structures, Appendix to the National Hurricane Plan (Government of Saint Lucia, 2009).

4.8.1.6 Flood Hazards

The drilling areas in Belle Plaine and Mondesir-Saltibus are not within flood hazard zones. The potential drilling area in Fond St. Jacques is located in an area that is at risk of flooding. The primary access corridors for all three of the project areas cross multiple canyons and drainages that have some level of flooding hazard, as shown on the Global Facility for Disaster Reduction's (GFDR's) Flood Hazard Map (2017).

Positioning equipment and workers within a flood hazard area in Fond St. Jacques during heavy rains would be a significant risk to life and property. Project activities should avoid potential flood hazard areas, such as those shown on the GFDR's Flood Hazard Map (2017), during periods of heavy rainfall in the region.

The geothermal exploration drilling program would disturb a limited amount of land for access roads and exploration well pads. The minimal areas of vegetation removal and ground disturbance would not substantially increase offsite flooding.

4.8.1.7 Fire

Workers smoking on the project site could potentially ignite a fire in the project area. In addition, the combustion engines, welding, or cooking at the site could start a fire in trees or brush surrounding the drilling area.

4.8.1.8 Worker Health and Safety

Drilling deep geothermal wells requires working at heights (on drill rigs) and use of equipment that could be hazardous to workers if proper protections were not in place. Geothermal drilling could also expose workers to geothermal gases, such as H_2S.

4.8.2 Recommended Mitigation

Table 4.8-1 below lists the recommended hazard mitigation measures with the applicable location(s) and timing for implementation.

Table 4.8-1 Hazard Mitigation Measures

Location	Timing	Recommendation
All infrastructure in landslide prone areas	Prior to project implementation	Relevant policies of the GoSL's Landslide Response Plan (2008) should be incorporated into Emergency Procedures Plan and project activities to address the general risk of landslides and slope failure on workers, equipment, and infrastructure, as well as to implement appropriate response procedures in the event of a landslide. Site-specific geotechnical analysis should be conducted in areas suspected of having unstable slopes prior to constructing or expanding roads, grading activities, and substantial vegetation removal on steep slopes or channels, to determine if specific design measures are necessary to address the hazard, such as construction of retaining walls, drainage improvements, or other reinforcement structures.
All	During project implementation	Project Emergency Procedures Plan should incorporate the applicable elements of the GoSL's Earthquake Contingency Plan (Government of Saint Lucia, 2007).
Drilling areas	During well drilling	A mitigation plan should be developed to require that proper personal protection equipment and gas detection devices are used during drilling activities
All	Prior to project implementation	Relevant policies of the GoSL's Volcanic Eruption Response Plan (2009) should be included in the Emergency Procedures Plans and implemented to protect workers in the event of volcanic activity during drilling activities and to the appropriate evacuation areas.

Location	Timing	Recommendation
All	Prior to project implementation Civil works and drilling operations	Any roads that are constructed should be designed with proper drainage channels and culverts that avoid substantial impacts to the existing drainage network. No new impervious surfaces, such as paved roads, should established within Fond St. Jacques flood hazard area. The relevant policies and procedures of the GoSL's National Flood Plan for floodplain management and flood response should be included in the Emergency Procedures Plans and adopted to protect workers, construction equipment, and project facilities (Government of Saint Lucia, 2006).
All	Civil works and drilling operations	Smoking shall only be permitted in designated areas.
All	Drilling and testing operations	The drilling contractor shall have extensive experience drilling geothermal wells to minimize the risk of blow-outs and uncontrolled flow of geothermal fluids.
Drilling areas	Drilling operations	All drill rigs that could encounter the geothermal resource shall be fitted with blow-out prevention equipment to avoid uncontrolled discharge of geothermal fluids and potential damage to vegetation, workers, and the surrounding area.

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5 SUMMARY AND CONCLUSIONS

5.1 SUMMARY OF SCOPING STUDY RESULTS

Panorama Environmental, Inc. has completed the scoping studies outlined in the TOR Activity 1 – Baseline Assessment Studies. The scoping studies included reviewing existing literature and field surveys to define the baseline physical, biological, archaeological/cultural and socio-economic aspects of the project area of interest. Data was obtained from the DSD and publicly available sources. Field surveys were conducted in September 2017.

The environmental resources within the project area of influence are summarized in Table 5.1-1:

Table 5.1-1 Summary of Scoping Study Results

Resource	Study Results
Water resources	Streams are located in proximity to the drilling areas in Fond St. Jacques and Mondesir-Saltibus. A spring and water supply infrastructure are located in proximity to the Fond St. Jacques East area. The spring in Fond St. Jacques is the only use of groundwater within the area of influence and the spring is upgradient of the drilling area. Water quality at times does not meet drinking water standards due to the presence of fecal coliform. Drought susceptibility and available water supply are key concerns.
Geology and Soils	There are no known sources of soil contamination within the area of influence. Pesticides may be used within the agricultural properties, but the of pesticides has not been documented. The underlying geology and rock cuttings extracted during drilling could contain high levels of heavy metals due to interaction with the geothermal resource.
Air Quality	Ambient air quality in the vicinity of the project areas is well below WHO guidelines for NO_2, SO_2, and H_2S. Elevated levels of NO_2, SO_2, and H_2S were measured at Sulphur Springs; however, these elevated levels were consistent with previous studies and are not representative of air quality conditions in the project area or vicinity.
Noise	Baseline noise levels in the area of influence are typical for rural areas. Intermittent noise from traffic and stationary noise from generators was detected in the area.
Biological Resources	The drilling sites are characterized by non-native habitats and agricultural land use. Forest habitats along the buffer of the drilling sites in Belle Plaine and Mondesir-Saltibus provide habitat for priority bird species.
Archaeological/Cultural Resources	The potential drilling area at Belle Plaine is located on or near the locations of two early plantations, Rabot Estate and Belle Plaine Estate. The potential drilling area at Mondesir-Saltibus is located within the Parc Estate area. Amerindian resources were present within the Belle Plaine and Mondesir-Saltibus potential drilling areas.

Resource	Study Results
Socio-economic Environment	The potential drilling areas at Belle Plaine and Mondesir-Saltibus are currently used for agricultural development. The Belle Plaine and Fond St. Jacques areas are primarily owned by families. The Mondesir-Saltibus area is primarily government owned land that is leased to farmers.
Natural Hazards	The Fond St. Jacques area is located in an area that is prone to flooding and landslides. The other drilling areas are not in flood prone or landslide prone areas. Other hazards that could affect the areas include hurricanes, seismic activity, flooding, and wildfires.

5.2 DATA GAPS

Several data gaps were identified in this study including:

- No data was available on groundwater aquifer properties sufficient to support a detailed hydrogeological model
- Insufficient data were available to calculate seasonal discharge on area streams
- The buried water line from the spring in Fond St. Jacques was not located
- Air quality data were collected during a short time period in the rainy season and data may not be characteristic of conditions during the dry season
- The biological surveys were conducted during a one-week period in September; the surveys may not reflect species use of the area during the spring when nesting is more likely to occur
- The archaeological pedestrian survey did not include any subsurface investigation and the presence of subsurface resources cannot be determined

Panorama provided recommendations for filling data gaps in situations where the geothermal exploration project would result in potentially significant social or environmental impacts. Subsequent evaluation and baseline study may be required prior to development of a geothermal power plant. Development of the geothermal resources is beyond the scope of this Scoping Study and ESIA.

5.3 PRELIMINARY IMPACT CONCLUSIONS AND RECOMMENDED MITIGATION

Panorama identified preliminary impact conclusions and recommended mitigation measures to avoid, minimize, and compensate for significant impacts (refer to Section 4). All potentially significant impacts could be mitigated to avoid significant impacts on the community.

The impacts of the geothermal exploration program would be temporary and most impacts would be limited to the duration of the drilling activity. There would be no long-term or lasting significant impacts if a geothermal resource is not identified. Well pads would be reclaimed through grading to match the natural contours and revegetation of the site. The wells would be plugged and abandoned according to industry standard if a viable geothermal resource is not indicated through the results of drilling and well testing.

If a viable geothermal resource is identified, the well pads would be a long-term feature. Full-size well at Belle Plaine and Mondesir-Saltibus wells, if successful, could potentially be used for geothermal production or injection. The slim holes could be used as monitoring wells or could be redrilled as larger, production-size wells. Large wells and production drilling is not expected at Fond St. Jacques.

The preliminary impact conclusions and mitigation in this Scoping Studies report will be evaluated further during preparation of the ESIA and detailed procedures for implementing the mitigation will be provided in the Environmental and Social Management Plan.

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APPENDIX A

Air Quality Data

APPENDIX A. AIR QUALITY SURVEY PHOTOS

DAY 1- SEPTEMBER 5TH, 2017

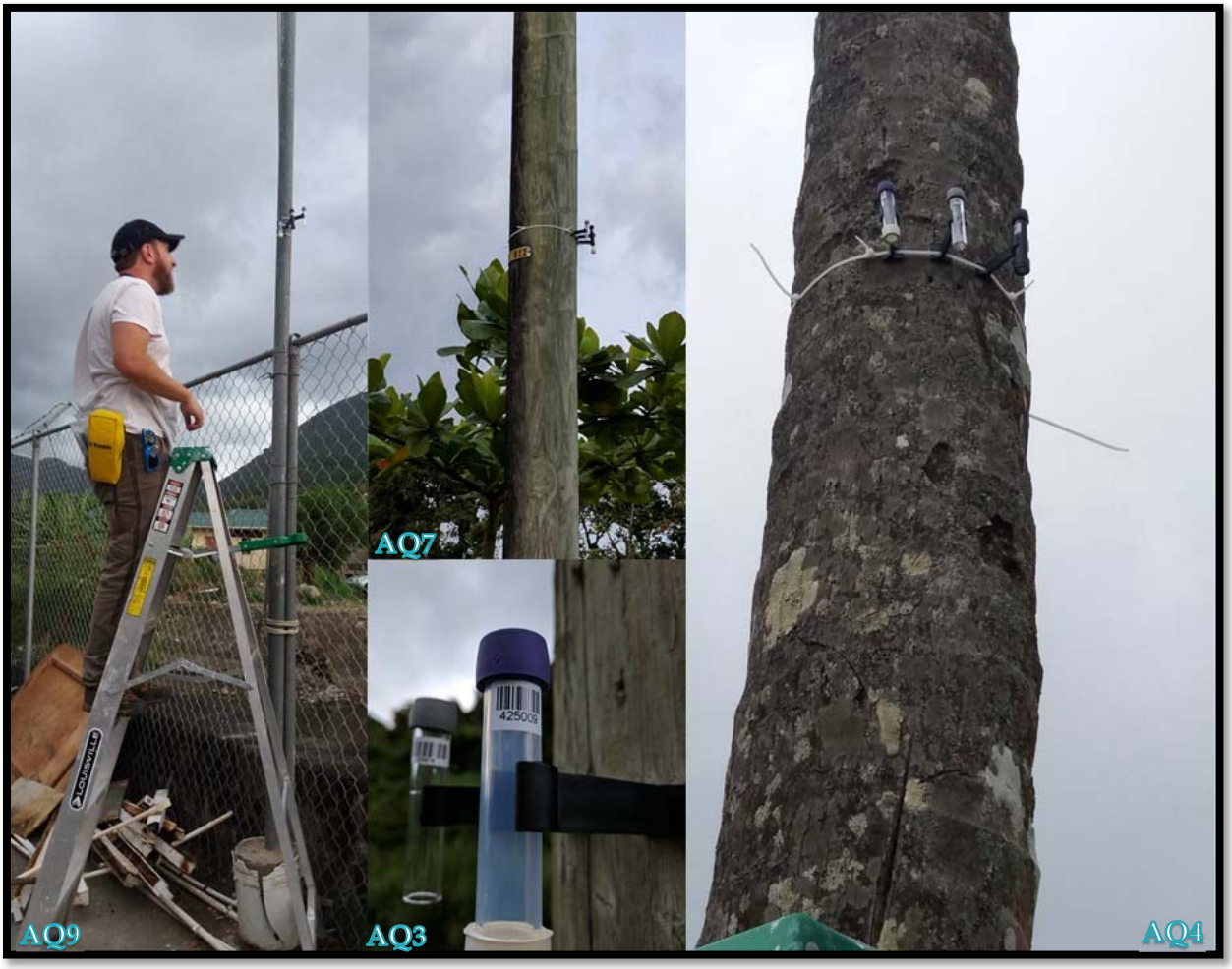


Illustration 1. Air Quality Survey - First Day.

DAY 2 - SEPTEMBER 6TH, 2017



Illustration 2. Air Quality Survey - Second Day.

Sample H_2S Protocol Sheet

Customer: ORMANTINE USA		**Contact:** Michael Willmont	
Address:		**Contact email:**	
		Contact Tel. No:	**Account No:** Y2000
Email			**Lab Ref:**
Type of Tube: H_2S	**Lot No:** 51161/4	**Bar Codes:** 1010223-1010245	
Purchase Order No: 18662	**SOR number:** 38804	**Date of dispatch:** 08/10/2017	
TO BE COMPLETED BY CUSTOMER			
Email address for reports to be sent to:			
Contact Name:	**Customer Reference/Job Number:**		

Inorganics – Analysis Required:

- ☐ Nitrogen Dioxide (NO_2)
- ☑ Hydrogen Sulphide (H_2S)
- ☐ Chloride (Cl)
- ☐ Sulphate (SO_4)
- ☐ Nitric Oxide (NO)
- ☐ Ammonia (NH_3)
- ☐ Bromide (Br)
- ☐ Nitrogen Dioxide/ Sulphur Dioxide
- ☐ Tubes returned – Analysis not required
- ☐ Ozone (O_3)
- ☐ Phosphate (PO_4)
- ☐ Sulphur Dioxide (SO_2)
- ☐ Fluoride (F)
- ☐ Nitrate (NO_3)

Fast Track Analysis – An additional charge will apply

- ☐ Fast Track Analysis & Report 5 working days – Must be pre-arranged.
- ☐ Premium Fast Track – Must be pre-arranged. Contact diffusionradko.com

Number of tubes returned: ☐

Sampling and Monitoring Record - Black

Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information
		Start date and time	Finish date and time		
1010223	Travel Blank	09/05/17 8:48 am	9/25/17 7:00	-	-
1010224	Travel Blank	09/05/17 8:48 am	9/25/17 7:00	-	-
1010225	Travel Blank	09/05/17	9/25/17	-	-

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		8:48 am	7:00		
1010226	Travel Blank	09/05/17 8:48 am	9/25/17 7:00	-	-
1010227	Travel Blank	09/05/17 8:48 am	9/25/17 7:00	-	-
1010228	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.
1010229	Fond St. Jacque 1 (505697.59; 1529120.83)	09/05/17 10:29	9/25/17 9:01	No trace of tubes	AQ1-B - Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.
1010230	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	9/25/17 8:46	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.
1010231	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	9/25/17 9:13	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.
1010232	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	9/25/17 9:30	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area is flat surrounded by steep mountains. There is a presence of agriculture interests (banana, coconut, cocoa), as well as livestock, goats, and domestic pets.
1010233	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	9/25/17 9:40	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near the

					samplings site, as well as a main road.
1010234	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	9/25/17 10:46	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.
1010235	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	9/25/17 10:37	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field. There is an unpaved road.
1010236	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	9/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.
1010237	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17	9/19/17 8:50	n/a	AQ15 (Blown into garden)
1010238	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	9/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side) on a light pole 3m above ground. Next to the main road. Next to a drainage.
1010239	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	9/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.
1010240	Union Vale (502289.70; 1526560.38)	09/06/17 12:25	9/25/17 11:28	455	AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).
1010242	Fiette (502251.56; 1523623.93)	09/06/17 13:30	9/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.
1010241	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	9/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.

Sample NO_2 Protocol Sheet

Customer	Dewhurst Group	**Account**	E1071
Address	13617 Anndyke, Pl.		
	Germantown		
Email	k.mccallum@dewhurstgroup.us	**Phone**	301 916 8996

Lot No.	DIF100-20WA	**Type of Tube**	NO_2
SOR number		**Date of dispatch**	08/17/2017

Inorganics – Gray

☑ Nitrogen Dioxide (NO_2)	☐ Nitric Oxide (NO)	☐ Ozone (O_3)
☐ Hydrogen Sulphide (H_2S)	☐ Ammonia (NH_3)	☐ Phosphate (PO_4)
☐ Chloride (Cl)	☐ Bromide (Br)	☐ Sulphur Dioxide (SO_2)
☐ Sulphate (SO_4)	☐ Nitrogen Dioxide/ Sulphur Dioxide	☐ Fluoride (F)
		☐ Nitrate (NO_3)

Sampling and Monitoring Record – Gray

Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information
		Start date and time	Finish date and time		
005627	Travel Blank	09/05/17 8:41	9/25/17 7:00	-	-
005626	Travel Blank	09/05/17 8:41	9/25/17 7:00	-	-
005625	Travel Blank	09/05/17 8:41	9/25/17 7:00	-	-
005624	Travel Blank	09/05/17 8:41	9/25/17 7:00	-	-
005623	Travel Blank	09/05/17 8:41	9/25/17 7:00	-	-
005622	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.

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005621	Fond St. Jacque 1 (505697.59; 1529120.83)	09/05/17 10:29	9/25/17 9:01	No trace of tubes	AQ01-B. Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.
005620	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	09/25/17 8:46	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.
005619	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	09/25/17 9:13	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.
005618	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	09/25/17 9:00	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area is flat surrounded by steep mountains. There is a presence of agriculture interests (banana, coconut, cocoa), as well as livestock, goats, and domestic pets.
005617	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	09/25/17 9:40	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near the samplings site, as well as a main road.
005616	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	09/25/17 10:45	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.
005615	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	09/25/17 10:37	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field. There is an unpaved road.

005614	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	09/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.
005613	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17 20:10	09/19/17 8:50	n/a	AQ15
005612	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	09/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side) on a light pole 3m above ground. Next to the main road. Next to a drainage.
005611	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	09/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.
005610	Union Vale (502289.70; 1526560.38)	09/06/17 12:25	09/25/17 11:28	455	AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).
005609	Fiette (502251.56; 1523623.93)	09/06/17 13:30	09/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.
005608	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	09/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.

Sample SO_2 Protocol Sheet

Customer	Dewhurst Group	**Account**	E1071
Address	13617 Anndyke, Pl.		
	Germantown		
Email	k.mccallum@dewhurstgroup.us	**Phone**	301 916 8996

Lot No.	12865	**Type of Tube**	SO_2
SOR number		**Date of dispatch**	08/17/2017

Inorganics – Purple

☐ Nitrogen Dioxide (NO_2)	☐ Nitric Oxide (NO)	☐ Ozone (O_3)
☐ Hydrogen Sulphide (H_2S)	☐ Ammonia (NH_3)	☐ Phosphate (PO_4)
☐ Chloride (Cl)	☐ Bromide (Br)	☑ Sulphur Dioxide (SO_2)
☐ Sulphate (SO_4)	☐ Nitrogen Dioxide/ Sulphur Dioxide	☐ Fluoride (F)
		☐ Nitrate (NO_3)

Sampling and Monitoring Record – Purple

Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information
		Start date and time	Finish date and time		
425002	Travel Blank	09/05/17 8:09 am	9/25/17 7:00 am	-	-
425003	Travel Blank	09/05/17 8:09 am	9/25/17 7:00 am	-	-
425004	Travel Blank	09/05/17 8:09 am	9/25/17 7:00 am	-	-
425018	Travel Blank	09/05/17 8:09 am	9/25/17 7:00 am	-	-
425005	Travel Blank	09/05/17 8:09 am	9/25/17 7:00 am	-	-
425006	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20 am	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.

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425007	Fond St. Jacque 1 (505697.59; 1529120.83)	09/05/17 10:29	9/25/17 9:01 am	No trace of tubes	AQ01-B - Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.
425008	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	9/25/17 8:46 am	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.
425009	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	9/25/17 9:13 am	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.
425010	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	9/25/17 9:30 am	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area is flat surrounded by steep mountains. There is a presence of agriculture interests (banana, coconut, cocoa), as well as livestock, goats, and domestic pets.
425011	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	9/25/17 9:40 am	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near the samplings site, as well as a main road.
425012	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	9/25/17 10:45 am	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.
425013	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	9/25/17 10:37 am	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field.

					There is an unpaved road.
425014	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	9/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.
425015	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17 20:10	9/19/17 8:50	n/a	AQ15 (Blown Into garden)
425016	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	9/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side) on a light pole 3m above ground. Next to the main road. Next to a drainage.
425017	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	9/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.
425019	Union Vale (502289.70; 1526560.38)	09/06/17 12:25	9/25/17 11:28	455	AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).
425020	Fiette (502251.56; 1523623.93)	09/06/17 13:30	9/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.
425021	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	9/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.

Sample H_2S Protocol Sheet

Customer: ORMANTINE USA		**Contact:** Michael Willmont	
Address:		**Contact email:**	
		Contact Tel. No:	**Account No:** Y2000
Email			**Lab Ref:**
Type of Tube: H_2S	**Lot No:** 51161/4	**Bar Codes:** 1010223-1010245	
Purchase Order No: 18662	**SOR number:** 38804	**Date of dispatch:** 08/10/2017	
TO BE COMPLETED BY CUSTOMER			
Email address for reports to be sent to:			
Contact Name:		**Customer Reference/Job Number:**	

Inorganics – Analysis Required:

- ☐ Nitrogen Dioxide (NO_2)
- ☑ Hydrogen Sulphide (H_2S)
- ☐ Chloride (Cl)
- ☐ Sulphate (SO_4)
- ☐ Nitric Oxide (NO)
- ☐ Ammonia (NH_3)
- ☐ Bromide (Br)
- ☐ Nitrogen Dioxide/ Sulphur Dioxide
- ☐ Tubes returned – Analysis not required
- ☐ Ozone (O_3)
- ☐ Phosphate (PO_4)
- ☐ Sulphur Dioxide (SO_2)
- ☐ Fluoride (F)
- ☐ Nitrate (NO_3)

Fast Track Analysis – An additional charge will apply

- ☐ Fast Track Analysis & Report 5 working days – Must be pre-arranged.
- ☐ Premium Fast Track – Must be pre-arranged. Contact diffusionradko.com

Number of tubes returned: ☐

Sampling and Monitoring Record - Black

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Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information	Results	
		Start date and time (MM/DD/YYYY)	Finish date and time (MM/DD/YYYY)			µg/m³	ppb
1010228	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.	0.17	0.12
1010229	Fond St. Jacque 1 (505697.59; 1529120.83)	09/05/17 10:29	9/25/17 9:01	No trace of tubes	AQ1-B - Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.	Tubes were missing	Tubes were missing
1010230	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	9/25/17 8:46	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.	0.09	0.06
1010231	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	9/25/17 9:13	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.	0.10	0.07
1010232	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	9/25/17 9:30	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area	0.05	0.03

					is flat surrounded by steep mountains. There is a presence of agriculture interests (banana, coconut, cocoa), as well as livestock, goats, and domestic pets.		
1010233	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	9/25/17 9:40	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near the samplings site, as well as a main road.	0.05	0.04
1010234	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	9/25/17 10:46	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.	0.06	0.04
1010235	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	9/25/17 10:37	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field. There is an unpaved road.	0.05	0.04
1010236	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	9/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.	0.04	0.03
1010237	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17 	9/19/17 8:50	n/a	AQ15 (Blown into garden)	0.08	0.06
1010238	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	9/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side)	0.17	0.12

					on a light pole 3m above ground. Next to the main road. Next to a drainage.		
1010239	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	9/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.	29.24**	20.64**
1010240	Union Vale (502289.70; 1526560.38)	09/06/17 12:25	9/25/17 11:28	455	AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).	0.31	0.22
1010242	Fiette (502251.56; 1523623.93)	09/06/17 13:30	9/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.	0.11	0.08
1010241	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	9/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.	0.16	0.12

Tubes marked ** were diluted to read within our UKAS accredited calibration range.

Analysed on UV08 Camspec M550

The Diffusion Tubes have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures calculations and assessments involving the exposure procedures and periods provided by the client are not within the scope of our UKAS accreditation. Any queries concerning the data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

Sample NO_2 Protocol Sheet

Customer	Dewhurst Group	**Account**	E1071
Address	13617 Anndyke, Pl.		
	Germantown		
Email	k.mccallum@dewhurstgroup.us	**Phone**	301 916 8996

Lot No.	DIF100-20WA	**Type of Tube**	NO_2
SOR number		**Date of dispatch**	08/17/2017

Inorganics – Gray

☑ Nitrogen Dioxide (NO_2)	☐ Nitric Oxide (NO)	☐ Ozone (O_3)
☐ Hydrogen Sulphide (H_2S)	☐ Ammonia (NH_3)	☐ Phosphate (PO_4)
☐ Chloride (Cl)	☐ Bromide (Br)	☐ Sulphur Dioxide (SO_2)
☐ Sulphate (SO_4)	☐ Nitrogen Dioxide/ Sulphur Dioxide	☐ Fluoride (F)
		☐ Nitrate (NO_3)

Sampling and Monitoring Record – Gray

Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information	Temperature °C	Results	
		Start date and time (MM/DD/YYYY)	Finish date and time (MM/DD/YYYY)				mg/m³	ppb
005622	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.	20	1.27	0.67
005621	Fond St. Jacque 1	09/05/17	9/25/17			n/a		

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	(505697.59; 1529120.83)	10:29	9:01	No trace of tubes	AQ01-B. Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.		Tubes were missing	Tubes were missing
005620	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	09/25/17 8:46	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.	20	1.23	0.64
005619	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	09/25/17 9:13	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.	20	1.13	0.59
005618	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	09/25/17 9:00	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area is flat surrounded by steep mountains. There is a presence of agriculture interests	20	0.80	0.42

					(banana, coconut, cocoa), as well as livestock, goats, and domestic pets.			
005617	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	09/25/17 9:40	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near the samplings site, as well as a main road.	20	1.06	0.55
005616	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	09/25/17 10:45	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.	20	1.03	0.54
005615	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	09/25/17 10:37	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field. There is an unpaved road.	20	1.25	0.65
005614	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	09/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.	20	1.97	1.03
005613	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17 20:10	09/19/17 8:50	n/a	AQ15 (Blown into garden)	20	1.01	0.53

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005612	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	09/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side) on a light pole 3m above ground. Next to the main road. Next to a drainage.	n/a	Tubes were missing	Tubes were missing
005611	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	09/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.	20	1.10	0.58
005610	Union Vale (502289.70; 1526560.38)	09/06/17 12:25	09/25/17 11:28	455	AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).	20	1.08	0.56
005609	Fiette (502251.56; 1523623.93)	09/06/17 13:30	09/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.	20	1.01	0.53
005608	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	09/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.	20	1.08	0.56

Note: The samples have been tested within the scope of Ormantine USA Ltd., Inc. Laboratory. Quality Procedures calculations. Any inquiries regarding the data in this report are to be directed to the Laboratory manager of Ormantine USA Ltd., Inc. This report is not to be reproduced, except in full, without the written permission of Ormantine USA, Ltd., Inc. Report Approved B. McLeod.

Limit of Detection: 0.037 μgNO_2

Preparation: 20% TEA / Water. Analyzed on UVS04 Camspec M550 equivalent Unico SQ4802.

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Sample SO_2 Protocol Sheet

Customer	Dewhurst Group	**Account**	E1071
Address	13617 Anndyke, Pl.		
	Germantown		
Email	k.mccallum@dewhurstgroup.us	**Phone**	301 916 8996

Lot No.	12865	**Type of Tube**	SO_2
SOR number		**Date of dispatch**	08/17/2017

Inorganics – Purple

☐ Nitrogen Dioxide (NO_2)	☐ Nitric Oxide (NO)	☐ Ozone (O_3)
☐ Hydrogen Sulphide (H_2S)	☐ Ammonia (NH_3)	☐ Phosphate (PO_4)
☐ Chloride (Cl)	☐ Bromide (Br)	☑ Sulphur Dioxide (SO_2)
☐ Sulphate (SO_4)	☐ Nitrogen Dioxide/ Sulphur Dioxide	☐ Fluoride (F)
		☐ Nitrate (NO_3)

Sampling and Monitoring Record – Purple

Bar Code label	Location Coordinates (X; Y) (Projection: Transverse Mercator. Datum: St. Lucia 1955)	Sampling		Exposure time (Hours)	Other information	Results	
		Start date and time (MM/DD/ YYYY)	Finish date and time (MM/DD /YYYY)			mg/m³	ppb
425006	La Haut (502354.16; 1532392.58)	09/05/17 9:21	9/25/17 8:20	479	AQ14 - Tubes installed near the registration building for the La Haut Hotel outside of Soufriere.	7.25	2.72

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425007	Fond St. Jacque 1 (505697.59; 1529120.83)	09/05/17 10:29	9/25/17 9:01	No trace of tubes	AQ01-B - Initially the tubes were installed on an abandoned house (south side of the house), next to a trail; however, to ensure the stability of these tubes, they were relocated to a tree next to the initial house. There are crops (bananas, cocoa). The main road is very narrow for the displacement of larger vehicles.	Tubes were missing	Tubes were missing
425008	Fond St. Jacque School (504975.66; 1529721.89)	09/05/17 11:15	9/25/17 8:46	477.5	AQ02 - The tubes were installed on a wall (west) of the Fond St. Jacques Primary School. This is located next to the main road.	6.88	2.58
425009	Belle Plaine Generator (504733.32; 1528664.69)	09/05/17 11:50	9/25/17 9:13	477.5	AQ03 - The tubes were installed on a light pole at 3m above ground between the local road and the LUCELEC generator.	7.31	2.74
425010	Belle Plaine Drill Site (504497.87; 1528007.49)	09/05/17 12:25	9/25/17 9:30	476	AQ04 - The tubes were installed on a coconut tree at 3.50m above ground. Windy day (NE-SW). The area is flat surrounded by steep mountains. There is a presence of agriculture interests (banana, coconut, cocoa), as well as livestock, goats, and domestic pets.	5.59	2.10
425011	Belle Plaine Nursery (504262.91; 1527572.65)	09/05/17 13:05	9/25/17 9:40	476.5	AQ05 - Tubes were installed on wall gutter at a 2,10m above ground. Windy day (E-W). There are 4 greenhouses located near	6.46	2.42

					the samplings site, as well as a main road.		
425012	Saltibus School (506717.32; 1525848.05)	09/05/17 15:10	9/25/17 10:45	475.5	AQ06 - Tubes were located on a pipe between the local school (Saltibus) and community center, 5m above ground.	6.36	2.39
425013	Parc Estate Drill Site (506428.84; 1525305.34)	09/05/17 15:50	9/25/17 10:37	475	AQ07 - Tubes were installed on a light pole at 4m above ground. The area has a soccer field. There is an unpaved road.	6.55	2.46
425014	Parc Estate/Tete Morne Main Road Entrance (504588.74; 1521330.67)	09/05/17 16:45	9/25/17 10:10	473.5	AQ08 - Tubes were located 3m above ground, at the intersection of the main road with two secondary unpaved roads.	7.88	2.95
425015	Rodney Heights - Base Station (513548.93; 1554903.44)	09/05/17 20:10	9/19/17 8:50	n/a	AQ15 (Blown Into garden)	6.78	2.54
425016	Soufriere - Fire Station (501662.68; 1531580.77)	09/05/17 17:30	9/25/17 8:29	471	AQ09 - Tubes were installed next to the fire station (west side) on a light pole 3m above ground. Next to the main road. Next to a drainage.	9.10	3.41
425017	Sulfur Springs (503220.76; 1529558.78)	09/06/17 11:25	9/25/17 11:45	456	AQ10 - Tubes were on a pole where previous air quality studies were made. Area with geothermal manifestations (hot springs, mud pools). Tourist area.	292.33**	109.62**
425019	Union Vale	09/06/17	9/25/17	455		6.97	2.61

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	(502289.70; 1526560.38)	12:25	11:28		AQ11 - Tubes were installed on a cocoa tree 2.10m above ground. The area is surrounded by a river, a main road and some crops (cocoa, coconut).		
425020	Fiette (502251.56; 1523623.93)	09/06/17 13:30	9/25/17 11:15	453.5	AQ12 - Tubes were installed on a light pole across the road from a historical ruin of a colonial windmill, 3m above ground.	6.88	2.58
425021	Dacretin (504053.18; 1524628.25)	09/06/17 14:25	9/25/17 9:35	451	AQ13 - Tubes were installed on a tree at 2.10m above ground. Next to a house. Crops: onions.	6.76	2.54

Notes:

**Tubes marked ** were diluted to read within our UKAS accredited calibration range.

The Diffusion Tubes have been tested within the scope of Gradko International Ltd. Laboratory Quality Procedures calculations and assessments involving the exposure procedures and periods provided by the client are not within the scope of our UKAS accreditation. Any queries concerning the data in this report should be directed to the Laboratory Manager Gradko International Ltd. This report is not to be reproduced, except in full, without the written permission of Gradko International Ltd.

Report Checked by J. Farbiszewska-Szulc

Analysed on Dionex ICS3000 ICU5

APPENDIX B

Noise Monitoring

APPENDIX B. NOISE MONITORING PHOTOS

DAY 1 - SEPTEMBER 5TH, 2017



Illustration 1. Noise Survey - First Day.

DAY 2 - SEPTEMBER 6TH, 2017



Illustration 2. Noise Survey-Second Day.

DAY 3 - SEPTEMBER 7TH, 2017



Illustration 3. Noise Survey-Third Day.

APPENDIX B. NOISE MONITORING DATA

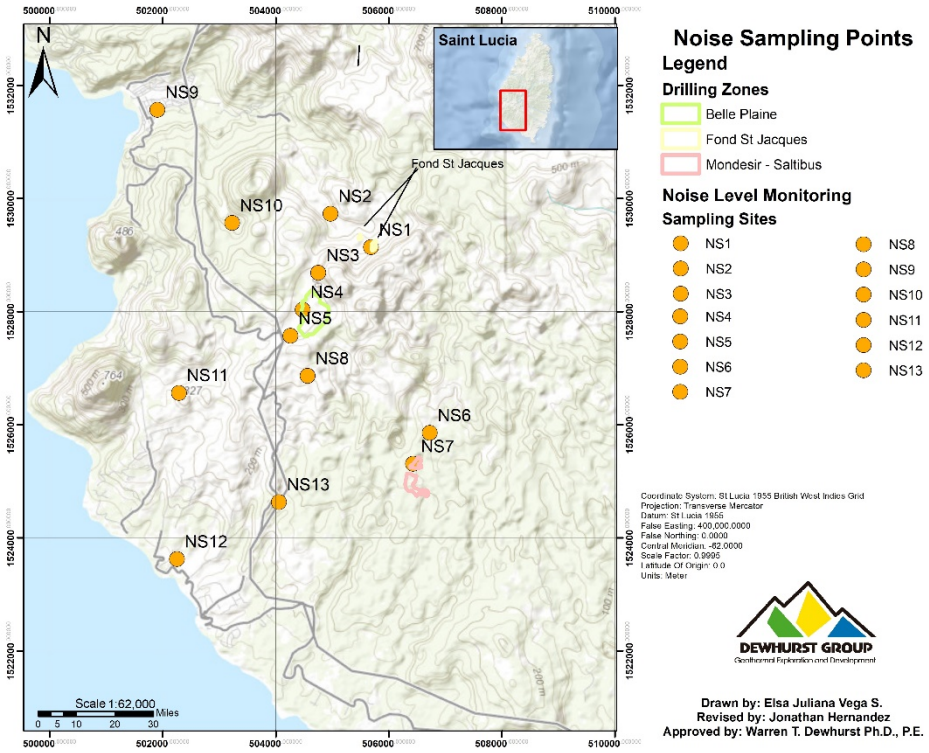


Figure 1. Location map of Noise Monitoring.

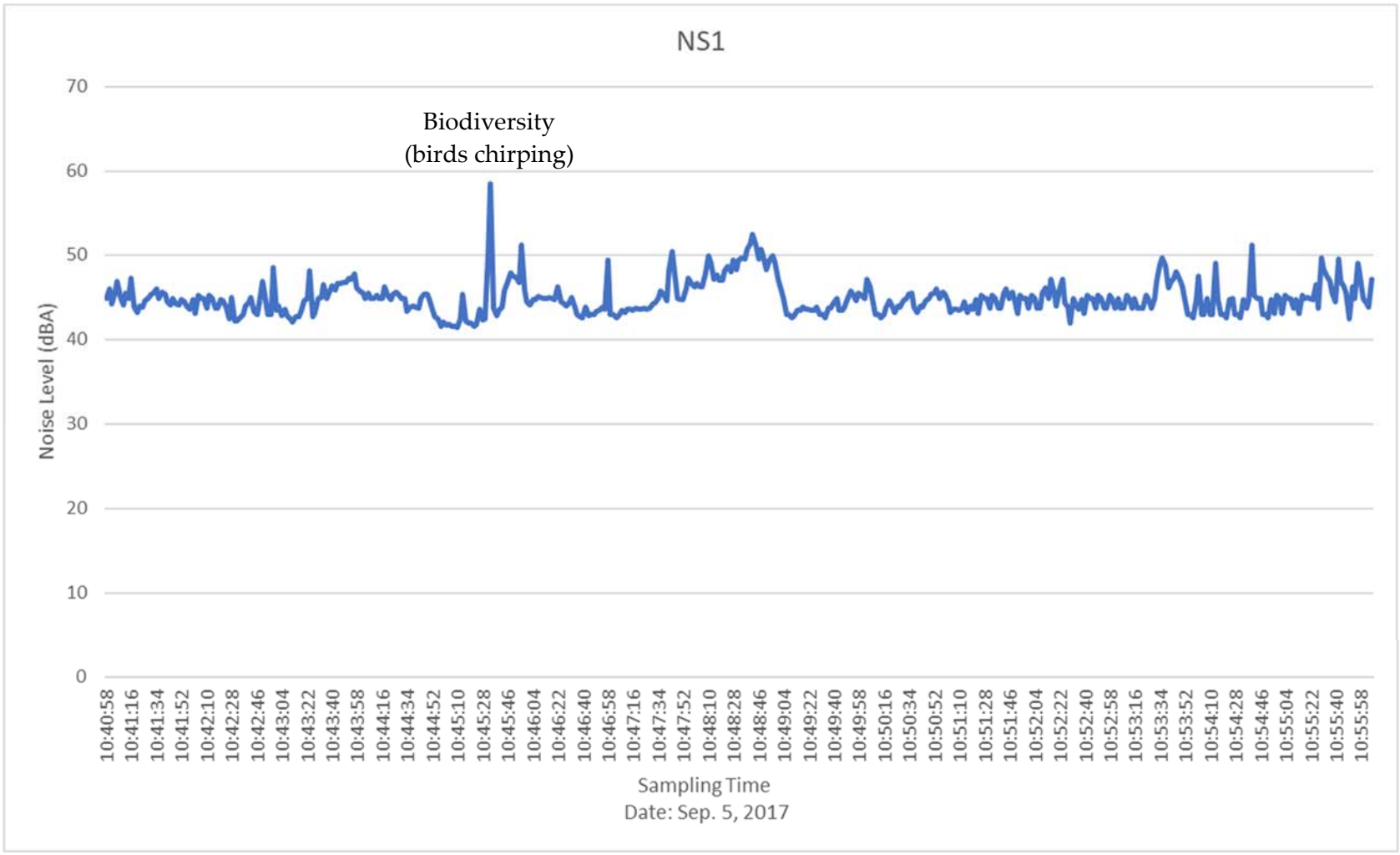
APPENDIX B: NOISE MONITORING

Table 1. Observation sites within each area of influence (Projection: Transverse Mercator. Datum: St. Lucia 1955).

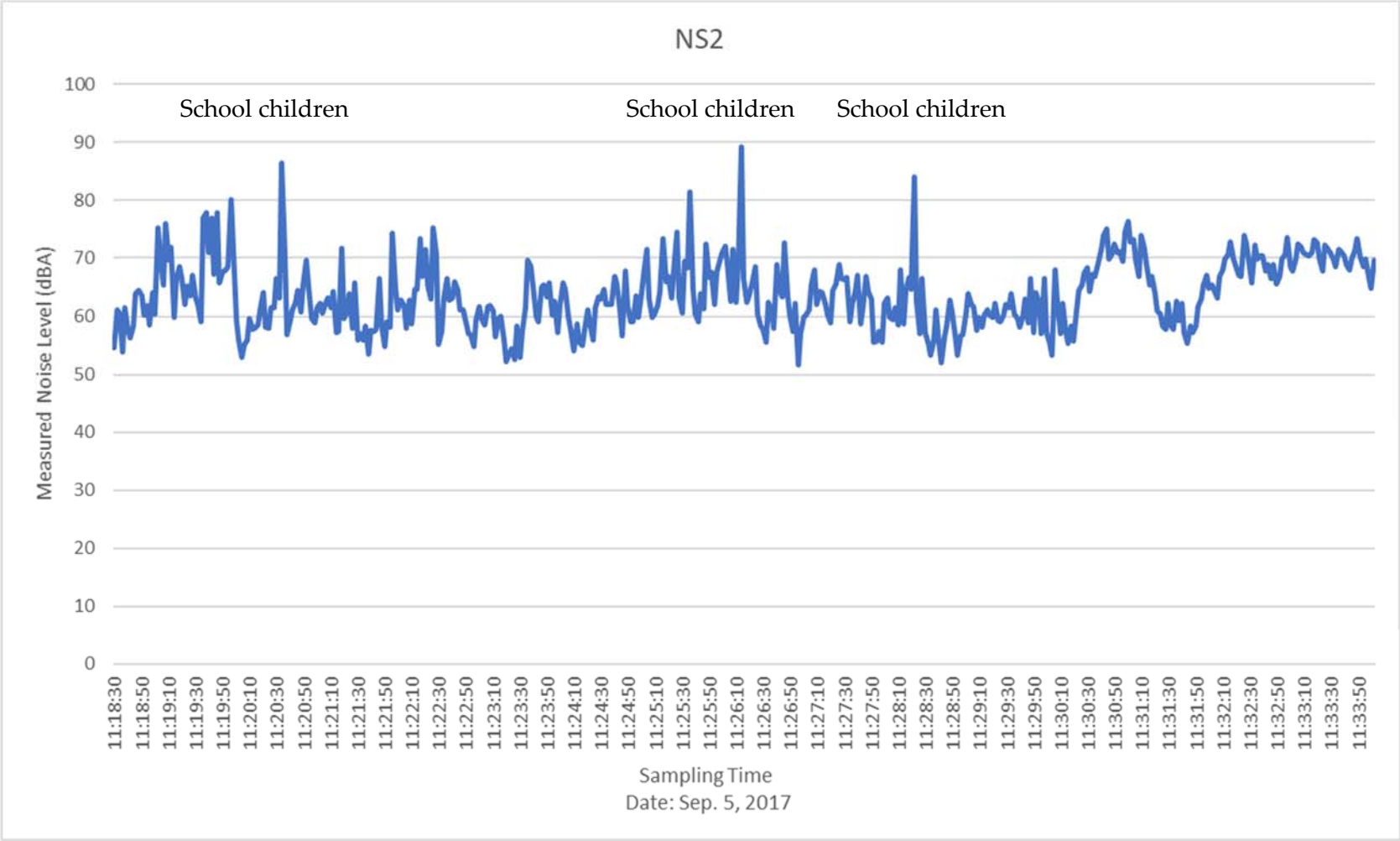
Site Name	X (mE)	Y (mN)	Elevation (m ASL)	Description of Area
NS1	505697,59	1529120,83	298	**St. Jacques** - Drill Site in the field by rundown shack near unpaved road in the area
NS2	504975,66	1529721,89	250	**St. Jacques -** Primary School Yard near the main road in the area
NS3	504733,32	1528664,69	400	**Belle Plaine** - LUCELEC Generator near the main road in the area
NS4	504497,87	1528007,49	337	**Belle Plaine** - Drill Site Field near the main unpaved road in the area
NS5	504262,91	1527572,65	362	**Belle Plaine** - Greenhouse near the bend on a main island paved road
NS6	506717,32	1525848,05	292	**Saltibus** - Primary School between local school and the Community Center
NS7	506428,84	1525305,34	261	**Saltibus** - Parc Estate Drill Site (Near a commercial establishment) and soccer field
NS8	504588,74	1521330,67	45	**Saltibus** – At the corner of the local access road (to Parc Estate) corner with Main Road
NS9	501662,68	1531580,77	-6	Soufriere - Fire Station Flagpole taken from within southern edge of parking lot
NS10	503220,76	1529558,78	223	Sulphur Springs – southern side of main walkway 5m due south of NS10
NS11	502289,70	1526560,38	225	Union Vale – About 15m from the main paved road/bridge and within vegetation
NS12	502251,56	1523623,93	53	Old Mill - Light Pole # SEQC04444 near main paved road in the area
NS13	504053,18	1524628,25	219	D'Quitoin - Off main road - terrace farm - high side/scarp side of the highway

Note: Sites in Bold represent the 3 prospective drilling areas. GPS measurements taken on site with Trimble.

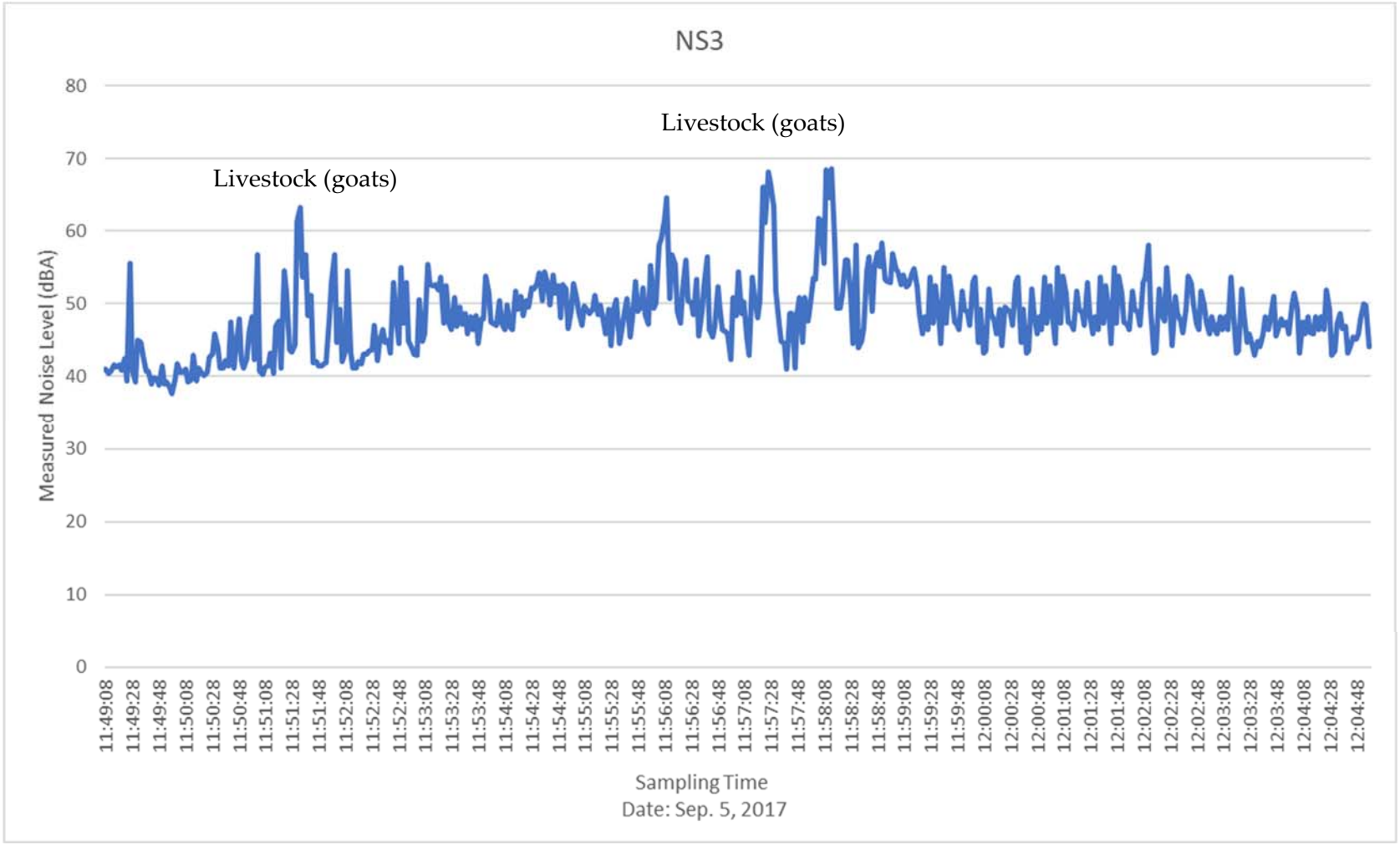
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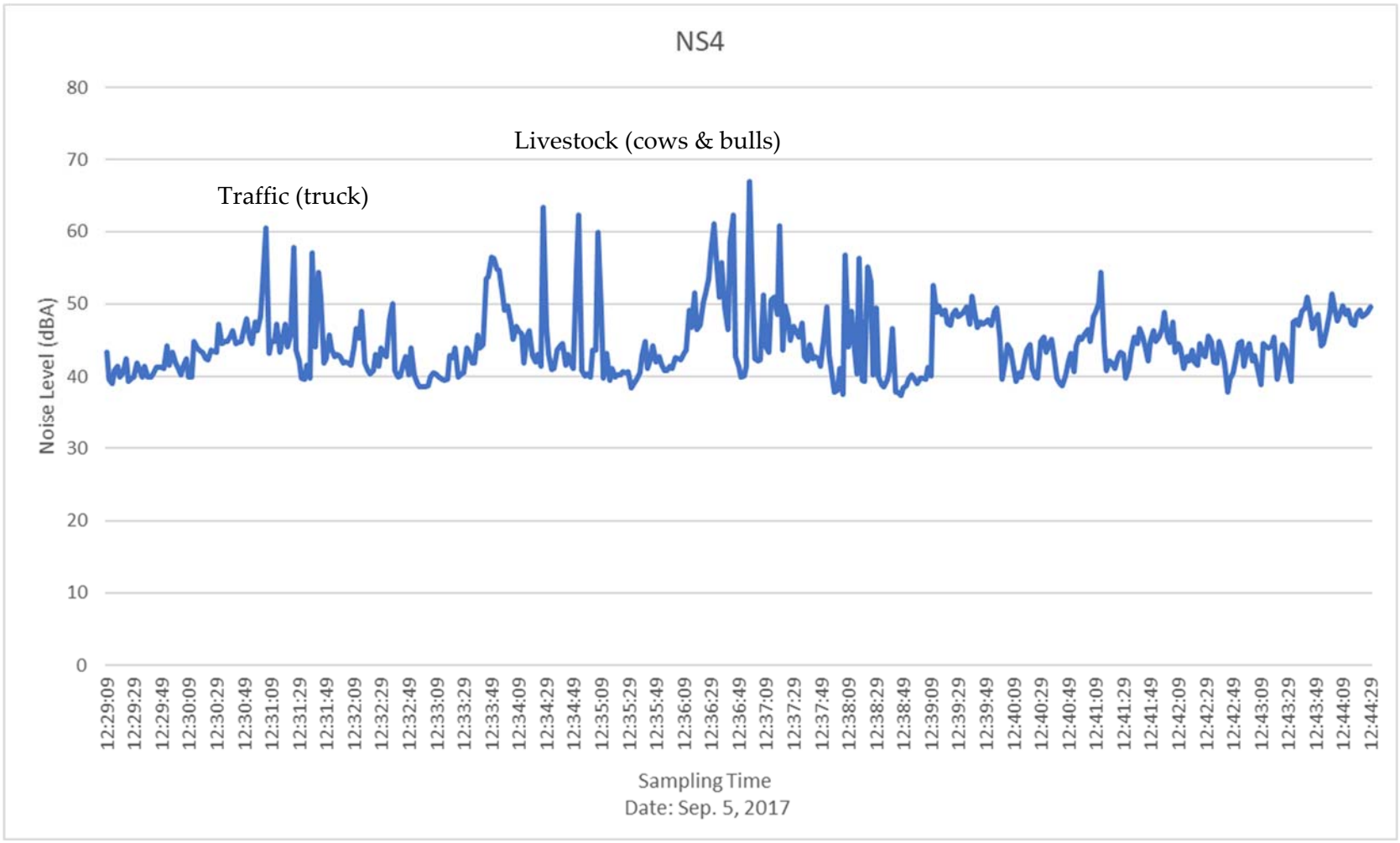
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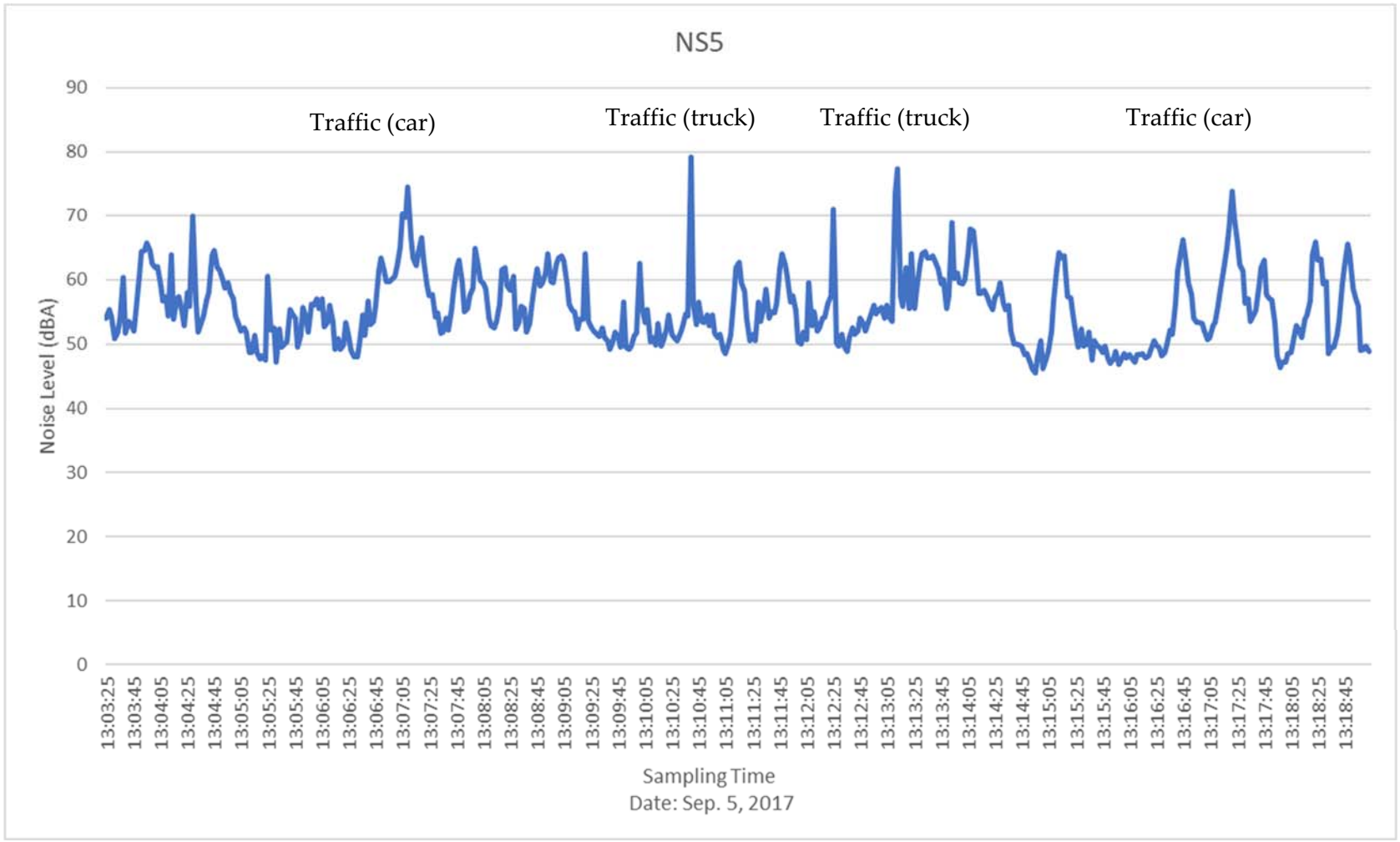
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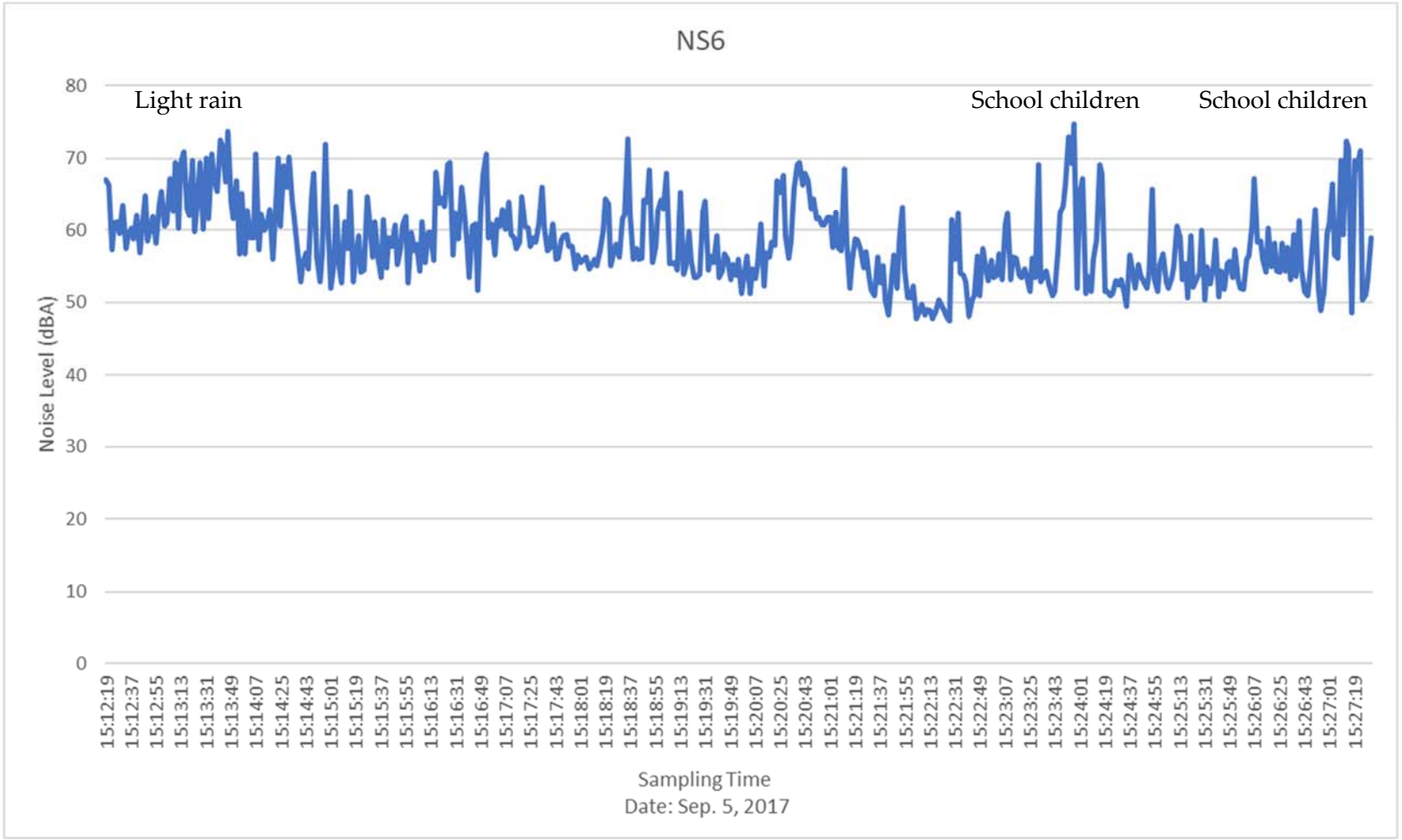
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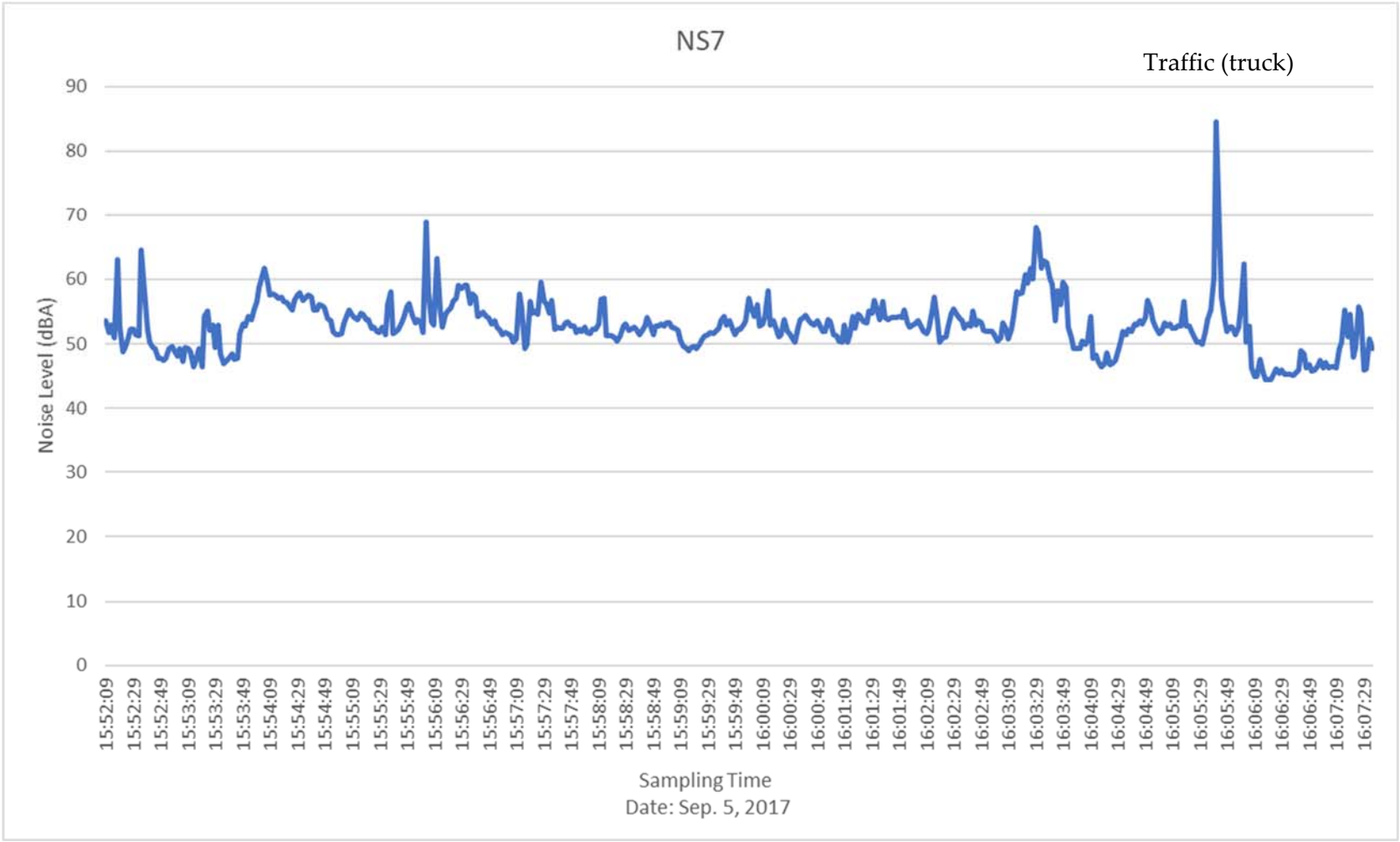
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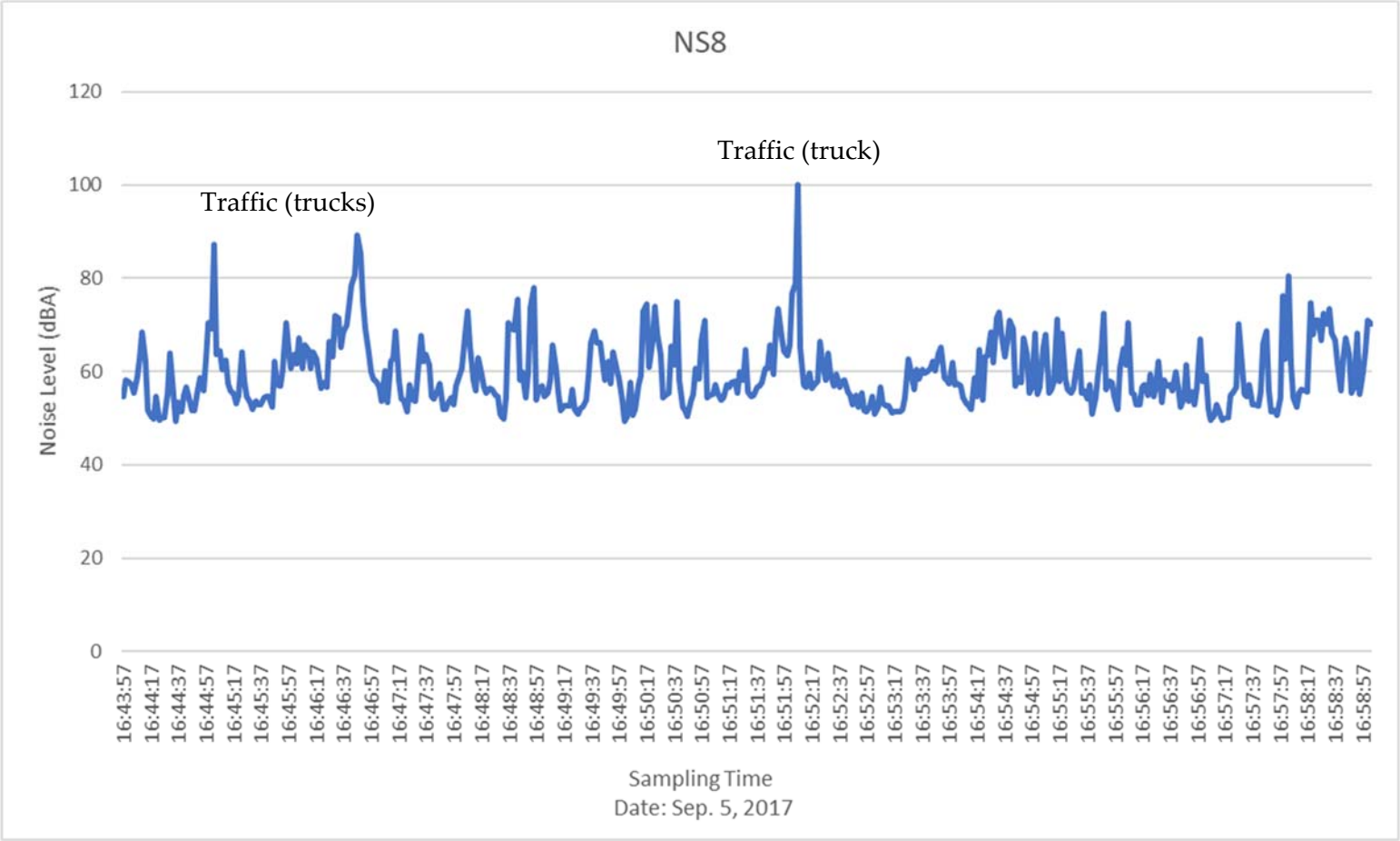
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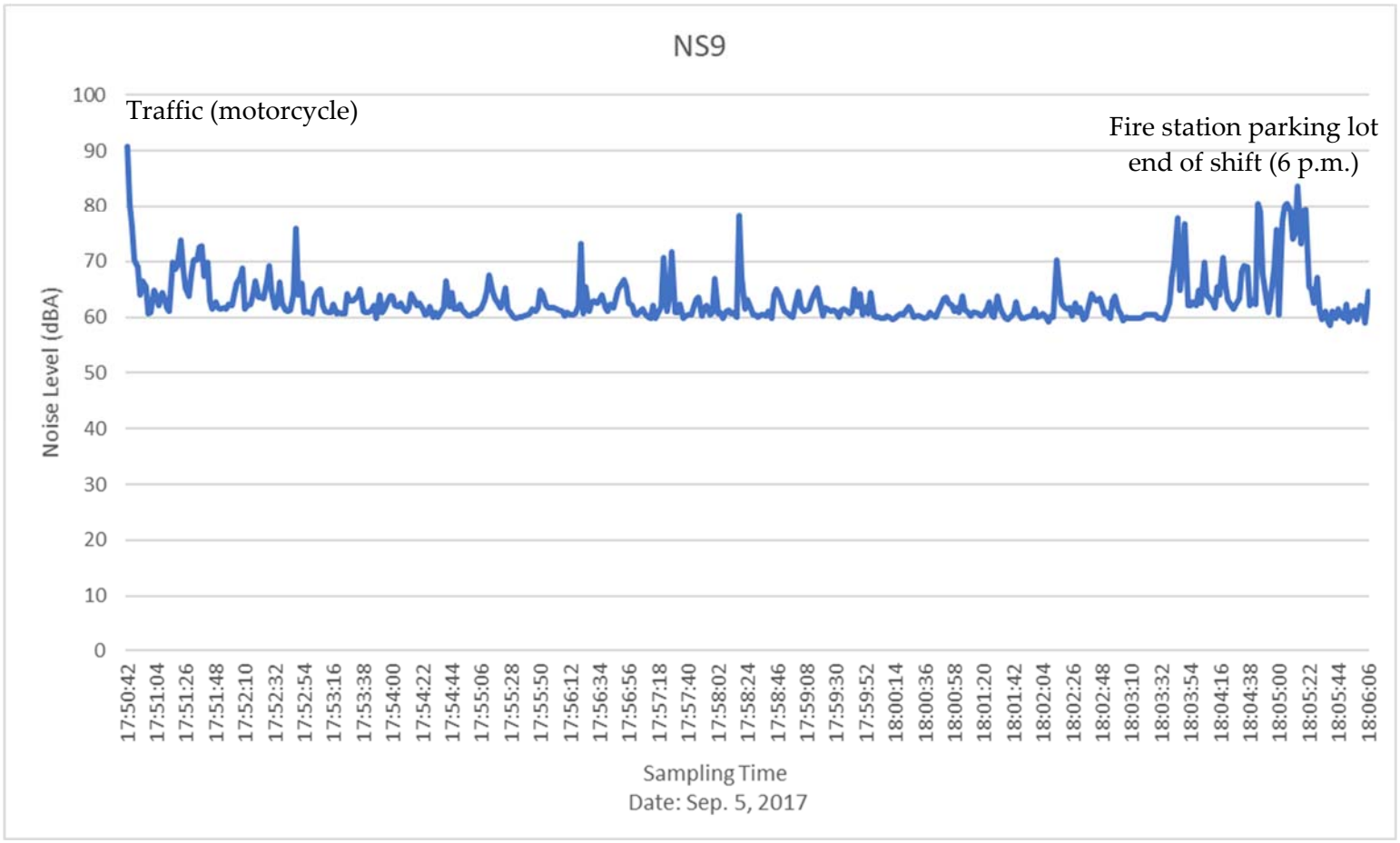
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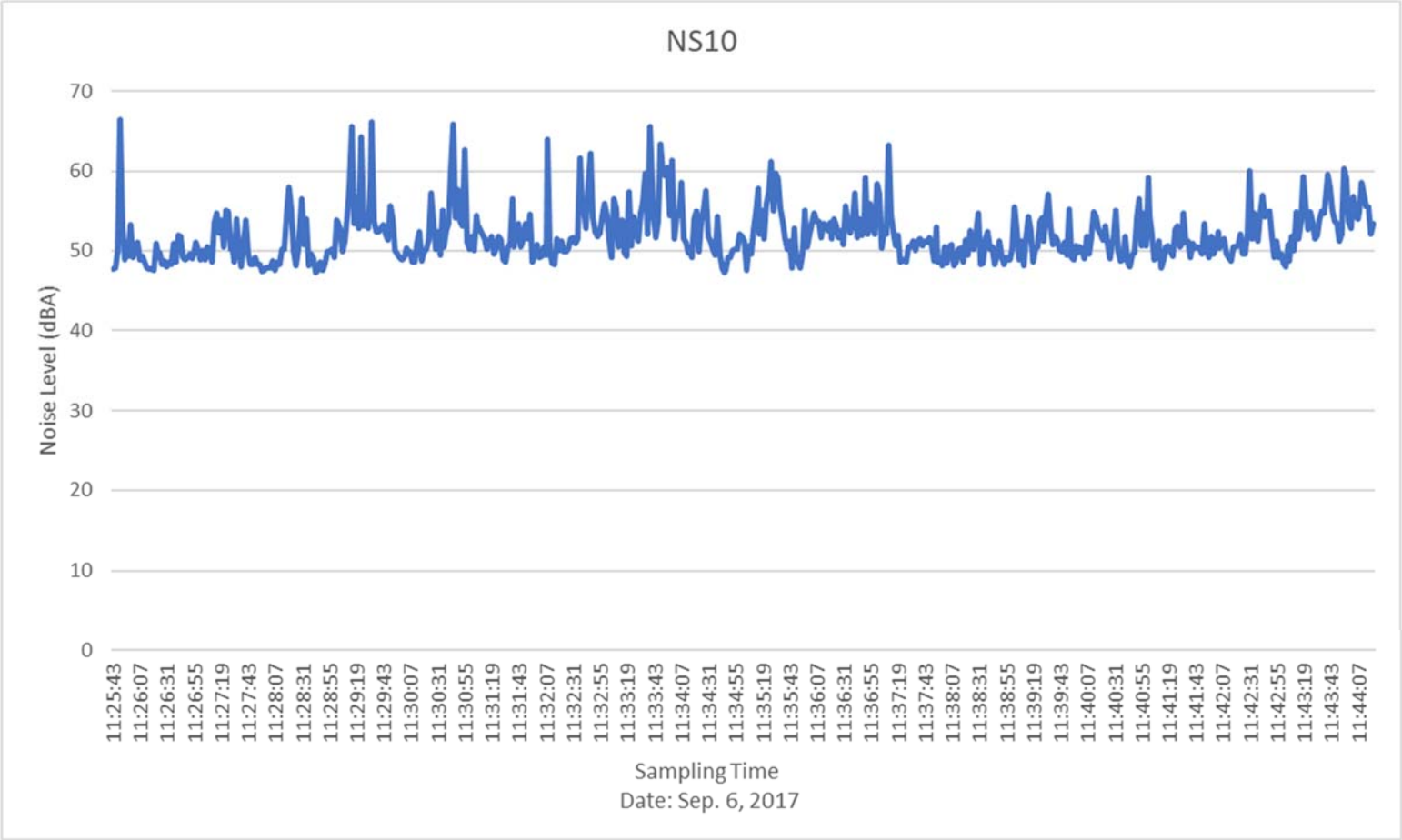
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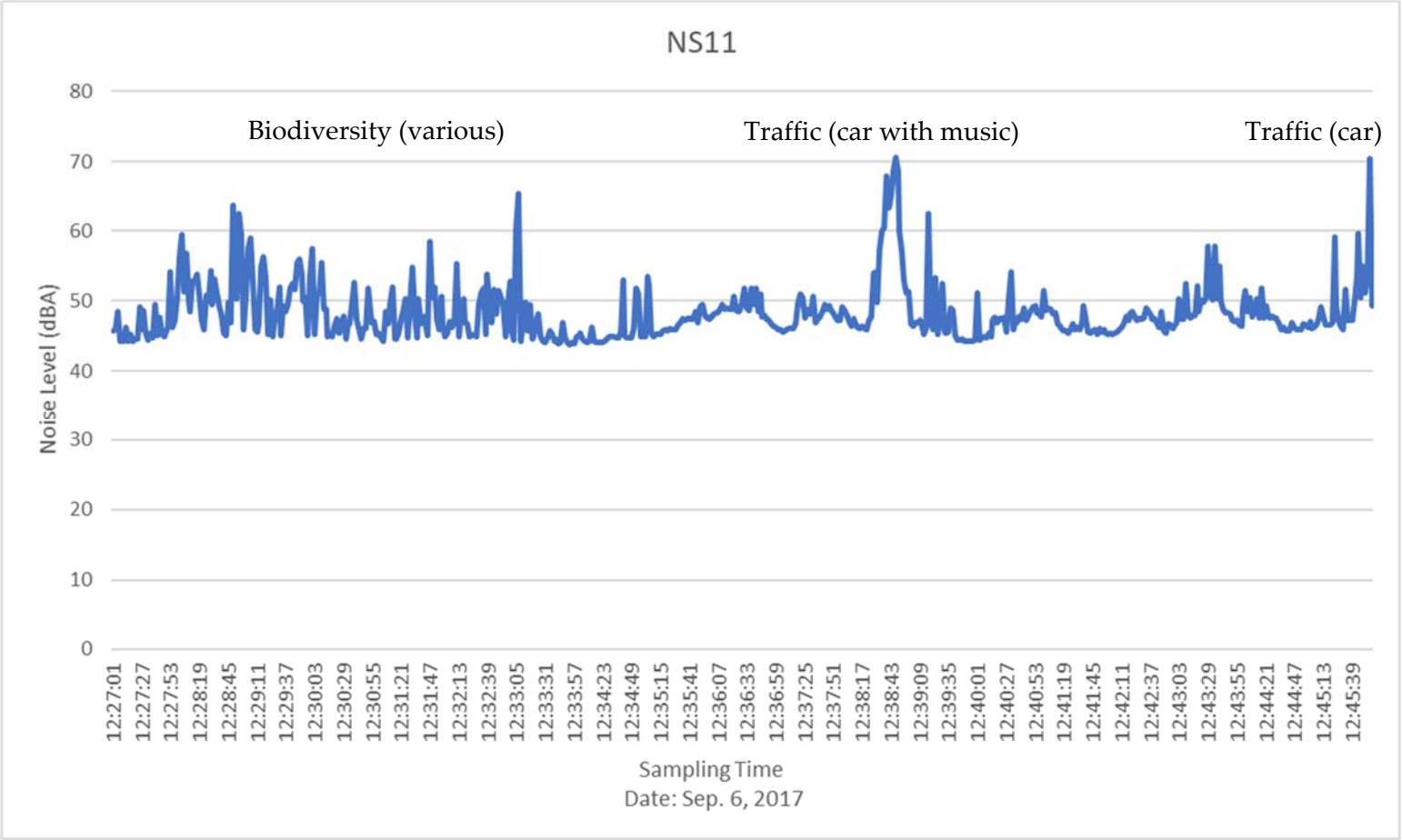
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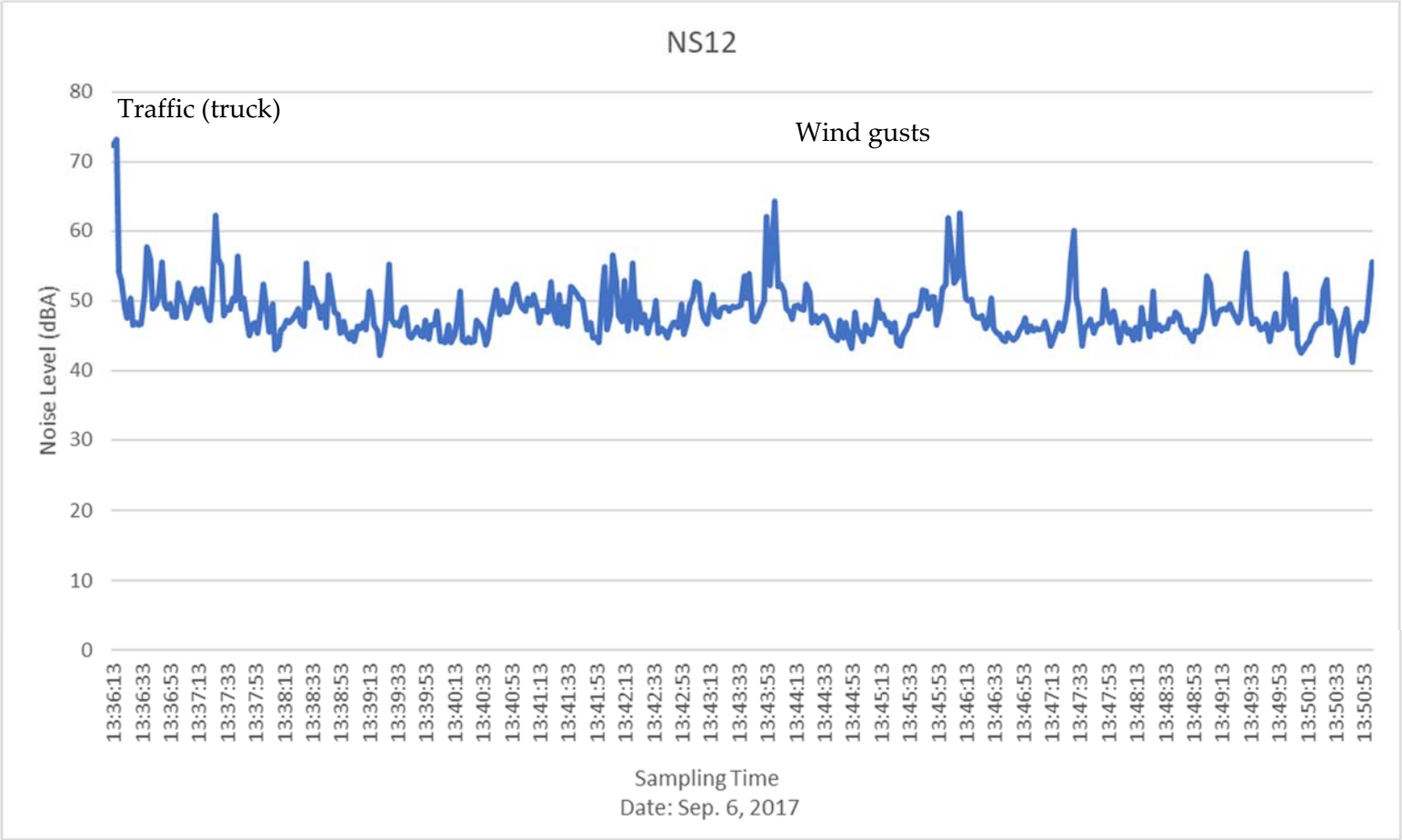
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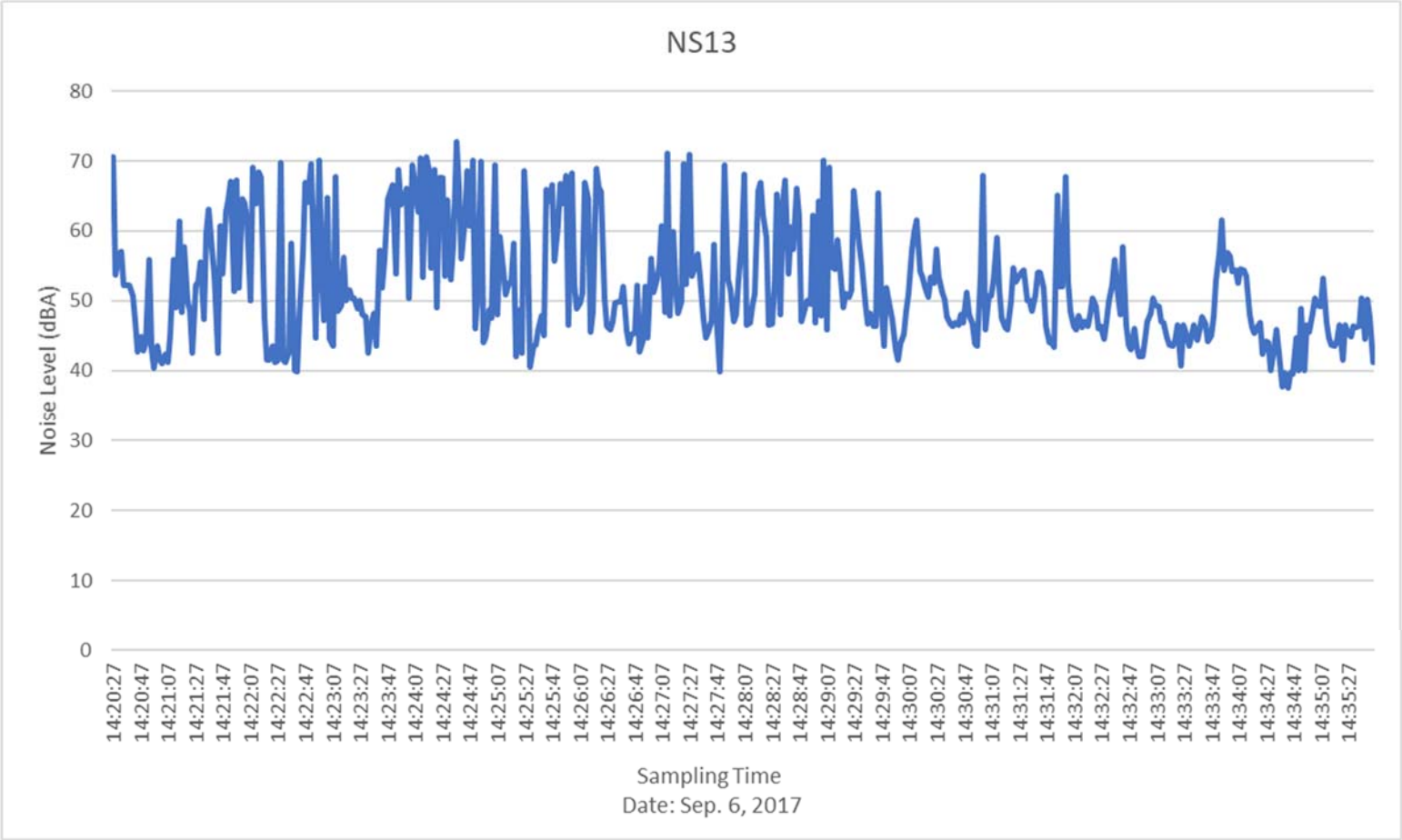
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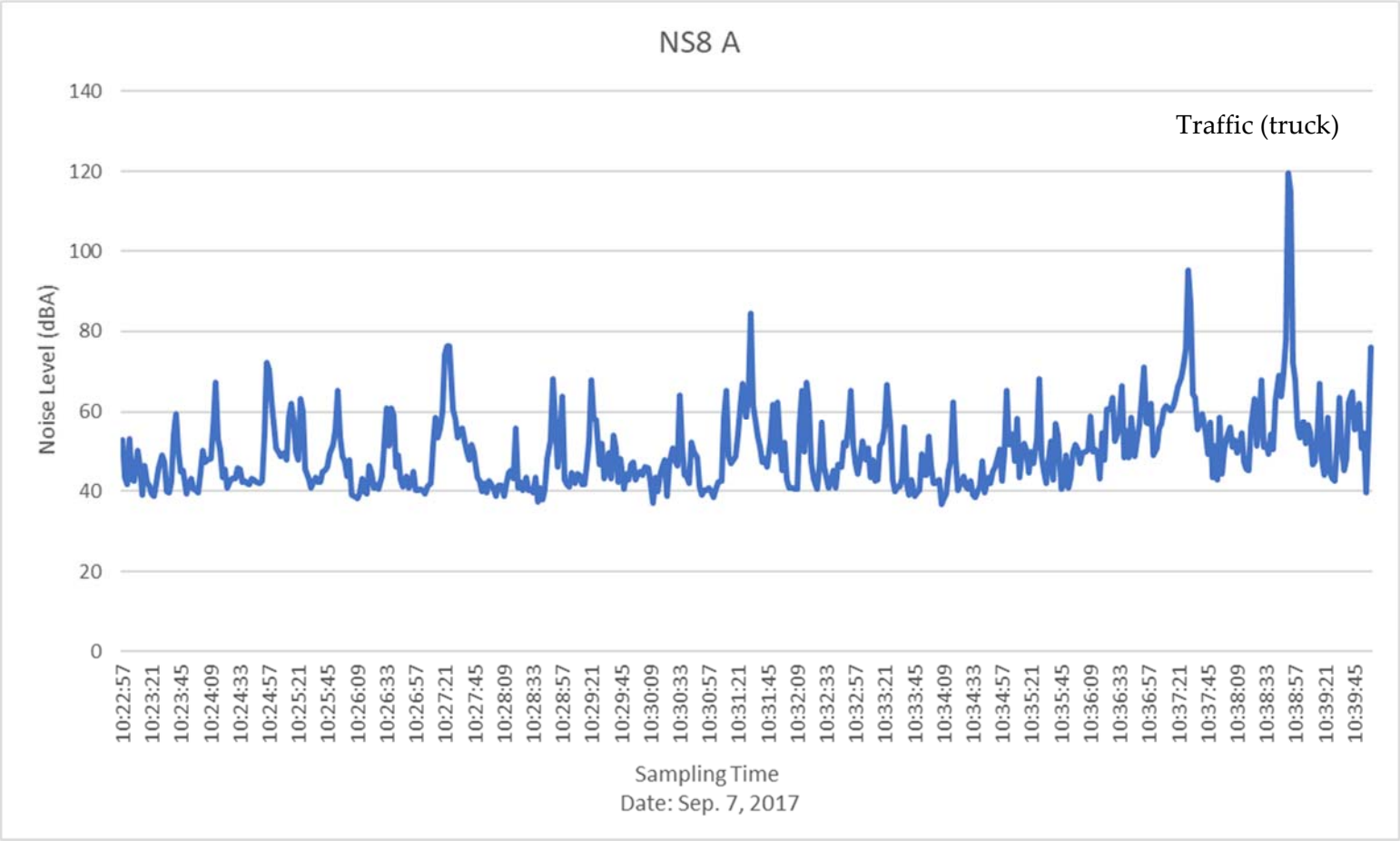
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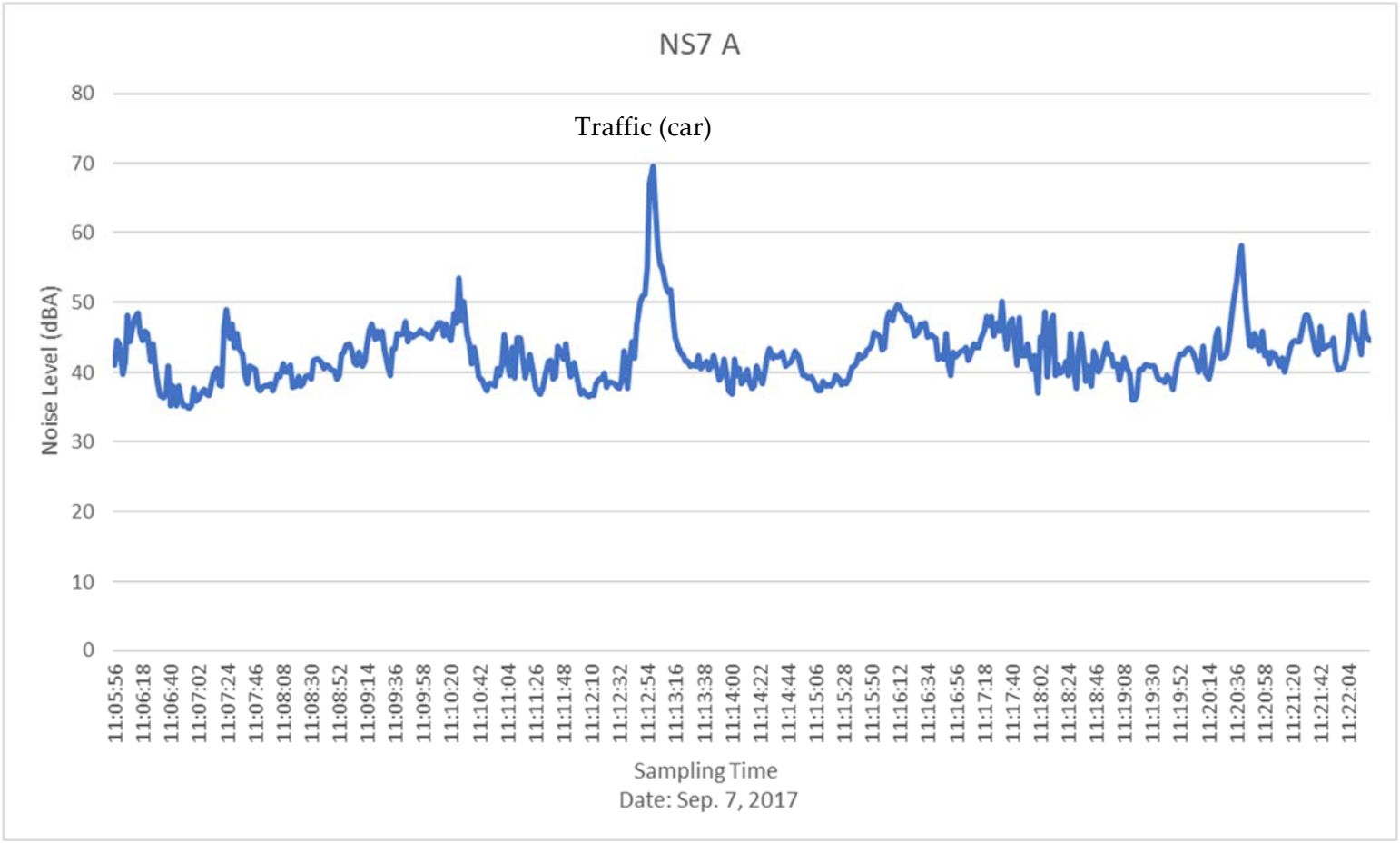
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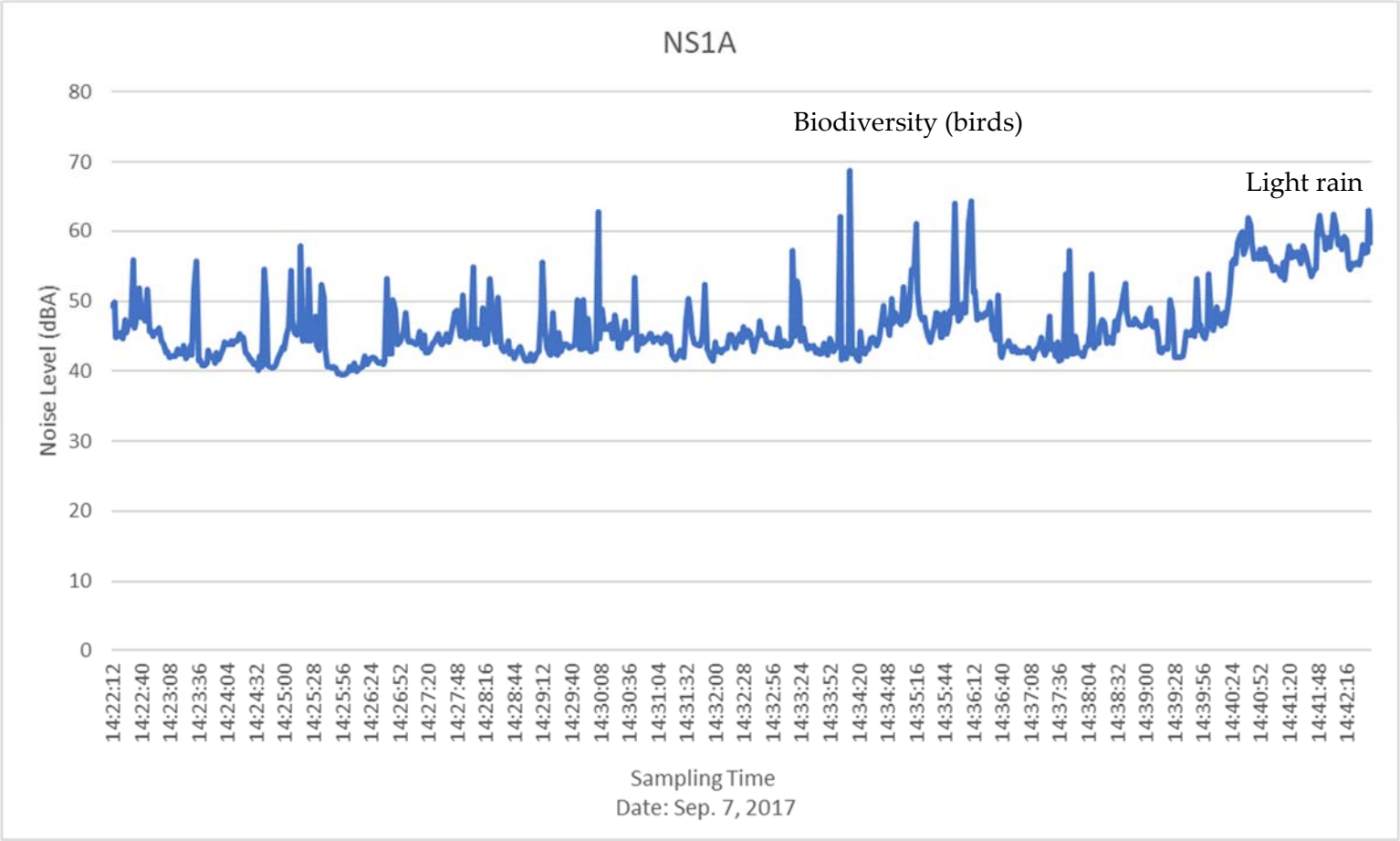
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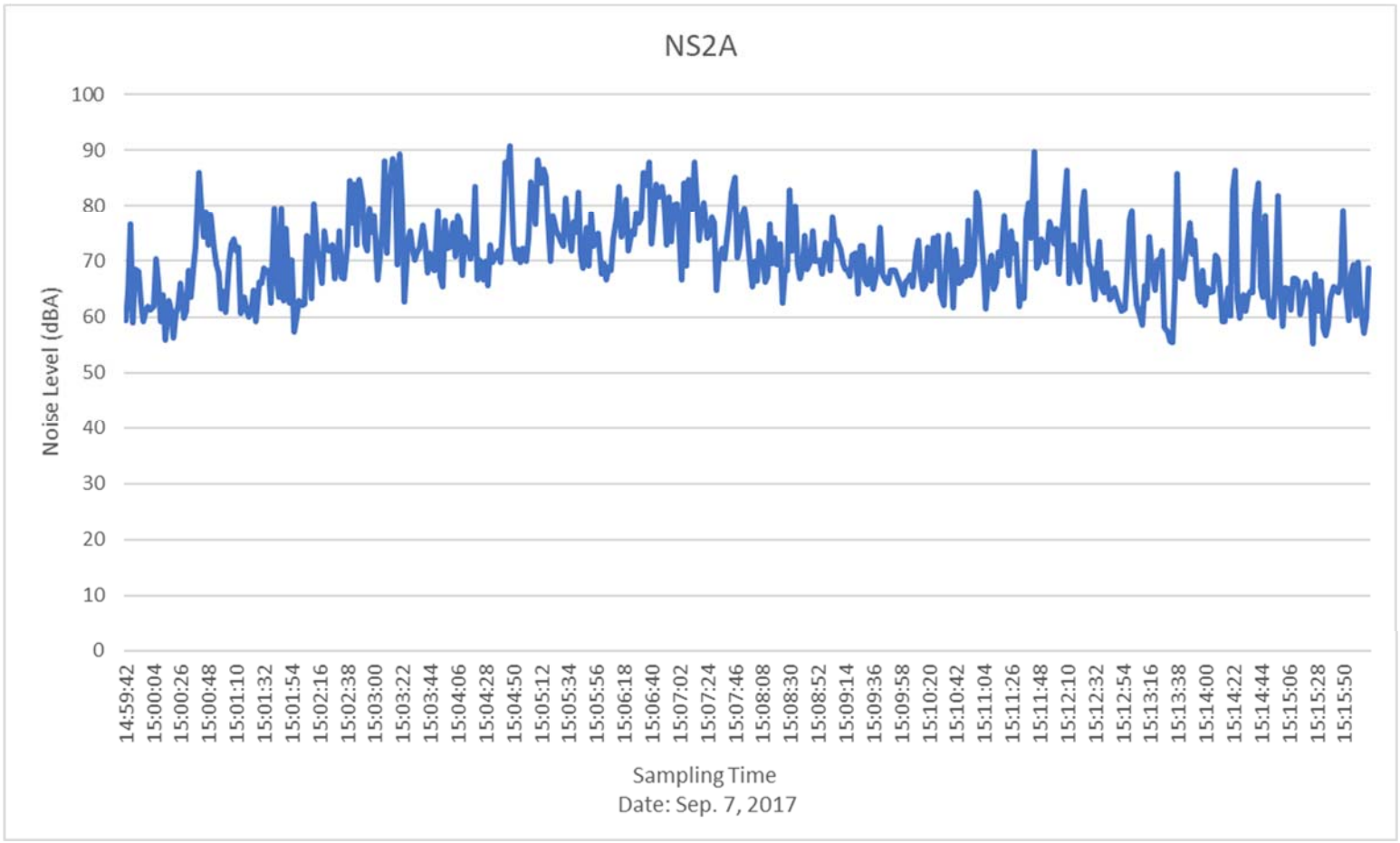
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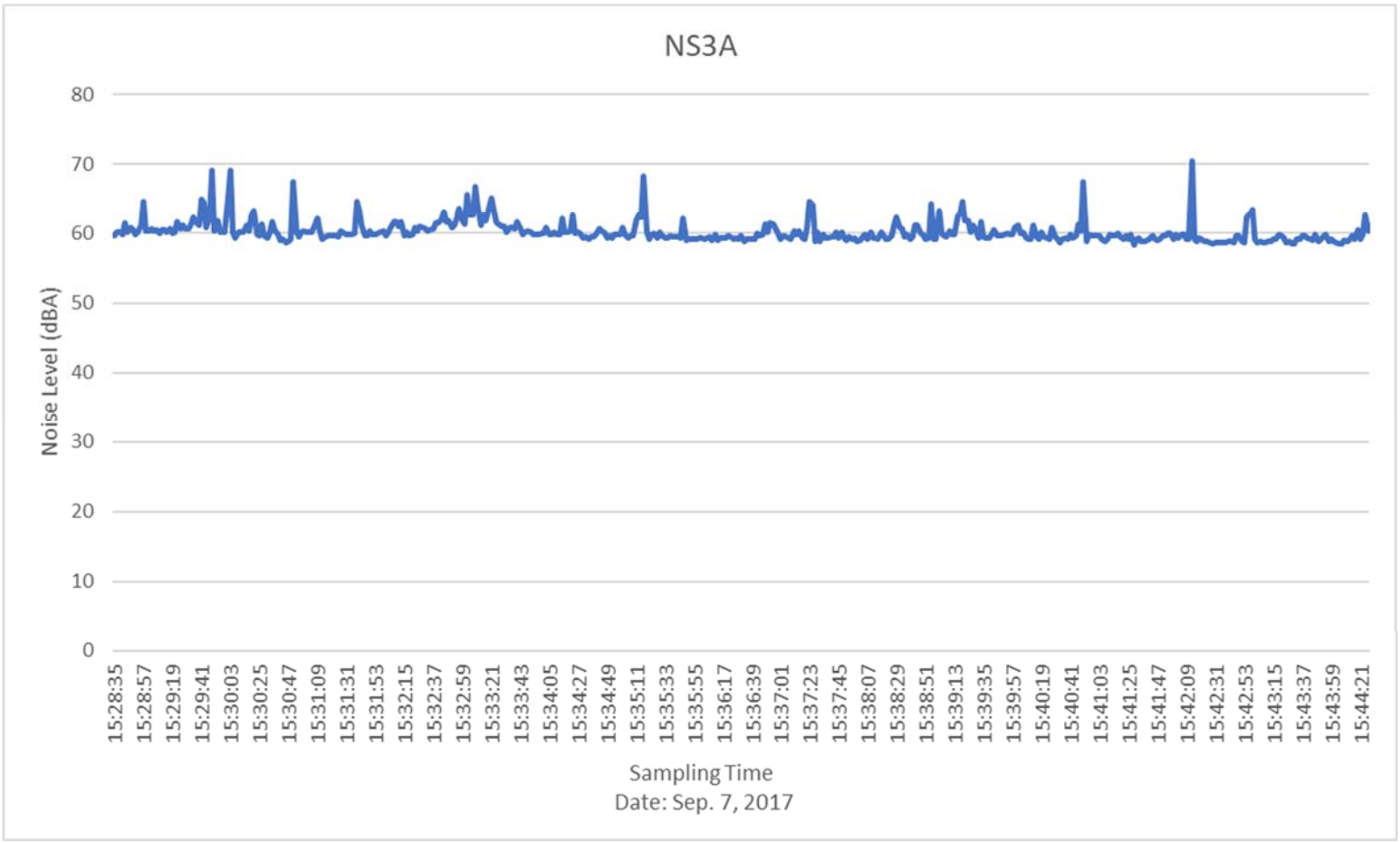
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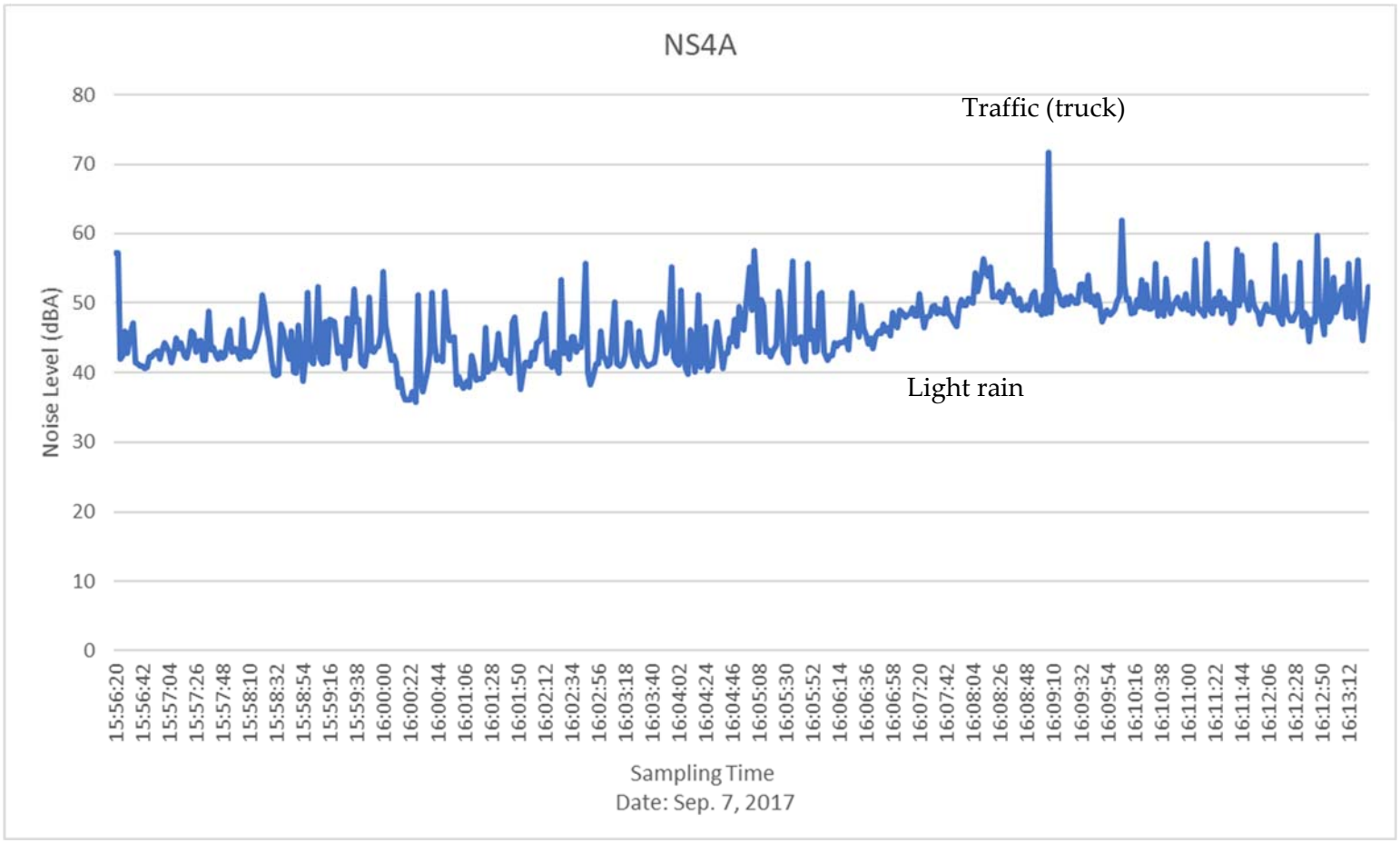
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APPENDIX B: NOISE MONITORING



APPENDIX B: NOISE MONITORING



APPENDIX C

Public Consultation Questionnaire and Notes

Appendix C - Questionnaire

ESIA - Geothermal Energy Development Project - St. Lucia

Interviewer Name ---------- Date ----------

Respondent Name ---------- Community ----------

Respondent Mobile No. ----------

1. How long have you lived in this community? --------- years

2. Gender: ☐ Male ☐ Female

3. Age: ------- ☐ 18 - 25 ☐ 26 - 29 ☐ 30 - 39 ☐ 40 – 49 ☒ 50 - 59
   ☐ 60 - 65 ☐ 66 and older

4. Educational Level: ☐ Primary ☐ Secondary ☐ Tertiary

5. Employment Status: ☐ Full-Time ☐ Part-Time ☐ Self-Employed ☐ Unemployed
   ☐ Student ☐ Retired ☐ Disabled

6. For each additional household member, please provide responses to Questions 2-5

Name	**Gender** Male (M) Female (F)	**Age**	**Educational Level** Primary (P) Secondary (S) Tertiary (T)	**Employment Status** Full Time (FT), Part Time (PT), Self-Employed (SE), Unemployed (UE), Student (S), Retired (R), Disabled (D)

7. Household monthly income range: ☐ $0-500 ☐ $501-1000 ☐ $1001-2000 ☐ $2001-3000 ☐ $3001-4000 ☐ >$4000

8. Main economic activities/sources of household income: ☐ farming ☐ fishing ☐ domestic
   ☐ construction ☐ labourer ☐ office ☐ hotel ☐ store/shop
   ☐ teacher ☐ Gov't worker ☐ income from family overseas
   ☐ other _____

9. Is there any work/employment done by household members likely to be affected by the loss of land to the project? ☐ Yes ☐ No If yes, Which ----------

10. Type of house: ☐ wooden ☐ masonry ☐ wood/masonry ☐ other ----------

11. Type of toilet: ☐ Septic tank ☐ Pit Latrine ☐ other ----------Sources of water: ☐ WASCO/pipe borne ☐ RWH tanks ☐ springs ☐ river

12. Quality & reliability of water: ☐ good ☐ not good/muddy/unsafe ☐ WASCO reliable ☐ WASCO unreliable

13. Form of lighting: ☐ electricity ☐ other----------

14. Form of cooking fuel: ☐ electricity ☐ gas ☐ charcoal ☐ wood

15. Land ownership and use

    Housing: ☐ Private ☐ Family Owned ☐ Rented/Private Lease) ☐ Gov't/NDC ☐ Private Leased ☐ Caretaker ☐ Squatting

    Farming: ☐ Private ☐ Family Owned ☐ Rented/Private Lease) ☐ Gov't/NDC ☐ Private Leased ☐ Caretaker ☐ Squatting

16. Type of animals reared/crops grown----------

17. Is there a community group in your community? ☐ Yes ☐ No

    If yes, which group ----------

    If yes does any member of the household belong to a community group? ☐ Yes ☐ No

18. Have there been any changes (good or bad) in the community over the past 5-10 years

    ☐ Yes ☐ No If yes, please explain----------

19. In your opinion, what is your general perception of the natural environment in your community in last 2 years? ☐ 1. Very bad ☐ 2. Not very good ☐ 3. Fair ☐ 4. Good ☐ 5. Very good

20. What do you like/don't like about your community?

    ---

21. What improvement would you like to see in the community?

    ---

22. Where/how did you hear about the Geothermal Project?

    ---

23. What do you know of the history of the past Geothermal Project?

    ---

24. How do you think the project will affect you, your household and the community (problems & advantages)?

    ---

25. Would you be looking for a job with the Geothermal Project? ☐ Yes ☐ No If yes, what type of job?

    ---

26. What should the Project do to make sure that the benefits to your community is maximised and the negative effects minimised?

    ---

27 What is the best way to contact you so that we can provide more information about the project in the future?

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Belle Plaine Community Consultation

Date:	Saturday, 2 September 2017
Time:	6:00 pm
Location:	Belle Vue Farmers' Cooperative, Soufriere
Attendees:	Participants/community members
	Valerie Leon – Permanent Secretary (PS), Department of Sustainable Development (DSD)
	Al Barthelmy (AB) – Geothermal Technical Coordinator, DSD
	Charlin Bodley (CB) – Public Utilities Officer, DSD
	Kurt Inglis (KI) – Public Utilities Officer, DSD
	Bethia Thomas – Science and Technology Officer, DSD
	Dr. Frederick Smith - Panorama Sub-consultants/Archaeologist
	Alison King (AK) – Panorama Sub-consultants/ECMC
	Egbert Louis (EL) – Panorama Sub-Consultants/ECMC
	Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

19 community members/participants (5 females; 14 males) attended the consultation.

Welcome and Background Information

Charlin Bodley delivered the welcome remarks. Bethia Thomas led the group in prayer. Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Al Barthelmy on the project location and the results of the surface exploration phase recently completed. Dr. Smith gave an overview of the archaeology work he will be doing, and the types of recommendations he would make if he identified any concerns in potential drilling areas.

ESIA of the Planned Exploration Phase

An overview of the geothermal exploration drilling and the ESIA process was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Following presentation of the Permanent Secretary:

Participant Input: If the project fails, are there other options e.g. water and wind? We are surrounded by water.

Response (DSD): The potential for hydro power here is small. Technology for harnessing of tidal energy is still in its infancy, and is not included in the plans of the government at this time. The focus is on the most viable resources, i.e. wind, solar and geothermal.

Participant Input: There used to be a hydro-plant in Soufriere. We have so many rivers, Can't that be an option?

Response: Hydro is not of great significance. The others have more potential. Our rivers are drying up, further reducing the potential for hydro.

Participant Input: The rivers are drying up because of man. We had 2 rivers along the Palmiste road, and they dried up one to do what they wanted, to build a school, etc. But when it rains, the river finds its path, and everywhere floods.

Following presentation of the Technical Coordinator:

Participant Input: Is there any problem with any of the sites?

Response (AB): It is too early to say. This is the reason for the studies.

Following presentation of the ESIA Consultant:

Participant Input: What if when drilling, instead of steam, you get fire?

Response (AB): Given all the data available to us to now, this is very unlikely.

Participant Input: In the last time of drilling in the Sulphur Springs, above the river, steam came up and they were happy. Then they stopped because they got fire coming up and they had to seal it.

Response (AB): It was not fire, they had a blowout. A well is a series of pipes. We must admit it. There was instability at Sulphur Springs. If the job is not done properly and material is coming up under high pressure there is a risk.

Participant input: I physically visited the site during the drilling. I saw fire. Even trees in the vicinity got burnt. Steam was coming off the mouth of the well. I saw gas or fire.

Response (AB): Steam is heat, more than 100 degrees. If it comes into contact with the trees it will destroy them.

Participant input: The fire was under the steam. It came after.

Participant input: In other places, is drilling done in residential areas? Sulphur is hazardous to health. It affects the lungs and the eyes. Persons working at the Sulphur Springs are getting these problems. What does the research show regarding the impacts? I am aware of the energy benefits but what about the health issues?

Secondly, the assessment must be done in a transparent manner. Ensure that community persons are privy to the reports, particularly regarding effects on their health.

Response (CB/AB): We have seen similar projects in similar settings. Government invested in sending a Ministry team to Hawaii where there was a functioning geothermal plant. Government has a developer in mind, the same developer for the Hawaii plant. The feedback from the team was that they were impressed with what they saw and observed no adverse effects. They followed a similar ESIA process to the one being undertaken here, and the ESIA document informed as to how to proceed with the project. Mitigation measures were developed after identifying possible negative effects. At a plant in Iceland, the

pipes are in a residential area. There is a plant operating in Guadeloupe, and explorations are underway in St. Kitts, Grenada, St. Vincent and Dominica. We are not aware of any serious negative effects.

(PS) In terms of transparency, the report will not be hidden. It will be available for public review, although this is not mandatory under the law. It will be online, in libraries and other public places where people can see it. If persons need help in reviewing it, we will send a team to assist. You will see the recommendations, and know whether the project proceeds in the manner recommended.

Participant input: Who is paying the experts?

Response (PS): The Government. The experts are independent and international experts, not involved in other aspects of the work. There are international standards that they are required to meet. ECMC is a sub-consultant to the company in California. This is a reputable company with expertise in this area. There has been no political interference in any way, and the technocrats are being left to do their work. We do not foresee any interference.

Participant Input: Conditions differ in different countries. In drilling we can have migration of gases.

Response (AK): The testing will include testing of the steam to determine what other constituents are in there and the risks they pose.

Participant Input: Geothermal sites usually experience dry spells. Will studies take that into account? Also, when drilling was done before, there were earth tremors in this area. The lands were not stable. Will the ESIA address this?

Response (AB): One well will not last; there must be makeup wells. If a well becomes non-viable, further drilling is needed.

When drilling SL2, the frequency of earthquakes increased, and there was concern that this was caused by the drilling. He visited the site and there was no evidence to support that. In his view, there was no connection.

Participant Input: The literature tells us that there is instability and ground movement. The ESIA must capture that.

Response (AB): Re-injection wells are required to replace the fluid and this largely addresses the stability issue. It is almost like recycling. The pre-feasibility will also examine the possibility of seismic activity in response to the TOR. If it is a concern, measures to address will be recommended.

Participant Input: Can the amount of steam and likelihood of dry spells be measured?

Response (AB): In SL2, the test ran for 2 weeks, and the steam declined thereafter.

Health-wise, we need to ensure that every contract has clauses to ensure that responsible entities comply with specified safety standards, to protect human health and the environment.

Participant Input: A project of this nature has positive and negative impacts. It will cost millions. We are told that it does not mean that the cost of electricity will go down, but this is something we were expecting. If not, is it economically viable in terms of the cost of exploring and drilling? There have been studies in other areas (solar, wind), but have you considered the comparative costs, and whether it is advisable to proceed over the long term? What is the long term sustainability of the project? We need to know how long the geothermal resource will last. Is it 10, 50, 100 years?

Looking at the negative aspects, what are the risks to the environment? Can drilling affect availability of water in streams or underground? Can it cause a volcanic reaction? Our grandparents said that all these valleys (Roblot, Fond St. Jacques, Belle Plaine) were linked underground, and there was “La Tou Noir” (the black hole), where water gets sucked into the ground.

We had higher rainfall before, all the valleys were swamps, and we had a lot of water that fed the hot rocks. What are the implications of the changing rainfall patterns?

What will be the implications for livelihoods? Many of these lands are farmed by Belle Plaine farmers, and this is a major revenue earner.

We must have access to the report.

Response (AB): The pre-feasibility study will include an economic assessment to address these. The national energy transition strategy (NETS) examined and compared the various sources of renewable energy. While geothermal may not guarantee a decrease in price, it provides stability in the price of electricity. The power purchase agreement between the generator and the utility will determine the price to consumers, over the 20 to 30 year life of the plant.

(CB) Although not widely publicized, government over the last three years has investigated the best mix of renewable energies for St Lucia, to achieve the best price for St Lucians. The mix must be stable. The NETS study is to be submitted to Cabinet for approval before the results can be shared. Our peak demand is 60 megawatts. Wind and solar are intermittent sources, especially wind. Geothermal is not a variable renewable energy source. The target is to develop a 30 MW plant, which with availability factors, may yield 28 MW and we would get it consistently. LUCELEC agrees that geothermal works well because our base load is 28 to 30 MW.

(CB) The two main objectives of the pre-feasibility study are to investigate the technical and economic feasibilities of the resource. We are hearing in other countries, a price of 18 US cents per kilowatt hour for geothermal power, but in these instances the developer does the exploration, and includes the cost of the risk associated with that. Government of St Lucia decided to get grant funding to do most of the exploration, so there is an expectation that the cost will be considerably reduced.

Participant Input: The last time they drilled in Sulphur Springs there were 13 strong quakes. Some houses got damaged. If it happens again, would there be compensation? Would the company take that responsibility?

Response (EL): One would have to establish a link between the drilling and the quake. This is difficult to pinpoint. If the property is insured the owner can call on insurance.

Participant input: This reminds me of a situation with LUCELEC. Appliances in Belle Vue were damaged after an electrical storm, and LUCELEC told customers it was their problem. I am hearing the same thing. What you are saying is "brace yourself".

Response (EL, AB): No, but it would have to be established that the quake is associated with the drilling. This would be difficult. The burden of proof is very important. Nobody can predict an earthquake. In the US, they are considering whether fracking may cause an earthquake.

Dr. Smith noted during his later comments that fracking is a big problem in the USA now, and the impacts are still being studied.

Participant Input: Are we saying that people need to get insurance for their houses? Who would pay for that?

Participant Input: I (KI) am wearing a resident's hat and have three concerns:

1. The access to the two sites in Belle Plaine. This is not truck friendly and would need to be upgraded, and reinstated after use.

2. The risk of contamination of farmlands to be used for drilling. If these are to be leased and returned to owners after two to three months, they must not be contaminated and made unusable.

3. Drilling along a fault or crack may cause these to widen. Residents are advised to photograph their homes before drilling starts, so that they may produce evidence of damage in the event of tremors.

A complaints board or some other facility should be established where community members may bring their concerns and not be turned away. Person conducting the investigation into such complaints should be independent of the project.

Participant Input: I am a resident of Etangs. When they were drilling there, they did not notify us. The generator used to pump water was making noise all the time. I could not hear my wife. We could not sleep at night.

Participant Input: Will the noise be bearable?

Response (AK, EL): There are measures that can be put in place to reduce noise. A baseline survey of noise will be undertaken, and noise standards will have to be complied with to ensure that the noise is bearable.

Participant Input: We have an issue now at Belle Plaine with LUCELEC generators. They were put there when work was being undertaken on the Soufriere feeder, but were not removed and are occasionally used since then. There is a siren that goes off on most weekends (late nights and early mornings).

Participant Input: If you have to drill on my property, can I refuse?

Response (PS): The government hopes to engage persons in negotiation, but compulsory acquisition for the national good can be a last resort.

Participant Input: My concern is the noise. I am an insomniac. I do not sleep well. How will it affect my health?

Response (AB): We do not know for sure where drilling will take place. We must select a developer with a good work record in environmental and health issues. The developer under consideration now is good. That developer has a proprietary technology that is environmentally friendly.

Participant Input: The permanent secretary mentioned a US$22 million grant. What is it to be used for?

Response (PS): It will be used for the drilling exploration and well testing.

Participant Input: We have a target for 35% renewables by 2025. What is it now?

Response (PS): Less than 1%.

Participant Input: Why did you stop the wind project?

Response (PS): It has not stopped. We are still in discussion with the developer. It is on hold for now. There are issues with land acquisition. We hope we will not have these issues with the geothermal project, and people will support for the good of St Lucia.

Participant Input: How will livelihood issues be addressed? If lands are acquired, how is this affect farmers and persons rearing animals?

Response (PS): These social aspects must be considered as part of the ESIA and will inform the decisions, including for compensation. The World Bank has safeguard measures that must be applied if we are to access the funding.

Participant Input: If residents live in close proximity, will they be relocated?

Response (AB): If we do not address these things we do not have a project.

Participant Input: The project has long term benefits. Consultation and feasibility studies are good. We do not want chaos like the DSH Project. You must present what will affect us. Our children stand to benefit.

Response (PS): There will be no chaos. When we get the results of the studies we will come back.

Participant Input: What about water quality?

Response (PS): Hydrologists will gather baseline information over next week, and the impact on water will be assessed. They will look at issues like when water disappeared as we heard in the last consultation, and what caused that to happen.

Participant Input: After completion, will geothermal energy be reliable and sustainable?

Response (AB): It has been factored into the NETS, which looked at improving energy security. We will reduce consumption of fossil fuels. We know roughly what the geothermal potential is, about 75 MW, more than we need.

(PS) The persons conducting the study will be in the area asking questions. They will have ID badges provided by our department.

Participant input: We are not against the project but we have genuine concerns based on past experiences, as well as current experiences, for example in relation to noise pollution. We want to see our concerns taken into consideration. We need to see what is being recommended, for example would it be advisable to take out insurance?

Response (PS): We will be surveying households close to the sites, to understand land ownership, land use etc., to ensure persons are not put in a worse situation.

Participant input: You mentioned consideration of including a requirement for the drillers to adhere to standards. There must be penalties for non-compliance.

Response (AK): The monitoring plan will set up a system, and identify who is responsible for monitoring and enforcement.

Closing Remarks

The Permanent Secretary noted that experts will be in the field for the next three weeks. She requested a volunteer from the community who would ensure that instrumentation is not tampered with. She requested that interested persons contact the DSD. The equipment is expensive, and loss of data can affect the progress of the project adversely.

Bethia Thomas closed the meeting at 9.30 pm, thanking all for their participation, and inviting them to share some refreshments.

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Community Consultation

Date: Thursday, 31 August 2017

Time: 7:00 pm

Location: Fond St Jacque Resource Centre, Soufriere

Attendees: Participants/community members
Valerie Leon – Permanent Secretary, Department of Sustainable Development (DSD)
Al Barthelmy – Geothermal Technical Coordinator, DSD
Charlin Bodley – Public Utilities Officer, DSD
Kurt Inglis – Public Utilities Officer, DSD
Alison King – Panorama Sub-consultants/ECMC
Egbert Louis – Panorama Sub-consultants/ECMC
Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

Twenty-five participants comprising six females and nineteen males attended. Their ages ranged from 30 – 70 years.

Welcome and Background Information

Charlin Bodley made the welcome remarks. Kurt Inglis lead the group in prayer. Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Al Barthelmy on the project location and the results of the surface exploration phase recently completed.

ESIA of the Planned Exploration Phase

An overview of the geothermal exploration drilling and the ESIA was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Spring Water Supplies

There are several springs in the Fond St. Jacques area (from Migny, down towards the community), that a significant number of persons in the community harness for drinking water. There is concern that the project will affect these very important water sources. The example of the disappearing lake at Robot after drilling was cited. The community members are very passionate about these springs.

One participant indicated that this has been his drinking water supply for more than 30 years. This water is all that some people in the Fond St. Jacques and surrounding communities drink. Although most people have a WASCO supply, many still use the local spring sources for drinking, and other surface supplies for washing.

When the WASCO water supply is interrupted, this is the only source of water for the community. They were forced to rely on this source for a protracted period after the passage of Hurricane Tomas.

Provision of increased storage of WASCO water in the community to improve water security would not be an acceptable mitigation measure, as:

- This is chlorinated water, and
- Where would the water come from if not the same source that would be affected by the project?

When asked to indicate the importance of this water supply to the community on a scale of 1 to 10, the community members were unanimous in rating it at 10.

Another participant noted that the WASCO supply to the community is unreliable, even though the area is an important source of raw water for WASCO (there are 3 WASCO intakes in the area) that is used to serve communities as far afield as Choiseul, Cresslands and Hotel Chocolat. As a result, some people have no choice but to go to the springs.

Impact on Agriculture

DSD must work hand in hand with Ministry of Agriculture. This is an agricultural community, and cultivated areas will be affected.

An undertaking was made by the Permanent Secretary to collaborate.

Impact of Noise

One participant indicated that he was a child during the first drilling project, and the noise was very intense. He is very concerned that persons would not be able to live next to the proposed well location shown, within the community. They would have to be moved.

ECMC and DSD representatives noted that the technology has advanced since then, and it is possible to reduce noise. It is also possible use directional drilling to set back the pad from the community.

DSD noted a need to include environmental standards in every contract, to protect against such impacts, with proper enforcement by the supervising entity.

One participant enquired whether there would be penalties in the contract for non-compliance with such clauses.

Cynicism

A participant noted that often the end justifies the means, and politicians often have their own agenda. Is the primary objective to reduce Saint Lucia's carbon footprint? The community is in great need of jobs, infrastructural development, and all the possible benefits of such a project. People can come in with a nice smile and big words that lay people do not understand, and only afterwards do the people understand that things are not what they expected. He recalled an experience with WASCO where the community was opposed to tapping into a water source, and this project was only aborted after significant expense had been incurred by the company.

After Hurricane Tomas, the geological report touted by technocrats was never shared with the community, as it was thought that it was something they would not understand. The people need to be provided with information and equipped to make informed decisions for themselves.

ECMC noted, confirmed by the Permanent Secretary, that the ESIA report will be made public. It will be placed on a website and in community libraries and resource centres such as this one in Fond St. Jacques. ECMC also noted that the funding agencies that support this project are very concerned about environmental and social issues and will not disburse any money unless the issues are properly addressed.

Aesthetics

After the drilling near Sulphur Springs, some 50 pipes were left all about the place, and the holes are still there. Another participant noted that aesthetics are important as they sell the area as an attraction.

DSD conceded that this did occur with one of the previous exploration projects. ECMC noted that it will be a requirement of contractors to properly remediate after completion.

Land Availability

The community is deprived of land space that is arable and/or flat. The demarcated potential drilling areas fall within such spaces. These lands are used for homes, recreation and farming by the community. (*Note that there was some uncertainty about the exact locations being proposed).*

The smaller portion of land identified does not appear to be large enough for the size of well pad described in the presentation. There would be no playing field anymore if this area was to be used.

Impacts of Weather on Drilling

A participant enquired whether drilling would continue, rain or shine. ECMC noted that work would likely be halted if a storm was approaching.

Impact on Telephone and Electricity Lines

A participant enquired about the impact of large trucks on low hanging lines.

ECMC responded that the access routes would be reviewed in the ESIA to ensure these would not be impacted.

Employment

A participant enquired whether priority will be given to persons in the area for jobs. Politics often becomes a factor.

The Permanent Secretary responded that once persons from the area have the required skill sets, they will be given priority. There are some things beyond the control of technocrats, but they would do all within their purview. Consideration may be given to placing in the contract, the need to use persons in the area for labour, and to also engage in knowledge transfer for a specified number of persons.

DSD is also presently reviewing the possibility of requesting that relevant training be included on the government's training priority list, in anticipation of future jobs in this field. Such persons could find work across the globe as the world goes green.

One participant asked where the drilling company would come from.

The Permanent Secretary noted that the project is not at the stage where she can confirm that there is a viable resource for drilling. More information will be available in early 2018 after the studies are complete. Although government has a preferred developer, if that negotiation process is not successful, the project will be opened up to international and unrestricted tender through a transparent and open process.

Cost of Electricity

One participant noted that if electricity costs will be reduced, he is in 100% support of the project. This positon was supported by most others present, with the proviso that all mitigations required are put in place, so that they are not negatively impacted.

The Permanent Secretary noted that government has secured grant support to do much of the exploratory work, reducing costs to local tax payers, significantly de-risking the project for a power plant investor, and placing the government is a stronger position to negotiate. This should redound to the benefit of the consumer in terms of cost.

A participant noted that the NURC will regulate the pricing, not LUCELEC.

Another noted that everyone in the country pays for the dam remediation although not all benefit from the dam supply.

Level of Participation in the Meeting

One participant was of the view that participation was low.

The Permanent Secretary responded that no effort was spared in informing the community about the meeting and it is up to persons to take an interest in matters that can affect them. This is the 4th community meeting in relation to this project.

Closing Remarks

Charlin Bodley closed the meeting at 9 pm, thanking all for their participation, and inviting them to share some refreshments. Contact numbers were provided for DSD so that participants may continue to engage project personnel.

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Mondesir Community Consultation

Date:	Sunday, 3 September 2017
Time:	3:00 pm
Location:	Saltibus Primary School, Choiseul
Attendees:	Participants/community members
	Valerie Leon – Permanent Secretary, Department of Sustainable Development (DSD)
	Al Barthelmy – Geothermal Technical Coordinator, DSD
	Charlin Bodley – Public Utilities Officer, DSD
	Kurt Inglis – Public Utilities Officer, DSD
	Bethia Thomas – Science and Technology Officer, DSD
	Dr. Frederick Smith - Panorama Sub-consultants/Archaeologist
	Mr. Kerry McCallum - Panorama Sub-consultants/Dewhurst Group
	Alison King – Panorama Sub-consultants/ECMC
	Egbert Louis – Panorama Sub-consultants/ECMC
	Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

23 (10 female; 13 males) community members/participants attended.

Welcome and Background Information

Curt Inglis made the welcome remarks. Bethia Thomas lead the group in prayer. Permanent Secretary Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Protect Coordinator Al Barthelmy on the project location and the results of the surface exploration phase recently completed.

ESIA of the Planned Exploration Phase

Dr. Fred Smith gave an overview of the archaeological work he will be doing, and the types of recommendations he would make if he identified any concerns in potential drilling areas. He informed the meeting that he had spent some time before the meeting on the Parc Estate site, north of the playing field, which is earmarked for possible geothermal exploration. He found ceramic pottery dating back to the mid 18th century to the 1830's, which suggests that people were living there at those times. It is possible that there may be other discoveries to be made there, and more research is required.

Mr. Kerry McCallum informed the meeting about the air quality sampling tubes that will be placed at various locations around Soufriere and Choiseul, and left for about 3 weeks, at which time they will be collected.

An overview of the geothermal exploration drilling and the ESIA process was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Participant Input: The area is agricultural flat land. The top soil will have to be removed to prepare for drilling. If the exploration is not successful, what will become of the area? Will they replace the topsoil? Secondly, what becomes of the pit/plug to ensure it does not become a hazard? Thirdly, what is the minimum distance that houses should be from the drill pad?

Response (DSD): The site must be restored to its previous condition. We had a situation in the 1970s where this did not happen, but this should be a requirement of the contract, with implications for non-payment if it does not occur satisfactorily. We will also need to require under the contract that the wells are plugged (with concrete) appropriately after the work is completed. This also has not been satisfactory under previous programmes, and we must ensure that it is done. The pipes will remain in the ground.

Participant Input: I was a taxi and truck driver before, and had work to supply the previous project. The area was left in the same way, top soil was not replaced.

Response (ECMC): We will recommend that top soil be set aside during site preparation, and spread back over the site as part of the site restoration works.

Participant Input: Mr. Barthelmy mentioned 6 miles to drill the well. How far down is the rock?

Response (DSD): From the moment you start drilling, you encounter rock.

Participant Input: I am born in Choiseul, resident in Gros Islet. What benefits will be derived by the population from this activity? Will there be competition? We only have 1 supplier, LUCELEC. What is the cost benefit for Saint Lucians?

Response (DSD): Our peak load is 60 MW. Geothermal can generate 30 MW, or 50% of our electricity. This is an indigenous resource, reducing our need for imported oil. Electricity prices will be less volatile because of fluctuations in oil prices. Geothermal brings added stability, which is attractive to investors. A lower cost power supply is also possible, which would benefit all residents.

Because we are a small island, it is not feasible to have multiple companies. We are 99% electrified and have very good infrastructure. LUCELEC will continue to provide the transportation infrastructure. Power generated by independent power producers will be sold to LUCELEC at a price lower than it costs LUCELEC to produce power from oil.

Although there is no guarantee, hopefully the price of power will go down.

Participant input: I work with the Ministry of Agriculture, based in this area. I am concerned as this area is a water catchment area and a farming area. It feeds water to the pineapple area. There is an intake at the Gia Bois. Mr. Ferguson John (past MP for the area) has three fish ponds with water fed from there. There is spring water lower down. When there is no water in the mains, the people go there for water. The Ministry of Agriculture may have more information on these water sources.

Participant input: Will members of the community be trained to help with equipment deployment?

Response (PS): The project is not in full force. We are just doing testing and analysis, and these experts have been contracted for that. The work is so specialised, but there may be some limited opportunity for young people to observe.

The contract will require the drilling company to employ persons from the community.

If there is a viable resource, there will be a power plant. Once the power plant is opened, there is a world of opportunities for young people.

Participant input: I have read that they have been different feasibility studies, and drilling. Will this be another failure?

Response (PS): A number of drilling programmes have been conducted. That is why the pre-feasibility consultant is required to analyse existing information, to guide next steps.

Of 7 wells, two were producing, but SL2 was acidic. It would corrode equipment. Now, we are not drilling in the same place. More drilling is needed to capture the quality of the resource. We hope this is the last go, and we will discover a commercially viable resource.

(AB): Geothermal is very challenging and complex, even for countries with more resources than us, such as the British and the Americans, who do not always succeed.

(PS): By the second half of next year we will know if we can drill production size wells.

Participant input: This is a very fertile area. From here to Tete Morne, you can grow anything. We would have to gain big time because there is a lot to lose.

In the past, lands here have been identified here for relocation of farmers from the water catchment area (upper Saltibus) and Black Bay. This is prime agricultural land. Speak to Invest St Lucia. Some of these lands are leased by farmers from the Crown/ Invest St Lucia.

Participant input: If you develop that area, what would be the buffer zone for farmers?

Response (DSD): The studies will advise.

Participant input: Will there be a follow up?

Response (PS): Yes, we will have a public review. The public will have access to the document.

Closing Remarks

Ms. Charlin Bodley noted that experts will be in the field for the next three weeks. She requested a volunteer from the community who would ensure that instrumentation is not tampered with. She requested that interested persons contact the DSD. The equipment is expensive, and loss of data can affect the progress of the project adversely.

Mr. Curt Inglis closed the meeting, thanking all for their participation, and inviting them to share some refreshments.

APPENDIX E

Biological Resources Supporting Information

FLORA AND FAUNA WITHIN THE PROJECT STUDY AREAS

Table E-1 Flora within the Belle Plaine Project Study Area

Common and Scientific Names	Family
Cultivated Vegetables	
Gonbo, Okra *Abelmoschus esculentus (Linnaeus) Moench*	Malvaceae
Ti lonyon, Chives *Allium species*	Amaryllidaceae
Pineapple *Ananas comosus (Linnaeus) Merrill*	Bromeliaceae
Selwi, Celery *A[ium graveolens Linnaeus*	Apiaceae
Zèpina, Spinach *Basella alba Linnaeus*	Basellaceae
Broccoli, Cabbage *Brassica oleracea Linnaeus*	Brassicaceae
Pwa angòl, Pigeon pea *Cajanus cajan (Linnaeus) Millspaugh*	Fabaceae-Faboideae
Toloman, Malobi *Canna glauca Linnaeus*	Cannaceae
Sweet, seasoning, hot peppers *Capsocum species*	Solanaceae
Watermelon *Citrullus lanatus*	Cucurbitaceae
Dasheen *Colocasia esculenta (Linnaeus) Schott*	Araceae
Jonmou, Pumpkin *Cucurbita moschata Duchesne*	Cucurbitaceae
Jenjanm dou, Kashibou *Curcuma zanthorrhiza Roxburgh*	Zingiberaceae
Carrots *Daucus carota Linnaeus*	Apiaceae
Chadon beni	Apiaceae

Eryngium foetidum Linnaeus	
Lanni, Fennel *Foeniculum vulgare Miller*	Apiaceae
Lettuce *Lactuca species*	Asteraceae
Manyòk, Cassava *Manihot esculenta Crantz*	Euphorbiaceae
Bazilik, Oktansya, Basil *Ocimum basilicum* Linnaeus	Lamiaceae
Parsley *Petroselinum crispum (Miller) A. W. Hill*	Apiaceae
Rosemary *Rosmarinus officinalis Linnaeus*	Lamiaceae
Sugar cane *Saccharum officinarum Linnaeus*	Poaceae
Tomato *Solanum lycopersicum Linnaeus*	Solanaceae
Thyme *Thymus vulgaris Linnaeus*	Lamiaceae
Salad bean *Vigna unguiculate (Linneaus) Walpers*	Fabaceae-Faboideae
Chou, Calalou *Xanthosoma species*	Araceae
Corn, Maize *Zea mays Linnaeus*	Poaceae
Bitter ginger *Zingiber zerumbet (L.) Roscoe ex Smith*	Zingiberaceae
Wild Herbs and Shrubs	
Acalypha aristata Kunth	Euphorbiaceae
Aeschynomene americana Linnaeus	F.Faboideae
Labonn fanm, Latifi *Ageratum conyzoides Linnaeus*	Asteraceae
Malanga, Fiant (upright) tayo *Alocasia macrorrhizos* (Linnaeus) G. Don	Araceae
Alternanthera tenella Colla var. *tenella*	Amaranthaceae
Alysicarpus vaginalis (L.) de Candolle	F.-Faboideae
Zèpina (blan) *Amaranthus dubius* Martius ex Thellung	Amaranthaceae

Zèpina wouj *Amaranthus spinosus* Linnaeus	Amaranthaceae
Axonopus compressus (Swartz) Palisot de Beauvois	Poaceae
Begonia humilis Dryand	Begoniaceae
Zèb a zédjwi, Needle grass *Bidens pilosa Linnaeus*	Asteraceae
Koko shak *Caladium bicolor (Aiton) Ventenat*	Araceae
Calathea lutea (Aublet) Schultes	Marantaceae
Callisia repens (Jacquin) Linnaeus	Commelinaceae
Pwa blé *Calopogonium mucunoides Desvaux*	F.-Faboideae
Zèb kolan, Burr grass *Cenchrus echinatus Linnaeus*	Poaceae
Elephant grass *Cenchrus purpureus (Schumacher) Morrone*	Poaceae
Fléwi Nwèl *Chloris radiata (Linnaeus) Swartz*	Poaceae
Godmò *Chromolaena odorata L.) R. M.King and H. Rob*	Asteraceae
Cissus verticillata (L.) Nicolson & C. E. Jarvis	Vitaceae
Cleome rutidosperma de Candolle	Cleomaceae
Clerodendrum chinense (Osbeck) Mabberley	Lamiaceae
Clerodendrum paniculatum Linnaeus	Lamiaceae
Kaka mèl *Clidemia hirta (Linnaeus) D. Don*	Melastomataceae
Zèb gwa, Water grass *Commelina diffusa Burman f.*	Commelinaceae
Conyza laevigata (Richard) Pruski	Asteraceae
Job's tears *Croix lacryma-jobi Linnaeus*	Poaceae
Cyanthillium cinereum (L.) H. Robinson	Asteraceae
Diverse small sedges *Cyperaceae species*	Cyperaceae
Desmanthus leptophyllus Kunth	F.-Mimosoideae
Sweetheart, Kòd-a-vyèlon *Desmodium species*	F.-Faboideae
Digitaria setigera Roth	Poaceae
Echinochloa colona (Linnaeus) Link	Poaceae
Pyé poul *Eleusine indica (Linnaeus) Gaertner*	Poaceae

Various Emilia species *Emilia species*	Asteraceae
Various low/prostrate species *Euphorbia species*	Euphorbiaceae
Zèb sèk *Flemingia strobilifera (L.) W. T. Aiton*	F.-Faboideae
Spanish shawl *Heterotis rotundifolia (Smith) Jacques-Félix*	Melastomataceae
Hyptis atrorubens Poiteau	Lamiaceae
Lyenn dous *Ipomoea tiliacea (Willdenow) Choisy*	Convolvulaceae
Jiwòf flè, Bwa wa tou *Lantana strigocamara R. W. Sanders*	Verbenaceae
Gwo ponpon *Leonotis nepetifolia (Linnaeus) R. Brown*	Lamiaceae
Leptochloa species	Poaceae
Jiwòf dlo *Ludwigia species*	Onagraceae
Macroptilium lathyroides (Linnaeus) Urban	F.-Faboideae
Zèb djiné, Guinea grass *Megathyrsus maximus (Jacq.) B. K. Simon & Jacobs*	Poaceae
Melochia nodiflora Swartz	Malvaceae
Mawi hont, Ti mawi *Mimosa pudica Linnaeus*	F.-Mimosoideae
Konmonm kouli *Momordica charantia Linnaeus*	Cucurbitaceae
Bwa gazon, (Mal) fonbwazen *Ocimum gratissimum Linnaeus*	Lamiaceae
Oxalis barrelieri Linnaeus	Oxalidaceae
Oxalis corniculata Linnaeus	Oxalidaceae
Panicum pilosum Swartz	Poaceae
Panicum trichoides Swartz	Poaceae
Paspalum conjugatum P. J. Bergius	Poaceae
Paspalum paniculatum Linnaeus	Poaceae
Paspalum virgatum Linnaeus	Poaceae
Phenax sonneratii (Poiret) Weddell	Urticaceae
Gwenn anba fèy *Phyllanthus species*	Phyllanthaceae
Malenbé, Bwa mal lèstomak *Piper dilatatum Richard*	Piperaceae
Koupyé *Portulaca oleracea Linnaeus*	Portulacaceae
Ti dayi *Priva lappulacea (Linnaeus) Persoon*	Verbenaceae
Setaria barbata (Lamarck) Kunth	Poaceae

Balyé wonzè *Sida acuta Burman f.*	Malvaceae
Balyé wonzè *Sida rhombifolia Linnaeus*	Malvaceae
Béléjenn djab *Solanum torvum Swartz*	Solanaceae
Ti makònèt *Spermacoce remota Lamarck*	Rubiaceae
Venvenn kawayib *Sphagneticola trilobata (L.) J. F. Pruski*	Asteraceae
Vèvenn latjé wat *Stachytarpheta jamaicensis (Linnaeus) Vahl*	Verbenaceae
Black-eyed Susan vine *Thunbergia alata Bojer ex Sims*	Acanthaceae
Tridax procumbens Linnaeus	Asteraceae
Tèt nèg *Triumfetta species*	Malvaceae
Pikan kouzen *Urena lobata Linnaeus*	Malvaceae
Ponm kannél, sugar apple *Annona squamosa Linnaeus*	Euphorbiaceae
Cultivated Trees	
Bwapen, breadfruit *Artocarpus altilis (Parkinson) Fosberg*	Annonaceae
Neem *Azadirachta indica A. Jussieu*	Moraceae
Papapya *Carica papaya Linnaeus*	Meliaceae
Kannèl, Cinnamon *Cinnamomum verum J. Presl*	Caricaceae
Citrus species	Lauraceae
Coconut *Cocos nucifera*	Rutaceae
Kalbas, Calabash *Crescentia cujete Linnaeus*	Arecaceae
Mòtèl *Erythrina poeppigiana (Walpers) O. F. Cook*	Bignoniaceae
Indian laurel tree *Ficus benjamina Linnaeus*	F.-Faboideae
Glory cedar *Gliricidia sepium (Jacquin) Kunth ex Walpers*	Moraceae
Gmelina *Gmelina arborea Roxburgh ex Smith*	F.-Faboideae
Mango *Mangifera indica Linnaeus*	Lamiaceae
Chennèt, Ginep, Ackee. *Melicoccus bijugatus Jacquin*	Anacardiaceae
Nutmeg *Myristica fragrans Houttuyn*	Sapindaceae
Caribbean pine *Pinus caribaea Morelet*	Myristicaceae

Guava *Psidium guajava Linnaeus*	Pinaceae
Saman *Samanea saman (Jacquin) Merrill*	Myrtaceae
Ponmsité., Golden apple *Spondias dulcis Solander ex Parkinson*	F.-Mimosoideae
Honduras mahogany *Swietenia macrophylla King*	Anacardiaceae
Ponm danmou, Love apple *Syzygium malaccense (Linnaeus) Merrill & Perry*	Meliaceae
Tanmawen, Tamarind *Tamarindus indica Linnaeus*	Myrtaceae
Cocao *Theobroma cacao Linnaeus*	F.-Mimosoideae
Wild Trees	
Bwa mou limou *Acnistus arborescens (Linnaeus) Schlechtendal*	Solanaceae
Bwa kòtlèt, Bwa kawé *Citharexylum spinosum* Linnaeus	Verbenaceae
Sip blan *Cordia sulcata* A. de Candolle	Boraginaceae
Kalbas, Calabash *Crescentia cujete* Linnaeus	Bignoniaceae
Fijé, Strangler fig *Ficus insipida* Willdenow	Moraceae
Kakoli *Inga ingoides* (Richard) Willdenow	Fabaceae-Mimosoideae
Leucaena *Leucaena leucocephala* (Lamarck) de Wit	Fabaceae-Mimosoideae
Kòsòl chyenn, Noni *Morinda citrifolia Linnaeus*	Rubiaceae
African tulip tree *Spathodea campanulata Palisot de Beauvois*	Bignoniaceae
Mouben, Hog plum *Spondias mombin Linnaeus*	Anacardiaceae
Maho nwè *Varronia martinicensis Jacquin*	Boraginaceae

Table E-2 Fauna within the Belle Plaine Project Study Area

Common and Scientific Name	Abundance	Status
Bird Species		
Cattle Egret *Bubulcus ibis ibis*	Common	Resident
Green Heron *Butorides virescens virescens*	Common	Resident
Spotted Sandpiper *Actitis macularius*	Common	Aug-May
Scaly-naped Pigeon *Patagioenas squamosal*	Common	Resident
Zenaida Dove *Zenaida aurita aurita*	Common	Resident
Common Ground-Dove *Columbina passerine antillarum*	Common	Resident
Ruddy Quail-Dove *Geotrygon montana marinica*	Common	Resident
Saint Luica Parrot *Amizona versicolor*	Uncommon	Resident
Mangrove Cuckoo *Coccyzus minor*	Common	Resident
Lesser Antillean Swift *Chaetura martinica*	Common	Resident
Purple-throated Carib *Eulampis jugularis*	Common	Resident
Green-throated Carib *Eulampis holosericeus holosericeus*	Common	Resident
Antillean Crested Hummingbird *Orthorhyncus cristatus exilis*	Common	Resident
Caribbean Elaenia *Elaenia martinica martinica*	Common	Resident
St. Luica Pewee *Contopus oberi*	Common	Resident
Gray Kingbird *Tyrannus dominicensis vorax*	Common	Resident
Lesser Antillean Flycatcher *Myiarchus oberi sanctaeluciae*	Uncommon	Resident

Common and Sicentific Name	Abundance	Status
Caribbean Martin *Progne dominicensis*	Common	Resident
Barn Swallow *Hirundo rustica erythrogaste*	Common	Sept-Oct April-May
House Wren *Troglodytes aedon mesoleucus*	Uncommon	Resident
Tropical Mockingbird *Mimus gilvus antillarum*	Common	Resident
Gray Trembler *Cinclocerthia gutturalis macrorhyncha*	Common	Resident
Scaly-breasted Thrasher *Allenia fusca schwartzi*	Common	Resident
Pearly-eyed Thrush *Margarops fuscatus klinikowski*	Common	Resident
Bare-eyed Thrush *Turdus nudigenis nudigenis*	Common	Resident
Black-whiskered Vireo *Vireo altiloquus barbatulus*	Common	Resident
Antillean Euphonia *Euphonia musica flavifrons*	Common	Resident
Saint Lucia Warbler *Dendroica delicata*	Common	Resident
Bananaquit *Palm Warbler*	Common	Resident
Black-faced Grassquit *Tiaris bicolor*	Common	Resident
Saint Lucia Black Finch *Melanospiza richardsoni*	Uncommon	Resident
Lesser Antillean Bullfinch *Loxigilla noctis sclateri*	Common	Resident
Lesser Antillean Saltator *Saltator albicollis albicollis*	Common	Resident
Carib Grackle *Quiscalus lugubris inflexirostris*	Common	Resident
Shiny Cowbird *Molothrus bonariensis minimus*	Common	Resident
Saint Lucia Oriole	Uncommon	Resident

Common and Sicentific Name	Abundance	Status
Icterus laudabilis		
Mammals		
Mongoose *Herpestes suropuntatus*	Common	Resident
Fruit Bats *Monophyllusplethodon* *Bracyphylluscavernum*	Common	Resident
Herpetofauna		
Saint Lucia Anolis Lizard *Anolis luciae*	Common	Resident
Common House Gecko *Hemidactylus mabouia*	Common	Resident
Zandoli Tarre *Gymnopthalmus pleei*	Common	Resident
Insects		
Southern Great White Butterfly	Common	Resident
White Peacock Butterfly	Common	Resident
Common Long Tail Skipper Butterfly	Common	Resident
Tropical Chequered Skipper Butterfly	Common	Resident
Ocoloa Skipper Butterfly	Common	Resident
Fiery Skipper Butterfly	Common	Resident
False Barred Sulphur Butterfly	Common	Resident
Spreadwing Skipper Butterfly	Common	Resident
Caribbean Buckeye Butterfly	Common	Resident
Southern Broken Dash Butterfly	Common	Resident
Hannos Blues Butterfly	Common	Resident

Table E-3 Flora within the Fond Saint Jacques Project Study Area

Common and Scientific Names	Family
Wild Herbacious Species	
Acalypha aristata Kunth	Euphorbiaceae
Malanga, Giant tayo *Alocasia macrorrhizos (L.) G. Don*	Araceae
Zèb a zédjwi, Needle grass *Bidens pilosa Linnaeus*	Asteraceae
Dasheen *Colocasia esculenta (Linnaeus) Schott*	Araceae
Zèb gwa, Water grass *Commelina diffusa Burman f.*	Commelinaceae
Cuphea carthagenensis (Jacq.) J. F. Macbride	Lythraceae
Cyanthillium cinereum (L.) H. Robinson	Asteraceae
Diverse small sedges *Cyperaceae species*	Cyperaceae
Sweetheart species *Desmodium species*	Fabaceae-Faboideae
Emilia species	Asteraceae
Epidendrum difforme Jacquin	Orchidaceae
Fuirena umbellata Rottbøll	Cyperaceae
Lavann, Lavender *Hedychium coronarium J. König*	Zingiberaceae
Hyptis atrorubens Poiteau	Lamiaceae
Nephrolepis brownii	Fern
Oxalis barrelieri Linnaeus	Oxalidaceae
Paspalum paniculatum Linnaeus	Poaceae
Pilea nummulariifolia (Swartz) Weddell	Urticaceae
Tèt nèg *Pseudelephantopus spicatus*	Asteraceae
Balyé wonzè *Sida acuta Burman f.*	Malvaceae
Balyé wonzè *Sida rhombifolia Linnaeus*	Malvaceae
Ti makònèt *Spermacoce remota Lamarck*	Rubiaceae

Thelypteris dentata (Forsskål) E. P. St. John	Fern
Tillandsia fasciculata Swartz	Bromeliaceae
Wild Herbs and Shrubs	
Kaka mèl *Clidemia hirta* (Linnaeus) D. Don	Melastomataceae
Zèb sèk *Flemingia strobilifera (*Linnaeus) W. T. Aiton	F.e-Faboideae
Jiwòf dlo *Ludwigia* species	Onagraceae
Sleeping hibiscus *Malvaviscus penduliflorus* de Candolle	Malvaceae
Malenbé, Bwa mal lèstomak *Piper dilatatum* Richard	Piperaceae
Anho bwa *Psittacanthus martinicensis (Presl) Eichler*	Loranthaceae
Pikan kouzen *Urena lobata* Linnaeus	Malvaceae
Fruit Trees	
Zabwiko, Apricot *Mammea americana* Linnaeus	Clusiaceae
Mango *Mangifera indica* Linnaeus	Anacardiaceae
Guava *Psidium guajava* Linnaeus	Myrtaceae
Ponmsité, Golden apple *Spondias dulcis* Solander ex Parkinson	Anacardiaceae
Cocoa *Theobroma cacao* Linnaeus	Malvaceae

Table E-4 Fauna withinin the Fond Saint Jacques East Project Study Area

Common and Scientific Name	Abundance	Status
Bird Species		
Cattle Egret *Bubulcus ibis ibis*	Common	Resident
Green Heron *Butorides virescens virescens*	Common	Resident
Scaly-naped Pigeon *Patagioenas squamosal*	Common	Resident
Saint Luica Parrot *Amizona versicolor*	Uncommon	Resident
Mangrove Cuckoo *Coccyzus minor*	Common	Resident
Lesser Antillean Swift *Chaetura martinica*	Common	Resident
Purple-throated Carib *Eulampis jugularis*	Common	Resident
Green-throated Carib *Eulampis holosericeus holosericeus*	Common	Resident
Antillean Crested Hummingbird *Orthorhyncus cristatus exilis*	Common	Resident
Caribbean Elaenia *Elaenia martinica martinica*	Common	Resident
St. Luica Pewee *Contopus oberi*	Common	Resident
Gray Kingbird *Tyrannus dominicensis vorax*	Common	Resident
Caribbean Martin *Progne dominicensis*	Common	Resident
Tropical Mockingbird *Mimus gilvus antillarum*	Common	Resident
Gray Trembler *Cinclocerthia gutturalis macrorhyncha*	Common	Resident
Scaly-breasted Thrasher *Allenia fusca schwartzi*	Common	Resident
Pearly-eyed Thrush	Common	Resident

Bird Species		
Margarops fuscatus klinikowski		
Bare-eyed Thrush *Turdus nudigenis nudigenis*	Common	Resident
Black-whiskered Vireo *Vireo altiloquus barbatulus*	Common	Resident
Antillean Euphonia *Euphonia musica flavifrons*	Common	Resident
Saint Lucia Warbler *Dendroica delicata*	Common	Resident
Bananaquit *Palm Warbler*	Common	Resident
Black-faced Grassquit *Tiaris bicolor*	Common	Resident
Saint Lucia Black Finch *Melanospiza richardsoni*	Uncommon	Resident
Lesser Antillean Bullfinch *Loxigilla noctis sclateri*	Common	Resident
Lesser Antillean Saltator *Saltator albicollis albicollis*	Common	Resident
Carib Grackle *Quiscalus lugubris inflexirostris*	Common	Resident
Shiny Cowbird *Molothrus bonariensis minimus*	Common	Resident
Saint Lucia Oriole *Icterus laudabilis*	Uncommon	Resident
Mammals		
Small Asian Mongoose *Herpestesou ropuntatus*	Common	Resident
Opossum *Didelphis marsupialis*	Common	Resident
Herpetofauna		
Saint Lucia Anolis Lizard *Anolis luciae*	Common	Resident
Common House Gecko *Hemidactylus mabouia*	Common	Resident
Zandoli tarre *Gymnopthalmus pleei*	Common	Resident

Bird Species		
Cane Tode *Rhinella marina*	Common	Resident

Table E-5 Flora Within the Mondesir North Project Study Area

Common and Scientific Names	Family
Herbs, Shrubs, and Vines	
Malanga, Giant tayo *Alocasia macrorrhizos (L.) G. Don*	Araceae
Alysicarpus vaginalis (Linnaeus) de Candolle	Fabaceae-Faboideae
Zèpina wouj *Amaranthus spinosus Linnaeus*	Amaranthaceae
Andropogon bicornis Linnaeus	Poaceae
Zèb a zédjwi, Needle grass *Bidens pilosa Linnaeus*	Asteraceae
Patagon *Boerhavia diffusa* Linnaeus	Nyctaginaceae
Bothriochloa pertusa (L.) Camus	Poaceae
Pwa blé *Calopogonium mucunoides* Desvaux	Fabaceae-Faboideae
Zèb kolan, burr grass *Cenchrus echinatus* Linnaeus	Poaceae
Elephant grass *Cenchrus purpureus* (Schumacher) Morrone	Poaceae
Chloris radiata (Linnaeus) Swartz	Poaceae
Fléwi Nwèl *Chromolaena odorata* (L.) R. M.King and H.Rob	Asteraceae
Cleome rutidosperma de Candolle	Cleomaceae
Kaka mèl *Clidemia hirta (Linnaeus) D. Don*	Melastomataceae
Zèb gwa, Water grass *Commelina diffusa Burman f.*	Commelinaceae
Condea verticillata (Jacq.) Harley & Pastore	Lamiaceae
Job's tears *Croix lacryma-jobi Linnaeus*	Poaceae
Sweetheart species *Desmodium species*	Fabaceae-Faboideae
Digitaria setigera Roth	Poaceae
Tèt nèg *Elephantopus mollis Kunth*	Asteraceae
Pyé poul	Poaceae

Eleusine indica (Linnaeus) Gaertner	
Various Emilia species	Asteraceae
Eragrostis pilosa (L.) Palisot de Beauv.	Poaceae
Euphorbia heterophylla Linnaeus	Euphorbiaceae
Euphorbia species	Euphorbiaceae
Hyptis atrorubens Poiteau	Lamiaceae
Kakoli *Inga ingoides* (Richard) Willdenow	Fabaceae-Mimosoideae
Lyenn dous *Ipomoea tiliacea* (Willdenow) Choisy	Convolvulaceae
Jiwòf flè, Bwa wa tou *Lantana strigocamara* R. W. Sanders	Verbenaceae
Gwo ponpon *Leonotis nepetifolia (L.) R. Brown*	Lamiaceae
Macroptilium lathyroides (L.) Urban	Fabaceae-Faboideae
Zèb djiné. Guinea grass. *Megathyrsus maximus*	Poaceae
Oxalis corniculata Linnaeus	Oxalidaceae
Panicum pilosum Swartz	Poaceae
Paspalum paniculatum Linnaeus	Poaceae
Paspalum virgatum Linnaeus	Poaceae
Gwenn anba fèy *Phyllanthus species*	Phyllanthaceae
Porophyllum ruderale (Jacq.) Cassini	Asteraceae
Koupyé *Portulaca oleracea Linnaeus*	Portulacaceae
Ti davi *Priva lappulacea (Linnaeus) Persoon*	Verbenaceae
Balyé wonzè *Sida acuta Burman f.*	Malvaceae
Balyé wonzè *Sida rhombifolia Linnaeus*	Malvaceae
Béléjenn djab *Solanum torvum Swartz*	Solanaceae
Ti makònèt *Spermacoce remota Lamarck*	Rubiaceae
Ti makònèt *Spermacoce verticillata Linnaeus*	Rubiaceae
Sporobolus jacquemontii Kunth	Poaceae
Tridax procumbens Linnaeus	Asteraceae
Pikan kouzen *Urena lobata Linnaeus*	Malvaceae
Fruit and Vegetable Species	

Gonbo, Okra *Abelmoschus esculentus (Linnaeus) Moench*	Malvaceae
Ti longyon, Chives *Allium species*	Amaryllidaceae
Pineapple *Ananas comosus (Linnaeus) Merrill*	Bromeliaceae
Kòsòl. Soursop. *Annona muricata Linnaeus*	Annonaceae
Ponm kannél, Sugar apple *Annona squamosa Linnaeus*	Annonaceae
Papaya *Carica papaya Linnaeus*	Caricaceae
Watermelon *Citrullus lanatus*	Cucurbitaceae
Citrus species	Rutaceae
Coconut *Cocos nucifera Linnaeus*	Arecaceae
Dasheen *Colocasia esculenta (Linnaeus) Schott*	Araceae
Bandja *Dioscorea alata Linnaeus*	Araceae
Sweet potato *Ipomoea batatas*	Convolvulaceae
Mango *Mangifera indica Linnaeus*	Anacardiaceae
Bananas, Plantains *Musa × paradisiaca*	Musaceae
Tabak, Tobacco *Nicotiana tabacum Linnaeus*	Solanaceae
Guava *Psidium guajava Linnaeus*	Myrtaceae
Salad pea *Vigna unguiculata (Linnaeus) Walpers*	Fabaceae-Faboideae
Chou, Calalou *Xanthosoma species*	Araceae
Corn, Maize *Zea mays Linnaeus*	Poaceae
Wild Trees	
Neem Tree *Azadirachta indica*	Meliaceae
Leucaena leucocephala	Fabaceae
Citharexylum spinosum	Verbenaceae
Tabebuia heterophylla	Bigoniaceae
Ficus insipda	Moraceae
Inga ingoides	Fabaceae

Table E-6 Fauna within the Mondesir North Study Area

Common and Scientific Name	Abundance	Status
Birds		
Purple-throated Carib *Eulampis jugularis*	Common	Resident
Green-throated Carib *Eulampis holosericeus holosericeus*	Common	Resident
Antillean Crested Hummingbird *Orthorhyncus cristatus exilis*	Common	Resident
Caribbean Elaenia *Elaenia martinica martinica*	Common	Resident
Gray Kingbird *Tyrannus dominicensis vorax*	Common	Resident
Caribbean Martin *Progne dominicensis*	Common	Resident
Tropical Mockingbird *Mimus gilvus antillarum*	Common	Resident
Scaly-breasted Thrasher *Allenia fusca schwartzi*	Common	Resident
Saint Lucia Warbler *Dendroica delicata*	Common	Resident
Bananaquit *Palm Warbler*	Common	Resident
Black-faced Grassquit *Tiaris bicolor*	Common	Resident
Lesser Antillean Bullfinch *Loxigilla noctis sclateri*	Common	Resident
Lesser Antillean Saltator *Saltator albicollis albicollis*	Common	Resident
Carib Grackle *Quiscalus lugubris inflexirostris*	Common	Resident
Shiny Cowbird *Molothrus bonariensis minimus*	Common	Resident
Insects		
Southern Great White Butterfly	Common	Resident
Caribbean Buckeye Butterfly	Common	Resident
White Peacock Butterfly	Common	Resident

Birds		
Tropical Chequered Skipper Butterfly	Common	Resident
Fierty Skipper Butterfly	Common	Resident
False Barred Sulphur Butterfly	Common	Resident
Southern Broken Dash Butterfly	Common	Resident

Table E-7 Flora within the Mondesir South Project Study Area

Common and Scientific Names	Family
Herbs and Shrubs	
Alysicarpus vaginalis (L. de Candolle	Fabaceae-Faboideae
Zèpina wouj *Amaranthus spinosus Linnaeus*	Amaranthaceae
Zèb a zédjwi, Needle grass. *Bidens pilosa Linnaeus*	Asteraceae
Pwa blé *Calopogonium mucunoides Desvaux*	Fabaceae-Faboideae
Zèb kolan, burr grass *Cenchrus echinatus Linnaeus*	Poaceae
Fléwi Nwèl *Chromolaena odorata (L.) R. M.King & H.Rob*	Asteraceae
Cleome rutidosperma de Candolle	Cleomaceae
Kaka mèl *Clidemia hirta (Linnaeus) D. Don*	Melastomataceae
Zèb gwa, Water grass *Commelina diffusa Burman f.*	Commelinaceae
Job's tears *Croix lacryma-jobi Linnaeus*	Poaceae
Sweeheart species *Desmodium species*	Fabaceae-Faboideae
Tèt nèg *Elephantopus mollis Kunth*	Asteraceae
Emilia species	Asteraceae
Euphorbia species	Euphorbiaceae
Hyptis atrorubens Poiteau	Lamiaceae
Lyenn dous *Ipomoea tiliacea (Willdenow) Choisy*	Convolvulaceae
Jiwòf flè. Bwa wa tou *Lantana strigocamara R. W. Sanders*	Verbenaceae
Gwo ponpon *Leonotis nepetifolia (L.) R. Brown*	Lamiaceae
Macroptilium lathyroides (L.) Urban	Fabaceae-Faboideae
Oxalis corniculata Linnaeus	Oxalidaceae
Gwenn anba fèy	Phyllanthaceae

Phyllanthus species	
Koupyé *Portulaca oleracea Linnaeus*	Portulacaceae
Ti dayi *Priva lappulacea (Linnaeus) Persoon*	Verbenaceae
Balyé wonzè *Sida acuta Burman f.*	Malvaceae
Balyé wonzè *Sida rhombifolia Linnaeus*	Malvaceae
Ti makònèt *Spermacoce remota Lamarck*	Rubiaceae
Ti makònèt *Spermacoce verticillata Linnaeus*	Rubiaceae
Tridax procumbens Linnaeus	Asteraceae
Pikan kouzen *Urena lobata Linnaeus*	Malvaceae
Fruit and Vegetable Species	
Pineapple *Ananas comosus* (Linnaeus) Merrill	Bromeliaceae
Papaya *Carica papaya* Linnaeus	Caricaceae
Citrus species	Rutaceae
Coconut *Cocos nucifera* Linnaeus	Arecaceae
Sweet potato, Patat *ipomoea batatas*	Convolvulaceae
Mango *Mangifera indica* Linnaeus	Anacardiaceae
Bananas, Plantains *Musa × paradisiaca*	Musaceae
Guava *Psidium guajava* Linnaeus	Myrtaceae

Table E-8 Fauna in the Mondesir South Study Area

Common and Scientific Name	Abundance	Status
Bird Species in Mondesir South		
Mangrove Cuckoo *Coccyzus minor*	Common	Resident
Purple-throated Carib *Eulampis jugularis*	Common	Resident
Green-throated Carib *Eulampis holosericeus holosericeus*	Common	Resident
Antillean Crested Hummingbird *Orthorhyncus cristatus exilis*	Common	Resident
Caribbean Elaenia *Elaenia martinica martinica*	Common	Resident
Saint Lucia Pewee *Contopus oberi*	Common	Resident
Gray Kingbird *Tyrannus dominicensis vorax*	Common	Resident
Caribbean Martin *Progne dominicensis*	Common	Resident
Tropical Mockingbird *Mimus gilvus antillarum*	Common	Resident
Gray Trembler *Cinclocerthia gutturalis macrorhyncha*	Common	Resident
Scaly-breasted Thrasher *Allenia fusca schwartzi*	Common	Resident
Bare-eyed Thrush *Turdus nudigenis nudigenis*	Common	Resident
Black-whiskered Vireo *Vireo altiloquus barbatulus*	Common	Resident
Saint Lucia Warbler *Dendroica delicata*	Common	Resident
Bananaquit *Palm Warbler*	Common	Resident
Black-faced Grassquit *Tiaris bicolor*	Common	Resident
Lesser Antillean Bullfinch *Loxigilla noctis sclateri*	Common	Resident

Common and Scientific Name	Abundance	Status
Lesser Antillean Saltator *Saltator albicollis albicollis*	Common	Resident
Carib Grackle *Quiscalus lugubris inflexirostris*	Common	Resident
Shiny Cowbird *Molothrus bonariensis minimus*	Common	Resident
Herpetofauna		
Saint Luica Anolis Lizard *Anolis luciae*	Common	Resident
Common House Gecko *Hemidactylus mabouia*	Common	Resident
Zandoli tarre *Gymnopthalmus pleei*	Common	Resident

REPRESENTATIVE PHOTOGRAPHS

Figure 1 Belle Plaine Cultivated Beds and Forested Edge



Figure 2 Belle Plaine Neglected Fields, Coconut Palms, and Forested Edge



Figure 3 Belle Plaine Open Weedy Area with Bananas/Plantains and Forested Edge



Figure 4 Fond St. Jacques West Bare Soil



Figure 5 Fond St. Jacques East Grasses, Sedges, Dasheen, and Forested Edge



Figure 6 Mondesir-Saltibus North Fallow Area with Bananas



Figure 7 Mondesir-Saltibus North Cleared Plot Ready for Planting and Mango Trees



Figure 8 Mondesir-Saltibus North Sweet Potato Beds Near Playing Field



Figure 9 Mondesir-Saltibus North Sports Field with Mown Grass *Eragrostis pilosa*



Figure 10 Mondesir-Saltibus North Weedy Growth Next to Sports Field



Figure 11 *Andropogon bicornis* on Side of Sports Field



Figure 12 Mondesir-Saltibus South Fallow, Some Sweet Potato Beds, Coconuts, Bananas



Figure 13 Mondesir Saltibus South Mature Sweet Potato Beds



Figure 14 Mondesir-Saltibus South Intensive Pineapple Cultivation



Figure 15. Saint Lucia Anolis



Figure 16. Great Southern White



Figure 17 White Peacock



Figure 18. Caribbean Buckeye



Figures 19. From top left: Saint Lucia Parrot, Saint Lucia Oriole, Saint Lucia Black Finch male/female



Figure 20. Saint Lucia Warbler



Figure 21. Lesser Antillean Saltator



APPENDIX D

Water Quality Sampling and Stream Flow

WASCO

THE WATER AND SEWERAGE COMPANY INC.

LABORATORY ANALYTICAL REPORT

SOURCE	Upper Fond St. Jaques Raw	
Date of sample	9.11.11	
Time	17:23	
Sampled by	D.Remy	
pH	6.92	
Colour	<1	
Turbidity [NTU]	0.21	
Appearance	Clear	
Odour	Odourless	
Conductivity [µS/cm]	169	
The following are in mg/l		
Dissolved Oxygen	6.91	
Residual Chlorine		
Total alkalinity as $CaCO_3$	58.4	
Total hardness as $CaCO_3$	65	
Calcium hardness as $CaCO_3$	47	
Magnesium hardness as $CaCO_3$	18	
Chlorides as Cl	23	
Fluorides as F	0.15	
Free ammonia as NH_3	0.054	
Nitrates as NO_3	1.76	
Phosphates as P_2O_5	25.13	
Phosphates as PO_4	0.249	
Sulphates as SO_4	1.7	
Silica as SiO_2	38.6	
Free Carbon Dioxide	19	
Non-filterable residue		
Total iron as Fe	0.064	
Copper as Cu	0.032	
Manganese as Mn	<0.001	
Aluminum as Al	0.071	
REMARKS		

BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	120	
Faecal Coliform	20	
Faecal Streptococci	20	

SOURCE	Upper Fond St. Jaques Raw	
Date of sample	26.03.12	
Time	14:55	
Sampled by	D.Remy	
pH	7.3	
Colour	<1	
Turbidity [NTU]	0.593	
Appearance	clear	
Odour	odourless	
Conductivity [µS/cm]	169.4	
The following are in mg/l		
Dissolved Oxygen	10.02	
Residual Chlorine	<0.1	
Total alkalinity as $CaCO_3$	56	
Total hardness as $CaCO_3$	53.5	
Calcium hardness as $CaCO_3$	35.4	
Magnesium hardness as $CaCO_3$	17.9	
Chlorides as Cl	16.5	
Fluorides as F	<0.01	
Free ammonia as NH_3	0.02196	
Nitrates as NO_3	0.88	
Phosphates as P_2O_5	26.25	
Phosphates as PO_4	0.391	
Sulphates as SO_4	4.9	
Silica as SiO_2	48.8	
Free Carbon Dioxide	18	
Non-filterable residue		
Total iron as Fe	0.126	
Copper as Cu	0.08	
Manganese as Mn	0.007	
Aluminum as Al	0.013	
REMARKS		

BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	1550	
Faecal Coliform	470	
Faecal Streptococci	20	

SOURCE	Upper Fond St. Jaques Raw	
Date of sample	26.8.13	
Time	15:34	
Sampled by	D.Remy	
pH	7.33	
Colour	<1	
Turbidity [NTU]	0.602	
Appearance	Clear	
Odour	Odourless	
Conductivity [µS/cm]	171	
The following are in mg/l		
Dissolved Oxygen	5.18	
Residual Chlorine	<0.1	
Total alkalinity as $CaCO_3$	24.8	
Total hardness as $CaCO_3$	53	
Calcium hardness as $CaCO_3$	36	
Magnesium hardness as $CaCO_3$	17	
Chlorides as Cl	17.25	
Fluorides as F	0.11	
Free ammonia as NH_3	0.0366	
Nitrates as NO_3	2.64	
Phosphates as P_2O_5	9.48	
Phosphates as PO_4	0.46	
Sulphates as SO_4	1	
Silica as SiO_2	58	
Free Carbon Dioxide	27	
Non-filterable residue		
Total iron as Fe	0.22	
Copper as Cu	0.03	
Manganese as Mn	0.007	
Aluminum as Al	<0.001	
REMARKS		

BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	TNTC	
Faecal Coliform	70	
Faecal Streptococci	0	

SOURCE	Upper Fond St. Jaques Raw	
Date of sample	27.05.14	
Time	15:53	
Sampled by	B.Fontenelle	
pH	7.46	
Colour	1	
Turbidity [NTU]	0.325	
Appearance	Clear	
Odour	Odourless	
Conductivity [µS/cm]	182.6	
The following are in mg/l		
Dissolved Oxygen	5.65	
Residual Chlorine	<0.1	
Total alkalinity as $CaCO_3$	27.2	
Total hardness as $CaCO_3$	55	
Calcium hardness as $CaCO_3$	35	
Magnesium hardness as $CaCO_3$	20	
Chlorides as Cl	24	
Fluorides as F	0.01	
Free ammonia as NH_3	<0.01	
Nitrates as NO_3	3.08	
Phosphates as P_2O_5	14.64	
Phosphates as PO_4	0.49	
Sulphates as SO_4	3	
Silica as SiO_2	53	
Free Carbon Dioxide	21	
Non-filterable residue		
Total iron as Fe	0.04	
Copper as Cu	0.27	
Manganese as Mn	<0.001	
Aluminum as Al	0.023	
REMARKS		

BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	1000	
Faecal Coliform	150	
Faecal Streptococci	90	

SOURCE	Upper Fond St. Jaques Raw	
Date of sample	16.08.16	
Time	14:45	
Sampled by	D.Remy	
pH	7.12	
Colour	8	
Turbidity [NTU]	0.586	
Appearance	Clear	
Odour	Odourless	
Conductivity [µS/cm]	146.2	
The following are in mg/l		
Dissolved Oxygen	5.61	
Residual Chlorine	<0.1	
Total alkalinity as $CaCO_3$	26.4	
Total hardness as $CaCO_3$	65	
Calcium hardness as $CaCO_3$	33	
Magnesium hardness as $CaCO_3$	32	
Chlorides as Cl	21	
Fluorides as F	0.12	
Free ammonia as NH_3	0.0122	
Nitrates as NO_3	3.52	
Phosphates as P_2O_5	14.4375	
Phosphates as PO_4	0.7	
Sulphates as SO_4	2	
Silica as SiO_2	37	
Free Carbon Dioxide	18	
Non-filterable residue		
Total iron as Fe	0.49	
Copper as Cu	<0.01	
Manganese as Mn	<0.001	
Aluminum as Al	0.029	
REMARKS		

BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	510	
Faecal Coliform	250	
Faecal Streptococci	40	

WASCO

THE WATER AND SEWERAGE COMPANY INC.

LABORATORY ANALYTICAL REPORT

SOURCE	**Upper Saltibus Treated Water**		
Date of sample	20.08.13	11.11.13	
Time	13:50	16:25	
Sampled by	D. Remy	D. Remy	
pH	7.9	7.6	
Colour	61		
Turbidity [NTU]	14.7	6.88	
Appearance	Clear	hazy	
Odour	odourless	odourless	
Conductivity [µS/cm]	132	127.2	
The following are in mg/l			
Dissolved Oxygen	4.68	5.11	
Residual Chlorine	0.5	0.4	
Total alkalinity as $CaCO_3$	17.6	20.8	
Total hardness as $CaCO_3$	45.5	39.5	
Calcium hardness as $CaCO_3$	27	21.5	
Magnesium hardness as $CaCO_3$	18.5	18	
Chlorides as Cl	23.5	30.25	
Fluorides as F	0.16	<0.01	
Free ammonia as NH_3	0.134	0.183	
Nitrates as NO_3	14.08	<0.01	
Phosphates as P_2O_5	3.27	1.68	
Phosphates as PO_4	0.14	0.34	
Sulphates as SO_4	<1.0	2	
Silica as SiO_2	32	26	
Free Carbon Dioxide	1	14.5	
Non-filterable residue			
Total iron as Fe	0.47	0.16	
Copper as Cu	<0.01	<0.001	
Manganese as Mn	<0.001	0.047	
Aluminum as Al	0.01	0.046	
REMARKS			

BACTERIOLOGICAL REPORT	count per 100ml		
Total Coliform	0	0	
Faecal Coliform	0	0	
Faecal Streptococci	0	0	

SOURCE	**Upper Saltibus Treated Water**			
Date of sample	24.03.14	13.05.14	09.09.14	
Time	17:13	15:50	17:40	
Sampled by	D. Remy	B.Fontenelle	D. Remy	
pH	7.98	14:24	7.55	
Colour	17	10	149	
Turbidity [NTU]	1.44	0.07	21.5	
Appearance	clear	clear	clear	
Odour	odourless	odourless	odourless	
Conductivity [µS/cm]	164	191.4	75.6	
The following are in mg/l				
Dissolved Oxygen	5.07	4.84	4.3	
Residual Chlorine	13	0.8	0.6	
Total alkalinity as $CaCO_3$	25.6	26.4	4	
Total hardness as $CaCO_3$	49	53.5	15	
Calcium hardness as $CaCO_3$	26	28.5	9	
Magnesium hardness as $CaCO_3$	23	25	6	
Chlorides as Cl	36.5	31.75	17.5	
Fluorides as F	0.11	0.14	<0.01	
Free ammonia as NH_3	0.049	<0.01	0.2318	
Nitrates as NO_3	3.96	7.04	12.32	
Phosphates as P_2O_5	12.83	12.06	5.8875	
Phosphates as PO_4	0.36	0.62	0.28	
Sulphates as SO_4	<0.1	2	<1	
Silica as SiO_2	32	35	15	
Free Carbon Dioxide	29	18	21	
Non-filterable residue				
Total iron as Fe	0.22	0.08	0.95	
Copper as Cu	0.1	0.04	0.29	
Manganese as Mn	<0.001	0.022	0.074	
Aluminum as Al	0.039	0.123	0.066	
REMARKS				

BACTERIOLOGICAL REPORT	count per 100ml			
Total Coliform	0	0	0	
Faecal Coliform	0	0	0	
Faecal Streptococci	0	0	0	

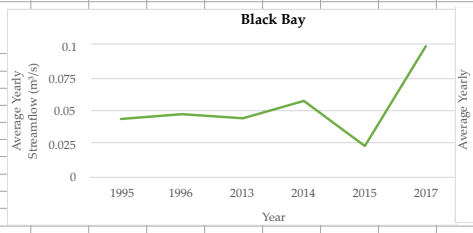
SOURCE	**Upper Saltibus Treated Water**	
Date of sample	24.8.15	
Time	17:17	
Sampled by	D.Remy	
pH	7.23	
Colour	<1	
Turbidity [NTU]	1.18	
Appearance	Clear	
Odour	Odourless	
Conductivity [µS/cm]	169.7	
The following are in mg/l		
Dissolved Oxygen	6.94	
Residual Chlorine	0.5	
Total alkalinity as $CaCO_3$	34.4	
Total hardness as $CaCO_3$	51	
Calcium hardness as $CaCO_3$	35	
Magnesium hardness as $CaCO_3$	16	
Chlorides as Cl	32	
Fluorides as F	<0.01	
Free ammonia as NH_3	0.0244	
Nitrates as NO_3	13.2	
Phosphates as P_2O_5	8.2125	
Phosphates as PO_4	0.5	
Sulphates as SO_4	5	
Silica as SiO_2	40	
Free Carbon Dioxide	16	
Non-filterable residue		
Total iron as Fe	0.22	
Copper as Cu	0.27	
Manganese as Mn	0.056	
Aluminum as Al	0.144	
REMARKS		

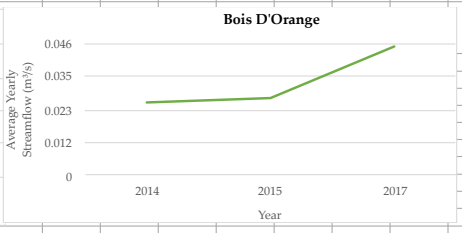
BACTERIOLOGICAL REPORT	count per 100ml	
Total Coliform	12	
Faecal Coliform	0	
Faecal Streptococci	0	

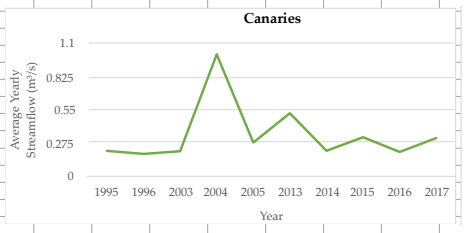
SOURCE	**Upper Saltibus Treated Water**		
Date of sample	17.02.16	12.07.16	
Time	18:38	16:08	
Sampled by	D.Remy	D.Remy	
pH	7.46	12:00	
Colour	25	63	
Turbidity [NTU]	4.26	13.4	
Appearance	clear	clear	
Odour	odourless	odourless	
Conductivity [µS/cm]	84.3	76.6	
The following are in mg/l			
Dissolved Oxygen	5.78	6.07	
Residual Chlorine	0.2	<0.1	
Total alkalinity as $CaCO_3$	10.4	17.6	
Total hardness as $CaCO_3$	30	23	
Calcium hardness as $CaCO_3$	15	12	
Magnesium hardness as $CaCO_3$	15	11	
Chlorides as Cl	20.5	20	
Fluorides as F	<0.01	<0.01	
Free ammonia as NH_3	0.0366	0.061	
Nitrates as NO_3	7.48	3.08	
Phosphates as P_2O_5	6.21	13.9125	
Phosphates as PO_4	0.45	0.74	
Sulphates as SO_4	1	1	
Silica as SiO_2	39	21	
Free Carbon Dioxide	22	44	
Non-filterable residue			
Total iron as Fe	0.26	0.46	
Copper as Cu	0.32	0.01	
Manganese as Mn	0.007	0.035	
Aluminum as Al	0.183	0.036	
REMARKS			

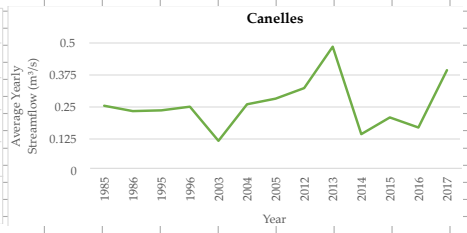
BACTERIOLOGICAL REPORT	count per 100ml		
Total Coliform	8		
Faecal Coliform	4		
Faecal Streptococci	0		

Watershed	Year	Q Average flow rate
AnseLa Raye	2016	0.09
Black Bay	1995	0.0438104
	1996	0.047464
	2013	0.044337
	2014	0.0575
	2015	0.0233095
	2017	0.099
Bois D'Orange	2014	0.02547
	2015	0.027
	2017	0.045
Canaries	1995	0.2091226
	1996	0.18365
	2003	0.2059238
	2004	1.011115166
	2005	0.2784
	2013	0.5217982
	2014	0.2094115
	2015	0.322509333
	2016	0.1998
	2017	0.315444444
Canelles	1985	0.251875
	1986	0.23075
	1995	0.23369575
	1996	0.24816
	2003	0.113405
	2004	0.2576528
	2005	0.279913
	2012	0.32155077
	2013	0.484994068
	2014	0.139756166
	2015	0.20577125
	2016	0.166
	2017	0.3924
Cap	2014	0.007314
Castries	2014	0.041786
	2017	1.455125
Choc	1984	0.05192925
	1985	0.045314444
	2003	0.036084666
	2004	0.07797775
	2005	0.426215
	2011	0.076240833
	2014	0.072642
	2015	0.032198
	2016	0.019
	2017	0.0515
Choiseul/ Trou Barbet	2014	0.027
Cul de Sac	1985	0.642
	1986	0.425
	1987	0.521464833
	1989	0.421545454
	1990	0.481783333
	1991	0.285966666
	1992	0.155971428
	1993	3.30145
	1995	0.16285
	1996	0.2963
	1998	0.122138363
	1999	0.241298
	2000	0.278760285
	2001	0.249828230
	2002	0.3117514
	2003	0.262966666
	2004	0.384273333
	2010	0.036323428
	2012	0.3950735
	2013	0.515187251
	2014	0.268601526
	2015	0.1978845
	2016	0.146416666
	2017	0.195416666
Dennery	1995	0.16717275
	1996	0.110256
	2003	0.074076333
	2004	0.1316346
	2005	0.3257415
	2015	0.041202
	2016	0.057
	2017	0.065
Doree	1995	0.1260266
	1996	0.117417
	2003	0.563333
	2004	0.28711
	2014	0.15619
	2015	0.1980774
	2016	0.12825
	2017	0.1884
Fond	1995	0.22868
	1996	0.21242
	2015	0.337259333
	2016	0.27625
	2017	0.285166666
	1990	0.293311111
	1991	0.14542
	1992	0.454584888
	1994	0.1407
	1995	0.183333333
	1996	0.1869
	1998	0.0627264
	1999	0.0753
	2000	0.157925
	2001	0.150756090

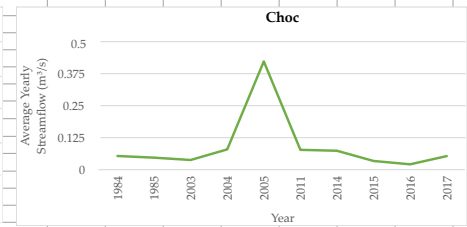


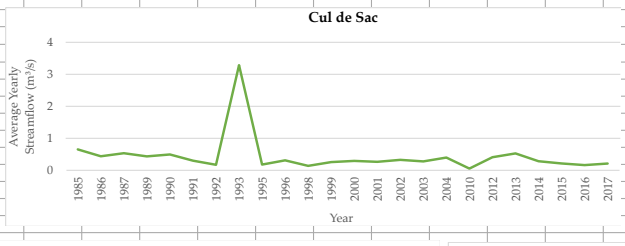


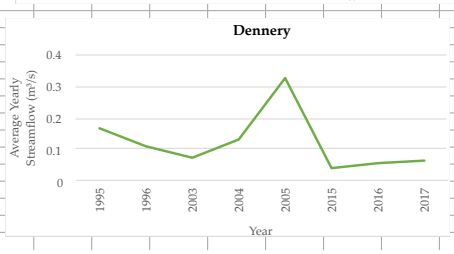


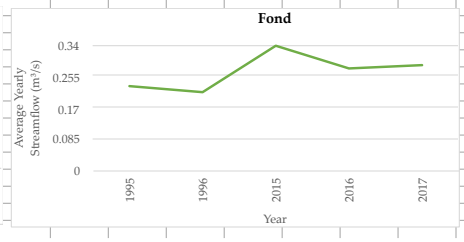


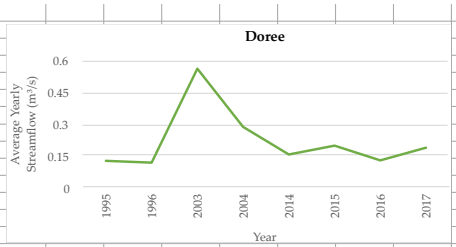


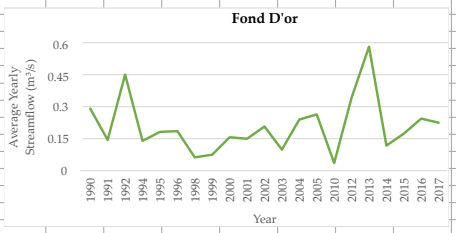




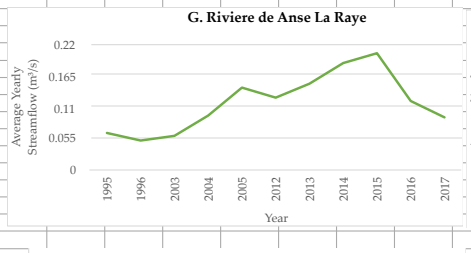


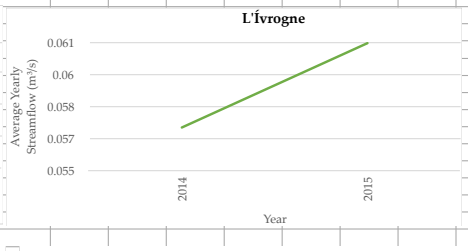


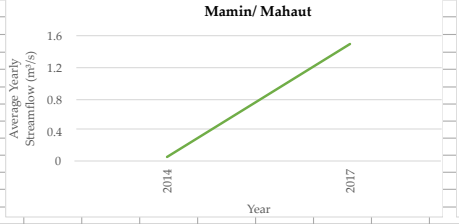


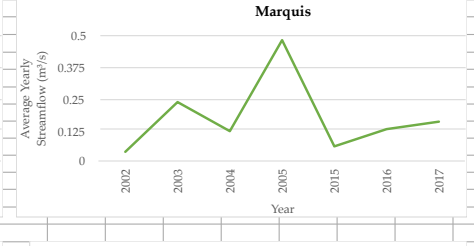


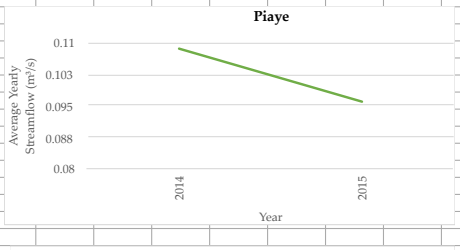
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	2005	0.266078692
	2010	0.035925
	2012	0.345252
	2013	0.586685738
	2014	0.118307428
	2015	0.1751225
	2016	0.246285714
	2017	0.226692307
G. Riviere de Anse La Raye	1995	0.0646525
	1996	0.0515
	2003	0.059624
	2004	0.09489925
	2005	0.143436666
	2012	0.125985
	2013	0.1502317
	2014	0.1860855
	2015	0.203175428
	2016	0.120166666
	2017	0.09175
L'Ívrogne	2014	0.057
	2015	0.061
Mamiku/Patience	2015	0.021573
Mamin/ Mahaut	2014	0.06
	2017	1.492
Marquis	2002	0.0390785
	2003	0.236171666
	2004	0.120969571
	2005	0.481514
	2015	0.060750416
	2016	0.129
	2017	0.1586
Piaye	2014	0.1085545
	2015	0.096
Roseau	1992	1.846818333
	1994	0.11706
	1995	0.52153875
	1996	0.31039
	2001	0.316279833
	2002	0.6976775
	2003	0.262347
	2004	0.6925
	2005	0.7576
	2012	0.420255
	2013	0.851198330
	2014	0.450277181
	2015	0.548228611
	2016	0.308642857
	2017	0.237285714
Soufriere	1995	0.1924636
	1996	0.221894
	2003	0.3909916
	2004	0.6160168
	2005	0.906427
	2013	0.5230108
	2014	0.2750968
	2015	0.2989283
	2016	0.309
	2017	0.5152
Troumassee	1990	0.7925818
	1991	0.4115
	1992	0.4365667
	1994	0.33735
	1995	0.54135
	1996	0.5105
	1998	0.2346
	1999	0.4259393
	2000	0.556225
	2001	0.42985
	2002	0.5452172
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	2004	1.1200823
	2005	1.1627335
	2013	4.93591
	2014	0.420858
	2015	0.6095417
	2016	0.721375
	2017	0.844125
Vieux Fort	1984	0.2586875
	1985	0.28332
	1986	0.4205
	1987	0.3657
	1988	0.3362
	1995	0.1708
	1996	0.161
	2003	0.1412942
	2004	0.3012032
	2005	0.4769615
	2006	0.168732
	2010	0.059668
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	2014	0.1741665
	2015	0.189817
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Volet	2015	0.010797

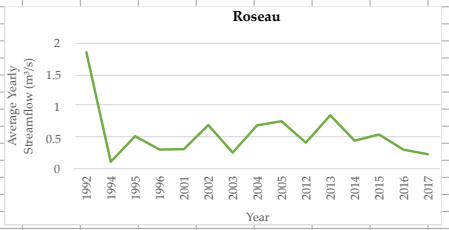


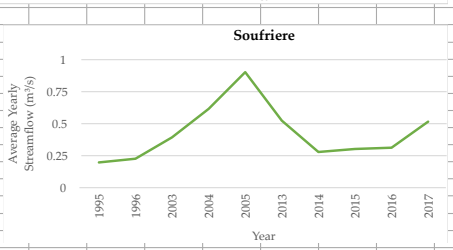


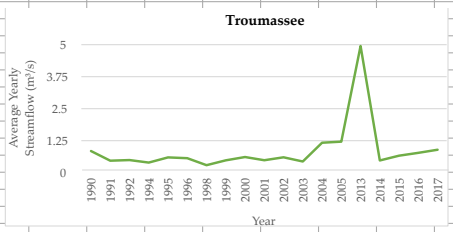


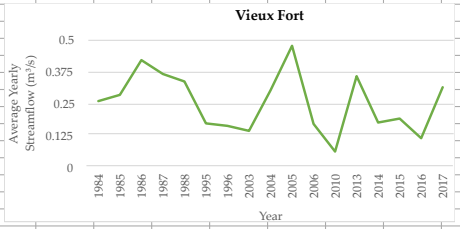




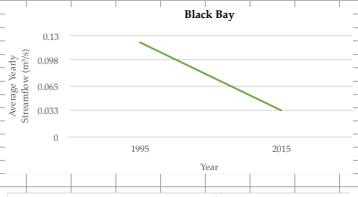


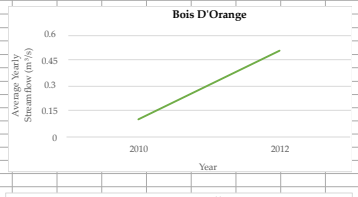


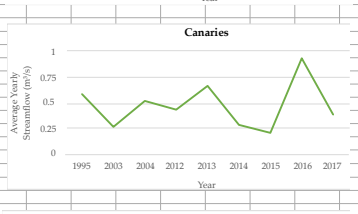


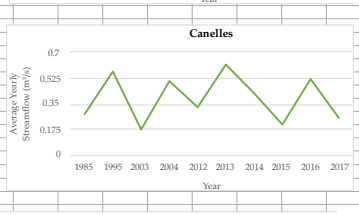


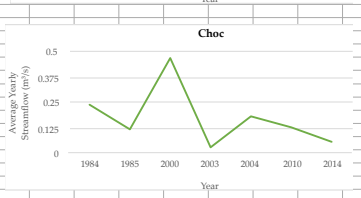
Watershed	Year	Q Average Flow Rate (m³/s)
Anse la Raye	2015	0.067
Anse La Verdue/Cochon	2014	0.023
Black Bay	1995	0.120819833333333
	2015	0.034
Bois D'Orange	2010	0.0995
	2012	0.504298
Canaries	1995	0.584465833333333
	2003	0.2635555
	2004	0.5178412
	2012	0.432322
	2013	0.66553875
	2014	0.2828486
	2015	0.204550272727273
	2016	0.936375
	2017	0.3842
Canelles	1985	0.279130434782609
	1995	0.57156
	2003	0.17308625
	2004	0.505553
	2012	0.3263155545
	2013	0.61938225
	2014	0.422269333333333
	2015	0.207200571428571
	2016	0.5196
	2017	0.2525
Castries	2017	0.076
Choc	1984	0.240369473684211
	1985	0.119586071428571
	2000	0.468767
	2003	0.031459
	2004	0.1832552
	2010	0.129319222222222
	2014	0.058421
Cul de Sac	1985	1.628775
	1986	0.896625
	1987	0.979421823529412
	1988	0.740171
	1990	1.819142857142860
	1991	0.568385714285714
	1992	0.444644444444444
	1994	0.1054
	1995	0.652871428571429
	1999	0.293005454545455
	2000	0.53663825
	2002	0.4369795
	2003	0.4549415
	2004	0.772497
	2012	1.354932
	2013	0.495297071428571
	2014	0.261650909090909
	2015	0.100287909090909
	2016	0.311333333333333
	2017	0.287
Dennery	1995	0.303271125
	2003	0.057490555555556
	2004	0.4397064
	2014	0.265
	2015	0.0625526
	2016	0.210333333333333
	2017	0.068
Doree	1995	0.196002333333333
	2003	0.227698
	2004	0.161976
	2013	0.395853
	2014	1.431228
	2015	0.129083333333333
	2016	0.7994
	2017	0.182666666666667
Esperance	2014	0.123
Fond	1995	0.474604833333333
	2014	0.5015
	2015	0.225525714285714
	2016	0.9975
	2017	0.312
Fond D'or	1990	1.51595
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	1992	0.328
	1993	3.3523
	1994	0.0793
	1995	0.40315
	1998	0.0835
	1999	0.215911111111111
	2000	0.421771428571429
	2001	0.154633333333333
	2002	0.32514725
	2003	0.143617666666667
	2004	0.598740571428571
	2012	0.541127333333333
	2013	0.6482274
	2014	0.275029333333333
	2015	0.151404076923077
	2016	0.624555555555556
	2017	0.29
G. Riviere de Anse La Raye	1995	0.160181
	2003	0.0818158
	2004	0.231701
	2013	0.163004666666667
	2014	0.091723833333333
	2015	0.069689
	2016	0.477
	2017	0.2155
Grand Anse/ Louvet	2016	0.13
L'Ívrogne	2013	0.08737
	2015	0.024
Mamiku/ Patience	2014	0.105
Marquis	2002	0.061760833333333
	2003	0.053619
	2004	0.244006333333333
	2014	0.727671
	2015	0.031603777777778
	2016	0.208833333333333
	2017	0.1698
P. Riviere de Anse La Raye	2013	0.192
	2014	0.011
Piaye	2014	1.621881
	2015	0.0776965
Roseau	1992	1.2401165
	1994	0.185475
	1995	1.184661
	2002	1.156118333333333
	2003	0.908178
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	2013	1.411673142857140
	2014	0.5471461
	2015	0.2587145
	2016	0.444333333333333
	2017	0.5945
Salee Lapins	2014	0.068
Soufriere	1995	0.417311333333333
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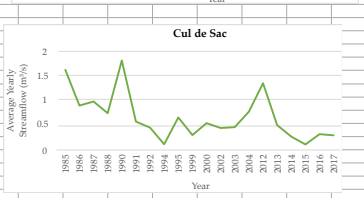


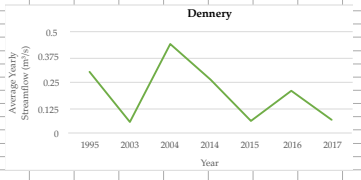


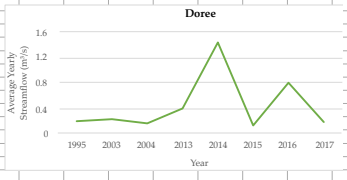


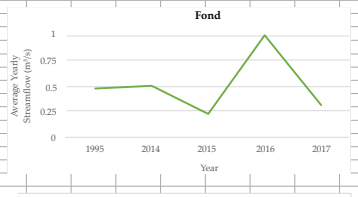


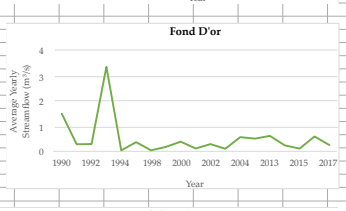


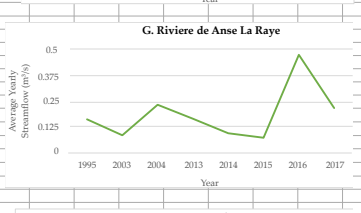


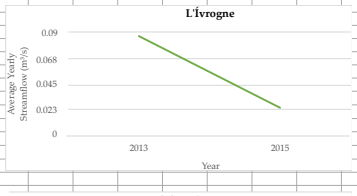


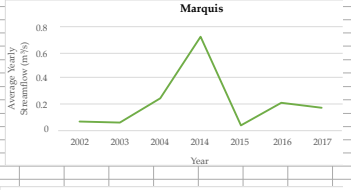


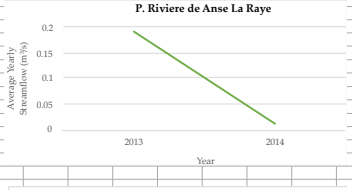


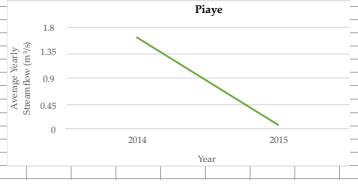


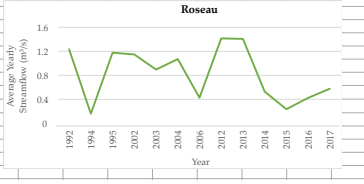




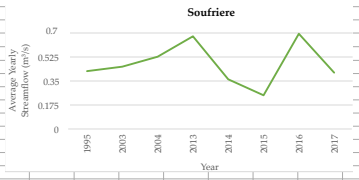


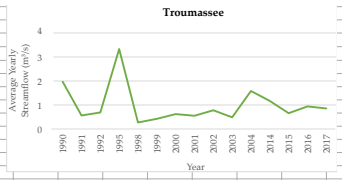


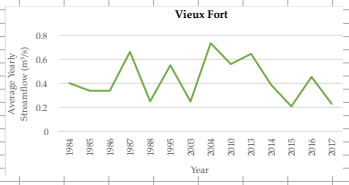




		2015	0.244162
		2016	0.6855
		2017	0.4063333333333333
	Trou Graval/ Dauphins	2010	0.024851
	Troumassee	1990	1.95076
		1991	0.5677727272727727
		1992	0.690166666666667
		1995	3.290116666666667
		1998	0.2805
		1999	0.4302555555555556
		2000	0.6243
		2001	0.5561
		2002	0.780809
		2003	0.49226
		2004	1.57050675
		2014	1.163358
		2015	0.661107
		2016	0.9393
		2017	0.85475
	Vieux Fort	1984	0.4034583333333333
		1985	0.3417826086956522
		1986	0.3412857142857143
		1987	0.6603076923076923
		1988	0.254447
		1995	0.55
		2003	0.253487
		2004	0.731396
		2010	0.559649
		2013	0.643828
		2014	0.3893375714285714
		2015	0.2135914166666667
		2016	0.4548888888888889
		2017	0.23375
	Volet	2014	0.6







APPENDIX F

Water Resource Sampling and Monitoring Plan

1 OVERVIEW

This appendix to the Scoping Studies Report for the Geothermal Resource Development Project Environmental and Social Impact Assessment details the water resource sampling and monitoring approach to be implemented during project construction. The following section contains information pertaining to the project TOR, Tasks 1.4 and 1.7.

1.1 PURPOSE

The purpose of the water sampling and testing program is to define the methods for water quality monitoring in potentially affected water resources during project implementation. The water quality sampling and testing program will support an evaluation of potential impacts of the geothermal exploration on water quality. The program will also provide baseline water quality data for assessment of future geothermal development. If water quality monitoring data indicates that the project is causing water quality to exceed acceptable levels, corrective actions will be implemented to protect downstream water quality.

1.2 WATER SAMPLING APPROACH

Water samples will be collected at designated locations; one upstream and one downstream of the project areas. Samples will be transported to a laboratory that is certified to perform the appropriate biological and chemical analysis. Sampling may also be conducted in the field using hand-held meters and visual observations.

1.3 DATA ANALYSIS

Water quality data will be compared relative to Saint Lucia and international water quality standards. If an exceedance of water quality standards or increase in downstream constituent loading is detected, an evaluation will be made to define the potential cause of the water quality conditions and corrective actions will be implemented to avoid degradation of water quality, where needed.

2 SAMPLING LOCATIONS

2.1 LOCATION OF SAMPLING POINTS OVERVIEW

Samples must be taken from locations that are representative of the water source (e.g., rivers or streams). One sampling point will be located upstream of the drilling site and one downstream of the drilling site on adjacent streams to allow for a comparison of data prior to potential project impacts (upstream sample) and after potential project impacts (downstream sample). The geothermal drilling locations are designated as Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus.

2.2 BELLE PLAINE

Two streams are located in proximity to the Belle Plaine area. Proposed sampling locations on each of these streams are shown on Figure 1 below. The two sampling points south of the Belle Plaine target drilling area (BP-1 and BP-3) will provide data on baseline or pre-project water quality. The western stream appears to terminate at the agricultural area where drilling is proposed and the BP-1 sampling location may be eliminated in the future if the stream does not flow through or continue past the drilling site. The northern sampling point (BP-2) will be located downstream of the drilling area to represent post-project water quality. The sampling locations may be adjusted after selection of the final drilling site to better approximate water quality conditions upstream and downstream of the project site.

2.3 FOND ST. JACQUES

Two streams are located adjacent to the Fond St. Jacques potential drilling areas. Proposed sampling locations are shown on Figure 2. FS-2 is representative of water quality conditions upstream of the Fond St. Jacque west area and FS-1 is representative of water quality conditions downstream of the Fond St. Jacques west drilling area. The southern stream that flows adjacent to Fond St. Jacques east is tributary to the northern stream. FS-3 represents water quality conditions upstream of Fond St. Jacques east. A downstream sampling location may be selected downstream of the target drilling area and depending on the final drilling location and direction of drainage from that area.

A spring in the Fond St. Jacques east area is used to provide water for the Fond St. Jacques community. A shallow groundwater monitoring well should be installed in proximity to the spring to monitoring water quality at the spring during drilling operations. FS-4 shows an approximate location for the shallow groundwater monitoring well. The location of FS-4 may be adjusted in the field to approximate the spring area. The shallow groundwater monitoring well should be installed using 1″slotted PVC pipe and clean sand backfill.

Figure 1 Belle Plaine Recommended Sampling Locations

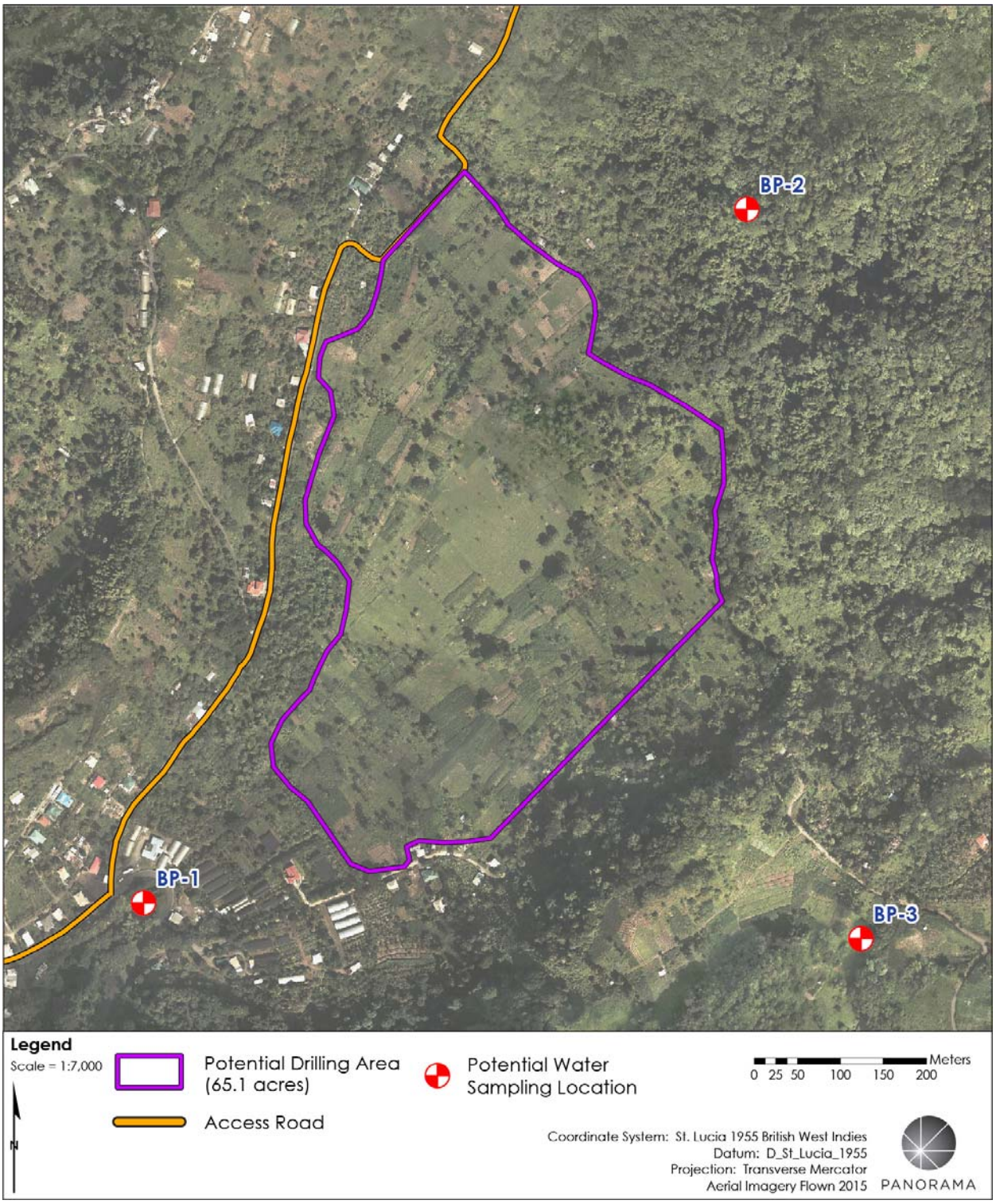


Figure 2 Fond St. Jacques Sampling Locations

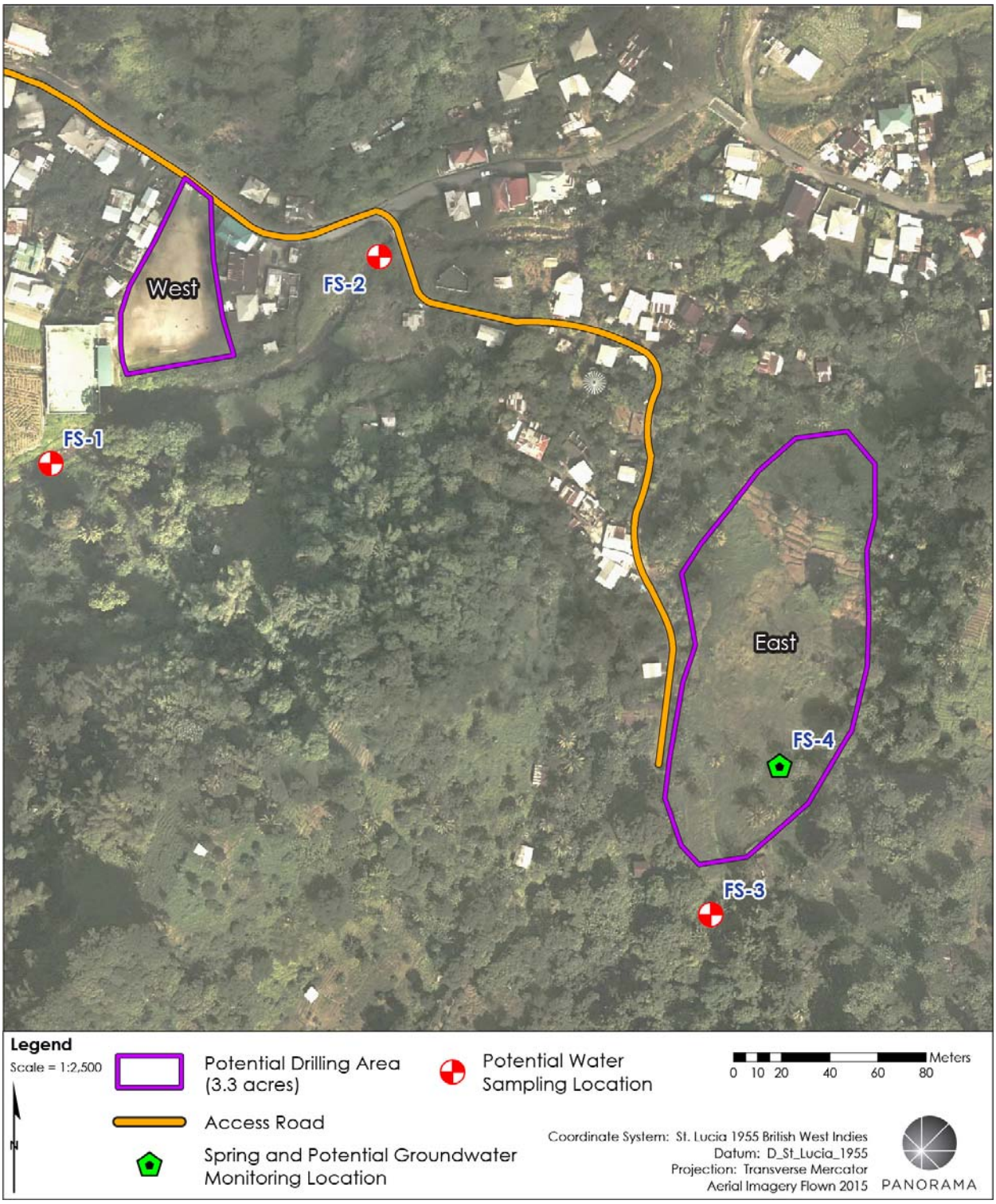
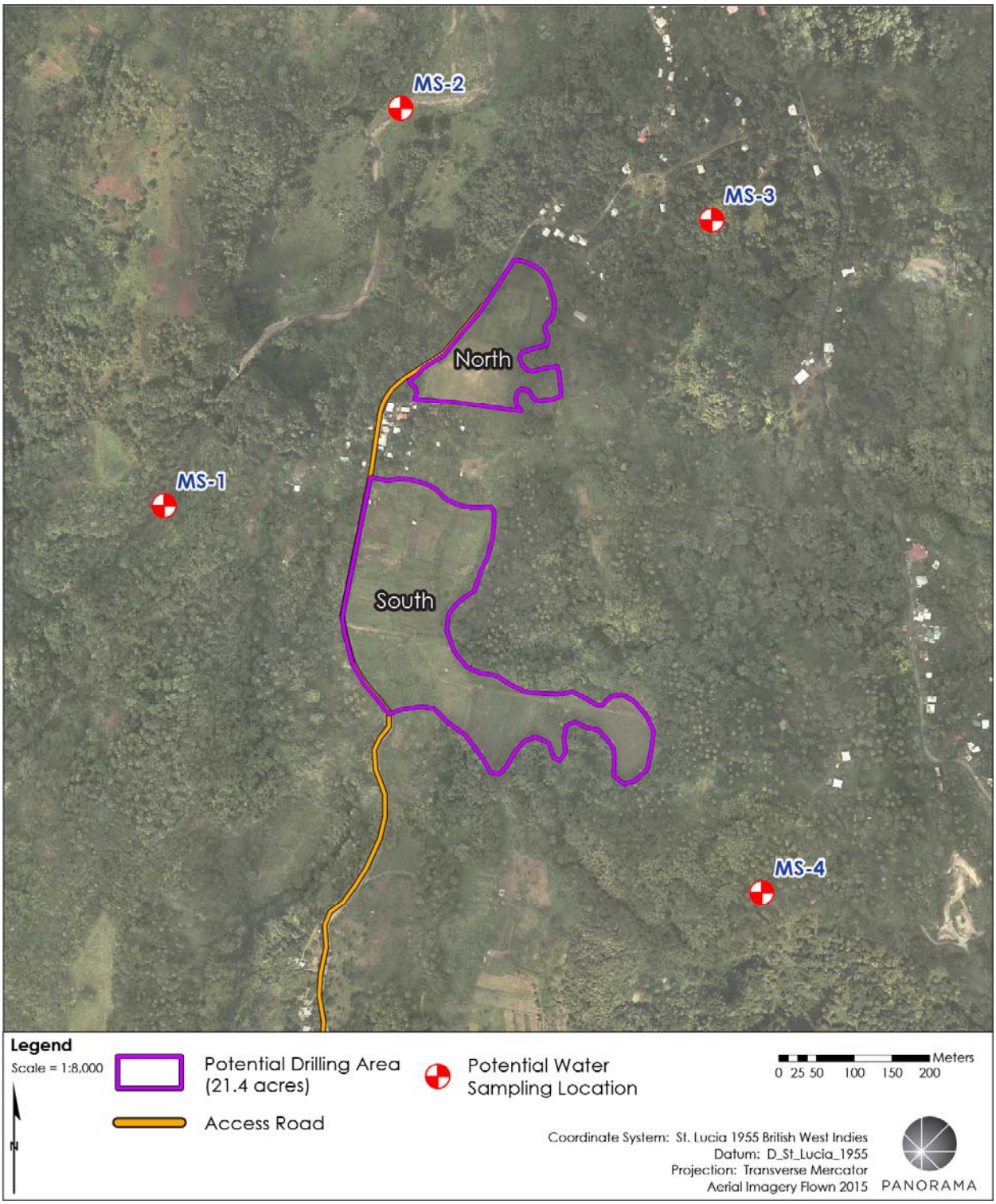


Figure 3 Mondesir-Saltibus Sampling Locations



2.4 MONDESIR-SALTIBUS

Two streams are located adjacent to the Mondesir-Saltibus potential drilling areas. The stream located to the west of the project area may be used for a water supply intake and a portion of the Mondesir-Saltibus north site may drain towards the west. Suggested sampling locations are shown on Figure 3. Depending on the final drilling location and water supply uses, one sampling location should be located upstream of the intake and one sampling location located downstream of the intake and potential discharge area. The Mondesir-Saltibus south potential drilling area drains toward the eastern stream. One sampling location should be located upstream of the drilling area and one downstream to represent pre- and post-project conditions. The sampling locations may be adjusted to reflect the final drilling sites and water supply intake location.

3 SAMPLING AND STREAM FLOW MEASUREMENT METHODS

3.1 FREQUENCY OF SAMPLING

Surface water monitoring/sampling should be conducted weekly during drilling and testing operations at sampling location in proximity to the drilling site. Groundwater monitoring/sampling should be conducted monthly during drilling and testing operations. Sampling shall also be conducted prior to and immediately following any rain storms and immediately following any suspected discharge to area streams.

3.2 PHYSICAL AND CHEMICAL SAMPLING METHODS

Water quality sampling methods are described below and include:

- Visual observation
- In-situ measurement
- Stream grab samples
- Groundwater samples

3.2.1 Visual Observations

Visual observations will be recorded for color, oil and grease, and visible solids, and erosion during water quality sampling. Photographs will be taken at each sampling location to record visual observations. Any observed project-related water quality discharge such as erosion, discharge of oil and grease, or other fluids, will be noted on field data sheets.

3.2.2 In-situ Measurements

The following measurements will be recorded in-situ using a hand-held meter:

- pH
- Dissolved oxygen
- Turbidity
- Conductivity
- Temperature

In-situ sampling equipment and the sensors must be calibrated prior to sampling events. The type of sampling equipment used and the sampling location shall be noted on field data sheets. Samples shall be recorded from the pre-defined sampling locations to provide consistency in data collection and analysis.

3.2.3 Grab Samples

Grab samples will be used to collect water samples for the following chemical analyses:

- Total suspended solids (TSS)
- Nitrogen (N)
- Organic material (e.g., fecal coliform)
- Biological oxygen demand-5 (BOD5)
- Chemical oxygen demand (COD)
- Heavy metals including:
  - Arsenic (As)
  - Boron (B)
  - Cadmium (Cd)
  - Chromium (Cr)
  - Nickel (N)
  - Mercury (Hg)
  - Zinc (Zn)
- Total petroleum hydrocarbons (TPH)
- Sulphur (S)
- Iron (Fe)
- Manganese (Mn)
- Uranium (U)
- Radium (Ra)
- Gross alpha and beta

Grab samples will be collected in an open container at the defined monitoring location. Grab samples may be collected in a suspended or handheld 5-gallon container, disposable bailer, or open-mouth bottle. The grab sample shall be stored and transported to the lab following proper chain-of-custody procedures. Grab sampling methods including allowable containers and maximum storage time for each analyte is provided in *National Field Manual for the Collection of Water Quality Data* (U.S. Geological Survey, n.d.). The height and depth of sample and staff obtaining the water sample shall be recorded on filed data sheets. All bottles must be marked individually, with key information such as project name or code, location, date, sample number, sample name, and type of analysis to be performed; this information must also will also be contained in a field notebook and in the sample-collection data sheets.

3.2.4 Groundwater Samples

Prior to obtaining a groundwater sample, the groundwater well should generally be purged. Exceptions to the groundwater purge method may be made in situations where the well is located in clay soils and the well fills very slowly. Once the groundwater well has refilled, a sample should be extracted using a pump. Data on the depth to groundwater shall be recorded on field data sheets. Methods for groundwater sampling shall follow *National Field Manual for the Collection of Water Quality Data* (U.S. Geological Survey, n.d.). Groundwater quality analysis will include the same analytes as the grab samples, listed above.

3.3 CHEMICAL WATER QUALITY ANALYSIS

Stream and groundwater grab samples will be transported to a laboratory that is certified to conduct the water quality analyses indicated. Water samples shall be properly stored and transported following proper chain-of-custody procedures.

3.4 MEASURING STREAM FLOW AT KEY POINTS UNDER BASE FLOW AND SEASONALLY VARIABLE CONDITIONS

The USGS splits stream gaging into a three-step process of measuring stream stage, measuring discharge, and determining the stage-discharge relation (Buchanan and Somers, 1969; https://water.usgs.gov/edu/measureflow.html). This is the process recommended for streamflow measurement. Stream flow measurements should be obtained upstream of any project water supply intake and downstream of the water supply intake. The Government of St. Lucia should determine the end use of any stream flow data collected under base flow and seasonally variable conditions prior to conducting measurements. The approach to measurement should reflect the end use of the data.

3.4.1 Measuring Stream Stage Procedures and Equipment

A variety of methods are currently used to measure streamflow. One of the most common is a stilling well located on the riverbank or attached to a bridge pier. Its operation consists of:

- Entry and exit of the water from the stilling well through underwater pipelines, allowing the surface of the water in the stilling well to be at the same height as the water surface in the river.
- The stage is measured inside the well by means of a float or an optical or acoustic pressure sensor.
- The measured phase value is stored in an electronic data recorder at a regular interval (usually every fifteen minutes).
- A telemetry system may also be present in a stilling well, allowing data to be transmitted remotely to a host computer in real time (Fundamentals and Environment Measurements, n.d.).

Depending on the budget and the field, it is not always possible to install a stilling well where stream gaging is necessary. For these cases, the following procedures can be performed:

- Stage can be measured with a vented pressure transducer installed within a PVC or metal pipe along the stream bank. In locations where a bridge or overhead structure is available for instrument mounting, a noncontact radar or ultrasonic water-level sensor can also be used (Fundamentals and Environment Measurements, n.d.).
- Stage can be determined by measuring the pressure required to maintain a small flow of gas through a tube and bubbled out at a fixed location underwater in the stream. The measured pressure is directly related to the height of water over the

tube outlet in the stream. As the depth of water above the tube outlet increases, more pressure is required to push the gas bubbles through the tube.

Choice of equipment will depend on recognition of conditions in the field as well as available budget. Stage must always be measured relative to a constant reference elevation, or datum. Since the present project seeks to consider seasonal variations, it is necessary to routinely survey the elevation of the stream gage structure and its datum, to ensure that elevations have not shifted due to seasonal variations.

It is not practical for a stream gage to continuously measure discharge. Fortuitously, however, there is a strong relation between river stage and discharge and, as a result, a continuous record of river discharge can be determined from the continuous record of stage. Determining discharge from stage requires defining the stage-discharge relationship by measuring discharge at a wide range of river stages.

3.4.2 Measuring Discharge and Equipment

River discharge is computed by multiplying the area of water in a channel cross-section by the average velocity of the water in that cross-section. Subsection width is best measured with a cable or steel measuring tape, while depth can be measured by a wading rod in shallower channels and suspended sounding weights in deeper waters (Fundamentals and Environment Measurements, n.d.).

One of the most common methods for discharge-velocity measurements is through a current meter. The current-meter method employs commercial equipment such as:

- Price® AA current meter
- Price® AA current meter attached to a wading rod
- Price® AA current meter suspended above a heavy weight

3.4.3 Determining the Stage-Discharge Relation and Equipment

Stage-discharge relation is a dynamic variable that is determined by comparing stage at a stream gage to discharge at the same point (Fundamentals and Environment Measurements, n.d.).

Prior to any estimation of stage and discharge and seasonal measurement, the end use of this data should be determined to evaluate the requirement for the data and the appropriate method to obtain the data.

4 WATER QUALITY STANDARDS AND CORRECTIVE ACTIONS

4.1 EFFLUENT STANDARDS

The IFC and World Bank Group Environmental, Health, and Safety General Guidelines (IFC and World Bank Group 2007a) have developed guidelines for effluent discharge to waters such as lakes, streams, rivers, or the ocean. The IFC and World Bank effluent threshold standards for mining, which has similar processes to geothermal drilling, are presented in Table 4.1-1 for informational purposes. The temperature threshold standard is a differential of less than 3 degrees Celsius (C).

Table 4.1-1 Threshold Standards for Effluent Discharge

Parameter	Threshold Standards (mg/L)
Total suspended solids	50
pH	6 to 9
Chemical oxygen demand	150
Five-day biological oxygen demand	50
Oil and grease	10
Arsenic	0.1
Cadmium	0.05
Chromium (hexavalent)	0.1
Copper	0.3
Cyanide (total)	1.0
Cyanide (free)	0.1
Cyanide (weak acid dissociable)	0.5
Iron	2.0
Lead	0.2
Mercury	0.002
Nickel	0.5
Phenols	0.5
Zinc	0.5

Source: (IFC and World Bank Group 2007b)

4.2 CORRECTIVE ACTIONS

Corrective actions will be implemented if downstream water quality exceeds indicates a 10 percent or greater increase in any constituent relative to upstream water quality or any constituent in the downstream water quality exceeds IFC thresholds for effluent discharge (see Table 4.1-1) and the upstream water quality does not exceed those thresholds. The corrective actions should be specified by a qualified hydrologist or hydrogeologist. Prior to implementing any corrective action, the source of the discharge should be identified so that the source may be properly treated. Potential project-related sources of water quality degradation include discharge of sediment to area streams, discharge of oil or grease from leaky equipment, discharge of water from overflow of sumps or mudpits. These effluent sources can be treated with proper best management practices including:

- Properly maintaining all equipment and only maintaining and fueling equipment in designated areas
- Providing secondary containment around the drill rig
- Installing sediment control barriers such as silt fence, straw bales, straw waddles, of functional equivalent along the downstream side of the project area to control erosion
- Controlling site run-on
- Designing mud pits and sumps with sufficient freeboard (1 meter)
- Ensuring proper location and use of toilets
- Proper storage of any hazardous materials
- Proper control of any geothermal fluids encountered to avoid surface water exposure









Government of Saint Lucia

Environmental and Social Management Plan

St. Lucia Renewable Energy Sector Development Project

July 2018

PANORAMA ENVIRONMENTAL, INC.

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Government of Saint Lucia

Environmental and Social Management Plan

St. Lucia Renewable Energy Sector Development Project

July 2018

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Saint Lucia

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EXECUTIVE SUMMARY

ES.1 PROJECT SUMMARY

The Government of Saint Lucia (GoSL) proposes to conduct St. Lucia Renewable Energy Sector Development Project (project) within the Soufrière, Choiseul, and Laborie regions of Saint Lucia to assess the feasibility of commercial development of geothermal resources in Saint Lucia. A pre-feasibility study has identified three potential drilling areas: Belle Plaine, Fond St. Jaques, and Mondesir-Saltibus (see Figure ES.1-1).

The project includes drilling slim-hole wells and potentially full-size geothermal exploration wells to evaluate the feasibility of commercial geothermal development in Saint Lucia. Slim-hole wells would be drilled first. Slim-hole wells (3.78-inch bottom hole diameter) typically require less capital investment and cause less environmental and social impact than deep full-sized wells because they are drilled with smaller drill rigs on smaller well pads, drilling takes less time, and less fluid is produced. The project would include the following activities and components:

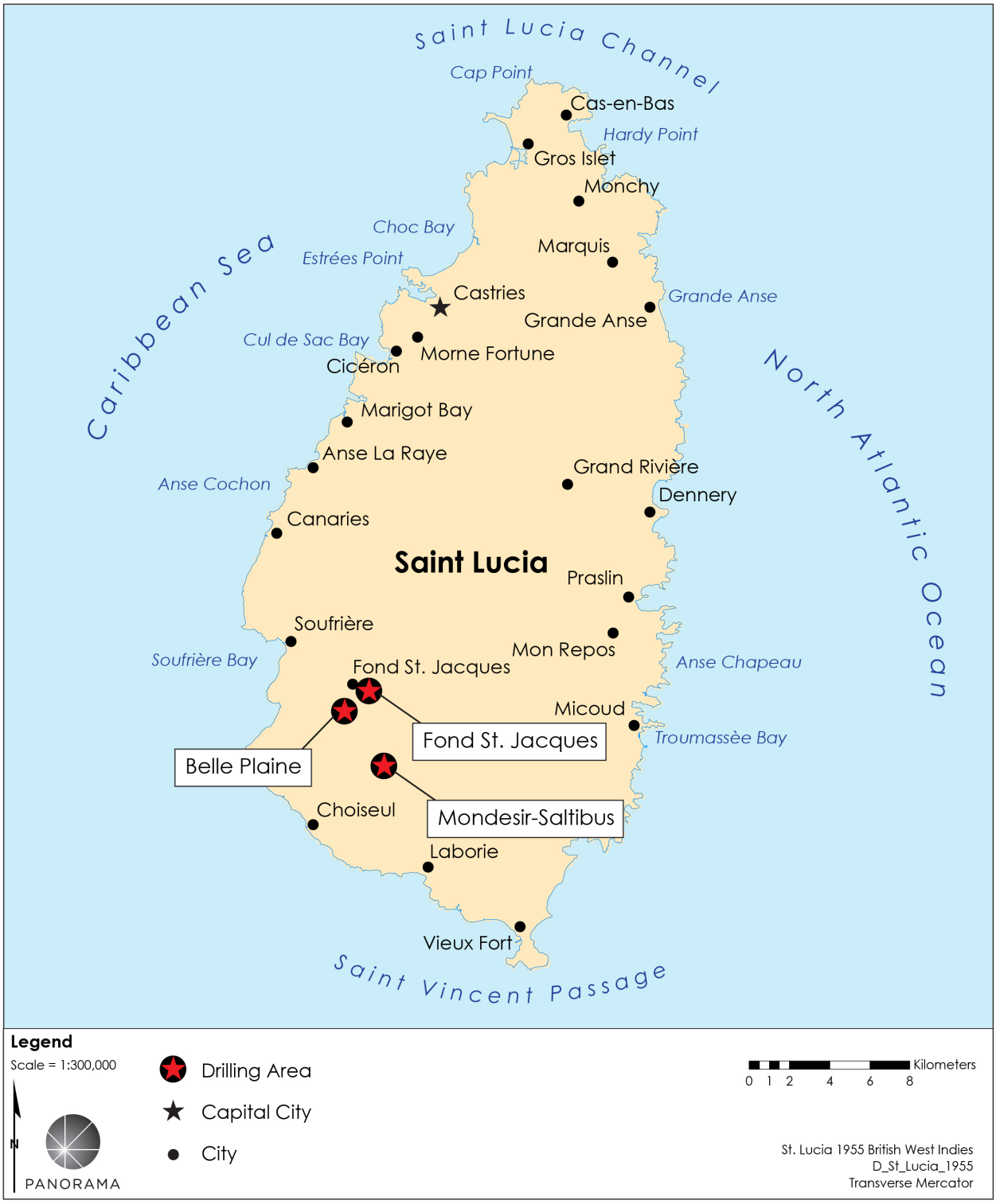
- Civil works and site development at three potential drilling areas
- Drilling up to four slim-holes and up to two full-size wells
- Well testing
- Well abandonment and site reclamation

ES. 2 ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS

Panorama Environmental, Inc. has completed a Scoping Studies Report to define the baseline environmental and socio-economic conditions in the potential drilling areas. The drilling sites are characterized as non-native habitats and agricultural land use. There is limited flat land available for drilling in the Fond St. Jacques area and two of the Mondesir-Saltibus sites (MS-3 and MS-4). Residential communities are also located in close proximity to the drilling areas in Fond St. Jacques and MS-3 and MS-4 making these areas only suitable for slimhole wells rather than full-size geothermal exploration wells.

The Belle Plaine and Mondesir-Saltibus drilling sites are currently used for agricultural development. The Belle Plaine and Fond St. Jacques areas are primary owned by families. The Mondesir-Saltibus area is primarily government owned land that is leased to farmers.

Figure ES.1-1 Project Location



Sources: (ESRI 2017, Jan Kindsay 2002)

ES. 3 KEY FINDINGS OF STAKEHOLDER ENGAGEMNT

During the ESIA scoping process, Panorama Environmental, Inc and the Department of Sustainable Development held consultation meetings with governmental agencies and local stakeholder representatives. Ministers provided comments that generally reflected issues related to previous geothermal exploration in Saint Lucia. Physical Planning agency expressed concerns about the topics covered in the ESIA. Tourism and Broadcasting agency expressed concerns about the potential impacts of drilling activities have on local tourism businesses. Local stakeholder representatives' comments generally reflect environmental issues related to geothermal development, and recommended developing education programs for local residents.

ES. 4 KEY MITIGATION MEASURES

The ESIA has identified mitigation measures to reduce and avoid impacts associated with the project. A summary of the ESIA mitigation measures is listed in This ESMP defines:

- Procedures for implementation of the mitigation measures in the ESIA
- Roles and responsibilities for mitigation implementation and reporting
- Costs for mitigation
- Institutional structure for oversight and management of the mitigation
- Capacity building requirements

ES. 5 ESMP ORGANIZATION

This ESMP is organized as follows:

- **Chapter 1: Introduction**. Provides an overview of the ESMP, background, and the proposed project
- **Chapter 2: Mitigation Management and Monitoring Plan**. Includes the detailed mitigation measures, roles and responsibilities for implementing the measures, and reporting procedures.
- **Chapter 3: Roles and Responsibilities**. Outlines the roles and responsibilities of parties involved with direct implementation of mitigation measures or implementation oversight.
- **Chapter 4: Implementation and Verification Procedures**. Defines implementation phases and describes documentation procedures for implementing mitigation measures.
- **Chapter 5: Institutional Structure and Capacity Building**. Defines the institutional structure and capacity for the PCU and key actions for capacity building.

Table ES.4-1 Summary of Mitigation Measures

~~Table ES.4–1~~**Error! Reference source not found.**. This ESMP defines:

- Procedures for implementation of the mitigation measures in the ESIA
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Table ES.4-1 Summary of Mitigation Measures

Resource	Mitigation Measures
Water Resources	Water-1: Stormwater, Erosion, and Sediment Control Water-2: Water Quality Monitoring Program Water-3: Drilling Waste and Effluent Management Water-4: Blowout Prevention Water-5: Water Supply System Protection Water-6: Water Extraction Strategy
Air Quality	Air-1: Fugitive Dust Management Air-2: Construction Emissions Controls Air-3: Air Quality Monitoring and Noxious Gas Management
Geology and Soils	Soils-1: Topsoil Preservation and Restoration Soils-2: Geotechnical Investigation
Noise	Noise-1: Noise Abatement and Community Coordination
	Noise-2: Vibration
Natural Habitats and Biodiversity	Biodiversity-1: Pre-Construction Surveys is MS-3 and MS-4 Biodiversity-2: Invasive Weed Control Biodiversity-3: Nesting Bird Avoidance and Impact Minimization
Archaeological and Cultural Resources	Cultural-1: Archaeological Testing or Monitoring Cultural 2: Pre-Construction Surveys in MS-3 and MS-4 Cultural 3: Worker Cultural Resources Sensitivity Training
Landscape and Visual Character	Landscape-1: Site Reclamation and Restoration
Traffic Circulation and Safety	Traffic-1: Traffic Control Traffic-2: Road Hazard Avoidance
Utilities and Communication Systems	Utilities-1: Protect Overhead Utility Lines
Hazards and Hazardous Materials	Hazards-1: Hazardous Materials Management Plan
Fires	Fires-1: Fire Prevention and Response
Solid Waste	Waste-1: Waste Management Plan
Livelihoods	Social-1: Compensation for Loss of Agricultural Production
Working Conditions and Equality	Social-2: Working Conditions and Equality Social-3: Community Engagement and Sensitivity
Recreation	Social-4: Recreation
Worker Health and Safety	Safety-1: Health and Safety Plan Safety-2: Personal Protection Equipment Safety-3: First Aid and Emergency Response Equipment
Community Health and Safety	Safety-4: Community Safety

1 INTRODUCTION

1.1 PURPOSE

The Government of Saint Lucia (GoSL) proposes to conduct the St. Lucia Renewable Energy Sector Development Project (project) within the Soufrière, Choiseul, and Laborie regions of Saint Lucia to assess the feasibility of commercial development of geothermal resources in Saint Lucia. This purpose of this Environmental and Social Management Plan (ESMP) is to detail:

1. The measures to be taken during the implementation and closure of the project to eliminate or offset adverse environmental and social impacts, or to reduce them to acceptable levels
2. The actions needed to implement these measures during the construction, operation and closure of the proposed project.

This ESMP has been prepared consistent with World Bank guidance specified in the draft *World Bank Environmental and Social Framework* (World Bank 2017).

1.2 BACKGROUND

The GoSL has obtained financial assistance and technical support from a number of development partners in support of the project. To date, the World Bank has assisted Saint Lucia in accessing grant financing from the Global Environmental Facility and the SIDS DOCK Support Program for the project. Technical assistance has also been received from the Government of New Zealand and the Clinton Climate Initiative. This ESMP has been prepared to address World Bank requirements for mitigation implementation including monitoring and reporting during implementation of the project.

1.3 ESMP CONTENTS

The ESMP includes the following:

- Mitigation measures from the ESIA
- Roles and responsibilities for implementation of the mitigation measures by the GoSL, civil works contractor, and drilling contractor
- Procedures for implementing mitigation measures, including the required timing of mitigation implementation
- Procedures for routinely verifying, documenting, and reporting implementation of the ESMP
- Capacity building requirements
- Costs for implementing mitigation measures and the ESMP

1.4 PROJECT SUMMARY

1.4.1 Project Location

The project is located in the Soufrière, Choiseul, and Laborie districts of Saint Lucia. The project includes geothermal exploration drilling on well pads in the following areas shown on **Error! Reference source not found.**~~Figure 1.4-1~~:

- Belle Plaine
- Mondesir-Saltibus (MS-1, MS-2, MS-3, and MS-4)
- Fond St. Jacques (east and west)

1.4.2 Project Activities

The proposed project includes drilling slim-hole wells and potentially full-size geothermal exploration wells to evaluate the feasibility of commercial geothermal development in Saint Lucia. Slim-hole wells would be drilled first. Slim-hole wells (3.78-inch bottom hole diameter) typically require less capital investment and cause less environmental and social impact than deep full-sized wells because they are drilled with smaller drill rigs on smaller well pads, drilling takes less time, and less fluid is produced. An exploratory drilling program using slim-hole wells is a cost-effective method for geothermal exploration.

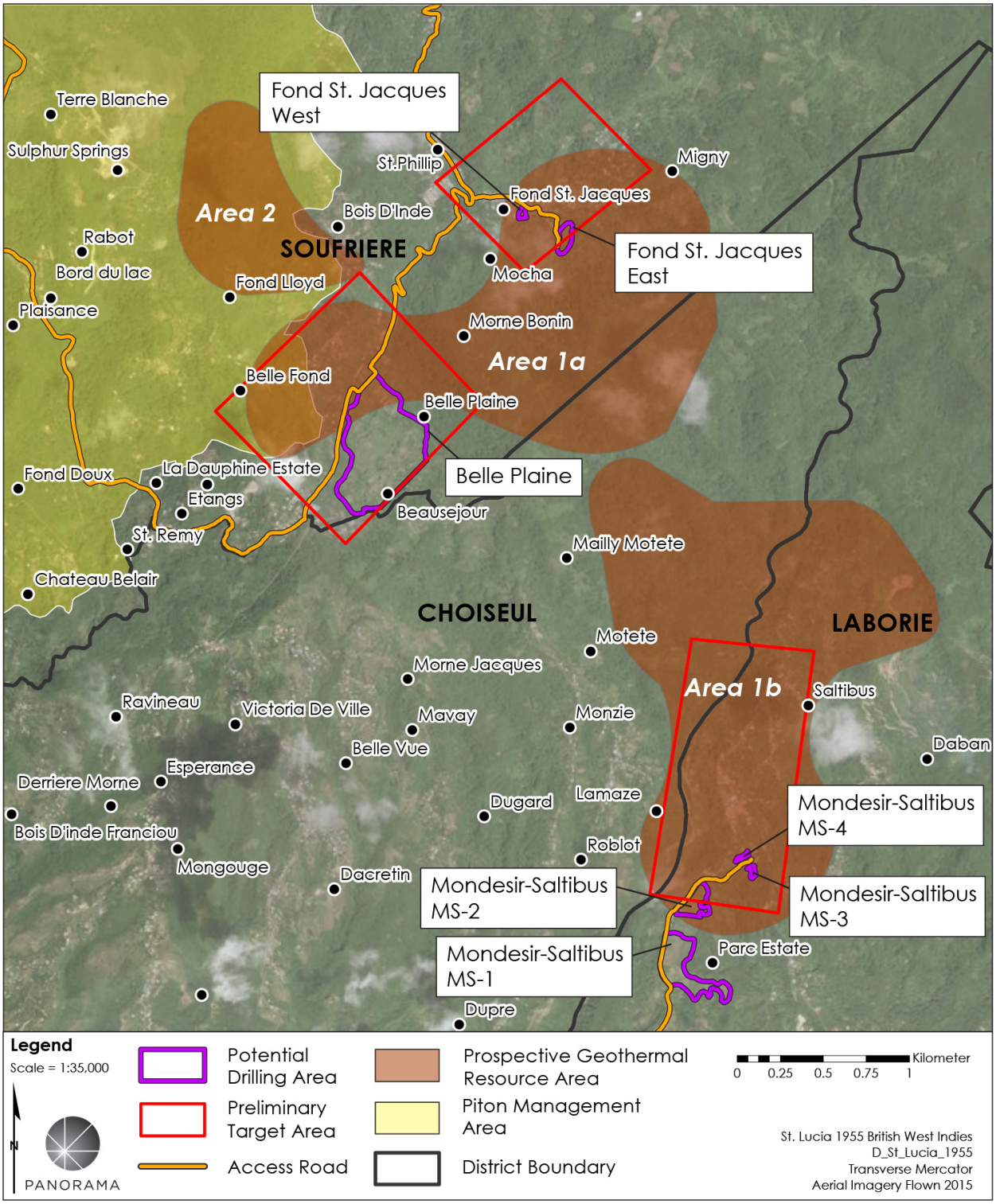
Full-sized (7-inch+ bottom hole diameter) geothermal exploration wells may be drilled in Belle Plaine or Mondesir-Saltibus (MS-1 or MS-2) if the slim-hole drilling results suggest the presence of a commercial geothermal resource.

The project address the possibility of drilling full-sized wells in addition to slim-hole wells to provide a range of options for the exploratory drilling program. The feasibility of drilling full-sized wells would depend on the results of slim-hole drilling, access to funds, access to sufficient workspace, and the presence or absence of environmental resources and receptors that may be impacted.

The project would include the following activities and components:

- Civil works and site development at three potential drilling areas
- Drilling up to four slim-holes and up to two full-size wells
- Well testing
- Well abandonment and site reclamation

Figure 1.4-1 Potential Drilling Areas



Sources: (Jacobs New Zealand Limited 2016, GeothermEx and Power Engineers 2017)

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2 MITIGATION MANAGEMENT PLAN

2.1 OVERVIEW

The purpose of the Mitigation Management Plan is to identify mitigation measures to reduce impacts from the project, describe the roles of participating parties and key personnel responsible for implementation the mitigation measures, and identify procedures to ensure that the mitigation measures are implemented adequately during all phases of construction.

Mitigation measures for the project are identified in **Error! Reference source not found.**~~Table 2.2-2~~. Parties responsible for implementing or overseeing implementation of mitigation measures, as well as their roles and responsibilities, are described in Section 3. Implementation and verification procedures are described in Section 4.

2.2 MITIGATION MEASURES

2.2.1 Detailed Mitigation Measures with Responsibilities

Table 2.2-1 lists the detailed mitigation measures, the impact that the mitigation measure is addressing, the party that is responsible for implementing the measures, and the timing of implementation. These parties include the civil contractor, drilling contractor, GoSL, and GCC.

Table 2.2-1 Detailed Mitigation Measures with Responsibilities

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	Environmental Mitigation Measures - Water Resources			
• Water Quality • Erosion and Topsoil Loss • Landslides and Mudflows	**Water-1: Stormwater, Erosion, and Sediment Control** At least 30 days prior to construction, the contractor shall prepare a sediment and erosion control plan for GoSL review that details the procedures for sediment and erosion control, best management practices (BMPs) that would be applied to the site including the location of all BMPs, and procedures for monitoring and maintenance of all BMPs. The sediment and erosion control plan shall include procedures for implementation of sediment and erosion control following industry standards as provided in Erosion and Sedimentation Control: Best Management Practices Manual, December 2016, Department of Transportation of Montana. BMPs and drainage systems shall be designed to accommodate rapid rainfall events that can be expected in the region. The following procedures shall be described in further detail in the sediment and erosion control plan and implemented to prevent soil loss, erosion, and sediment transport in project areas: • Project activities shall be scheduled to avoid the heaviest rain season, to the extent possible. • Soil disturbance shall be limited to the minimum amount necessary. • All disturbed areas shall be stabilized as soon as possible (i.e., covered,	• No visible erosion or sedimentation is caused by the project. • Pipelines are maintained free of leaks. • Stormwater flows are directed away from hazardous material storage areas.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	compacted, or secured with BMP materials). • Project traffic shall be restricted to designated areas. • Pipelines shall be monitored for leaks and any leaks shall be repaired immediately. • Sediment shall be controlled and prevented from leaving disturbed project areas. All BMPs shall be properly inspected and maintained on a frequent basis to ensure they are functioning properly.			
• Water Quality	**Water-2: Water Quality Monitoring Program** The drilling contractor shall implement a water quality monitoring program to ensure the project does not cause or substantially contribute to a condition that exceeds acceptable water quality standards. Water quality sampling, as described in Appendix F: Water Resources Sampling and Monitoring Plan to the Scoping Studies Report (Appendix C) shall occur prior to the start of project activities to determine the baseline contaminant levels, and then every few weeks during project activities in the area, in order to determine if the project is reducing water quality. Samples shall be taken upstream and downstream in potentially affected waterways. If it is determined that the project is reducing water quality, the drilling contractor shall make the appropriate adjustments to the construction activities to correct the problem. If the water supply becomes unsafe to drink, safe water shall be supplied to the affected	• Water quality is analyzed for the constituents listed. • Water quality is disclosed to workers and worker exposure is minimized or avoided. • Geothermal fluid is discharged to a reserve pit or tank.	• Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	communities and workers. Water quality monitoring and any necessary supplemental water supply shall continue until the water conditions are safe and returned to pre-project conditions. A Draft Water Quality Monitoring Program is provided in Appendix F of the Scoping Studies Report. In the unlikely event that water quality is impacted for a long-term basis (longer than project activities are occurring), long-term water treatment and/or supply systems shall be installed that provide safe water to those affected at pre-project constituent and flow levels, while also considering seasonal fluctuations.			
• Water Quality • Hazardous Materials	**Water-3: Drilling Waste and Effluent Management** The drilling contractor shall incorporate specific procedures for managing drilling waste and effluent into the Hazardous Materials Management Plan and the Waste Management Plan. All drilling muds, fluids, and cuttings shall be tested for water quality parameters before discharging such fluids into the environment or disposing the materials into landfills, to ensure contaminant levels in waste water do not exceed acceptable standards and are disposed of properly in accordance with the Waste Management Plan. Water quality parameters that may be sampled include: pH, Temperature, Boron, Bicarbonate, Calcium, Chloride, Sulfide, Iron*, Fluoride, Copper, Cadmium, Mercury, Lead, Chromium (hexavalent* and total), Nickel, Arsenic, Vanadium, and Silver. Geothermal fluid shall also be tested for the following	• Drilling muds and fluids are contained in storage tank or reserve pits. • Drilling mud with foams is contained and protected from wind transport. • Hazardous materials are properly contained. • A Hazardous Materials Storage, Disposal and Spill Containment Plan is prepared by the contractors prior to construction.	• Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	radiological elements: Radium 226/228 (combined), gross alpha (adjusted), and uranium. Fluid that exceeds acceptable standards shall be contained and/or disposed of in accordance with applicable laws and policies. Note: Elements marked with an asterisk (*) require testing within 24 hours due to short hold times. If it is not feasible to transport the samples to a certified lab within the specified hold times, testing shall be conducted on site. Reserve pits for drilling materials shall be maintained in proper functioning order with a minimum of 0.5 meter (1.6 feet) of freeboard at all times. If foams are applied to the drilling fluid, the drilling contractor shall cover any reserve pits containing drilling cuttings or line the downwind perimeter of the reserve pits with hay bales or equivalent to prevent the foam from being transported offsite via wind. Drilling fluids, mud, and spoils shall be stored in either storage tanks or reserve pits adjacent to the wells. Drilling fluids shall be reused to the extent feasible to conserve freshwater.			
• Water Quality • Geothermal Emissions • Hazards	**Water-4: Blowout Prevention** All drill rigs used during the exploration program shall be equipped with blowout prevention (BOP) equipment to prevent blowout if the geothermal resource is encountered. The GoSL shall require that the drilling contractor or the drilling supervisor have experience in geothermal drilling. Drillers shall	• Blowouts equipment is available at drilling sites. • A Well Blowout Prevention and Containment Plan is prepared by contractors.	• PCU • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	receive proper training for response to blowouts, should one occur. The drilling contractor shall prepare and implement a Well Blowout Prevention and Containment Plan. At a minimum, the plan shall address the following: • Proper use of BOP equipment that meets industry standards • Specific procedures for preventing and controlling an incidental blowout, such as using a blowout preventer stack and stocking material for quelling the blowout • Training requirements for all workers that may be exposed to a well blowout • Staffing requirements to ensure qualified individual(s) who are certified in well control and blowout response are present during all drilling operations • Blowout documentation and cleanup procedures			
• Water Supply	**Water-5: Water Supply System Protection** Public and private water supply systems (i.e., pipes, intakes, tanks, and ditches) shall be identified and marked for avoidance prior to initiating project activities that could damage such systems. If water supply systems are inadvertently damaged, they shall be repaired immediately. Water shall be supplied to the affected community members if the water supply is interrupted. The PCU will consider the community benefit of leaving water supply systems that are developed for the project (i.e., pipes, intakes, tanks, and wells) after exploration drilling is complete.	• Water supply systems are marked for avoidance.	• PCU • Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction • After Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
• Water Supply	**Water-6: Water Extraction Strategy** The drilling contractor, in conjunction with the PCU, shall develop a strategy for obtaining water that does not disrupt the water supply for domestic and agricultural users. Water extraction for the project, including the locations of water pipelines and tanks, shall not deplete water reserves below levels that are required to supply the community. The PCU and drilling contractor shall consult with Water and Sewerage Company of Saint Lucia (WASCO) and Water Resource Management Agency (WRMA) of Saint Lucia to ensure communities are supplied with adequate water during extraction. Where water is extracted from rivers, the project intake systems shall be designed to limit impacts on sensitive aquatic habitat and wildlife, and screen barriers shall be installed to prevent impingement and entrapment of wildlife. Intake areas and potential hazards where pipelines cross roadways shall be clearly marked with signs and/or flagging.	• The PCU coordinates with drilling contractor to develop a strategy for water extraction.	• PCU • Drilling Contractor	• Before Construction • During Construction
	Environmental Mitigation Measures - Air Quality			
• Air Quality	**Air-1: Fugitive Dust Management** The following procedures shall be implemented where dry exposed soils are located in project areas: • Water shall be applied to active construction areas to prevent visible dust, to the extent that water is readily available. Water shall not be over applied so that it creates runoff that leaves the site. As an alternative to	• Water application is implemented during ground disturbance and stabilizing disturbed areas.	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	water, chemical stabilizers or surfactants may be applied to disturbed areas, being careful to not allow overspray on nearby vegetation. • Vehicle speeds shall not exceed 25 kilometers (15 miles) per hour on unpaved surfaces. • Inactive areas shall be covered or otherwise stabilized to reduce the potential for wind transporting dust. Disturbed areas shall be stabilized and restored once project activities are completed.			
• Air Quality	**Air-2: Construction Emissions Controls** The construction contractors shall be responsible for ensuring all vehicles and equipment are properly operated and maintained according the manufacturer's specifications, and equipped with appropriate emission control devices (i.e., catalytic converters, etc.). Malfunctioning equipment shall be repaired immediately or removed from the site.	• All vehicles and equipment are equipped with appropriate emission control devise.	• Civil Works Contractor • Drilling Contractor	• During Construction
• Worker Health and Safety • Community Health and Safety	**Air-3: Air Quality Monitoring and Noxious Gas Management** The drilling contractor shall be responsible for managing risks to workers and local communities from potentially harmful geothermal gas emissions (e.g., hydrogen sulphide, carbon dioxide, boron, arsenic, mercury, and bicarbonate) during well drilling and testing. At a minimum, the following procedures shall be implemented during drilling and testing activities:	• Gas monitoring devices area installed and operating at each well. • Respiratory equipment is available at drill rigs. • Workers are trained on risk of hydrogen sulfide exposure.	• Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	• Well drilling or testing that could cause the release of potentially harmful geothermal gases shall not occur where the public could be put at undue risk. An appropriate geothermal gas hazard zone shall be established around well sites based on the risk of gas release from the drilling and testing activities that would occur. The hazard zone shall be marked with signs and communicated to the local community members. If occupied structures would be located within a hazard zone, the drilling site must be relocated or drilling activities shall be limited to techniques that would not release unsafe levels of geothermal gases, such as surface coring. • Minimize the potential for gas release by using properly weighted drilling mud to keep the well from flowing or by implementing other well head abatement measures. • Install gas detection and monitoring devices during well drilling and testing activities, that are equipped with alarms that would be trigged if gas concentrations reach unsafe levels. • Autonomous respiratory equipment shall be provided in enclosed areas of the drill rig. • The Health and Safety Plan shall specify safety procedures for potential exposure to geothermal gases and emergency response. The drilling contractor shall implement an air quality monitoring program to monitor air			

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	quality during well drilling and testing for signs of unsafe levels of potentially harmful geothermal gases using automated detection and alarm systems. If unsafe gas levels are detected, the area shall be evacuated and properly trained workers wearing appropriate PPE shall attempt to stop the release by injecting hydrogen peroxide, capping the well, or another suitable method.			
	Environmental Mitigation Measures - Geology and Soils			
• Topsoil Loss	**Soils-1: Topsoil Preservation and Restoration** Where grading occurs within farmland, topsoil shall be separated and stockpiled during the construction period. The topsoil stockpile shall be secured with plastic and BMP materials. Following construction, the topsoil shall be applied evenly to the site during the restoration process. The topsoil shall be properly compacted and stabilized to prevent erosion and sediment transport.	• Topsoil stockpile is secured with plastic and BMP materials.	• Civil Works Contractor	• Before Construction • During Construction
• Unstable Slopes and Saturated Soils	**Soils-2: Geotechnical Investigation** The civil works contractor shall complete a geotechnical investigation prior to initiating civil works activities for access road expansion or well pad construction in Fond St. Jacques. The contractor shall implement all recommendations contained in the geotechnical investigation.	• Contractors complete geotechnical investigation prior to initiating civil works activities.	• Civil Works Contractor	• Before Construction • During Construction
	Environmental Mitigation Measures - Noise			
• Noise	**Noise-1: Noise Abatement and Community Coordination**	• Construction activities are limited in day hours.	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	Construction noise and the associated effects shall be reduced or minimized, to the extent possible, by implementing the following procedures: • Select quieter equipment and construction activities, whenever feasible; • Ensure motorized vehicles and equipment are equipped with the greatest possible noise reduction parts, such as mufflers, silencers, insulators, and enclosures; • Locate access roads and well pads as far from sensitive receptors as feasible; • Limit civil work activities to daytime hours (7:00 to 18:00), to the extent feasible; • Avoid civil works during sensitive morning, evening, and nighttime periods, to the extent feasible; • Notify and coordinate with residents adjacent to project areas prior to construction to inform them of the possibility of temporary noise disruption, and how to report noise complaints; • Install acoustic barriers between stationary equipment and sensitive receptors located within 300 meters (1,000 feet); • Use a rock muffler or other effective, industry standard silencer during well testing; • Notify community members at least 24 hours prior to conducting well tests; • Implement a Noise Complaint Program to record and respond to noise complaints during construction.	• Constructors inform residents of temporary noise disruption prior to construction. • Contractors implement noise abatement strategies to minimize construction noise.	• Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
• Vibration	**Noise-2: Vibration** Structures within 100 feet of drilling activities will be documented with photographs prior to construction and after the completion of drilling to assess and record any pre-construction cracking and any post-drilling cracking. If any structural damage as evidenced by new post-drilling cracking is documented during the photo survey that could have been caused by the drilling activity, homeowners will be compensated to repair the damage that was incurred as a result of the project.	• Contractors document structures with photographs before and after drilling activities to record possible structural damages.	• Drilling Contractor	• Before Construction • After Construction
	Environmental Mitigation Measures - Natural Habitats and Biodiversity			
• Biodiversity	**Biodiversity-1: Pre-Construction Surveys in MS-3 and MS-4** The GoSL shall conduct surveys for rare plants and priority or endemic wildlife species prior to civil work activities in MS-3 and MS-4. If any rare plants or sensitive wildlife species occur in the drilling area, the sensitive resource shall be fenced and no activities will be allowed within 15 meters (50 feet) of the resource.	• The PCU conducts pre-construction rare plants or sensitive wildlife species surveys.	• PCU	• Before Construction
• Natural Habitats	**Biodiversity-2: Invasive Weed Control** All equipment shall arrive at the work site clean and free of caked mud and plant material. Any weeds encountered in the work area during post-construction site restoration monitoring shall be removed using mechanical equipment or by hand. No herbicides shall be applied to the site.	• Constructors clean all equipment before entering work site	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
• Nesting Birds	**Biodiversity-3: Nesting Bird Avoidance and Impact Minimization** Well drilling activities shall be scheduled outside of the prime bird nesting season (April to June) to the extent feasible. If well drilling occurs during the prime nesting bird season, well pads shall be positioned at least 75 meters (250 feet) from the forested areas where suitable nesting habitat for priority bird species may be located. Prior to well drilling during the nesting season, a qualified biologist shall survey potentially suitable nesting habitat for priority species birds. If active nests are identified, a qualified biologist shall monitor the nesting birds responses to the loudest level of construction noise for an appropriate duration. If the nesting birds show signs of disturbance that could result in nest failure, all work activities that disturb the birds shall be temporarily halted and visual and acoustic barriers shall be erected between the nesting location and work areas. Installation of any visual and acoustic barriers shall be overseen and approved by the qualified biologist.	• Contractors conduct nesting birds survey prior to well drilling. • Contractors avoid well drilling activities during the nesting bird season. • Visual and acoustic barriers are installed to minimize impacts on nesting birds.	• Civil Works Contractor • Drilling Contractor	• Before Construction
	Environmental Mitigation Measures - Archaeological and Cultural Resources			
• Archeological and Cultural Resources	**Cultural-1: Archaeological Testing or Monitoring** The contractor shall either conduct subsurface archaeological testing prior to grading and earthwork. If the results of the subsurface testing indicate the presence of subsurface archaeological resources, archaeological monitoring shall be conducted during grading and earthwork in the drilling area. In the event of an	• Contractors conduct archaeological testing prior to grading and earthwork. • Qualified archeological monitor presents during grading activities when necessary.	• Civil Works Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	unanticipated discovery of an archaeological resource in any area where archaeological monitoring is not being conducted, work within 15 meters of the resource will halt, and an archeological monitor will be contacted to investigate the find. The procedures for site evaluation defined under archaeological monitoring below will be followed for any unanticipated discovery of archaeological resources. *Archaeological Testing*. Prior to ground disturbing activities in Belle Plaine and Mondesir-Saltibus, a qualified archeologist shall conduct subsurface archaeological testing, site recording, and artifact recovery in previously undisturbed areas that would be significant impacted by project activities (e.g., grading deeper than 6 inches and drilling). The testing shall include a series of 50 cm shovel test pits at 10-meter (30-foot) intervals within the immediate areas that would be affected. *Archaeological Monitoring*. During grading activities in Belle Plaine and Mondesir-Saltibus that are greater than 6 inches in depth, a qualified archeological monitor shall be present. The archeological monitor shall observe grading activities and collect any artifacts that may be unsurfaced. If the archeological monitor determines that a sensitive archeological site may be present, work shall be redirected until the site can be evaluated for its significance. If the site is determined to be significant or if the site evaluation efforts would be extensive, project areas that pose a risk to the site may be relocated away from the site			

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	to avoid potential delays to project activities. Alternatively, special protection measures may be implemented to continue project activities while preserving possible site features, as determined appropriate by the archeological monitor.			
• Archeological and Cultural Resources	**Cultural-2: Pre-Construction Surveys in MS-3 and MS-4** The GoSL shall conduct surveys for archeological and cultural resources prior to civil work activities in MS-3 and MS-4. If any sensitive resources are identified, the resources shall be evaluated to determine appropriate treatment or avoidance procedures. If the sites contain resources or if inadvertent discoveries are made during construction, the testing and monitoring provisions detailed in Cultural-1 shall be implemented, as determined necessary by the archeologist and GoSL.	• The PCU conducts archeological and cultural resources surveys prior to civil work activities.	• PCU	• Before Construction
• Archeological and Cultural Resources	**Cultural-3: Worker Cultural Resource Sensitivity Training** Workers shall be properly trained on identifying potential archeological and cultural resources that could be uncovered during construction, including procedures for reporting potential discoveries to the archeological monitor. If potential resources are discovered, they must be left in place or turned over to the archeological monitor for proper record keeping and cataloging.	• Workers receive cultural resource sensitivity training from qualified archeologist.	• PCU	• Before Construction • During Construction
	Environmental Mitigation Measures - Landscape and Visual Character			
• Landscape and Visual Character • Waste	**Landscape-1: Site Reclamation and Restoration**	• All temporary facilities and equipment are removed from the site.	• Drilling Contractor	• After Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	The following reclamation and restoration activities shall be completed following construction: • Prior to construction the contractor shall take photos of the well pad and access roads to document pre-construction conditions. • The contractor shall restore grades on site to match pre-construction conditions. • The proper restoration of the site shall be documented by the contractor in a post-construction report containing pre- and post-construction photos. • The drilling mud treatment facilities and water intake and/or drilling fluid disposal pipes shall be dismantled upon completion of the exploration phase and removed from the project site. • Where applicable, the temporary treatment facilities and pipes for disposal of geothermal fluids produced during the well tests shall be dismantled after completion of the tests and the temporary treatment facilities and pipes shall be removed from the project site. • The drilling fluid and mud reserve pits, and any water supply sumps shall be filled in, and graded to match the surrounding area. • The worker camp and storage area, including all aggregate and materials and any latrines, shall be dismantled and removed from the site. The worker • camp and storage area shall be resurfaced as necessary to match the surrounding area.	• Areas of temporary disturbance have been returned to natural grade and match surrounding conditions.		

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	• Heavily compacted areas should be appropriately de-compacted to facility quicker vegetation regrowth.			
	Environmental Mitigation Measures - Traffic Circulation and Safety			
• Traffic Circulation • Community Health and Safety	**Traffic-1: Traffic Control** Informational signs shall be posted where lane and road closures could substantially disrupt traffic circulation at least 7 days prior to the closure. Proper traffic controls shall be in place during closures to minimize impacts on traffic circulation and for traffic safety, such as signs, flaggers, and temporary barriers. Local traffic laws and speed limits shall be followed at all times. Appropriate safety precautions shall be taken when transporting large equipment on public roadways, such as using a pilot car.	• Information about traffic control is provided in a publicly accessible location near the project.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Community Health and Safety	**Traffic-2: Road Hazard Avoidance** If road work occurs on public roadways, the civil works contractor shall design the modifications in accordance with applicable road and traffic safety laws. The project shall not degrade road safety or create a new road hazard. Any damage to the existing road condition caused by the project shall be repaired. The designs for any road modifications shall be submitted to the GoSL for review and approval prior to conducting the work.	• Contractors avoid road work on public roadways.	• Civil Works Contractor	• Before Construction • During Construction
	Environmental Mitigation Measures - Utilities and Communication Systems			
• Utilities and Communication Systems	**Utilities-1: Protect Overhead Utility Lines** The construction contractors shall identify and mark any overhead utility and	• Overhead utility lines are marked for avoidance.	• Civil Works Contractor	• Before Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	communication lines that hang over access roads and work areas to ensure the lines are not inadvertently damaged during construction. A minimum of 5 feet of clearance shall be maintained between construction equipment and low-hanging lines. If the minimum clearance cannot be maintained, the construction contractors shall work with the applicable system providers to temporarily disconnect or reposition the lines for the duration of construction.		• Drilling Contractor	
	Environmental Mitigation Measures - Hazards and Hazardous Materials			
• Water Quality • Hazardous Materials • Worker Health and Safety • Community Health and Safety	**Hazards-1: Hazardous Materials Management Plan** The construction contractors shall prepare and implement a Hazardous Materials Management Plan. The Hazardous Materials Management shall identify proper management procedures for all hazardous materials and wastes that may be encountered during construction, including handling, labeling, transporting, and storing procedures. In addition, the Hazardous Materials Management Plan shall address the following: • Non-toxic and biodegradable produces will be used whenever possible. • Hazardous materials shall be transported and stored in appropriate containers with clearly visible labels. Hazardous materials shall be stored at least 100 feet from any downgradient drainage or within secondary containment cable of containing its entire volume.	• Hazardous materials are properly contained. • A Hazardous Materials Storage, Disposal and Spill Containment Plan is prepared by the contractor prior to construction.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	• Stormwater flows shall be directed away from hazardous material storage areas. • Equipment and work areas shall be regularly inspected for signs of leaks and spills. Spill containment and cleanup kits shall be available wherever hazardous materials are being used or stored. Any incidental spills or leaks shall be contained and cleaned up as soon as it is safe to do so. Any contaminated soil shall be collected and disposed of in an appropriate land fill. • Equipment refueling and maintenance shall be limited to designated areas at least 30 meters (100 feet) from any downgradient drainage. All workers shall receive training on proper handling and storage of hazardous materials, as well as spill response and cleanup procedures, prior to working on the project site.			
	Environmental Mitigation Measures - Fires			
• Wildfire Ignition	**Fires-1: Fire Prevention and Response** The risk of fires shall be evaluated for each project site based on the activities that would occur, environmental conditions, and presence of ignitable or combustible materials in the area. If the activities pose a risk of igniting a wildfire, appropriate fire prevention and response equipment shall be available at each active site, such as shovels, axes, fire extinguishers, and dedicated water tanks. All workers shall be trained on proper fire prevention and response procedures prior to working on the site.	• Fire prevention equipment is available at drilling sites.	• Civil Works Contractor • Drilling Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	Any smoking on site shall be restricted to barren areas away from ignitable or combustible material. Smoking waste shall be fully extinguished and disposed of appropriately.			
	Environmental Mitigation Measures - Solid Waste			
• Water Quality • Hazardous Materials • Waste	**Waste-1: Waste Management Plan** The construction contractors shall prepare and implement a Waste Management Plan. At a minimum, the plan shall address the sources of waste; waste minimization, reuse, and recycling opportunities; and waste collection, storage, and disposal procedures. The Waste Management Plan should distinguish between solid and liquid waste, as applicable, and include procedures for addressing waste that may be hazardous to health and the environment. In addition, the Waste Management Plan shall address the following: • All food waste shall be contained in covered bins and disposed of on a frequent basis to avoid attracting wildlife. • Trash bins shall be accessible at all locations where waste is generated. • The project area shall be kept clean and free of litter and no litter shall be allowed to disperse to the surrounding area. • Solid waste shall be removed from the site and transported to a municipal landfill. • Waste shall not be dumped or buried in unauthorized areas or burned.	• A Waste Management Plan is prepared by the contractors prior to construction. • Solid waste is properly contained and removed to a landfill. • The area is maintained free of litter and debris. • Latrines are available on site for male and female workers and latrines are kept in a clean condition and meet GoSL requirements for disposal of wastewater.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	• Human waste associated with the worker camp and latrines shall be properly contained and disposed of. The construction contractors shall ensure all workers receive training on proper disposal of all waste prior to working on the project site.			
	Social Mitigation Measures			
• Livelihoods	**Social-1: Agriculture Production** Impacts to active farmland should be avoided to the extent possible. The locations of access roads and well pads should be positioned away from active agricultural areas, as feasible. The limits of all access roads and well pads shall be clearly identified and marked, if necessary, to ensure impacts from ground disturbance are limited to approved properties and work areas. If active farmland cannot be avoided, crops with long maturing periods (i.e., bananas, coconuts, cocoa, avocados, mangoes, and citrus) should be avoided to the greatest extent possible. Where farmland and crops are impacted by the project, farm owners and farmworkers should be compensated for the loss in pay and agriculture production for affected growing seasons in accordance with the Resettlement Action Plan and Resettlement Policy Framework. Male and female farm owners and farmworkers shall be compensated for impacts to agriculture production equally.	• Access road and well pads are modified to avoid new impacts to active farmland.	• Civil Works Contractor • Drilling Contractor	• Before Construction • After Construction
• Working Conditions and Equality	**Social-2: Working Conditions and Equality**	• Local residents are given preference in hiring.	• Civil Works Contractor	• During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	Employment opportunities created by the project shall be equally available to men and women. If locals are hired for construction jobs, job postings and/or notices shall be disseminated that foster participation from women and men. The GoSL shall include a preference for hiring from the project region in the civil works contract. The construction contractors shall provide safe and equal working conditions and comply with the World Bank's social policies regarding age, gender, ethnicity, and religious equality. Workers shall be provided with: • Information on their rights regarding safety and payment prior to working on the site • Gender-specific latrines at each project area that are maintained in a sanitary condition with adequate capacity • Gender-specific sleeping quarters at the worker camp • Clean drinking water at all times • Adequate training for their position Violence, sexual harassment, discrimination, and drug abuse shall not be tolerated. Workers engaging in such activities shall be dismissed immediately. Any concerns and complaints regarding workplace or community harassment shall be addressed with respect and due diligence by a grievance and redress committee designated by the GoSL; women shall be appointed to the grievance and redress committee. Workers and community	• Equal employment opportunities are given to women and men. • Contractors implement the grievance redress procedures defined in this ESMP.	• Drilling Contractor	

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	members who issue concerns or complaints shall be protected from retaliation. Prior to working on the project site, all workers shall receive equality and harassment awareness training, for both workplace and community relations, in conjunction with other social trainings for the project.			
• Working Conditions and Equality • Noise • Community Health and Safety	**Social-3: Community Engagement and Sensitivity** **Pre-construction Meeting.** Prior to the start of construction activities, the PCU shall hold a public meeting for the affected communities to explain the project activities, schedule, possible inconveniences that may be experienced during construction, and safety considerations associated with drilling operations (refer to Health and Safety-4). The affected communities shall be informed of how they can submit complaints about the project should they arise. **Informational Signs.** The PCU shall install an informational sign at the entrance of each project area to inform the public about the project, construction schedule, and important information about health and safety related to project activities, such as evacuation areas in the event of an emergency. The sign shall include procedures and contact information for submitting complaints about the project to the community liaison officer (CLO). **Community Complaints.** Complaints that relate to the requirements set forth in the ESIA shall be recorded and addressed as set forth in the Stakeholder Engagement Plan,	• Information about the project is provided in a publicly accessible location near the project. • Workers receive sensitivity training from local community leaders. • The PCU communicates safety risks to the community.	• PCU • Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	and the underlying issue shall be corrected, to the extent feasible. **Worker Sensitivity Training.** The PCU shall prepare a social and community sensitivity training that would be provided to all workers. The training shall be designed to inform all workers of the local customs, traditions, and community considerations for each area affected by the project. The construction contractors shall be responsible for providing the social and community sensitivity training to all workers prior to initiating work.			
• Recreation	**Social-4: Recreation** Avoid project activities (i.e., drilling, staging, or storing material) in recreational areas such as playing fields where feasible to minimize disruption to the communities in the drilling areas. Any use of recreational fields for material staging shall be coordinated with the community.	• Contractors avoid project activities in recreational areas.	• Civil Works Contractor • Drilling Contractor	• During Construction
	Health and Safety Mitigation Measures			
• Fires • Worker Health and Safety • Community Health and Safety	**Safety-1: Health and Safety Plan** The construction contractors shall prepare and implement a Health and Safety Plan that addresses the applicable risks and prevention procedures applicable to each contractor's work. At a minimum, the Health and Safety Plan shall address hazards that may be encountered during construction, including prevention and response procedures, for the following topics: • General occupational hazards that may be encountered (e.g., moving machinery and motorized equipment,	• Health and Safety Plan is prepared to the approval of the GoSL and the PCU. • Contractors implement the Health and Safety Plan and address health and safety risks for workers.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	working at heights or in confined spaces, repetitive motions, falling objects, exposure to heat, loud noises, and hazardous materials, protective clothing); • Unique occupational hazards associated with drilling activities (e.g., exposure to potentially harmful geothermal gases, hot geothermal fluids and drilling materials, and hazards associated with a potential well blowout); • Minimum training requirements for operating vehicles, equipment, and machinery, in accordance with applicable laws and industry standards; • Fire prevention and response procedures, including compliance with the with relevant policies in the GoSL's Wildfire Management Plan; • Natural hazards that may be experienced during construction (e.g., hurricanes and tropical storms, landslides, earthquakes, volcanic eruptions, and flooding), including designated response procedures and evacuation areas for each project area that are consistent with the GoSL's natural hazards and emergency response plans; • Biological hazards in the environment (e.g., dangerous or infectious insects, animals, and plants); • Disease risk and prevention (i.e., HIV/AIDs, etc.);			

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	• Community safety considerations (e.g., traffic, harmful geothermal gases, and unsafe areas); • Emergency preparedness and response procedures, including the locations of hospitals and medical services in the region in the event of an injury or medical emergency. The construction contractors shall provide all workers with training on the contents of the Health and Safety Plan prior to working on the site. Refresher trainings shall be given on an occasional basis and before beginning work in new project areas.			
• Worker Health and Safety	**Safety-2: Personal Protective Equipment** The construction contractors shall supply all workers with personal protective equipment (PPE), and ensure workers use the proper PPE during all work activities. At a minimum, PPE for workers shall include: • Safety headgear • Steel toed boots • Safety glasses or impact-resistant eye protection • Ear protective devices • Harnesses for workers operating at heights • Respirators • Gloves • High visibility clothing or vests • Other specialized protective equipment for the drilling, welding, etc. All PPE shall be properly fitted for each worker, including body size and gender, and	• Workers are supplied with PPE and trained in the proper use of PPE appropriate to their job.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	workers shall be trained in the proper use of PPE, prior to working on the project site.			
• Worker Health and Safety	**Safety-3: First Aid and Emergency Response Equipment** The construction contractors shall provide first aid training to all workers prior to working on the project. The construction contractors shall ensure all project sites are equipped with first aid and emergency response equipment. The drilling contractor shall ensure that adequate safety equipment is located at drilling sites and maintained in good working order, such as firefighting equipment, protective suits, respirators, and other breathing apparatuses.	• All employees are trained in first-aid and accident and emergency response. • Emergency medical equipment is available on site. • Emergency medical technician is hired by the contractor and is available on the site.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction
• Community Health and Safety	**Safety-4: Community Safety** Communities that may be exposed to hazards from drilling activities (communities within 500 meters of well pads) shall be informed of the risks and provided information regarding emergency preparedness and response. If and where necessary at drilling areas, alarms shall be installed for major emergencies that could require evacuation, such as a well blowout or geothermal gas emission. Evacuation procedures during an alarm shall be communicated to community members during the Pre-construction Information Meeting and on applicable display panels (refer to Social-3). The construction contractors shall install temporary signs and fences around all unsafe areas to prevent members of the public from entering the areas. If installing	• Information signs are installed around unsafe areas. • Contractors plan for safe evacuation in the event of a volcanic eruption or emergency is included in the EHS Plan.	• Civil Works Contractor • Drilling Contractor	• Before Construction • During Construction

Issues/Potential Impacts	Mitigation Measure	Key Performance Indicators	Responsible for Implementing	Timing of Implementation
	fences is not feasible, the area shall be clearly identified as unsafe with signs and flagging.			

2.2.2 Mitigation Plans

Table 2.2-2 includes a list of the required mitigation plans described in the detailed mitigation measures listed in Error! Reference source not found.~~Table 2.2-1~~. The contractor responsible for preparing each plan is specified.

Table 2.2-2 Mitigation Plans

Mitigation Plan	Mitigation Measure	Applicable to Contractor?	
		Civil	Drilling
EHS Plan	Safety-1 Health and Safety Plan	Yes	Yes
	Other measures with ESH requirements (to address in EHS Plan)		
	Water-4; Blowout Prevention		Yes
	Air-3: Air Quality Monitoring and Noxious Gas Management		Yes
	Hazards-1: Hazardous Materials Management Plan	Yes	Yes
	Fires-1: Fire Prevention and Response	Yes	Yes
	Waste-1: Waste Management Plan	Yes	Yes
	Safety-2: Personal Protection Equipment	Yes	Yes
	Safety-3: First Aid and Emergency Response Equipment	Yes	Yes
	Safety-4: Community Safety	Yes	Yes
Water Quality Monitoring Program	Water-2: Water Quality Monitoring Program		Yes
Water Extraction Strategy	Water 6: Water Extraction Strategy		Yes
Hazardous Materials Management Plan	Hazards-1: Hazardous Materials Management Plan	Yes	Yes
	Water-3: Drilling Waste and Effluent Management		Yes
Waste Management Plan	Waste-1: Waste Management Plan	Yes	Yes
	Water-3: Drilling Waste and Effluent Management		

2.2.3 ESMP Implementation Cost

Error! Reference source not found.~~Table 2.2-3~~ defines the estimated costs for implementation of the mitigation measures included in this ESMP.

Table 2.2-3 ESMP Implementation Costs

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
Mitigation Measures						
Water-1: Stormwater, Erosion, and Sediment Control	• Implement water quality procedures to prevent soil loss	• Install BMPs at start of civil works • Quarterly maintenance • Weekly inspection	$1,500	$8,000	$5,000	**$14,500**
Water-2: Water Quality Monitoring Program	• Water quality testing and analysis before and during construction	• Assume monthly water quality testing and analysis in each area prior to and during drilling			$10,000	**$10,000**
Water-3: Drilling Waste and Effluent Management	• Testing of drilling cuttings at each site	• Assumes analysis of up to 6 wells			$12,000	**$12,000**
Water-4: Blowout Prevention	• Use blow-out preventers	• Blow-out preventers on each well ($2,000 per well)			$12,000	**$12,000**
Water-5: Water Supply System Protection	• Repair water supply systems when damages are made	Not anticipated				**$0**
Water-6: Water Extraction Strategy	• Water supply	• 50 units at $500/unit			$25,000	**$25,000**
Air-1: Fugitive Dust Management	• Prevent fugitive dust through water application during ground disturbance	• Assume one water truck and locally sourced water would be used by the civil workers contractor for up to 90 days		$18,000		**$18,000**

[1] Standard procedures and tasks that would be included with contractor construction contracts are identified in project mitigation measures and this table. Costs associated with these tasks are considered to be a standard construction cost and would not require additional funds associated with mitigation implementation.

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
	and stabilizing disturbed areas					
Air-2: Construction Emissions Controls	• Maintain and repair equipment according the manufacturer's standard	• N/A – Standard procedure				**$0**
Air-3: Air Quality Monitoring and Noxious Gas Management	• Install gas detection and monitoring devices during well drilling and testing activities	• Up to 30 air tubes and air analysis over course of project activities			$10,000	**$10,000**
Soil-1: Topsoil Preservation and Restoration	• Plastic sheeting to secure topsoil; reapply topsoil	• Equipment used to reapply topsoil would be available locally		$500		**$500**
Soil-2: Geotechnical Investigation	• Conduct geotechnical investigation prior to initiating civil works activities	• Geotechnical engineer	$10,000			**$10,000**
Noise-1: Noise Abatement and Community Coordination	• Install acoustic barriers between stationary equipment and sensitive receptors	• Up to 4 noise blankets			$1,000	**$1,000**
Noise-2: Vibration	• Conduct preconstruction surveys of structures within 200 feet of drilling. Compensate for structural damage.	• Driller will conduct pre-construction and post-construction photo surveys • No damage is anticipated; however $10,000 should be set aside as a contingency			$10,000	**$10,000**
Biodiversity-1: Pre-Construction Surveys in MS-3 and MS-4	• Conduct surveys for endemic species	• Cost of study in remaining area	$1,000			**$1,000**
Biodiversity-2: Invasive Weed Control	• Clean work vehicles and equipment prior to entering the site	• N/A – Standard procedure				**$0**

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
Biodiversity-3: Nesting Bird Avoidance and Impact Minimization	• Biologist survey and monitoring if necessary • Possible implementation of visual and acoustic barriers	• Cost for survey	$2,000			**$2,000**
Cultural-1: Archaeological Testing or Monitoring Cultureal-2: Pre-Construction Surveys in MS-3 and MS-4	• Conduct surveys for archeological and cultural resources prior to civil work activities	• Estimate includes testing and site visiting	$5,000			**$5,000**
Cultural-3: Worker Cultural Resource Sensitivity Training	• Provide archeological and cultural resources training to workers	• N/A- No cost measure				**$0**
Landscape-1: Site Reclamation and Restoration	• Dismantle temporary treatment facilities and worker camps	• One week to restore each drilling site			$10,000	**$10,000**
Traffic-1: Traffic Control	• Provide information signs where land and road closures could substantially disrupt traffic circulation	• N/A – Standard procedure				**$0**
Traffic-2: Road Hazard Avoidance	• No cost associated with the measure	• No cost measure				**$0**
Utilities-1: Protect Overhead Utility Lines	• No cost associated with the measure	• No cost measure				**$0**
Hazards-1: Hazardous Materials Management Plan	• Use non-toxic and biodegradable drilling mud where feasible	• N/A – Standard procedure				**$0**
	• Embank reserve pits if drilling mud contains foams	• N/A – Standard procedure				**$0**
	• Install containment berms and redirect stormwater	• N/A – Part of construction				**$0**

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
	flows around hazardous material storage sites					
	• Cap drilling mud determined to be toxic with clean fill materials	• Cost to import fill materials. Assumes 500 cubic meters of fill obtained from local quarry			$4,000	**$4,000**
Fires-1: Fire Prevention and Response	• Provide fire prevention and response equipment at each work site, such as shovels, axes, fire extinguishers, and dedicated water tanks	• N/A – Standard procedure				**$0**
Waste-1: Waste Management Plan	• Prepare a Waste Management Plan for solid waste; store and dispose of solid waste at an appropriate facility	• Waste disposed weekly at a municipal landfill		$800	$1,800	**$2,600**
Social-1: Agriculture Production	• Provide compensation for farmers where farmland and crops are impacted by the project	• The loss of active agricultural production cannot be determined at this time (see RPF)				**$0**
Social-2: Working Conditions and Equality	• Provide information to workers regarding their rights on safety and payment; and provide training to workers for their position	• N/A – Standard procedure				**$0**
Social-3: Community Engagement and Sensitivity	• Hold public meetings with the affected communities and install an informational sign at the entrance of each project area	• Assume a two-hour public meeting will be held with affected communities before construction occurs	$3,000	$1,000		**$4,000**
Social-4: Recreation	• No cost associated with the measure	• No cost measure				**$0**

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
Safety-1: Health and Safety Plan	• Prepare and implement an EHS plan with all required elements	• Drilling contractor plan would include greater hazards, risk management strategies, and emergency response procedures		$4,000	$10,000	**$14,000**
Safety-2: Personal Protective Equipment	• Provide personal protective equipment	• N/A – Standard procedure				
Safety-3: First Aid and Emergency Response Equipment	• Provide First Aid and safety equipment	• N/A – Standard procedure				**$0**
Safety-4: Community Safety	No cost measure	No cost measure				**$0**
Mitigation Measures Subtotal			**$22,500**	**$32,300**	**$100,800**	**$165,600**
Monitoring						
On-site Compliance Inspection and Monitoring	• GoSL Monitor – Inspect construction sites (approx. weekly)	• Weekly GoSL inspections during drilling and monthly during civil works • Contractor inspections would be conducted by staff present on the site (no cost)	$25,000			**$25,000**
Reporting and Documentation	• Prepare/review Pre- and Post-Construction Audit Reports, Monthly Compliance Reports, and Quarterly Monitoring Reports	• Prepare/review Pre-and Post-Construction Audit Reports, Monthly Compliance Reports, and Biannually Monitoring Reports	$15,000			**$15,000**
Grievance and Redress Mechanisms	• Redress grievances from community members, if needed	• N/A – It is assumed that this will be within the duties of GoSL and addressing grievances will not have a direct cost.				**$0**

Implementation Requirements	Requirements with Direct Costs	Assumptions[1]	GoSL	Civil Works Contractor	Drilling Contractor	Req. Total
Emergency Response/Cleanup Environmental	• Respond to emergencies and clean up hazardous material spills, if needed	• No spills are anticipated				**$0**
Monitoring Subtotal			**$40,000**	**$0**	**$0**	**$27,000**
Stakeholder Engagement						
Stakeholder Engagement	• Meetings and consultations with the community • Educational materials for the community	Assumes regular coordination with the community throughout the geothermal exploration phase. Assumes use of a consultant to assist with public outreach efforts.	$120,000			$120,000
Stakeholder Engagement Subtotal			**$120,000**			**$120,000**
Project Total			**$182,500**	**$32,300**	**$110,800**	**$325,600**

3 ROLES AND RESPONSIBILITIES

This section outlines the roles and responsibilities of parties involved with direct implementation of mitigation measures or implementation oversight.

3.1 DEPARTMENT OF SUSTAINABLE DEVELOPMENT

The Department of Infrastructure, Ports and Energy (DIPE) is responsible for managing the overall project. The construction contractors and DIPE will employ environmental and health and safety (EHS) professionals to oversee implementation of the ESMP.

3.1.1 Expert on Environment Health and Safety

The DIPE and a Project Implementation Unit (PIU) within the DIPE will oversee the project during all construction phases and ensure that mitigation measures are implemented correctly. The PIU expert on EHS shall be responsible for verifying that the mitigation measures are implemented adequately. The EHS expert shall have relevant experience monitoring construction on projects that have World Bank funding and mitigation compliance components. The qualified candidate should also have experience with environmental compliance on projects involving drilling. The EHS expert shall become familiar with mitigation measure requirements and ESMP procedures for the project. The EHS expert shall serve as the monitor for the PIU and shall be the key contact person regarding compliance with mitigation measures. The EHS expert shall be responsible for:

- Acting as the key point of contact for contractors and oversight agencies regarding compliance with mitigation measures
- Verifying project compliance with mitigation measure requirements through auditing and field inspection
- Providing direction to contractors regarding mitigation measure interpretation and ESMP procedures
- Issuing notices of non-compliance (addressed in Section 4.5.2) to contractors if they do not comply with mitigation measures or environmental laws
- Overseeing any rehabilitation of environmental damage that may occur

3.1.2 Community Liaison Officer

The GoSL Community Liaison Officer (CLO) will be responsible for coordinating with the local community and verifying the socio-economic measures in the ESMP are properly implemented. The CLO shall have knowledge of the local community and shall have relevant experience addressing social issues and responding to grievances. The CLO expert shall serve as the point

of contact for the local community and for workers should a social issue arise during project implementation. The CLO shall be responsible for:

- Activating a project phone number and email address for local residents and community members to contact if they have grievances with the project (address in Section 4.7), and acting as the key point of contact to resolve project grievances
- Acting as the point of contact for filing of any worker grievances and responding to worker grievances
- Verifying project implementation of socio-economic mitigation measures

3.2 PROJECT STEERING COMMITTEE

The project is subject to oversight from agencies with stake in the project or who are responsible for enforcing environmental laws. The DIPE will establish a Project Steering Committee (PSC) that will guide the project implementation. The PSC will be responsible for ensuring the smooth execution of project activities and for the successful accomplishment of project objectives. The PSC will meet monthly to review project implementation and performance. The PSC shall include representative from the following agencies (addressed in the Resettlement Policy Framework):

- Representatives of the DIPE:
  - Chief Technical Officer;
  - Legal Officer;
  - Technical Director – Geothermal Resource Development Project
- Representative of the PIU;
- Representatives of the Department of Physical Planning:
  - The Authorized Officer or his/her representative:
  - Commissioner of Crown lands or his/her representative;
  - Quantity Surveyor;
  - Valuation Surveyor.
- Social Transformation Officers for each of the affected communities;
- Member of a recognized community-based organization
- Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives.

3.3 CONTRACTORS

Project contractors are responsible for complying with all mitigation measure requirements and ESMP procedures, and for ensuring that contracts and construction plans for the project meet all design requirements identified in the mitigation measures.

3.3.1 Drilling Services Contractor

A drilling services contractor will be contracted to perform the physical drilling and sampling at well sites. The drilling services contractor shall be responsible for implementing applicable mitigation measures identified in Table 2.2-1. The drilling services contractor will be required to retain a qualified EHS Officer and comply with reporting requirements defined in this section.

3.3.2 Civil Works Contractor

A civil contractor will be contracted by DIPE to prepare roads leading to the site and construct spur roads to the well pads, construct the well pads, construct worker housing, and construct the storage area. The civil contractor shall be responsible for implementing applicable mitigation measure requirements identified in Table 2.2-1. The civil contractor will need to retain a qualified EHS Officer and comply with reporting requirements defined in this section.

3.3.3 Construction Contractor EHS Officers

Each construction contractor is responsible for retaining an EHS Officer to oversee compliance with mitigation measures applicable to their scope of work. The construction contractors are responsible for selecting EHS Officers with the necessary skills, experience, and availability to perform their duties adequately. Necessary qualifications include previous experience monitoring the implementation of mitigation measures on a project of similar scope and scale. Experience complying with World Bank environmental requirements is preferred. Construction contractors shall ensure their EHS Officers have completed all necessary EHS training prior to the project. EHS Officers will be responsible for the day-to-day implementation of mitigation measure requirements identified in Table 2.2-1. EHS Officers will be responsible for:

- Acting as the key point of contact for the PIU EHS expert, as well as oversight agencies if applicable, regarding compliance with mitigation measures
- Ensuring that all personnel including subcontractors have received environmental training prior to work on the project site and have been informed of mitigation measures and their associated responsibilities when working
- Ensuring that all personnel comply with mitigation measures
- Inspecting active work sites on a daily basis, and documenting compliance through completion of a daily compliance checklist and photographs (addressed in Section **Error! Reference source not found.**~~4.2~~)
- Preparing required reports and managing compliance documentation during all phases of construction (addressed in Section **Error! Reference source not found.**~~4.2~~)
- Ensuring that compliance documentation is complete and available for PCU or oversight agency auditing
- Managing any rehabilitation of environmental damage that may have occurred

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4 IMPLEMENTATION, MONITORING AND REPORTING PROCEDURES

4.1 OVERVIEW

The purpose of monitoring and reporting plan is designed to provide timely and operationally useful information on compliance with the mitigation measures. The objective of monitoring and reporting is to provide feedback on mitigation measure implementation and to identify problems and corrective measures as early as possible to resolve any compliance issues early to avoid significant impacts.

4.2 IMPLEMENTATION PHASES

Mitigation measure requirements, as well as implementation and verification procedures, are applicable during one or more of three construction phases. Implementation phases include:

- Prior to construction ("Pre-construction")
- During construction, drilling, and well testing ("Construction")
- Following construction ("Post-construction")

Implementation phases for mitigation measure requirements are identified in Table 2.2-1. Implementation phases for ESMP procedure requirements are identified in this section.

4.3 MONITORING PLAN

4.3.1 Pre-Construction Monitoring and Reporting

The PIU EHS expert and Civil Works EHS Officer shall survey the project site prior to construction to document the condition of all work areas, identify sensitive areas to avoid, and select the location of the worker camp, if needed. The PCU EHS expert will prepare a pre-construction monitoring report that documents the detailed status of each project work area prior to project activities. The pre-construction monitoring report shall include:

- Description of each project work area that identifies and describes the locations of previously disturbed or undisturbed features
- Areas that should be avoided to the extent feasible (e.g., active farmland)
- Photographs of each work area and important feature from multiple angles if necessary

The pre-construction monitoring report and photographs will be compared to site conditions following construction and determine the adequacy of restoration.

4.3.2 Construction Monitoring and Reporting

The PIU EHS expert shall visit the site monthly during civil works and weekly (or more frequently if needed) to verify compliance at the site. Oversight agencies may also visit the site on an as needed basis at any time. A monitoring report documenting compliance with all applicable construction mitigation measures shall be prepared at the completion of each site visit (see weekly compliance checklist below).

4.3.3 Post-Construction Monitoring and Reporting

The PIU EHS expert shall visit the project site following construction to document the condition of all work areas and sensitive areas adjacent to work areas. The status of each location and any issues shall be documented in a post-construction monitoring report prepared by the PIU EHS expert. The post-construction monitoring shall address all post-construction mitigation requirements. Any issues identified with the condition of the work sites shall be addressed by the responsible contractor to the satisfaction of the PIU.

4.3.4 Monitoring and Reporting Frequency

Contractor EHS Officers would be on site on a daily basis or otherwise defined in the mitigation measures to inspect active work sites and verify compliance with all applicable mitigation measures for the work phase. PIU EHS Officers shall monitor the site on a weekly basis during drilling and a monthly basis during civil works. More frequent monitoring may be conducted if needed to ensure compliance with the mitigation measures and resolution of any issues that are noted.

4.4 MITIGATION COMPLIANCE REPORTING

4.4.1 Weekly Compliance Checklists

Contractor EHS Officers shall complete a daily compliance checklist each day that work occurs in the field. Photographs will be attached to the checklist to document work activities.

A checklist form may be developed for use on mobile devices (i.e., smart phones and tablets). If so, access to digital copies of the checklists would made available to agencies upon request.

4.4.2 Monthly Compliance Reports

Contractor EHS Officers shall prepare and submit a monthly compliance report to GCC and the PIU EHS expert to document construction and compliance activities completed during the month, and to track the resolution of any issues that may have occurred. The reports should include the following information for the period:

- Summary of completed construction activities
- Estimate of remaining construction and schedule
- Summary of compliance activities

- Updated list of all EHS incidents that occurred during the project
- Follow up information from any past issues that are still being resolved
- Photographs of project activities

4.4.3 Biannual Compliance Reports

The PIU shall prepare and submit a biannual compliance report to the World Bank to document construction and compliance activities completed during the period, and to track the resolution of any issues that may have occurred. The PIU will use daily compliance checklists and monthly reports prepared by the construction contractors to develop the biannual report.

The PIU EHS expert shall be responsible for reviewing and submitting the biannual reports to applicable oversight agencies. The reports should include the following information for the period:

- Summary of completed construction activities
- Estimate of remaining construction and schedule
- Summary of compliance activities
- Contractor's implementation activities
- PIU's and agency oversight activities (i.e., site visits)
- Updated list of all EHS incidents that occurred during the project, including attached notices of non-compliance that were issued
- Follow up information from any past issues that are still being resolved
- Photographs of project activities

4.5 CONTRACTOR TRAINING

4.5.1 Environmental Responsibilities

Contractors are required to train workers on the environmental requirements for the project as a whole, as well as how to comply with applicable mitigation measure requirements when completing their work. In addition to general environmental awareness training, specific environmental training requirements are identified in Table 2.2-1.

4.5.2 Health, Safety, and Environmental Incidents and Non-Compliance

Contractors are required to ensure their workers are adequately trained prior to beginning work on the project. In addition to applicable worker safety laws, mitigation measures identify specific health and safety requirements that each contractor must comply with. Health and safety training requirements are identified in Table 2.2-1.

4.6 NON-COMPLIANCE AND SAFETY INCIDENTS

4.6.1 Incident Reports

Contractor EHS Officers are responsible for preparing and submitting incidents reports to the PIU EHS expert within 72 hours from discovery of and non-compliance or safety incident. EHS Officers shall maintain a complete project record of incidents associated with their contract scope of work. The record shall be regularly updated and included with monthly reports submitted to the PIU.

Examples of EHS incidents include:

- Fires
- Accidents or "near miss" events
- Hazardous material spills that contaminate soil or water resources
- Improvement orders or notices issued by oversight agencies
- Non-compliance with mitigation measures

At a minimum, EHS incident reports should include:

- Dates the incident occurred and was discovered, if different
- Description of the incident
- Mitigation measures or environmental laws that were violated
- Parties present during the event
- Corrective actions taken to remedy the issue and prevent it from recurring
- Any remaining actions that are required to correct the situation, such as rehabilitation

4.6.2 Notices of Non-Compliance

If any issues with compliance are discovered by the PIUEHS expert, the observing party shall submit a written notice of non-compliance to the alternate party and contractors that documents the issue and presents preliminary corrective actions, if applicable. Notices of non-compliance shall include the following information:

- Dates the issue occurred and was discovered, if different
- Description of the issue
- Mitigation measures or environmental laws that were violated
- Parties present during the event
- Description of corrective actions taken
- Description of any necessary follow up actions or longer-term rehabilitation requirements if environmental damage occurred

4.6.3 Corrective Actions

Contractors are responsible for responding to and addressing notices of non-compliance in a timely manner and to the satisfaction of the PIUEHS expert. Contractors will be responsible for

the rehabilitation costs and work effort associated with any environmental damage that may occur due to non-compliance with mitigation measures and environmental laws.

4.7 GRIEVANCE AND REDRESS MECHANISM

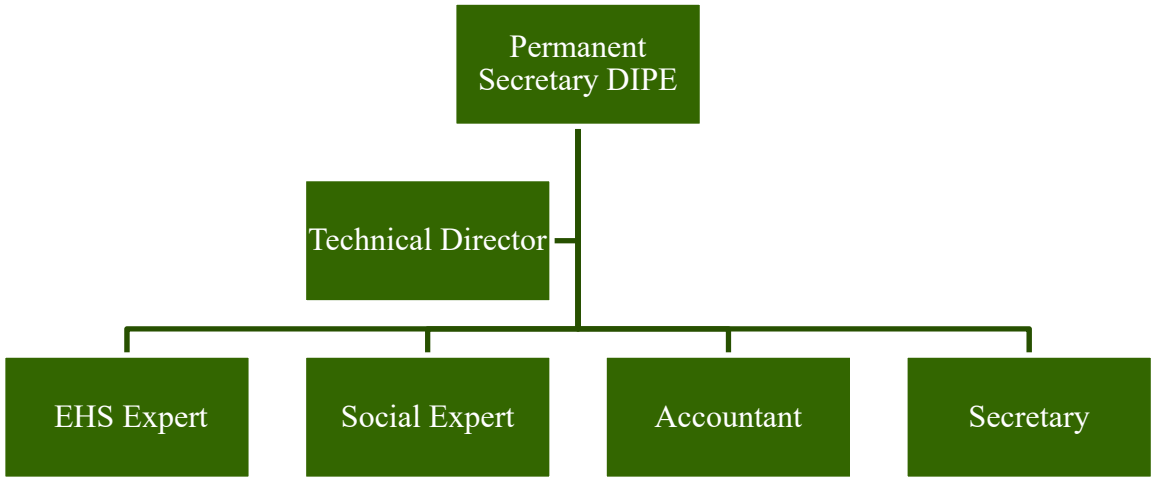
A Grievances Redress Committee (GRC) is addressed in the Stakeholder Engagement Plan to manage concerns and complaints raised by project affected persons (PAPs) within the communities affected by the project. The GoSL will appoint a community liaison officer (CLO) to conduct stakeholder outreach and respond to any grievances or complaints that may arise. The CLO will act as the key point of contact to resolve project grievances from construction workers, local residents, and community members. The CLO will be responsible for addressing project grievances and directing contractors to make any appropriate change to their work. The contractor shall take reasonable action to address grievances as required by local laws. Contractor EHS Officers will also act as points of contact for local residents or workers that express grievances at the project site. If grievances are expressed in the field, the receiving EHS Officer is responsible for notifying the GRC, DIPE, PIU and SSO within 48 hours of receipt.

5 INSTITUTIONAL CAPACITY AND CAPACITY BUILDING

5.1 INSTITUTIONAL STRUCTURE

This Section outlines the institutional and management arrangements designed to effectively implement the mitigation measures for the project. The geothermal exploration project will be implemented by several contractor teams including the Civil Works contractor and Drilling contractor The management structure for implementation of the ESMP within DIPE is illustrated in Figure 5.1-1.

Figure 5.1-1 Project Management Structure



5.2 INSTITUTIONAL CONSTRAINTS AND CONCERNS

5.2.1 Labor Capacity

Institutional constraints were defined through coordination with the DIPE and stakeholders. The DIPE has not currently staffed/assigned an EHS expert and CLO. This management expertise is critical to successful oversight of this ESMP.

5.2.2 Training

In office training is needed prior to well drilling. In the field training is required during implementation of the project. Training requirements include technical training in geothermal exploration for geologists and hydrologists and training for environmental monitoring and mitigation implementation.

5.2.3 Equipment

A full list of equipment required for implementation of the project and ESMP mitigation measures will be included in the Request for Proposals for civil works and drilling and testing. The selected contractors will be responsible for providing the necessary equipment to implement the mitigation measures. Equipment required to implement the well drilling and testing are specified in the *Pre-feasibility Study of a Proposed Geothermal Project in Saint Lucia Final Report* (GeothermEx and Power Engineers 2017)

5.3 KEY ACTIONS FOR CAPACITY BUILDING

5.3.1 Labor

DIPE shall hire the necessary EHS experts and CLO. The qualified individuals shall meet the minimum qualifications defined in Section 3. The project will provide a technical knowledge base for geothermal drilling in Saint Lucia. This knowledge base is important for future development efforts in the country.

5.3.2 Trainings

The civil works and drilling contractors will prepare and implement worker training programs. The training programs will be specific to the project, incorporating information specific to geothermal exploration and mitigation measures in this ESMP. The mitigation measures in this ESMP require that all staff working on the project site receive health and safety training.

Technical experts at the DIPE will receive in the field training by working side-by-side with drilling contractor experts during drilling. In the field training may be organized by topics, which include:

- Geothermal well design
- Geothermal well monitoring (using gages, software for logging the well, taking samples)
- Well testing (surface and belowground well testing instruments, short- and long-term testing, injectivity, interpretation methods)
- Geothermal reservoir modeling and software
- Power plant design

5.3.3 Equipment Procurement

Several pieces of equipment would need to be acquired prior to project initiation. In addition to the equipment needed to analyze water and soil samples and log the wells (listed above Section 5.2.3), the following pieces of equipment would be necessary for the project:

- Carbon dioxide and hydrogen sulfide measurement instruments
- Chemical analysis field kit
- Liquid and gas sampling devices
- Flame ionization detector for gas chromatography equipment

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APPENDIX A

Civil Works EHS Officer Daily Compliance Checklist

Project Title: _____ Site Location: _____

Construction Stage: _____

Inspection Date: _____ Inspection Time: _____

Inspected by: _____

Mitigation Measures	Implementation Timing	Compliance Status		Remarks (good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
		Y	N	
Water Resources				
Water-1: Stormwater, Erosion, and Sediment Control	• Before Construction • During Construction			
Water-5: Water Supply System Protection	• Before Construction • During Construction • After Construction			
Air Quality				
Air-1: Fugitive Dust Management	• During Construction			
Air-2: Construction Emission Controls	• During Construction			
Geology and Soils				
Soils-1: Topsoil Preservation and Restoration	• Before Construction • During Construction			
Soils-2: Geotechnical Investigation	• Before Construction • During Construction			

Mitigation Measures	Implementation Timing	Compliance Status		Remarks
		Y	N	(good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
Noise				
Noise-1: Noise Abatement and Community Coordination	• Before Construction • During Construction			
Noise-2: Vibration	• Before Construction • After Construction			
Natural Habitats and Biodiversity				
Biodiversity-2: Invasive Weed Control	• During Construction			
Biodiversity-3 Nesting Bird Avoidance and Impact Minimization	• Before Construction			
Archaeological and Cultural Resources				
Cultural-1: Archaeological Testing or Monitoring	• Before Construction • During Construction			
Traffic Circulation and Safety				
Traffic-1: Traffic Control	• Before Construction • During Construction			
Traffic-2: Road Hazard Avoidance	• Before Construction • During Construction			
Utilities and Communication Systems				
Utilities-1: Protect Overhead Utilities Lines	• Before Construction			
Hazards and Hazardous Materials				
Hazards-1: Hazardous Materials Management Plan	• Before Construction • During Construction			

Mitigation Measures	Implementation Timing	Compliance Status		Remarks (good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
		Y	N	
Fires				
Fires-1: Fire Prevention and Response	• During Construction			
Solid Waste				
Waste-1: Waste Management Plan	• Before Construction			
Social Mitigation Measures				
Social-1: Agriculture Production	• Before Construction • After Construction			
Social-2: Working Conditions and Equality	• During Construction			
Social-3: Community Engagement and Sensitivity	• Before Construction • During Construction			
Social-4: Recreation	• During Construction			
Health and Safety Mitigation Measures				
Safety-1: Health and Safety Plan	• Before Construction • During Construction			
Safety-2: Personal Protective Equipment	• Before Construction • During Construction			
Safety-3: First Aid and Emergency Response Equipment	• Before Construction • During Construction			
Safety-4: Community Safety	• Before Construction • During Construction			

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APPENDIX B

Drilling EHS Officer Daily Compliance Checklist

Project Title: _____ Site Location: _____

Construction Stage: _____

Inspection Date: _____ Inspection Time: _____

Inspected by: _____

Mitigation Measures	Implementation Timing	Compliance Status		Remarks (good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
		Y	N	
Water Resources				
Water-1: Stormwater, Erosion, and Sediment Control	• Before Construction • During Construction			
Water-2: Water Quality Monitoring Program	• Before Construction • During Construction			
Water-3: Drilling Waste and Effluent Management	• During Construction			
Water-4: Blow Prevention	• During Construction			
Water-5: Water Supply System Protection	• Before Construction • During Construction • After Construction			
Water-6: Water Extraction Strategy	• Before Construction • During Construction			
Air Quality				
Air-1: Fugitive Dust Management	• During Construction			

Mitigation Measures	Implementation Timing	Compliance Status		Remarks
		Y	N	(good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
Air-2: Construction Emission Controls	• During Construction			
Air-3: Air Quality Monitoring and Management	• During Construction			
Noise				
Noise-1: Noise Abatement and Community Coordination	• Before Construction • During Construction			
Noise-2: Vibration	• Before Construction • After Construction			
Natural Habitats and Biodiversity				
Biodiversity-2: Invasive Weed Control	• During Construction			
Biodiversity-3 Nesting Bird Avoidance and Impact Minimization	• Before Construction			
Landscape and Visual Character				
Landscape-1: Site Reclamation and Restoration	• After Construction			
Traffic Circulation and Safety				
Traffic-1: Traffic Control	• Before Construction • During Construction			

Mitigation Measures	Implementation Timing	Compliance Status		Remarks
		Y	N	(good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
Utilities and Communication Systems				
Utilities-1: Protect Overhead Utilities Lines	• Before Construction			
Hazards and Hazardous Materials				
Hazards-1: Hazardous Materials Management Plan	• Before Construction • During Construction			
Fires				
Fires-1: Fire Prevention and Response	• During Construction			
Solid Waste				
Waste-1: Waste Management Plan	• Before Construction • During Construction			
Social Mitigation Measures				
Social-1: Agriculture Production	• Before Construction • After Construction			
Social-2: Working Conditions and Equality	• During Construction			
Social-3: Community Engagement and Sensitivity	• Before Construction • During Construction			
Social-4: Recreation	• During Construction			

Mitigation Measures	Implementation Timing	Compliance Status		Remarks (good practices, problem observed, possible cause of noncompliance and/or proposed corrective/preventive actions)
		Y	N	
Health and Safety Mitigation Measures				
Safety-1: Health and Safety Plan	• Before Construction • During Construction			
Safety-2: Personal Protective Equipment	• Before Construction • During Construction			
Safety-3: First Aid and Emergency Response Equipment	• Before Construction • During Construction			
Safety-4: Community Safety	• Before Construction • During Construction			



Government of Saint Lucia

Resettlement Action Plan

Saint Lucia Renewable Energy Sector Development Project

September 2018

ECMC

PANORAMA ENVIRONMENTAL, INC.

Government of Saint Lucia

Resettlement Action Plan

Saint Lucia Renewable Energy Sector Development Project

September 2018

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Acronyms and Abbreviations

AO	Authorized Officer
CBO	Community-Based Organization
CCL	Commissioner of Crown Lands
DAFP	Department of Agriculture, Fisheries, Physical Planning, Natural Resources and Cooperatives
DPP	Department of Physical Planning
DSD	Department of Sustainable Development
ESIA	Environmental and Social Impact Assessment
GRC	Grievances Redress Committee
GOSL	Government of Saint Lucia
GPS	Global Positioning System
IFC	International Finance Corporation
IVSC	International Valuations Standards Council
LO	Legal Officer
LUCELEC	St. Lucia Electricity Services Limited
NGO	Non-Government Organization
OP	Operational Policy
PAP	Project Affected Persons
PC	Project Coordinator
PCU	Project Coordinating Unit
PS	Permanent Secretary
PSC	Project Steering Committee
QS	Quantity Surveyor
RAP	Resettlement Action Plan
RFP	Relocation Policy Framework
RICS	Royal Institute of Chartered Surveyors
RPF	Resettlement Policy Framework

STO	Social Transformation Officers
TD	Technical Director
TO	Technical Officer
VS	Valuation Surveyor
WASCO	Water and Sewerage Company Inc.

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1 INTRODUCTION

1.1 OVERVIEW

The Government of Saint Lucia (GOSL) proposes a geothermal exploration program, Saint Lucia Renewable Energy Sector Development Project (project), to test the geothermal resource and evaluate the feasibility of commercial geothermal power production in Saint Lucia. The geothermal exploration is proposed within the Soufrière, Choiseul, and Laborie regions of Saint Lucia. The geothermal exploration program would include slim-diameter wells to obtain information on the geology and temperature gradient in the area. Deep geothermal wells may be drilled with larger drilling rigs if the initial drilling is successful.

The World Bank requires preparation of a Resettlement Action Plan (RAP) to address compulsory acquisition of land, that would give rise to the relocation or loss of shelter; loss of assets or access to assets; or loss of income sources or means of livelihood. This RAP has been prepared consistent with World Bank policies and guidelines.

1.2 BACKGROUND

Jacobs of New Zealand conducted a geoscientific study in 2015 and 2016 which indicated the presence of a geothermal resource in areas to the southeast of the Sulphur Springs (Jacobs of New Zealand 2016[1]). The GOSL contracted GeothermEx to conduct a pre-feasibility study of commercial geothermal power generation in the resource target areas identified by Jacobs of New Zealand. Exploratory drilling is required in the resource target areas to evaluate the geothermal resource and to determine the viability of generating commercial geothermal power.

The GOSL contracted Panorama Environmental, Inc. in July 2017 to prepare an Environmental and Social Impact Assessment (ESIA) for geothermal exploratory drilling activities in the communities of Fond St. Jacques and Belle Plaine in the district of Soufriere and Mondesir-Saltibus in the districts of Choiseul/Laborie. The ESIA includes preparation of a Resettlement Action Plan (RAP) and a Relocation Policy Framework (RPF) for the geothermal exploration drilling.

[1] Soufriere Geothermal Resource - Integrated Exploration Report; Jacobs New Zealand Limited, May 2016

1.3 PROJECT SUMMARY

The project includes drilling slim-hole wells and potentially full-size geothermal exploration wells to evaluate the feasibility of commercial geothermal development in St. Lucia. Slim-hole wells would be drilled first. Slim-hole wells (3.78-inch bottom hole diameter) typically require less capital investment and cause less environmental and social impacts than deep full-sized wells because they are drilled with smaller drill rigs, drilling takes less time, and less material is removed from the ground. An exploratory drilling program using slim hole wells is a cost-effective method for geothermal exploration.

Full-sized (7-inch or greater bottom hole diameter) geothermal exploration wells may be drilled in Belle Plaine or Mondesir-Saltibus if the slim hole drilling results are positive and suggest the presence of a commercial geothermal resource.

The project description and analysis in the ESIA address the possibility of drilling full-sized wells in addition to slim-hole wells to provide a range of options for the exploratory drilling program. The feasibility of drilling full-sized wells would depend on the results of slim-hole drilling, access to funds, access to sufficient workspace, and the environmental and social risks and impacts addressed in the ESIA.

The project would include the following activities and components:

- Civil works and site development
- Slim hole and full-size well drilling
- Well testing
- Well abandonment and site reclamation

1.4 OBJECTIVES AND SCOPE OF THE RESETTLEMENT ACTION PLAN

The exploratory drilling phase of the project will not require the acquisition of land because the land will be leased, exploration drilling is a temporary activity, and the site will be restored at the completion of drilling.

The drilling will also not require the physical resettlement of housing or farm structures as efforts to minimize resettlement have resulted in the drilling sites being selected on lands without houses or farm structures. However, the drilling and staging activities will require temporary displacement of agricultural production and recreational activities on private and public (i.e., Crown) lands in the target communities.

If the geothermal exploration program is successful and future development of the resource is expected to occur, the wells could become permanent infrastructure as part of a future development phase. A separate RAP will be developed prior to development to address the long-term impacts of a separate geothermal development project.

World Bank-assisted projects that entail resettlement and/or displacement, require the development of a Resettlement Action Plan (RAP). An abbreviated RAP is acceptable if fewer than 200 people are displaced. The overall intention of the RAP is to devise a plan that will ensure that the Project Affected Persons (PAPs) are left no worse off than they were before the commencement of the exploratory drilling phase of the project. The term PAP is defined as *"All persons who as result of work to be carried out under the Project, would incur temporary involuntary loss of land, productive assets or access to productive assets, or of income or means of livelihood; and as a consequence, would have their living standards or production levels adversely affected"*; (the term is used interchangeably with "Displaced Persons").

This draft abbreviated RAP sets out the policies, procedures, compensation measures and schedule for the issue of compensation to people/households affected by the project (PAPs), in the Fond St. Jacques, Belle Plaine and Mondesir-Saltibus communities, whose agricultural production activities will be temporarily displaced during the exploratory drilling phase of the project. The PAPs will, therefore, be entitled to full and fair compensation for that land take.

The RAP is consistent with World Bank's Operational Policy (OP) 4.12[2]. The RAP is also in general compliance with Saint Lucia's law and policies governing resettlement matters; where it is not, the policies of the World Bank Group take precedence.

The RAP is a working document, which will be subject to periodic updates as progress is made during the planning, implementation, and consultation processes. This RAP reflects the understanding of the project and affected areas in November 2017. The RAP will need to be updated prior to project implementation because the project engineering/design and specific drilling areas have not been defined.

The RAP and RPF adopt the principle of minimization of land acquisition and involuntary resettlement.

1.5 ELIGIBILITY FOR COMPENSATION

This RAP pertains exclusively to the PAPs whose agricultural production activities will be temporarily displaced during the exploratory drilling phase of the project and will, therefore, be entitled to full and fair compensation for that land take. Only PAPs identified during the socio-economic survey/inventory of assets in September 2017 shall be eligible for compensation. Section 3 Census and Socioeconomic Survey provides additional information on PAPs and eligibility for compensation.

Any new agricultural activity or physical structure established after the cut-off date, shall not be considered affected. The owners shall not be eligible for compensation unless they can

[2] Involuntary Resettlement Sourcebook - Planning and Implementation in Development Projects,

demonstrate that the socio-economic survey/inventory of assets failed to identify them as being affected.

1.6 PROJECT COMPONENTS GIVING RISE TO RESETTLEMENT/DISPLACEMENT

Land resettlement is expected to be required for the exploratory drilling phase. The land used for the exploratory drilling phase will be leased and impacts would be temporary. The project activities that are likely to cause resettlement and /or land acquisition include the following:

1. **Site Development, Civil Works and Material Staging and Storage** – This first stage of the geothermal exploration drilling program will involve civil works to provide access to the drilling areas, the construction of a worker camp (if needed); and the establishment of well pads and areas for material storage.
2. **Well Drilling –** The initial exploration phase will consist of drilling slim-hole wells in the resource target areas to evaluate sub-surface conditions and determine whether the areas show indications of a presence or absence of an exploitable geothermal system. Full-sized geothermal exploration wells may be drilled in Belle Plaine and Mondesir-Saltibus if the results of the slim-hole drilling indicate the presence of a geothermal resource.
3. **Geothermal Resource Testing –** Geothermal resource testing would be conducted following the completion of each exploration well.
4. **Well Abandonment and Site Reclamation –** The commercial potential of each exploration well would be assessed following the completion of testing. If the well is determined to have long-term use, the appropriate steps will be taken to leave the well pad in its original state, with access to the wellbore for future monitoring. If a well is not determined to have commercial potential, monitoring of the well may continue or the well may be abandoned and the well pad restored to its approximate original topography.

The project will require use of private and Government (Crown) land resulting in temporary land take. The temporary land taking has triggered the need for the development of this RAP to address involuntary displacement.

The GOSL may enter into a development agreement with a geothermal developer if the results of the exploration drilling program indicate the presence of a commercially viable geothermal resource. The location and impacts of any future geothermal resource development are speculative; therefore, this RAP does not address the impact of future geothermal resource development. A separate RAP will be developed prior to development phase, in accordance with the RPF, to address the long-term impacts of a separate geothermal development project.

1.7 OVERALL ESTIMATE OF LAND RESETTLEMENT/DISPLACEMENT

The three resource target areas are located in the communities of Fond St. Jacques, Belle Plaine and Mondesir-Saltibus. The resource target areas comprise a total of 44 parcels of land (listed in Appendix A) with a combined area of approximately 36.6 hectares (90.4 acres). Based on records from the Land Registry, the lands in Mondesir-Saltibus MS-1 and MS-2 comprises one parcel which belongs to the Crown. Most of the parcels in Belle Plaine, Fond St. Jacques, MS-3, and MS-4 are held privately (by mainly families/heirs of the original owners), while a few parcels are owned by the Crown and the Water and Sewerage Company Inc. (WASCO). Private and public pedestrian rights-of-way are also held by the many of the parcels in Belle Plaine and Fond St. Jacques. The estimated total area of land required for each exploratory drilling site is approximately 0.12 hectares (0.3 acres) for slim-hole wells and 0.84 hectares (2.0) acres for full-size exploration wells. The exploratory drilling program is expected to include three to five slim-hole wells and potentially two full-size exploration wells. In total, the footprint of the exploratory drilling comprises agricultural lands comprising approximately 0.36 – 2.3 hectares (0.9 - 5.7 acres).

1.8 PRELIMINARY COST OF RESETTLEMENT/DISPLACEMENT

The preliminary cost of displacement includes compensation for loss of land, income, crops and trees, and land lease costs. The actual compensation will be defined once the drilling site is selected. The compensation will be defined using the procedures in this RAP and the RPF and would reflect the valuation for affected crops and lands.

2 MINIMIZING RESETTLEMENT

2.1 EFFORTS OF MINIMIZING RESETTLEMENT

Two main approaches were used to minimize involuntary physical resettlement and/or economic displacement of the PAPs. These approaches are:

- Consultation with the potential PAPs including the Water and Sewerage Company (WASCO manages a spring water intake within the proposed target drilling area in Belvedere, Fond St. Jacques).
- Investigating technically feasible alternative exploratory-drilling sites within each geothermal resource target area.

2.1.1 Consultations

The GOSL and ECMC conducted consultations in the communities of Belle Plaine, Fond St. Jacques and Mondesir in August and September 2017. ECMC also conducted interviews and had discussions with PAPs during the socio-economic baseline survey in September 2017. Individual interviews were held with the PAPs in each community in September 2017. The interviews provided direct information on the PAPs, particularly those in Belle Plaine who expressed concern about to the use of their lands and community as exploratory drilling areas.

The focused discussions and interviews also provided general information on the land use and tenure arrangements within the immediate vicinity of the geothermal resource target areas. The consultations provided information on the least agriculturally productive section of the potential exploratory-drilling areas in MS-1 and MS-2. The discussions also provided an appreciation of the portions of land which are not under leasehold or rental arrangements with the Crown.

ECMC held discussions with WASCO regarding the location of a spring water intake tank in the Belvedere, Fond St. Jacques resource target area. In particular, the alignment of the water inlet and outlet pipes and the specifics on the depth of the latter are critical to determining technically feasible drilling sites in the Fond St Jacques resource target area. ECMC also requested information on the sustainability of the spring source and the high landslide susceptibility index of the resource target area due to the surrounding steep hills.

2.1.2 Investigating Technically Feasible Options

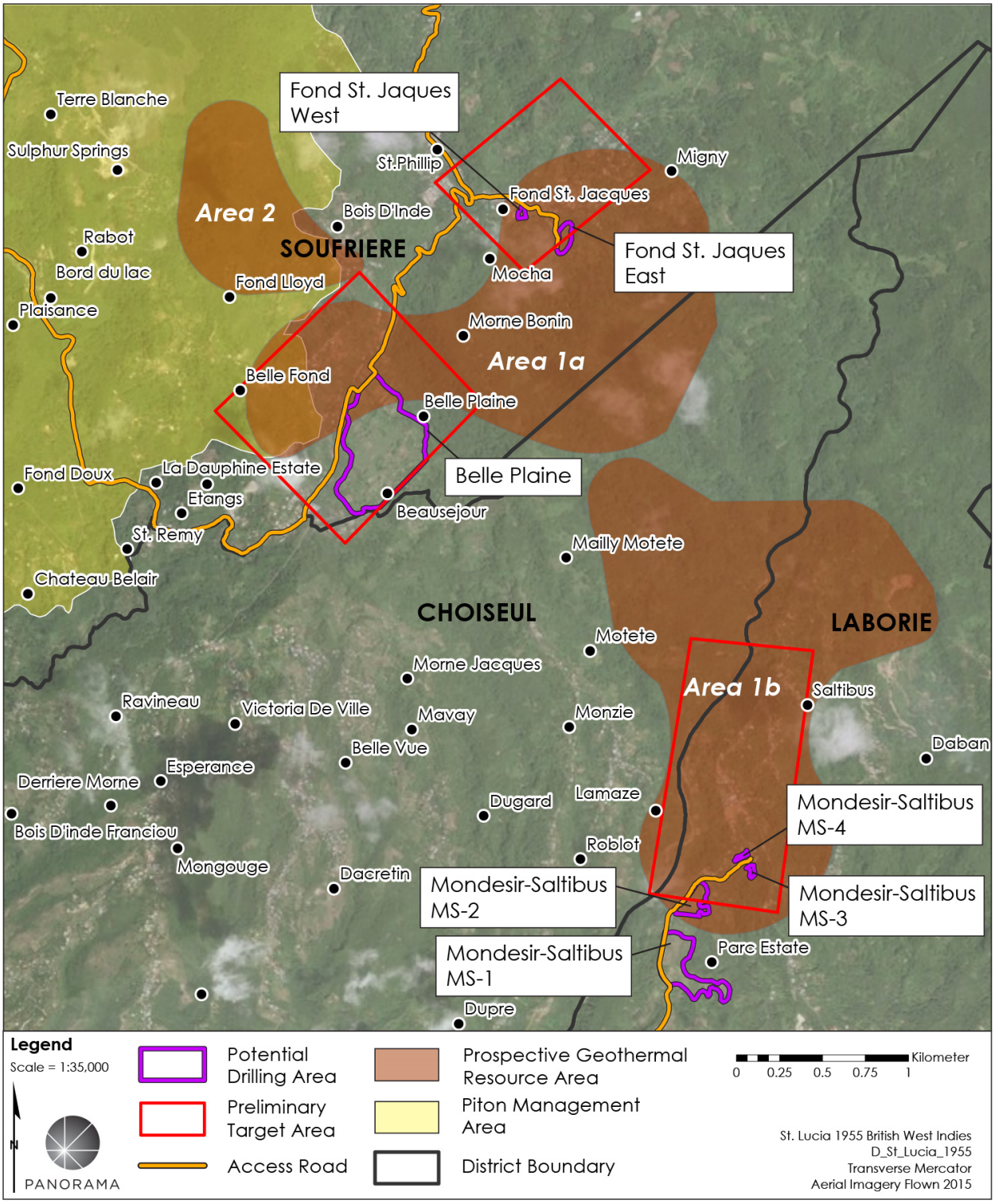
In exploring technically viable alternative drilling sites, the potential drilling areas showing in Figure 2-1 were first superimposed over GOSL's map sheet 3 showing the legal demarcation of the parcels (Block and Parcel numbers) of land. The parcels of land and consequently the potential PAPs were then identified. This desktop exercise indicated that the boundaries of the targeted exploratory drilling areas cut across boundaries of parcels, and, in some cases if the land was to be demarcated for exploratory drilling using the boundaries established, this would result in slivers of land that would be of little use to the owners. Consequently, the boundaries of the targeted exploratory drilling areas were realigned to minimize the number of slivers of land and thus the number of PAPs to be economically displaced.

Supplementary reconnaissance visits were then made to the targeted exploratory drilling areas, during which photographs were taken to establish the sections of lands that are least cultivated particularly in the Belle Plaine and Mondesir target areas. During the visits, Global Positioning System (GPS) locations were also obtained for any physical structures – residential buildings, for example (complete or under construction), farm sheds or improvement to the land. Where possible, these physical structures were identified on a map using the GPS coordinates captured on site, the 2010 aerial photography of Saint Lucia and through the use of Google Maps (2015 imagery). This information facilitated the siting of the drilling and staging areas away from lands that are under active cultivation or occupation by buildings/structures.

Panorama also held meetings with the pre-feasibility contractor and the Department of Sustainable Development (DSD) to discuss methods to minimize impacts from resettlement and loss of livelihood. The pre-feasibility contractor (GeothermEx and POWER Engineers) determined that only slim-hole wells shall be used in Fond St. Jacques to avoid loss of any homes or structures. The pre-feasibility contractor also recommended a drilling strategy that involves slim-hole wells to start and full-size exploration wells would only be drilled in Belle Plaine or Mondesir if the slim-hole wells indicated the presence of a geothermal resource and further testing was needed. Use of slim-hole wells minimizes the land required for the project and minimizes the area subject to temporary land take.

[3] The Land Registration and Titling Project (LRTP) map sheets of the Government of Saint Lucia.

Figure 2-1 Original Proposed Exploratory Drilling Target Areas



2.2 RESULTS OF EFFORTS TO MINIMIZE RESETTLEMENT

The efforts aimed at minimizing the displacement of potential PAPs resulted in the following:

- Avoidance of homes/structures to avoid loss of shelter
- Identification of uncultivated agricultural areas to minimize loss of income and impacts on livelihood
- The realignment of the exploratory drilling areas for the Fond St. Jacques and Belle Plaine sites to allow for the boundaries of these areas to match some of the boundary lines of the land parcels. In the cases of Fond St. Jacques and Belle Plaine, this will ensure that the land selected as the drill site will be confined to a single parcel;
- The identification of alternative sites/parcels which can be used for both the placement of the well pads and staging areas for the proposed exploratory drilling;
- The identification of single-owner parcels (as opposed to family-owned) particularly in the Belle Plaine community, which has a high prevalence of family land tenure;
- The increased likelihood of PAPs on each of the Fond St. Jacques and Belle Plaine sites who are willing to provide access to their property without any major disagreement;
- Omitting a number of parcels from the original exploratory drilling area, thus reducing the total area of land potentially subject to involuntarily resettlement/ displacement;
- A reduction in the number of persons potentially displaced in each exploratory drilling area and a reduction in economic displacement/compensation.

2.3 MECHANISMS TO MINIMIZE RESETTLEMENT/DISPLACEMENT DURING IMPLEMENTATION

The mechanisms proposed to minimize displacement during the implementation of the RAP, include:

- **Installation of appropriate infrastructure** – where sites are not directly accessible from the public road, a well-drained, dry-weather road will be constructed to facilitate access to and from the site. The road shall be regularly maintained and kept wet if site preparation works are being done in the dry season. Should the operations be ongoing during the hurricane season, drains shall be properly cleared in advance of any impending storm of an extreme rain event. All storm water from the drains along the access roads shall be directed to a public drain, which the project will ensure is functional. The access roads shall be properly illuminated with cones (powered by solar energy or equivalent lighting source). The installation of this infrastructure will serve to avoid and/or minimize both physical and economic (claims for compensation) resettlement /displacement during the implementation of the RAP.

- **Site Delineation** –The limits of the well pad and civil works infrastructure will be demarcated using a GPS device and construction limit fencing. This mechanism will facilitate the continued use of the surrounding lands by the parcel owner for agricultural purposes.

- **Parcel Selection** – In Fond St. Jacques, there are two separate sites (east and west) that will need to be managed as the western site falls on/near the community playing field. The relocation of the playing field will not be considered given the limited availability of flat land to re-establish this facility and the cost associated. Therefore, every effort will be made to allow both the recreational activity and the geothermal exploration activities co-exist at the proposed site. The drill rig and project work areas will be properly fenced and illuminated where needed for safety.

  Parcel limits and ownership will be considered during selection of the drilling sites for slim-hole wells and potentially full-size wells in the Belle Plaine area. To the extent feasible, each well pad should be located within a single parcel to minimize negotiations. The location of the access road should also consider parcel boundaries to minimize negotiations with landowners. Access to the Belle Plaine parcel will be off an existing subdivision road which will be transformed into a dry-weather pavement.

  Mondesir sites MS-1 and MS-2 comprise one large parcel owned by the Crown. The parcel is uncultivated except for small plots located mostly along the main road that is being farmed by tenants of the Crown and squatters. At the commencement of the contractor site works, an access route to the well pad area may traverse a cultivated plot. Should this be the case, the entitlement matrix will be revised to include the affected cultivated plot(s) so that crop valuation and loss of income information will be readily available to estimate compensation to the PAPs. MS-3 and MS-4 are located in privately-owned parcels and cross public easements and WASCO easements. The well pad location and access path will be defined in consultation with the property owner to minimize disruption to the adjacent residences.

- **Impact of Noise and Air Quality Levels** – Mitigation measures to avoid or minimize displacement due to the impact of noise and poor air quality during implementation are detailed in the ESIA Scoping Studies Report. Generally, to mitigate the impact of noise, the wells will be located at least 150 metres (500 feet) or more from the nearest PAP's residence, to the extent feasible. In addition, wells should be vented through a silencer to avoid direct venting onto vegetation. With regard to unacceptable air quality levels (due to fugitive dust and geothermal gases), the drilling contractor is required to prepare, inter alia, an air quality

monitoring plan and emergency evacuation plan. Noise and air quality levels will be constantly monitored during geothermal drilling and testing and the plan implemented if the need arises. Any emergency evacuation from a blowout or unacceptable air quality levels would be very brief because the air emissions would quickly disperse into the atmosphere.

In order to minimize displacement during the implementation of the RAP, a complaints hotline will be established and the contact numbers will be posted on notice boards in the immediate vicinity of the sites. Should residents call regarding excessive noise, dust, and unbearable smells, immediate mitigation actions will be undertaken by the contractor to prevent reoccurrence.

3 CENSUS AND SOCIOECONOMIC SURVEY

The World Bank requires a census of all PAPs, "*regardless of their legal status—landowner, holder of land rights, tenant, illegal squatter—or whether they are actually living on an affected site at the time of the census*". Therefore, private landowners and holders of rights to the land in the geothermal target areas including any persons (tenants, caretakers[4], squatters,) currently occupying private and public (i.e. Crown) land for sources of livelihood are to be included in the census. The World Bank indicates that while landless people or squatters may not be eligible for land compensation, they may be eligible for compensation for assets (such as standing crops, orchards, or woodlots).

3.1 PROJECT-AFFECTED PERSONS

The term PAPs refers to "all those people who lose land or the right to use land or who lose access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods". The term "displaced persons" is synonymous with "project-affected persons" and is not limited to those subjected to physical displacement.

For the purposes of this project, the PAPs comprise five categories of individuals, who own and/or occupy land at the three geothermal resource target areas:

1. Property owners;
2. Landlords,
3. Tenants of property owners,
4. Tenants of the Crown; and
5. Squatters.

The general conditions of the entitlement policy, compensation and rehabilitation measures for the resettlement/displacement of each category of PAP are described below:

1. **PAPs losing land or structures** (or losing access to those assets) and/or having to physically relocate due to loss of livelihood, or losing access to income sources or means of livelihood: Generally, all PAPs with legal rights of land use. Compensation shall be made for loss of affected land, structures, and economic

[4] Occupant that is managing the land for relatives overseas

assets on the land at full replacement value. They will receive resettlement assistance in line with the World Bank policy requirements.

2. **PAPs experiencing temporary loss of land or temporarily losing access to these assets or access to income sources or means of livelihood.** All PAPs with legal rights to land use shall be entitled to compensation. Lease agreements will be negotiated between the government and landowners for temporary land take. They will also receive displacement assistance in line with the World Bank requirements.
3. **PAPs losing rental/leased land**: Holders of rental or lease agreements will be assisted with finding alternative land to rent/lease. Transitional assistance may be necessary to ensure that livelihoods are not affected.
4. **PAPs losing crops or economic trees**: Affected persons shall be allowed to harvest any crops planted prior to the date that land is taken. If land must be taken before the crops are ready for harvest, crop compensation shall be determined by the ministry with responsibility for agriculture and paid for by the project.
5. **PAPs who are squatters:** Squatters are persons who have no recognizable legal rights or claim to the land they are occupying. No record of squatters exists, but reconnaissance visits and interviews indicate that at least 5 to 10 landless farmers are on Crown lands. Whereas there will be no compensation for land, compensation for other assets such as crops or trees shall be determined by the ministry with responsibility for agriculture and paid for the project. Those using land unofficially for agricultural purposes shall be assisted with finding alternative areas available for use.

PAPs will provide proof of eligibility according to the identified categories above. Acceptable forms of evidence shall include:

1. Formal legal rights, documented in written form such as land registers, deeds, mortgages, lease agreements, tenancy agreements or rent receipts.
2. Criteria for Eligibility: Displaced persons may be classified in one of the following groups
    a. Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country
    b. Those who do not have formal legal rights to land at the time the census begins but have a claim to such land or assets- provided that such claims

are recognized under the laws of the country or become recognized through a process identified in the resettlement plan (see Annex A, para. 7 (f), and

3. Alternative means of proof of eligibility, which may include an affidavit signed by landowners and tenants that are witnessed or evidenced by a reputable member of society, such as Notary Royal, Justice of the Peace, priest, senior public servant, etc.

Any new agricultural activity or physical structure established after the cut-off date, shall not be considered affected; and the owners shall not be eligible for compensation unless they can demonstrate that the socio-economic survey/inventory of assets failed to identify them as being affected.

3.2 PRELIMINARY CENSUS

Based on records from the Land Registry, of the 42 parcels potentially affected by the project, 37 are privately held, four are owned by the Crown, and the remaining parcel is owned by WASCO. The Land Registry also reveals that the privately-held parcels in Belle Plaine and Fond St. Jacques are owned by several landowners/holders of land rights (trustees for sale, executrix, and heirs). Table 3-1 presents a summary of the ownership of lands in the potential drilling areas for the project. The final location of the drilling area has not been defined prohibiting preparation of a final census.

Table 3-1 Land Ownership in the Target Area

Community	Potential Drilling Area (ha)	Parcels Privately Held	Registered No. of Private Owners	Crown/ GOSL Parcels
Belle Plaine	26.3	29	26	2
Fond St. Jacques	1.3	5	8	1*
Mondesir	9.0	3	4	2
Total	**36.6**	**37**	**38**	**5**

*WASCO land ownership

Given the prevalence of "family lands" in Saint Lucia, the census (total number) of PAPs for the privately-held parcels is expected to be more than that listed on the Land Register. Initial consultations with some family members in the Fond St. Jacques target area indicated that some of the PAPs might be residing overseas; therefore, there may be a likelihood of caretakers' compensation. In the Belle Plaine target area, 16 of the 29 parcels belong to the heirs of one landowner. Preliminary discussions have also been held with some of these heirs.

With regard to the 8.7 hectares of Crown lands in Mondesir, there are only two tenants[5] currently farming a total of about 1.2 acres through lease agreements with Government. One of these tenants is a female who leases an acre for agricultural production and the other is a male, occupying 8,150 square feet for residential purposes. There is no recorded information on landless farmers (squatters/encroachers). However, based on reconnaissance visits and interviews conducted during the baseline socioeconomic survey, it is estimated that there are at least 5-10 landless farmers producing short-term crops on about 5-10 acres of these Crown lands. Ownership status of the lands at the four drilling sites was identified during the scoping exercise in September 2017; details are presented in Table 3-2.

Table 3-2 Land Ownership Status, September 2017

Block	Parcel	Area (m^2)	Owner of Record	Encumbrances
Fond St. Jacques Site				
	196	1,897 (Staging)	Four Trustees for Sale –(private land)	Private pedestrian right of way as shown on Registry Map. Vendor's Privilege
	174	5560	Private land owner	Private pedestrian right of way as shown on Registry Map.
	175	10,584 (Drilling)	Private land owner	Private pedestrian right of way as shown on Registry Map. (Partly along Eastern Boundary)
	238	255	The Water & Sewerage Company Inc.	Private pedestrian right of way as shown on Registry Map.
0428B	82	9,762	Executor of private land owner	Two Private pedestrian rights of way as shown on Registry Map.
	48	1,786	Heirs of Private land owner	Private pedestrian right of way as shown on Registry Map.
Belle Plaine Site				
0427B	193	2,152	Executors of private land owner	Private pedestrian right of way as indicated on the Registry Map.
	190	28,000		
	188	10,571		
	191	28,708		

[5] Source of information: Crown Lands Section, Department of Physical Planning, Government of Saint Lucia

Block	Parcel	Area (m^2)	Owner of Record	Encumbrances
0427B	189	26,260	Executors of private land owner	Private pedestrian right of way as indicated on the Registry Map.
	156	21,437		
	155	6,781	Private land owner	None
	154	9,374	Two private land owners	One Hypothec [mortgage???]
	157	2,596	Private land owner	One Hypothec
	158	2,234	Two private land owners	None
	159	1,225	Private land owner	None
	194	3,300	Private land owner	Two Hypothecs
	196	600	Crown	None
	197	41,100	Private land owner	Two Hypothecs
	103	3,334	Crown	Public pedestrian right of way as shown on Registry Map.
	104	4,532	Heirs of Private land owner	Public pedestrian right of way as shown on Registry Map.
	105	4,699	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.
	106	3,834	Administrators of estate of private land owner	• Usufruct: Brigitte Simeon for life. • Public pedestrian right of way as shown on Registry Map.
0427B	107	12,601	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.
	108	12,425	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.
	109	5,444	Five private land owner	Public pedestrian right of way as shown on Registry Map.
0428B	126	5,393	Executors of estate of private land owner	Private pedestrian right of way as indicated on the Registry Map.
	127	9,562		
	128	9,580		
	129	9,625		
	130	9,701		
	124	10,188		
	125	30,576		
	117	2,236		
	121	394		

Block	Parcel	Area (m^2)	Owner of Record	Encumbrances
	122	251		
Mondesir Site				
0624B	140	87,000	Crown	None

The geothermal exploratory drilling phase will include slim-hole wells in each of the three communities. The slim-holes will each displace approximately 0.12 hectares (0.3 acres) of land. If the slim-hole wells indicate the presence of a geothermal resource, additional slim-hole wells or full-size geothermal exploration wells could be drilled in Belle Plaine or Mondesir-Saltibus. The total temporary impact of the exploration phase is estimated at between 0.36 hectares (0.9 acres) and 2.3 hectares (5.6 acres) for the well pads depending on the number and size of the wells that are constructed. Additional lands would be affected by the construction of temporary access roads to the well pad area. The landowners/users within the affected parcels will be eligible for compensation for loss of livelihood. The exact number of PAPs and their specific socio-economic characteristics will be defined during the revised census survey to be conducted after the well pad and access road location and size has been defined and prior to the implementation of the RAP.

3.3 SOCIOECONOMIC SURVEY

The three project-affected communities span four rural settlements. Based on the last population census (2010), two of the settlements (Belvedere-Fond St. Jacques and Belle Plaine) in Soufrière district had an estimated 574 persons accounting for approximately 6.8 percent of Soufrière's total population. The other two settlements (Gayabois and Parc Estate) in Mondesir-Saltibus in the districts of Laborie/Choiseul, had 172 persons, which represents only 2.8 percent of Laborie's total population.

In September 2017, as part of ESIA Scoping Studies, a socioeconomic, land ownership, and land use survey was conducted for a sample of a cluster of the potentially affected households in the target communities. The main objectives of the survey were to collect baseline socioeconomic information from a representative group of the PAPs in the communities affected by the exploratory drilling and to solicit their comments and opinions about the project.

Although the sample size was relatively small (a total of 30 people), the results of the survey provide a general understanding of the size, distribution, and socioeconomic characteristics of the communities affected by the project. The survey also set a framework for future socioeconomic studies required to establish fair compensation rates and to design, monitor, and evaluate sustainable livelihood restoration strategies for the PAPs. The details of the methodology and results of the socioeconomic survey are contained in the ESIA Scoping

Report. A summary of the main demographic and socioeconomic information that is pertinent to the RAP's compensation and livelihood restoration strategies is presented in Appendix B.

3.4 CATEGORIES OF IMPACT AND PROJECT AFFECTED PERSONS

The ESIA Scoping Study Report (November 2017) provided an initial qualitative assessment of the potential impacts of the exploratory drilling phase of the project. The potential major impacts are associated with water resources, soils, air quality, noise, archaeological and cultural resources and socioeconomic conditions of the PAPs. Table 3-2 lists these potential impacts and the PAPs likely to be affected.

Table 3-3 Broad Categories of Project Impacts

Potential Impacts of Exploratory Drilling	Project Affected Persons likely to be impacted
Environmental Impact	
Water Resources - Contamination of the soil, surface water, or groundwater if the hazardous materials were spilled or not properly stored; may also reduce water availability	Residents in the three target communities - Belle Plaine, Fond St. Jacques, and Mondesir-Saltibus
Soils - site de-stabilization and soil contamination associated with site grading activities.	
Air Quality - fugitive dust and geothermal gases	
Noise - increase in noise levels from constant drilling for up to 3 months	
Archaeological and Cultural Resources - disturbance or destruction to historical resources (Ceramics, Amerindian pottery, etc)	Residents in the communities Belle Plaine and Mondesir-Saltibus/entire country;
Social and Economic Beneficial Impact	
Creation of temporary non-specialized jobs opportunities for men and women	Residents in the project region
Social and Economic Adverse Impacts	
Temporary loss of livelihood	Landowners, landlords, tenants of landlords, and caretakers in Fond St. Jacques and Belle Plaine Tenants and squatters/landless farmers on Crown lands in Mondesir-Saltibus
Temporary loss of agricultural land	
Loss of crops (i.e. short and long-term crops)	
Temporary Loss of income streams from agricultural production	

Potential Impacts of Exploratory Drilling	Project Affected Persons likely to be impacted
Limited use of land due to easements	
Temporary loss of land rental agreements	Tenant of landlords , and caretakers in Fond St. Jacques and Belle Plaine Tenants and squatters/landless farmers on Crown lands in Mondesir-Saltibus
Temporary Loss of income streams from the lease /rental of land	Landowners/landlords
Temporary loss of vacant nonresidential land	Landowners, community
Temporary loss of community land	Individuals who use the recreational facilities in the communities of Fond St. Jacques and Mondesir-Saltibus

Mitigation measures to avoid or minimize the environmental, social, and economic impacts that do not result from land taking are addressed through the ESIA. Compensation measures for all adverse impacts of economic displacement— the loss of income streams or means of livelihood associated with land taking are specifically addressed in Section 5 of this RAP document.

3.5 PROCESS FOR CONSULTATION ON THE RESULTS OF THE PRELIMINARY CENSUS SURVEYS

The GOSL has already conducted consultations in the communities of Belle Plaine, Fond St. Jacques, and Mondesir in its campaign to inform potential PAPs of the overall project and the associated impacts. The Department of Infrastructure, Ports, and Energy (DIPE)will continue its consultation program prior to project implementation and throughout the project duration by contacting the target communities and PAPs and addressing any grievances during project implementation. The main purpose of these consultations will be to explain why the displacement is necessary, discuss the preliminary assessment of the impacts, and disclose the procedures for assessing compensation, and the proposed timetable.

On completion of the preliminary census survey of the PAPs, the DIPE will convene consultations to discuss the results with the respective PAPs and/or their nominated representatives. The outcome of these consultations will be confirmation of the area of land required from each PAP and a reasonable consensus on the methods and formulas for assigning values to lost assets and income forgone during the resettlement/displacement period. The consultations, which will provide the PAPs with an opportunity to further express their concerns and suggest alternatives, will be held at times and venues most convenient to the PAPs.

3.6 NEED AND MECHANISMS FOR CENSUS AND SOCIOECONOMIC SURVEY UPDATES

Depending on the time lag between the completion of the revised census survey and implementation of the RAP, there may be a need to update the census and socio-economic surveys to ensure accuracy and equitable compensation of the PAPs. The information gathered from these surveys will also assist in determining the social dynamics likely to hinder or help the effectiveness of displacement measures.

Therefore, prior to implementation of the RAP, the DIPE, will develop and discuss with representatives of each community, the plans for the updated census and registration program of the PAPs. Given the relatively small number of PAPs involved, a Community Liaison Officer/ census enumerator will be recruited by the DIPE and will be thoroughly informed of the objectives and timetable of the project and the plans for compensation for lost assets, and restoration of livelihood.

Under the guidance of the DIPE, an updated census survey of the PAPs will then be undertaken by the enumerator who will register the PAPs according to location and inventory of immovable affected assets such as standing crops and fruit trees. The enumerators will take photographs to record the pre-project land occupancy and use of each property as well as the PAPs associated with each recorded property. These photographs will also provide the DIPE with a baseline with which to protect the project from claims by people who move into the affected area after the cut-off date (the date of completion of the updated census and asset/crop inventory). The updated census surveys will also include a socioeconomic study of each PAP in each community. The DIPE will then analyze the census information to determine the appropriate compensation for income restoration and to identify baseline monitoring indicators.

4 RESETTLEMENT POLICIES AND ENTITLEMENTS

4.1 WORLD BANK POLICIES FOR INVOLUNTARY RESETTLEMENT

The World Bank's Operational Policy on involuntary resettlement (OP 4.12[6]) covers direct economic and social impacts resulting from Bank-assisted investment projects which require:

- The compulsory acquisition of land, that would give rise to the relocation or loss of shelter; loss of assets or access to assets; or loss of income sources or means of livelihood, whether or not the affected persons are required to move to another location.
- The involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

In the case of this RAP, the applicable direct economic and social impacts resulting from the temporary land-take include displacement of agricultural production on private and public (i.e. Crown) lands in the three target communities.

In the context of the World Bank's social and environmental safeguard policies, this displacement establishes a basis for resettlement and thus OP 4.12 applies. In the World Bank's terminology, resettlement is not limited to physical relocation; it includes all direct economic and social losses resulting from land take and restriction of access, together with the requisite compensatory and remedial measures.

4.2 SAINT LUCIA LEGAL FRAMEWORK FOR RESETTLEMENT AND LEASE AND ACQUISITION OF LAND

4.2.1 Framework for Resettlement

There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. Over the years, the Government's resettlement initiatives have generally involved the physical relocation of households to resettlement sites; the displacement of agricultural production; and to a lesser extent the displacement of business operations, all for the purpose of making land available for development/public purpose.

[6] Involuntary Resettlement Sourcebook - Planning and Implementation in Development Projects,

Some of the principles for the implementation of local resettlement projects mirror that of the World Banks's resettlement policy. Displaced persons are: consulted about their options and rights; compensation standards are transparent and applied consistently across the board; and consideration is given to their concerns and specific requests. However, displaced persons are not always presented with a range of viable options for their resettlement. In some instances, the resettlement site has been one fixed location or the options among which an affected person may choose a resettlement site were limited. In some instances, the resettlement site has been one fixed location or the options among which an affected person may choose a resettlement site were limited.

In cases where households have been displaced, the focus has been on the reinstatement of these households at the resettlement site (i.e. an approved land development, where the necessary services have been installed). The typical relocation package offers the project beneficiary a replacement home and a house lot at subsidized prices and a relocation grant. In addition, the value of the household's equity in the property (i.e. house or house and land) at the relocation site, is deducted from the price of the house and land package offered.

The Government has typically focused on the payment of compensation in the displacement of persons involved in agricultural production and the displacement of businesses. In the case of displaced agricultural production, the landowner is paid the market value of the land and crops. Land-based compensation is generally avoided as it has proven challenging to find available agricultural lands for which a combination of productive potential, locational advantages, and other factors are at least equivalent to the advantages of the old site.

In cases where the occupier of the land is a squatter or tenant of the Crown, the affected party is given a minimum period of 6 months to harvest the existing short-term crops and to vacate the land. In circumstances involving long-term crops (e.g. such as fruit trees) or where the land will be required before or within the specified timeframe, crop compensation is determined by the ministry responsible for agriculture and paid by the ministry/agency responsible for project implementation. In the event that access to the land cannot be reestablished, prohibiting resumption of crop growing, compensation is determined dependent upon a reasonable time period for the individual to seek out an alternative livelihood, as also noted in Section 5.1.

Since the project will not require the permanent acquisition of land, the focus of the following sections will be on the legal framework for the lease of land in Saint Lucia (i.e., the recommended mechanism for dealing with the administrative issues associated with the temporary land take). The legal framework for land acquisition is discussed in the RPF for the project.

4.2.2 Saint Lucia Legal Framework for the Lease of Land

There is no single statute that deals solely with land lease agreements; however, there are pieces of legislation that address some specific types and/or aspects of leases. For example, the Civil Code of Saint Lucia, Cap. 4.01, which contains provisions for the governance and formalities of these type of contracts, provides guidance for the administration of the emphyteutic lease.

Another example is the Rent Restriction Act, Cap 13.23 of the Revised Laws of Saint Lucia that deals specifically with the rental of dwelling houses. In effect, none of the existing pieces of legislation are applicable in the context of this RAP.

There is no particular government ministry or agency with direct responsibility for the administration of lease agreements between the government and private individuals/companies /agencies etc. except in the case of the lease of Crown property, which falls under the purview of the Commissioner of Crown Lands. Should the need arise for private property to be leased by the Government for the purposes of a project, the ministry responsible for that project will negotiate and enter into a lease agreement (on behalf of the government) with that private entity. The lease agreement must be submitted by the responsible ministry to the Attorney General Chambers for vetting.

4.3 CONFLICTS/GAPS BETWEEN LOCAL LEGISLATION/POLICY AND WORLD BANK POLICIES

Table 4-1 provides a summary of the key conflicts/gaps that exist between the World Bank's policy and local legislation and policy as it relates specifically to resettlement. The proposed measures for addressing these conflicts are also presented in Table 4-1.

Since there exists no conflict/gap as it relates to the use of a lease as an instrument for acquiring the right of access to land for temporary use, this method of compensation is not included in Table 4-1. The World Bank's Involuntary Resettlement Handbook identifies the lease of land as a measure for acquiring the right of access to land, for temporary land acquisition, a practice that is widely employed in Saint Lucia.

Table 4-1 Conflicts/Gaps between Bank Policy and Local Legislation/Policy and Mechanisms to Address

Conflict/Gap	Local Legal Framework /Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
• Restoration of livelihoods and living standards; • Support for displacement; • Development assistance.	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. World Bank type policy pertaining to the restoration of income sources and livelihoods, support after displacement for a transition period; and the provision of development assistance, do not apply except in the case where replacement homes of greater value are provided as part of the relocation package.	OP 4.12 – Involuntary Resettlement: Section 2 (c) - Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher. Section 6 (c) - Where necessary … compensation should also include measures to ensure that displaced persons are offered support after displacement for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living. The displaced persons should also be provided with development assistance such as land preparation, credit facilities, training, or job opportunities, in addition to the	The Social and Environmental Safe Guards of the World Bank take precedence. All PAPs should be eligible for full compensation costs[7] per World Bank Policy requirements.

[7] Defined as the method of valuation of assets that helps determine the amount sufficient to replace lost assets and cover transaction costs. In applying this method of valuation, depreciation of structures and assets should not be taken into account. For losses that cannot easily be valued or compensated for in monetary terms (e.g., access to public services, customers, and suppliers; or to fishing, grazing, or forest areas), attempts are made to establish access to equivalent and culturally acceptable resources and earning opportunities.

Conflict/Gap	Local Legal Framework /Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
		other compensation measures stipulated.	
Opportunity to derive development benefits from project	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. Opportunities to derive development benefits are not generally part of the objectives or scope of work of local resettlement projects.	Performance Standard 5, Section 9 - The client will also provide opportunities to displaced communities and persons to derive appropriate development benefits from the project.	The Scoping Studies Report indicates that the project may create temporary job opportunities (during the civil works and drilling operations) for which specialized skill might not be available locally. However, for non-specialized jobs, it is recommended that the Government encourages the Contractor for the site works to give priority to the employment of workers originating from the target communities.

4.4 ENTITLEMENT POLICY FOR EACH CATEGORY OF IMPACT

The general conditions of the entitlement policy, compensation and rehabilitation measures for the resettlement/displacement of each category of PAP are as follows:

- **Project Affected Persons experiencing temporary loss of land** or temporarily losing access to these assets or access to income sources or means of livelihood. All PAPs with legal rights to land use will be considered entitled. Lease agreements will be negotiated between the government and landowners for temporary land take. Displacement assistance in line with the World Bank policy requirements will be provided.
- **Project Affected Persons losing rental/leased land:** Holders of rental or lease agreements will be assisted with finding alternative land to rent/lease. Transitional assistance may be necessary to ensure that livelihoods are not affected.
- **Project Affected Persons losing crops or economic trees:** Affected persons will be allowed to harvest any crops planted prior to the date that land is taken. If land must be taken before the crops are ready for harvest, crop compensation will be determined by the ministry with responsibility for agriculture and paid for by the project.
- **Project Affected Persons who are squatters:** Persons who have no recognizable legal rights or claim to the land they are occupying. Squatters will receive no compensation for land. Compensation for other assets such as crops or trees will be determined by the ministry with responsibility for agriculture and paid for by the project. Those using land unofficially for agricultural purposes will be assisted with finding alternative areas available for use.

4.5 ENTITLEMENT MATRIX

The compensation measures for displacement resulting from the temporary land-take which is addressed by this RAP are presented in Table 4-2.

Table 4-2 Entitlement Matrix

Category of PAP	Type of Loss	Compensation for Temporary Loss of Land or Access to Land	Compensation for Loss of Crops and Trees	Compensation for Loss of Income	Other Forms of Assistance
Landowner/ absentee land owner	Temporary loss of land or temporary loss of access to this asset	Negotiated lease agreements	Cash compensation to affected landowner/ farmers	Compensation based on the annual output of the leased land (multiplied by the total number of years for which the project operations will be taking place) plus the costs associated with land preparation and re-cultivation	Crop loss to be minimized to the extent possible by avoiding land-take during harvesting Return of land to owners after use
Landowner/ Landlord	Loss of rental income	Negotiated lease agreements	Not Applicable	Rental income lost will be covered by negotiated lease agreement	Return of land to owners after use
Tenants of Landowners/ Sharecroppers/ caretakers	Loss of rented/leased land; and crops and/or trees	Assistance with finding alternative land to rent /lease	Cash compensation to affected farmers.	Compensation based on the annual output of the leased land (multiplied by the total number of years for which the project operations will be taking place) plus the costs associated with land preparation and re-cultivation	Crop loss to be minimized to the extent possible by avoiding land take during harvesting Transitional assistance to ensure that livelihoods are not adversely impacted
Tenants of the Crown	Loss of rented/leased land; and crops and/or trees	Lease of equivalent land nearby if available	Cash compensation to affected farmers	Compensation based on the annual output of the leased land (multiplied by the total number of years for which the project operations will be taking place) plus the costs associated with land preparation and re-cultivation	Crop loss to be minimized to the extent possible by avoiding land take during harvesting. Transitional assistance to ensure that livelihoods are not adversely impacted

Category of PAP	Type of Loss	Compensation for Temporary Loss of Land or Access to Land	Compensation for Loss of Crops and Trees	Compensation for Loss of Income	Other Forms of Assistance
Squatters	Loss of crops or economic trees	Assistance with finding alternative land to rent /lease	Cash compensation to affected farmers	Compensation based on the annual output of the leased land (multiplied by the total number of years for which the project operations will be taking place) plus the costs associated with land preparation and re-cultivation	Crop loss to be minimized to the extent possible by avoiding land take during harvesting Transitional assistance to ensure that livelihoods are not adversely impacted

4.6 METHODS FOR VALUATION OF IMPACTS

The total compensation cost to be paid out to affected individuals would consist of the valuation of the crops and economic trees, land, and structures. Each of these methods are detailed below.

4.6.1 Valuation of Crops and Economic Trees

In the context of Government-related projects, crop valuation falls under the purview of the Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives. The values assigned to crops are specified as a range and are set by a committee of technical experts who take into consideration factors such as the species, location, production cost, market value, climate and environmental influences. The applicable compensation range for each crop is documented in the ministry's "Crop Valuation Guide" (2008), which provides a scale of royalty rates for timber according to cubic foot measurement; and a comprehensive list of crops and economic trees under the following broad categories:

- Fruit and tree crops;
- Vegetables and herbs;
- Cut flower and ornamental plants;
- Food and root crops.

Where crops are being valued for displacement from the land or removal of the crop, the economic life of the crop is considered (particularly for tree crops). When a valuation is required for an assessment of damage to the crop, where the crop continues to grow but growth is retarded, the age at the time of damage is taken into account. Consideration is given for the time it will take for a tree crop to attain a similar level of production on a new plot when conducting a displacement valuation.

The aforementioned provisions are generally in keeping with World Bank policy. Contrary to local practice, however, OP 4.12 notes that in some countries, the value of the harvest is determined by the average market value of crops for the previous 3 years. It states further that whatever the multiplier, if food supplies are sold in the area, enough cash compensation is paid to purchase equivalent supplies, taking into account the possibility of price increases caused by heightened demand from displaced persons. When determining the appropriate level of compensation. consideration shall be given to the duration of lost production, including the time it would take for the crops to return to their present production value.

4.6.2 Valuation of Land

Leasing will be used as an instrument for acquiring the right of access to land for temporary use. The land that will be temporarily acquired must be valued to facilitate the preparation of the lease agreement and compensation of owners. The methods for undertaking land valuations are guided by the code of ethics and standards of the Institute of Surveyors St. Lucia Inc. as well as that of the Royal Institute of Chartered Surveyors (RICS); and the International Valuations

Standards Council. The value of the land is the amount which the land (in its present condition) will realize if sold in the open market. Various methodologies (e.g., market approach, income approach and the investment [cost] method) are utilized in determining open market value as described above. The market approach involves valuation of land based on the selling price of a similar plot, which would be conducted by a qualified appraiser. Land is valued using the income approach by dividing the net operating income and by the capitalization rate. The investment method values land by estimating the cost to replace or reproduce facilities on land, minus depreciation, plus land value. The method most predominantly utilized, however, is the market approach, while the other methodologies are normally used as a check against the market approach. Whatever the approach used, the key considerations include factors such as location, topography, size, available services, tenure, land use and the presence or absence of natural hazards. The duration of use and loss of income would also be considered when determining appropriate compensation.

Note that where land-based options for compensation of land acquired are not feasible, the use of replacement cost, including the open market value of land and associated costs, as the means of determining the value of compensation is in keeping with World Bank Policy OP 4.12.

4.6.3 Valuation of Structures

There is no existing legislation to guide the process for valuation of structures or buildings (residential, commercial or institutional) or other constructions such as foundations, fences, latrines, storage sheds or platforms for water storage tanks. Methods for undertaking the valuation of structures are guided by the code of ethics and standards of the Institute of Surveyors St. Lucia Inc. as well as that of the RICS.

The RICS Valuation - Global Standards (the RICS 'Red Book' as it has become widely known) contains mandatory rules and best practice guidance for undertaking asset valuations. The valuation report is the common way of communicating the value of a property, through an opinion on the "Replacement Cost". This opinion is based on the use of data concerning location, amenities, structural condition, age of structure; and recent sales of similar local properties.

In keeping with World Bank Policy OP 4.12, the replacement cost is the method of valuation of assets that are used to help determine the cost of replacing lost assets and transaction costs. In applying this method of valuation, the depreciation of structures and assets is not considered.

5 INCOME RESTORATION

The income restoration strategies will comprise mainly monetary compensation since only a few PAPs will be economically displaced due to the limited area required for the exploration activities (0.4 to 2.8 hectares). The lands at two of the drilling sites (Fond St. Jacques and Belle Plaine) are privately-held and appear to be uncultivated agricultural land; while the 8.7-hectare parcel of Crown lands at Mondesir is sparsely populated/cultivated by mostly squatters. Efforts should be made during final drilling site selection to minimize the displacement of the squatters. The land-take for the exploratory drilling is temporary, requires no physical relocation and the total area of the temporary land-take will be small (0.4 to 2.8 hectares for the well pads). Therefore, cash compensation (as outlined in the entitlement matrix) is an appropriate strategy for income restoration. This strategy is not expected to vary significantly with the area/locality of impact as all impacts are essentially the temporary loss of use of agricultural land in largely rural communities within a 15-mile radius.

5.1 RESTORATION STRATEGIES

The RAP implementation program will be carried out in parallel with the Project planning, infrastructure preparation, drilling design, procurement – and will need to be completed before the drilling work program.

On the basis of the final technical design and in keeping with the RAP implementation schedule, the implementing agency (IA), particularly the safeguards team, will:

1. Screen identified project sites to:
    - Update the preliminary census and household surveys of PAPs
    - Determine the nature of land acquisition - whether temporary or permanent – and establish if land is to be purchased or leased. This includes private and crown lands.
2. Finalize valuation methods and entitlements
3. Coordinate land and crop surveys; land and crop valuations
4. Negotiate with PAPs to finalize compensation rates
5. Establish the budget for compensation payments
6. Disburse compensation to PAP. PAPs will receive compensation either by check or by bank transfer. For vulnerable households, special attention will be paid to providing assistance to facilitate the payment process.

The PAPs will be provided with prompt and effective cash compensation at full replacement cost for losses of land and crops to restore their income and living standards after the temporary land acquisition. Table 5-1presents and Income Restoration Matrix for the displacement of the PAPs due to the geothermal drilling stage.

Compensation will be paid for crop loss and loss of use of income that would have been obtained from the land during the period of temporary project acquisition. Transitional assistance will be provided to squatters who are affected by the project to ensure that their livelihoods are not adversely impacted. These compensation entitlements are sufficient to restore income streams for the temporary loss of land or livelihood, until the squatter can resume tending the land or find another suitable livelihood. The compensation will be paid in its entirety and in a timely manner to enable displaced PAPs to make productive use of their cash compensation.

The lands will be restored to their original productive use at the completion of the geothermal exploration activities. The responsibility and cost of restoring the land to its former productive use will be explicitly defined in the drilling contract.

Table 5-5-1 Income Restoration Matrix

Project Impact	Assets/PAPs	Income Restoration Policy	Other Measures
Loss of use of/ access to/and livelihood from temporary land acquisition	Agricultural lands of: • Private landlords, tenants and caretakers; • Crown lands/ squatters	Cash compensation to PAPs; method for determination set out in the Resettlement Policy Framework (RPF) and Entitlements section of the RAP Restore the land to its former productive use at the end of the exploratory phase	Return of temporary land in restored condition to owner or user after use Assistance with identifying alternative lands for rent or lease;
Loss of crops and trees	• Crops and economic trees of private land-lords/tenants and caretakers; • Sharecroppers • Crown lands/ squatters	Cash compensation of PAPs based on the valuation method set out in the RPF and Entitlements section of the RAP	Crop loss to be minimized by avoiding acquisition during harvesting

Other additional economic rehabilitation measures include development assistance to the PAPs, such as job opportunities. The civil works and drilling contractors will give priority to agricultural tenants for non-specialized labour employment opportunities. The displaced

persons/PAPs will also be consulted to explore other options for economic rehabilitation measures and income restoration. These income restoration measures do not require significant changes in livelihoods or development of alternative farmlands and do not involve other activities which require a substantial amount of time for preparation and implementation.

5.2 INSTITUTIONAL RISK FOR IMPLEMENTATION

One of the main institutional risks for the smooth implementation of this resettlement program is the possible delay in disbursement of cash compensation to the PAPs due to the procedures involved in approving and releasing these funds. Project activities will not be able to commence until compensation has been made to the PAPs, resulting in the delay. Additionally, the length of time taken by the collaborating Government Departments is outside the control of the Project Manager (PS/DIPE). For example, an increase in the length of time taken by the Attorney General's Chambers to vet leases or by the Crown Lands sections to identify alternative lands for lease could pose a risk in the transfer of lands to be used temporarily by the project and thus delay the timely disbursement of compensation. These risks will be addressed by ensuring sufficient budgetary allocation in the project for cash compensation and by ensuring that all collaborating agencies are continually informed of the urgency of the project and the impacts of delays on the project.

5.3 MONITORING FOR INCOME RESTORATION

The process for monitoring the effectiveness of the income restoration measures will form part of the general monitoring and evaluation of the implementation of the RAP. Internal monitoring of disbursement of compensation will be the responsibility of the Project Steering Committee (PSC) and the DIPE. The PSC and parties responsible for income restoration are discussed further in Section 6. The Technical Director (TD), Al Barthelmy, will provide the DIPE and PSC with regular updates on the progress of compensation disbursements to identify problems and to allow timely corrective actions.

6 INSTITUTIONAL ARRANGEMENTS

6.1 INSTITUTIONAL RESPONSIBILITY AND CAPACITY

The project is a manifestation of GOSL's commitment to reduce the island's reliance on fossil fuels for energy generation and to meet its energy targets from renewable sources by the year 2020. The GOSL has committed the resources of the Government agencies (indicated in Table 6-1) to provide the services required to facilitate inter alia, the resettlement efforts of this project. A rapid assessment of the institutional capacity of these agencies to undertake the tasks assigned indicates that it is part of their regular mandate to provide these services. In addition, the agencies possess the relevant personnel with the capacity to deliver the services indicated and as such, no specific training requirements have been planned as part of this project to develop staff capacity.

Table 6-1 Key Agencies Responsible for Entitlement Delivery

Agency	Department/Section	Responsibility
DIPE	Office of Permanent Secretary	• Identify and categorize the PAPs and determine entitlement
DPP	Registrar of Lands	• Verification of Title (ownership) and the quantum of property
DPP	Crown Lands	• Identification of alternative land for rent or lease
DIPE	Accounts	• Financial support for the implementation of the RAP and payment of compensations
Department of Agriculture	Extension Unit	• Valuation of crops and trees; determines crop compensation
Department of Equity and Social Justice	Social Transformation Office	• Assist with the coordination of RAP activities in the targeted communities, and resolution of any grievances
Project Co-ordination Unit (PCU)	Social Safeguards Officer	• Responsible for coordination of the RAP

6.1.1 Department of Infrastructure, Ports, and Energy

The Project is proposed to be implemented by the DIPE within the MoIPEL. The latter took over responsibility for the entire energy sector portfolio, including renewable energy, as part of a restructuring process that was implemented in 2017. DIPE is led by a Permanent Secretary (PS-DIPE), who is responsible for energy policy and Project implementation in Saint Lucia. As the project's lead implementing agency, DIPE will have the responsibility of managing the process of implementing the Project consistent with World Bank guidelines, procedures and practices for environment and social safeguards (including resettlement, if needed), procurement, disbursement, accounting, and financial management.

DIPE is in the process of establishing a dedicated PIU dedicated to geothermal resource development, with functions, staffing and sufficient resources to manage all aspects of Project implementation. The PIU will be headed by a Project Manager who will report directly to the PS-DIPE. The PIU will also comprise, at minimum, a

(i) Technical Officer (TO),
(ii) Procurement Officer (PO),
(iii) Financial Management Officer (FMO),
(iv) Social Development Officer (SDO), and an
(v) Environmental Safeguards Officer (ESO).

Many of these positions will be hired during the Project preparation phase, benefiting from the availability of a grant prior to Board approval and/or through retroactive financing of eligible activities defined and agreed with the Bank prior to Board approval.

The process to hire the Project Manager is currently underway and is expected to be completed by October 2018.

The Social Safeguards Officer (SSO) team will coordinate with the various contributing responsible agencies, and will act as liaison for all relevant institutions and agencies responsible for the execution of the RAP.

6.1.2 Department of Economic Development, Transport and Civil Aviation

Given that the Project Implementation Unit (PIU) has not been established, the project will utilize the existing Project Coordinating Unit (PCU) – under the Department of Economic Development, Transport and Civil Aviation (DETC) – to undertake the fiduciary and safeguards functions until such time that the PIU is determined to have adequate capacity to manage these activities, after which time the responsibility to undertake these functions will transfer to the PIU, including the social safeguards responsibility for reporting on RAP implementation.

The PCU currently administers all existing World Bank loans and grants, including for the ongoing GRDP TA project, and has dedicated staff that benefit from the experience of implementing World Bank projects for the past 15 years. However, the PCU is overloaded with heavy responsibilities, making it important to establish a dedicated team to handle the

additional workload and the complexity arising from the proposed highly specialized geothermal exploration project.

6.1.3 Memorandum of Understanding between DIPE and DETC

A Memorandum of Understanding (MOU) will be signed prior to Negotiations between DIPE and DETC to agree on the transition arrangements for these functions. It is expected that the transition will take place approximately 6 to 12 months after Project effectiveness. During the transition period, the PO and FMO will report jointly to the PCU Project Coordinator and the PS-DIPE. The SDO function will also be undertaken initially by the PCU. The PCU currently has under contract a environmental consulting firm (Panorama Inc.), a social safeguards specialists, a community liaison officer, and communications consultancy; however, a dedicated SDO will be needed for this Project. Thus, a new SDO will be brought on board as soon as possible to ensure the stakeholder engagement plan can be effectively implemented. The SDO will oversee the work of the communications firm that is already hired by the PCU to support this Project. As soon as the PIU Project Manager is on board, the new SDO will transfer to the PIU and will report directly to the PIU Project Manager. During the transition period, if any, the SDO will report jointly to the PCU Project Coordinator and the PS-DIPE. The ESO function will be on board prior to the initiation of the EMC activities. Given that the PIU is expected to be operating by that time, it is anticipated that the ESO will initiate work directly under the PIU. The ESO will be responsible for the faithful execution of the Environmental and Social Management Plan (ESMP) through supervision of the EMC and oversight of the drilling contractor, as well as liaison with stakeholders and reporting to the World Bank Group.

For technical expertise, DIPE currently has a technical staff dedicated to geothermal activities, and is supported by consultancies of two international experts (technical and transaction advisory). However, given the GOSL's lack of experience in overseeing and implementing a geothermal exploration program of this complexity, the PIU will hire an EMC to enhance the PIU's capacity to implement and oversee the drilling program (DP). The scope of the EMC will include inter alia final DP site selection; preparation of terms of reference for the DP and associated ancillary services; and supervision of the same. The terms of reference for the EMC has been prepared, and the EMC should be on board by early 2019.

The key government agencies with responsibility for entitlement delivery and the implementation of the RAP are outlined in Table 6-1.

Table 6-26-3 Key Agencies Responsible for Entitlement Delivery Agency	Department/Section	Responsibility
Department of Infrastructure, Ports and Energy (DIPE)	Office of the Permanent Secretary	• Identify and categorize the PAPs and determine entitlement
Dept. of Physical Planning (DPP)	Survey and Mapping Unit Section	• Survey and valuation of lands to be leased/acquired
DPP	Registrar of Lands	• Verification of Title (ownership) and the quantum of property
DPP	Crown Lands	• Identification of alternative land for rent or lease
DIPE	Accounts	• Financial support for the implementation of the Rap and payment of compensations
Department of Agriculture		• Valuation of crops and trees; determines crop compensation
Department of Agriculture, Fisheries, Natural Resources and Cooperatives	Extension Unit	• Valuation of crops and trees; determine crop compensation
Project Coordination Unit (PCU)	Social Safeguards Officer	• Responsible for coordination of the RAP
Department of Equity, Social Justice, Empowerment and Human Services	Social Transformation Office	Social Transformation Officers will: • Assist with the coordination of RAP activities in the 3 target communities. • Assist with the resolution of grievances arising during implementation of the RAP

6.1.4 Saint Lucia Electricity Services Ltd.

Saint Lucia Electricity Services Ltd. (LUCELEC) will play a key role in the geothermal power off-take and its integration in the electricity supply system to support the GOSL's renewable energy policy goals. However, despite the utility's strong experience in power sector operations, neither the GOSL nor LUCELEC has prior experience in geothermal development or in negotiating of a suitable off-take agreement. Nonetheless, once completed, LUCELEC, as system operator, will integrate the geothermal plant's output into the domestic electricity network. As project implementation progresses, the GoSL will explore alternative models for future implementation, including, among others, a Special Purpose Vehicle (SPV) to implement the geothermal Project or, alternatively other arrangements, e.g. a joint venture with the government and/or LUCELEC working in strategic partnership with a qualified private developer.

6.2 PROJECT STEERING COMMITTEE

A Project Steering Committee (PSC) will be established by the DIPE. DIPE will provide inter alia, dedicated attention to the coordination of the implementation of the RAP for each phase of the Project. The chairperson of the PSC will be selected by the PS from among the representatives of that Department. The PSC will be responsible for ensuring the smooth execution of project activities; and for the successful accomplishment of project objectives. The PSC will meet monthly to review project implementation and performance. Meetings will also be convened when necessary to attend to urgent matters, which may arise in the course of project implementation.

The roles and responsibilities of the PSC will be to:

- Assess project progress and performance;
- Provide technical advice and guidance on project implementation activities;
- Assist with resolving strategic-level issues and risks;
- Use influence and authority to assist the project in achieving its outcome.

The PSC will be accountable to the PS of the DIPE, and comprise the following members

- Representatives of the DIPE:
  - Chief Technical Officer
  - Legal Officer
  - Technical Director – Project
  - Procurement Officer (PO),
  - Financial Management Officer (FMO),
  - Social Development Officer (SDO), and an
  - Environmental Safeguards Officer (ESO)
- Representative of the PIU
- Representatives of the Department of Physical Planning:
  - The Authorized Officer or his/her representative
  - Commissioner of Crown lands or his/her representative
  - Quantity Surveyor
  - Valuation Surveyor
- Social Transformation Officers for each of the affected communities
- Member of a recognized community-based organization (i.e. one member from each community)
- Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives

6.3 ROLES AND RESPONSIBILITIES OF SSO AND CLO

Social Safeguards Officer (SSO) has the following responsibilities:

- Lead the RAP implementation activities and liaise with relevant government departments
- Ensure the RAP is updated with results of supplementary census surveys and asset/crop inventory
- Manage the stakeholder database
- Review all construction contracts for compliance with the ESMP and other associated plans; including meetings and audits
- Manage the Renewable Energy Sector Development project grievance redress mechanism
- Minutes of all meetings and consultations will be maintained by the PCU (and eventually the PIU) and shared with all parties. The Bank and all other agencies will be informed by email immediately following each meeting.
- Contribute to the Renewable Energy Sector Development project's regular reports to the World Bank, on the implementation of social safeguards measures.
- Report to stakeholders regarding: important details on the undertakings, routines, status, project progress and new or corrected information since the last report. Report frequency will be in accordance with the order set in the SEP.

Community Liaison Officer (CLO) will, in collaboration with the SSO:

- Conduct stakeholder outreach during project implementation and respond to any grievances or complaints that may arise
- Act as the key focal contact to bring project grievances from construction workers, local residents, and community members to the GRC.
- Be responsible for making sure the recommendations of the GRC are implemented and directing contractors to make any appropriate change to their work.
- Provide monthly monitoring reports on stakeholder outreach and grievance redress to the SSO

6.4 GRIEVANCES REDRESS COMMITTEE

The Grievances Redress Committee (GRC) will be a subcommittee of the PSC. The GRC's will be responsible for managing in a fair, objective, and constructive manner, all concerns or complaints raised by PAPs (individual or group) within the communities affected by the Project. The GRC, which will be established by the PSC and sanctioned by the PS, DIPE, will comprise, the Technical Director, other representatives of the DIPE (the Legal Officer, and Chief Technical Officer), Social Transformation Officers and community-based organization for each of the affected communities; representative of the Department of Physical Planning (Commissioner of Crown Lands, Quantity Surveyor, Valuation Surveyor) as well as a representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives

The broad responsibilities of the GRC include:

- Developing and publicizing the grievance management procedures
- Receiving, reviewing, investigating and keeping track of grievances
- Developing resolution options and responding to grievances
- Adjudicating grievances
- Monitoring and evaluating fulfillment of agreements achieved through the grievance redress mechanism

More details of the grievance redress mechanism are provided in Section 10 of the RAP.

7 IMPLEMENTATION SCHEDULE

7.1 STEPS IN THE DISPLACEMENT PROCESS

The main chronological steps involved in the implementation of the resettlement/ displacement are broken down below.

1. Receipt of final technical design clearly indicating planned location of test pits
2. Refine/approve project budget and establish PSC
3. Convene consultations with PAPs and communities on preliminary census and socioeconomic survey of PAPs
4. Update Preliminary Census and household surveys of PAPs
   - 4.1 Plan Surveys (budgeting and recruitment of enumerator)
   - 4.2 Identify and record affected land and crops
   - 4.3 Identify and record official names of RAP including addresses, demographic and socioeconomic characteristics
5. Finalize valuation methods and entitlements
   - 5.1 Review valuation methods
   - 5.2 Hold consultations to verify entitlements and disclose valuation methods;
   - 5.3 Establish cut-off-date for eligibility for compensation
   - 5.4 Develop draft agreement for land lease
6. Undertake land surveys and valuation of land
7. Undertake crop surveys and valuation of crop
8. Update the RAP Report
   - 8.1 Disclose/present draft RAP to PAPs
   - 8.2 Obtain and incorporate comments on draft RAP
   - 8.3 Prepare and approve updated RAP
9. Implement the RAP
   - 9.1 Establish budget for compensation payments
   - 9.2 Finalize procedure for compensation payments
   - 9.3 Verify eligibility of the PAPs
   - 9.4 Revise and approve compensation schedules
   - 9.5 Sign agreements/contracts and disburse compensation to PAPs
   - 9.6 Finalize arrangements for grievances mechanisms
   - 9.7 Take possession of the drilling and staging sites by DIPE
10. Start civil works and exploratory drilling operations by contractor
11. Monitor and evaluate the implementation of the RAP

7.2 RESPONSIBLE AGENCIES

The DIPE headed by the PS, will be the main Government agency responsible for implementing the RAP. The PSC will comprise representatives of other key agencies that have particular expertise to facilitate the smooth implementation of the project. The Grievances Redress Committee (GRC) will be a sub-committee of the PSC.

The main agencies responsible for implementation are listed below and their role in each step of the RAP process is provided in Table 7-1:

Agency	Abbreviation
Department of Infrastructure, Ports, and Energy	**DIPE**
Permanent Secretary	PS
Chief Technical Officer	CTO
Technical Director	TD
The Legal Officer	LO
Project Steering Committee	**PSC**
Grievances Redress Committee	**GRC**
Social Transformation Officers; Department of Equity, Social Justice, Empowerment and Human Services	**STO**
Department of Physical Planning	**DPP**
Authorized Officer	AO
Commissioner of Crown Lands	CCL
Quantity Surveyor	QS
Valuation Surveyor	VS
Recognized community-based organization	**CBO**
Department of Agriculture, Fisheries, Natural Resources and Cooperatives;	**DAF**
Project Coordination Unit	**PCU**
Attorney General's Chambers	**AGC**

The project implementation schedule (Gantt/Bar chart) for resettlement is illustrated in Table 7-1. The agencies that are responsible for the various activities are also indicated in the schedule. It is anticipated that activities will be implemented within a 12-month duration coinciding with Government's fiscal year (2018-2019) to facilitate the local budgetary processes for funding for the implementation of the RAP.

7 IMPLEMENTATION SCHEDULE

Table 7-1 Implementation Schedule for the Land Resettlement

Activities	Main Agency*	Fiscal Year 2019/2020											
		Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
1. Receive final technical design with test pits' locations	DIPE (PS, TD, CTO)												
2. Refine/approve Project budget & establish PSC	DIPE (PS, TD, CTO)												
3. Convene consultations with PAPs & communities	DIPE (TD, STO), CBO												
4. Update Census & household surveys of PAPs	DIPE (TD, CTO) , CBO												
4.1 Plan Census & Surveys	DIPE (TD, CTO), CBO												
4.2 Identify & record affected land & crops	DIPE (TD, CTO)												
4.3 Identify & record PAPs characteristics	DIPE (TD, CTO)												
5. Finalize valuation & entitlements	DIPE, DPP, DAFP												
5.1 Review valuation methods	DPP, DAFP												
5.2 Hold consultations to verify entitlements	DIPE (TD, STO)												
5.3 Establish cut-off-date for compensation eligibility	DIPE, DPP, DAFP												
5.4 Draft agreement for land lease.	DIPE, PS, LO, AO												
6. Undertake land surveys and valuation of land	DPP, DAF												
7. Undertake crop surveys and valuation of crop	DAF												
8. Update RAP Report/present draft RAP to PAPs	DIPE (TD, CTO)												
9. Implement RAP	DIPE (TD, CTO)												
9.1 Finalize budget for compensation payments	PCU; DIPE (PS, TD)												
9.2 Finalize procedure for compensation payments	DIPE (LO, TD)												
9.3 Verify eligibility PAPs for compensation payments	DIPE, DPP, STO												
9.4 Revise & approve compensation schedules	DIPE, PCU,												
9.5 Sign agreements & disburse compensation to PAPs	DIPE, AGC												
9.6 Finalize arrangements for grievances mechanisms	DIPE (LO); GRC												
9.7 Take possession of drilling & staging sites by DIPE	DIPE (PS, TD)												
10. Start civil works & exploratory drilling by contractor	Contractor												
11. Monitor & evaluate the RAP	DIPE (PS, TD)												

7.3 LINKAGE BETWEEN RESETTLEMENT AND CIVIL WORKS

The bidding documents for civil works will be timed appropriately and include provisions to account for potential delays in negotiations and compensation to landownders. . The civil works will commence only after all compensations are satisfactorily agreed, payment is received by the PAPs and the sites taken over by the DIPE. The PAPs will be allowed a period of four weeks within which all activities at the affected property should cease after receiving compensation payments. Once these activities have been completed, the contractor will be instructed to mobilize and take possession of the sites to commence implementation of the civil works. According to the schedule, all resettlement/ displacement activities will be completed in time for the drilling contractor to have full access to the land to commence the civil works and exploratory drilling operations.

8 COMPENSATION PROCEDURES, COSTS, AND BUDGETS

8.1 IMPLEMENTATION PROCEDURES FOR COMPENSATION PAYMENT

The RAP implementation program will be carried out in parallel with the Project planning, infrastructure preparation, drilling design, procurement – and will need to be completed before the drilling work program.

On the basis of the final technical design and in keeping with the RAP implementation schedule, the implementing agency (IA), particularly the safeguards team, will:

1. Screen identified project sites to:
   a. Update the preliminary census and household surveys of PAPs
   b. Determine the nature of land acquisition - whether temporary or permanent – and establish if land is to be purchased or leased. This includes private and crown lands.
2. Finalize valuation methods and entitlements
3. Coordinate land and crop surveys; land and crop valuations
4. Negotiate with PAPs to finalize compensation rates
5. Establish the budget for compensation payments
6. Disburse compensation to PAPs. PAPs will receive compensation either by check or by bank transfer. For vulnerable households, special attention will be paid to providing assistance to facilitate the payment process.

8.2 COMPENSATION

8.2.1 Types of Compensation

Compensation will take one of the following forms, depending on the status of the project affected person:

- **Compensation at replacement cost:** Replacement cost addresses compensation for tangible assets - primarily land, houses, other structures, trees, crops, access to water, and other improvements upon the land. According to OP4.12, replacement cost is the method of valuation of assets that helps determine the amount sufficient to replace lost assets and cover transaction costs. In applying this method of valuation, depreciation of structures and assets should not be taken into account. For losses that cannot easily be valued or compensated for in monetary terms (e.g., access to public services, customers, and suppliers; or to

fishing, grazing, or forest areas), attempts are made to establish access to equivalent and culturally acceptable resources and earning opportunities. Where domestic law does not meet the standard of compensation at full replacement cost, compensation under domestic law is supplemented by additional measures necessary to meet the replacement cost standard. Such additional assistance is distinct from resettlement assistance to be provided. For agricultural land, it is the pre-project or pre- displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes. For land in urban areas, it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes. For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes. In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset. Where domestic law does not meet the standard of compensation at full replacement cost, compensation under domestic law is supplemented by additional measures so as to meet the replacement cost standard. Because valuation cannot be established for intangibles, such as sentimental attachments, proximity to neighbors or relatives, spiritual sites, or aesthetic qualities such as view, compensation at replacement cost refers to compensation for tangible assets only.

- **Land for land**: PAPs losing land must receive an option allowing them to obtain comparable replacement land. Direct replacement of expropriated land with land identified by the Borrower is acceptable as an option to be presented to PAPs. These replacement lands - typically government land, converted forest, or degraded lands - must be of equivalent productive potential (or developed to make them so) and must be acceptable to PAPs themselves.

- **Employment as Rehabilitation**: Providing employment is acceptable as an option presented to PAPs as a measure of livelihood restoration. Employment must be guaranteed for three years and must include payment of fair wages.

8.3 SOURCES OF FUNDING AND ESTIMATED COST

The national budget will be relied on for the land acquisition and resettlement compensation. The DIPE makes provision for the costs related to compensation for acquisition, resettlement, relocation and other associated administrative and logistical costs that may be incurred. This forms part of the appropriation bill and approved estimates (annual budget) of the DIPE after approval of the Capital Estimates of the GOSL. Funds to affected persons are paid directly by the DIPE.

8.4 ESTIMATED COST OF DISPLACEMENT

The main cost associated with the temporary acquisition of land is the payment of cash compensation to be made to the PAPs for leasing their land to facilitate the exploratory drilling. Compensation will be made, as detailed in Table 4-2, for the consequential loss of the use of the land, access, crops/trees and income streams from agricultural production, and/or land rent. The compensation amount payable to each PAP will be based on their individual entitlement which will be computed on the basis of the annual output of the leased land, plus the costs associated with land preparation and re-cultivation. Rental income lost will be covered by negotiated lease agreements.

The other areas of project expenditure include administrative expense for implementation, monitoring, and evaluation of the RAP.

8.5 PRELIMINARY BUDGET ESTIMATE

Table 8-1 presents a broad preliminary estimate of XCD150,000.00 for implementation of the RAP. The budget was derived using information obtained from the Department of Agriculture and the Crown Lands section of the Department of Physical Planning. It was observed that most of the rates/prices are dated; therefore, a price adjustment factor was used to reflect current market prices and the need to projectize the implementation of the RAP in order to achieve the desired objectives within the time schedule. However, the final budget estimate will be determined after the valuation exercises are conducted by the Valuation Section of the DPP and the Extension Division.

The farming practiced in the potential drilling areas is generally crop production, especially root crops (dasheen and sweet potatoes) followed by vegetables (cucumbers, cabbages, melons, and tomatoes). Given the uncertainty of the status of crops at the cut-off date, a relatively higher allowance of 25 percent was made for economic and performance contingencies. Since it is anticipated that these costs will be incurred during a one-year fiscal period (2018/2019), there

will be no need for specific mechanisms to adjust cost estimates by the inflation factor. The actual compensation will need to be defined at the time of drilling site selection using current valuation for affected crops and lands.

Table 8-1 Preliminary Budget for Implementation of the RAP

Cost Component	Cost Estimate (XCD)
Cash Compensation:	
Loss of land/income restoration[1/]	25,000
Loss of crops and trees[1/]	20,000
Land Lease[2/]	15,000
Total Compensation Cost	***60,000***
Administrative Expenses [3/]	40,000
Monitoring & evaluation [4/]	20,000
Total Cost	**120,000**
Contingencies [5/]	30,000
Grand Total	**150,000**

1/ Figures are based on rates obtained from the Extension Division of the Department of Agriculture. The information is dated (1990 and 2008 Crop Valuation Guide" (2008). Therefore an adjustment factor was used to reflect current market prices. However, the final budget estimate for this cost will be determined by the Extension Division.

2/ Approx. 4 acres; these figures do not include the land at Mondesir (Crown lands) and are based on rates of $100.00- $300.00/acre/year for agricultural production obtained from the Crown Lands Section of the Department of Physical Planning (DPP). These rates were adjusted upwards to reflect the short-term nature of the lease and the need to achieve the project objectives within the time schedule. However, the final budget estimate for this cost will be determined by the Valuation Section of the DPP.

3/ Clerical staff.

4/ Figure is based on a short-term consultancy of 10-15 person-days.

5/ 25% of Total Cost due to economic and performance contingencies – the high uncertainty of (a) rates for cash compensation and (b) time delays in executing the RAP.

8.6 PAYMENT PROCESS

A Requisition Order containing a unique number will be prepared by the Office Assistant (designated or assigned administrative personnel). All relevant supporting documentation including proof of ownership, Resettlement Action Plan, invoice and any other supporting documents must be attached to the requisition order and certified correct by the Safeguards Officer or an Officer with delegated authority.

The Requisition Orders will be reviewed and verified by the Procurement Officer with responsibility for the Project. The Requisition Order will also be reviewed and approved by the Project Manager and the Permanent Secretary of DIPE or a person with delegated authority. Once approved by all parties above, the Requisition Order will be forwarded to the Accounts Department of DIPE for finalization of payment.

An Accounts Officer within DIPE will create an invoice on SmartStream attaching the completed Requisition Order and all supporting documents. The invoice is approved (electronically) by a Senior Accountant within DIPE. The final level of approval is done by the Accountant General. Once approved the payment is marked as completed in SmartStream. The cheque is printed and then made available to the payee.

Persons presenting themselves for a cheque will need to present a valid form of photographic identification. Third party collections will only be done if the third party possesses the following:

- ✓ A written authorization from the supplier
- ✓ His/her valid form of photographic identification

9 PARTICIPATION AND CONSULTATION

Stakeholder engagement is an ongoing process conducted throughout the life cycle of the project. Its aim is to develop strong and responsive relationships that are important for successful project implementation. The safeguards team will engage and consult with stakeholders on an ongoing basis according to the evolution of the issues, impacts and opportunities.

9.1 PROJECT STAKEHOLDERS

The stakeholders include individuals, groups, organizations, and institutions interested in and potentially affected by the project as well as those having the ability to influence the project, either positively or negatively. The primary stakeholders comprise persons that are directly or indirectly affected by the project impacts and include the PAPs and other community individuals and groups. The secondary stakeholders are the institutional (the government agencies, non-profit, community-based) organizations and other people who have an interest in the project including potential beneficiaries (such as consumers for the geothermal energy). Table 9-1 presents a brief analysis of the various stakeholders of the project.

Table 9-1 Stakeholders of the Project

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
Potential receptors – those ultimately affected (directly or indirectly) by the project (positively or negatively) due to the project's impacts	Interested and affected parties in the project's area of influence	Primary key stakeholders (individuals and groups) High stake, but low influence
Project Affected Persons	Residents, landowners and farmers/ farm workers, agricultural squatters near the exploratory drilling sites in target communities	Primary key stakeholders (individuals and groups) High stake, but low influence
Other Affected Persons	Vulnerable persons (women, children, disabled); local community advisory groups; parliamentary representatives; drive-in, drive-out workers (DIDO) and fly-in, fly-out (FIFO) workers	Primary stakeholders Advocates/supporters Blockers/critics
Other Stakeholders in Soufriere, Laborie & Choiseul districts	Project Affected Communities Local private businesses, schools, hoteliers; tour operators	Primary stakeholders Advocates/supporters Blockers/critics

Stakeholder Type	Individuals/Groups/Organization	Level/Influence
	The unemployed (potential workforce seeking employment) Local recreational users including national & foreign tourists	
National and local NGOs & CBOs /Regulators/organizations (Legal mandates)/ interest groups	Soufriere Regional Development Foundation; Fond St. Jacques Dev. Foundation; Laborie Dev. Foundation; Saint Lucia National Trust; Saint Lucia Archaeological & Historical Society	Secondary key stakeholders Advocates/supporters Blockers/critics
Government/Institutional/ Authorities/supporting organization (Legal mandates)/facilitators	Government Departments/Ministry of: • Agriculture, Fisheries, Physical Planning, Natural Resources & Co-operatives • Economic Development, Housing, Urban Renewal, Transport & Civil Aviation • Education, Innovation, Gender Relations & Sustainable Development • Equity, Social Justice, Empowerment, Youth Development, Sports & Local Government • Finance, Economic Growth, Job Creation, External Affairs & the Public Service • Health and Wellness • Infrastructure, Ports, Energy and Labor • Tourism, Information, and Broadcasting • Soufriere Town Council	Secondary stakeholders Advocates/Supporters
Customer/Client/ Implementing Agency/Implementer	Renewable Energy Unit, Dept. of Sustainable Development; Ministry of Sustainable Development, Energy, Science, & Technology	Secondary project partners/ Advocates/ Supporters
Project Sponsor/Fiduciary Support/facilitator	Project Coordination Unit (PCU), Dept. of Planning and National Development; World Bank	Secondary Advocates/Supporters

9.2 CONSULTATION AND PARTICIPATION IN RESETTLEMENT PREPARATION AND PLANNING

From the inception of the project in 2014 and 2015, the DSD implemented an active consultation campaign to ensure public consultation and disclosure. The campaign involved a series of public meetings to facilitate the flow of information between the Government/Client and key stakeholders. These initial consultations were essential in promoting active public participation in the Project and providing the broad framework for achieving the objectives of resettlement planning.

9 PARTICIPATION AND CONSULTATION

At the commencement of the ESIA assignment (in early August 2017), Panorama Inc. convened a stakeholder's conference. Several meetings and consultations were held with all relevant government departments/agencies, NGOs/CBOs, affected community residents and other project stakeholders. Table 9-2 provides a summary of these consultations and concerns raised regarding compensation and resettlement. The notes of public/community consultation are provided in Appendix C- Notes of Community Consultation.

Table 9-2 Summary of Consultations Convened

Consultation/Date/ Venue	Stakeholders Consulted	Purpose & Outcome	Resettlement and Compensation Concerns
Conference/ Aug. 8, 2017/ at PCU's conference room	All relevant government departments; DSD and Panorama in attendance	• To discuss the project and issues that would be covered in the ESIA • Comments were obtained from government agencies in attendance	• No concerns
Individual meetings/ Aug. 8 and 11, 2017/ at stakeholders' offices	Government ministers officials and ministers; DSD and Panorama in attendance	• To guide the scope of the analysis in the ESIA • To ensure that all stakeholders' concerns are considered and effective mitigation measures are adopted to address the negative impacts	• No concerns
Meeting/on Aug. 8, 2017/at the office of Soufriere Development Foundation	Representatives of concerned NGOs, CBO's and other project stakeholders	• To discuss the project and issues that would be covered in the ESIA • Comments were obtained from NGOs and CBOs	• No concerns
Community/ public Consultations/ between Aug. 31 and Sept. 3 2017/ Fond St. Jacques Resource Centre; Bellevue Farmers' Cooperative; and Saltibus Combined School	Community stakeholders and other interested persons	• Stakeholders were briefed regarding the anticipated impacts of the project and their concerns were documented • Avoidance and mitigation options to be considered in the project design and ESIA were also discussed	• Loss of usable, flat land by the community • Concern regarding damage to utilities • Concerns about lack of transparency • Relocation of residents in proximity • Livelihood for farmers and ranchers concerns

Consultation/Date/ Venue	Stakeholders Consulted	Purpose & Outcome	Resettlement and Compensation Concerns
Community meetings/ between March 12 and March 15, 2018/ Bellevue Farmers' Cooperative; Whispers Bar; Castries Town Hall; and Saltibus Primary School	Community stakeholders and other interested persons	• Information regarding the project was provided including potential site locations and size of drill site once selected • Responses to some concerns identified during scoping were provided	• Inability to restore agricultural land and preserve soil • Questions regarding relocation of residents • Loss of a recreational area

The aforementioned consultations have established the ground-work for the next rounds of consultations with stakeholders for the planning and implementation of the RAP. The next round of consultations will be convened to inform the key stakeholders about the resettlement component of the project and to provide opportunities for the PAPs to voice their concerns and propose alternatives.

The main key stakeholders that will be involved in the resettlement component of the project include:

- PAPs and their representatives
- Local NGOs & CBOs
- Soufriere Town Council
- Government agencies supporting the project
- The drilling contractor
- Consultants conducting various studies

One-on-one meetings will be convened with the PAPs and their representatives to discuss inter alia, eligibility requirements and to negotiate their compensation packages. These consultations will assist in building consensus on the proposed resettlement plan and address legitimate concerns of the PAPs. The DIPE/Social Transformation Officers (STO) will recruit a Community Liaison Officer (resident in the Soufriere-Choiseul area) to facilitate the management of these public consultations for the resettlement preparation and implementation.

As a mechanism for continual consultations during the planning of the RAP, regularly scheduled meetings will be held between the PC/STO and PAPs preferably at the same location and the same date/day of every month to avoid any difficult logistics sometimes involved in planning such events. A consultation log (registering the date, location/community, issues discussed, and actions taken) will be maintained by the PC/STO. These consultations with the PAPs will continue throughout RAP planning and implementation.

9.3 STAKEHOLDER INVOLVMENT IN RESETTLEMENT IMPLEMENTATION AND MONITORING

The cooperation and collaboration of all people affected by the project in the resettlement planning and implementation are essential for the successful execution of the project. Therefore, throughout the implementation and monitoring phases of the project, the PAPs will be involved in identifying other alternatives available. Special efforts will be made to ensure that women and vulnerable persons are included in expressing their issues and concerns in implementation and monitoring.

The PAPs will be contacted directly to ensure that the views being reflected by other stakeholders are indeed those of the PAPs. Key income restoration issues such as the compensation rates and timing of resettlement will be discussed directly with the PAPs during the implementation and monitoring of the resettlement/displacement.

The SSO will report to stakeholders in order to provide: important details on the undertakings, routines, status, project progress and new or corrected information since the last report. Report frequency will be in accordance with the order set in the SEP.

The local CBOs and NGOs stakeholders, as well as the STO and Community Liaison Officer, will also be involved in providing critical assistance to ensure continual community participation during the implementation and monitoring stages.

9.4 STRATEGY FOR DISSEMINATING INFORMATION TO PROJECT AFFECTED PERSONS

After completion of the census and the updated socioeconomic survey of the PAPs, notices will be issued to the PAPs concerning the eligibility criteria and the cut-off date for qualification as a PAP. The notices will also inform that the erection of new structures or improvements on lands to be temporarily acquired in the potential exploration target areas will not be considered when compensation is determined. Information will also be provided compensation rates and other entitlements, the timetable for implementation, and grievance procedures.

During the baseline socio-economic survey conducted in September 2017, most of the PAPs had indicated that mobile telephone was the best method for direct and immediate contact to obtain updates on the project. The PAPs mobile contact will be re-confirmed during the census/updated socio-economic surveys. Given the relatively small number involved in the resettlement exercise, the PAPs will be contacted directly via their mobile telephone to facilitate updates and the dissemination of information. General information will be disseminated through leaflets/flyers posted on community information boards. Although this may not represent the best method of communicating information to PAP, the leaflets/flyers will provide physical proof of this form of information dissemination. Printed notices of community meetings will be sent for announcement at places of worship where some PAPs usually gather. The Community Liaison will also assist in disseminating information to the PAPs.

The national and local media (for example, Soufriere radio station) will also be used for disseminating information to the PAPs. The information will be given to the media representatives for dissemination to PAPs in both English and Kweyol (the local language) as the baseline socio-economic survey noted that some of the older PAPs used Kweyol to communicate.

Stakeholders, forms of engagement, and the timing of engagement is summarized in Table 9-3.

Table 9-3 Stakeholder Groups and Forms of Engagement

Stakeholder Group	Forms of Engagement	*Timing
Government Ministries /Officials	Formal meetings Roundtable Discussions Presentations of plans	Design phase Implementation phase Monitoring & Evaluation phase
NGOs within the communities where drilling will be done	Formal meetings Roundtable Discussions Presentations of plans Site Visits	Design Phase Implementation phase Monitoring & Evaluation phase
PAPs (residents and business community)	Community Consultations One on one interviews Radio and television Print media Surveys Social media	Design Phase Implementation phase Monitoring & Evaluation phase
Business Community		Design Phase Implementation phase Monitoring & Evaluation phase

*Will be updated once project start date has been confirmed

10 GRIEVANCE REDRESS

A grievance redress mechanism is necessary for addressing the legitimate concerns of the PAPs, as laid out in the Bank Grievance Redress Service (GRS) Procedure. Transparency, integrity, and accountability are World Bank guiding principles for grievance redress. A complaint mechanism is transparent when members of the affected community know what entity is in charge of the grievance redress mechanism and possess sufficient information on how to access it. Integrity requires behaviors and actions consistent with ethical principles and standards. Accountability requires the complaint mechanism to: (i) comply with all relevant legislation, regulatory requirements, and professional standards, (ii) all parties to a complaint to have decisions reviewed, (iii) a complainant has a right to an appeal and after the appeal there is no further process, and (iv) zero tolerance for conflict of interest and misuse of the complaint mechanism for the people involved in the process of handling complaints.

It is anticipated that the concerns will focus mainly on eligibility criteria, compensation entitlements; and noise associated with drilling. The mechanism for grievance redress will thus include:

- Provision for the establishment of a Grievance Redress Committee that includes women;
- A reporting and recording system;
- Procedure for assessment of the grievance;
- A time frame for responding to the grievances filed; and
- The mechanisms for adjudicating grievances and appealing judgments.

In the interest of all parties concerned, the grievance redress mechanisms are designed with the objective of solving disputes at the earliest possible time. World Bank OP. 4.12 emphasizes that the PAPs should be heard and as such, they must be fairly and fully represented. Further, the mechanism should implicitly discourage referring matters to the court system for resolution. Table 10-1 outlines the process for registering and addressing grievances and provides specific information regarding registering complaints, response time, communication modes.

Table 10-1 Grievance Redress Procedures

Issue/Action	Procedure
Establishment of a Grievances Redress Committee (GRC)	The GRC shall be established by the Project Steering Committee (PSC) and sanctioned by the Permanent Secretary (PS), Department of Infrastructure, Ports, and Energy (DIPE). The members of the GRC shall comprise the following: • Technical Director (TD) - DIPE

Issue/Action	Procedure
	• Social Transformation Officers (STO) for each of the affected communities • The Authorized Officer or his/her representative – Department of Physical Planning (DPP) • Member of a recognized community-based organization (i.e. one member from each community) • The Legal Officer, DIPE • Chief Technical Officer, DIPE • Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives • Commissioner of Crown Lands or his/her representative, DPP • Quantity Surveyor, DPP • Valuation Surveyor, DPP
Reporting, Recording, and Transmission of Grievances	• Grievances must be filed with the PSC, though the project office (location anticipated at Soufriere Regional Development office). • Grievances must be made in writing and be signed and dated by the PAP. • Grievances may be submitted to the: – DIPE (Ministry of Infrastructure Complex, Union, Castries), – PIU office at the Soufriere Regional Development Foundation, or – on project site. • The civil works and drilling contractors will be required to document any grievances reported during project implementation and immediately and appropriately document and report the grievance to the SSO. • Grievances received verbally must be documented, verified and signed by the PAP and the officer receiving the report. • Grievances received anonymously or via phone calls must be documented; signed and dated by the TD or PSC. • Complainants may request confidentiality in the complaint, but anonymous complaints will not be processed. • The TD will establish a grievance log or register; all reports must be recorded in the log. • Grievances received via a web complaint form on the project/institutional website must also be recorded in the log. • The grievance log will outline the name of the PAP (where available) and the reason for the complaint. • The PSC will submit the grievance reports to the chairperson of the GRC within 24 hours of receipt. The report will also be copied to the PS, DIPE. • Acknowledgement of the grievance shall be issued by the TD to the PAP in writing, within 3 working days of receipt.

10 GRIEVANCE REDRESS

Issue/Action	Procedure
Assessment of the grievance and timeframe for response Mechanisms for adjudicating grievances and appealing judgments	• The first assessment of the grievance will be conducted by the GRC. • The nature of the grievance would ascertain the period (not exceeding 3 working days) necessary for the GRC to address the grievance. • The 3-day timeframe will not apply in the case of complaints and grievances that specifically pertain to the valuation of affected assets, since these may be determined by a Board of Assessment or the courts. • Where resolution is not reached at the level of the GRC or if the PAP does not receive a response or is not satisfied with the outcome within the agreed time he/she can appeal to the PS, DIPE. • If the PAP is not satisfied with the decision of the GRC or the response to the appeal to the PS, he/she as a last resort may submit the complaint to a court of law. • The PAP will be exempt from all administrative and legal fees incurred pursuant to the grievance redress procedures.

11 MONITORING AND EVALUATION

The monitoring and evaluation plan is designed to provide timely and operationally useful information on the progress of the resettlement effort, the disbursement of compensation, the effectiveness of public consultation and participation activities; and the sustainability of the income restoration and development efforts planned for the PAPs. The objective of the monitoring and evaluation is to provide feedback on RAP implementation and to identify problems and successes as early as possible, to allow timely adjustment of implementation arrangements.

11.1 MONITORING

Internal monitoring of the implementation of the RAP will be the responsibility of the PSC and the DIPE. The Technical Director (TD) will provide the DIPE and PSC with monthly status reports on the progress made with resettlement preparation and implementation. A database of resettlement monitoring information will be established and updated monthly. This information will be utilized to improve monitoring procedures and the efficiency of the processes employed.

Quarterly internal monitoring reports will also be prepared by the TD and submitted through the DIPE and the World Bank. The quarterly reports shall include information about the following monitoring indicators:

- **Payment of compensation** to the various categories of PAP, according to the compensation policy described in the RAP
- **Delivery of other forms of assistance** including the return of land to owners after use
- Delivery of **income restoration** and social support entitlements
- **Public information dissemination and consultation procedures**
- **Adherence to grievance procedures** and outstanding issues requiring management's (i.e. Permanent Secretary - DIPE) attention
- Attention given to **the priorities of PAPs** regarding the options offered
- Coordination and **completion of resettlement activities**

In accordance with World Bank requirements for consultant procurement, the PCU will hire a company/consortium/individual to conduct the independent monitoring and evaluation of the implementation of the RAP. The entity will provide specialized services in social sciences and should be experienced in resettlement monitoring. The organization should start its work as soon as the updated RAP has been approved.

The rationale for hiring an external institution is to ensure that the overall objective of the resettlement plan is achieved in an equitable and transparent manner. In addition to reviewing the issues covered by the internal monitoring progress report, the external agency will also evaluate and assess:

- The competence and effectiveness of the project implementing agencies
- The adequacy of compensation, development and transitional assistance packages provided for the PAPs
- The ability of the project to meet the needs of all PAPs
- Consultation and public disclosure of the RAP
- The effectiveness of the grievance redresses mechanism

11.2 EVALUATION

The evaluation component of the plan will determine whether policies (both local and the World Bank's) have been adhered to, and provide the feedback necessary for adjusting strategic directions. The objectives of the evaluation are therefore as follows:

- To undertake a general assessment of the compliance of resettlement activities with the objectives and methods as set out in this RAP
- To assess the compliance of resettlement activities with the laws and safeguard policies cited in Section 4.0
- To assess resettlement procedures as they have been implemented
- To identify outstanding issues in the compensation process and implement measures to rectify the issues
- To evaluate the impact of resettlement on the incomes and standard of living of the PAPs
- To identify lessons learned from the implementation of the RAP

In the conduct of the evaluation, the project and consultant(s) will utilize local legislation and policy and the World Bank's OP 4.12 on Involuntary Resettlement as the guidance documents.

APPENDIX A – TOTAL PARCELS OF LAND IN TARGET GEOTHERMAL RESOURCE AREA

Appendix – A - Land Ownership in the Target Communities

Block	Parcel	Area (m^2)	Owner of Record	Encumbrances
Fond St. Jacques Site				
0429B	196	1,897 (Staging)	Four Trustees for Sale –(private land)	Private pedestrian right of way as shown on Registry Map. Vendor's Privilege
	174	5560	Private land owner	Private pedestrian right of way as shown on Registry Map.
	175	10,584 (Drilling)	Private land owner	Private pedestrian right of way as shown on Registry Map. (Partly along Eastern Boundary)
	238	255	The Water & Sewerage Company Inc.	Private pedestrian right of way as shown on Registry Map.
0428B	82	9,762	Executor of private land owner	Two Private pedestrian rights of way as shown on Registry Map.
	48	1,786	Heirs of Private land owner	Private pedestrian right of way as shown on Registry Map.
Belle Plaine Site				
0427B	193	2,152	Executors of private land owner	Private pedestrian right of way as indicated on the Registry Map.
	190	28,000		
	188	10,571		
	191	28,708		

Block	Parcel	Area (m²)	Owner of Record	Encumbrances	Comments
0427B	189	26,260	Executors of private land owner	Private pedestrian right of way as indicated on the Registry Map.	
	156	21,437			
	155	6,781	Private land owner	None	
	154	9,374	Two private land owners	One Hypothec	
	157	2,596	Private land owner	One Hypothec	
	158	2,234	Two private land owners	None	
	159	1,225	Private land owner	None	
	194	3,300	Private land owner	Two Hypothecs	Dismembered from 123
	196	600	Crown	None	Dismembered from 194 & 195
	197	41,100	Private land owner	Two Hypothecs	
	103	3,334	Crown	Public pedestrian right of way as shown on Registry Map.	
	104	4,532	Heirs of Private land owner	Public pedestrian right of way as shown on Registry Map.	
	105	4,699	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.	
	106	3,834	Administrators of estate of private land owner	• Usufruct: Brigitte Simeon for life. • Public pedestrian right of way as shown on Registry Map.	
0427B	107	12,601	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.	
	108	12,425	Heirs of private land owner	Public pedestrian right of way as shown on Registry Map.	
	109	5,444	Five private land owner	Public pedestrian right of way as shown on Registry Map.	

0428B	126	5,393	Executors of estate of private land owner	Private pedestrian right of way as indicated on the Registry Map.	
	127	9,562			
	128	9,580			
	129	9,625			
	130	9,701			
	124	10,188			
	125	30,576			
	117	2,236			
	121	394			
	122	251			
Mondesir Site					
0624B	140	87,000	Crown	None	

APPENDIX B - SUMMARY OF MAIN DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF PROJECT AFFECTED PERSONS

APPENDIX 3-1

SUMMARY OF THE BASELINE SOCIOECONOMIC SURVEY[1]

Age and Gender

The ages of respondents in the project-affected communities ranged from 20 to 85 years; the youngest (1.5 years) being a female from Belvedere and the oldest, an 89-year-old male from Parc Estate. The majority of respondents (59 percent) were males. Reported household sizes ranged from 1 to 15 persons. The higher end of the spectrum comprised households with extended families. These types of households were more prevalent in Belvedere and Mondesir settlements. The largest household was an extended family in Parc Estate. It was reported that this settlement basically comprises 7 to 8 families living in separate or extended family households. The average size of all the households surveyed was 3.5 persons.

Males account for roughly 60 percent of the total household population. The working age group (15 to 64 years) was the largest proportion of the population (69 percent). Three disabled (mentally challenged) males, both in the 50 to 55 years age group, are accommodated in households in Belvedere. One physically disabled male was identified in Gayabois. Dependents (residents younger than 15 or older than 64 years) accounted for about 31 percent of the household population with persons 65 years and over representing 13 percent.

Education

Approximately 54 percent of the household populations attained primary level education; 28 percent were educated at the secondary and 9 percent at tertiary (community college) levels. Around 9 percent had no schooling; these individuals comprised older (73 to 89 years old) persons who live in Belvedere and Mondesir. Belle Plaine's population had the highest proportion of tertiary and secondary level schooling. Respondents in Mondesir had the lowest percentage of tertiary and secondary schooling. The Mondesir community also had the highest percentage of residents with no schooling.

Type of Housing Facilities

The houses in the three communities are all detached/individual structures mostly built of masonry (concrete/block-wall) or a combination of masonry and wood. The Belle Plaine community had the highest proportion of houses constructed out of a combination of masonry and wood materials. A higher percentage of wooden houses was observed in Belvedere and Mondesir.

All the houses surveyed in the Belle Plaine community reported having septic tank toilet facilities whereas 18 percent and 36 percent in Belvedere and Mondesir, respectively, had pit latrines. In all the target communities, every house in the sample stated that electricity is their

[1] Extracted from the Scoping Studies Report, ESIA Geothermal Resource Development project, October 2017

main form of lighting; however, electricity was not used as fuel for cooking. The majority of households used either gas (LPG) or a combination of LPG and charcoal as fuel for cooking. The use of charcoal and wood was reported more frequently in Mondesir and Belvedere.

Sources and Quality of Water Supplies

The survey indicated that the majority of households in all the affected communities use mainly public pipe-borne (WASCO's) water as their primary source of water for domestic purposes. A few households in Mondesir reported using public standpipe as their main source of water. Overall, the quality of WASCO's water was rated as good and generally reliable. Rainwater harvesting tanks/containers were also used by most households. Spring "sous" water was generally used for other non-drinkable domestic purposes and farming in all the communities.

A few households in Mondesir also reported using a combination of public standpipe, spring, and river as their sources of water. Some households were of the perception that spring water was a better and a more natural source of water than the public-piped water, which they believe contains too much chlorine. This view was expressed more frequently in Belvedere where 36 percent of respondents reported using only spring water. It should be noted that a spring is located near the target drilling area; WASCO's water storage tank is also within close proximity to the affected households.

Belvedere's respondents indicated that the spring water is extremely important to them as a "back-up" particularly during public water shortages and natural disasters such as Hurricane Tomas when WASCO's supplies had been damaged. Some respondents indicated that their spring water supplies are piped alongside WASCO's pipelines and into their households. One respondent reported that since Hurricane Tomas, spring water, instead of WASCO's water, was now piped to the household for domestic purposes (except drinking).

Land Ownership and Land Use

The respondents indicated that the primary form of land tenure was family-owned land followed by leased and privately-held land. Among the three communities, private ownership of lands was highest in Belle Plaine, whereas family-owned land was the main form of land tenure in Belvedere. Leasing, primarily from the Crown and Invest Saint Lucia was the predominant form of land tenure in Mondesir.

Belle Plaine's respondents reported the highest percentage (80 percent) of family-land used for farming. In the Belle Plaine community cluster, members of a family comprising many siblings declared ownership of over 81 hectares (200 acres) of land, which is currently being used to grow a variety of crops for sale. These lands have already been sub-divided and titles are currently being prepared. In Belvedere, family-owned land was the main form of tenure reported for both housing and farming. Leasing from the Crown and Invest Saint Lucia was the primary form of land tenure in Mondesir. Some respondents in Mondesir claimed that they had acquired lands from the Danes' Project in the 1990's.

Employment, Livelihoods, and Income

Approximately 36 percent of the total working household population are unemployed. A large proportion (39 percent) reported being self-employed, primarily as farmers. The main type of farming practiced is crop production, especially root crops (dasheen and sweet potatoes) followed by vegetables (cucumbers, cabbages, melons, and tomatoes). Subsistence cattle, sheep, and goat rearing was also being undertaken by a few households (mainly in Belle Plaine and Belvedere). In Belle Plaine, 62 percent of the household population were self-employed in farming. Around 50 percent of Belle Plaine's respondents indicated that their employment would likely be negatively affected by loss of land to the project. Compared with Belvedere and Mondesir, fulltime employment was relatively higher in Belle Plaine, with 38 percent of household population working in the private or public sector. A few respondents of Belle Plaine also reported being retirees from overseas. Unemployment in Belle Plaine was not reported by any of the households interviewed.

Conversely, 33 percent of the households' working population surveyed in Belvedere (Fond St. Jacques) was unemployed; 39 percent self-employed in farming and 22 percent were employed full-time. Among the three communities, Belvedere had the widest range of livelihoods comprising hotel work, construction, small business/shop owner, and Government work. The majority (64 percent) of Belvedere's respondents were of the view that their livelihoods would likely be negatively affected by loss of land to the project compared with 50 percent in Belle Plaine.

Mondesir reported the highest level (43 percent) of unemployed persons. Self-employment was around 39 percent and full-time employment, the lowest at 18 percent. About 57 percent of Mondesir's respondents were of the view that their employment would likely be negatively affected by loss of land to the project. Respondents were generally unwilling to provide information on income. From the data obtained, Belle Plaine reported the highest income levels, followed by Belvedere. Mondesir had the lowest income level, reporting monthly household incomes ranging from less than $500.00 to $1,000.00.

APPENDIX C – NOTES OF COMMUNITY CONSULTATIONS

Appendix C - Questionnaire

ESIA - Geothermal Energy Development Project - St. Lucia

Interviewer Name ---------- Date ----------

Respondent Name ---------- Community ----------

Respondent Mobile No. ----------

1. How long have you lived in this community? --------- years

2. Gender: ☐ Male ☐ Female

3. Age: ------- ☐ 18 - 25 ☐ 26 - 29 ☐ 30 - 39 ☐ 40 – 49 ☒ 50 - 59
   ☐ 60 - 65 ☐ 66 and older

4. Educational Level: ☐ Primary ☐ Secondary ☐ Tertiary

5. Employment Status: ☐ Full-Time ☐ Part-Time ☐ Self-Employed ☐ Unemployed
   ☐ Student ☐ Retired ☐ Disabled

6. For each additional household member, please provide responses to Questions 2-5

Name	**Gender** Male (M) Female (F)	**Age**	**Educational Level** Primary (P) Secondary (S) Tertiary (T)	**Employment Status** Full Time (FT), Part Time (PT), Self-Employed (SE), Unemployed (UE), Student (S), Retired (R), Disabled (D)

7. Household monthly income range: ☐ $0-500 ☐ $501-1000 ☐ $1001-2000 ☐ $2001-3000 ☐ $3001-4000 ☐ >$4000

8. Main economic activities/sources of household income: ☐ farming ☐ fishing ☐ domestic
   ☐ construction ☐ labourer ☐ office ☐ hotel ☐ store/shop
   ☐ teacher ☐ Gov't worker ☐ income from family overseas
   ☐ other _____

9. Is there any work/employment done by household members likely to be affected by the loss of land to the project? ☐ Yes ☐ No If yes, Which ----------

10. Type of house: ☐ wooden ☐ masonry ☐ wood/masonry ☐ other ----------

11. Type of toilet: ☐ Septic tank ☐ Pit Latrine ☐ other ----------Sources of water: ☐ WASCO/pipe borne ☐ RWH tanks ☐ springs ☐ river

12. Quality & reliability of water: ☐ good ☐ not good/muddy/unsafe ☐ WASCO reliable ☐ WASCO unreliable

13. Form of lighting: ☐ electricity ☐ other----------

14. Form of cooking fuel: ☐ electricity ☐ gas ☐ charcoal ☐ wood

15. Land ownership and use

    Housing: ☐ Private ☐ Family Owned ☐ Rented/Private Lease) ☐ Gov't/NDC ☐ Private Leased ☐ Caretaker ☐ Squatting

    Farming: ☐ Private ☐ Family Owned ☐ Rented/Private Lease) ☐ Gov't/NDC ☐ Private Leased ☐ Caretaker ☐ Squatting

16. Type of animals reared/crops grown----------

17. Is there a community group in your community? ☐ Yes ☐ No

    If yes, which group ----------

    If yes does any member of the household belong to a community group? ☐ Yes ☐ No

18. Have there been any changes (good or bad) in the community over the past 5-10 years

    ☐ Yes ☐ No If yes, please explain----------

19. In your opinion, what is your general perception of the natural environment in your community in last 2 years? ☐ 1. Very bad ☐ 2. Not very good ☐ 3. Fair ☐ 4. Good ☐ 5. Very good

20. What do you like/don't like about your community?

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21. What improvement would you like to see in the community?

    ---

22. Where/how did you hear about the Geothermal Project?

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23. What do you know of the history of the past Geothermal Project?

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24. How do you think the project will affect you, your household and the community (problems & advantages)?

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25. Would you be looking for a job with the Geothermal Project? ☐ Yes ☐ No If yes, what type of job?

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26. What should the Project do to make sure that the benefits to your community is maximised and the negative effects minimised?

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27 What is the best way to contact you so that we can provide more information about the project in the future?

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Belle Plaine Community Consultation

Date:	Saturday, 2 September 2017
Time:	6:00 pm
Location:	Belle Vue Farmers' Cooperative, Soufriere
Attendees:	Participants/community members
	Valerie Leon – Permanent Secretary (PS), Department of Sustainable Development (DSD)
	Al Barthelmy (AB) – Geothermal Technical Coordinator, DSD
	Charlin Bodley (CB) – Public Utilities Officer, DSD
	Kurt Inglis (KI) – Public Utilities Officer, DSD
	Bethia Thomas – Science and Technology Officer, DSD
	Dr. Frederick Smith - Panorama Sub-consultants/Archaeologist
	Alison King (AK) – Panorama Sub-consultants/ECMC
	Egbert Louis (EL) – Panorama Sub-Consultants/ECMC
	Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

19 community members/participants (5 females; 14 males) attended the consultation.

Welcome and Background Information

Charlin Bodley delivered the welcome remarks. Bethia Thomas led the group in prayer. Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Al Barthelmy on the project location and the results of the surface exploration phase recently completed. Dr. Smith gave an overview of the archaeology work he will be doing, and the types of recommendations he would make if he identified any concerns in potential drilling areas.

ESIA of the Planned Exploration Phase

An overview of the geothermal exploration drilling and the ESIA process was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Following presentation of the Permanent Secretary:

Participant Input: If the project fails, are there other options e.g. water and wind? We are surrounded by water.

Response (DSD): The potential for hydro power here is small. Technology for harnessing of tidal energy is still in its infancy, and is not included in the plans of the government at this time. The focus is on the most viable resources, i.e. wind, solar and geothermal.

Participant Input: There used to be a hydro-plant in Soufriere. We have so many rivers, Can't that be an option?

Response: Hydro is not of great significance. The others have more potential. Our rivers are drying up, further reducing the potential for hydro.

Participant Input: The rivers are drying up because of man. We had 2 rivers along the Palmiste road, and they dried up one to do what they wanted, to build a school, etc. But when it rains, the river finds its path, and everywhere floods.

Following presentation of the Technical Coordinator:

Participant Input: Is there any problem with any of the sites?

Response (AB): It is too early to say. This is the reason for the studies.

Following presentation of the ESIA Consultant:

Participant Input: What if when drilling, instead of steam, you get fire?

Response (AB): Given all the data available to us to now, this is very unlikely.

Participant Input: In the last time of drilling in the Sulphur Springs, above the river, steam came up and they were happy. Then they stopped because they got fire coming up and they had to seal it.

Response (AB): It was not fire, they had a blowout. A well is a series of pipes. We must admit it. There was instability at Sulphur Springs. If the job is not done properly and material is coming up under high pressure there is a risk.

Participant input: I physically visited the site during the drilling. I saw fire. Even trees in the vicinity got burnt. Steam was coming off the mouth of the well. I saw gas or fire.

Response (AB): Steam is heat, more than 100 degrees. If it comes into contact with the trees it will destroy them.

Participant input: The fire was under the steam. It came after.

Participant input: In other places, is drilling done in residential areas? Sulphur is hazardous to health. It affects the lungs and the eyes. Persons working at the Sulphur Springs are getting these problems. What does the research show regarding the impacts? I am aware of the energy benefits but what about the health issues?

Secondly, the assessment must be done in a transparent manner. Ensure that community persons are privy to the reports, particularly regarding effects on their health.

Response (CB/AB): We have seen similar projects in similar settings. Government invested in sending a Ministry team to Hawaii where there was a functioning geothermal plant. Government has a developer in mind, the same developer for the Hawaii plant. The feedback from the team was that they were impressed with what they saw and observed no adverse effects. They followed a similar ESIA process to the one being undertaken here, and the ESIA document informed as to how to proceed with the project. Mitigation measures were developed after identifying possible negative effects. At a plant in Iceland, the

pipes are in a residential area. There is a plant operating in Guadeloupe, and explorations are underway in St. Kitts, Grenada, St. Vincent and Dominica. We are not aware of any serious negative effects.

(PS) In terms of transparency, the report will not be hidden. It will be available for public review, although this is not mandatory under the law. It will be online, in libraries and other public places where people can see it. If persons need help in reviewing it, we will send a team to assist. You will see the recommendations, and know whether the project proceeds in the manner recommended.

Participant input: Who is paying the experts?

Response (PS): The Government. The experts are independent and international experts, not involved in other aspects of the work. There are international standards that they are required to meet. ECMC is a sub-consultant to the company in California. This is a reputable company with expertise in this area. There has been no political interference in any way, and the technocrats are being left to do their work. We do not foresee any interference.

Participant Input: Conditions differ in different countries. In drilling we can have migration of gases.

Response (AK): The testing will include testing of the steam to determine what other constituents are in there and the risks they pose.

Participant Input: Geothermal sites usually experience dry spells. Will studies take that into account? Also, when drilling was done before, there were earth tremors in this area. The lands were not stable. Will the ESIA address this?

Response (AB): One well will not last; there must be makeup wells. If a well becomes non-viable, further drilling is needed.

When drilling SL2, the frequency of earthquakes increased, and there was concern that this was caused by the drilling. He visited the site and there was no evidence to support that. In his view, there was no connection.

Participant Input: The literature tells us that there is instability and ground movement. The ESIA must capture that.

Response (AB): Re-injection wells are required to replace the fluid and this largely addresses the stability issue. It is almost like recycling. The pre-feasibility will also examine the possibility of seismic activity in response to the TOR. If it is a concern, measures to address will be recommended.

Participant Input: Can the amount of steam and likelihood of dry spells be measured?

Response (AB): In SL2, the test ran for 2 weeks, and the steam declined thereafter.

Health-wise, we need to ensure that every contract has clauses to ensure that responsible entities comply with specified safety standards, to protect human health and the environment.

Participant Input: A project of this nature has positive and negative impacts. It will cost millions. We are told that it does not mean that the cost of electricity will go down, but this is something we were expecting. If not, is it economically viable in terms of the cost of exploring and drilling? There have been studies in other areas (solar, wind), but have you considered the comparative costs, and whether it is advisable to proceed over the long term? What is the long term sustainability of the project? We need to know how long the geothermal resource will last. Is it 10, 50, 100 years?

Looking at the negative aspects, what are the risks to the environment? Can drilling affect availability of water in streams or underground? Can it cause a volcanic reaction? Our grandparents said that all these valleys (Roblot, Fond St. Jacques, Belle Plaine) were linked underground, and there was “La Tou Noir” (the black hole), where water gets sucked into the ground.

We had higher rainfall before, all the valleys were swamps, and we had a lot of water that fed the hot rocks. What are the implications of the changing rainfall patterns?

What will be the implications for livelihoods? Many of these lands are farmed by Belle Plaine farmers, and this is a major revenue earner.

We must have access to the report.

Response (AB): The pre-feasibility study will include an economic assessment to address these. The national energy transition strategy (NETS) examined and compared the various sources of renewable energy. While geothermal may not guarantee a decrease in price, it provides stability in the price of electricity. The power purchase agreement between the generator and the utility will determine the price to consumers, over the 20 to 30 year life of the plant.

(CB) Although not widely publicized, government over the last three years has investigated the best mix of renewable energies for St Lucia, to achieve the best price for St Lucians. The mix must be stable. The NETS study is to be submitted to Cabinet for approval before the results can be shared. Our peak demand is 60 megawatts. Wind and solar are intermittent sources, especially wind. Geothermal is not a variable renewable energy source. The target is to develop a 30 MW plant, which with availability factors, may yield 28 MW and we would get it consistently. LUCELEC agrees that geothermal works well because our base load is 28 to 30 MW.

(CB) The two main objectives of the pre-feasibility study are to investigate the technical and economic feasibilities of the resource. We are hearing in other countries, a price of 18 US cents per kilowatt hour for geothermal power, but in these instances the developer does the exploration, and includes the cost of the risk associated with that. Government of St Lucia decided to get grant funding to do most of the exploration, so there is an expectation that the cost will be considerably reduced.

Participant Input: The last time they drilled in Sulphur Springs there were 13 strong quakes. Some houses got damaged. If it happens again, would there be compensation? Would the company take that responsibility?

Response (EL): One would have to establish a link between the drilling and the quake. This is difficult to pinpoint. If the property is insured the owner can call on insurance.

Participant input: This reminds me of a situation with LUCELEC. Appliances in Belle Vue were damaged after an electrical storm, and LUCELEC told customers it was their problem. I am hearing the same thing. What you are saying is "brace yourself".

Response (EL, AB): No, but it would have to be established that the quake is associated with the drilling. This would be difficult. The burden of proof is very important. Nobody can predict an earthquake. In the US, they are considering whether fracking may cause an earthquake.

Dr. Smith noted during his later comments that fracking is a big problem in the USA now, and the impacts are still being studied.

Participant Input: Are we saying that people need to get insurance for their houses? Who would pay for that?

Participant Input: I (KI) am wearing a resident's hat and have three concerns:

1. The access to the two sites in Belle Plaine. This is not truck friendly and would need to be upgraded, and reinstated after use.

2. The risk of contamination of farmlands to be used for drilling. If these are to be leased and returned to owners after two to three months, they must not be contaminated and made unusable.

3. Drilling along a fault or crack may cause these to widen. Residents are advised to photograph their homes before drilling starts, so that they may produce evidence of damage in the event of tremors.

A complaints board or some other facility should be established where community members may bring their concerns and not be turned away. Person conducting the investigation into such complaints should be independent of the project.

Participant Input: I am a resident of Etangs. When they were drilling there, they did not notify us. The generator used to pump water was making noise all the time. I could not hear my wife. We could not sleep at night.

Participant Input: Will the noise be bearable?

Response (AK, EL): There are measures that can be put in place to reduce noise. A baseline survey of noise will be undertaken, and noise standards will have to be complied with to ensure that the noise is bearable.

Participant Input: We have an issue now at Belle Plaine with LUCELEC generators. They were put there when work was being undertaken on the Soufriere feeder, but were not removed and are occasionally used since then. There is a siren that goes off on most weekends (late nights and early mornings).

Participant Input: If you have to drill on my property, can I refuse?

Response (PS): The government hopes to engage persons in negotiation, but compulsory acquisition for the national good can be a last resort.

Participant Input: My concern is the noise. I am an insomniac. I do not sleep well. How will it affect my health?

Response (AB): We do not know for sure where drilling will take place. We must select a developer with a good work record in environmental and health issues. The developer under consideration now is good. That developer has a proprietary technology that is environmentally friendly.

Participant Input: The permanent secretary mentioned a US$22 million grant. What is it to be used for?

Response (PS): It will be used for the drilling exploration and well testing.

Participant Input: We have a target for 35% renewables by 2025. What is it now?

Response (PS): Less than 1%.

Participant Input: Why did you stop the wind project?

Response (PS): It has not stopped. We are still in discussion with the developer. It is on hold for now. There are issues with land acquisition. We hope we will not have these issues with the geothermal project, and people will support for the good of St Lucia.

Participant Input: How will livelihood issues be addressed? If lands are acquired, how is this affect farmers and persons rearing animals?

Response (PS): These social aspects must be considered as part of the ESIA and will inform the decisions, including for compensation. The World Bank has safeguard measures that must be applied if we are to access the funding.

Participant Input: If residents live in close proximity, will they be relocated?

Response (AB): If we do not address these things we do not have a project.

Participant Input: The project has long term benefits. Consultation and feasibility studies are good. We do not want chaos like the DSH Project. You must present what will affect us. Our children stand to benefit.

Response (PS): There will be no chaos. When we get the results of the studies we will come back.

Participant Input: What about water quality?

Response (PS): Hydrologists will gather baseline information over next week, and the impact on water will be assessed. They will look at issues like when water disappeared as we heard in the last consultation, and what caused that to happen.

Participant Input: After completion, will geothermal energy be reliable and sustainable?

Response (AB): It has been factored into the NETS, which looked at improving energy security. We will reduce consumption of fossil fuels. We know roughly what the geothermal potential is, about 75 MW, more than we need.

(PS) The persons conducting the study will be in the area asking questions. They will have ID badges provided by our department.

Participant input: We are not against the project but we have genuine concerns based on past experiences, as well as current experiences, for example in relation to noise pollution. We want to see our concerns taken into consideration. We need to see what is being recommended, for example would it be advisable to take out insurance?

Response (PS): We will be surveying households close to the sites, to understand land ownership, land use etc., to ensure persons are not put in a worse situation.

Participant input: You mentioned consideration of including a requirement for the drillers to adhere to standards. There must be penalties for non-compliance.

Response (AK): The monitoring plan will set up a system, and identify who is responsible for monitoring and enforcement.

Closing Remarks

The Permanent Secretary noted that experts will be in the field for the next three weeks. She requested a volunteer from the community who would ensure that instrumentation is not tampered with. She requested that interested persons contact the DSD. The equipment is expensive, and loss of data can affect the progress of the project adversely.

Bethia Thomas closed the meeting at 9.30 pm, thanking all for their participation, and inviting them to share some refreshments.

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Community Consultation

Date: Thursday, 31 August 2017

Time: 7:00 pm

Location: Fond St Jacque Resource Centre, Soufriere

Attendees: Participants/community members
Valerie Leon – Permanent Secretary, Department of Sustainable Development (DSD)
Al Barthelmy – Geothermal Technical Coordinator, DSD
Charlin Bodley – Public Utilities Officer, DSD
Kurt Inglis – Public Utilities Officer, DSD
Alison King – Panorama Sub-consultants/ECMC
Egbert Louis – Panorama Sub-consultants/ECMC
Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

Twenty-five participants comprising six females and nineteen males attended. Their ages ranged from 30 – 70 years.

Welcome and Background Information

Charlin Bodley made the welcome remarks. Kurt Inglis lead the group in prayer. Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Al Barthelmy on the project location and the results of the surface exploration phase recently completed.

ESIA of the Planned Exploration Phase

An overview of the geothermal exploration drilling and the ESIA was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Spring Water Supplies

There are several springs in the Fond St. Jacques area (from Migny, down towards the community), that a significant number of persons in the community harness for drinking water. There is concern that the project will affect these very important water sources. The example of the disappearing lake at Robot after drilling was cited. The community members are very passionate about these springs.

One participant indicated that this has been his drinking water supply for more than 30 years. This water is all that some people in the Fond St. Jacques and surrounding communities drink. Although most people have a WASCO supply, many still use the local spring sources for drinking, and other surface supplies for washing.

When the WASCO water supply is interrupted, this is the only source of water for the community. They were forced to rely on this source for a protracted period after the passage of Hurricane Tomas.

Provision of increased storage of WASCO water in the community to improve water security would not be an acceptable mitigation measure, as:

- This is chlorinated water, and
- Where would the water come from if not the same source that would be affected by the project?

When asked to indicate the importance of this water supply to the community on a scale of 1 to 10, the community members were unanimous in rating it at 10.

Another participant noted that the WASCO supply to the community is unreliable, even though the area is an important source of raw water for WASCO (there are 3 WASCO intakes in the area) that is used to serve communities as far afield as Choiseul, Cresslands and Hotel Chocolat. As a result, some people have no choice but to go to the springs.

Impact on Agriculture

DSD must work hand in hand with Ministry of Agriculture. This is an agricultural community, and cultivated areas will be affected.

An undertaking was made by the Permanent Secretary to collaborate.

Impact of Noise

One participant indicated that he was a child during the first drilling project, and the noise was very intense. He is very concerned that persons would not be able to live next to the proposed well location shown, within the community. They would have to be moved.

ECMC and DSD representatives noted that the technology has advanced since then, and it is possible to reduce noise. It is also possible use directional drilling to set back the pad from the community.

DSD noted a need to include environmental standards in every contract, to protect against such impacts, with proper enforcement by the supervising entity.

One participant enquired whether there would be penalties in the contract for non-compliance with such clauses.

Cynicism

A participant noted that often the end justifies the means, and politicians often have their own agenda. Is the primary objective to reduce Saint Lucia's carbon footprint? The community is in great need of jobs, infrastructural development, and all the possible benefits of such a project. People can come in with a nice smile and big words that lay people do not understand, and only afterwards do the people understand that things are not what they expected. He recalled an experience with WASCO where the community was opposed to tapping into a water source, and this project was only aborted after significant expense had been incurred by the company.

After Hurricane Tomas, the geological report touted by technocrats was never shared with the community, as it was thought that it was something they would not understand. The people need to be provided with information and equipped to make informed decisions for themselves.

ECMC noted, confirmed by the Permanent Secretary, that the ESIA report will be made public. It will be placed on a website and in community libraries and resource centres such as this one in Fond St. Jacques. ECMC also noted that the funding agencies that support this project are very concerned about environmental and social issues and will not disburse any money unless the issues are properly addressed.

Aesthetics

After the drilling near Sulphur Springs, some 50 pipes were left all about the place, and the holes are still there. Another participant noted that aesthetics are important as they sell the area as an attraction.

DSD conceded that this did occur with one of the previous exploration projects. ECMC noted that it will be a requirement of contractors to properly remediate after completion.

Land Availability

The community is deprived of land space that is arable and/or flat. The demarcated potential drilling areas fall within such spaces. These lands are used for homes, recreation and farming by the community. (*Note that there was some uncertainty about the exact locations being proposed).*

The smaller portion of land identified does not appear to be large enough for the size of well pad described in the presentation. There would be no playing field anymore if this area was to be used.

Impacts of Weather on Drilling

A participant enquired whether drilling would continue, rain or shine. ECMC noted that work would likely be halted if a storm was approaching.

Impact on Telephone and Electricity Lines

A participant enquired about the impact of large trucks on low hanging lines.

ECMC responded that the access routes would be reviewed in the ESIA to ensure these would not be impacted.

Employment

A participant enquired whether priority will be given to persons in the area for jobs. Politics often becomes a factor.

The Permanent Secretary responded that once persons from the area have the required skill sets, they will be given priority. There are some things beyond the control of technocrats, but they would do all within their purview. Consideration may be given to placing in the contract, the need to use persons in the area for labour, and to also engage in knowledge transfer for a specified number of persons.

DSD is also presently reviewing the possibility of requesting that relevant training be included on the government's training priority list, in anticipation of future jobs in this field. Such persons could find work across the globe as the world goes green.

One participant asked where the drilling company would come from.

The Permanent Secretary noted that the project is not at the stage where she can confirm that there is a viable resource for drilling. More information will be available in early 2018 after the studies are complete. Although government has a preferred developer, if that negotiation process is not successful, the project will be opened up to international and unrestricted tender through a transparent and open process.

Cost of Electricity

One participant noted that if electricity costs will be reduced, he is in 100% support of the project. This positon was supported by most others present, with the proviso that all mitigations required are put in place, so that they are not negatively impacted.

The Permanent Secretary noted that government has secured grant support to do much of the exploratory work, reducing costs to local tax payers, significantly de-risking the project for a power plant investor, and placing the government is a stronger position to negotiate. This should redound to the benefit of the consumer in terms of cost.

A participant noted that the NURC will regulate the pricing, not LUCELEC.

Another noted that everyone in the country pays for the dam remediation although not all benefit from the dam supply.

Level of Participation in the Meeting

One participant was of the view that participation was low.

The Permanent Secretary responded that no effort was spared in informing the community about the meeting and it is up to persons to take an interest in matters that can affect them. This is the 4th community meeting in relation to this project.

Closing Remarks

Charlin Bodley closed the meeting at 9 pm, thanking all for their participation, and inviting them to share some refreshments. Contact numbers were provided for DSD so that participants may continue to engage project personnel.

ESIA – GEOTHERMAL ENERGY DEVELOPMENT PROJECT - SAINT LUCIA

Notes of Mondesir Community Consultation

Date:	Sunday, 3 September 2017
Time:	3:00 pm
Location:	Saltibus Primary School, Choiseul
Attendees:	Participants/community members
	Valerie Leon – Permanent Secretary, Department of Sustainable Development (DSD)
	Al Barthelmy – Geothermal Technical Coordinator, DSD
	Charlin Bodley – Public Utilities Officer, DSD
	Kurt Inglis – Public Utilities Officer, DSD
	Bethia Thomas – Science and Technology Officer, DSD
	Dr. Frederick Smith - Panorama Sub-consultants/Archaeologist
	Mr. Kerry McCallum - Panorama Sub-consultants/Dewhurst Group
	Alison King – Panorama Sub-consultants/ECMC
	Egbert Louis – Panorama Sub-consultants/ECMC
	Theresa Alexander-Louis – Panorama Sub-consultants/ECMC

Community Members Profile

23 (10 female; 13 males) community members/participants attended.

Welcome and Background Information

Curt Inglis made the welcome remarks. Bethia Thomas lead the group in prayer. Permanent Secretary Valerie Leon provided an overview of the Geothermal Energy Development Project, followed by a presentation delivered by Protect Coordinator Al Barthelmy on the project location and the results of the surface exploration phase recently completed.

ESIA of the Planned Exploration Phase

Dr. Fred Smith gave an overview of the archaeological work he will be doing, and the types of recommendations he would make if he identified any concerns in potential drilling areas. He informed the meeting that he had spent some time before the meeting on the Parc Estate site, north of the playing field, which is earmarked for possible geothermal exploration. He found ceramic pottery dating back to the mid 18th century to the 1830's, which suggests that people were living there at those times. It is possible that there may be other discoveries to be made there, and more research is required.

Mr. Kerry McCallum informed the meeting about the air quality sampling tubes that will be placed at various locations around Soufriere and Choiseul, and left for about 3 weeks, at which time they will be collected.

An overview of the geothermal exploration drilling and the ESIA process was provided by Alison King. This was based on the PowerPoint presentation developed by Panorama.

Plenary Discussion

Participant Input: The area is agricultural flat land. The top soil will have to be removed to prepare for drilling. If the exploration is not successful, what will become of the area? Will they replace the topsoil? Secondly, what becomes of the pit/plug to ensure it does not become a hazard? Thirdly, what is the minimum distance that houses should be from the drill pad?

Response (DSD): The site must be restored to its previous condition. We had a situation in the 1970s where this did not happen, but this should be a requirement of the contract, with implications for non-payment if it does not occur satisfactorily. We will also need to require under the contract that the wells are plugged (with concrete) appropriately after the work is completed. This also has not been satisfactory under previous programmes, and we must ensure that it is done. The pipes will remain in the ground.

Participant Input: I was a taxi and truck driver before, and had work to supply the previous project. The area was left in the same way, top soil was not replaced.

Response (ECMC): We will recommend that top soil be set aside during site preparation, and spread back over the site as part of the site restoration works.

Participant Input: Mr. Barthelmy mentioned 6 miles to drill the well. How far down is the rock?

Response (DSD): From the moment you start drilling, you encounter rock.

Participant Input: I am born in Choiseul, resident in Gros Islet. What benefits will be derived by the population from this activity? Will there be competition? We only have 1 supplier, LUCELEC. What is the cost benefit for Saint Lucians?

Response (DSD): Our peak load is 60 MW. Geothermal can generate 30 MW, or 50% of our electricity. This is an indigenous resource, reducing our need for imported oil. Electricity prices will be less volatile because of fluctuations in oil prices. Geothermal brings added stability, which is attractive to investors. A lower cost power supply is also possible, which would benefit all residents.

Because we are a small island, it is not feasible to have multiple companies. We are 99% electrified and have very good infrastructure. LUCELEC will continue to provide the transportation infrastructure. Power generated by independent power producers will be sold to LUCELEC at a price lower than it costs LUCELEC to produce power from oil.

Although there is no guarantee, hopefully the price of power will go down.

Participant input: I work with the Ministry of Agriculture, based in this area. I am concerned as this area is a water catchment area and a farming area. It feeds water to the pineapple area. There is an intake at the Gia Bois. Mr. Ferguson John (past MP for the area) has three fish ponds with water fed from there. There is spring water lower down. When there is no water in the mains, the people go there for water. The Ministry of Agriculture may have more information on these water sources.

Participant input: Will members of the community be trained to help with equipment deployment?

Response (PS): The project is not in full force. We are just doing testing and analysis, and these experts have been contracted for that. The work is so specialised, but there may be some limited opportunity for young people to observe.

The contract will require the drilling company to employ persons from the community.

If there is a viable resource, there will be a power plant. Once the power plant is opened, there is a world of opportunities for young people.

Participant input: I have read that they have been different feasibility studies, and drilling. Will this be another failure?

Response (PS): A number of drilling programmes have been conducted. That is why the pre-feasibility consultant is required to analyse existing information, to guide next steps.

Of 7 wells, two were producing, but SL2 was acidic. It would corrode equipment. Now, we are not drilling in the same place. More drilling is needed to capture the quality of the resource. We hope this is the last go, and we will discover a commercially viable resource.

(AB): Geothermal is very challenging and complex, even for countries with more resources than us, such as the British and the Americans, who do not always succeed.

(PS): By the second half of next year we will know if we can drill production size wells.

Participant input: This is a very fertile area. From here to Tete Morne, you can grow anything. We would have to gain big time because there is a lot to lose.

In the past, lands here have been identified here for relocation of farmers from the water catchment area (upper Saltibus) and Black Bay. This is prime agricultural land. Speak to Invest St Lucia. Some of these lands are leased by farmers from the Crown/ Invest St Lucia.

Participant input: If you develop that area, what would be the buffer zone for farmers?

Response (DSD): The studies will advise.

Participant input: Will there be a follow up?

Response (PS): Yes, we will have a public review. The public will have access to the document.

Closing Remarks

Ms. Charlin Bodley noted that experts will be in the field for the next three weeks. She requested a volunteer from the community who would ensure that instrumentation is not tampered with. She requested that interested persons contact the DSD. The equipment is expensive, and loss of data can affect the progress of the project adversely.

Mr. Curt Inglis closed the meeting, thanking all for their participation, and inviting them to share some refreshments.









Government of Saint Lucia

Resettlement Policy Framework

Saint Lucia Renewable Energy Sector Development Project

September 2018

ECMC

PANORAMA ENVIRONMENTAL, INC.

Government of Saint Lucia

Resettlement Policy Framework

Saint Lucia Renewable Energy Sector Development Project

September 2018

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List of Abbreviations

AO	Authorized Officer
CBO	Community-Based Organization
CCL	Commissioner of Crown Lands
DAFP	Department of Agriculture, Fisheries, Natural Resources and Cooperatives
DIPE	Department of Infrastructure, Ports, and Energy
DPP	Department of Physical Planning
DSD	Department of Sustainable Development
ESIA	Environmental and Social Impact Assessment
GRC	Grievances Redress Committee
GOSL	Government of Saint Lucia
IFC	International Finance Corporation
IVSC	International Valuations Standards Council
LO	Legal Officer
NGO	Non-Government Organization
OP	Operational Policy
PAP	Project Affected Persons
PCU	Project Coordinating Unit
PS	Permanent Secretary
PSC	Project Steering Committee
QS	Quantity Surveyor
RAP	Resettlement Action Plan
RPF	Relocation Policy Framework
RICS	Royal Institute of Chartered Surveyors
RPF	Resettlement Policy Framework
STO	Social Transformation Officers
TD	Technical Director
TO	Technical Officer
VS	Valuation Surveyor

Glossary[1]

Compensation	Payment in cash or in kind to replace losses of land, structures, agricultural income, lease/rental income and other assets caused by the project.
Cut-off Date	Date of completion of the census and assets inventory of persons affected by the project. Persons occupying the project area after the cutoff date are not eligible for compensation and/or resettlement assistance. Similarly, fixed assets (such as built structures, crops, fruit trees, and woodlots) established after the date of completion of the assets inventory, or an alternative mutually agreed on date, will not be compensated
Involuntary	Actions that may be taken without the displaced person's informed consent or power of choice.
Involuntary Resettlement	Resettlement is involuntary when it occurs without the informed consent of the displaced persons or if they give their consent without having the power to refuse resettlement.
Land Acquisition	The process whereby a person is compelled by the state to alienate all or part of the land s/he owns or possesses, to the ownership and possession of the state for a public purpose, in return for full and fair compensation.
Monitoring	The process of repeated observations and measurements of environmental and social quality parameters to assess and enable changes over a period of time.
Project Affected Person	All those people who lose land or the right to use land or who lose access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods.
Replacement (Compensation) Cost	With regard to land and structures, "replacement cost" is defined as follows: For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive

[1] Some of the definitions were taken from the Involuntary Resettlement Sourcebook - Planning and Implementation in Development Projects, World Bank

	potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes. For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes. In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset. Where domestic law does not meet the standard of compensation at full replacement cost, compensation under domestic law is supplemented by additional measures so as to meet the replacement cost standard.
Resettlement Action Plan (RAP)	A time-bound action plan with a budget, setting out resettlement strategy, objectives, options, entitlements, actions, approvals, responsibilities, monitoring and evaluation.
Resettlement Policy Framework (RPF)	A resettlement policy framework is required for projects with subprojects or multiple components that cannot be identified before project approval.
Stakeholders	Any and all individuals, groups, organizations, and institutions interested in and potentially affected by a project or having the ability to influence a project.
Vulnerable Groups	Distinct groups of people who might suffer disproportionately from resettlement effects, including the poor, landless and semi-landless, female-headed, disabled and elderly households without means of support and those from minority groups.

GLOSSARY

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1 INTRODUCTION

1.1 BACKGROUND OF THE GEOTHERMAL RESOURCE DEVELOPMENT PROJECT

1.1.1 Project Objectives

In keeping with Saint Lucia's policy objective of reducing reliance on fossil fuels for energy generation, and in an effort to realize the commitment to achieve a national target of meeting 35% of its energy requirements from renewable sources by the year 2020, the Government of Saint Lucia (GOSL) has resumed the active exploration of geothermal energy in the south-western districts of Soufriere, Laborie, and Choiseul. In addition to providing a reliable source of clean renewable energy, development of the geothermal resource would assist Saint Lucia in reducing its reliance on imported oil.

1.1.2 Project Components for which Land Acquisition is Required

The GOSL proposes a geothermal exploration program, Saint Lucia Renewable Energy Sector Development Project (project), to test the geothermal resource and evaluate the feasibility of commercial geothermal power production in Saint Lucia. The geothermal exploration is proposed within the Soufrière, Choiseul, and Laborie regions of Saint Lucia. The geothermal exploration program would include slim-diameter wells to obtain information on the geology and temperature gradient in the area. Deep geothermal wells may be drilled with larger drilling rigs if the initial drilling is successful.

Land resettlement/acquisition is expected to be required for the exploratory drilling phase of the geothermal exploration project .

The land used for the exploratory drilling phase will be leased and impacts would be temporary. If the geothermal program is successful and future development of the resource occurs, a separate Resettlement Action Plan (RAP) will be developed prior to development to address the long-term impacts of a separate geothermal development project. The RAP addresses the temporary impact at the well pads. The proposed well pads would be located within the larger drilling areas shown in Figure 1.1-1 and 1.1-2. The land use at the exploratory well pads could be long-term (30 years or more) if the wells are successful. This Resettlement Action Plan (RPF) addresses this potential long-term use and required land acquisition if the wells are successful. The land use for the power plant development and operation phase would be long-term (30 years of more).

For both phases, land is required for civil works, the construction and/or improvement of access roads, and for the establishment of drilling pads and wells at the geothermal resource target

areas. This land use will involve involuntary resettlement – the economic and/or physical displacement of people in the drilling area.

1.2 PURPOSE AND SCOPE OF THE RESETTLEMENT POLICY FRAMEWORK

The areas identified for geothermal drilling and impacts have been broadly identified, the precise areas for geothermal exploration drilling or all the land parcels required for the project cannot be identified pre-appraisal. The nature of geothermal resource development may require progressive land acquisition over a period of time because the desired locations for drilling may be modified as each well is drilled and cannot be fully known pre-appraisal.

The locations for drilling were defined by the Environmental and Social Impact Assessment (ESIA). The drilling locations will be further defined before construction. The ESIA identifies areas to avoid and specifies buffers between well pads and homes.

World Bank-assisted projects that entail resettlement and/or displacement, require the development of a RPF, if all the land parcels required for the project cannot be identified before appraisal. Additionally, an RPF needs to be prepared if the extent and location of resettlement cannot be known at appraisal because the project has multiple components.

The purpose of this RPF is to establish resettlement objectives, principles, organizational arrangements, the overall design of the resettlement programme and funding mechanisms for any resettlement operation that may be required during the activities of Component 2 of the project. Should the need arise to resettle Project Affected Persons (PAPs), the resettlement process will follow the principles outlined in this RPF and take into account the social context and adapt the process to the specific circumstances. This RPF along with the RAP will be utilized to establish appropriate mechanisms that will be specifically tailored to deal with resettlement issues that may arise. The RPF is in keeping with the provisions stipulated in the World Bank's Operational Policy (OP) 4.12: Involuntary Resettlement.

1.3 METHODOLOGY

In preparing the RPF, Panorama, through ECMC, conducted several stakeholder engagement consultations. In August and September 2017, consultations were held in the affected communities (Belle Plaine, Fond St. Jacques and Mondesir). Interviews and discussions were also held with PAPs during the socio-economic baseline survey in each community in September 2017. These consultations provided direct information on the PAPs and their concern about to the use of their lands and community as exploratory drilling areas. General information on the land use and tenure arrangements within the immediate vicinity of the geothermal resource target areas were also obtained during the consultations.

Institutional stakeholders were also consulted during preparation of the RPF. Discussions were held with WASCO regarding the location of a spring water intake tank in the Belvedere, Fond St. Jacques resource target area. The Technical Director of the Geothermal Project was

consulted concerning background information on the project and with the PS – DSD was consulted regarding the institutional arrangements for Project implementation. Discussions were also held with the technical staff of the various Government departments (Department of Housing, Urban Renewal and Telecommunications, Department of Sustainable Development Department of Physical Planning, Department of Agriculture, Fisheries, Natural Resources and Co-operatives) concerning the GOSL's resettlement policies; legal framework for land acquisition; valuation of land for acquisition; and the lease of Crown property and crop compensation. Members of the Institute of Surveyors St. Lucia Inc. were also contacted concerning the process for valuation of structures and for the valuation of land.

2 PRINCIPLES AND OBJECTIVES

2.1 PRINCIPLES GOVERNING RESETTLEMENT PREPARATION AND IMPLEMENTATION

The World Bank OP 4.12 on Involuntary Resettlement includes safeguards to address and mitigate risks resulting from involuntary resettlement under development projects and covers any involuntary land taking. In that regard, the implementers of Work Bank-sponsored projects are expected to adhere to a number of basic principles for addressing the adverse effects of involuntary resettlement associated with its investment projects. These principles are as follows:

- Involuntary resettlement should be avoided
- Where involuntary resettlement is unavoidable, all people affected by it should be compensated fully and fairly for lost assets
- Involuntary resettlement should be conceived as an opportunity for improving the livelihoods of the affected people and undertaken accordingly
- All people affected by involuntary resettlement should be consulted and involved in resettlement planning to ensure that the mitigation of adverse effects as well as the benefits of resettlement are appropriate and sustainable

2.2 POLICY OBJECTIVES

The overall objectives of this policy are to ensure that the PAPs are left no worse off than they were before the commencement of the project.

3 PROCESS FOR PREPARING AND APPROVING RESETTLEMENT PLANS

The RAP implementation program will be carried out in parallel with the project exploration program – planning, infrastructure preparation, drilling design, procurement – and will need to be completed before the drilling work program. A draft RAP has been prepared that will be submitted to the World Bank for approval. The RAP will be revised during the project engineering/design phase to address the specific drilling areas and access road locations. The RAP will be prepared consistent with the draft RAP and this RPF.

Since the precise areas for geothermal exploration drilling or all the land parcels required for the project cannot be identified pre-appraisal, it is recommended that the preparation and disclosure of the draft RAP and this RPF be conditional for project appraisal. If involuntary resettlement and/or the compulsory acquisition of land becomes unavoidable, the Department of Infrastructure, Ports, and Energy (DIPE) shall update the draft RAP ensuring that it is consistent with this RPF. Preparation and processing of the updated RAP thus will entail the following steps:

- Disclosure of the RAP (approved by the World Bank) for public consultation;
- Revision and finalization of the RAP based on public disclosure and consultation - where necessary:
  - Review and update census and socio-economic information/database;
  - Review and update eligibility criteria;
  - Redefine project areas of influence and potential socio-economic impacts;
  - Select resettlement site(s) if applicable;
  - Revise entitlements policy and matrix;
  - Consults with the PAPs concerning eligibility criteria and entitlements;
  - Re-examine income restoration plan and update where necessary;
  - Reassess the capacity of the agencies responsible entitlement delivery to execute assigned tasks; and if necessary build capacity.
  - Verify monitoring and evaluation indicators;
  - Assign implementation and monitoring responsibilities;
  - Complete arrangements for the participation of key stakeholders in implementation and monitoring activities;
  - Finalize the RAP budget.
- Seek World Bank approval for the revised RAP.

4 ESTIMATED POPULATION DISPLACEMENT

The baseline socioeconomic study conducted as part of ESIA Scoping Studies in September 2017 reported that the three project-affected communities comprise a total of four human settlements spanning two districts as indicated in Table 4-1. The Belvedere settlement includes individuals who may be affected by drilling in the Fond St. Jacques community and the Parc Estate and Gayabois settlements include individuals who may be affected by drilling in Mondesir-Saltibus communities. Based on the last population census (in 2010), the total population of these four settlements was estimated at 746 persons as summarized in Table 4-1.

Table 4-1 Population of the Affected Communities

Population (2010)	Females	Males	Total
Soufriere			
Belvedere	221	252	473
Belle Plaine	47	54	101
Total	**268**	**306**	**574**
Laborie			
Parc Estate	45	54	99
Gayabois	31	42	73
Total	**76**	**96**	**172**

Source: (Central Statistics Office 2011)

The baseline socioeconomic study also showed that agricultural production was one of the main forms of livelihoods in all the settlements. In the case of Belvedere/Fond St. Jacques and Belle Plaine, the PAPs include mostly landowners, landlords, absentee landowners tenants and sharecroppers. Gayabois and Parc Estate (in Mondesir-Saltibus) are sparsely populated and many of the PAPs are landless farmers/squatters occupying Crown lands for residential and agricultural purposes.

In the RAP for the exploratory drilling phase, it was estimated that a total of 5-10 persons are likely to be economically and/or physically displaced during the exploratory drilling phase; a maximum of 2 each in Belvedere/Fond St. Jacques and Belle Plaine. The economic displacement could be short-term (less than 1 year) if the wells are not successful. The economic displacement could be permanent if the wells are successful. The physical displacement, if necessary, would be temporary during geothermal testing (approximately 60 days), but may be permanent if the wells are successful and the GOSL decides to maintain the well pads for future geothermal development.

4 ESTIMATED POPULATION DISPLACEMENT

A census and an updated socioeconomic survey of the PAPs shall be undertaken to confirm the exact numbers within each category of PAPs after the location of the well pads is identified in the potential drilling areas.

5 ELIGIBILITY CRITERIA

The term Project Affected Persons (PAPs) used in this RPF refers to "all those people who lose land or the right to use land or who lose access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods". The term "displaced persons" is synonymous with "project-affected persons" and is not limited to those subjected to physical displacement.

For the purposes of this RPF, the PAPs comprise five categories of individuals, who own and/or occupy land at the three geothermal resource target areas; they are classified as follows:

1. Property owners[2];
2. Landlords;
3. Tenants of property owners;
4. Tenants of the Crown;
5. Squatters.

The general conditions of the entitlement policy, compensation and rehabilitation measures for the resettlement/displacement of each category of PAP are as follows:

- **PAPs losing land or structures** (or losing access to those assets) and/or having to physically relocate due to loss of livelihood, or losing access to income sources or means of livelihood: Generally, all PAPs with legal rights of land use. Compensation shall be made for loss of affected land, structures, and economic assets on the land at full replacement value. Resettlement assistance in line with the World Bank policy requirements, shall be provided for them.
- **PAPs experiencing temporary loss of land or temporarily losing access to these assets or access to income sources or means of livelihood.** Generally, all PAPs with legal rights to land use shall be considered entitled. Lease agreements will be negotiated between the government and landowners for temporary land take. In effect, displacement assistance in line with the World Bank policy requirements shall be provided.

[2] Property covers land and structures. Structures include buildings (residential, commercial or institutional) or other constructions such as foundations, fences, latrines, storage sheds or platforms for water storage tanks).

- **Project Affected Persons losing rental/leased land**: Holders of rental or lease agreements will be assisted with finding alternative land to rent/lease. Transitional assistance may be necessary to ensure that livelihoods are not affected.
- **Project Affected Persons losing crops or economic trees**: Affected persons shall be allowed to harvest any crops planted prior to the date that land is taken. If land must be taken before the crops are ready for harvest, crop compensation shall be determined by the ministry with responsibility for agriculture and paid for by the project.
- **Project Affected Persons who are squatters:** Squatters are persons who have no recognizable legal rights or claim to the land they are occupying. No record of squatters exists, but reconnaissance visits and interviews indicate that at least 5 to 10 landless farmers are on Crown lands. Whereas there will be no compensation for land, compensation for other assets such as crops or trees shall be determined by the ministry with responsibility for agriculture and paid for the project. Those using land unofficially for agricultural purposes shall be assisted with finding alternative areas available for use.

The project will consider various forms of evidence as proof of eligibility for the various categories of PAP identified above. Acceptable forms of evidence shall cover the following:

1. Project Affected Persons with formal legal rights, documented in written form such as land registers, deeds, mortgages, lease agreements, tenancy agreements or rent receipts.
2. Project Affected Persons with no formal or recognized legal rights criteria for establishing non-formal, undocumented or unrecognized claims to eligibility, shall be established by DIPE on a case by case basis through the assessment of the peculiarities of each individual situation.
3. Alternative means of proof of eligibility, which may include an affidavit signed by landowners and tenants that are witnessed or evidenced by a reputable member of society, such as Notary Royal, Justice of the Peace, priest, senior public servant, etc.

Generally, only PAPs identified during the 2017 socio-economic survey and inventory of assets shall be eligible for compensation. Any new agricultural activity or physical structure established after the cut-off date, shall not be considered affected; and the owners shall not be eligible for compensation unless they can demonstrate that the socio-economic survey/inventory of assets failed to identify them as being affected.

6 LEGAL FRAMEWORK

6.1 POLICIES OF THE WORLD BANK FOR INVOLUNTARY RESETTLEMENT

6.1.1 World Bank Operation Policy 4.12 Involuntary Resettlement

The World Bank's Operational Policy on involuntary resettlement (OP 4.12[3]) covers direct economic and social impacts resulting from Bank-assisted investment projects that require:

- The compulsory acquisition of land, that would give rise to the relocation or loss of shelter; loss of assets or access to assets; or loss of income sources or means of livelihood, whether or not the affected persons are required to move to another location.
- The involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

In the case of this RPF, the applicable direct economic and social impacts may arise as a consequence of temporary and/or permanent acquisition of private lands for the purpose of the project, and the use of public (i.e., Crown lands) for the geothermal exploration and future development (if the exploration is successful). The GOSL will need to acquire the necessary land rights to facilitate the conduct of civil works and geothermal exploration activities, and potentially for development activities.

In the context of the World Bank's social and environmental safeguard policies, both temporary and permanent acquisition establish a basis for resettlement and thus OP 4.12 applies. In the Bank's terminology, resettlement is not limited to physical relocation; it includes all direct economic and social losses resulting from land take and restriction of access, together with the requisite compensatory and remedial measures.

The current project is expected to be implemented at a distance from homes in order to avoid the need for relocation of homes. The project will require compensation for lost livelihood because some of the project well pads will be located on agricultural lands. In the event that unforeseen project activities result in impacts that require the physical relocation of households/homes, the RPF will cover measures to ensure that the displaced persons are provided with residential housing or housing sites, in addition to other entitlements.

[3] Involuntary Resettlement Sourcebook - Planning and Implementation in Development Projects,

6.2 LEGAL FRAMEWORK FOR RESETTLEMENT, LEASE AND ACQUISITION OF LAND IN SAINT LUCIA

This section includes a discussion of the framework for resettlement in Saint Lucia; and provides the key elements of the legal framework for two instruments (i.e., the lease agreement; and compulsory acquisition) used by the government for obtaining the right of access to land for public use.

6.2.1 Framework for Resettlement

6.2.1.1 St. Lucia Policies

There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. Over the years, the Government's resettlement initiatives have generally involved or resulted in the physical relocation of households to resettlement sites, the displacement of agricultural production, and to a lesser extent the displacement of business operations; all for the purpose of making land available for development/public purpose. This RPF was prepared for the proposed project.

6.2.1.2 Examples of Policy Implementation

General Approach

Displaced persons are consulted about their options and rights, compensation standards are transparent, and are applied consistently across the board. Consideration is given to concerns and specific requests, but the parties may not always be presented with a range of viable options in the matter of their resettlement. In some instances, the resettlement site has been one fixed location or the options among which an affected person may choose a resettlement site were limited. In the more recent examples of relocations projects (e.g., the Conway Relocation Project), the selection of the resettlement sites and lot allocation were conducted through a lottery system.

In cases where households have been displaced, the focus has been on the reinstatement of these households at the resettlement site (i.e., an approved land development, where the necessary services have been installed). The typical relocation package offers the project beneficiary a replacement home and a house lot at subsidized prices and a relocation grant. In addition, the value of the household's equity in the property (i.e., house or house and land) at the relocation site is deducted from the price of the house and land package offered.

The response to the displacement of persons involved in agricultural production and the displacement of businesses has typically focused on the payment of compensation. In the case of displaced agricultural production, the landowner is paid the market value of the land and crops. Land-based compensation is generally avoided as it has proven challenging to find available agricultural lands for which a combination of productive potential, locational advantages, and other factors are at least equivalent to the advantages of the old site.

In cases where the occupier of the land is a squatter or tenant of the Crown, the affected party is given a minimum period of six (6) months to harvest the existing short-term crops and to vacate

the land. In circumstances involving long-term crops (such as fruit trees) or where the land will be required before or within the specified timeframe, crop compensation is determined by the ministry responsible for agriculture and paid by the ministry/agency responsible for project implementation.

Previous Geothermal Exploration

Geothermal resource exploration in Saint Lucia has had a long history dating as far back as the 1950's when reconnaissance investigations were undertaken in the Soufrière district. In the 1970's and 1980's, exploratory drilling was done near the Sulphur Springs and Etangs areas in Soufriere. However, there is no documented information on whether the conditions of use of the existing drilling sites have been fulfilled and closed. Anecdotal information indicates that the Government leased and/or purchased lands in Etangs and Belfond from private owners. Cash compensation was paid for crops for the lands in Etangs and an annual lease paid to the owner; however, drilling did not take place. The lands at Belfond were acquired by Government and cash compensation was also paid for the crops. The drilling site near the Sulphur Springs was eventually proven to be Crown lands and claims by a private owner were terminated.

Overall, it appears that all owners were compensated for the use of the lands that has been permanently altered due to the exploratory drilling. Visual observation of the abandoned drilling sites in August 2017 indicates that well-head fixtures are still in place. Information gathered during the community consultations in September 2017 suggest that these well-head fixtures and pipes continue to pose an aesthetic problem to some residents. Therefore, any new contract between the GOSL and the exploratory drilling contractor should specifically state how the site is to be restored when drill heads are left in place in order to minimize these adverse visual impacts.

6.2.2 Legal Framework for the Lease of Land in Saint Lucia

There is no single statue that deals solely with lease agreements; there are however pieces of legislation that address some specific types and/or aspects of leases. For example, the Civil Code of Saint Lucia, Cap. 4.01, which contains provisions for the governance and formalities of these type of contracts, provides guidance for the administration of the emphyteutic lease. Another example is the Rent Restriction Act, Cap 13.23 of the Revised Laws of Saint Lucia that deals specifically with the rental of dwelling houses. In effect, none of the existing pieces of legislation are applicable in the context of this RPF.

There is no particular government ministry or agency with direct responsibility for the administration of lease agreements between the government and private individuals/companies /agencies etc., except in the case of the lease of Crown property, which falls under the purview of the Commissioner of Crown Lands.

Should the need arise for private property to be leased by the Government for the purposes of a project, the ministry responsible for that project will negotiate and enter into a lease agreement

(on behalf of the government) with that private entity. Note that the lease agreement must be submitted by the responsible ministry to the Attorney General Chambers for vetting.

6.2.3 Legal Framework for Acquisition of Land in Saint Lucia

The guidelines and protocols pertaining to the acquisition of private land for public purpose are embodied in the Land Acquisition Act, Cap 5.04 of the Revised Laws of Saint Lucia. In addition, Constitution of Saint Lucia, Cap 1.01 of the Revised Laws of Saint Lucia provides protection from deprivation of property rights and makes provision for the prompt payment of compensation, in cases of compulsory acquisition of property or curtailment of right.

The following are procedures covered by the Act that are applicable to the land acquisition process required by the geothermal project:

i. **Preliminary notification and power to enter the land** – if the Governor General determines that any land is required for public purpose and it is necessary to make a preliminary survey or other investigation of the land, he/she may cause the publication of notification to that effect; and thereafter it shall be lawful for the Authorized Officer or his/her agents to enter onto the land to undertake the investigative works required.

ii. **Power to apply land to purposes of acquisition without waiting for formal vesting** - at any time after the publication of a notification of the intention to acquire land for public purpose, it appears to the Governor General that this land should be acquired, he/she may make an immediate declaration to that effect; and it is lawful for him/her to direct the Authorized Officer to do any work on the land connected with the use for which the land is being acquired.

iii. **Appointment of Board of Assessment** - in the event that the parties cannot reach agreement on compensation to be paid, a Board of Assessment may be appointed and granted full power to assess, award and apportion compensation in such cases, in accordance with the provisions of the Act.

Sections 4 of the Act permits access to the land for investigative purposes before compensation is paid; Section 5 allows the government to take possession of land acquired and to commence development before compensation is paid. These provisions stand contrary to the World Bank's policy on involuntary resettlement, which states that the client will take possession of land acquired and related assets ***only after*** compensation has been made available and, where applicable, resettlement sites and moving allowances have been provided to the displaced persons in addition to compensation.

Notwithstanding official agreement by governments to adhere to the provisions of the Bank's Social and Environmental Safeguard policies, in reality, it is not always feasible for the agency with responsibility for acquisition to readily facilitate the compliance of the implementing agency. Case in point, as it relates to the matter of the prompt payment of compensation as stipulated by the Constitution and Bank policy if the allocation for acquisition in the national

budget is deficient, this is likely to hinder the ability of the government to comply with this provision. Further, in cases where agreement over the payment of compensation cannot be reached between the Authorized Officer and the landowner, the appointment of a Board of Assessment would further delay payment. Experience has shown that negotiations for compensation (using either medium) can sometimes take several years to be concluded.

6.3 CONFLICTS/GAPS BETWEEN LOCAL LEGISLATION/POLICY AND WORLD BANK POLICY

Table 6-1 overleaf provides a summary of the key conflicts/gaps that exist between the World Bank's policy and local legislation and policy as it relates specifically to resettlement and land acquisition. The proposed measures for addressing these conflicts are also indicated in Table 6-1.

Since there exists no conflict/gap as it relates to the use of a lease as an instrument for acquiring the right of access to land for temporary use, this method of compensation is not included in Table. 6-1. The World Bank's Involuntary Resettlement Handbook identifies the lease of land as a measure for acquiring the right of access to land, for temporary land acquisition[4], a practice that is widely employed in Saint Lucia.

[4] Appendix 6 – Resettlement Entitlement Matrix

Table 6-1 Conflicts/Gaps between Bank Policy and Local Legislation/Policy and Mechanisms to Address the Same

Conflict/Gap	Local Legal Framework /Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
1. Restoration of livelihoods and living standards; 2. Support for displacement; 3. Development assistance.	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. World Bank type policy pertaining to the restoration of income sources and livelihoods, support after displacement for a transition period; and the provision of development assistance, do not apply; except in the case where replacement homes of greater value are provided as part of the relocation package.	OP 4.12 – Involuntary Resettlement: Section 2 (c) - Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher. Section 6 (c) - Where necessary … compensation should also include measures to ensure that displaced persons are offered support after displacement for a transition period, based on a reasonable estimate of the time likely to be needed to restore their livelihood and standards of living. The displaced persons should also be provided with development assistance such as land preparation, credit facilities, training, or job opportunities, in addition to the other compensation measures stipulated.	The Social and Environmental Safe Guards of the World Bank take precedence. All PAPs should be eligible for full compensation costs [1/] per World Bank Policy requirements.
4. Opportunity to derive development benefits from project	There is no existing legislation or official policy document that specifically supports resettlement initiatives in Saint Lucia. Opportunities to derive development benefits are not generally part of the objectives or	Performance Standard 5, Section 9 - The client will also provide opportunities to displaced communities and persons to derive appropriate development benefits from the project.	According to the Scoping Studies Report, the project will create temporary job opportunities during the civil works and drilling operations. While many of the jobs during the drilling operations require specialized skills that may not be available locally, for non-specialized jobs, the project is expected to create equal employment opportunity for both men and women. In

Conflict/Gap	Local Legal Framework /Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
	scope of work of local resettlement projects.		that regard, it is recommended that the Government seek to enter into agreement with the service providers for the planned works to give priority to the employment of workers originating from the target communities.
5. Timing for the Payment of Compensation and Taking Possession of Land Acquired.	Chapter 1, Section 6 of the Constitution of Saint Lucia provides for inter alia, the prompt payment of compensation in cases of compulsory acquisition of property or curtailment of right. Sections 4 of the Land Acquisition Act permits access to the land for investigative purposes before compensation is paid. Section 5 allows the government to take possession of land acquired and to commence development before compensation is paid.	Performance Standard 5, Section 9 - The client will take possession of land acquired and related assets only after compensation has been made available …	To ensure compliance with Bank Policy: • The implementing agency (IA) is required to submit an early request for land acquisition to the Authorized Officer / Department of Physical Planning to ensure that this task is included in the Department's annual work programme and that the relevant budgetary allocation is made. • It is essential that the IA includes the Authorized Officer or his/her representative on the Project Steering Committee to facilitate active involvement in project activities and to ensure that he is kept abreast with issues and progress. This type of collaboration is highly likely to ensure that preferred attention is given to the land acquisition requests. • The IA is required to make provision for the acquisition cost in the project budget (i.e., preferred course of action) to ensure the availability of funds for prompt payment. • The IA will ensure that more than the required number of sites are identified for the surface level reconnaissance activities, in an effort to provide alternative locations for exploration in the event that any of the negotiations for compensation are drawn out,

Conflict/Gap	Local Legal Framework /Policy	World Bank Policy Requirements	Measures to Address Conflict/Gap
			rendering the preferred sites unavailable for use. • In collaboration with the Authorized Officer / Department of Physical Planning, the IA will explore options for the lease of the lands required as an alternative to acquisition or as an interim measure to accommodate a potentially lengthy acquisition process.

1/ Defined as the method of valuation of assets that helps determine the amount sufficient to replace lost assets and cover transaction costs. In applying this method of valuation, depreciation of structures and assets should not be taken into account. For losses that cannot easily be valued or compensated for in monetary terms (e.g., access to public services, customers, and suppliers; or to fishing, grazing, or forest areas), attempts are made to establish access to equivalent and culturally acceptable resources and earning opportunities.

7 METHODS OF VALUING AFFECTED ASSETS

The total compensation cost to be paid out to affected individuals would consist of the valuation of the land, crops and trees, and structures. Each of these methods are detailed below.

7.1 VALUATION OF LAND FOR COMPULSORY ACQUISITION

Valuations for land under compulsory acquisition are guided by the Land Acquisition Act, Cap 5.04 of the Revised Laws of Saint Lucia, which sets out the "Rules for Assessment of Compulsory Acquisition". In addition, methods for undertaking valuations for compulsory acquisition are guided by the code of ethics and standards of the Institute of Surveyors St. Lucia Inc., as well as that of the Royal Institute of Chartered Surveyors (RICS), and the International Valuations Standards Council.

In the context of the foregoing, the key components for undertaking a valuation of land for compulsory acquisition includes that:

- The value of the land is taken to be the amount which the land, in its condition at the time of acquisition, if sold in the open market by a willing seller, might have been expected to have realized, at a date twelve (12) months prior to the date of the second publication of the notice of Declaration of Acquisition in the National Gazette.
- The valuation of the property does not take into consideration any special suitability for any purpose for which the land can be utilized.

In the local context, various methodologies (e.g., market approach, income approach and the investment method) are utilized in determining open market value as described above. The method most predominantly utilized, however, is the market approach, while the other methodologies are normally used as a check against the market approach. The market approach involves valuation of land based on the selling price of a similar plot, which would be conducted by a qualified appraiser. Notwithstanding the foregoing, whatever the approach used, the key considerations include factors such as location, topography, size, available services, tenure, land use and the presence or absence of natural hazards. The duration of use and loss of income would also be considered when determining appropriate compensation.

Note that where land-based options for compensation for land acquired are not feasible, the use of replacement cost, including the open market value of land and associated costs, as the means of determining the value of compensation is in keeping with World Bank Policy OP 4.12 (see full definition in Glossary section).

7.2 VALUATION OF CROPS AND ECONOMIC TREES

In the context of Government-related projects, crop valuation falls under the purview of the Ministry of Agriculture, Fisheries, Natural Resources and Co-operatives. The values assigned to crops are specified as a range and are set by a committee of technical experts who take into consideration factors such as the species, location, production cost, market value, climate and environmental influences. The applicable range for each crop is documented in the ministry's "Crop Valuation Guide" (2008), which provides a scale of royalty rates for timber according to cubic foot measurement, and a comprehensive list of crops and economic trees under the following broad categories:

- Fruit and tree crops;
- Vegetables and herbs;
- Cut flower and ornamental plants;
- Food and root crops.

Where crops are being valued for displacement from the land or removal of the crop, the economic life of the crop is considered (particularly for tree crops). When a valuation is required for an assessment of damage to the crop, where the crop continues to grow but growth is retarded, the age at the time of damage is taken into account.

The aforementioned provisions are generally in keeping with World Bank policy. Contrary to local practice, however, OP 4.12 notes that in some countries, the value of the harvest is determined by the average market value of crops for the previous three years. It states further that whatever the multiplier, if food supplies are sold in the area enough cash compensation is paid to purchase equivalent supplies, taking into account the possibility of price increases caused by heightened demand from displaced persons. When determining the appropriate level of compensation. consideration shall be given to the duration of lost production, including the time it would take for the crops to return to their present production value.

7.3 VALUATION OF STRUCTURES

There is no existing legislation to guide the process for valuation of structures or buildings (residential, commercial or institutional) or other constructions such as foundations, fences, latrines, storage sheds or platforms for water storage tanks. Methods for undertaking the valuation of structures are guided by the code of ethics and standards of the Institute of Surveyors St. Lucia Inc. as well as that of the RICS.

The RICS Valuation - Global Standards (the RICS 'Red Book' as it has become widely known) contains mandatory rules and best practice guidance for undertaking asset valuations. The valuation report is the common way of communicating the value of a property, through an opinion on the "Replacement Cost". This opinion is based on the use of data concerning location, amenities, structural condition, age of structure; and recent sales of similar local properties.

7 METHODS OF VALUING AFFECTED ASSETS

In keeping with World Bank Policy OP 4.12, the replacement cost is the method of valuation of assets that are used to help determine the cost of replacing lost assets and transaction costs. In applying this method of valuation, the depreciation of structures and assets is not considered.

8 ORGANIZATIONAL PROCEDURES

8.1 INSTITUTIONAL RESPONSIBILITIES FOR IMPLEMENTING THE RAP

The Project is proposed to be implemented by the DIPE within the Ministry of Infrastructure, Ports, Energy, and Labor (MoIPEL). The latter took over responsibility for the entire energy sector portfolio, including renewable energy, as part of a restructuring process that was implemented in 2017[5]. DIPE is led by a Permanent Secretary (PS-DIPE), who is responsible for energy policy and Project implementation in Saint Lucia. As the project's lead implementing agency, DIPE will have the responsibility of managing the process of implementing the Project consistent with World Bank guidelines, procedures and practices for environment and social safeguards (including resettlement, if needed), procurement, disbursement, accounting, and financial management.

The Social Safeguards Officer (SSO) team will coordinate with the various contributing responsible agencies, and will act as liaison for all relevant institutions and agencies responsible for the execution of the RAP. Given that the Project Implementation Unit (PIU) has not been established, the project will utilize the existing Project Coordinating Unit (PCU) – under the Department of Economic Development, Transport and Civil Aviation (DETC) – to undertake the fiduciary and safeguards functions until such time that the PIU is determined to have adequate capacity to manage these activities, after which time the responsibility to undertake these functions will transfer to the PIU, including the social safeguards responsibility for reporting on RAP implementation.

The key government agencies with responsibility for entitlement delivery are outlined in Table 8-1.

Table 8-1 Key Agencies Responsible for Entitlement Delivery

Agency	Department/Section	Responsibility
Department of Infrastructure, Ports and Energy (DIPE)	Office of the Permanent Secretary	• Identify and categorize the PAPs and determine entitlement

[5] Prior to this restructuring, the renewable energy portfolio was under the Ministry of Education, Innovation, Gender Relations and Sustainable Development (MoESD) and the remainder of the energy portfolio was under the MoIPEL.

Agency	Department/Section	Responsibility
Department of Physical Planning (DPP)	Survey and Mapping Units	• Survey and valuation of lands to be leased/acquired
DPP	Registrar of Lands	• Verification of Title (ownership) and the quantum of property
DPP	Crown Lands	• Identification of alternative land for rent or lease
DIPE	Accounts	• Financial support for the implementation of the Rap and payment of compensations
Department of Agriculture	Extension Unit	• Valuation of crops and trees; determines crop compensation
Department of Equity and Social Justice	Social Transformation Office	• Assist with the coordination of RAP activities in the targeted communities, and resolution of any grievances
Project Co-ordination Unit (PCU)	Social Safeguards Officer	• Responsible for coordination of the RAP

DIPE is in the process of establishing a dedicated PIU dedicated to geothermal resource development, with functions, staffing and sufficient resources to manage all aspects of Project implementation. The PIU will be headed by a Project Manager who will report directly to the PS-DIPE. The PIU will also comprise, at minimum, a (i) Technical Officer (TO), (ii) Procurement Officer (PO), (iii) Financial Management Officer (FMO), (iv) Social Development Officer (SDO), and an (v) Environmental Safeguards Officer (ESO).

8.2 PROJECT STEERING COMMITTEE

The DIPE will establish a Project Steering Committee (PSC). DIPE will provide inter alia, dedicated attention to the coordination of the implementation of the RAP for each phase of the Project. The chairperson of the PSC will be selected by the PS from among the representatives of that Department. The PSC will be responsible for ensuring the smooth execution of project activities and for the successful accomplishment of project objectives. The PSC will meet monthly to review project implementation and performance. Meetings shall be convened when necessary to attend to urgent matters, which may arise in the course of project implementation.

Roles and Responsibilities of the PSC will be to:

- Assess project progress and performance;
- Provide technical advice and guidance on project implementation activities;
- Assist with resolving strategic-level issues and risks;
- Use influence and authority to assist the project in achieving its outcome.

The PSC shall be accountable to the Permanent Secretary of the DIPE, and comprise the following members:

1. Representatives of the DIPE:
    a. Chief Technical Officer;
    b. Legal Officer;
    c. Technical Director - Project
    d. Procurement Officer (PO),
    e. Financial Management Officer (FMO),
    f. Social Development Officer (SDO), and an
    g. Environmental Safeguards Officer (ESO)
    a.
2. Representative of the PIU;
3. Representatives of the Department of Physical Planning:
    a. The Authorized Officer or his/her representative;
    b. Commissioner of Crown lands or his/her representative;
    c. Quantity Surveyor;
    d. Valuation Surveyor.
4. Social Transformation Officers for each of the affected communities;
5. Member of a recognized community-based organization (i.e. one member from each community);
6. Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives.

8.3 ROLES AND RESPONSIBILITIES

Social Safeguards Officer (SSO) has the following responsibilities:

- Lead the RAP implementation activities and liaise with relevant government departments
- Ensure the RAP is updated with results of supplementary census surveys and asset/crop inventory
- Manage the stakeholder database
- Review all construction contracts for compliance with the ESMP and other associated plans; including meetings and audits
- Manage the Renewable Energy Sector Development project grievance redress mechanism
- Minutes of all meetings and consultations will be maintained by the PCU (and eventually the PIU) and shared with all parties. The Bank and all other agencies will be informed by email immediately following each meeting.

- Contribute to the Renewable Energy Sector Development project's regular reports to the World Bank, on the implementation of social safeguards measures.
- Report to stakeholders regarding: important details on the undertakings, routines, status, project progress and new or corrected information since the last report. Report frequency will be in accordance with the order set in the SEP.

Community Liaison Officer (CLO) will, in collaboration with the SSO:

- Conduct stakeholder outreach during project implementation and respond to any grievances or complaints that may arise
- Act as the key focal contact to bring project grievances from construction workers, local residents, and community members to the GRC.
- Be responsible for making sure the recommendations of the GRC are implemented and directing contractors to make any appropriate change to their work.
- Provide monthly monitoring reports on stakeholder outreach and grievance redress to the SSO

9 IMPLEMENTATION PROCESS

9.1 IMPLEMENTATION

The implementation process of preparing resettlement plans for the project shall involve the following activities as shown in Figure 9-1:

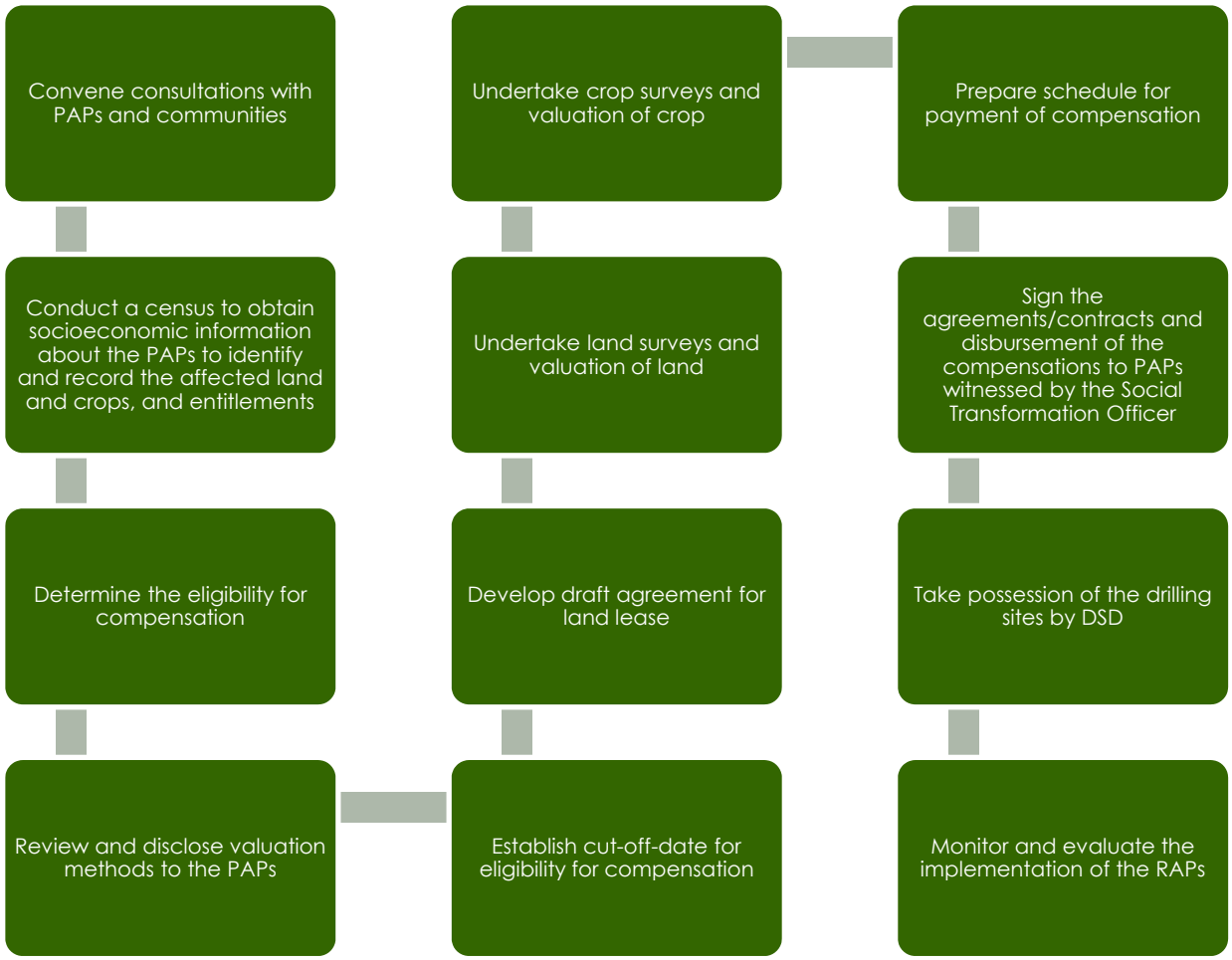
1. Convening consultations with PAPs and communities
2. Conducting a census to obtain socioeconomic information about the PAPs to identify and record the affected land and crops, and entitlements
3. Determining the eligibility for compensation
4. Reviewing and disclosing valuation methods to the PAPs
5. Establishing cut-off-date for eligibility for compensation
6. Developing draft agreement for land lease
7. Undertaking land surveys and valuation of land
8. Undertaking crop surveys and valuation of crop
9. Preparing schedule for payment of compensation
10. Signing of the agreements/contracts and disbursement of the compensations to PAPs witnessed by the Social Transformation Officer
11. Taking possession of the drilling sites by DIPE
12. Monitoring and evaluating the implementation of the RAPs.

The timeframes for implementing the activities shall be developed by the GOSL and approved by all collaborating institutions including, the PAPs. The schedule shall allocate sufficient time for linkages between settlement activities and civil works.

With regard to linking resettlement implementation to the civil works:

- The civil works shall commence only after all compensations have been satisfactorily agreed, payment is received in full by the PAPs and the sites taken over by the GOSL.
- The contractor will be instructed to mobilize and take possession of the sites to commence the civil works only after the PAPs confirm that compensation has been received and that they shall not be affected or displaced due to the civil works.
- Any unresolved issues shall be submitted to the Grievance Redress Committee (GRC) and must be resolved prior to commencement of the civil works by the contractor

Figure 9-1 RPF Implementation Process Steps



9.2 CONTRACTUAL OBLIGATIONS

The funding of the project will warrant compliance with the World Bank's specific conditions and international best practice, while at the same time, be governed by the Laws of Saint Lucia. The legacy of the geothermal exploratory drilling operations in Saint Lucia suggests that there needs to be specific policy framework principles to guide and enforce compliance with these agreed conditions and international best practice.

The acquisition of any lands, whether on a temporary or permanent basis, shall be in compliance the laws of Saint Lucia and Bank policy. Prior to the taking possession of any lands, specific measures shall be taken to address any conflict/legal gap between the two entities to ensure congruence.

The conditions of contract between the GOSL and the drilling contractor shall be based on an internationally adopted standard form of contract approved by the World Bank. Embodied in a

set of special conditions will be actions requiring the contractor to return the property to its original condition except for where drilling is undertaken and or drill heads remain installed. Where drilling and or drill heads are left in place, the contract will specifically dictate how the site is to be restored.

The standard form of contract used shall contain clauses making reference to the use of performance securities and the withholding of retention payments. No contract shall, therefore, become effective until the contractor has met the specific conditions of the performance security and agree to the provision of a retention bond, both of which must be provided by a surety of international standing acceptable to both the GOSL and the World Bank. Any site affected by the contractor's non-performance or non-compliance with the clean-up/site restoration requirements of the contract shall be taken over by the GOSL and necessary restoration action undertaken from the amounts to be paid under the bonds. Such clean-up actions shall be performed within a reasonable time as would be expected of the contractor or as stipulated in the contract.

9.3 STAKEHOLDER ENGAGEMENT AND COMMUNICATION

Stakeholder engagement is an ongoing process conducted throughout the life cycle of the project. Its aim is to develop strong and responsive relationships that are important for successful project implementation. The safeguards team will engage and consult with stakeholders on an ongoing basis according to the evolution of the issues, impacts and opportunities.

The Safeguards Officer will report to stakeholders in order to provide: important details on the undertakings, routines, status, project progress and new or corrected information since the last report. Report frequency will be in accordance with the order set in the SEP.

Table 9-1 Identifies stakeholder groups and forms of engagement.Additional information regarding stakeholder engagement is provided in the RAP. Stakeholder engagement is further addressed in Section 12 Mechanism for Consultation.

Table 9-1 Stakeholder Groups and Forms of Engagement

Stakeholder Group	Forms of Engagement	*Timing
Government Ministries /Officials	Formal meetings Roundtable Discussions Presentations of plans	Design phase Implementation phase Monitoring & Evaluation phase
NGOs within the communities where drilling will be done	Formal meetings Roundtable Discussions Presentations of plans Site Visits	Design Phase Implementation phase Monitoring & Evaluation phase

10 GRIEVANCE REDRESS MECHANISM

Stakeholder Group	Forms of Engagement	*Timing
PAPs (residents and business community)	Community Consultations One on one interviews Radio and television Print media Surveys Social media	Design Phase Implementation phase Monitoring & Evaluation phase
Business Community		Design Phase Implementation phase Monitoring & Evaluation phase

*Will be updated once project start date has been confirmed

10 GRIEVANCE REDRESS MECHANISM

A grievance redress mechanism is necessary for addressing the legitimate concerns of the PAPs, as laid out in the Bank Grievance Redress Service (GRS) Procedure. Transparency, integrity, and accountability are World Bank guiding principles for grievance redress. A complaint mechanism is transparent when members of the affected community know what entity is in charge of the grievance redress mechanism and possess sufficient information on how to access it. Integrity requires behaviors and actions consistent with ethical principles and standards. Accountability requires the complaint mechanism to: (i) comply with all relevant legislation, regulatory requirements, and professional standards, (ii) all parties to a complaint to have decisions reviewed, (iii) a complainant has a right to an appeal and after the appeal there is no further process, and (iv) zero tolerance for conflict of interest and misuse of the complaint mechanism for the people involved in the process of handling complaints.

It is anticipated that the concerns will focus mainly on eligibility criteria, and compensation entitlements for loss of livelihood or use of land, and for noise associated with drilling. The mechanism for grievance redress shall thus include:

- Provision for the establishment of a grievance redress committee that includes women;
- A reporting and recording system;
- Procedure for assessment of the grievance;
- A time frame for responding to the grievances filed; and
- The mechanisms for adjudicating grievances and appealing judgments.

In the interest of all parties concerned, the grievance redress mechanisms are designed with the objective of solving disputes at the earliest possible time. World Bank OP. 4.12 emphasizes that the PAPs should be heard and as such, they must be fairly and fully represented. Further, the mechanism should implicitly discourage referring matters to the court system for resolution. Table 10-1 outlines the process for registering and addressing grievances and provides specific information regarding registering complaints, response time, and communication modes.

Table 10-1 Grievance Redress Procedures

Issue/Action	Procedure
Establishment of a Grievance Redress Committee (GRC)	• The GRC shall be established by the Project Steering Committee (PSC) and sanctioned by the Permanent Secretary (PS), Department of Infrastructure, Ports, and Energy (DIPE). • The members of the GRC shall comprise the following: – Technical Director (TD); – Social Transformation Officers (STO) for each of the affected communities; – The Authorized Officer or his/her representative – Department of Physical Planning (DPP); – Member of a recognized community-based organization (i.e., one member from each community); – The Legal Officer, DIPE; – Chief Technical Officer, DIPE; – Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives; – Commissioner of Crown Lands or his/her representative, DPP; – Quantity Surveyor, DPP; – Valuation Surveyor, DPP.
Reporting, Recording, and Transmission of Grievances.	• Grievances must be filed with the PSC, though the project office, located at the Soufriere Regional Development Foundation office or the determined location; • Grievances must be made in writing and be signed and dated by the PAP; • Grievances may be submitted to the DIPE, PIU office at the Soufriere Regional Development Foundation, or on site. The civil works and drilling contractors will be required to document any grievances reported during project implementation and immediately and appropriately document and report the grievance to the SSO. • Grievances received verbally must be documented, verified and signed by the PAP and the officer receiving the report; • Complainants may request confidentiality in the complaint, but anonymous complaints will not be processed. • The TD shall establish a grievance log or register; all reports must be recorded in the log; • The grievance log shall outline the name of the PAP and the reason for the complaint; • The PSC shall submit the grievance reports to the chairperson of the GRC within 24 hours of receipt. The report shall also be copied to the PS, DIPE; • Acknowledgement of the grievance shall be issued by the TD to the PAP in writing, within 2 working days of receipt.
Assessment of the Grievance and Timeframe for Response.	• The first assessment of the grievance shall be conducted by the GRC;

10 GRIEVANCE REDRESS MECHANISM

Issue/Action	Procedure
Mechanisms for Adjudicating Grievances and Appealing Judgments	• The nature of the grievance would ascertain the period (not exceeding 3 working days) necessary for the GRC to address the grievance. • The 3-day timeframe shall not apply in the case of complaints and grievances that specifically pertain to the valuation of affected assets, since these may be determined by a Board of Assessment or the courts; • Where resolution is not reached at the level of the GRC or if the PAP does not receive a response or is not satisfied with the outcome within the agreed time he/she can appeal to the PS, DIPE; • If the PAP is not satisfied with the decision of the GRC or the response to the appeal to the PS, he/she as a last resort may submit the complaint to a court of law. • The PAP shall be exempt from all administrative and legal fees incurred pursuant to the grievance redress procedures.

11 ARRANGEMENTS FOR FUNDING RESETTLEMENT

11.1 IMPLEMENTATION PROCEDURES

The RAP implementation program will be carried out in parallel with the Project planning, infrastructure preparation, drilling design, procurement – and will need to be completed before the drilling work program.

On the basis of the final technical design and in keeping with the RAP implementation schedule, the implementing agency (IA), particularly the safeguards team, will:

1. Screen identified project sites to:
    a. Update the preliminary census and household surveys of PAPs
    b. Determine the nature of land acquisition - whether temporary or permanent – and establish if land is to be purchased or leased. This includes private and crown lands.
2. Finalize valuation methods and entitlements
3. Coordinate land and crop surveys; land and crop valuations
4. Negotiate with PAPs to finalize compensation rates
5. Establish the budget for compensation payments
6. Disburse compensation to PAP. PAPs will receive compensation either by check or by bank transfer. For vulnerable households, special attention will be paid to providing assistance to facilitate the payment process.

11.2 PAYMENT PROCESS

A Requisition Order containing a unique number will be prepared by the Office Assistant (designated or assigned administrative personnel). All relevant supporting documentation including proof of ownership, Resettlement Action Plan, invoice and any other supporting documents must be attached to the requisition order and certified correct by the Safeguards Officer or an Officer with delegated authority.

The Requisition Orders will be reviewed and verified by the Procurement Officer with responsibility for the Project. The Requisition Order will also be reviewed and approved by the Project Manager and the Permanent Secretary of DIPE or a person with delegated authority. Once approved by all parties above, the Requisition Order will be forwarded to the Accounts Department of DIPE for finalization of payment.

An Accounts Officer within DIPE will create an invoice on SmartStream attaching the completed Requisition Order and all supporting documents. The invoice is approved

(electronically) by a Senior Accountant within DIPE. The final level of approval is done by the Accountant General. Once approved the payment is marked as completed in SmartStream. The cheque is printed and then made available to the payee.

Persons presenting themselves for a cheque will need to present a valid form of photographic identification. Third party collections will only be done if the third party possesses the following:

- ✓ A written authorization from the supplier
- ✓ His/her valid form of photographic identification

11.3 SOURCES OF FUNDING AND ESTIMATED COST

The national budget will be relied on for the land acquisition and resettlement compensation. The DIPE makes provision for the costs related to compensation for acquisition, resettlement, relocation and other associated administrative and logistical costs that may be incurred. This forms part of the appropriation bill and approved estimates (annual budget) of the DIPE after approval of the Capital Estimates of the GOSL. Funds to affected persons are paid directly by the DIPE.

12 MECHANISM FOR CONSULTATION

Public meetings and one-on-one meetings shall be convened by the DIPE with the displaced persons (i.e., PAPs) and their representatives to discuss inter alia, eligibility requirements and to negotiate their compensation packages. Preliminary consultation informed the public about the broad principles of the RPF World Bank policies requiring compensation for loss of livelihood. These consultations will assist with building consensus on the proposed resettlement plan and provide a forum for addressing the concerns of the PAPs. The DIPE shall recruit the services of a Community Liaison Officer (CLO), a resident of the Soufriere-Choiseul community, to facilitate the management of the public consultations and one-on-one meetings. The DIPE will be guided by the Social Transformation Officers (STOs) in the selection of the CLO.

As a mechanism for continued consultations during the planning of the RAP, a regular schedule of meetings with the PAPs shall be convened by the DIPE. The DIPE will be assisted by the STOs in that regard. Every effort shall be made to organize the meetings at the same location and on the same date/day of every month to avoid any of the difficult logistics sometimes involved in planning such events. A consultation log (registering the date, location/community, issues discussed, and actions taken) shall be maintained by the DIPE. These consultations with the PAPs shall continue throughout all the stages of the project implementation.

After completion of the census and the updated socioeconomic survey of the PAPs, notices shall be issued to the PAPs concerning the eligibility criteria and cut-off date for qualification as a PAP. The notices will also inform that the erection of new structures or improvements on lands to be temporarily acquired in the potential exploration target areas shall not be considered when compensation is determined. Information will also be provided concerning compensation rates and other entitlements, the timetable for implementation; and grievance procedures.

General information shall also be disseminated through the CLO using leaflets/flyers posted on community information boards; and via announcements made at public gathering places, such as places of worship. The national and local media (e.g. Radio Free Iyanola and 88.5 Soufriere FM) will also be used for disseminating information. The information shall be given to the media representatives for dissemination in both English and Kweyol (the local language) as the baseline socio-economic survey noted that some of the older PAPs used Kweyol to communicate. Another key medium for information dissemination will be via the mobile

telephone, since most of the PAPs have indicated[6] this as the best method for direct and immediate contact to obtain updates on the project.

The World Bank requires that the DIPE monitor and report on the effectiveness of resettlement implementation. For that reason the PAPs will play a key role in the internal and external monitoring processes described in Section 13.0, as they represent one of the key sources from which information will be sought for evaluating the project's performance and impact. The resettlement monitoring framework would typically include a range of activities that provide the PAPs with opportunities to contribute to the assessment of performance and impact; these would include but not be limited to the following:

- Public consultations;
- Interviews of random samples of PAPs (e.g., to assess their knowledge and concerns regarding the resettlement process, their entitlements and rehabilitation measures);
- Grievance reporting;
- Surveys of the standards of living of the PAPs;
- Socio-economic studies;
- Quantitative surveys; and
- Completion audits.

[6] During the baseline socio-economic survey conducted in September 2017, most of the PAPs had indicated that mobile telephone was the best method for direct and immediate contact to obtain updates on the project.

13 MONITORING AND EVALUATION

13.1 MONITORING

Internal monitoring of the implementation of the resettlement effort shall be the responsibility of the PSC and the DIPE. The Technical Director (TD) shall provide the DIPE and PSC with monthly status reports on the progress made with resettlement preparation and implementation. A database of resettlement monitoring information shall be established and updated monthly. This information shall be utilized to improve monitoring procedures and the efficiency of the processes employed.

Quarterly internal monitoring reports shall also be prepared by the TD and submitted through the DIPE to the World Bank. The quarterly reports shall include information about the following monitoring indicators:

- **Payment of compensation** to the various categories of PAP, according to the compensation policy described in the RAP;
- **Delivery of other forms of assistance** including the return of land to owners after use;
- Delivery of **income restoration** and social support entitlements;
- **Public information dissemination and consultation procedures**;
- **Adherence to grievance procedures** and outstanding issues requiring management's (i.e. Permanent Secretary - DIPE) attention;
- Attention given to **the priorities of PAPs** regarding the options offered;
- Coordination and **completion of resettlement activities.**

In accordance with World Bank requirements for consultant procurement, the PIU will hire an independent consultant/firm to conduct the external monitoring and evaluation of the implementation of the resettlement. The consultant/firm shall provide specialized services in social sciences and shall be experienced in resettlement monitoring. The rationale for hiring an external institution is to ensure that the overall objective of the resettlement plan is achieved in an equitable and transparent manner. The external monitoring and evaluation will start as soon as the updated RAP has been approved.

In addition to reviewing the issues covered by the internal monitoring progress report, the consultant/firm shall evaluate and assess:

- The competence and effectiveness of the project implementing agencies;
- The adequacy of compensation, development and transitional assistance packages provided for the PAPs;
- The ability of the project to meet the needs of all PAPs;

- Consultation and public disclosure of the RAPs; and
- The effectiveness of the grievance redresses mechanism.

13.2 EVALUATION

The evaluation component of the plan shall determine whether policies (both local and the World Bank's) have been adhered to, and provide the feedback necessary for adjusting strategic directions. The objectives of the evaluations are therefore as follows:

- To undertake a general assessment of the compliance of resettlement activities with the objectives and methods as set out in this RAP;
- To assess the compliance of resettlement activities with the laws and safeguard policies cited in Section 4.0;
- To assess resettlement procedures as they have been implemented;
- To evaluate the impact of resettlement on the incomes and standard of living of the PAPs;
- To identify lessons learnt from the implementation of the RAP.

In the conduct of the evaluation, the project and consultant/firm shall utilize local legislation and policy and the World Bank's OP 4.12 on Involuntary Resettlement as the guidance documents.









Government of Saint Lucia

Stakeholder Engagement Plan

Saint Lucia Renewable Energy Sector Development Project

September 2018

PANORAMA ENVIRONMENTAL, INC.

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Government of Saint Lucia

Stakeholder Engagement Plan

Saint Lucia Renewable Energy Sector Development Project

September 2018

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1 INTRODUCTION

1.1 BACKGROUND

The Government of Saint Lucia (GoSL) proposes to conduct the Saint Lucia Renewable Energy Sector Development Project (project) within the Soufrière, Choiseul, and Laborie regions of Saint Lucia (Figure ES-1) to assess the feasibility of commercial development of geothermal resources in Saint Lucia. The project would include drilling slim-diameter and potentially full-size geothermal exploration wells to obtain information on the geothermal resource in the area.

The GoSL has obtained financial assistance and technical support from a number of development partners in support of the project. To date, the World Bank has assisted Saint Lucia in accessing grant financing from the Global Environmental Facility and the SIDS DOCK Support Program for the project. Technical assistance has also been received from the Government of New Zealand and the Clinton Climate Initiative.

This Stakeholder Engagement Plan has been prepared to meet the requirements specified in:

- The Terms of Reference (ToR) for the Environmental and Social Impact Assessment (ESIA) for the renewable energy sector development project;
- World Bank's *Guidance Note on Stakeholder Consultation in Investment Operations* and; and
- International Finance Corporation (IFC) Performance Standards, *Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets*.

1.2 STAKEHOLDER ENGAGEMENT OBJECTIVES

The stakeholder engagement process serves many purposes. The goals of stakeholder engagement for the geothermal project are to:

- Provide ongoing information on the project to the public and government agencies
- Provide timely and appropriate information prior to and during construction to enable informed participation in the project and definition of appropriate mitigation measures
- Encourage equal participation of all affected groups in the consultation process
- Disclose the impacts of the project and proposed mitigation measures
- Obtain public input on the mitigation measures
- Provide ongoing information on the implementation of the mitigation measures
- Facilitate open and continuous communication and consultation between various groups including construction contractors, stakeholders, and the general public

1 INTRODUCTION

The stakeholder engagement process is ongoing throughout the life of the project and includes formal scheduled consultations and meetings. Information will also be disseminated as needed to address significant changes in schedule or other important project developments. The stakeholder engagement process includes two key aspects:

- Early and ongoing outreach to key stakeholders to provide information on the project
- A grievance redress process to address public complaints during implementation of the project

2 STAKEHOLDER IDENTIFICATION AND ANALYSIS

2.1 WHAT IS STAKEHOLDER ENGAGEMENT?

Stakeholder engagement is an inclusive process conducted throughout the project life cycle. Where properly designed and implemented, it supports the development of strong, constructive and responsive relationships that are important for successful management of a project's environmental and social risks. Stakeholder engagement is most effective when initiated at an early stage of the project development process, and is an integral part of early project decisions and the assessment, management and monitoring of the project's environmental and social risks and impacts.

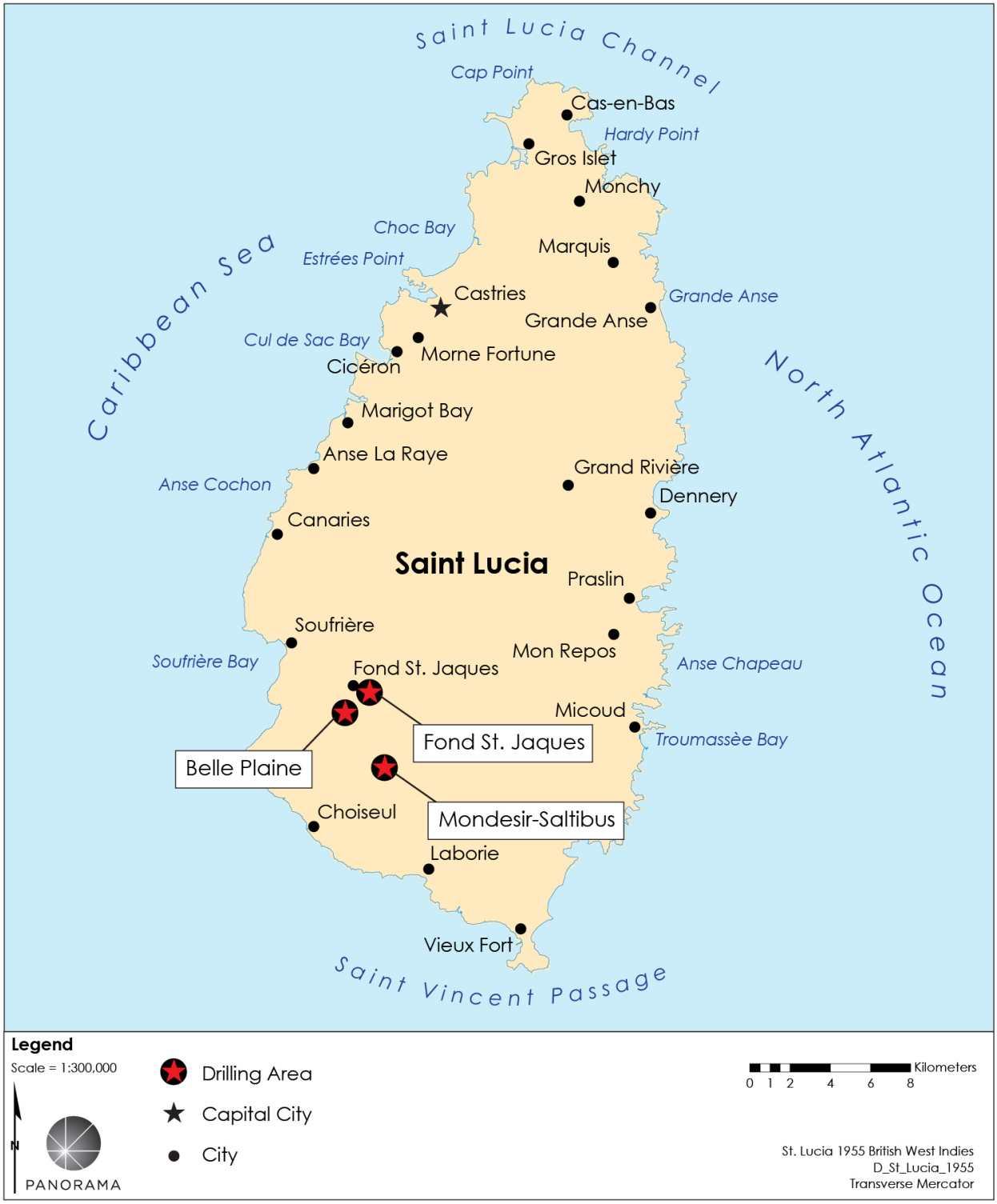
Stakeholder engagement will be free of manipulation, interference, and intimidation, and conducted on the basis of timely, relevant, understandable and accessible information, in a culturally appropriate formant. It involves interactions between identified groups of people and provides stakeholders with an opportunity to raise their concerns and opinions, and ensure that this information is taken into consideration when making project decisions.

2.2 STAKEHOLDER IDENTIFICATION

The first step in the stakeholder engagement process is to identify the key stakeholders to be consulted and involved. Stakeholders are individuals or groups who are affected or likely to be affected by the project and who may have an interest in the project. The initial list of stakeholders for the renewable energy sector development project was developed based on the Terms of Reference (ToR) and updated following the inception meeting in August through direct conservations with the Government of Saint Lucia (GoSL), inception meeting stakeholder participants, and community members. The stakeholder groups to be engaged may be expanded during project implementation.

In addition to government agencies and non-governmental organizations, key stakeholders include individuals living near the project area and potential private interests. The towns near the project area include Belle Plaine, Mondesir, Guyabois, Parc Estate, Saltibus, Fond St. Jacques and Belvedere. The project location is shown on Figure 2.2-1 below. Table 2.2-1 lists key stakeholder groups that will require engagement during project implementation and a record of consultation efforts during ESIA preparation.

Figure 2.2-1 Project Location



Sources: (ESRI 2017, Jan Kindsay 2002)

Table 2.2-1 Stakeholder Groups

Stakeholder	Point of Contact	Previous Consultation Efforts
Ministers		
Minister in the Office of the Prime Minister with responsibility for Commerce, Industry, Investment, Enterprise Development and Consumer Affairs	Honorable Bradley Felix	8 August 2017 Inception Meeting
Minister in the Ministry for Economic Development, Housing, Urban Renewal, Transportation and Civil Aviation	Honorable Herod Stanislaus	8 August 2017 Inception Meeting
Minister for Economic Development, Housing, Urban Renewal, Transportation and Civil Aviation	Honorable Guy Joseph	8 August 2017 Inception Meeting
Government Departments		
Department of Sustainable Development	Deputy Permanent Secretary Debra Charlery	On-going throughout project planning
Project Coordination Unit	Al Barthelmy and Jenna Flavien	On-going throughout project planning
Department of Finance	Jacqueline Francois jfrancois@gosl.gov.lc	8 August 2017 Inception Meeting
Department of Social Research	Leca James leca.james@govt.lc	8 August 2017 Inception Meeting
Department of Physical Planning	Warner Houson whouson@gosl.gov.lc	8 August 2017 Inception Meeting
Department of Social Planning	Danna Jr. Charles danna.jrcharles@govt.lc	8 August 2017 Inception Meeting
Department of Tourism and Broadcasting	Timothy Ferdinand timothy.ferdinand@govt.lc	8 August 2017 Inception Meeting
Department of Energy, Public Utilities	Charlin Bodley	8 August 2017 Inception Meeting 9 August 2017 Site Visit
Department of Agriculture	Deputy Permanent Secretary Barrymore Felicien bfelicien@gosl.gov.lc Annette Rattigan-Leo	8 August 2017 Inception Meeting
Soufrière Town Council		None
Water Resource Management Agency	Patrish Lionel wrma@govt.lc	September 2017 requests for information

Stakeholder	Point of Contact	Previous Consultation Efforts
Land Survey	Deputy Chief Surveyor, Luther Goddard	11 August 2017
Non-Governmental Organizations/Community Groups		
Soufrière Regional Development Foundation	Franklin Solomon and Shem Jean 758-719-2142 shemjean1985@gmail.com	9 August 2017 Site Visit
Soufrière Marine Management Agency	Michael Bobb Michaelbobb_2000@yahoo.com	9 August 2017 Site Visit
Saint Lucia National Trust	Craig Henry southofficer@slunatrust.org	9 August 2017 Site Visit
Pitons Management Authority	Augustine Dominique Augustine.dominique@govt.lc	9 August 2017 Site Visit
Saint Lucia Archaeological and Historical Society	Archaeological Secretary Laurent Jean Pierre First Vice President Francis Pappin	Consulted prior to archaeological and historical site investigation in September 2017
IUCN/UNESCO	Augustine Dominique (see above)	Consulted for review of Draft ESIA
Affected Communities		
Belle Plaine	Residents	2 September 2017 and 13 March 2018 Community Consultations Interviews were held with residents in the region in September 2017
Mondesir, Guyabois, Parc Estate, and Saltibus	Residents	3 September 2017 and 12 March 2018 Community Consultations Interviews were held with residents in the region in September 2017
Fond Saint Jacques and Belvedere	Residents	31 August 2017 and 14 March 2018 Community Consultations Interviews were held with residents in the region in September 2017
Other Private Interests		
Hotels	Calabash Mountain Villa Boinin Heart Villa Belle Plaine Hills B&B	None
Electric Utility	LUCELEC	Meeting in December 2017
Geothermal Developers	Ormat	Meeting with Ormat in December 2017

Stakeholder	Point of Contact	Previous Consultation Efforts
Water and Sewerage Company (WASCO)	Jim King	8 September 2017 Meeting

2.3 STAKEHOLDER ANALYSIS

2.3.1 Stakeholder Analysis Process

Stakeholder analysis is the process of identifying the stakeholder groups that are likely to affect or be affected by a proposed action, and sorting them according to their impact on the action and the impact the action will have on them. Stakeholder analysis is an ongoing process, which may evolve as new stakeholders are introduced to the project. The preliminary stakeholder analysis has identified the various interests of stakeholder groups and the influence these groups may have on the project. The analysis also shaped the design of stakeholder consultation events and which stakeholders to engage and when.

2.3.2 Government

Government agencies are key stakeholders for the project. Engagement with government will serve two main purposes:

1. Involve ministries and departments in each phase of the Project to build consensus and ownership of the findings
2. Identify the governance framework for geothermal development

Table 2.3-1 lists the potential role, interest, and influence on the project for each of the government stakeholders.

Table 2.3-1 Government Stakeholder Analysis

Stakeholder	Potential Role in Project	Interest	Influence
Ministries			
Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Cooperatives	Provide project specific information on agriculture, physical planning, and natural resources.	High	High
Ministry of Economic Development, Housing, Urban Renewal, Transport and Civil Aviation	Provide project specific information on economic, planning and transportation policies.	High	High
Ministry of Education, Innovation, Gender Relations and Sustainable Development	Contribute to the development of education opportunities for geothermal energy	High	High

Stakeholder	Potential Role in Project	Interest	Influence
Ministry of Equity, Social Justice, Empowerment, Youth Development, Sports and Local Government	Provide information on resettlement and displacement policies for geothermal infrastructure project	Moderate	Low
Ministry of Finance, Economic Growth, Job Creation, External Affairs and the Public Service	Provide statistics on economic growth and labor to develop the baseline for job creation	Moderate	High
Ministry of Health and Wellness	Provide project specific information on health and wellness policies	Low	Low
Ministry of Infrastructure, Ports, Energy and Labor	Provide data and information on energy development	High	High
Ministry of Tourism, Information and Broadcasting	Contribute to the creation of tourism opportunism	High	High
Government Agencies			
Department of Sustainable Development	**Project Partner**: identify issues and opportunists on sustainable energy development; assist in arranging field and site visits	High	High
Project Coordination Unit	Project administration	High	High
Department of Tourism	Identify issues and potential opportunities for tourism	High	High
Department of Physical Planning	Evaluate consistency with physical planning requirements	High	High
Infrastructure and Port Services and Energy	Identify issues and opportunities for energy infrastructure development	High	High
Department of Equity, Social Justice, Empowerment, and Human Services	Identify issues related to resettlement	Moderate	Low
Economic Development	Identify issues and opportunities for economic development	Moderate	High

Stakeholder	Potential Role in Project	Interest	Influence
Department of Agriculture	Address compensation requirements for temporary loss of agricultural production	High	High

2.3.3 Non-Governmental Organizations

There are a number of active non-governmental organizations (NGOs) in the project region who are primarily focused on tourism and protection of the Pitons Management Area (PMA). The NGOs have substantial influence, particularly regarding activities allowed in the PMA and PMA buffer zone. Table 2.3-2 outlines the potential role, interest and influence in the Project for each of the NGO stakeholders.

Table 2.3-2 NGO Stakeholder Analysis

Stakeholder	Potential Role in Project	Interest	Influence
Soufrière Regional Development Foundation	Outreach and communication with the community about the geothermal development project	High	High
Pitons Management Authority	Define issues and opportunities for geothermal development within the PMA buffer area	High	High
Soufrière Marine Management Association	Provide information on sustainable use and development of the project area	Moderate	High
Saint Lucia National Trust	Provide information on significant natural, cultural and historical significance about the project area	High	High
Saint Lucia Archaeological and Historical Society	Provide archaeological information about the project site	High	Low

2.3.4 Local Community

Local communities near the potential drilling areas are likely to have a high interest in the project. Individual land owners or agricultural producers in the project drilling area will have a very high interest in the project. The requirements for economic compensation for temporary loss of land or agricultural production are included as a mitigation measure in the ESIA and are addressed in the Resettlement Action Plan. Stakeholder concerns from the initial scoping and

consultation meetings with the community and comments received on the Draft ESIA are summarized in Table 2.3-3 below.

Table 2.3-3 Summary of Scoping Comments and Comments on the Draft ESIA

Resource Topic	Stakeholder Concerns Addressed in the ESIA
Water	• Impact on availability of surface water resources and drying up of reservoirs; access to water was a key concern for all communities • Discharge of geothermal fluid • Impact on water quality
Air	• Emissions of gases from the geothermal reservoir and impact on the adjacent communities
Soil	• Loss of topsoil during well pad grading and impacts on agricultural productivity • Degradation of soil quality for future agricultural production
Noise	• Disruption to the adjacent communities from drilling noise • Vibration impacts on homes or structures near the drilling location
Tourism	• Effects on tourist access and the tourist experience
Visual Impacts	• Effects on viewsheds within Soufrière and tourist areas in particular • Clean-up of sites after the drilling is completed • Effects on the PMA
Traffic and Transportation	• Effects on vehicle access to the area during road work and during drilling operations
Seismicity and Volcanic Activity	• Potential seismicity and volcanic activity
Hazards	• Fires caused by the geothermal drilling • Hazards from air quality emissions • Well blowouts and damage to adjacent properties • Landslide hazards
Waste	• Contamination of farmlands from geothermal drilling
Socio-economics	• Loss of prime agricultural land during drilling operations and future development • Loss of livelihood from displacement of agricultural production • Relocation of community members • Job opportunities for the community during drilling • Loss of community recreation areas during drilling
Telephone and electrical service	• Impact of drill rig transport on telephone and electrical service due to low hanging lines along roadways

2.3.5 Other Private Interests

Key private interests include hotels in the vicinity of the potential drilling areas, potential geothermal developers, and WASCO. The nearest hotel to the potential drilling areas is located approximately 1 kilometer from Belle Plaine. The level of interest of each hotel listed in Table 2.3-4 below is based on proximity to the drilling site and potential for views of the drilling area.

Hotels that are more than 2 kilometers from the drilling area and separated from the drilling areas by mountains would have a low interest in the project due to the limited potential for impact on the hotel activities.

The GoSL has been in discussion with LUCELEC and Ormat regarding potential future development of the geothermal resource. As the potential future developer, Ormat has a very high interest and high influence over the geothermal exploration activities. LUCELEC also has a high interest and high influence over the project because LUCELEC would need to procure any future geothermal electricity.

Table 2.3-4 Hotel Stakeholder Interest

Stakeholder	Potential Role in Project	Interest
Calabash Mountain Villa	Provide perspectives from hospitality on issues and opportunities for geothermal development	High
Boinin Heart Villa	Provide perspectives from hospitality on issues and opportunities for geothermal development	High
Belle Plaine Hills B&B	Provide perspectives from hospitality on issues and opportunities for geothermal development	High

WASCO provides water and sewer service to the communities in the project vicinity. Water for drilling may be obtained from WASCO and the extraction of water for the project has the potential to affect WASCO water supplies. WASCO has a high interest and influence over water use for the project drilling activities.

2.3.6 Funding Entities

To date, the World Bank has assisted Saint Lucia in accessing USD 2,000,000.00 of grant financing from the Global Environmental Facility and the SIDS DOCK Support Program for the project. In addition, technical assistance valued at USD 800,000.00 and USD 500,000.00 has been received from the Government of New Zealand and the Clinton Climate Initiative respectively. These funds are being used to provide the technical, transaction and regulatory support required for making informed decisions about geothermal exploration and development in Saint Lucia. The project funders have a high interest and high influence over the project outcome and have received frequent updates on the project progress during the pre-feasibility stage.

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3 INFORMATION DISCLOSURE

3.1 INCEPTION MEETINGS

During the initial steps of the scoping phase, the Panorama team consulted with the GoSL and other government stakeholders to confirm work plans for the activities described in the ToR.

An inception workshop was held with government stakeholders on 8 August 2017 at the Finance Administrative Center. Laurie Hietter of Panorama presented a PowerPoint presentation with information on the geothermal exploration and development process and issues that would be covered in the ESIA. GoSL staff, Judith Ephraim, and Panorama staff member Susanne Heim conducted follow-up meetings on 11 August 2017 with the Departments of Physical Planning, Land Survey, and Land Registry.

The GoSL and Panorama conducted a site visit with local stakeholder representatives on 9 August 2017. The site visit included travel to Sulfur Springs where previous geothermal exploration had been completed and the three target areas for geothermal exploration including the Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus areas. Panorama presented a PowerPoint presentation on the geothermal exploration and development process and ESIA procedures and scope at the Soufrière Regional Development Foundation Office after completion of the site visit.

3.2 PUBLIC SCOPING MEETINGS

The GoSL and Panorama subconsultants Engineering, Construction & Management Consulting Ltd. specialists (ECMC) conducted community meetings and presented the proposed geothermal exploration project in each of the local communities (Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques) in August and September 2017. Community comments were obtained during each meeting (refer to Table 3.2-3) and subsequent surveys were conducted with community members.

3.3 MEETINGS ON THE DRAFT ESIA

The Draft ESIA was published on the GoSL website and made available for public review beginning in February 2018. The GoSL and Panorama conducted community meetings in Mondesir-Saltibus, Belle Plaine, and Soufriere between 12 and 14 March 2018. A meeting was also held on 15 March 2018 in Castries to obtain public feedback and comments on the Draft ESIA. All comments received and responses to comments were documented in the Final ESIA. All public meetings on the ESIA were advertised through radio announcements, fliers, and engagement of local community members. The community meetings were well attended by the

local community and provided an opportunity for community members to voice their concerns about the project and obtain information from the ESIA.

3.4 APPROACH TO INFORMATION DISSEMINATION

There are a variety of engagement methods used to build relationships, gather information, consult, and disseminate project information to stakeholders. Table 3.4-1 provides a list of different methods to disseminate information on the project, and describes the application of these methods.

Table 3.4-1 Information Dissemination Methods

Information Dissemination Method	Application
Correspondence by phone/email/Text/Instant message	• Distribute project information to government officials, organizations, agencies and companies • Inform stakeholders about consultation meetings
Print media	• Disseminate project information to public, and illiterate stakeholders • Inform the stakeholders about consultation meetings
Radio and television	• Prepare pubic information material including Q&A and a jingle in both English and Kweyol for radio and television public service announcements • Prepare bimonthly advertisements to facilitate the dissemination of information on the Project
Website and social media	• Develop a geothermal information website to disseminate project information to large audiences, and stakeholders • Create a GoSL geothermal Facebook page with information similar to the website
One-on-One interviews	• Solicit views and opinions • Build personal relations with stakeholders • Record interviews
Formal meetings	• Present project information using PowerPoint presentations • Build impersonal relations with high level stakeholders • Distribute technical documents • Record discussion, comments/questions raised and responses
Public meetings	• Present project information to a large audience of stakeholders or to a particular community using PowerPoint presentations, posters, video or project information documents • Build relationships with local communities • Distribute non-technical project information • Record discussion, comment/questions raised and responses
Focus group meetings	• Facilitate meeting in smaller group of between 8 and 15 people to provide their views and opinions of the Project • Record discussion, comment/questions raised and responses

Information Dissemination Method	Application
Workshops	• Present project information to a group of stakeholders • Use participatory exercises to facilitate group discussions, brainstorm issues, analyses information, and develop recommendations and strategies • Record responses
Roundtable discussions	• Use prepared questions or gather preliminary questions to facilitate group discussions • Each person is given equal right to participate • Record responses
Surveys	• Gather opinions and views from individual stakeholders • Gather baseline data • Record data • Develop a baseline database for monitoring impacts
Site visit	• Gather opinions and views from individual stakeholders through visiting project site

3.5 STAKEHOLDER CONSULTATION PROCESS

It is critical to plan each consultation process, consult inclusively, document the process, and communicate follow-up. The timing of stakeholder engagement is broken down by stakeholder and project phase. The timing and methods of engagement with stakeholders are provided below in Table 3.5-1. Engagement and consultation will be carried out on an ongoing basis as the nature of issues, impacts, and opportunities evolves.

Table 3.5-1 Stakeholder Engagement and Timing

Stakeholder	Engagement Method	Timing
Government Officials		
Ministry of Agriculture, Fisheries, Physical Planning, Natural Resources and Co-operatives	• Correspondence by phone/email/Text/Instant message • One-on-one interviews • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase
Ministry of Economic Development, Housing, Urban Renewal, Transport and Civil Aviation	• Correspondence by phone/email/Text/Instant message • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase
Ministry of Education, Innovation, Gender Relations and Sustainable Development	• Formal meetings	• Design Phase • Implementation Phase

Stakeholder	Engagement Method	Timing
Ministry of Equity, Social Justice, Empowerment, Youth Development, Sports and Local Government	• Formal meetings	• Design Phase • Implementation Phase
Ministry of Finance, Economic Growth, Job Creation, External Affairs and the Public Service	• Correspondence by phone/email/Text/Instant message • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase
Ministry of Health and Wellness	• Formal meetings	• Design Phase
Ministry of Infrastructure, Ports, Energy and Labor	• Correspondence by phone/email/Text/Instant message • One-on-one interviews • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Ministry of Sustainable Development, Energy, Science, and Technology	• Correspondence by phone/email/Text/Instant message • One-on-one interviews • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Ministry of Tourism, Information and Broadcasting	• Correspondence by phone/email/Text/Instant message • One-on-one interviews • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Soufrière Town Council	• Correspondence by phone/email/Text/Instant message • Formal meetings • Roundtable discussions	• Design Phase • Implementation Phase
NGOs		
Soufrière Regional Development Foundation	• Correspondence by phone/email/Text/Instant message • Roundtable discussions • Site visit	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Pitons Management Authority	• Correspondence by phone/email/Text/Instant message • One-on-one interviews • Roundtable discussions • Site visit	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Saint Lucia National Trust	• Correspondence by phone/email/Text/Instant message • Roundtable discussions • Site visit	• Design Phase • Implementation Phase

Stakeholder	Engagement Method	Timing
Saint Lucia Archaeological and Historical Society	• Correspondence by phone/email/Text/Instant message • One-on-one interviews	• Design Phase • Implementation Phase
Soufrière Marine Management Association	• Correspondence by phone/email/Text/Instant message • Roundtable discussions • Site visit	• The Design Phase • The Implementation Phase • Monitoring and Evaluation Phase
Local Communities		
• Belle Plaine • Mondesir • Guyabois • Parc Estate • Saltibus • Fond St. Jacques • Belvedere	• Correspondence by phone/email/Text/Instant message • Interviews • Print media • Radio and television • Website and social media • Public meetings • Workshops • Survey • Grievance Redress	• Design Phase • Implementation Phase • Monitoring and Evaluation Phase
Hotels		
• Calabash Mountain Villa • Boinin Heart Villa • Belle Plaine Hills B&B	• Correspondence by phone/email/Text/Instant message • One-on-one interview • Print media • Radio and television • Website and social media • Public meetings • Workshops	• Design Phase • Implementation Phase

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4 GRIEVANCE REDRESS PROCESS

4.1 PURPOSE

A grievance redress mechanism is necessary for addressing the legitimate concerns of the PAPs. It is anticipated that some of these concerns may include eligibility criteria, and compensation entitlements for loss of livelihood or use of land, and for noise associated with drilling. The mechanism for grievance redress shall thus include:

- Provision for the establishment of a grievance redress committee that includes women
- A reporting and recording system
- Procedure for assessment of the grievance
- A time frame for responding to the grievances filed
- The mechanisms for adjudicating grievances and appealing judgments

In the interest of all parties concerned, the grievance redress mechanisms are designed with the objective of solving disputes at the earliest possible time. World Bank OP. 4.12 emphasizes that the PAPs should be heard and as such, they must be fairly and fully represented. Further, the mechanism should implicitly discourage referring matters to the court system for resolution.

4.2 ROLES AND RESPONSIBILITIES

The Grievances Redress Committee (GRC) will be responsible for receiving and resolving in a fair, objective, and constructive manner, all concerns or complaints raised by project affected persons (PAPs) within the communities affected by the Project. The broad responsibilities of the GRC include:

- Developing and publicizing the grievance management procedures
- Receiving, reviewing, investigating and keeping track of grievances
- Adjudicating grievances
- Monitoring and evaluating fulfillment of agreements achieved through the grievance redress mechanism

The GoSL will appoint a community liaison officer (CLO) to conduct stakeholder outreach during project implementation and respond to any grievances or complaints that may arise. The CLO will act as the key point of contact to bring project grievances from construction workers, local residents, and community members to the GRC. The CLO will be responsible for making sure the recommendations of the GRC are implemented and directing contractors to make any appropriate change to their work. The contractor shall take reasonable action to address grievances.

4.3 GRIEVANCE REDRESS PROCEDURES

Table 4.3-1 outlines the process for registering and addressing grievances and provides specific information regarding registering complaints, response time, and communication modes.

Table 4.3-1 Grievance Redress Procedures

Issue/Action	Procedure
Establishment of a Grievance Redress Committee (GRC)	• The GRC shall be established by the Project Steering Committee (PSC) and sanctioned by the Permanent Secretary (PS), Department of Infrastructure, Ports and Energy(DIPE) prior to civil works activities in each community. • The members of the GRC shall comprise the following: – CLO; – Social Transformation Officers (STO) for the affected communities (e.g., Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus); – The Authorized Officer or his/her representative – Department of Physical Planning (DPP); – One member of a recognized community-based organization from the affected community (e.g., Belle Plaine, Fond St. Jacques, and Mondesir/Saltibus); – The Legal Officer, GoSL; – Chief Technical Officer, GoSL; – Representative of the Department of Agriculture, Fisheries, Natural Resources and Cooperatives (only required for grievances involving loss of agricultural production); – Commissioner of Crown Lands or his/her representative (only required for grievances involving Crown Lands), DPP; – Quantity Surveyor, DPP (only required for grievances involving loss of land or livelihood); – Valuation Surveyor, DPP (only required for grievances involving loss of land or livelihood).
Reporting, recording, and Transmission of Grievances.	• Grievances must be filed with the PSC, though the project office, located at the Soufrière Regional Development Foundation office or the determined location; • Grievances must be made in writing and be signed and dated by the PAP • Grievances received verbally must be documented, verified and signed by the PAP and the officer receiving the report; • The CLO shall establish a grievance log or register; all reports must be recorded in the log; • The grievance log shall outline the name of the PAP and the reason for the complaint; • The PSC shall submit the grievance reports to the chairperson of the GRC within 24 hours of receipt. The report shall also be copied to the PS, DIPE; • Acknowledgement of the grievance shall be issued by the CLO to the PAP in writing, within 2 working days of receipt.
Assessment of the Grievance and Timeframe for Response.	• The first assessment of the grievance shall be conducted by the GRC;

Issue/Action	Procedure
Mechanisms for Adjudicating Grievances and Appealing Judgments	• The nature of the grievance would ascertain the period (not exceeding 3 working days) necessary for the GRC to address the grievance. • The 3-day timeframe shall not apply in the case of complaints and grievances that specifically pertain to the valuation of affected assets, since these may be determined by a Board of Assessment or the courts; • Where resolution is not reached at the level of the GRC or if the PAP does not receive a response or is not satisfied with the outcome within the agreed time he/she can appeal to the Permanent Secretary, DIPE; • If the PAP is not satisfied with the decision of the GRC or the response to the appeal to the Permanent Secretary, he/she as a last resort may submit the complaint to a court of law. • The PAP shall be exempt from all administrative and legal fees incurred pursuant to the grievance redress procedures.

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5 REPORTING

5.1 OBJECTIVES

In both personal and business relationships, follow-through is important. The same principle applies to stakeholder engagement. Once consultations have taken place, stakeholders will want to know which of their suggestions will be used, what risk or impact mitigation measures will be put in place to address their concerns, and how, for example, project impacts are being monitored. Often the same methods used in information disclosure are applied to reporting back to stakeholders. This follow up can include large-scale forums, brochures, targeted meetings, and consultative committees.

5.2 REPORTING TO STAKEHOLDERS

Reporting to stakeholders involves providing important details on the undertakings, routines, status, and progress of the project team and the project progress. Reporting to stakeholders may also include new or corrected information since the last report. Keeping track of the many commitments made to various stakeholder groups at various times, and communicating progress made against these commitments on a regular basis, requires planning and organization. The methods and frequency of reporting to stakeholders are provided below Table 5.2-1.

Table 5.2-1 Methods and Frequency of Reporting to Stakeholders

Reporting Party	Reporting Method	Stakeholder	Reporting Information	Frequency
Project Steering Committee	Formal meetings	Government of St. Lucia	• Project status • Plans for next period • Issues and changes • Progress of the communication campaign	Quarterly meeting
Government of St. Lucia	Public meetings	NGOs Local Community Private Interests	• Project status • Plans for next period • Issues and changes	Quarterly meeting
Project Steering Committee	Correspondence by email or postal mail	Government	• Project status • Issues and changes	When changes occur
Government of St. Lucia	Print media	NGOs Local Community Private Interests	• Project status • Issues and changes	When changes occur
Government of St. Lucia	Radio and television (English and Kweyol)	NGOs Local Community Private Interests	• Project status • Issues and changes	When changes occur
Government of St. Lucia	Website and social media	NGOs Local Community Private Interests	• Project status • Issues and changes	When changes occur

APPENDIX A

Sample Stakeholder Register Template

Name	Designation	Type of Stakeholder	Expectation/Interests	Influence on Project Outcome	Contact Information (Tel, Fax & Email)

APPENDIX B

Sample Stakeholder Consultation Notes Template

Stakeholder Consultation Notes	
Date/Time:	
Location:	
Attendees:	
Reported by:	
Subject:	
Notes:	

APPENDIX C

Sample Grievance and Comment Logging Form Template

Comment/Grievance Reference Number			
Name of Commenter/ Aggrieved			
Name of Organization/ Position			
Address			
Telephone			
Email Address			
Best Contact Method	☐Mail	☐Email	☐Phone
Date of Input			
Nature and Location of Comment/Grievance			
Received by			
Initial Response Details and Sent by			
Date of Initial Response			
Resolved/Addressed by			
Nature of Resolution			
Signed (Project Representative)		Date	

APPENDIX D

Sample Initial Response Template

Dear (NAME):

Department of Infrastructure, Ports, and Energy (SDepartment) is writing to you regarding the grievance received mm/dd/yyyy. The Department *will begin/not be* (delete as appropriate) investigation this grievance, as the Department feels that it *may be/is not* (delete as appropriate) responsible for the grievance.

[If the Department is going to investigate the case further, please give summary details of the next steps in the investigation]

The Project Coordination Unit officer will serve as the point of contact for this case, and will update you as necessary. In the meantime, please do not hesitate to contact the officer should you have any questions.

Best regards,

NAME

DATE

APPENDIX H COMMUNITY CONSULTATIONS AND RESPONSE TO COMMENTS

APPENDIX H-1: COMMUNITY FACT SHEETS

BELLE PLAINE

FOND ST. JACQUES

MONDESIR-SALTIBUS

Saint Lucia Renewable Energy Sector Development Project (Belle Plaine)

Background

The Government of Saint Lucia (GoSL) obtained financial assistance and technical support from a number of development partners, including the World Bank, to explore a potential geothermal resource within the Soufrière, Choiseul, and Laborie regions of Saint Lucia, including in the Belle Plaine area. The objective of the project is to determine if there is a geothermal resource capable of commercial power generation.

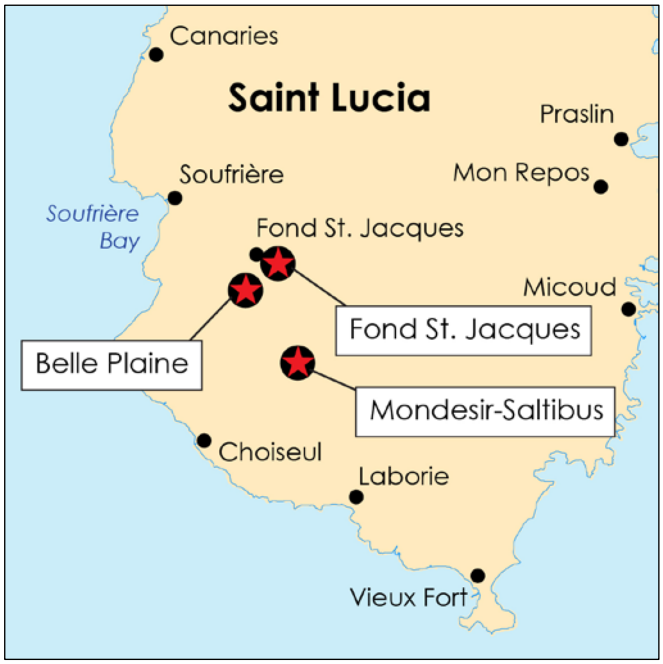
In February 2018, the GoSL completed a Draft Environmental and Social Impact Assessment (ESIA) for the project pursuant to World Bank policies. The primary purpose of the ESIA is to present a detailed analysis of the risks and impacts the project would have on the existing environmental and social conditions in the project area. Project stakeholders are being given an opportunity to comment on the Draft ESIA (available online, here: http://www.govt.lc/media.govt.lc/www/resources/publications/01-draft-esia-st-lucia-geothermal-exploration-project.pdf).

Project Summary

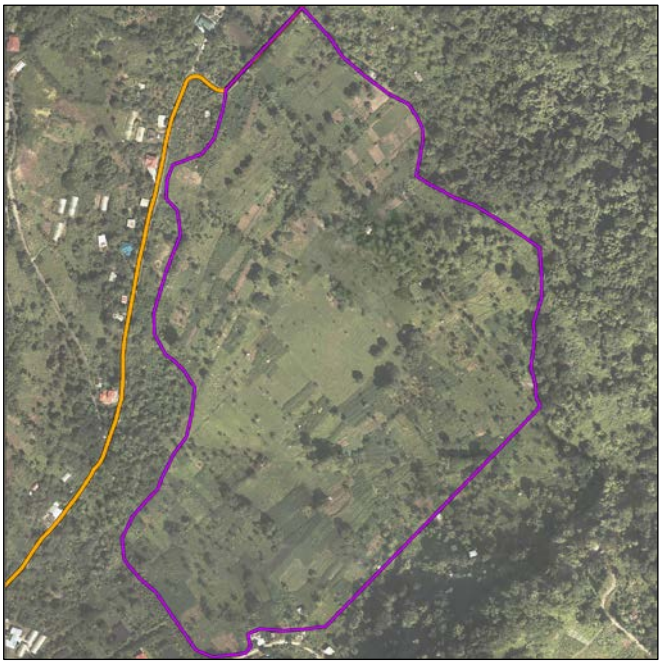
The project would include geothermal exploration in three areas: Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques. Project activities specific to the Belle Plain area would include:

- **Site Development (0 to 90 days):** Establish access to drilling areas by improving roads, bridges, and culverts, as needed, and clearing vegetation and grading work areas, where necessary
- **Well Drilling (30 to 90 days):** Drill slim-diameter exploratory wells and potentially full-sized wells, if warranted, based on cost and results of initial wells
- **Well Testing (0 to 90 days):** Well testing would include measuring the temperature gradient, and potentially short-term flow testing
- **Well Abandonment and Pad Reclamation (up to 30 days):** Wells with no commercial potential would be plugged with cement and the well pad would be fully restored; wells that may have commercial potential would be secured for future testing and monitored

Potential Drilling Areas



Potential Drilling Area at Belle Plaine



Saint Lucia Renewable Energy Sector Development Project (Belle Plaine)

Summary of Comments Identified during Scoping in the Belle Plaine Area

Issue	Addressed in the ESIA?	Mitigation	Response
Fire risk	Section 5.2.11	Fire-1: Fire Prevention and Response	The geothermal resource is a steam resource and would not release substantial quantities of combustible gases and fluids. The risk of fire ignition from equipment activity is addressed in the ESIA. The risk of fires would be less than significant with mitigation.
Health risks from exposure to sulphur and hazardous gases	Sections 5.2.2, 5.4.1, and 5.4.2	Air-3: Air Quality Monitoring and Noxious Gas Management Safety-1: Health and Safety Plan Safety-4: Community Safety	All potential geothermal gas emissions would be temporary during geothermal drilling and testing. Mitigation includes air quality monitoring in proximity to the wells and evacuation planning, where necessary. Blowout prevention would also be used to prevent an uncontrolled release of geothermal gases. The risk of geothermal gases would be less than significant with mitigation.
Induced seismicity and earthquakes from drilling	Section 5.2.3	--	There is no causal link between exploratory geothermal drilling and induced seismicity. The project does not involve fracking.
Affects to surface and groundwater availability	Section 5.2.1	Water-6: Water Extraction Strategy	The project will require temporary water supply during drilling. Mitigation would be implemented to ensure the water supply is not disrupted for domestic and agricultural users.
Impact to livelihoods and relocation	Section 5.3.1, Appendix E, and Appendix F	Social-1: Agricultural Production	The project could result in a temporarily loss of agricultural production. Compensation would be provided as defined in the Resettlement Action Plan (Appendix E) and Resettlement Policy Framework (Appendix F). No relocation is proposed.
Contamination of farmlands	Section 5.2.10	Hazards-1: Hazardous Materials Management Plan	The project would use minimal volumes of hazardous materials. The geothermal fluid and drill cuttings have the potential to contain contaminants, which would be tested and managed and disposed of properly. The mitigation would avoid contamination of farmlands.
Upgrading of access roads	Section 5.2.3	--	The project would improve access roads, bridges, and culverts, if and where necessary to access the drilling areas. The geotechnical investigation will define specific engineering requirements.
Noise during drilling, particularly at night	Section 5.2.4	Noise-1: Noise Abatement and Community Coordination	Communities would be notified in advance of drilling. Silencers and noise mitigation devices will be installed on drilling equipment. Well pads will be located as far away from homes as possible.
Compliance tracking	Appendix D	--	The Environmental and Social Management Plan (ESMP) defines procedures for tracking compliance with mitigation (Appendix D).
Access to the ESIA	--	--	The Draft ESIA is available online (see reverse) and a copy is available at the public meeting location. Comments are being accepted on the Draft ESIA.

Saint Lucia Renewable Energy Sector Development Project (Fond St. Jacques)

Background

The Government of Saint Lucia (GoSL) obtained financial assistance and technical support from a number of development partners, including the World Bank, to explore a potential geothermal resource within the Soufrière, Choiseul, and Laborie regions of Saint Lucia, including in the Fond St. Jacques area. The objective of the project is to determine if there is a geothermal resource capable of commercial power generation.

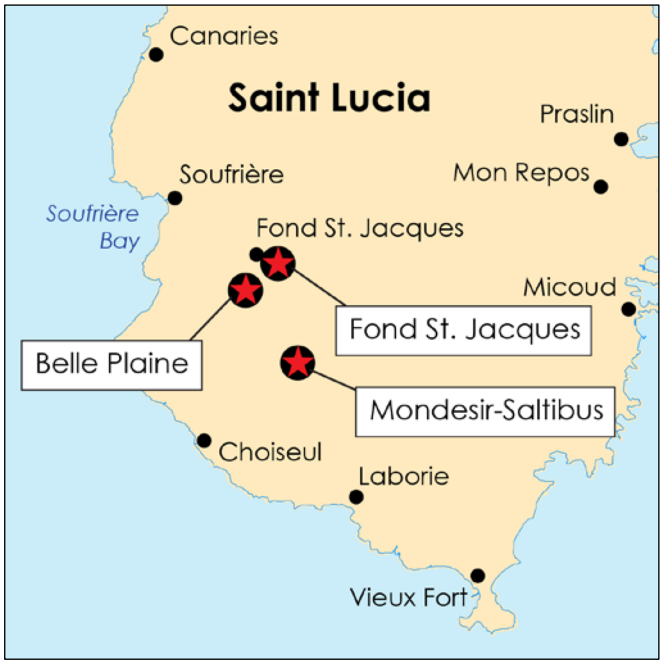
In February 2018, the GoSL completed a Draft Environmental and Social Impact Assessment (ESIA) for the project pursuant to World Bank policies. The primary purpose of the ESIA is to present a detailed analysis of the risks and impacts the project would have on the existing environmental and social conditions in the project area. Project stakeholders are being given an opportunity to comment on the Draft ESIA (available online, here: http://www.govt.lc/media.govt.lc/www/resources/publications/01-draft-esia-st-lucia-geothermal-exploration-project.pdf).

Project Summary

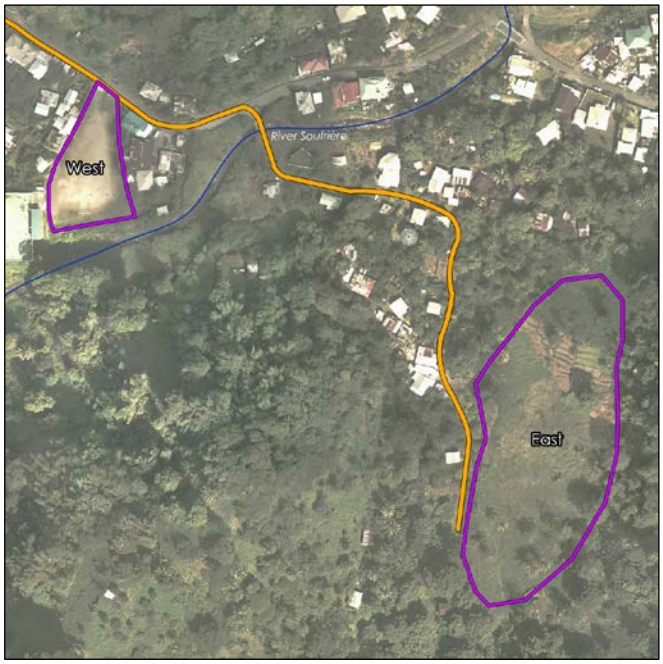
The project would include geothermal exploration in three areas: Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques. Project activities specific to the Fond St. Jacques area would include:

- **Site Development (0 to 90 days):** Establish access to drilling areas by improving roads, bridges, and culverts, as needed, and clearing vegetation and grading work areas, where necessary
- **Well Drilling (30 to 90 days):** Drill slim-diameter exploratory wells
- **Well Testing (0 to 60 days):** Well testing would include measuring the temperature gradient
- **Well Abandonment and Pad Reclamation (up to 30 days):** Wells with no commercial potential would be plugged with cement and the well pad would be fully restored; wells that may have commercial potential would be secured for future testing and monitored

Potential Drilling Areas



Potential Drilling Areas at Fond St. Jacques



Saint Lucia Renewable Energy Sector Development Project (Fond St. Jacques)

Summary of Comments Identified during Scoping in the Fond St. Jacques Area

Issue	Addressed in the ESIA?	Mitigation	Response
Impacts on spring water resources	Section 5.2.1	Water-2: Water Quality Monitoring Program Water-5: Water Supply System Protection	Drilling activities would be conducted downhill from the spring. The water quality monitoring and mitigation plan includes monitoring of spring water quality and measures to protect spring water quality and quantity.
Impact on agricultural and cultivated land	Section 5.3.1, Appendix E, and Appendix F	Social-1: Agriculture Production Soils-1: Topsoil Preservation and Restoration Landscape-1: Site Reclamation and Restoration	The project would temporarily disrupt agricultural production where well pads and access routes would be located on active agricultural land. The well pad would be reclaimed to pre-construction conditions Compensation for loss of agricultural production would be provided as defined in the Resettlement Action Plan (Appendix E) and Resettlement Policy Framework (Appendix F). No relocation is proposed.
Construction noise, and compliance checking	Section 5.2.4 and Appendix D	Noise-1: Noise Abatement and Community Coordination	Communities would be notified in advance of drilling. Silencers and noise mitigation devices will be installed on drilling equipment. Well pads will be located as far away from homes as possible. The Environmental and Social Management Plan (ESMP) defines procedures for tracking compliance with mitigation (Appendix D).
Impacts on aesthetics	Section 5.2.7	Landscape-1: Site Reclamation and Restoration	Impacts on aesthetics would be temporary during construction. Mitigation would require contractors to document pre-project conditions and properly restore project areas following drilling activities. The project does not include geothermal power plant development
Land availability	--	--	The project will require the use of private and government land. Compensation for impacts to private land would be provided as defined in the Resettlement Action Plan (Appendix E) and Resettlement Policy Framework (Appendix F).
Will drilling be affected by weather?	--	--	It is likely that drilling will be halted during storms.
Impacts on telephone and electricity lines by large trucks	Section 5.2.9	Utilties-1: Protect Overhead Utilities Lines	Contractors and applicable system provides would temporarily disconnect or reposition the lines to avoid conflicts during transport of large equipment and construction, where necessary.
Employment opportunities for local residents	Section 5.3.6	Social-2: Working Conditions and Equality	The project could provide short-term employment opportunities to local and surrounding communities. Preference is given to hiring local residents.
Will the project reduce the cost of electricity?	--	--	The project does not involve development of a power plant. If the project is successful, the GoSL may pursue power plant development opportunities.
Access to the information/ESIA	--	--	The Draft ESIA is available online (see previous page) and a copy is available at the public meeting location.

Saint Lucia Renewable Energy Sector Development Project (Mondesir-Saltibus)

Background

The Government of Saint Lucia (GoSL) obtained financial assistance and technical support from a number of development partners, including the World Bank, to explore a potential geothermal resource within the Soufrière, Choiseul, and Laborie regions of Saint Lucia, including in the Mondesir-Saltibus area. The objective of the project is to determine if there is a geothermal resource capable of commercial power generation.

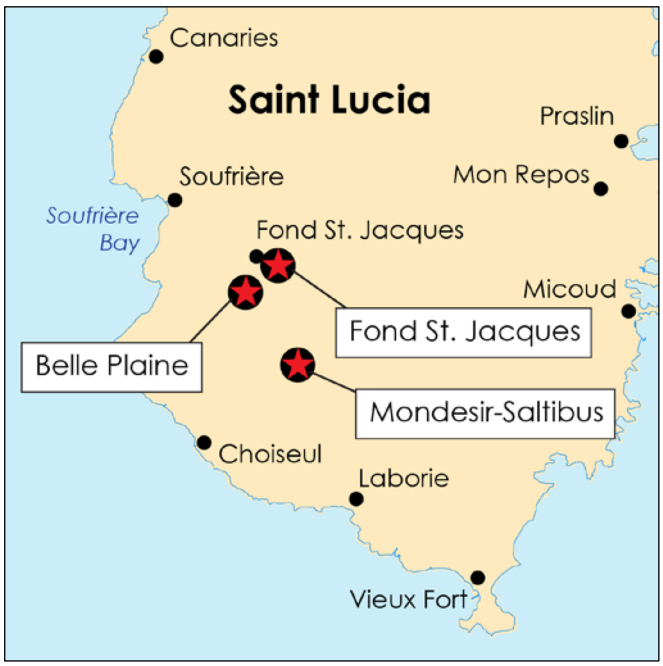
In February 2018, the GoSL completed a Draft Environmental and Social Impact Assessment (ESIA) for the project pursuant to World Bank policies. The primary purpose of the ESIA is to present a detailed analysis of the risks and impacts the project would have on the existing environmental and social conditions in the project area. Project stakeholders are being given an opportunity to comment on the Draft ESIA (available online, here: http://www.govt.lc/media.govt.lc/www/resources/publications/01-draft-esia-st-lucia-geothermal-exploration-project.pdf).

Project Summary

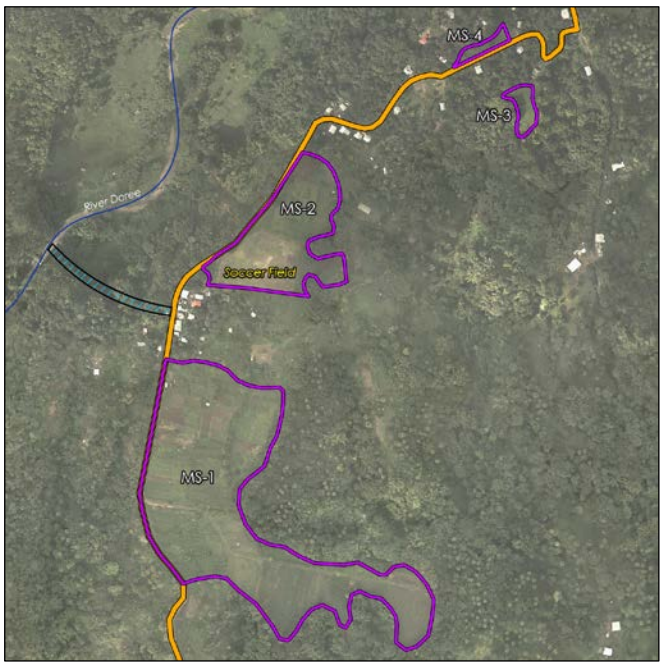
The project would include geothermal exploration in three areas: Belle Plaine, Mondesir-Saltibus, and Fond St. Jacques. Project activities specific to the Mondesir-Saltibus area would include:

- **Site Development (0 to 90 days):** Establish access to drilling areas by improving roads, bridges, and culverts, as needed, and clearing vegetation and grading work areas, where necessary
- **Well Drilling (30 to 90 days):** Drill slim-diameter exploratory wells (at any of the four potential drilling sites) and potentially full-sized wells at either MS-1 or MS-2, if warranted, based on cost and results of initial wells
- **Well Testing (0 to 90 days):** Well testing would include measuring the temperature gradient, and potentially short-term flow testing
- **Well Abandonment and Pad Reclamation (up to 30 days):** Wells with no commercial potential would be plugged with cement and the well pad would be fully restored; wells that may have commercial potential would be secured for future testing and monitored

Potential Drilling Areas



Potential Drilling Areas at Mondesir-Saltibus



Saint Lucia Renewable Energy Sector Development Project (Mondesir-Saltibus)

Summary of Comments Identified during Scoping in the Mondesir-Saltibus Area

Issue	Addressed in the ESIA?	Mitigation	Response
Impacts to agricultural land	Section 5.3.1, Appendix E, and Appendix F	Social-1: Agriculture Production Soils-1: Topsoil Preservation and Restoration Landscape-1: Site Reclamation and Restoration	The project would temporarily disrupt agricultural production where well pads and access routes would be located on active agricultural land. The well pad would be reclaimed after exploration to pre-existing conditions. Compensation would be provided as defined in the Resettlement Action Plan (Appendix E) and Resettlement Policy Framework (Appendix F). No relocation is proposed.
Removal of topsoil	Section 5.2.3	Soils-1: Topsoil Preservation and Restoration	Construction sites would be restored to pre-existing conditions and topsoil would be replaced.
Hazards from abandoned wells	Section 3.3.5	--	Abandoned wells will be plugged with cement and the well pad site would be restored to the original topography to avoid hazards.
Distance of residences from drill pads	Figure 4.2-4	--	Figure 4.2-4 in the ESIA depicts the residents located near the potential drilling areas at Mondesir-Saltibus. Full-sized wells would not be drilled at MS-3 and MS-4 where residences are in close proximity to the drilling area.
Community benefits	Sections ES 4.2, 1.5, and 6.2 (Water-5)	--	The project has the potential to create temporary local jobs and opportunities for training. If the project is successful, the development of a geothermal power plant would reduce reliance on fossil fuels and reduce emissions of pollutants. The Project Coordination Unit will also consider the community benefit of leaving any water supply systems that are developed for the project (i.e., pipes, intakes, tanks, and wells) after exploration drilling is complete.
Impacts on water resources	Section 5.2.1	Water-1: Stormwater, Erosion, and Sediment Control Water-2: Water Quality Monitoring Program Water-3: Drilling Waste and Effluent Management Water-4: Blowout Prevention Water-5: Water Supply System Protection Water-6: Water Extraction Strategy	The project would use water during drilling and would require discharge of drill cuttings during drilling activities. The water quality monitoring program would ensure that the project does not substantially degrade water quality. Drilling waste and effluent would be managed so that hazardous materials are not released into the water supply. A blowout preventer would be installed to ensure that a well blowout does not impact water resources. The water extraction strategy requires that the existing water uses in the area are maintained during project extraction of water. Drilling may be reduced to avoid significant impacts on water supplies. Any water supply impacts would be temporary during drilling activities.
Public review	--	--	The Draft ESIA is available online (see reverse) and a copy is available at the public meeting location.

APPENDIX H-2: POWERPOINT PRESENTATIONS FOR COMMUNITY CONSULTATIONS

BELLE PLAINE

FOND ST. JACQUES

MONDESIR-SALTIBUS









Saint Lucia Renewable Energy Sector Development Project (Belle Plaine)

Environmental and Social Impacts and Mitigation

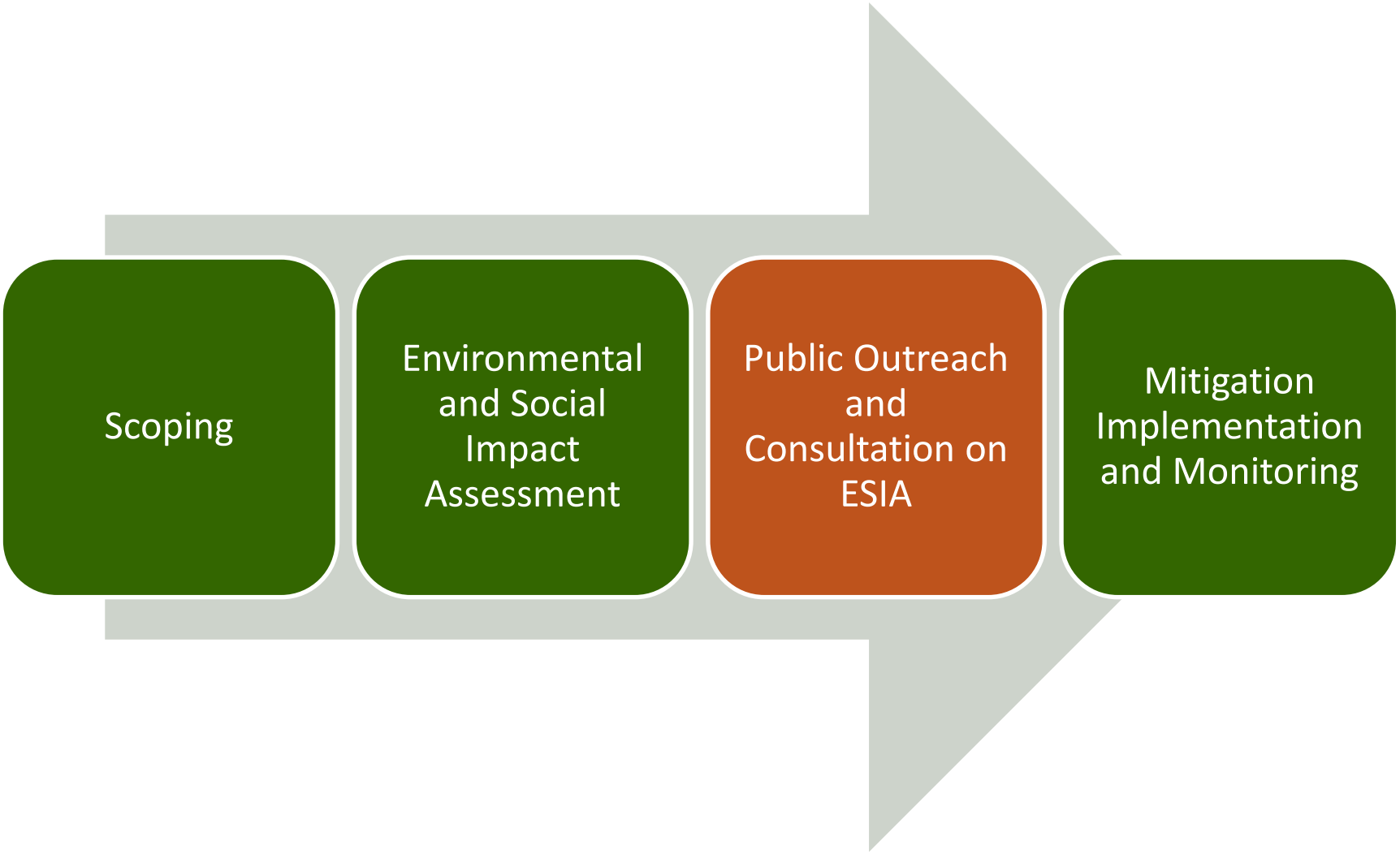
March 2018

PANORAMA ENVIRONMENTAL, INC.

Overview

1. Potential Drilling Areas
2. Specific Activities in the Belle Plaine Area
3. Scoping Comments received from the Belle Plaine Area
4. Environmental Considerations in the Belle Plaine Area
5. Questions and Comments

Purpose of Meeting – Obtain Comments on ESIA









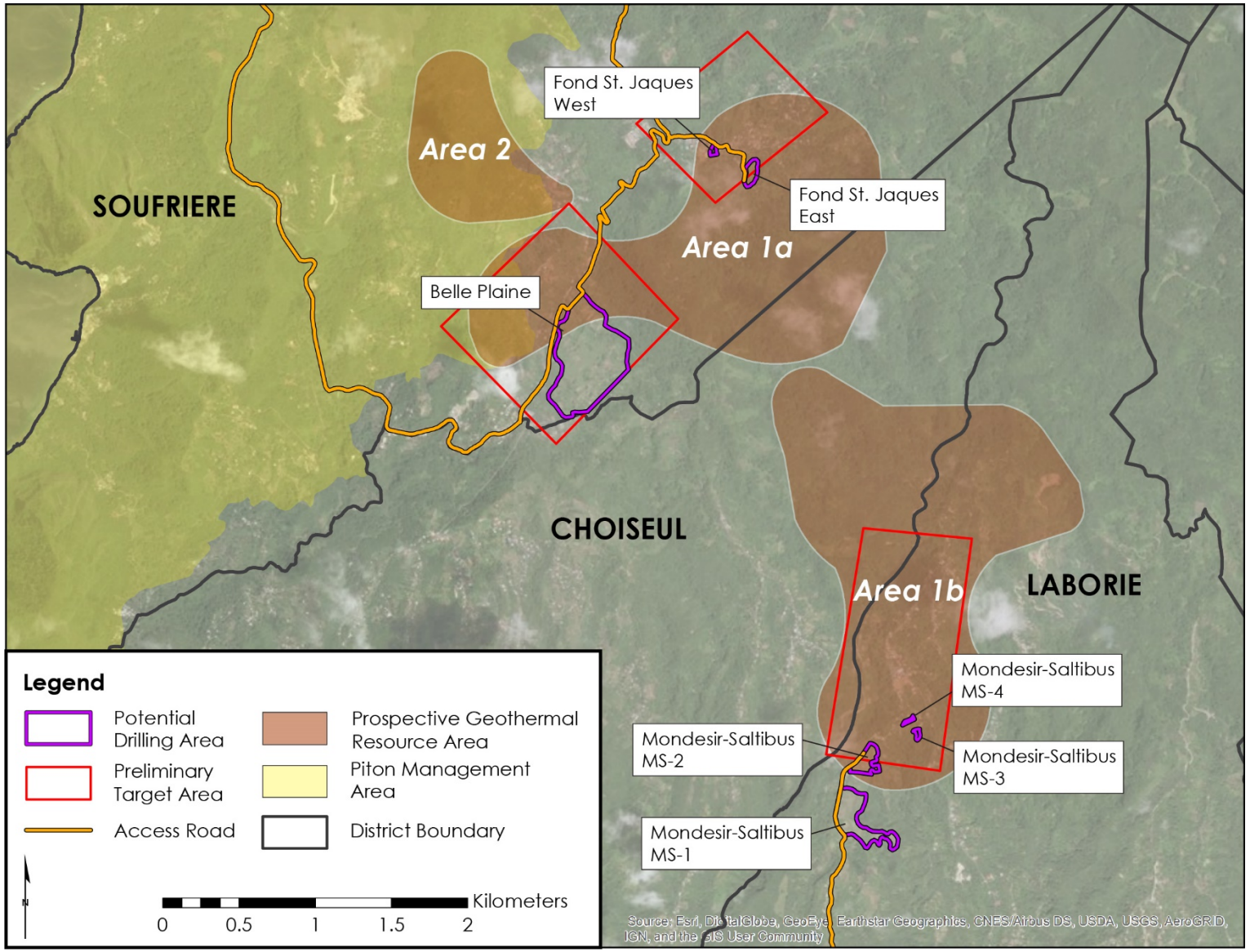


Potential Drilling Areas

Saint Lucia

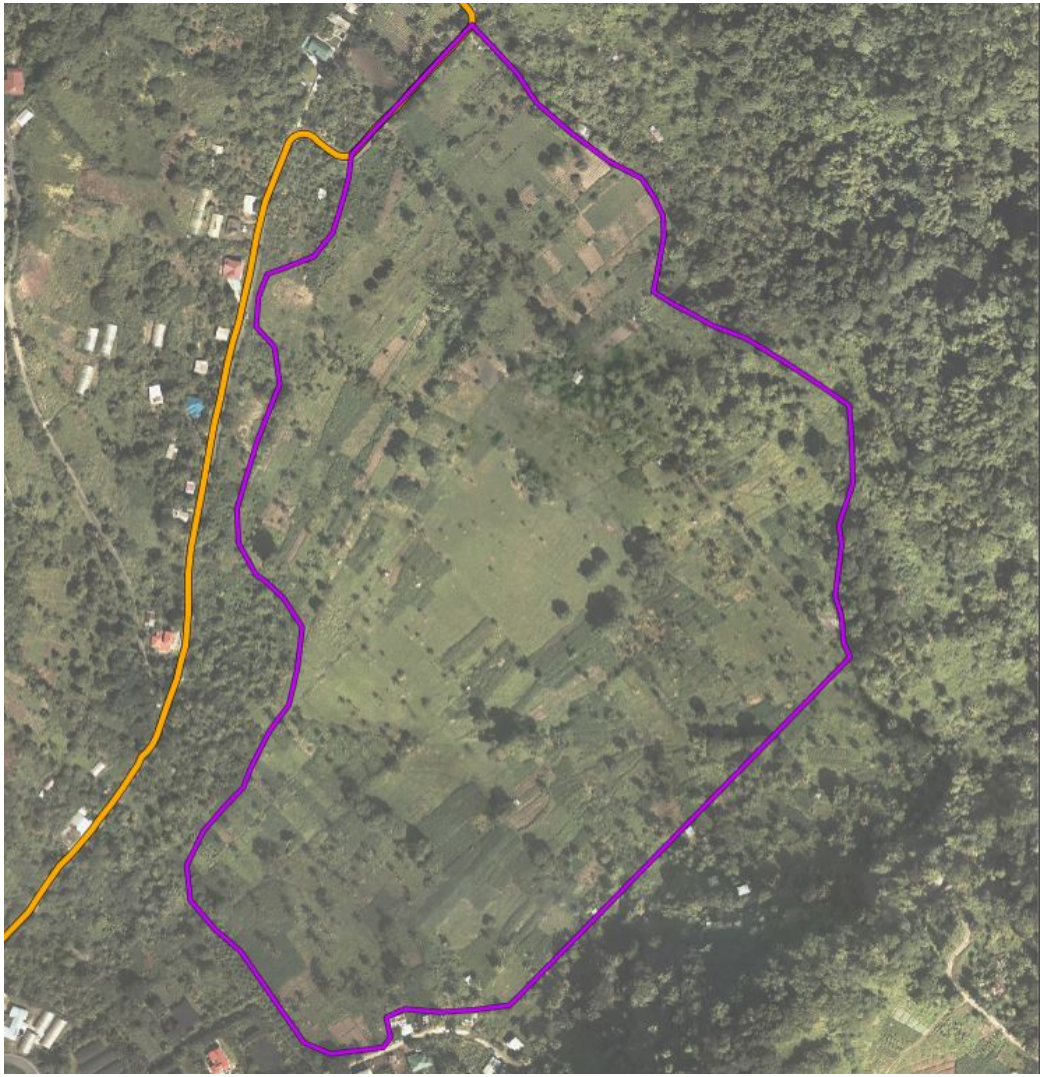
PANORAMA
ENVIRONMENTAL, INC.

Potential Drilling Areas



Potential Drilling Area at Belle Plaine

- Just south of prospective resource Area 1a
- Logistically favorable of the three potential drilling areas
- Abundant flat and open agricultural land near established roads











Specific Activities in the Belle Plaine Area

Saint Lucia

PANORAMA
ENVIRONMENTAL, INC.

Belle Plaine Activities

- Site Development (0 to 90 days)
  - Road, bridge, and culver improvements, if necessary (i.e., widening and reinforcing)
  - Vegetation removal and grading, where necessary, for access roads and well pads
- Well Drilling (30 to 90 days)
  - Slim-diameter exploratory wells
  - Full-sized wells, if justified, based on cost and results of initial drilling
- Well Testing (0 to 90 days)
  - (i) pressure/temperature logging, (ii) flow testing, (iii) injection testing, (iv) falloff or buildup testing
- Full-sized wells, if justified, based on cost and results of initial drilling

Belle Plaine Activities

- Well Abandonment and Pad Reclamation (up to 30 days)
  - Wells with no commercial potential plugged with cement and well pad restored
  - Wells with commercial potential secured for future testing and monitored













Scoping Comments received from the Belle Plaine Area

Saint Lucia

PANORAMA ENVIRONMENTAL, INC.

Belle Plaine Scoping Comments: Environmental

Scoping Comment/Topic	Conclusion of ESIA
Fire risk	Steam would not release combustible gases or fluids. Fire risks would be less than significant with mitigation
Health risk from exposure to hazardous gases	Gas emissions would be temporary and mitigated through air quality monitoring and blow out preventers to prevent uncontrolled release of gases
Induced seismicity	There is no causal link between exploratory drilling and induced seismicity
Water availability	Mitigation would ensure that water supply is not disrupted for domestic or agricultural use
Contamination of farmlands	Contaminants would be tested, managed, and disposed of properly to avoid contamination of farmlands
Access roads	Roads, bridges, and culverts used to access drilling areas would be improved

Belle Plaine Scoping Comments: Environmental

Scoping Comment/Topic	Conclusion of ESIA
Noise	Communities would be notified, and mitigation would be implemented to reduce noise levels and disturbance. Well pads will be located as far away from homes as possible
Compliance tracking	The Environmental and Social Management Plan defines procedures for tracking compliance with mitigation

Belle Plain Scoping Comments: Social

Scoping Comment/Topic	Conclusion of ESIA
Livelihoods and relocation	The project could result in temporary loss of agricultural production. Compensation would be provided as defined in the Resettlement Action Plan and Resettlement Policy Framework. No relocation is proposed
Access to the ESIA	The Draft ESIA is available online and available at the public meeting location. Comments on the Draft ESIA are being accepted









Environmental Considerations in the Belle Plaine Area

Saint Lucia

PANORAMA ENVIRONMENTAL, INC.

Belle Plaine Area General Characteristics

- Large flat area in the valley bottom
- Good access from Soufrière
- Few homes or structures in the target area
- Active agricultural use
- Suitable for full-size exploration wells



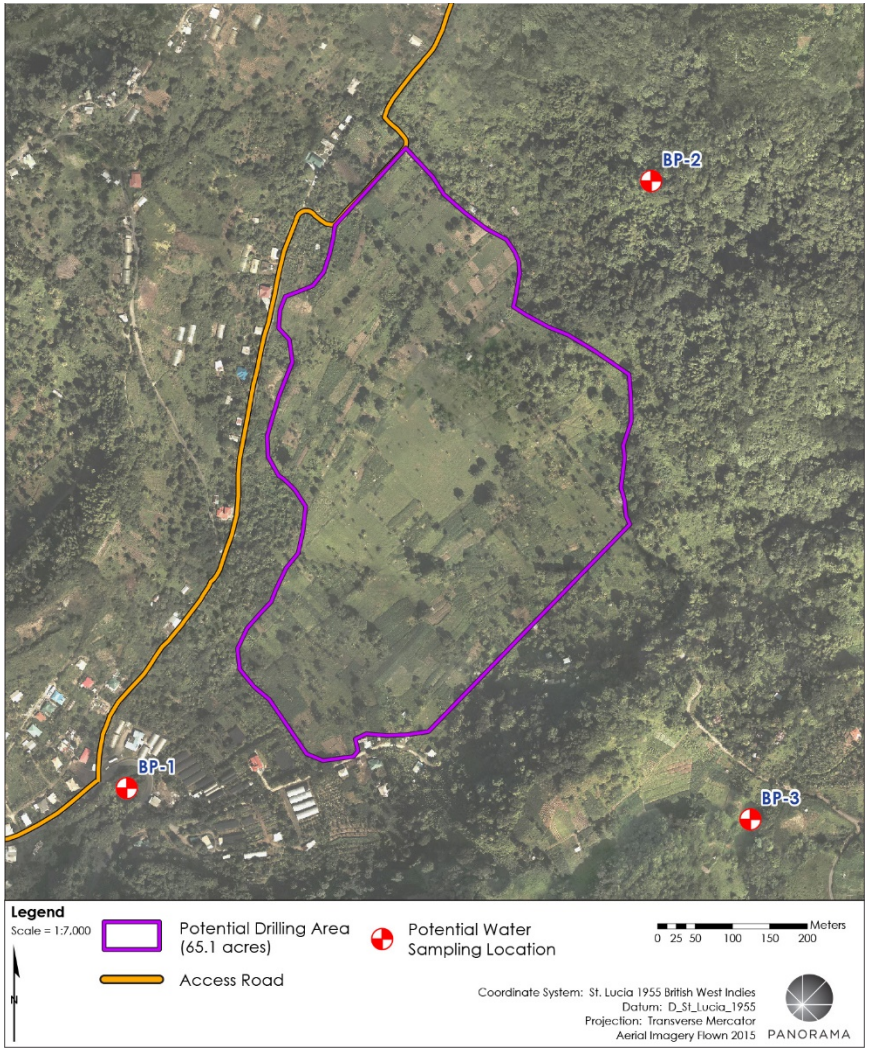
Belle Plaine Water Resources

Conditions

- Two rivers flow along the Belle Plaine Area – Choiseul and Trou Barbet
- No water storage infrastructure in the target area
- Not within a mapped floodplain

Mitigation

- Erosion control
- Water monitoring along area streams
- Water supply considerations



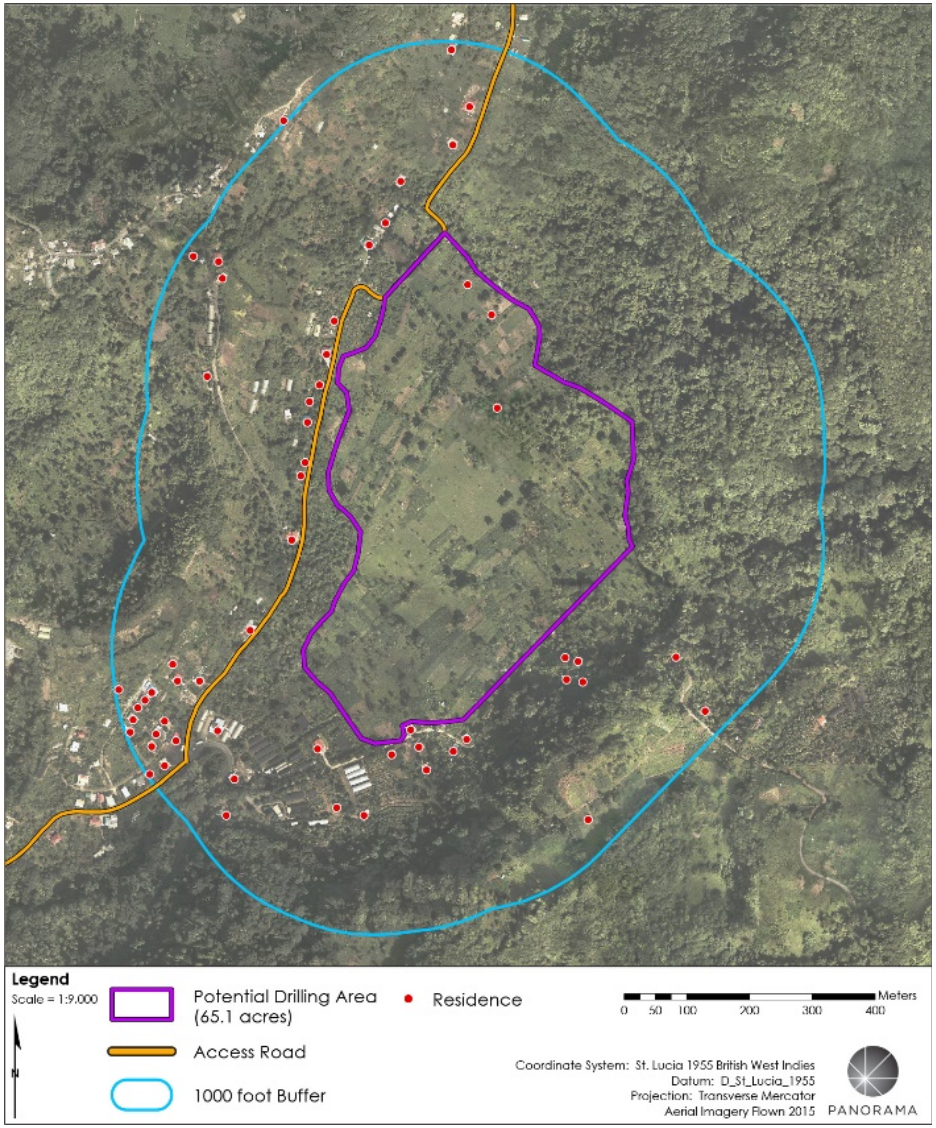
Belle Plaine Air Quality and Noise

Receptors

- Residences along border of drilling area
- Three structures in northern portion of drilling area

Mitigation

- Community engagement
- Buffer between drilling area and residences
- Address any community complaints
- Air quality monitoring and incidental evacuation plan



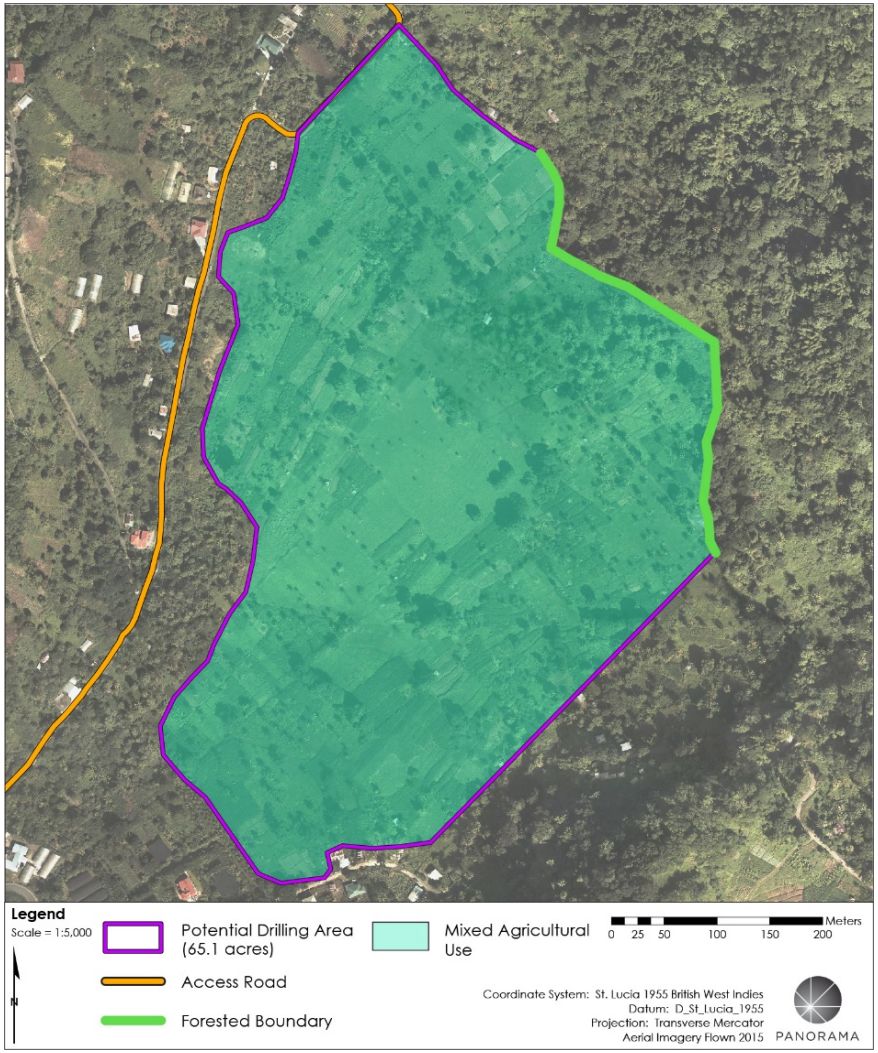
Belle Plaine Biological and Archaeological Resources

Conditions

- No native habitats in the drilling area
- Adjacent forest habitat
- Historical plantations
- Amerindian resources

Mitigation

- Worker training
- Subsurface archaeological testing
- Biological monitoring
- Buffer from forest edge, if feasible
- Avoid peak nesting season



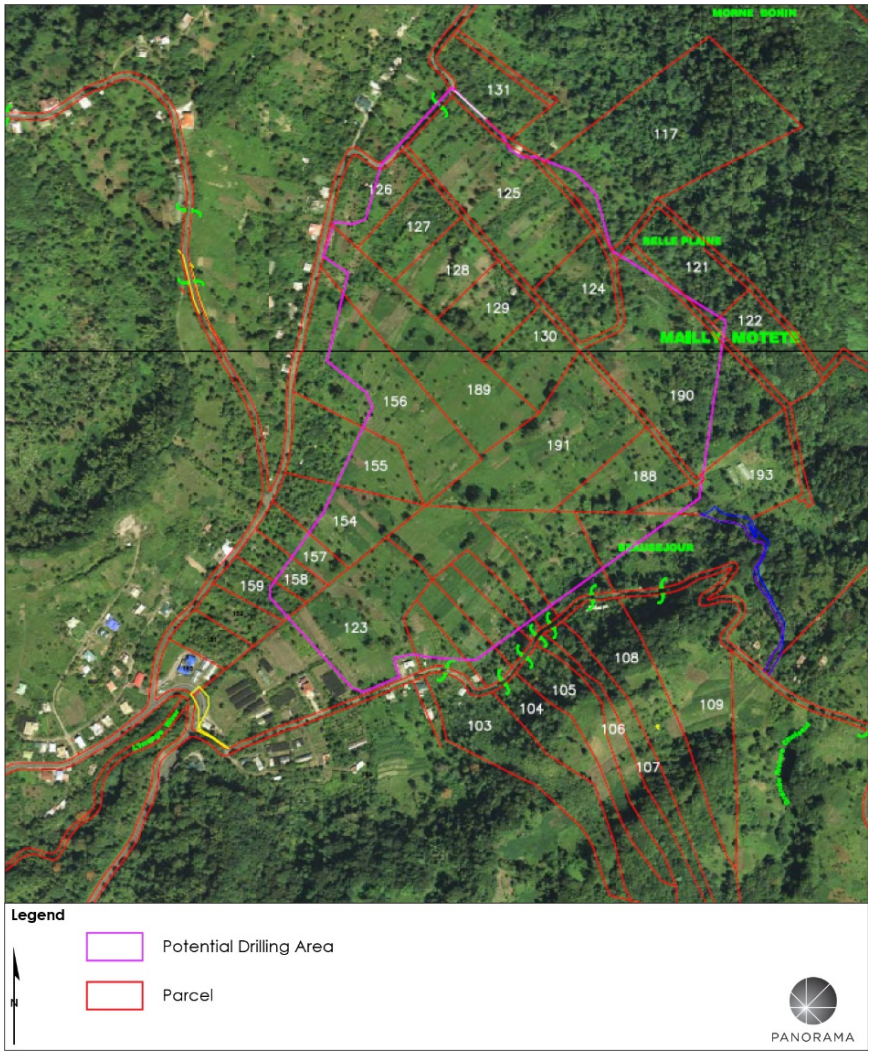
Belle Plaine Socio-Economic Considerations

Conditions and Impacts

- Active agricultural production
- Mostly family-owned parcels
- Loss of livelihood from displaced agricultural production

Mitigation

- Compensate landowner for use of land
- Provide priority hiring to local workers
- Stockpile topsoil for agricultural production
- Restore sites at completion of drilling











Questions and Comments

Saint Lucia

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Saint Lucia Renewable Energy Sector Development Project (Fond St. Jacques)

Environmental and Social Impacts and Mitigation

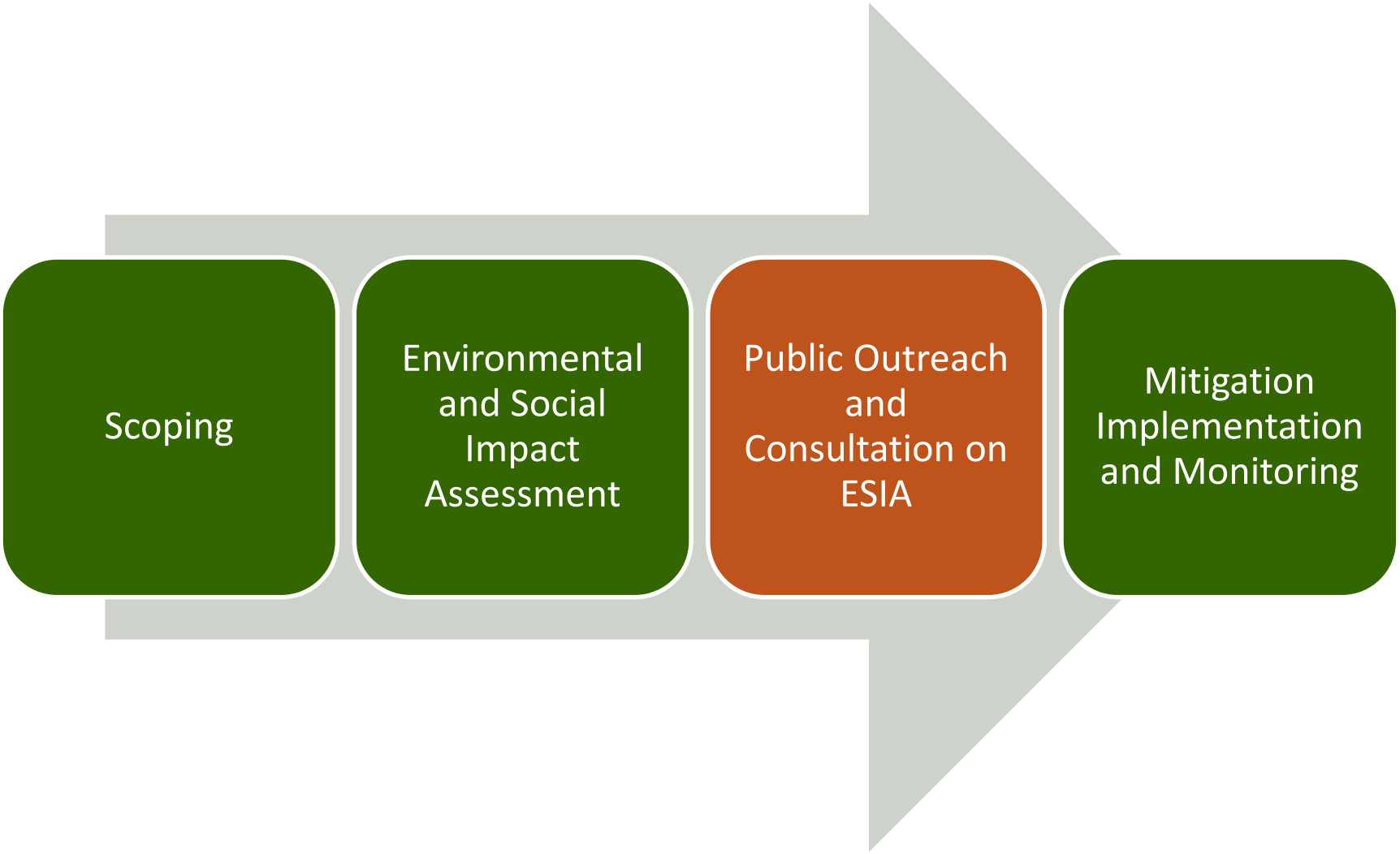
March 2018

PANORAMA ENVIRONMENTAL, INC.

Overview

1. Potential Drilling Areas
2. Specific Activities in the Fond St. Jacques Area
3. Scoping Comments received from the Fond St. Jacques Area
4. Environmental Considerations in the Fond St. Jacques Area
5. Questions and Comments

Purpose of Meeting – Obtain Comments on ESIA









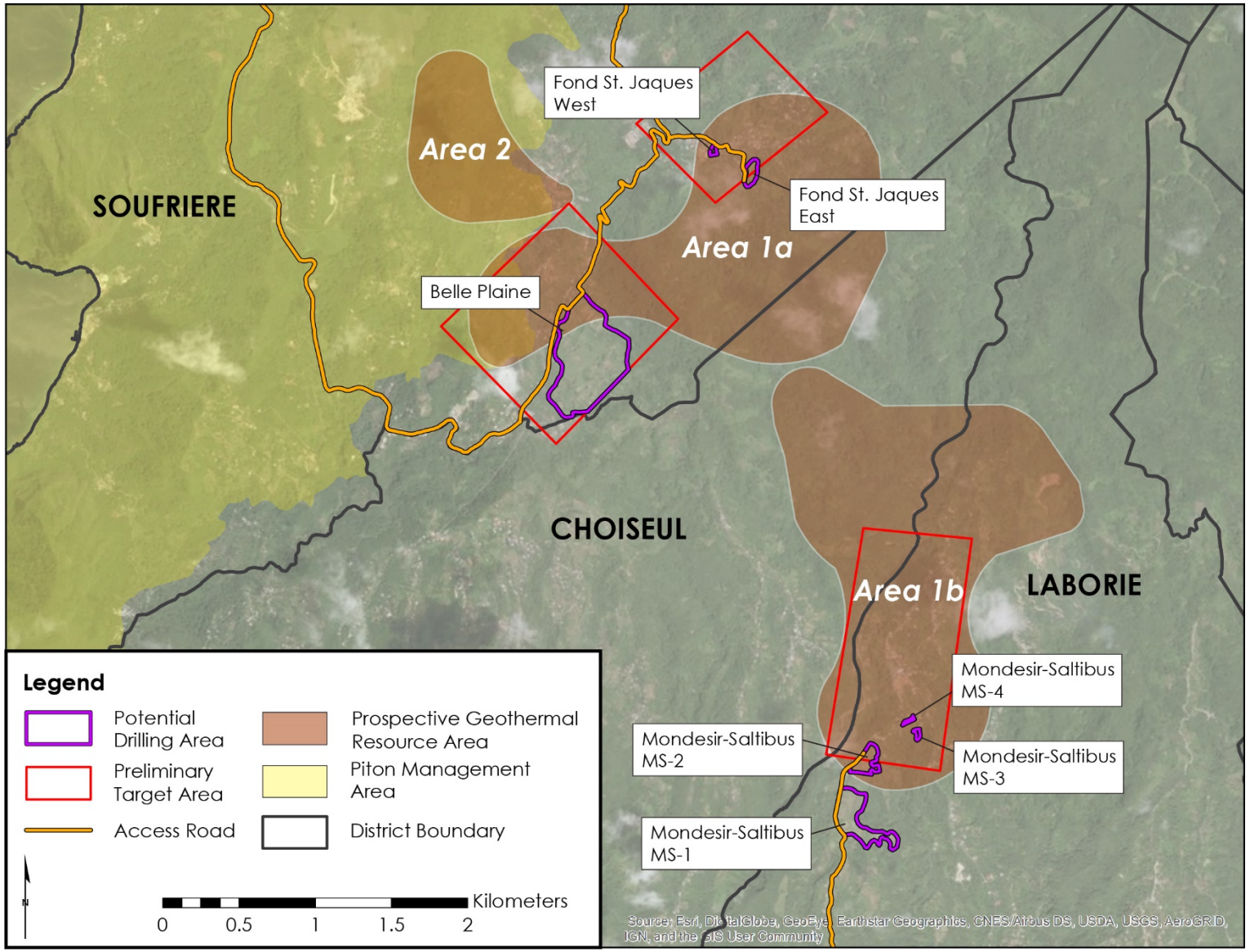


Potential Drilling Areas

Saint Lucia

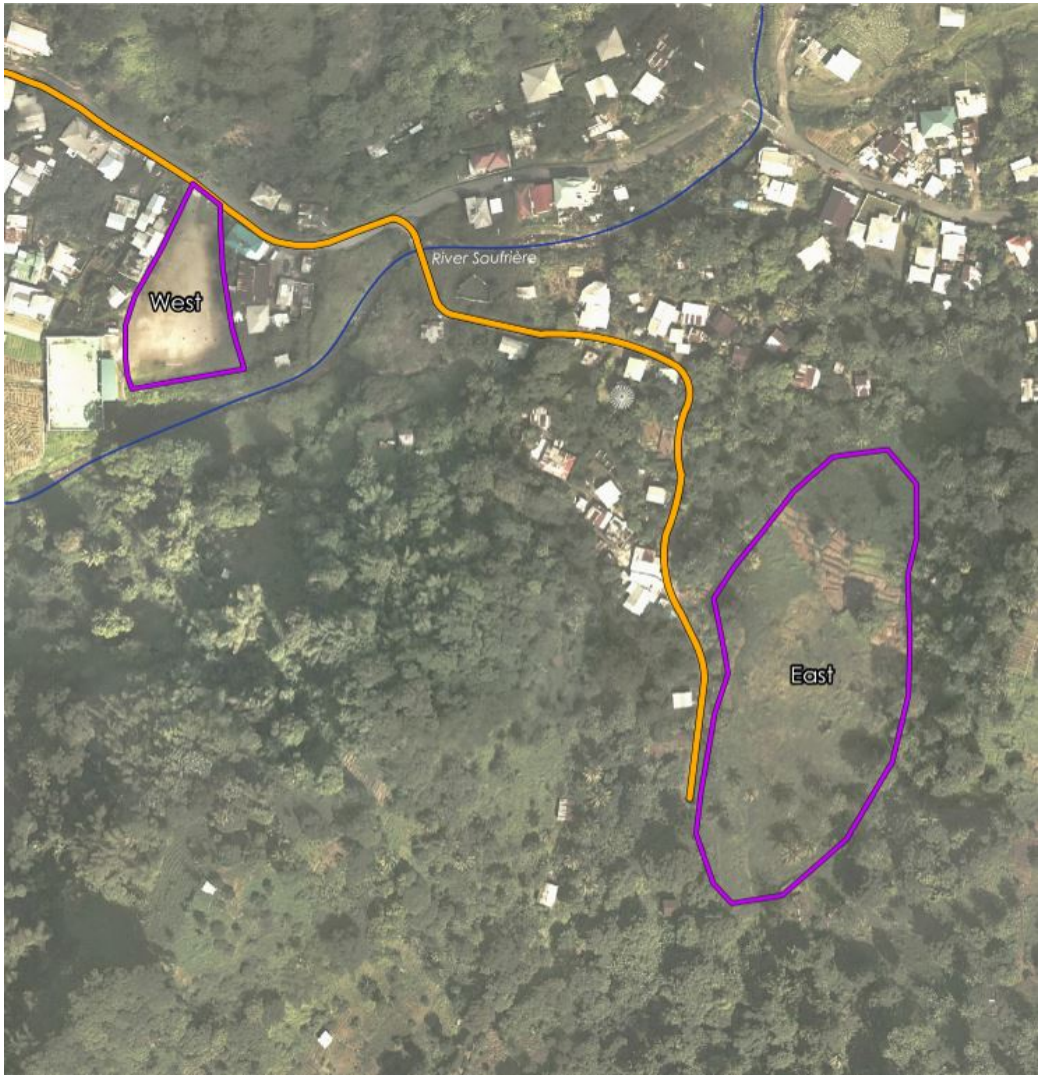
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Potential Drilling Areas



Potential Drilling Areas at Fond St. Jacques

- Entirely within Resource Area 1a
- Two small flat and open areas
- Western area is a recreational facility
- Eastern area is swampy and used for agriculture
- Residential community surrounding drilling areas











Specific Activities in the Fond St. Jacques Area

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Fond St. Jacques Activities

- Site Development (0 to 90 days)
  - Road, bridge, and culver improvements, if necessary (i.e., widening and reinforcing)
  - Vegetation removal and grading, where necessary, for access roads and well pads
- Well Drilling (30 to 90 days)
  - Slim-diameter exploratory wells
- Well Testing (0 to 30 days)
  - (i) pressure/temperature logging, (ii) flow testing, (iii) injection testing, (iv) falloff or buildup testing
- Well Abandonment and Pad Reclamation (up to 30 days)
  - Wells with no commercial potential plugged with cement and well pad restored
  - Wells with commercial potential secured for future testing and monitored









Scoping Comments received from the Fond St. Jacques Area

Saint Lucia

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Fond St. Jacques Scoping Comments: Environmental

Scoping Comment/Topic	Conclusion of ESIA
Spring water resources	Drilling would occur downhill from the spring. Mitigation would protect spring water quality and quantity
Noise	Communities would be notified, and mitigation would be implemented to reduce noise levels and disturbance. Well pads would be located as far away from homes as possible. The ESMP would define compliance procedures for mitigation measures
Aesthetics	Aesthetics impacts would be temporary. Contractors would restore project areas following drilling. The project does not include construction of permanent facilities
Weather	Drilling would likely be halted during storms
Hazards to telephone and electricity lines	Contractors would temporarily disconnect or reposition lines to avoid conflicts during transport of large equipment

Fond St. Jacques Scoping Comments: Social

Scoping Comment/Topic	Conclusion of ESIA
Land acquisition	The project will require the use of private and government land. Compensation is defined in the Resettlement Action Plan and Resettlement Policy Framework. No relocation is proposed
Employment opportunities	The project could provide short-term employment opportunities. Priority would be given to local residents
Cost of electricity	The project does not involve development of a power plant. If the project is successful, the GoSL may pursue power plant development
Access to information/ESIA	The Draft ESIA is available online and a copy is available at the public meeting location. Comments on the Draft ESIA are being accepted









Environmental Considerations in the Fond St. Jacques Area

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Fond St. Jacques Area General Characteristics

- Steep slopes surrounding east drilling area
- Residential homes directly adjacent to drilling areas
- Access roads will need improvement
- Soufrière River directly adjacent to west drilling area
- Small drilling areas suitable for slim-diameter wells



Fond St. Jacques West Area

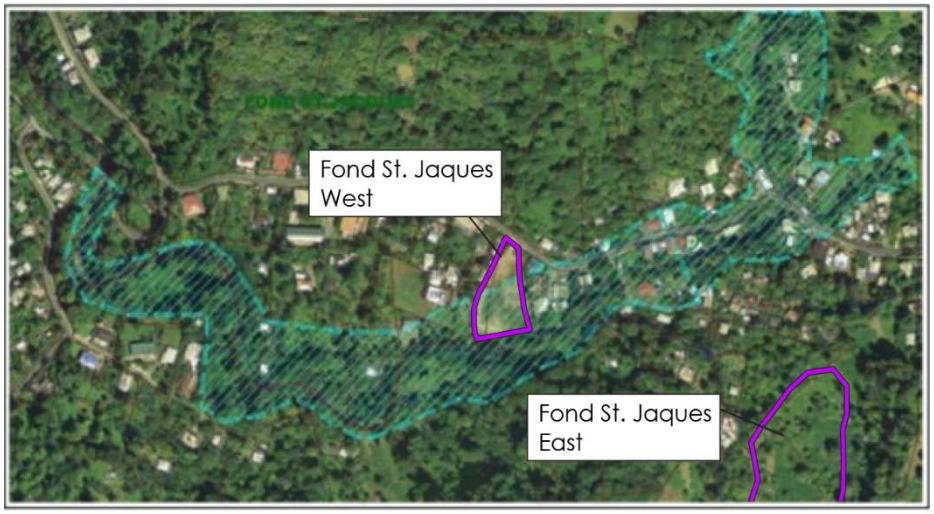
Fond St. Jacques Water Resources and Unstable Soils

Conditions

- Spring and water supply infrastructure
- Shallow groundwater and saturated soils in eastern drilling area
- Western drilling area within floodplain
- Potential upslope landslide hazards

Mitigation

- Geotechnical study
- Avoid water supply infrastructure and immediately repair any incidental damage
- Water quality monitoring
- Flood and landslide contingency plans









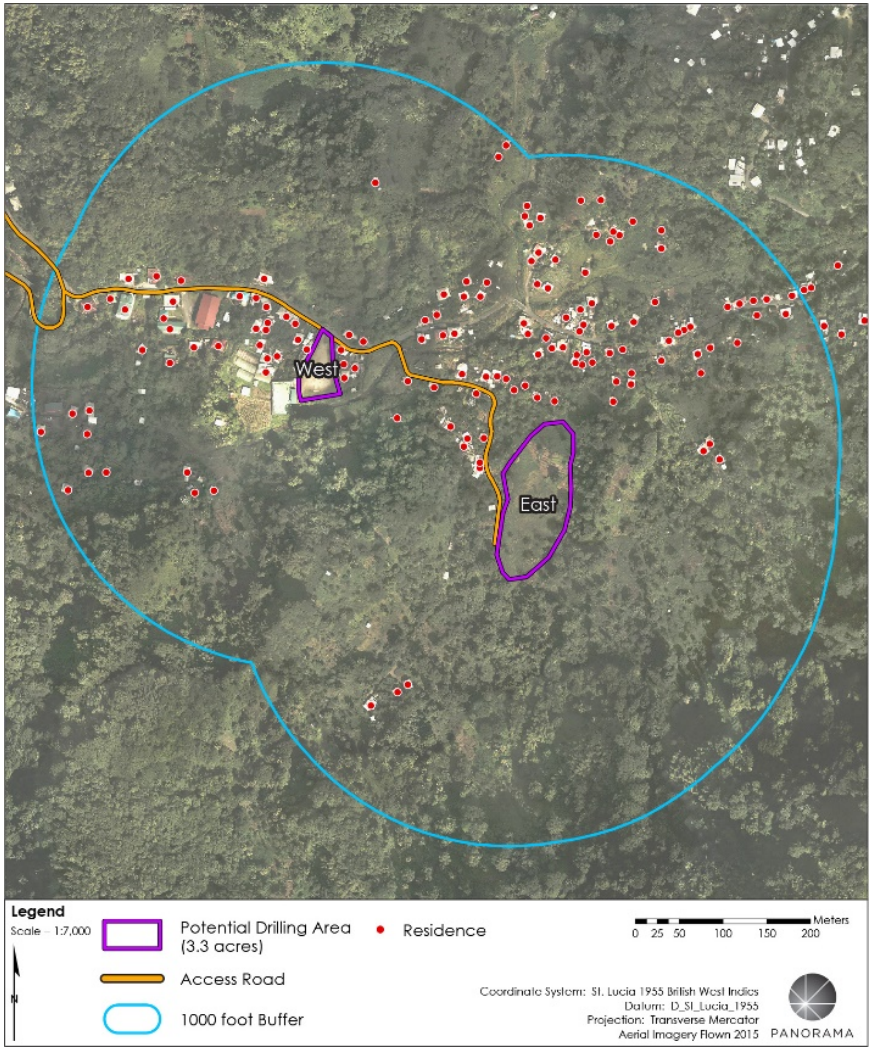
Fond St. Jacques Air Quality and Noise

Conditions

- Residences immediately adjacent to drilling area
- Recreational field in Fond St. Jacques west

Mitigation

- Community engagement
- Reduce noise levels, exposure, and disturbance; install noise barriers
- Address any community complaints
- Air quality monitoring and incidental evacuation plan



Fond St. Jacques Biological and Archaeological Resources

Conditions

- No native habitats
- Eastern area is under agricultural use
- Western area was graded
- Not sensitive for archaeological or historical resources

Mitigation

- Worker training
- Biological monitoring if working during nesting season



Fond St. Jacques East

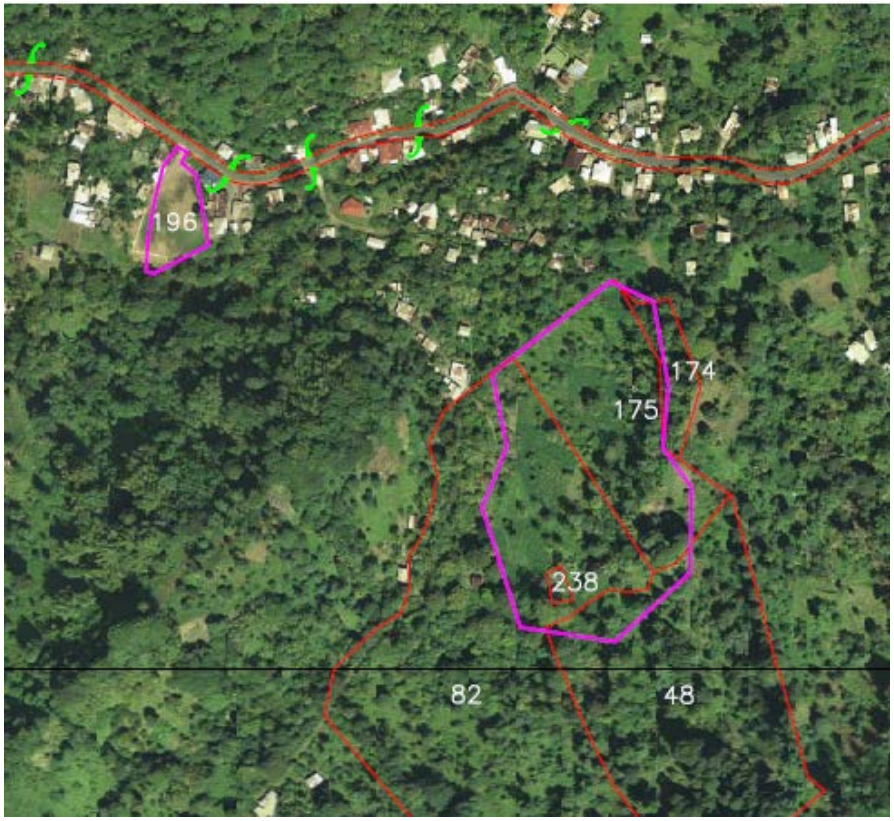
Fond St. Jacques Socio-Economic Considerations

Conditions and Impacts

- Community recreation in western area
- Displacement of agriculture in eastern area
- Community concerns about impacts on water supply infrastructure in eastern area

Mitigation

- Compensate land owners and growers for loss of agricultural production
- Stockpile soils and restore sites
- Avoid water supply infrastructure and immediately repair any incidental damage











Questions and Comments

http://www.govt.lc/media.govt.lc/www/resources/publications/01-draft-esia-st-lucia-geothermal-exploration-project.pdf

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Saint Lucia Renewable Energy Sector Development Project (Mondesir-Saltibus)

Environmental and Social Impacts and Mitigation

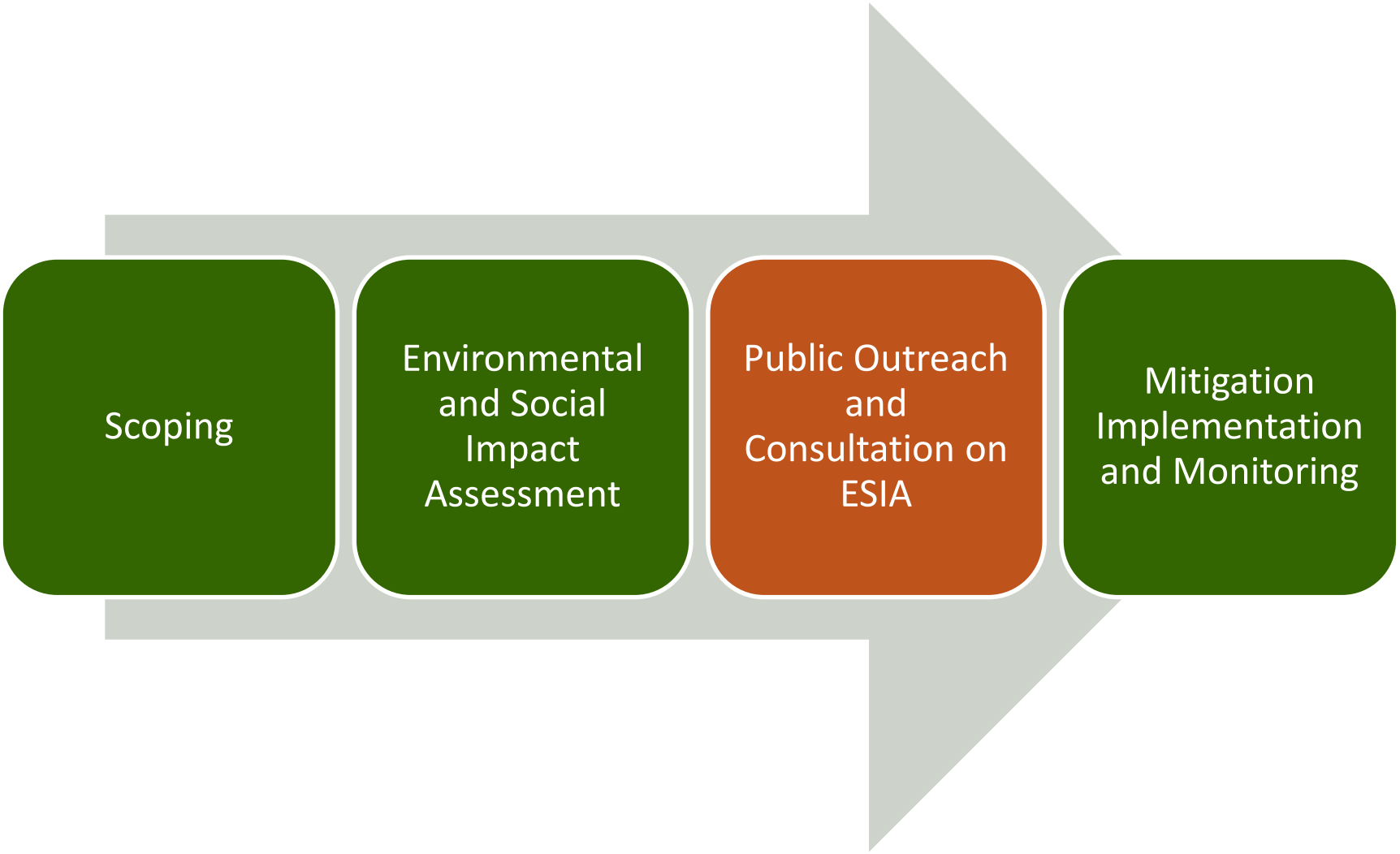
March 2018

PANORAMA ENVIRONMENTAL, INC.

Overview

1. Potential Drilling Areas
2. Specific Activities in the Mondesir-Saltibus Area
3. Scoping Comments received from the Mondesir-Saltibus Area
4. Environmental Considerations in the Mondesir-Saltibus Area
5. Questions and Comments

Purpose of Meeting – Obtain Comments on ESIA









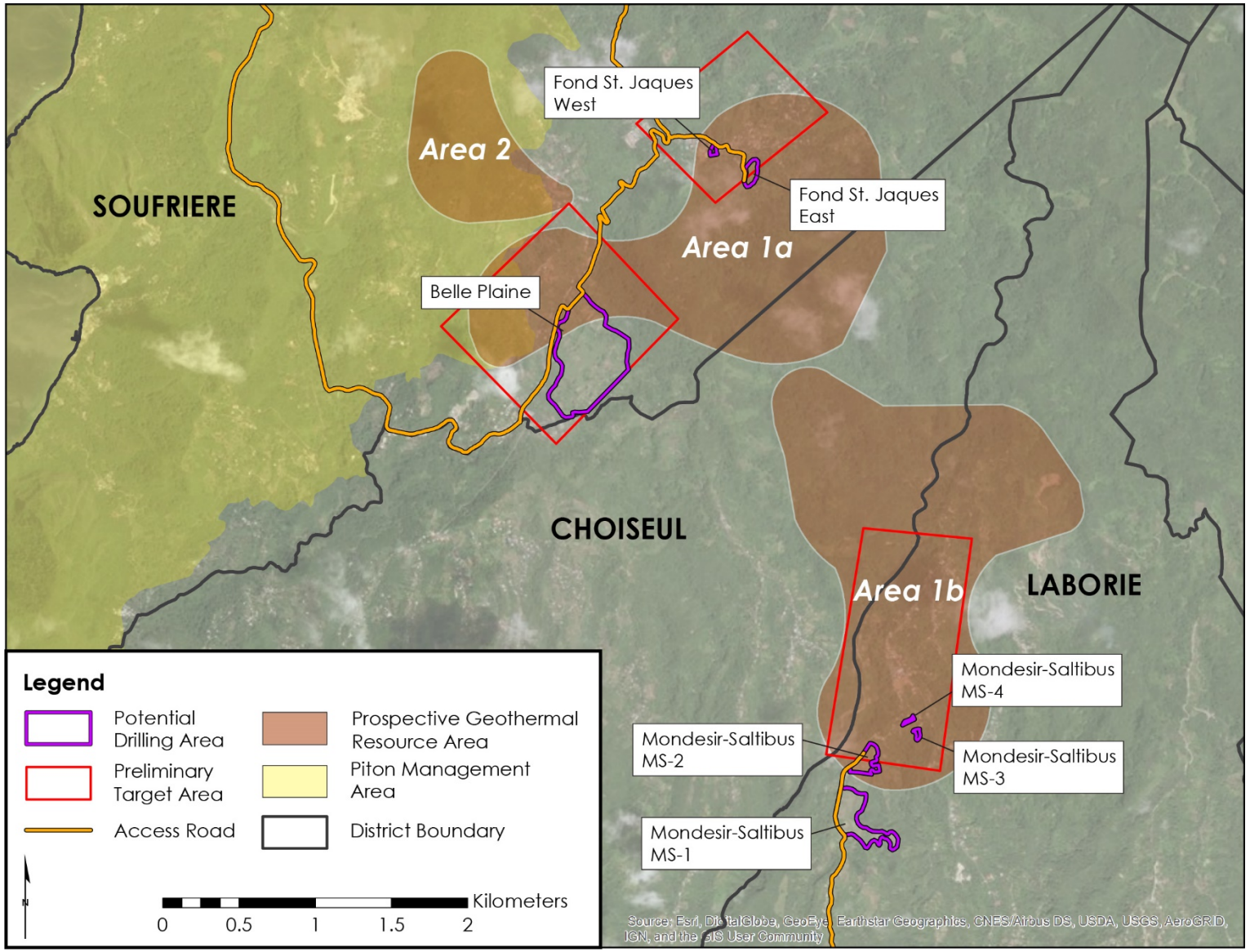


Potential Drilling Areas

Saint Lucia

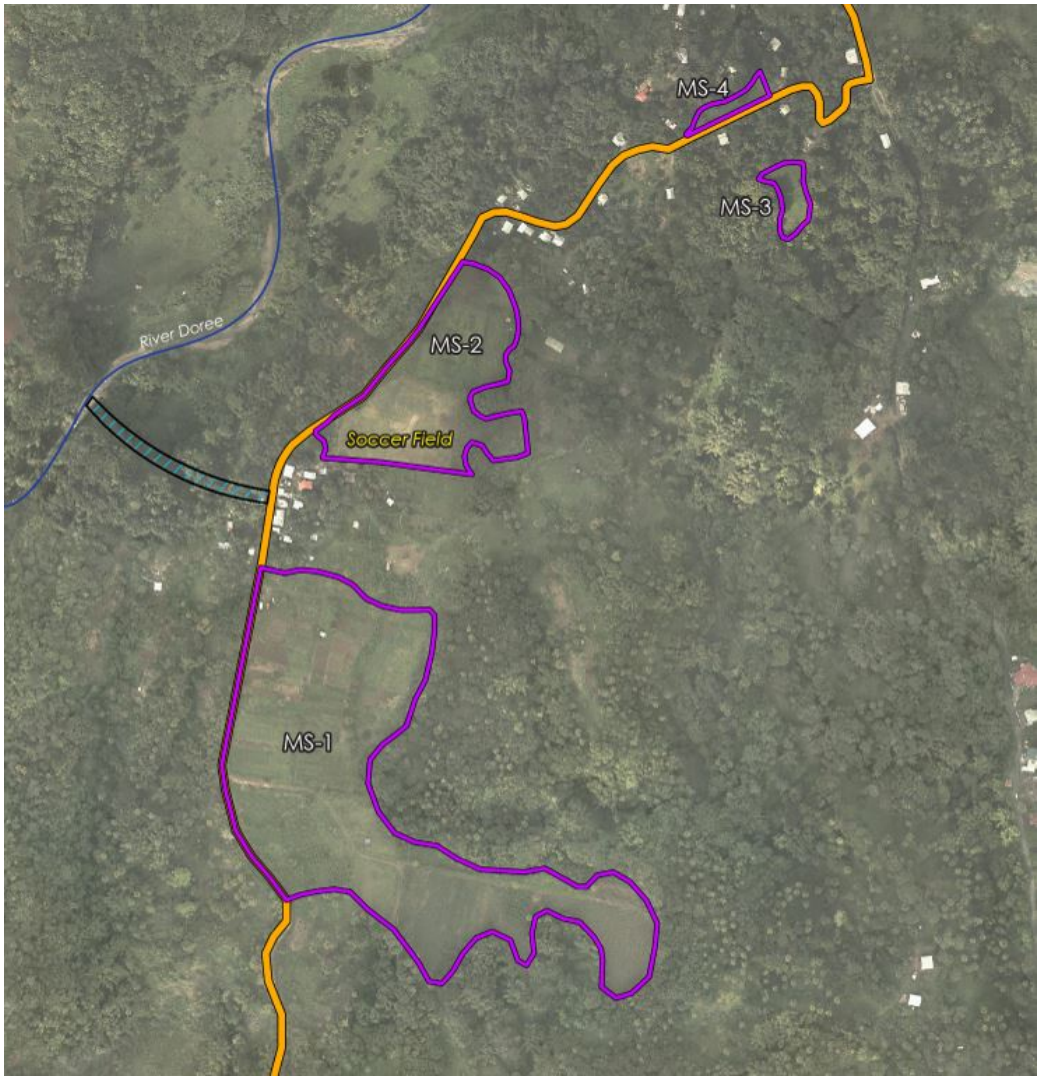
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Potential Drilling Areas



Potential Drilling Areas at Mondesir-Saltibus

- Two large flat and open areas to the south in agricultural fields and a soccer field
- Two smaller relatively flat and open areas to the north near the road and a residential area











Geothermal Exploration Activities in the Mondesir-Saltibus Area

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Mondesir-Saltibus Geothermal Exploration Activities

- Site Development (0 to 90 days)
  - Road, bridge, and culvert improvements, if necessary (i.e., widening and reinforcing)
  - Vegetation removal and grading, where necessary, for access roads and well pads
- Well Drilling (30 to 90 days)
  - Slim-diameter exploratory wells
  - Full-sized wells at MS-1 and MS-2, if justified, based on cost and results of initial drilling
- Well Testing (0 to 90 days)
  - (i) pressure/temperature logging, (ii) flow testing, (iii) injection testing, (iv) falloff or buildup testing

Mondesir-Saltibus Geothermal Exploration Activities

- Well Abandonment and Pad Reclamation (up to 30 days)
  - Wells with no commercial potential plugged with cement and well pad restored
  - Wells with commercial potential secured for future testing and monitored













Scoping Comments Received from the Mondesir-Saltibus Area

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Mondesir-Satlibus Environmental Scoping Comments Summary

Scoping Comment/Topic	How Was Comment Addressed in ESIA?
Removal of topsoil	Construction sites would be restored to pre-existing conditions and topsoil would be replaced
Hazards from abandoned wells	Abandoned wells would be plugged with cement and the well pad site would be restored to the original topography to avoid hazards
Water quality	The water quality monitoring program and other mitigation measures would ensure that the project does not substantially degrade water quality
Water availability	Mitigation would ensure that water supply is not disrupted for domestic or agricultural use

Mondesir-Satlibus Social Scoping Comments Summary

Scoping Comment/Topic	How Was Comment Addressed in the ESIA?
Distance of residences from drill pads	The ESIA depicts the distance of residences from the potential drilling areas. Full-sized wells would not be drilled at MS-3 and MS-4 where residences are in close proximity to drilling areas
Community benefits	The project could potentially create temporary jobs and opportunities for training. Other community benefits could include leaving water supply systems after exploration drilling is complete
Public review	The Draft ESIA is available online and a copy is available here









Environmental Considerations in the Mondesir-Saltibus Area

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Mondesir-Saltibus General Characteristics



- Mondesir and Parc Estate areas include flat areas with good access
- Saltibus is very steep with inadequate access north of drilling areas
- MS-1 and MS-2 are suitable for full-size exploration wells
- MS-3 and MS-4 suitable for slim-diameter wells only

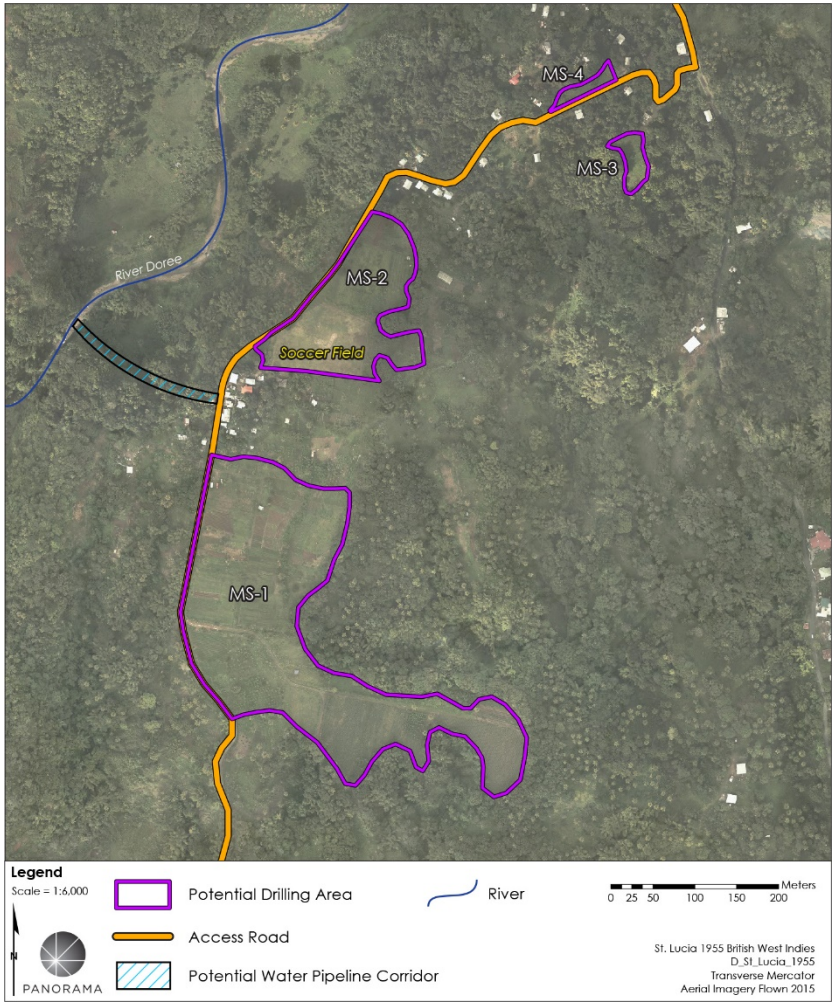
Mondesir-Saltibus Water Resources

Conditions

- River Doree flows year-round Drilling areas not within the floodplain
- No water storage infrastructure in the area

Mitigation

- Erosion control
- Water resource monitoring
- Test drilling cuttings and treat appropriately
- Water supply considerations



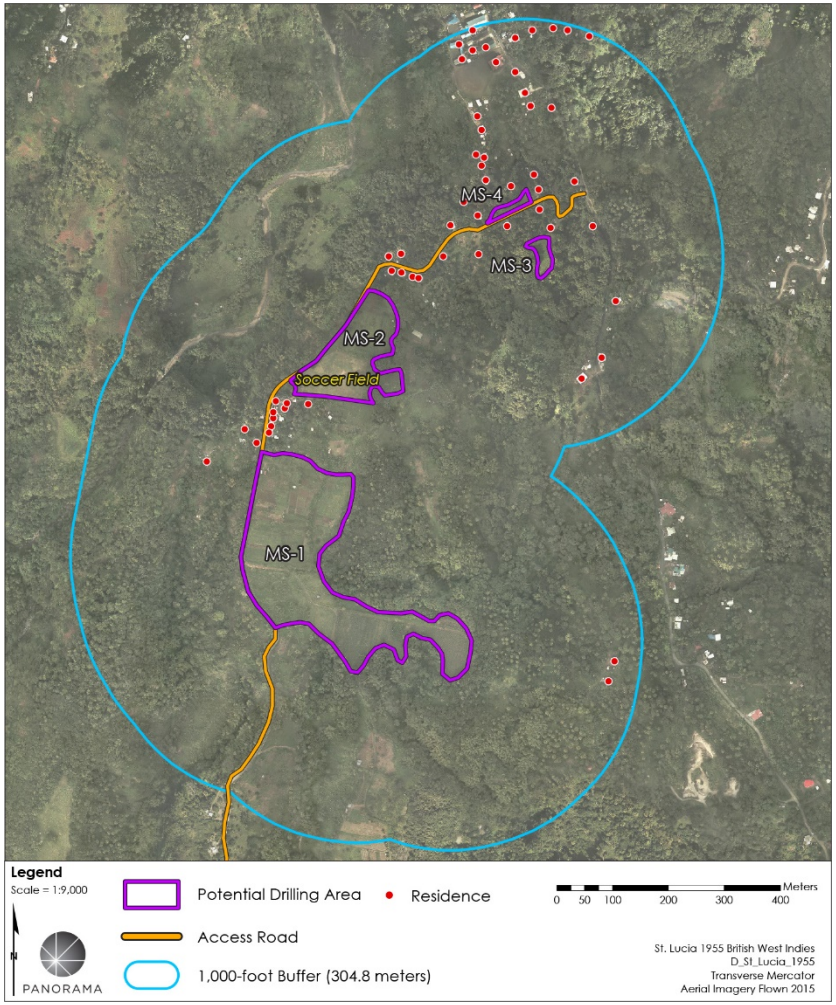
Mondesir-Saltibus Air Quality and Noise

Conditions

- Few sensitive receptors near MS-1 and MS-2
- Homes directly adjacent to MS-3 and MS-4
- Recreational field in MS-2

Mitigation

- Community engagement
- Reduce noise levels, exposure, and disturbance; install noise barriers at MS-3 and MS-4
- Address any community complaints
- Air quality monitoring and incidental evacuation plan



Mondesir-Saltibus Biological and Archaeological Resources

Conditions

- No native habitats in drilling areas; agricultural use
- Priority birds along forested edge
- Historical plantation in MS-1 and MS-2
- Amerindian resources



Mitigation

- Worker training
- Pre-construction surveys for biological and cultural resources in MS-3 and MS-4
- Subsurface investigation in MS-1 and MS-2
- Buffer from forested edge



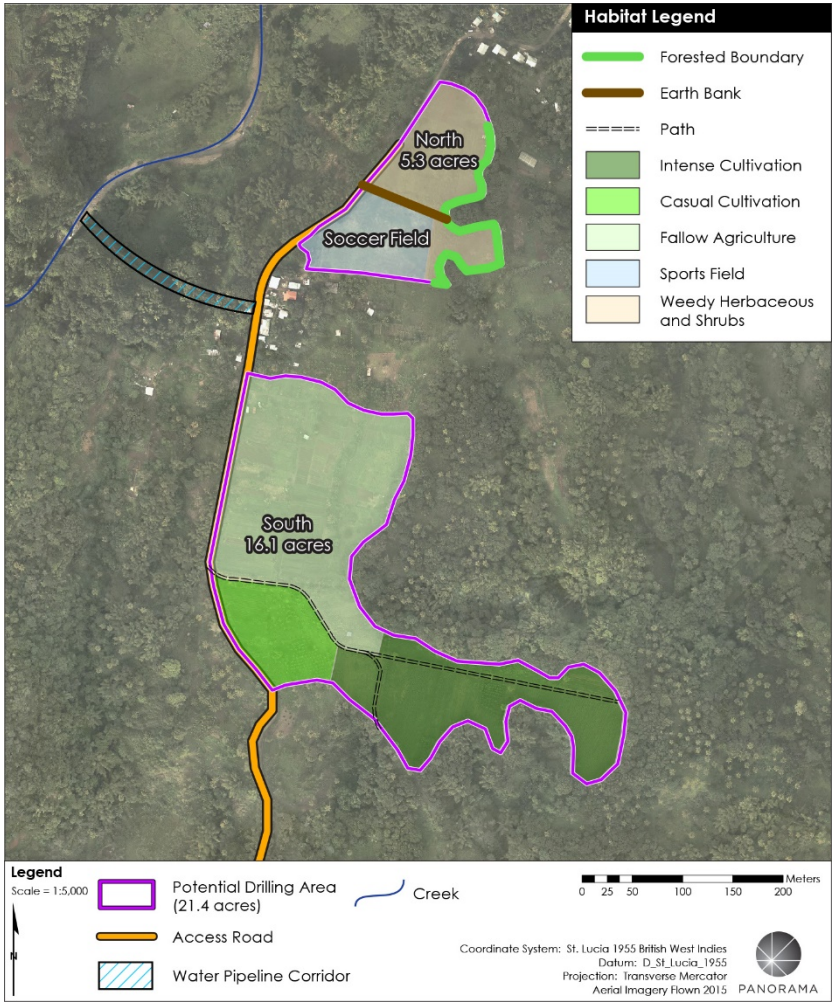
Mondesir-Saltibus Socio-Economic Considerations

Conditions and Impacts

- MS-1 and MS-2 are government land with areas of agricultural use; community recreation area in MS-2
- MS-3 and MS-4 are private parcels
- Loss of livelihood from displaced agricultural production

Mitigation

- Use fallow agricultural areas, if possible
- Avoid drilling in recreation area
- Compensate land owners and growers for loss of agricultural production
- Stockpile soils and restore sites











Questions and Comments

Saint Lucia

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APPENDIX H-3: COMMUNITY CONSULTATION NOTES

BELLE PLAINE

FOND ST. JACQUES

MONDESIR-SALTIBUS

CASTRIES CITY

ESIA – SAINT LUCIA RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT- SAINT LUCIA

Notes of the Belle Plaine Community Consultation on the Presentation of the ESIA

Date: Tuesday, 13 March 2018
Time: 6:05 pm
Location: Belle Vue Farmers' Cooperative, Soufriere
Attendees: Community members

Other Participants

Government of Saint Lucia (GOSL)

- Aloysius Barthelmy – Geothermal Technical Coordinator, Department of Sustainable Development (DSD)
- Charlin Bodley – Acting Energy Officer, DSD
- Danielle Gordon – Acting Science and Technology Officer, DSD
- Merill DuBoulay – Secretary to the Permanent Secretary, DSD

World Bank

- Mark Lambrides – Senior Energy Specialist
- Gibwa A. Kajubi – Senior Social Development Specialist
- Emily Chessin – Clean Energy Policy Specialist
- Rahul Srinivasan – Energy Specialist

Other

- Augustin Dominique – Manager of the Piton Management Area (PMA)

ESIA Consultants

- Susanne Heim – ESIA Consultant, Panorama Environmental, Inc.
- Theresa Alexander-Louis – Sub-consultant/ECMC

Community Members' Profile

Approximately 40-50 (around 20 female; 30 males) community members were present in the room; approximately 35-40 additional community members listened from outside

Welcome Remarks and Introduction

Ms. Gordon led the attendees in prayer. Ms. Bodley delivered the welcome remarks and apologized for the absence of Mr. Barrymore Felicien – Deputy Permanent Secretary, Ministry of Infrastructure, Ports, Energy and Labour. She acknowledged presence of the World Bank's representatives and stated the purpose of the consultation. She indicated that geothermal energy is being pursued to reduce dependence on fossil fuel. The GOSL would like to achieve energy independence so that Saint Lucia would be free from the instability of the oil market. Although the country lacks oil; solar, wind and geothermal resources exist and are being explored. She remarked that at yesterday's Mondesir-Saltibus consultation at the Saltibus Primary School, there was passion and interest. The project has national significance and the GOSL would like stakeholder involvement throughout the project.

Project Background and Update on Drilling Sites

Mr. Barthelmy mentioned that geothermal development has been of interest since 1951. A recent study proved that there was sufficient evidence to support exploratory drilling. In previous years, 12-inch wide wells were drilled, but this exploratory phase would consist of drilling 5-inch diameter slim holes which will provide the requisite information. The consultants have concluded that it is reasonable to commence the exploratory phase and surface exploration has already been done. The ESIA is being done to determine the

impacts and concerns; if any relocation is deemed necessary, the resettlement plan would be utilised and the stakeholders would be involved in this process.

Community member's input: What is being said might not be practised.

Response - Mr. Barthelmy: The GOSL does not know whether the project will be successful. The purpose of the consultation is to complete an impact assessment. The project is being financed by the World Bank. The site locations are not exact and the drilling areas are potential sites.

Remarks by Ms. Kajubi, World Bank

Ms. Bodley introduced Ms. Kajubi who explained that her role was to ensure that the drilling activity and related actions followed Saint Lucia's environmental policies as well as the World Bank's environmental and social policies. The avoidance and minimization of harm to persons are key and persons should be compensated so that they will be better off or the same, as before the commencement of the drilling. The World Bank's policies highlight the identification of the impacts, positive and negative, permanent and reversible, and measures to address those impacts. The World Bank has many policies concerning air pollution, water quality, and gas emitted and whether people will have to be moved; there are procedures that have to be followed. The World Bank insists on consultation with the people who will be affected; some of this has been done in this community already. There will be grievance redress mechanisms and avenues for receiving feedback from stakeholders. The World Bank's representatives are very pleased to be here to listen to the findings and obtain feedback.

Presentation of the ESIA by Ms. Heim, Panorama Inc.

Using PowerPoint, Ms. Heim first outlined the contents of her presentation. She encouraged persons to fill out comment cards and to provide feedback. She stated that there would be monitoring to ensure that impacts are lessened. She explained the manner in which the preferred sites were selected and confirmed that areas within the PMA were not selected and that areas with housing were avoided. She explained that instead, agricultural land was chosen and the selected sites would be easily restored since this was only a testing phase. She described the location of the sites and asked whether the community members were familiar with the location of the sites.

Ms. Heim added that the (exact) site areas would be cleared. The exact locations of the sites were unknown and a separate geothermal contractor would provide the locations later on (prior to drilling). The well pad would be approximately 0.5 to 1 acre and a small drill rig would be used. If there is potential for sufficient, commercially viable, geothermal energy then a larger drill rig will be used. After the drilling phase, the temperature and pressure information would be collected to detect commercial viability. The well would be abandoned and the well pad would be restored. The well head would be left behind but it will be much smaller and would not be noticeable.

Ms. Heim recalled that several comments had been made in the scoping phase. A community member had commented that there was a risk of fire as she (the community member) saw fire shoot out of the well. Ms. Heim opined that this was a blowout in which there was a sudden uncontrolled flow of steam that shot out. The rigs which are to be used have blowout prevention equipment and an expert in geothermal drilling (and avoiding blowouts) will be hired.

Community member's Query: Where did the blowout occur?

Response - Mr. Barthelmy: The blowout occurred at the Sulphur Springs. The area at that time was unstable and cement was poured into the well to quench it.

Response - Ms. Heim: Provisions will be made to avoid blowout incidents.

In relation to sudden quakes, there is no correlation to the exploration drilling as no fracking (injecting of high-pressure fluids to open fractures underground) would be done. She explained that in previous projects, the tremors were a coincidence and with geothermal drilling activities around the world there is no relationship between exploratory geothermal drilling and seismic activity.

Ms. Heim highlighted the characteristics of the Belle Plaine potential drilling area. Belle Plaine is flat, has good road access, few homes, the sites are actively being used for agriculture, and large enough to encompass small or large wells. The project is in the testing phase and the well pad would be small in relation to the Belle Plaine area. In terms of water quality, there is a water extraction plan that would ensure that water from drilling activities will not affect downstream use during the 50-60 days of drilling. There would be cooperation with WASCO. Regarding the threat of hazardous waste, drill cuttings would be examined for heavy metal/hazardous waste and if found to be hazardous, it would be deposited safely. The roads may have to be improved for a proper turning radius; the main road will be mostly used. The drilling site would be away from residences. To mitigate noise, there would be a buffer and silencers would be placed on the drill rigs. The complaints tracking system follows the World Bank standards. In relation to the loss of livelihood (agriculture); compensation and permanent restoration of the sites are measures which would be taken.

Ms. Bodley recognized the arrival of Minister Guy Joseph and Cheryl Mathurian of PCU. This was a courtesy visit following an official site visit to the neighbouring district of Choiseul.

Plenary Discussion

Community member's comment: I am a landowner and the only persons seriously affected are five persons in this room. It is unfair because often, for community development projects, external persons dictate whether a project commences or continues, (at this juncture, other community members voiced their concurrence comments with the community member). The property has sentimental value due to it belonging to my father. I was not properly informed of the selection of Belle Plaine as a potential site and I believe that contacting community members would have been an easy task. Community members should have been consulted. The project is risky and prone to failure and the estate is among the most fertile on the island with pH of 5.5 and 5.7.

Why weren't the landowners of the selected area invited to a consultation or meeting prior to the selection of Belle Plaine? Future generations will have the responsibility of repaying the resultant loan. I would like an agronomist to be involved in the project. Is an agriculturist part of the team? Will the project continue if the majority of the community members oppose the project? I do not think it is probable that the GOSL will support a project which will have a detrimental impact on farmers' livelihoods.

Response - Ms. C. Bodley: I understand your concern and I assure you that this is the fifth round of consultations (the community members disagreed). The phase is only an exploratory phase. The well's final footprint will be 4 feet by 4 feet; not much land will be utilised.

Ms. C. Mathurin's comment: The pre-feasibility study was the first phase and an ESIA is the second step. It is up to the GOSL to decide; the GOSL has not financed the exploratory phase. The goal is to explore the possibility of utilizing the geothermal resource. The GOSL has to determine whether it would be willing to be bound by a loan, the cost of compensation and Soufriere landscape changes.

Community member's comment: Restoration is impossible. Farmers understand what I mean; the engineers are not able to comprehend what the detrimental impacts would be in relation to soil quality. The soil after the exploration phase will be dry, heavy, damaged clay soil. As a result of a similar project, the La Dauphin Estate's soil is still damaged 40 years later and I am of the belief that the soil will never be restored. I would like an agronomist to confirm restoration.

Response - Ms. Heim: The topsoil will be stockpiled. The same soil will be reapplied onto the same property.

Community member's query: Will the soil be shaded?

Response - Ms. Heim: The soil will be placed in a contained area and it will be covered.

Community member's comment: The soil will be damaged due to it being covered and no water passing through.

Response - Ms. Heim: This soil will be preserved. The phase is only a 60-day phase.

Community member's comment: The area is a high rainfall zone and I doubt that the soil could be restored.

Hon. Joseph's Query: Are the sites suitable and after exploratory drilling what will be the next step?

Response - Mr. Barthelmy: The selected areas are large and were selected between 2014 and 2016. The company Jacobs identified the areas. Only in 2017 were the site areas specified. The selected sites will reduce in size in that they will become more specific. In the near future, a consultant will inform the community members of the exact location of the drilling sites. Belle Plaine is a large area and the exact drilling activity locations are not known.

Community member's comment: Landowners should have been informed before the selection of Belle Plaine and the GOSL know what the next step will be.

Community members' comment: I am opposed to the project utilising Belle Plaine as a drilling site; the community members' health will be adversely affected.

Response - Ms. Heim: The wells will be exploration wells and that the successive steps will require more consultation with the community. Scoping was done as soon as the potential drilling areas were identified. The comments from consultation were included in the ESIA and a consultation was done in this very same building, the Belle Vue Farmers' Co-operative building in September.

Community members' query: Who was the consultation was done with? I am interested in finding out whether the owners of the relevant lots were consulted prior to the preliminary investigation.

Response - Ms. Bodley: During the ESIA stage, landowners would be contacted prior to the actual exploration drilling.

Community member's comment: The entire community should not be consulted; the relevant landowners should be the ones consulted. The consultation should be done only with the parcel owners.

Community member's comments: The project is past the preliminary stage. Preliminary stage means that no plans have been made. *Other community members expressed their agreement.*

Community member's comments: The landowners should have a separate consultation meeting and I do not think that the process should be continued. Who attended the consultation?

Response - Ms. Alexander-Louis: Community consultations were conducted in September 2017. Consultation meetings were held in each of the affected communities. Stakeholders were then consulted through door to door visits and the names of the persons visited along with the consultation dates were recorded. Additionally, the associated advertisements dates were noted. Consultations were done with some of the community members present at this meeting and I can identify those individuals. Telephone calls were made and I can give the names of some community members who were contacted.

Various community members expressed almost unanimously their disagreement with the continuation of the project. Those comments were included in the consultation record.

Hon. Joseph's comments: Community members should explain their concerns without making assumptions and should express themselves in a proper manner. I believe that most persons present are against the project. I am here for the same reason you the community members are here. I believe that more work should have been done in order to determine whether drilling should commence. My opinion is similar to that of the community members. I do not believe that the project will be successful. (A number of community members voiced their concurrence with the Minister).

Hon. Joseph's comments: I am dissatisfied with how the Soufriere community members expressed themselves in prior consultations in that they did not clarify whether they disagreed or agreed with the commencement of the project. I am concerned about the World Heritage site's location. The previous leaders of the GOSL requested the presence of the consultants. The GOSL will give the final decision and I question why Belle Plaine was selected.

Hon. Joseph's comments: There are other areas better than Belle Plaine and of less agricultural importance which could have been selected. The GOSL is under new leadership and therefore a different decision may be made. The World Heritage Site's location is not suitable because there was a lack of adequate community member compensation. There are other areas with less valuable agricultural land and I would like to know whether there could be a replacement site area.

Response, - Ms. Charlin Bodley: There are other potential sites.

Response – Hon. Guy Joseph: No decision had been made and the consultants need to present to the GOSL in order to obtain permission to commence drilling. I do not expect to see the construction of geothermal power plants in the near future in Saint Lucia. I believe that in other countries within the region geothermal energy development projects have not been fully realised. The consultants are trying to educate you, the community members on the possible impacts. I remain unconvinced of the suitability of Belle Plaine as a potential site. (Several community members voiced their agreement*).*

Hon. Joseph's comments: A final decision has not been made. The consultations being done form part of the ESIA which has to be submitted to the GOSL. Double standards exist due to land acquisition in the area being difficult for locals yet a geothermal development project is being proposed. I am aware of the GOSL's position on the project. I encourage you the community members, to express your opposition to the project civilly. The World Bank will not finance a project which is against stakeholders' desires. Community opposition to the project will guarantee that the project will not continue due to adherence to World Bank policies.

Community member's comment: Thank you, Minister Guy Joseph. I was surprised when I was informed of the selection of Belle Plaine. I informed Mr. Clauzel (of the Ministry of Sustainable Development, Energy, Science and Technology) of my opinion in either 2015 or 2016. I informed Ms. Alexander-Louis of my opinion.

Response – Hon. Joseph: Was this highlighted in the past reports?

Community member's input: The true objective of the project is to construct a geothermal power plant and community members are against the construction of a geothermal power plant.

Response – Hon. Joseph: The project is still in the exploratory phase.

Community member's comment: The ecosystem will not be restored. The community members are opposed to the construction of a geothermal power plant. The community members are fearful of the effects of the tremors and blowouts. The area is very valuable biologically. Drilling is too risky.

Response – Hon. Joseph: The GOSL will make a final decision. Consultations were done in other areas. I have similar concerns in relation to what the impacts of drilling will be. Geothermal drilling activity is not a

new concept however. [Note, it is unlikely that geothermal drilling will cause tremors. Blowout prevention equipment will be required and the project will select drillers experienced with geothermal drilling to reduce the potential for a blowout. Blowouts are rare with blowout prevention equipment and experienced drillers.]

Community member's input: The more pertinent issue is food security. I was informed that Latin America and the Caribbean have some of the highest rates of obesity. Individuals should be consuming more local food and less processed food. Processed food is linked to obesity.

Response – Hon. Joseph: I agree that food security is an important issue. Are there any questions?

Community member's query: Will the project continue despite opposition to it?

Response - DSD representative: The project cannot continue if there is opposition to it due to the World Bank's policies.

Response – Hon. Joseph: I cannot answer due to possible misinterpretation of my answer. The GOSL will make the final decision but due to the level of opposition, the World Bank will not be able to proceed to delve into exploratory drilling in this area. Production drilling will not be immediately done. It requires more consultation. I encourage you the community members to become more open-minded. I agree with the statement that the immediate landowners should be the focus of the consultation. The project will have an impact on the community so that all community members should be consulted however landowners should be the main group targeted; the World Bank prefers stakeholders to be thoroughly informed.

Community member's query: Is there a possibility of gases escaping during the drilling?

Response - Ms. Heim: No gases will escape during drilling. Gases will only be emitted during the testing phase. However, there will be a gas monitoring system.

Community member's query: The concentration of gases at the Sulphur Springs is high. What preventative measures will be utilized to prevent the inhalation of perilous gases? Will the gases be contained when they exceed a certain threshold? Is there an associated evacuation plan and will there be a 24-hour gas monitoring system?

Response - Ms. Heim: The gas of concern in geothermal resources is hydrogen sulphide. The well will be tested to determine the concentrations. The hydrogen sulphide disperses rapidly and is not usually found to be hazardous in areas surrounding well pads. Safeguards will be in place to protect human health. Preventative measures will be utilised and there will be a 24-hour monitoring system. The monitoring system will be an early detection monitoring system. There will be an evacuation plan, but the hydrogen sulphide would disperse rapidly.

Community member's query: Will the air quality monitoring system be operational 24 hours a day?

Response - Ms. Heim: Yes it will be.

Community member's query: Can community members access the gas monitoring data results?

Response - Ms. Heim: There will be a local committee and the data could be made available to the community members.

Community member's query: Can the project continue if there is great opposition, as in if all the landowners and all the community members opposed it?

Response – Hon. Joseph: I cannot give a definitive answer. The process is ongoing and the next consultations may be with the landowners. There are multiple factors. For instance, landowners could

agree to have their land utilised by donating their land or selling their land. The final decisions are not imminent at this point.

Community member's query: Is bribery a possibility?

Response – Hon. Joseph: This will not occur.

Community member's query: Is there a possibility that the GOSL may become involved in the act of bribery?

Response, Minister Guy Joseph: This will not occur. The GOSL always requires a valuation performed before any payment is offered to an individual in order to purchase the property.

Community member's input: I am against the project and no mention was made of the majority of the community members' opposition to the project.

Some community members expressed their agreement.

Community member's input: There is a risk of hazardous gases escaping. [Note: Hydrogen sulphide is the gas of concern; it is unlikely to be in concentrations that present a health risk to the public. Worker will be protected with monitoring devices and protective equipment if necessary.]

Community member's query: I read the report; the project is being presented in a manner such that it indicates that the project will continue. I encourage other community members to refrain from supporting the project.

Hon. Joseph's comment: I inherited an ongoing process and this process cannot be stopped due to the guidelines it follows which are the World Bank's guidelines. Cessation of the project will create possible implications. These implications would affect the Island Wide Drainage project, the Soufriere Hospital project and the Choiseul Secondary School project. The World Bank was invited to start the project by the GOSL. You, the community members should not be disgruntled with the World Bank's interest in the project.

Community member's query: Honourable Guy Joseph do you have the capacity to end the project?

Response – Hon. Joseph: I am not opposed to the idea of acquiring geothermal energy. I am opposed to the idea of drilling within the Belle Plaine area.

Community member's comment: Honourable Guy Joseph, can you stop the process? Farmers will be affected by the project.

Response – Hon. Joseph: I do not have the authority to do so due to my position as part of the GOSL and my decision will follow what the GOSL decides.

Community member's comment: Minister Guy Joseph you are explaining your inability to do so in a hypothetical manner.

Response – Ms. Cheryl Mathurin: Minister Guy Joseph is attempting to explain that the GOSL had the final decision. Belle Plaine is a potential area and a consultation is being conducted to ascertain if support exists for the project.

Community member's query: Can the process be stopped due to great opposition to its continuation?

Response – Hon. Joseph: I, as a minister, cannot terminate the project.

Community member's input: Ministers have to cater to the people.

Response – Hon. Joseph: My duty is to cater to what the people of Saint Lucia decide.

Community member's input: The people control the GOSL due to the people being the ones who appoint the ministers and so the ministers have to support the people. (Other community members expressed their agreement).

Response – Hon. Joseph: I do not have the authority to control whether the project continues.

Community member's query: Why can't you voice your opinion in order to stop the project?

Response – Hon. Joseph: I am not the only stakeholder with the ability to disagree with the continuation of the project.

Community member's comment: I have a petition and I require signatures.

Ms. Alexander-Louis's comment: Another community member has a question. I encourage the community members present to listen to the community member's question.

Community member's query: Will there be a possible reduction in consumers' electricity bills after the construction of the geothermal power plant? After the construction of the Roseau Dam, there was no evident decrease in the water bill charges and so comparably consumers' electricity bill charges will not be resultantly decreased.

Response – Hon. Joseph: The project is not aimed at facilitating a reduction in consumers' electricity bills. (*Note: this is inaccurate.*)

Community member's query: What amount of energy will be generated?

Response – Hon. Joseph: The project hopes to accomplish a reduction in the use of fossil fuels as fossil fuel use has adverse effects on the environment. Eventually, consumers' electricity bills will reflect lower charges if geothermal energy is utilised. Reducing the carbon footprint is the primary focus of the project. (*Note: energy independence and reduced electricity prices for consumers are goals of the project.)*

Community member's query: Why is geothermal energy being explored instead of solar energy? The GOSL has not attempted to create a wind farm.

Response – Hon. Joseph: A wind farm would lead to an increase electricity use fees. (Some community members expressed shock at the possibility of wind farms leading to an increase in electricity costs and this statement is not accurate).

Response – Hon. Joseph: A hurricane would greatly damage a wind farm as damage of one turbine would have detrimental effects on the functionality of entire the wind farm. The development of a solar farm was my first choice. The project is an inherited project. A solar farm would require more land acquisition than geothermal energy development.

Community member's input: A solar farm would be a safer alternative.

Response – Hon. Joseph: One of the issues is food security and a solar farm generating 5MW would require a vast amount of land.

Community member's query: A solar farm can be developed. What prevents the development of a solar farm in Saint Lucia?

Community member's query: Why was the Sulphur Springs drilling project discontinued?

Response - Mr. Barthelmy: The Sulphur Springs did produce gas but in order to produce electricity a geothermal developer would have to co-operate with LUCELEC. The negotiations abruptly ended between LUCELEC and the geothermal developer for the project.

Community member's query: Can you explain what happened?

Response - Mr. Barthelmy: The CDC which was a British company owned the majority of the shares in contrast to the geothermal developing company. There were differences between the two.

Community member's comment: Is this why the project was terminated?

Ms. Mathurin's comment: The questions are beginning to veer away from the topic. The purpose of the consultation is to complete the environmental and social impact assessment. The Draft ESIA report is available online and it was assembled by the company, Panorama. I implore community members to provide feedback to the GOSL after viewing the document. The commencement of drilling has not been finalized.

Mr. Barthelmy's comment: The report is a draft but after the consideration of the comments, the report will be final. The hard copy of the report is available in Soufriere at the library, the Roman Catholic Church in Soufriere (Church of Assumption), and at the Ministry of Sustainable Development, Energy, Science and Technology, and other locations. Mr. Barthelmy provided the telephone number of the Ministry of Sustainable Development, Energy, Science and Technology.

Remarks by Mr. Lambrides of the World Bank

Mr. Lambrides stated that the prior and current government administrations gave permission to commence the project. He stated that the project could not continue without permission. He explained that the World Bank consultants were invited to come to support the project. The World Bank is committed to mitigating and considering the concerns. The project is being funded by external sources such as the World Bank. As the project continues there will be the establishment of a zero interest loan which Saint Lucia would be required to pay.

The project would create an approximately 25 percent reduction in electricity bills and the usage of geothermal energy will lead to significant savings. He explained that Saint Lucia purchases oil and diesel from other countries at high prices. The project could lead to a reduction in electricity bills. The project cannot continue without the community's support and that the consultations produced varied responses. He informed the community members of future consultations in different communities. The sites were selected due to the geology of the region; no site within the PMA has been chosen.

He stated that if community members were against the project in the area then Belle Plaine would not be selected. He thanked the community members for providing their feedback and reassured the community members that the World Bank would consider their concerns. He urged the community members to read the reports done on the project. The goal of the consultation was not to convince individuals but to inform them. He reiterated that the project was not finalized and the consultation was aimed at revealing the risks and mitigation strategies.

Closing Remarks

Mr. Barthelmy summarized what was learned from the consultation and suggested that alternative sites could be selected. He encouraged the community members to visit GOSL's website to review the ESIA document and he invited the community members to partake in the refreshments provided.

ESIA – SAINT LUCIA RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT- SAINT LUCIA

Notes of Fond St. Jacques Community Consultation on the Presentation of the ESIA

Date: Wednesday, 14 March 2018
Time: 6:05 pm
Location: Whispers Bar, Soufriere
Attendees: Community members
Other Participants

Government of Saint Lucia (GOSL)
- Aloysius Barthelmy – Geothermal Technical Coordinator, Department of Sustainable Development (DSD)
- Deborah Hippolyte – Safeguards Specialist
- Charlin Bodley – Acting Energy Officer, DSD
- Danielle Gordon – Acting Science and Technology Officer, DSD
- Leslie Serieux – DSD representative
- Merill DuBoulay – Secretary to the Permanent Secretary, DSD
- Ivor Daniel – Permanent Secretary, Ministry of Infrastructure, Ports, Energy and Labour
- Barrymore Felicien – Deputy Permanent Secretary, DSD

World Bank
- Mark Lambrides – Senior Energy Specialist
- Mike Darr – Environmental and Social Safeguards Specialist

ESIA Consultants
- Susanne Heim – Panorama Environmental, Inc.
- Theresa Alexander-Louis – Sub-consultant (ECMC)

Community Members Profile
Approximately 46 (19 females, 27 males) community members were present.

Please note that the majority of invitees from the Fond St. Jacques community elected not to attend the community consultation in Soufriere, despire trasnportation arranagements, citing that a community consultation was held in Fond St. Jacques in August 2017. Approximately 5 of the attendees indicated they were from the Fond St. Jacques community. The invitees were surprised that Fond St. Jacques, a potential drilling site, was not included as a venue.

Welcome and Background Information
Ms. Charlin Bodley welcomed the attendees and acknowledged the presence of the Ministry heads and staff (Department of Infrastructure, Ports, Energy and Labour and the Department of Sustainable Development) and the World Bank representatives and ESIA consultants. Mr. Daniel stated that the utilisation of green energy was a GOSL objective. The DSD has the responsibility of handling the geothermal energy project and the team is working laboriously on the project. The community members as stakeholders and beneficiaries are very important to the project and it is a pleasure to consult with the community. He explained that as a country, we use fossil fuel, oil, and diesel, to generate our electricity but the price of oil on the market is volatile. He expressed (in Kweyol) that as a country Saint Lucia has to ensure that we can generate a form of economically viable, clean, green energy that is reliable so that when oil prices increase, Saint Lucia is not affected too much. Saint Lucia has an opportunity, it has a geothermal resource and the economic viability of commercial geothermal energy generation needs to be determined. Exploration is necessary to determine the generation

potential of the resource and to reduce risk to improve the price negotiation with a future developer. The purpose of the consultation is to discuss the ESIA and community members should provide their comments respectfully.

Ms. Bodley informed that the consultation was being done in order to complete the ESIA and to acquire feedback from the communities. The project is still in the exploration phase and the construction of a geothermal power plant is not imminent. Ms. Bodley invited Mr. Lambrides to make a few remarks.

Remarks by Mr. Lambrides, World Bank

Mr. Lambrides stated that the World Bank was here to facilitate the exploration stage of the project. He outlined the various stages involved in the project. The objective of the geothermal project is to reduce dependence on fossil fuel due to the instability of oil prices on the market. He noted that several studies were done, methods utilizing geophysics were used amongst other to obtain data and that holes would be drilled to assess the resource. The Piton Management Area (PMA) would remain untouched. The project is risky due to the possibility of the resource being found to be unproductive. Therefore, the early phase of the project is being funded through grants from several sources including DFID. The goal is to substitute fossil fuel usage with geothermal energy usage.

Ms. Bodley briefly interpreted in Kweyol Mr. Lambrides' remarks about the funding aspects.

Remarks by Mr. Darr, World Bank

Mr. Darr highlighted his role as Environmental and Social Safeguards Specialist in the project. The World Bank's policy has specific policies to protect the people and the environment. One of these policies is that an environmental assessment is required. The assessment should include consultation with the persons potentially affected; this is an important step. The World Bank will not engage in any practice which would adversely affect individuals. The Bank will ensure that environmental resources including habitats, the PMA, archeological resources, will not be adversely affected. Most importantly, the project will be implemented consistent with World Bank policies, which ensure that land is not taken from community members; people's livelihoods would not be affected.

Presentation by Ms. Bodley

Ms. Bodley provided telephone contact numbers for the DSD and the hyperlink for the ESIA document. She highlighted that the energy sector in Saint Lucia is almost 100% dependent on fossil fuel. In adherence to the Paris Agreement, the GOSL's objective is to achieve more energy independence. Saint Lucia aims to have 50% of its energy supplied by renewable sources by 2030. Solar, wind and geothermal energy are all being explored. A solar farm is being developed in Vieux Fort and. Surface exploration studies confirmed the presence of a reservoir of geothermal energy in Saint Lucia. The OECS countries have made geothermal energy a priority, with Saint Lucia being one of the ten countries interested in the exploration. She highlighted the benefits of developing geothermal energy and reiterated that the project is in the exploratory stage.

Ms. Bodley revealed that almost 60% of Saint Lucia's electricity demand could be covered through the use of geothermal energy and that a lower electricity bill could be expected. Public funds would de-risk the project. Using PowerPoint software, she displayed a graph and explained that high financial risk during the early phases of the project would be absorbed by external financiers. She recounted success stories in Guadeloupe and in Costa Rica which now have existing geothermal power plants. Guadeloupe's geothermal exploration began in 1963 followed by the construction of a power plant which produced 2 MW of power in 2003. She indicated that multiple forms of energy were being considered by the GOSL and that geothermal power plants posed no risk to the community members.

History of Prior Drilling in Saint Lucia

Mr. Barthelmy recounted that in 1951 a study of the Sulphur Springs' steam was done to determine its capability for power generation and possible industrial application for drying to tobacco amongst other uses. In 1975-1976, UK consultants undertook the drilling of seven wells, three of which were discovered to be dry. Well No. 5 had a blowout which led to its abandonment. The blowout occurred due to a high level of gas and lack of proper equipment. In 1984, under USAID funds the Los Alamos National Laboratory, conducted geotechnical studies and reviewed the cost of electricity. In 1987-1988 deep drilling was done for the first time in Saint Lucia., Two production wells had been drilled (in Belfond) and one at the Sulphur Springs. In 2015-2016 comprehensive studies were undertaken, photographs of the terrain were taken and a LIDAR survey was done. A pre-feasibility study has been done and a power purchase agreement will need to be done.

Presentation of the ESIA by Ms. Susanne Heim, Panorama Environmental, Inc.
Ms. Heim thanked all community members for attending and outlined the summary of her presentation. She discussed the reasons why Fond St. Jacques was selected. Ms. Alexander-Louis interpreted into Kweyol what Ms. Heim said. Ms. Alexander-Louis stated that previous consultations and interviews had been done during the scoping in the three communities, Belle Plaine, Mondesir – Saltibus (Park Estate and Guyabois) and Fond St. Jacques.

Using a PowerPoint presentation Ms. Heim displayed the potential drilling areas and indicated that the PMA had been avoided. She explained how the drilling areas had been selected. There are two areas in Fond St. Jacques, one of which is an agricultural area. Slim-hole wells will be drilled. The site development phase would last up to 90 days. The community's concerns to be addressed are mainly the spring water, aesthetics, noise, land use. Groundwater close to the spring will be monitored, silencers would be used to minimize noise and that the land would be restored. Compensation will be given where necessary and there is a resettlement plan for loss of livelihood, should it occur. Few jobs will be available during the exploration phase but this may increase during further exploration and the construction of a power plant.

Ms. Heim provided the hyperlink for the draft ESIA document and informed community members where hard copies could be viewed; her hard copy was also available at the consultation. She explained that a geotechnical investigation would be done. Homes and structures will be avoided by the exploratory drilling activity. Water quality monitoring will be done and an emergency plan will be in place for landslide and flood occurrences Community pipes from the spring will be avoided; the drill rigs will have protective equipment to prevent a blowout and there is an air quality monitoring plan along with a resettlement action plan, which addresses compensation of individuals who experience a loss of livelihood.

Plenary Discussion
Community member's query: How many helicopters are there to reach the area in case of landslides? Why isn't solar or wind being explored instead?

Response - Ms. Heim: The project will not cause natural disasters; the reason why a geotechnical investigation is required is if there is any new construction along the roads, the stability of the area must be ensured. If there were a landslide in the area, worker safety must be ensured. The comment on the potential for landslides was related to the project's response to landslides in the area and not that the project would cause a landslide. The potential drilling area is in a flat area at the base of a slope where there is a potential for a landslide to occur.

Response - Ms. Bodley: The GOSL is pursuing solar, wind and geothermal energy. It is not technically viable to pursue only solar energy; it is intermittent and variable as it depends on sunlight hours which is not the case for geothermal energy. Likewise, wind depends on weather conditions. The GOSL intends to use an optimal mix of all three, solar, wind and geothermal sources to provide our energy needs.

Community member's query: There has been more than two geothermal explorations, how will this one

be more successful? Secondly, has any thought been given to the location of residents in case the project is economically viable?

Response - Mr. Felicien: Yes, we have been on the geothermal energy path for a long while. There are several reasons why this time will be different. Technology for geothermal exploration now is more advanced; LIDAR technology has been used to explore the surface. The size of the drill rig and drilling area are small. We are now better prepared. There are legislations and regulations in place to ensure that the geothermal project is developed in a consistent and safe manner. There are also social safeguards in place. Time has been spent from 2014 on developing the project in the right way to ensure that nobody is adversely affected.

In terms of relocation, at this stage of the project, there will be no relocation. All the precaution has been taken to ensure that nobody is disturbed, and crops or land are not taken.

Response - Ms. Heim: A determination of where a plant could be located cannot be made because the results of the testing are not known. The areas have been examined and it has been found that there is a large area in Belle Plaine where there are no residences. For Mondesir-Saltibus, there is a large area with no residences but it is too early to say whether there will be a future development and where that would be located. The testing must be finished first.

Community member's query: Will the drilling cause any vibrations, seismic impact?

Response - Ms. Heim: The short answer is no; this is a geothermal exploration and there is no connection between the drilling and seismic activity. No fracking is proposed. [Note: Any vibration caused by drilling would dissipate within 15 to 30 meters.

Community member's query: What is the probability of acidic fluid being emitted from the wells and affecting the water and coral reefs?

Response - Ms. Heim: Geothermal fluid will not be discharged to the surface or into the water. During the testing phase some gases will be released and there will be air quality monitoring in place.

Community member's comment: The seismic activity query should not be dismissed. In the 1970s and 1980's, persons reported cracks in their houses due to the Sulphur Springs vibrations from the drilling. What is GOSL's plan if the drilling results in cracks in residents' houses? In part of Soufriere, the vibrations from the drilling could be seen. Secondly, I would like to see the aerial map of Belle Plaine as some people from Soufriere have property in Belle Plaine. More information should have been provided on Belle Plaine and the focus shouldn't solely be on Fond St. Jacques.

Response - Ms. Bodley: This consultation tonight was specifically intended for community members of Fond St. Jacque, Mini, Ravine Claire and the environs. A similar consultation was conducted for Belle Plaine last evening, and the presentation for each consultation has been tailored to each community. It is not the intension to exclude any community.

Response - Ms. Heim: I have the information on Belle Plaine here and I am very willing to provide more detailed information to individuals afterwards. Regarding seismic activity and the previous drillings, studies carried out found that there was no causation, the two may have happened at the same time but no cause was found between the previous drilling and the seismic activity.

Community member's comments: I am sceptical about this geothermal drilling due to the previous, similar project. During that project, the scientific community assured the residents that the environmental impact assessment had been done and there would have been no consequences. However, the water from the Rabot Lake disappeared and the entire environment of the area has changed. The scientists could not plug the wells with cement without the assistance of a local, so do not

discount the history that we are fearful about. Also, it is very difficult to accept that for a country of only 185,000 people, sufficient solar and wind energy cannot be produced and that geothermal energy is needed to sustain our needs. There is no reason why GOSL should be interfering we do not know what the consequences; there is no certainty.

Mr. Felicien's comment: We are not here to discount history; we have had several consultations about the disappearance of the lake. We have found there to be no link with the drillings. We are here to give the community the facts on the project in terms of the impacts and benefits as well as to gather the community concerns. The various benefits of geothermal versus solar energy were outlined in Ms. Bodley's presentation; this can re-done at the end of this consultations.

Community member's comments: I am very concerned about the project and its effluents, but I am positive and believe that the project is the best way to reduce our electricity bills. However, from what I have heard, not much energy will be generated. So we the community members will be monitoring the project very closely.

Response - Ms. Bodley: The ESIA is for the exploratory drilling phase of the geothermal energy project, we are not at the power plant stage. It is for testing. Data is being acquired. The GOSL's decision is to proceed with an optimal mix of technologies – solar, wind and geothermal energy. A 3 megawatt solar farm that belongs to LUCELEC is being developed in Vieux Fort. A vast amount of land (32 acres) and the cost is high. With regard to rooftops solar systems, the GOSL with assistance from the World Bank is installing solar panels on the Owen King Hospital.

Community member's input: There is solar energy storage technology which supports up to 1 million users. Instead of solar farms on thousands of acres, the GOSL should place its money towards consumers' concessions for installing solar energy devices on their roof tops. GOSL should focus on zero rating consumers' bills and LUCELEC can sell power to other industries.

Response - Ms. Bodley: Through Cabinet Conclusion No. 464 of 1999, Saint Lucians are able to import renewable energy technologies and components duty-free.

Community member's comment: If consumers put solar panels on their roofs, permission must be obtained from LUCELEC and consumers must pay them; LUCELEC does not buy power from consumers.

Response - Mr. Felicien: Currently, there are concessions on renewable energy technologies. There is the National Utilities Regulatory Commission (NURC) whose role is to regulate electricity supply services. The issue now is the exchange – what is consumed and what is given back to LUCELEC. The excess is not paid for; there are different structures such as "net metering, net billing arrangements" etc. The possible exchange and pricing are on the table. Subsidies for renewable energy products exist and remember that the drilling will be exploratory drilling.

Response - Ms. Bodley: Remember that the project is only at the testing phase in order to confirm the commercial viability of the resource. She assured the residents that the purpose of the consultation was not to persuade community members; individuals could call the DSD for more in-depth information and or utilize the comment cards made available at the consultation to provide feedback.

Community member's query: My major concern as a member of the Youth and Sports Council is the playing field towards the West – which is the only recreational area for the community, will be utilized by the project for almost a year. What will happen to the community's youth?

Response - Ms. Heim: From the ESIA, it was found that this area is a playing field; so the plan was to use it as a staging area (for the storage of materials). This is a small area and the drilling will be for about 60 days so the field should not be out of commission.

Community member's query: Will use as a staging area affect the youth playing football and cricket?

Response - Ms. Alexander-Louis: Part of the mitigation is to cordon off the staging area so that the youth can continue to use the field. If the community members do not support the use of their recreational area then another staging area will have to be obtained.

Community member's input: Fond St. Jacques is susceptible to disasters and the project can affect the entire community. Community members'opinions and concerns should be considered. The consultation is vital and all stakeholders of Fond St. Jacques should be informed of the project. This consultation should have been held in Fond St. Jacques.

Response - Ms. Heim: From our investigations, Fond St. Jacques is susceptible to landslides; this is why minimal work will be done in this area. The project would not cause a landslide or flooding.

Response - Ms. Bodley: When we started the ESIA, Fond St. Jacque stakeholders were consulted. The GOSL provided buses to transport for community members of Fond St. Jacque (to and from) today's consultation. Further consultations will be done and permission will be obtained from the community before the exploratory drilling can advance.

Community member's query: Only two consultations were planned for Soufriere, yet a consultation is planned for Castries?

Response - Ms. Bodley: This is a national project, it will affect the entire nation. This is the first consultation for Castries. To date, five rounds of consultations have been done for Soufriere, the project area.

Community member's input: Geothermal exploration commenced years ago. There is a possible link between drilling and the power plant. Those pipes may run through individuals' properties. If households receive part of the funding to become involved in capturing solar energy then a significant amount of energy will be produced. Why can't LUCELEC be replaced?

Response - Mr. Felicien: Production drilling will be a future step. The finance received is for geothermal exploration. Saint Lucia's geothermal resource is on the verge of having its commercial suitability determined. Less dependence on fossil fuel energy is needed to foster stability and reductions in consumer electricity bills. Geothermal energy can supply a significant amount of energy.

Response - Mr. Darr: This exploratory phase is important to discover the geothermal resource's suitability.

Response - Ms. Bodley: LUCELEC is a vital component of Saint Lucia's electricity distribution.

Community member's query: When will the drilling commence?

Response - Ms. Bodley: The exploration drilling will begin in the first quarter of 2019.

Community member's query: What would be done if there is photographic evidence to show that cracks occurred as a result of the drilling? If a connection can be proved between the drilling and the cracks what would happen.

Response - Mr. Darr: A survey of the houses could be done, but I doubt the drilling is linked to the occurrence of cracks. (*Note: additional information on vibration was added to the Final ESIA to address this comment.*)

Response - Mr. Felicien: In the case of proof of damage, compensation has been considered and an amount will be allocated for this. (*Note: a mitigation measure was added to the ESIA to address this concern.*)

Closing Remarks

Ms. Bodley reiterated that project was in an early phase and that more consultations would take place. She stated her appreciation of the attendance and hoped that all concerns were addressed. Ms. Bodley invited the residents to enjoy the refreshments.

ESIA – SAINT LUCIA RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT- SAINT LUCIA

Notes of Mondesir-Saltibus Community Consultation on the Presentation of the ESIA

Date: Monday, 12 March 2018
Time: 6:30 pm
Location: Saltibus Primary School, Choiseul
Attendees: Community members
Other Participants
Government of Saint Lucia (GOSL)
- Barrymore Felicien – Deputy Permanent Secretary, Ministry of Infrastructure, Ports, Energy and Labour
- Aloysius Barthelmy – Geothermal Technical Coordinator, Department of Sustainable Development (DSD)
- Deborah Hippolyte – Safeguards Specialist
- Charlin Bodley – Acting Energy Officer, DSD
- Danielle Gordon – Acting Science and Technology Officer, DSD
- Merill DuBoulay – Secretary to the Permanent Secretary, DSD

World Bank
- Mark Lambrides – Senior Energy Specialist
- Megan Meyer – Energy Specialist
- Camilla Gandini – Gender Specialist

Other Consultants
- Alastair Brookes – Clean Energy Advisor, Jacobs International
- Richard Carter – DFID Representative

ESIA Consultants
- Susanne Heim – ESIA Consultant, Panorama Environmental, Inc.
- Theresa Alexander-Louis –Sub-consultant/ECMC

Community Members' Profile
Approximately 50-60 (25 female; 35 males) community members were present in the room – approximately 35 additional community members viewed from outside.

Welcome Remarks and Introduction
Mr. Felicien gave the welcome remark. He stated that the purpose of the consultation was to receive feedback and to respond to any queries or concerns. He also encouraged the participants to partake in an open discussion. Ms. Bodley spoke of the utilization of media to introduce the project to stakeholders. She explained why the consultation was necessary and provided an overview of similar global geothermal initiatives. Ms. Bodley stated the importance of the community taking advantage of the opportunity to comment on the ESIA documents which had been made public, citing locations of the hard copies within the communities, and online via the GOSL website. She then introduced the other presenters.

Project Background and Update on Drilling Areas
Mr. Barthelmy informed the participants of the purpose of the meeting and completion of the pre-feasibility study which was to ascertain where to drill. He pointed out on a map, the four areas that have been identified for drilling within the Mondesir-Saltibus (MS) area. MS 1 and MS 2 in Mondesir, Parc Estate near the playing field are larger areas; M3 and MS4 are smaller. He also highlighted the characteristics of the site and the importance of the consideration of the immediate land use such as agriculture or residential. No

relocation of homes would be required for the project. For agricultural land, compensation will be made for loss of income. The four drillingareas were definite, but the exact location of the well/hole could not be pinpointed as yet. Slim-hole wells will be used. [Note: Bigger wells may be drilled later if the slim holes are successful.]

Community member's query: What occurred during the drilling at the Sulphur Springs and in what ways would technological advancements avoid these incidents during drilling?

Response - Mr. Barthelmy: The Sulphur Springs produced highly corrosive steam which damaged the drilling equipment. The Sulphur Spring area is within the Piton Management Area and this is one of the reasons why the potential drilling areas are located away from the Sulphur Springs. The steam produced at the potential drilling areas will not be as hostile as the steam at the Sulphur Springs. [Note: blowout prevention equipment and experienced geothermal drillers will be used to avoid blowouts.]

Community member's query: Where exactly in Mondesir Saltibus are the sites?.

Response - Mr. Barthelmy: One of the areas is in the vicinity of Parc Estate – the football field. *Ms. Heim pointed the location on the map. Mr. Barthelmy explained that out of the four potential drilling areas , only one will be selected; the final decision has not been made.* If the results are very good, there is a possibility that a second well can be drilled.

Community member's query: What about toxic gases from the drilling, how will this be dealt with? [Note: Hydrogen sulphide is the geothermal gas of concern. There will be monitors at the well site and there wil be tests to determine the concentration of hydrogewn sulphide in the steam. It is unlikely that the hydrogen sulphide would be emitted in concentrations that would exceed international air quality standards.]

Response - Mr. Barthelmy: This question will be addressed by the ESIA expert during her presentation.

Presentation of the ESIA, Ms. Heim, Panorama Inc.

Ms. Heim, explained that the purpose of the ESIA study was to analyze the risks and impacts of the environmental and social conditions in the project areas and how to mitigate these impacts**.** Ms. Alexander-Louis translated into Kweyol, the purpose of the ESIA study reiterating that it was for the exploratory phase and not a permanent activity.

Ms. Heim thanked attendees for their presence and began a PowerPoint presentation which provided an overview of the environmental impacts that were determined from the study and the mitigation measures that will be implemented. She indicated that the areas were specifically located away from infrastructure, buildings and homes as there is no point in relocating houses especially as the drilling is a temporary short-term activity. She informed the attendees that she was here to also take comments, verbally or written on comment cards. She displayed a map of the potential drilling areas and indicated that the larger areas would provide more opportunities for site selection – the drilling site would be much smaller than the larger area. MS-1 and MS-3 provide more opportunities for site selection due to the larger space and ease of access.

Community member's query: Can drilling occur outside of the areas?

Response - Ms. Heim: This can't happen, it can only be in the four areas. The study limits the areas that can be selected so the drilling cannot take place beyond the purple boundaries (on the map).

Ms. Heim continued with the presentation explaining that a small drill rig will be placed on the site after the preparation of the well pad. The wells will be tested for up to 60 days and at the end of the process, the site will be restored, the soil will be revegetated. She recapped the key comments obtained from community members during the scoping phase of the study and how these are addressed in the ESIA.

Community member's query: If it is discovered that there is a resource after the exploratory drilling, what will happen to the site?

Response - Ms. Heim: The slim-hole wells for the exploratory drilling are small and cannot be used for power production so these wells will always be restored. If there is a resource, a larger well will be placed at a later stage. The larger well could be used for production, injection, or monitoring if a power plant is built. If the wells are not successful the will be plugged and abandoned. The geothermal power production is a separate project, outside the scope of the ESIA.

Community member's query: What depth of drilling is being looked at?

Response - Ms. Heim: The target depth for this exploration is up to about 2000 metres.

Community member's query: What would happen if other natural resources were discovered; who does it belong to?

Response - Mr. Barthelmy: Under the Mineral Act, all minerals found below the soil inherently belong to the Crown (government).

Community member's query: How far from the site would you consider houses to be safe from the project site?

Response - Ms. Heim: The houses can be close to the site as the drilling activity will not produce anything that would directly impact the structure or the people living in it. The issue would be the air quality emissions, so the monitoring will be part of what would help to protect the community member. The monitoring station would pick up the issue before it reaches the residents. Typically, because of the noise from drilling, the drill rig would be located about 300 feet or more away from any homes.

Community member's query: What about vibration from the drilling?

Response - Ms. Heim: The vibration dissipates with distance, so anything more than 50 feet away, would not cause effects to the structure and drilling would be further away from structures than 50 feet.

Ms. Heim informed the participants that the ESIA document is available at the consultation today, and online; she provided the link. She then presented an overview of the observations made during the scoping phase and the mitigation measures recommended. The issue of access roads, water supply for drilling, air quality, noise, land use, biological and archaeological resources, loss of livelihood and compensation/Resettlement Action Plan were discussed.

Community member's query: Where will the drill cuttings with heavy metal waste be deposited?

Response - Ms. Heim: Drill cuttings would first be tested. If the drill cuttings do not contain heavy metals in excess of thresholds they would be contained on site and capped with clean soils. Drill cuttings containing heavy metals in excess of thresholds will be moved to a landfill that is authorized to handle the waste. [Note: drill cuttings do not necessarily contain heavy metals above thresholds. Materials would be tested and if metals are found and exceed thresholds would be disposed of at an appropriate facility. Drill cuttings would be buried in place if not hazardous.]

Community member's query: Will the noise level impact community members?

Response - Ms. Heim: The equipment can be noisy but the recommendation is to locate it as far away as possible, especially for MS1 and MS2, it would be very feasible to locate the equipment more than 300-500 feet away so the noise will be lessened. For drilling near residences the ESIA requires use of noise barriers.

Community member's query: Were owners consulted before?

Response - Ms. Heim: Yes, community members were consulted during the Scoping consultations phase in September 2017; MS1 and MS2 are Crown lands.

Community member's query: What is the likelihood of job opportunities during the drilling?

Response - Ms. Heim: The recommendation is preferential hiring of locals but there would be few opportunities during the exploration stage because of the specialized nature of the drilling. However, during the civil works, there would be a higher possibility of job creation for locals. If the resource exploration was determined to be successful, then more jobs would be created.

Community member's query: How soon will the drilling start?

Response - Ms. Heim: Around 2019; there are a lot of things that need to be done to get to that stage such as hiring a drilling contractor, securing funding sources, etc.

Community member's query: If the equipment is stored on the field then would the community have access to the field?

Response - Ms. Heim: The staging area will be small and it will occupy a small section to the side of the field.

Plenary Discussion

Community member's query: Were there any previous exploration drilling in Soufriere in the past?

Response - Mr. Barthelmy: There were indeed past drilling works, the first was done by the UK government in the 1970's and was unsuccessful; the second by the American government. The latter done in the 1980s proved the possibility of the resource (geothermal energy). The point is, drilling deep in the ground can be very risky; if there is a geothermal resource, the payoff is tremendous especially if grant funds are used for the drilling. The customer should benefit from the geothermal energy resource through a lower tariff/cost in their electricity bill. To be successful, the power company and the developer who is taking the risk should be in agreement and there must be supportive legislation. The previous drilling program demonstrated the existence of a geothermal resource but its commercial suitability has not been determined.

Community member's query: Were there any life threats?

Response - Mr. Barthelmy: There was a blowout in one of the wells during the British funded geothermal exploration. The problem with the Sulphur Springs is that the ground is very unstable.

Response – Ms. Bodley: Ms. Bodley re-assured the community members that the proposed drilling project is not life-threatening. There are benefits to be obtained from the project and the goal/intention is to lower the cost of electricity for this small Island developing state.

Community member's query: Will the discovery of the new resource automatically result in savings in electricity bill?

Response – Ms. Bodley: Government has taken the decision to use public/grant financing and not a developer at the early stage of financing. The early stages of the project are higher risk (cost-wise) and so de-risking the project and bringing in a developer in the later stages can lower consumers' electricity bills. *Mr. Felicien:* Grant funding will be used but public funding will also be utilized to reduce the amount of grant funding used. The tariff will be resultantly lower. *Ms. Bodley*: An alternate source of electricity will lead to more stability in electricity distribution. Using renewable energy will reduce and stabilize the cost of producing electricity and therefore will be reflected in electricity bills. *Mr. Barthelmy*: Geothermal

energy like solar is Saint Lucia's natural and renewable resource and this can cater to a significant portion of Saint Lucia's energy needs. Avoiding fuel importation is a benefit of geothermal energy development.

Community member's query: Why doesn't the government spend the time and money on harnessing solar energy and utilizing it?

Response – Mr. Felicien/Ms. Bodley: The Government is indeed doing so. The Government has endorsed the 3 megawatt solar farm, and we are still proceeding with wind. Geothermal energy is not being favored over the other sources of energy. Solar, wind and geothermal energy are all of key interest, especially as a result of the Paris Agreement. Saint Lucia is hoping to have 35% of its electricity derived from solar, wind and/or geothermal energy.

Community member's query: Why can't the grant funds be utilized for a solar farm? Tesla batteries could be used for the storage of solar energy.

Response – Mr. Felicien: Solar farms would require larger amounts of land than geothermal energy development. The 3 megawatt solar farm is on 15 acres. Solar energy panels can be placed on rooftops and in parking spaces.

The batteries would not be sufficient as storage alone cannot distribute electricity.

Community member's query: If the exploratory drilling is successful, what will the power plant look like, visually for the community compared with the solar or wind farms?

Response - Ms. Heim: The plant has several components. The construction of the plant is separate from the exploratory drilling phase in terms of the impacts it would produce.

Mr. Barthelmy: The power plant would have a very small footprint and would require a few acres.

Community member's query: Most community members present are farmers and so the project is of great concern. I know that the project will be beneficial, but I wanted to know how beneficial the project will be in terms of its nationwide significance.

Response – Mr. Felicien: The project will benefit the entire country and by 2038, the Government is hoping to see a gradual decrease in electricity costs as in bills due to the use of geothermal energy and, energy obtained from wind and solar farms respectively. Geothermal energy development will make the country less vulnerable to the changes in the fuel market.

Community member's comment: The Project can bring some good things for the community but the question is to what extent will it affect the people in the community? The Saltibus community has several qualified individuals and yet the Government has decided to hire persons who are not community members to work on projects.Several persons in the Castries area are from the Saltibus or Choiseul area because there is nothing to keep them in Saltibus. It would be of economic benefit to the community to have more locals involved in the implementation of the project.

Community member's query: What amount of electricity will be obtained from geothermal energy? How impactful will the use of geothermal energy be?

Community member's query: Will new installation be done and how will LUCELEC tackle the distribution of geothermal electricity?

Response - Mr. Felicien: All electricity must be sold to LUCELEC. The cost of the geothermal energy exploration could be lower than the cost of fossil fuel. The Government of Saint Lucia predicts that 25 percent of the peak demand will be supplied through geothermal energy.

Community member's query: What do you mean by peak demand?

Response - Mr. Felicien: The peak demand is the highest amount of energy that is consumed in a 24-hour period. The plant would be constructed and designed to cater to a significant portion of consumers' needs.

Community member's query: I need more information to understand how LUCELEC generates their prices for consumer electricity use; there is VAT and an amount that we have to pay even if we use the light or not. How would we benefit?

Response - Mr. Felicien: We are a small island and LUCELEC has the transmission and distribution infrastructure over the entire island already. Saint Lucia would not be able to support another company. The goal is to utilize LUCELEC to distribute the power generated from geothermal energy. LUCELEC already distributes electricity to approximately 90 percent of the island.

Community member's query: In the past, new telephone companies came into the market and promised to lower the rates but this has not happened. Will this happen with LUCELEC?

Response - Mr. Felicien: There is a regulatory body - the National Utilities Regulatory Commission (NURC) that monitors the fees charged by LUCELEC.

Community members' query: What guarantee is there that LUCELEC will lower the consumer electricity bill?

Response - Mr. Felicien: The amount LUCELEC charges is regulated and there is an electricity tariff. All aspects contributing to the price LUCELEC charges are scrutinized and analyzed. The process follows the law and LUCELEC cannot on its own, charge what it determines suitable.

Mr. Lambrides' Input: Remember, that this is an exploration phase. This drilling is being funded at no cost to the Government of Saint Lucia. If there is a resource with lots of heat and flow, then there will be negotiations between a developer and LUCELEC. If the negotiations do not result in a price lower than the current price to consumers, there will be no deal.

Community member's query: What are the impacts of the cost of production to LUCELEC?

Response - Mr.Lambrides: They will be sourcing cheaper power and LUCELEC will still make a margin on what they buy. They need to be compensated for their infrastructure in place.

Community member's query: Wouldn't island-wide solar panel use on everybody's roof be more beneficial? How much does this cost to explore versus geothermal energy?

Response – Ms. Bodley: Solar technology depends on the hours of sunlight. Technically, we have to look at the reliability of the grid without battery storage. Solar energy is an intermittent resource and stability is necessary in order to properly distribute electricity. [Note: Geothermal power is baseload power, which means it is available all the time (74 percent capacity factor). Solar and wind power are intermittent power sources, 25 and 34 percent capacity factor, respectively. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b]

Mr. Lambrides' Input: The baseload for Saint Lucia is about 30 megawatts and this can be supplied by geothermal energy.

Response - Mr. Felicien: LUCELEC needs to exist as it is a stable system for distributing energy. Solar energy only would not support stability.

Community Member's comment: Solar energy can be stored.

Response – Ms. Bodley: The storage would be at an additional cost to consumers.

Community member's query: Solar storage versus geothermal exploration, which one makes more sense?

Response - Mr. Barthelmy: In any country, one must look at economic, industrial, physical infrastructure etc. Solar energy alone will not facilitate that type of economic growth. We need geothermal energy to be included in the national mix.

Community member's query: Couldn't that money be applied to giving everybody on the island solar panels instead of continuing to explore geothermal energy?

Response – Ms. Bodley: Geothermal energy, unlike solar energy, can produce the required 30 megawatts of baseload power needed by the country. There is a minimum demand that LUCELEC must meet and the relevant technology needs to be operational 24 hours per day. In the near future, geothermal energy development in Saint Lucia, could supply 15 megawatts of electricity. Saint Lucia needs to achieve energy independence.

Community member's query: What is the cost of solar energy storage and how does this cost compare to the cost of geothermal energy storage?

Response - Mr. Lambrides: Geothermal energy storage is cheaper. However, in the near future, there may be advances in solar energy storage.

Community member's comment: Geothermal energy exploration began 40 years ago. If solar energy was used, the country would currently have some of its demand supplied. We can keep on drilling over and over and may never get geothermal energy

Response - Mr. Lambrides: Utilizing the grant funds now on solar energy would not resolve the problem. The project is intended to, for a final time, explore the possibility of utilizing geothermal energy in Saint Lucia.

Closing Remarks

Mr. Felicien stated that the DSD would like to receive queries, concerns and feedback. He thanked the community members for their attendance and indicated that their concerns would be documented in the final ESIA which would be made available. Ms. Bodley invited the participants to refreshments.

ESIA – SAINT LUCIA RENEWABLE ENERGY SECTOR DEVELOPMENT PROJECT- SAINT LUCIA

Notes of Castries City Consultation on the Presentation of the ESIA

Date: Thursday, 15 March 2018
Time: 6:30 pm
Location: Castries Town Hall, Castries
Attendees: Community members
Other Participants

Government of Saint Lucia (GOSL)

- Ivor Daniel – Permanent Secretary, Ministry of Infrastructure, Ports, Energy and Labour
- Aloysius Barthelmy – Geothermal Technical Coordinator, Department of Sustainable Development (DSD)
- Charlin Bodley – Acting Energy Officer, DSD
- Danielle Gordon – Acting Science and Technology Officer, DSD
- Caroline Eugene – Chief Technical Officer, DSD
- Merrill DuBoulay – Secretary, DSD
- Shannon Lebourne – Information Assistant

World Bank

- Mark Lambrides –Senior Energy Specialist
- Michael Darr, Environmental and Social Safeguards Specialist,
- Camilla Gandini – Consultant Social Anthropologist

ESIA Consultant

- Susanne Heim – ESIA Consultant, Panorama Environmental, Inc.
- Theresa Alexander-Louis – Sub-consultants/ECMC

Community Members' Profile

Approximately 48 community members were present (20 females, 28 males) including two members of the media (Star Publishing). A few school children were also present.

Welcome Remarks and Introduction

Ms. Bodley welcomed the attendees and acknowledged the various GOSL participants and the consultants including Ms. Judith Ephraim (the DSD's former Energy Officer who was involved in the project), current Program Coordinator for the OECS' Commission Sustainable Energy Unit. Mr. Shannon Lebourne led the group in prayer then invited Mr. Daniel to address the participants. Mr. Daniel informed the participants of the GOSL's interest in the development of the project as it would provide a stable and renewable energy source particularly in light of the negative impacts of the volatility of oil prices.

Remark by Mr. Lambrides, World Bank

Mr. Lambrides thanked persons for attending and explained that in terms of the Bank's technical approach, surface studies had been the first stage of determining the location of St. Lucia's geothermal resource. The exploratory drilling is the next phase; if the resource is obtained through the slim-hole wells, then it would be the production well drilling stage, and later the power plant. The project is now at the exploration well drilling phase, a financially risky stage, which entails drilling slim-hole wells to determine if there is a resource. The World Bank, at the request of the GOSL, is providing grant and contingent grant funding through several sources, including DFID, for this exploration phase thus reducing the financial risk to eventually lead to power production and a decrease in the cost of electricity. Prior to the exploratory drilling, the World Bank's rules require an environmental and social impact assessment (ESIA).

Presentation by Ms. Bodley, DSD

Ms. Bodley indicated that the electricity sector is of great concern as St. Lucia is almost fully dependent on imported fossil fuels to generate electricity and to meet our energy needs. The relatively high cost of electricity erodes our competiveness as a small island development state and as a country heavily dependent on tourism. The island has several sources of renewable energy, wind, solar and geothermal. Saint Lucia is a signatory to the Paris Agreement and has committed to reducing its greenhouse gas emissions and producing 35% of its electricity from renewable sources by 2025 through a mix of wind, solar and geothermal energy.

Utilizing a PowerPoint presentation, Ms. Bodley explained the nature of geothermal energy and its importance to Saint Lucia and that the island has become one of the ten OECS states that have been working towards development of geothermal energy. Geothermal energy has the potential to cover the baseload energy (the island's daily minimum energy demand) – about 30 megawatts. Geothermal energy can also produce power 24 hours per day in contrast to intermittent solar and wind energy which are reliant on climatic or weather conditions. In addition, solar and wind energy are more land-intensive. The project would affect the entire nation. Ms. Bodley recounted the success of geothermal energy development in other countries, particularly in Guadeloupe. She provided the web address for the ESIA document and encouraged community members to contact the DSD if necessary.

Project Background and Update on Drilling Sites

Mr. Barthelmy recounted that geothermal energy exploration started in the early 1950's. He demonstrated on a map the area of potential geothermal energy in Saint Lucia that had been identified by Jacobs international in 2014. Surface exploration and reconnaissance studies had been undertaken by Jacobs. A LIDAR survey, essentially an aerial survey utilizing remote sensing to detect faults which indicate a resource, had also been done. Through a PowerPoint presentation, Mr. Barthelmy highlighted the three areas of exploration interest and amount of the energy that could potentially be derived. The exact locations of the slim-hole wells are not yet known and will be developed by another consultant. There is exploration risk or cost as there is no visual manifestations of geothermal energy in these areas. Drilling to depth of over 1000 metres to reach the reservoir will be costly.

Remarks by Mr. Darr, World Bank

Mr. Darr explained that the World Bank's environmental and social safeguards are to ensure that there is no damage to the people and the environment. His responsibilities includes highlighting and ensuring that these safeguards policies are followed. These policies were established since 1974 and have evolved over time to ensure adherence to environmental and social safeguards. One way to achieve this is to take a slow, deliberate, step-by-step approach to ensure that everything is considered. Some of the earlier studies, several years ago, did not have the benefits of environmental and social safeguard integration. One of the most important umbrella policies is the environmental and social impact assessment to ascertain the environmental and social effects. An important component is public participation to obtain the community's feedback to make the whole project better and safer for everyone involved. The protection of people's land, access and rights, environmental habitat and public safety are important. The ESIA will be examining the potential impacts of drilling the slim-hole wells; these holes will not affect anything within the Piton Management Area (PMA) because the potential drilling areas are located outside the PMA.

Presentation of the ESIA, Ms. Heim, Panorama Inc.

Ms. Heim used a PowerPoint presentation to identify the three target drilling areas which had been selected after the geologic surface exploration studies. Previous studies had focused on the Sulphur

Springs area, but now new areas that have potential for producing viable geothermal resource are being examined. Areas that are larger, relatively flat, with good access were considered to reduce the amount of surface disturbance and grading that would be required for the exploratory drilling phase. Water must be brought in by the exploratory drilling contractor. The exact site for drilling have not yet been identified and three, to a maximum of five, wells are being considered for exploratory drilling.

The activities that are included in the ESIA are site development and the existing access roads may have to be improved. Once the well pads have been constructed, the drilling phase can start – about 50-60 days of drilling. Small drill rigs would be utilized and much smaller wells will be drilled compared to previous investigations. The testing stage will include monitoring and collection of important data such as the resource chemistry, temperature and pressure of the wells. The sites would then be restored, very small well heads, around four feet in diameter, will be left in place for monitoring. The rest of the site, including well pad, will be restored, top soil will be replaced. For noise from the drilling, new technology will be used to minimize noise. Small drill rigs will be used and all drill rigs will use blowout prevention equipment. The ESIA includes measures which require hiring a drilling contractor with geothermal drilling experience. The option of using a larger drill rig has been include if a viable geothermal resource was discovered during the initial drilling.

Ms. Heim mentioned that for the ESIA process, scoping studies were conducted, which included a round of consultations in each of the communities where exploratory drilling could be conducted including Fond St. Jacques, Belle Plaine and Mondesir-Saltibus. Community comments were obtained to inform the environmental issues. A set of environmental studies were completed to define the baseline environmental conditions. Information on biological and archaeological resources, air quality, hydrology and noise were collected. The environmental and social impact analysis was developed to predict the impact. We are now here to discuss the results of the ESIA with the community and obtain feedback.

She highlighted the characteristics of each potential drilling area, pointing out that Belle Plaine community for example is large enough for a full-size exploration well, has good road access, flat land and the proposed area is being used mainly for agricultural purposes in the community. There are very few homes nearby and the drilling sites will be situated away from residences. Mitigation measures would include air quality monitoring that would be done according to international standards. Noise monitoring will also be in place and silencers would be used to reduce noise. Monitoring of other biological and archeological resources will also be done and mitigation measures used.

The steepness of the Fond St. Jacques area and its susceptibility to landslides constrain the number and space available for drilling sites. There is the Soufriere River, and many community members and residences, so there are fewer opportunities for drilling locations. Resources include a spring and monitoring of the spring water will be done. Fond St. Jacques is a less biologically sensitive area. There is a recreational field in Fond St. Jacques that is being considered as a staging area. The Mondesir-Saltibus area is further away from the Sulphur Springs and is mostly Crown Lands generally used for agriculture. Some of the constraints are similar to Fond St. Jacques due to access, topography, households near MS-3 and MS-4 and community recreational activity. There is a river to the West and there will be a water extraction plan to protect downstream water uses. Mitigation measures require water quality and archaeological monitoring as well as addressing the impacts on agricultural areas. Even though the area is mostly crown land, compensation would still be given for loss of livelihood consistent with World Bank policies.

Plenary Discussion

Community member's comment: In 1992, I attended a meeting about reducing our peak load. LUCELEC doesn't have any motivation to reduce peak load. In 1950 geothermal was a good idea, but in 2018, the

technology for solar and wind energy is there. We do not need to drill a hole to bring up sulphides that will pollute our waters, and, we have to have monitors; I am very skeptical about that. Every house in Saint Lucia should have solar on their roof to feed back into the grid. But they want to put the geothermal drilling at Belle Plaine. We have to feed ourselves, we must save our agricultural lands. Are we going to clear off the people who own it? Whatever happened to our wind generation?
Response - Mr. Felicien: Geothermal energy is more suitable. Ms. Bodley's presentation highlighted the benefits of geothermal energy – greater energy security, small footprint, saving to be made and it not at the risk of an exorbitant amount of agricultural land. We are not certain of the exact site and a final decision has not been made. In terms of solar, the GOSL is setting up a solar farm which require 50 acres; the amount of land for a geothermal plant is five acres (Note the size of the plant will depend on the type of plan and amount of power produced). The Guadeloupe example shows all different types of properties around the geothermal plant. Geothermal energy will not affect the properties, communities nor lifestyles and it will not drastically affect land use. The GOSL is also pursuing solar energy and is in discussion with a wind developer; wind energy development has not stopped. The GOSL was instrumental in setting up the National Energy Commission which regulates energy to ensure that electricity is accessible and affordable to everyone.

Response - Ms. Bodley: From 1999 the GOSL has subsidized the importation of renewable energy products. The GOSL offers incentives for solar panels on people's roofs.

Community member's query: How much noise will be emitted as a result of exploratory drilling and what will be done to create a noise barrier to protect the community?

Response - Ms. Heim: The drill rig will be located as far away from communities as feasible and noise barriers will be used. There will be noise barriers which would reduce the noise by about 20 decibels; international standards will be adhered. The drill rigs will have noise reducing equipment and the communities' distances away from the sites will provide protection. The noise barriers will be used to prevent damage to hearing and the workers on the drill will also have protective equipment due to the higher noise levels that workers will be exposed to. There will be a grievance redress committee to address and respond to issues raised by the community during the drilling.

Community member's query: Considering the Kick 'em Jenny volcano in Grenada and its possible activation, is this volcanic activity a factor? Will there be multiple sites for exploratory drilling in Saint Lucia and what are the exact risks if we have to go below the cap that Mr. Barthelmy referred to? Will the drilling impact tourism? Will the Sulphur Springs be affected by the drilling for example through loss of steam? Was the impact of Hurricane Tomas considered for the Fond St. Jacques? Was topography and, flood and landslide susceptibility are being considered.

Response - Ms. Heim: A geotechnical investigation will be done to evaluate the risks and landslide possibility for Fond St. Jacques. The drilling activity will not cause landslides. The project will require a minimum of three wells and a maximum of five in the three areas. No wells will be located in Sulphur Springs and the project areas were specifically selected to avoid the PMA. No effect on tourism will occur because the drilling areas are not visible from tourist areas. During the test phase, the geothermal fluid will be tested for up to 60 days. The wells will be capped after the drilling is done. In terms of the impact on the Sulphur Springs there is no link between the Sulphur Springs and the current drilling sites.

Response - Mr. Barthelmy: There are no manifestations in the areas selected. It is not known how deep the wells will have to be drilled. Due to the lack of information on the nature of the reservoir, there is a chance of a dry well.

Community member's query: I am concerned about the possible safety risks both long term and short term of this project. I would like information on the blowout prevention strategies and the possibility of the closed-off wells reopening 20 years later.

Response - Ms. Heim: Geothermal drilling is one of the oldest renewable energy technologies. We have looked at how frequent these issues have occurred; blowouts are rare occurrences. What happened 30 years ago is not indicative of what to expect now; drilling technology and equipment has advanced and there will be a more experienced drilling team. There will be plans to address these issues. The abandoned wells will be closed off and capped with cement to prevent blowouts after abandonment.

Community member's comment: I support the exploration of geothermal energy. In the past, Belfond was chosen as a drilling site and I visited the site. One day there was a loud noise and steam shot out of a well. This created fear among Soufriere residents. The occurrence was quickly rectified but no information was provided to explain what caused the occurrence. It was very loud and community members could not avoid hearing it.

Response - Ms. Heim: We acknowledge that there was a blowout in the history of geothermal exploration in Saint Lucia. A different approach will be used. The community will be informed throughout the drilling process so that you know what is happening in the area. The World Bank, experts and contractor will ensure that well construction is done properly and that safeguards are in place to prevent a blowout.

Response - Mr. Barthelmy: The blowout occurred very long time ago and environmental safeguards were not being utilized at the time. The well-produced super-heated steam and there was no adequate functional noise-reducing equipment on the drill rigs. Two weeks later testing was discontinued.

Community member query: Is there documentation of the activities during the previous drilling project? There was a large well drilled in Etangs. Does the GOSL have records of the past drilling activities? No one informed the residents of what was occurring during the past drilling efforts. Detailed documents of each phase should be provided to the community members.

Response - Mr. Felicien: The GOSL does have the records and the documents relating to the consultations; details on studies done are also available. We will continue to engage the communities every step of the way for this geothermal project. Persons can obtain the pertinent documents from the Department of Sustainable Development. *Ms. Charlin Bodley:* Hard copies of the document can be obtained at the DSD. A soft copy of the ESIA document is available at GOSL's website (the contact number for the DSD as well as the hyperlink for the soft copy of the ESIA were provided by Ms. Bodley.)

Community member's comment: The Sustainable Development Goals (SDGs) are pertinent to the discussion but have not been addressed. SDG 1 highlights the importance of food security and agriculture. The SDGs 2 and 3 are of vital importance. Drilling will prove to be detrimental to the country. SDGs 4 through 7 are integral goals which must be incorporated. The project does not cater to SDG 7. There is a possibility of infant mortality. The land belongs to the future generations. All should think about the impacts on future generations and the tourism sector will never recover from the success of constructing a geothermal power plant due to the high possibility that there will be subsequent developments which will lead to a reduction in undeveloped, land space. The World Heritage Site will also be endangered.

Response - Ms. Bodley: SDG 7 is aimed at sustainable development to benefit everyone.

Community member's comment: I would like more similar consultations to be done for other projects and increased ESIA exposure for other projects. Other more impactful projects have fewer consultations despite their importance. A consultation should be done on detailing national energy strategy and the risks

should be highlighted. All renewable energy development projects have risks. The diameter of the slim hole should be explained. The conditions of the relevant roads should be considered as well as what can be done to improve them. Will drilling be done simultaneously at the sites?

Response – Ms. Heim: Slim hole wells are wells which are 5 inches at the base but larger at the top as in 2 feet in diameter. To avoid unnecessary costs, the drilling will not be done simultaneously.

Community member's query: Can you provide more information on the drilling activity that will be done?

Response - Ms. Heim: The drilling will be done by small drill rigs. The activity will be regular geothermal drilling activity and will last up to 60 days. There will be other activities such as transport of water and vehicle activity to transport supplies, typical of a construction project.

Community member's query: What protective measures will be implemented to prevent harmful exposure to hydrogen sulphide?

Response - Ms. Heim: The geothermal testing phase will be brief, 60 days or less. The venting of geothermal fluid may release some hydrogen sulphide, but monitoring will be in place and international standards will be followed to protect human health. The testing would not expose people to a level of hydrogen sulphide that would put anyone at risk. If the hydrogen sulphide levels briefly exceeded standards, persons in proximity to the well may be evacuated for a few hours until the hydrogen sulphide dispersed.

Community member's comment: I accompanied an individual in the 2000's to survey a site at Belfond. I saw a well, which had a nearby pump. I was informed by the individual that the pump's function was to remove the sludge. I would like to know whether the volcano's brackish water which was from the sea and consisted of hydrochloric or sulphuric acid sludge would be present at the future sites during drilling. Also, where is the fault located near the potential drilling sites? I was told that the crater extends through the Soufriere town and I would like to know whether a survey to ascertain this was done. How is the fault connected to the sites? I saw by-product emanating from the ground and it was linked to the fault. I would like to know if the fault is an isolated fault.

Response - Ms. Heim: This is the first time that I am hearing about the issue of a past discharge of sludge. There has been geological mapping of the area for fractures and the exploratory drilling will target those fractures. The wells will be cased to the depth of the geothermal resource and will be closed off from shallow groundwater resources by cement and steel casing, The bottom of the well will be in the geothermal resource several thousand feet below the surface and this resource is separated from the surface by a thick clay layer, which caps the resource. The geothermal drilling activity would not cause release of sludge to any surface waters.

Community member query: What is the starting sound output from the drilling activity?

Response - Ms. Heim: A typical geothermal drill rig is about 80-90 decibels at the drill rig. However, the noise will be reduced by 20 decibels or more at the nearest receptor due to distance from the drill rig and by more decibels due to noise reducing barriers. The project would not risk hearing loss for people living near the potential drilling area. The drillers would be exposed to higher noise levels because they would be at the noise source and noise protective devices would be provided to workers,

Community member query: It was stated that when the project uncovered a commercially viable geothermal resource, a loan would have to be repaid. Who would be working on the project? Will workers be brought down? Would the project continue if faced with opposition from the majority of the stakeholders?

Response – Mr. Lambrides: The project is a phased one. The early phases are grant financed. This grant consisted of 10 million dollars for exploration activities. If the project is deemed unsuccessful then the 10 million dollars repayment is unnecessary. If successful, then the 10 million dollars would have to be repaid along with any other financing. The loan would be a zero percent interest with a 10 year grace period.

The phase is an exploratory one and there will be few employment opportunities during the exploratory phase in contrast to the production phase which will have more opportunities for employment.

If the stakeholders are against the project then the World Bank will discontinue the project and the ESIA will indicate whether stakeholders are in support or not. The documents will be summarized so that stakeholders will be able to better understand the project.

Community member's query: Why should we build a plant that will last for only 35 years? This will naturally lead to the construction of another plant after the 35 years and then another plant. Landowners will be losing valuable land; what will happen to those persons? The other issue is that air quality; what is in place to ensure that these gases do not get into the atmosphere? Will the air quality will be what is was prior to the commencement of drilling activity?

Response - Ms. Heim: There will not be long-term impacts on air quality. During the testing phase, there may be short-term emissions of hydrogen sulphide and CO_2 .The air quality will be monitored to international standards.

Concerning loss of land, at this stage of the project, it is only a four foot square area that will be required for the well head, the rest will be restored.

In countries where geothermal energy is used for power production there are power plants that have been in operation for more than 35 years. This is a resource that if properly managed could provide long-term power.

Closing Remarks

Mr. Lebourne thanked the participants and informed them that the results of the ESIA would be available for individuals to review and feedback would be accepted. He invited the participants to partake in the refreshments.

APPENDIX H-4: RESPONSES TO WRITTEN COMMENTS ON THE ESIA

Table 1 Comments on ESIA

ESIA Text	Discussion Points/Comments	Response to Comment
p.3-5. Full-size wells are not anticipated at Fond St. Jacques or the MS-3 and MS-4 [Mondesir-Saltibus] areas due to an absence of flat open areas and the presence of residences in close proximity to the drilling area making access with a large drill-rig infeasible during this initial exploration stage.	Only slim-hole wells could be installed in MS-3 or MS-4.	Revised text in ESIA to clearly state that full size well will **not** be installed in the Fond St. Jacques or MS-3 or MS-4 areas. Only slim-home wells could be installed in Fond St, Jacques or MS-3 or MS-4 due to practical limitations on use of a large drill rig in these areas.
p.3-8. If required, a worker camp would be established in the Belle Plaine/Fond St. Jacques area and another worker camp could be established in the Mondesir/Saltibus area to house the construction workforce during exploration activities in each area. The worker camp would house up to 50 workers and would include separate sleeping and bathing facilities for men and women, safe food and drinking water, air conditioning, first aid and medical facility, water storage, generators for electricity, and access to communication networks. Transportation from the worker camp to the project site will be provided. If necessary, a security fence and lighting would be installed around the worker camp, and security guards may be stationed at the camp.	Determine if there has been prior experience with worker camps in the community and address any concerns that are raised. Ensure any concerns are adequately addressed in the ESIA. Include a draft "fit-for-purpose" environmental and social clauses, for inclusion in the bidding documents, in the ESIA appendix section.	No worker camp is currently anticipated due to the small number of international workers that will be on site. If a worker camp is required, the mitigation in the ESIA address the potential impacts from workers coming to the area. Added to the ESIA that a worker camp is not anticipated and would not be used during slim-well drilling due to the limited number of workers that would be involved.
p.4-2. Community members in Fond St. Jacques/Belvedere indicated that the spring water is extremely important to them as a "back-up" water supply, particularly during public water shortages and natural disasters, such as Hurricane Tomas when WASCO's supplies had been damaged. Some individuals indicated that their spring water supplies are piped alongside WASCO's pipelines and into their households. One respondent reported that since Hurricane Tomas, spring water, instead of WASCO's water, was now piped	Address the concerns regarding the household water supply during consultation with the Fond St. Jacques/Belvedere	Concerns regarding household water supply were discussed and addressed during consultation with the Fond St. Jacques/Belvedere community. The ESIA mitigation requires a water extraction plan and protection of the pipelines in the area.

ESIA Text	Discussion Points/Comments	Response to Comment
to the household for domestic purposes (except drinking).		
p.4-27. Belvedere and Belle Plaine are in Soufrière. Belvedere is about 8,000 meters (5 miles) north of the Fond St. Jacque areas	The location of Belvedere is incorrectly stated in the table.	Corrected in the Final ESIA to read Belvedere is the community within Fond St. Jacques where the drilling area is located
p.6-13. Social-2: Working Conditions and Equality Employment opportunities created by the project shall be equally available to men and women. If locals are hired for construction jobs, job postings and/or notices shall be disseminated that foster participation from women and men. The GoSL shall include a preference for hiring from the project region in the civil works contract.	Discuss with the government this mission and revise this issue in the ESIA on the basis of the discussion outcome.	The preference for hiring from the project region is included in mitigation measure Social-2.
p.8-3. Community Consultation on Draft ESIA	A summary of the major outcomes of all consultants will be included in the ESIA, including how each issue has been addressed.	Responses to comments for issues raised during the consultations are provided in this appendix and are summarized in Section 8-3 of the ESIA.
p.8-4. Stakeholder Engagement Plan	There is no budget included in the ESMP for stakeholder engagement.	ESMP has been revised to include budget for stakeholder engagement.

Table 2 Belle Plaine Community Consultation – Responses to Written Comments

Question/Comment	Response to Comment
What will be the implications for livelihoods? Many of these lands are farmed by Belle Plaine farmers and this is a major revenue earner.	A resettlement action plan and policy framework as been prepared that addresses procedures for any loss of livelihood from the potentially affected persons.
The access to the two sites in Belle Plaine. This is not truck friendly and would need to be upgraded and reinstated after use. The risk of contamination of farmlands to be used for drilling. If these are to be leased and returned to owners after two to three months, they must not be contaminated and made unusable. Drilling along a fault or crack may cause these to widen. Residents are advised to photograph their homes before drilling starts, so that they may produce evidence of damage in the event of tremors.	Requirements for restoration are included in the ESIA (see mitigation measure Soils-1: Topsoil Preservation and Restoration and Landscape-1: Site Reclamation and Restoration). Mitigation addressing potential contamination of farmlands is included in the ESIA (see mitigation measures Water-3: Drilling Waste and Effluent Management and Social-1: Agriculture Production). Drilling along a fault or crack will not cause faults to open. No fluids will be injected under pressure as a part of the exploratory drilling program. Geothermal exploratory drilling is conducted internationally and there is no link between geothermal exploration and seismic activity.
A complaints board or some other facility should be established where community members may bring their concerns and not be turned away. Person conducting the investigation into such complaints should be independent of the project.	A community liaison officer will be appointed and responsible for addressing project grievances consistent with the grievance redress mechanism and grievance redress committee procedures described in the ESIA, Resettlement Action Plan, and Stakeholder Engagement Plan.
How will livelihood issues be addressed? If lands are acquired, how is this affect farmers and persons rearing animals?	Effects to livelihood are addressed in the Resettlement Action Plan. The World Bank has safeguard measures that must be applied to protect livelihood.
We are not against the project, but we have genuine concerns based on past experiences, as well as current experiences, for example in relation to noise pollution. We want to see our concerns taken into consideration. We need to see what is being recommended, for example would it be advisable to take out insurance?	Social safeguards will be put in place and mitigation measures are provided in the ESIA. The mitigation measures in the ESIA require that any damage that is caused to pipelines or structures by the drilling activity is repaired or compensated by the government.

Table 3 Fond St. Jacques Community Consultation - Response to Written Comments

Question/Comment	Response to Comment
Impact of noise. One participant enquired whether there would be penalties in the contract for non-compliance with such clauses.	Corrective actions to non-compliance incidents are addressed in the ESMP.
Tremors (cracking of houses). Show area of Belle Plaine . Residents in town have problem with drilling causing earthquakes.	There is no causal link between exploratory drilling and earthquakes. The exploratory drilling will not injection fluids under pressure and will not cause earhtqueakes. A mitigation measure has been added to the ESIA to address any potential vibration impacts on structures near the drilling area (refer to mitigation measure Noise-2: Vibration). The Belle Plaine area was addressed more directly in the consultation in Belle Plaine. The community consultation in Soufriere was targeting the Fond St. Jacques community. Impacts in the Belle Plaine area area addressed in the ESIA.
Hold a consultation in Fond st. Jacques, the community that will be directly affected. Why wasn't a consultation scheduled to present this information for site exploration in that community? There was seismic activity in Soufriere town during previous drilling explorations. The Rabot Lake dried up. No scientific explanation has been given to disprove that the drilling did not cause the cracks in houses or the lake drying up.	A scoping meeting was held in Fond St. Jacques. During the planning phase for the ESIA consultations the government was looking at a means to involve the community in Soufriere. Buses were provided to transport community members from Fond St. Jacques to Soufriere. Future consultations would be held in Fond St. Jacques prior to any drilling activity and consistent with the procedures in the Stakeholder Engagement Plan. There is no connection between drilling a narrow hole in the ground and earthquakes. Geothermal exploratory drilling occurs around the world and is not known to induce earthquakes. The geothermal aquifer is isolated from surface and shallow groundwater resources by a thick clay layer. Testing the geothermal reservoir would not cause drawdown of groundwater. The drilling will require water during the 50-60 days of drilling activity. The ESIA requires preparation of a water extraction plan so that downstream surface water uses are protected.
What compensation will be made available to residents should their houses be affected?	A mitigation measure has been added to the ESIA to address potential impacts on residences from vibration during drilling (refer to mitigation measure Noise-2: Vibration). No relocation or direct impact on structures would be required for the exploratory drilling phase.

Table 4 Mondesir-Saltibus Community Consultation - Response to Written Comments

Question/Comment	Response to Comment
I work with the Ministry of Agriculture, based in this area. I am concerned as this area is a water catchment area and a farming area. It feeds water to the pineapple area. There is an intake at the Gia Bois. Mr. Ferguson John (past MP for the area) has three fishponds with water fed from there. There is spring water lower down. When there is no water in the mains, the people go there for water. The Ministry of Agriculture may have more information on these water sources	Requirements for water extractions are included in the ESIA and include protections for existing downstream water uses. Refer to mitigation measure Water-6: Water Extraction Strategy. The project would not create impervious surfaces beyond the approximately 4-foot wide well head. Runoff and infiltration rates would remain the same after project completion.
I think it might be a good thing if there will be no harm to our environment and our children will be able to breathe fresh air during these drillings	Geothermal exploration and testing activities are conducted around the world in proximity to communities. These activities are safe when implemented properly. World Bank safeguards will be in place and the ESIA mitigation procedures will be implemented to ensure that the project does not cause harm to the environment and does not affect human health.