添付資料-3　スコーピング報告書

DATA COLLECTION SURVEY FOR GEOTHERMAL DEVELOPMENT IN SAINT VINCENT AND THE GRENADINES

GEOTHERMAL DEVELOPMENT PROJECT IN SVG

DRAFT ESIA SCOPING REPORT

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ABBREVIATIONS

AoI	Area of Influence
BOP	Blow Out Preventer
CARICOM	Caribbean Community and Common Market
CBD	Convention on Biodiversity
CWSA	Central Water & Sewerage Authority
EC	Emera (Caribbean) Incorporated
ECLAC	Economic Commission for Latin America and the Caribbean
EHS	Environmental, Health and Safety
ESIA	Environmental & Social Impact Assessment
ESMP	Environmental & Social Management Plan
GIIP	Good International Industry Practice
GoSVG	Government of St Vincent & the Grenadines
IFC	International Finance Corporation
JICA	Japan International Cooperation Agency
LOI	Letter of Intent
MOU	Memorandum of Understanding
NBSAP	National Biodiversity Strategy and Action Plan
NCG	Non-Condensable Gases
NGO	Non-Governmental Organisation
NSR	Noise Sensitive Receiver
OECS	Organization of Eastern Caribbean States
PDC	Polycrystalline Diamond Compact
PPDB	Physical Planning and Development Board
PPU	Physical Planning Unit
RG	Reykjavik Geothermal
SEP	Stakeholder Engagement Plan
SGD	Saint George's Declaration
SVG	St Vincent & the Grenadines
SVGNT	St Vincent and the Grenadines National Trust
ToR	Terms of Reference
VINLEC	St. Vincent Electricity Services Limited

1 EXECUTIVE SUMMARY

The present report is the Scoping Study for the Geothermal Development Project in SVG. The report outlines the proposed project details and provides information on the environmental and social baseline in the project area. This has facilitated a preliminary assessment of the potential impacts of the project, which has enabled the Terms of Reference (ToR) for the Phase 1 Environmental and Social Impact Assessment (ESIA) study to be drawn up. The Scoping Study has been conducted in some depth to ensure that the ToR are appropriate, and much of the material in the report may therefore be utilised again in the subsequent ESIAs.

The Project involves evaluation of the geothermal resource, drilling and testing of geothermal wells, construction of a 10 to 15 megawatt geothermal power plant, construction of transmission lines to connect the power plant to the grid, and the operation of the power plant. The first phase of implementation is the exploratory drilling phase, which, if the geothermal resource proves to be viable, will be followed by the construction of a generating station and other infrastructure.

The Project is located on the south-eastern slopes of La Soufrière volcano, some 4 km inland on the eastern side of the island of St. Vincent. The Scoping Study found that the Project Area is fairly sparsely populated, and is a mosaic of agricultural land and secondary forest/scrub, and is generally already disturbed by anthropogenic activity. Although the areas in which exploratory drilling is to take place are agricultural plots, it is likely that small areas of forest will be lost during the Project development, and that these areas may be habitat for one or more rare and/or endemic species.

The Scoping study has confirmed that overall, the Project is likely to have significant positive impacts on the socio-economics of SVG by, *inter alia*, reducing reliance on imported energy, creating jobs and improving local technical capacity, improving local infrastructure, stabilising/strengthening the economy, and reducing energy costs, which is expected to stimulate the economy (particularly the manufacturing sector). In addition to the positive socio-economic impacts, the geothermal development will generate a significant reduction in SVG's greenhouse gas emissions due to the offset diesel generation from the move to sustainable geothermal production.

The scoping study has concluded that there are no major "show stopper" issues relating to environmental and social considerations that could seriously affect the project. Nevertheless, a number of potentially significant areas of negative impact have been identified by the Scoping Study. These require substantial further investigation during the Phase 1 and Phase 2 ESIAs.

The study has also concluded that, owing to the nature of the project and that of the Project Area, the geothermal development is likely to have only modest effects across the spectrum of environmental and social issues. The environmental issues requiring most attention in the forthcoming detailed ESIAs are those relating to the likelihood of the Project Area being classified as Critical Habitat in accordance with the International Finance Corporation (IFC) Performance Standard 6; and concerns relating to the supply /over abstraction of water during exploratory drilling. The principal concern that arose during the study relating to social issues was that the resettlement/land acquisition processes were not being managed by the proponent in compliance with the IFC PS5.

2 INTRODUCTION

2.1 Introduction to Project

Instability in international oil prices have resulted in a high cost of electricity in St. Vincent and throughout the Caribbean. The high cost of electricity represents a major barrier to economic growth and has resulted in decreased customer satisfaction and high foreign exchange outflows.

The Government of St. Vincent & the Grenadines (GoSVG), recognizing the potential for the development of geothermal energy, is advancing plans for the development of a geothermal power plant in the vicinity of La Soufrière volcano in the north of the island of St. Vincent (see Figure 1 for location map).

The main objectives of the project are:

- Moving the country from a dependency on high priced and volatile diesel fuel to a sustainable energy path based on an indigenous, stable and affordable resource;
- Increasing St. Vincent's energy security and supporting the government's energy policies;
- Reducing and stabilizing electricity prices to St. Vincent Electricity Services Limited (VINLEC) customers in St. Vincent. The target cost of geothermal will not exceed a ceiling cost of US$0.18 per kWh, which is less than 75 % of the cost of diesel fired generation; and
- Reducing greenhouse gas emissions.

Additionally, as early evidence exists to support the eventual development of additional geothermal generation for export, the present project is expected to serve as a pilot project in the sense that the lessons learned and skills developed during its implementation will better prepare the country for any future developments.

The Project is expected to transform the energy situation in SVG and is in line with national climate, energy and economic objectives.

The Project involves evaluation of the geothermal resource, drilling and testing of geothermal wells, construction of a 10 to 15 megawatt geothermal power plant, construction of transmission lines to connect the power plant to the grid, and the operation of the power plant (collectively, the "project").

A Letter of Intent ("LOI") for the project was signed on May 13, 2014 by GoSVG and a consortium of Reykjavik Geothermal ("RG"), based in Iceland, and Emera (Caribbean) Incorporated ("EC") based in Barbados (collectively, the "the Proponents").

Under the terms of the LOI, commercial operation of the power plant is to commence by June 2018. The Clinton Foundation, under a signed Memorandum of Understanding (MOU), is providing policy and strategy support to the GoSVG to ensure agreements are reasonable for all parties.

Electricity supplied by the plant will be sold to the state owned electric utility, VINLEC, under a Power Purchase Agreement. Electricity demand in St. Vincent indicates that a 10 to 15 megawatt power plant is justifiable.

Source:
Created using maps found at:
http://en.18dao.net/Map/Saint_Vincent_and_the_Grenadines
http://alabamamaps.ua.edu/contemporarymaps/world/americas/index2.html

Figure 1: Project General Location

The Project is located on the south-eastern slopes of La Soufrière volcano, some 4 km inland on the eastern [1] side of the island of St. Vincent. Geo-scientific data indicates a deep geothermal reservoir with temperatures in excess of 200ºC.

The Project will be developed in two phases, as follows:

- Phase I: Civil work: Construction of road, drill pad and water system followed by the drilling of up to 5[2] exploration wells.
- Phase II: Additional civil work followed by further drilling, construction and installation of a 15 MW geothermal power plant including transmission lines.

To date, a considerable amount of technical study (including surveys) and economic analysis has been undertaken, and the results have indicated that the Project would help achieve the goals of price stability and economic sustainability for St Vincent & the Grenadines (SVG). Furthermore, the studies have allowed the identification of nine potential exploratory drill sites (Figure 8), of which two sites are preferred as the most suitable for exploration activities.

The Project is now about to enter the phase of exploratory drilling which involves the construction of drill pads, operation of drilling rigs and the planning and development of required infrastructure such as access roads. This work is expected to commence in mid-2016. If the exploratory drilling results are favourable, the Project will then enter the next phase of design, construction and commissioning of the generation plant and associated facilities such as a substation and two transmission lines to evacuate power to the national grid. The overall target is to have the Project in commercial operation by 2018.

2.2 Background to JICA's involvement in the Project

The JICA Survey Team was originally requested to prepare a proposal for preparation of an Environmental and Social Impact Assessment (ESIA) Report in compliance with IFC performance standards, using the pre-existing scoping report and the baseline data collected by the Proponents. It was, however, determined that the existing scoping and baseline reports were prepared before the key project details were known, and prior to the selection of favoured locations for the exploratory drilling. The reports therefore lacked sufficient information to allow the JICA Survey Team to prepare an ESIA report that would be deemed to have followed IFC guidance. It was therefore proposed by the JICA team that the scoping exercise previously carried out be built upon to develop a more up to date scoping report which focusses on the specific project area and latest project details, including Terms of Reference (ToR) for the required ESIA.

JICA decided to offer the Scoping Study to the GoSVG as technical assistance and this report is the product of the new scoping exercise.

2.3 Introduction to Scoping Study

Scoping is widely accepted as a key stage in the ESIA process, and is recommended by the IFC performance standards and Good International Industry Practice (GIIP). It is also a requirement of the draft SVG Environmental Impact Assessment Regulations (2009)[3]. The

[1] Referred to locally as the "windward" side
[2] However, 3 is most likely
[3] Although a Scoping Study is not explicitly mentioned, several articles of the draft regulations imply that some of scoping, as well as submission of the draft ToR, is required.

purpose of scoping is to provisionally identify the negative impacts of the Project which are likely to be significant, so that the assessment studies can be planned and focussed on these important issues, and time and effort is not wasted investigating issues that are not likely to be significant. Scoping is also an early opportunity to inform stakeholders of the project and canvass opinions on what affected communities believe key issues related to the project may be.

The overall study aim was to produce a Scoping Report and ToR for an ESIA (or ESIAs[4]) that complies with SVG laws and the IFC Performance Standards. During the field survey, the main objective was to obtain a good understanding of the socio-environmental conditions in the project area and of the project infrastructure, allowing the team to gauge which issues require further investigation during the subsequent ESIA work.

Within that broad objective, the key aims of the study were as follows:

- To summarise the SVG ESIA requirements and process for obtaining an environmental licence for the project;
- To determine and describe the latest project design and the current project development status;
- To determine the project location and project area of influence;
- To determine and describe the key environmental and social features within the project's area of influence;
- To identify the main potential environmental and social effects of the project (both adverse and beneficial), as well as determining issues commonly examined during ESIA studies that may not be relevant to the present project;
- To outline the likely environmental & social requirements of IFIs and other investors in the project;
- To prepare the Stakeholder Engagement Plan (SEP);
- To consult identified stakeholders (government institutions, local residents and community leaders) in line with the SEP; and
- To develop the ToR for the baseline studies and other work that will be required to complete a "compliant" ESIA for the project.

2.4 Scope of Application

It was originally planned that the Scoping Study would investigate the possibility of carrying out just one ESIA covering both the exploration and production phases. It was also envisaged that, should the two ESIA approach be maintained, the Scoping Study would be applicable to both ESIA phases, and would provide ToR for both ESIA studies.

[4] Upon the first involvement of the Study Team it was expected that it would be possible to "streamline" the proposed two-ESIA approach such that both exploration and construction/operation be covered by one comprehensive ESIA.

It became clear during the early stages of the scoping that, due to the significant levels of uncertainty with regards to the production phase[5], and the urgency to commence the exploration phase, that a two-phase ESIA is the most pragmatic approach.

As a result of the uncertainties described above, it should be borne in mind that the present Scoping Report, whilst attempting to address both exploration and production phases, is more focussed on the exploration phase. Likewise, it was determined by the study team that it would only be possible to produce ToR for the exploration phase ESIA; the ToR for the production phase ESIA will need to be developed following the results of the phase one ESIA and once more details are known about the production phase of the Project.

[5] Both in terms of location of facilities/infrastructure, and construction/operation details

3 METHODOLOGY

3.1 Study Phasing

The Scoping Study was split into three work phases, as follows:

- Inception Phase;
- Site Visit Phase; and
- Reporting Phase

Methodologies for each of the above phases are provided below.

3.2 Inception Phase

The Inception Phase included the following tasks:

- Project familiarisation;
- Preparation of data requests and site visit planning;
- Organisation of logistics for site visits;
- Organisation of meetings;
- Update of the project schedule;
- Preparation of the draft Stakeholder Engagement Plan (SEP); and
- Preparation of reporting templates.

3.3 Site Visit Phase

The site visit to SVG took place between the 19th and 31st October 2015[6]. The visit consisted of meetings with the Geothermal Consortium, meetings with government stakeholders, meetings with NGOs and community representatives in the Project area, and field reconnaissance.

During the Site Visit Phase the team collected as much information as possible about the environmental and social conditions in the project area. The team also focussed on the Project design and construction methodology, the policy and legal context, as well as the definition of the project area of influence.

Further details on the three main activities are provided below.

3.3.1 Meetings with the Geothermal Consortium

Following the Kick-off meeting (in which issues such as logistics, stakeholder meeting arrangements and schedules were discussed) several technical discussion sessions were held with the representatives of the Geothermal Consortium. The objective of these discussions was for the study team to fully understand the proposed project, in terms of items such as:

- Project phasing and schedule;

[6] The Team Leader travelled to SVG several days in advance to permit a meeting with the Director of the Energy Unit, as the Director was due to leave SVG before the official start of the field survey.

- Project status;
- Ownership and contractual arrangements;
- Scenario discussions;
- Infrastructure;
- Construction methodologies;
- Operational information such as water and fuel needs, manpower, effluents and wastes, etc.;
- Land acquisition; and
- Stakeholder engagement.

The outcome of the meetings was that the Geothermal Consortium provided the study team with a variety of project documents and relevant SVG laws and policies, in addition to the provision of specific technical explanations. Following the technical meetings, a progress meeting to discuss provisional findings was held with the Geothermal Consortium mid-way through the field visit, and a wrap up meeting was also held on the final day of the survey.

3.3.2 Stakeholder Meetings

Relevant information and opinion was also gathered through a combination of meetings with government stakeholders (see Section 8 for further information), and research by the team's local environmental specialist. The information collected via these two channels was as follows:

- Information on relevant laws and policies to consider;
- Social and environmental baseline data;
- Awareness of the Project; and
- Opinions on key issues and potential impacts for consideration in the ESIA.

The obtained information also included; laws and legal frameworks, other past ESIA studies that have been carried out in SVG recently and whose 'area of project influence', in terms of study area, overlaps with the proposed geothermal project site, and up-to-date data on proposed land take.

In addition to the government stakeholder meetings, and in line with the SEP, the team also held a meeting intended to discuss the project with local NGOs, and an initial meeting with a representative sample of the key community-level local stakeholders and community leaders in the project area. The objective of the latter was to inform participants of the Project and to seek their views and information relevant to the environmental and social aspects of the Project.

3.3.3 Site Survey

The team spent several days at the project site on the slopes of La Soufrière volcano, and in the c. 20 km^2 area around Orange Hill and Georgetown, which was identified as the likely area of project influence.

The main tasks of the site survey were as follows:

- Familiarisation with the immediate project area and the key sites where the principal infrastructure elements will be situated (including drilling sites and access roads);
- Familiarisation with the wider project area of influence;
- Familiarisation with likely locations of temporary construction facilities such as quarries, fabrication yards, etc.;
- Carrying out a site reconnaissance survey. This involved a general walkover of the immediate project area and the wider area of influence, to note key environmental or social features of interest or concern. Detailed field notes and photographs were taken and the locations of interest were recorded using a handheld GPS unit;
- Interviews with local residents and business owners;
- Spatial analysis of prevailing settlement patterns and trends; and
- Consideration of land uses and key livelihoods including trends.

Several days were then spent in Kingstown where the data were analysed, notes prepared and further data collection/stakeholder meetings were held, followed by a wrap up meeting with the client in which the results of the survey were discussed.

3.4 Reporting Phase

Following the field visit to SVG, the team prepared the present Scoping Report. Several virtual meetings were also held during this period, to discuss the next steps with the Geothermal Consortium.

4 LEGISLATION, POLICY AND INSTITUTIONAL FRAMEWORK

The aim of this chapter is to present the context within which the Project will be implemented and managed if all approvals were to be obtained. However, as this is an ESIA-focused Scoping Report, particular attention is paid to components of the framework that pertain, specifically, to the ESIA/'development control' and approval process. General legal and institutional aspects are considered separately from policy matters in terms of context setting and they are followed by a summary of national EIA requirements. Finally, a brief account is provided of the international standards/guidance that are being applied to the proposed Project.

4.1 Project Proponent

A company will be formed by the Geothermal Consortium (GoSVG; EC and RG) under the laws of SVG to own and operate the geothermal power plant assets. During the study, the Geothermal Consortium confirmed that the joint company is not yet formed, but that it will be the project Proponent. The company is provisionally referred to by the Geothermal Consortium as the "Phase 1 Company".

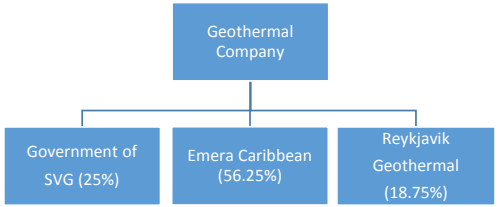


Figure 2: Ownership Structure for the Phase 1 Company

The Parties have agreed to negotiate the right of the GoSVG to acquire the majority interest in the Project after a minimum of 25 years of operation and a right of first refusal upon any sale of Emera/RG's equity interest in the Project.

4.2 Legal and Institutional Context

St. Vincent & the Grenadines has legislation and institutions with the twin objectives of i) protection, conservation, enhancement and restoration of natural resources and addressing environmental and social issues arising from development/s and ii) managing sectoral development initiatives. International Conventions to which GoSVG is a signatory are included in this section, key laws and regulations are as follows (not in any order of significance):

4.2.1 Environmental and social management

- Natural Forest Resource Act (1947);
- Land Acquisition Act (Chapter 241, 1947);
- Central Water and Sewerage Authority Act (No.17, 1991);
- Public Health Act (No.9, 1977);
- Noise Control Act (No.18, 1988);
- Wildlife Protection Act (No.16, 1987) & later amendments (1988, 1991);
- Environmental Health Services Act (No.14, 1991);

- Wildlife Conservation Act (1991);
- Forest Resource Conservation Act (No.47, 1992);
- Town and Country Planning Act (No.45, 1992) & later amendments;
- Plant Protection Act (No.16, 2005);
- Waste Management Act (No.31, 2000);
- National Parks Act (No.33, 2002) and accompanying Regulations;
- The Montreal Protocol Act (2003);
- National Parks (Amendment) Act (No.13, 2010);
- Environmental Management Act (Draft, 2009); and
- Environmental Impact Assessment Regulations (Draft, 2009).

4.2.2 Sectoral development initiatives

Of particular relevance are the two Acts dealing with electricity and geothermal development:

- Electricity Supply Act (No.14, 1973); and the
- Geothermal Resources Development Act (Draft, 2012).

In addition, GoSVG is a signatory to a number of international Conventions and Agreements and five key Conventions/Agreements related to the proposed project are presented below:

- UN Convention on Biodiversity (UNCBD);
- Convention Concerning the Protection of the World Cultural and Natural Heritage (WHC);
- Kyoto Protocol;
- UN Framework Convention on Climate Change (UNFCC); and
- UN Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) – LBS protocol[7].

4.2.3 Institutions and Functions

The main institutions (with their parent Ministries) are presented in Table 1 with a summary of their enabling legislation or key legislative instruments for which they exercise executive functions.

[7] The LBS Protocol Concerning Pollution from Land-Based Sources and Activities is a regional mechanism assisting the United Nations Member States in the Wider Caribbean Region to meet the goals and obligations of two international agreements: The United Nations Convention on the Law of the Sea (UNCLOS) and the Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities (GPA).

Table 1: Key Ministries, Subordinate Entities, Legislation and Functions

Ministries [subordinate Agencies, Departments, Authorities, Offices]	Legislation	Functions
Office of the Prime Minister [Energy Unit]	Not Applicable	Acts as Ministry of Energy. Formulation and implementation of energy policy, encompassing renewable energy and energy efficiency.
Ministry of Health, Wellness and the Environment [Central Water and Sewerage Authority]	• *Central Water and Sewerage Act* (No.6, 1978), amended in 1992 • *Central Water and Sewerage Authority Act* (No.17, 1991)	Conservation and maintenance of the environment in the interest of public health generally and, particularly, in relation to places frequented by the public. Improved provision for the conservation, control, apportionment, and use of water resources.
Ministry of Health, Wellness and the Environment [Environmental Management Department [Solid Waste Management Unit]	• *Environmental Health Services Act (No.14, 1991)* • *Environmental Impact Assessment Regulations (Draft, 2009)* • *Environmental Management Act (Draft, 2009)* • *Waste Management Act (No.31, 2000)*	Conservation and maintenance of the environment Responsible for the collection and disposal of Solid waste on St. Vincent.
Ministry of Agriculture, Rural Transformation Forestry and Fisheries [Forestry]	• *Natural Forest Resource Act (1947)* • *Forest Resource Conservation Act (No.47, 1992*	Conservation, management and proper use of the forest and watersheds, declaration of forest reserves, cooperative forest and conservation areas.
Ministry of Agriculture, Rural Transformation Forestry and Fisheries	• *Wildlife Protection Act (No.16, 1987) & later amendments (1988, 1991)* • *Wildlife Conservation Act (1991)*	Conservation and sustainable management of the Nation's forest, wildlife and national park resources.
Ministry of Tourism and Culture	• *National Parks Act (No.33, 2002)*	Preserve, manage, protect and develop natural and cultural heritage.

Ministries [subordinate Agencies, Departments, Authorities, Offices]	Legislation	Functions
[National Parks, Rivers and Beaches Authority]	• *National Parks (Amendment) Act (No.13, 2010)*	Oversight and co-ordination for management of national parks and protected areas, but with a focus on tourism/recreation.
Ministry of Housing, Informal Human Settlement, Physical Planning, Lands and Surveys [Physical Planning Unit] [Office of the Chief Surveyor]	• *Town and Country Planning Act (No.45, 1992)*	Management of development and how it interacts with the environment and communities, within the planning framework, including the evaluation of, need for and level of EIA requirements. Land surveys for planning purposes and input to GoSVG land acquisition actions
Ministry of Transport, Works, Urban Development & Local Government	• *Road Act (No 15, 1955)*	Oversight of all public infrastructure including roads
Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth		Management of community development-, poverty-, gender- and youth-oriented programmes

The Town and Country Planning Act (1992), the Draft Environmental Management Act (2009) and the Geothermal Resources Exploration and Development Bill (Final Draft, 2012) are the three key pieces of current, or potentially applicable, overarching legislation governing the proposed Project. The Draft Environmental Management Act (2009) is treated here as if it is in force: however, as a number of its provisions resemble policy statements, with regard to renewable energy, it is considered in the section below on 'Policy'.

The Town and Country Planning Act (1992) is the principal legislation governing land-use, spatial and physical planning and the control of the development process. The Physical Planning Unit (PPU) plays an important role in implementing the Act and in the management of the EIA process. Under the Act, Article 29, an EIA for environmentally sensitive projects or activities is required.

The Geothermal Resources Exploration and Development Bill (Final Draft, 2012) is a bill whose provisions are very likely to be applicable in the near future. It describes requirements for, and categories of, approvals such as permits and licences for geothermal development. Approval conditions include the avoidance, minimization and mitigation of adverse environmental impacts.

Also of importance is the Land Acquisition Act (Chapter 241, 1947) as the project will require the occupation of land, whether temporarily or permanently, and it is known that some of the land that is likely to be occupied is agricultural land and in at least one instance contains human habitation (a single household). This Act sets out the procedures and institutional responsibilities for acquiring land for a public purposes and accompanying compensation arrangements.

4.2.4 Permits

As SVG has a well-developed land use planning/development control system the key permit for all proposed developments that fall under the development control process is the "planning" approval that may be issued to a project proponent following consideration of a planning application. The consideration of planning applications takes into account the results of EIA studies, other technical studies and the results of public consultations. Thus, an application accompanied by an acceptable ESIA report can be refused due to other planning concerns (such as architecture/design or location). A 'planning' approval is required before a proposed project can proceed. It has no time limit within which the approved project must be implemented nor is a fee payable. This approval may contain conditions to control/manage potential environmental impacts.

There are very few other permits issued to control/manage interaction between development projects and the environment. For example, no permits are needed for water abstraction, de-watering or aqueous effluent discharges. In term of such discharges SVG applies international standards (this may done via the 'planning approval'). Similarly, there are no permits for managing 'special' solid wastes.

The PPU has the primary responsibility for monitoring a project during construction and operation. This is based on the provisions of an EIA's Environmental and Social Management Plan (ESMP) rather than any requirements set by law. PPU responsibilities are complemented by the Environmental Management Department of the Ministry of Health and Environment, who exercise certain monitoring and inspection functions.

4.3 Policy Context

Two policy levels are considered: regional/international - Caribbean Community and Common Market (CARICOM) and Organization of Eastern Caribbean States (OECS), and national - SVG itself (with a focus on renewable energy).

4.3.1 CARICOM and OECS

SVG is a member of CARICOM and CARICOM energy policy aims to fundamentally transform the energy sectors of member states through the provision of secure and sustainable supplies of energy in a manner which minimizes energy waste in all sectors to ensure that all CARICOM citizens have access to modern, clean and reliable energy supplies at affordable and stable price, and to facilitate the growth of internationally competitive regional industries towards achieving sustainable development of the community.

To reach the goal of the CARICOM Energy Policy and to assure access to affordable, adequate, safe and clean energy products necessary for the development of Member States, CARICOM has developed a programme of regional actions in pursuit of the following objectives including *inter alia*:

a) Sustainable and secure energy supplies developed through diversification of energy sources;
b) Accelerated deployment of renewable and clean sources of energy supplies towards increased energy supply diversification and affordability;
c) Increased investment in production, transformation and distribution of viable energy sources; and
d) Greater use of renewable energy for electricity generation as well as in the transportation, industrial and agricultural sectors.

Finally, GoSVG is committed to the OECS Principles for Environmental Sustainability as set out in the Saint George's Declaration (SGD) of 2001. The 21 principles contained in the SGD place environmental management as a key cornerstone of sustainable development, and OECS Member States have agreed to apply these principles in national policy-making and development decision-making.

4.3.2 St Vincent & the Grenadines

The National Economic and Social Development Plan for St. Vincent and the Grenadines covers the period 2013-2025, and outlines the country's long-term strategies for national development. The Plan *"…offers a vision for improving the quality of life for all Vincentians…."* and is anchored on the achievement of a range of over-arching goals, including *inter alia*:

- High and sustained levels of economic growth;
- Improved physical infrastructure and environmental sustainability; and
- High levels of human and social development.

The goal "Improved physical infrastructure and environmental sustainability" encompasses 'building resilience to climate change'.

A National Physical Development Plan is in preparation. In 2013, the National Physical Development Plan: Preliminary Methodological Framework Report was issued. In 2015, the Ministry of Housing, Informal Human Settlement, Physical Planning, Lands and Surveys initiated public consultations on the draft National Land Policy. However, as the Plan has not been finalized nor the Policy adopted it is too early to consider their policy implications for energy developments. Although neither the Plan nor the Policy have been finalized and/or approved they will influence decision-making on energy projects in the future.

The Prime Minister's office currently functions as the Ministry of Energy and has responsibility for the energy sector. In 2008, an Energy Unit was created, within the Prime Minister's Office, with the responsibility for the formulation and implementation of energy policy, encompassing renewable energy and energy efficiency. A key element of the Energy Policy is to facilitate the safe production of geothermal energy for the benefit of the people of SVG.

Part V of the Draft Environmental Management Act (2009) addresses renewable energy and states *inter alia*:

1) In collaboration with other Ministries, government departments, statutory authorities, civil society organisations and the private sector, as appropriate, the Department [Environmental Management Department] shall evaluate and promote the use of new and renewable sources of energy and energy efficient technologies and systems through the application of economic instruments and the rationalisation and simplification of regulatory regimes; and

2) Without limiting the generality of subsection (1), the Department shall *inter alia*:
   a) Review current energy supply mixes to determine how the contribution of environmentally sound energy systems as a whole, particularly new and renewable energy systems, could be increased in an economically efficient manner;
   b) Cooperate in identifying and developing environmentally sound and cost effective energy sources to promote the availability of increased energy supplies;
   c) Promote the research, development and use of technologies and practices for environmentally sound energy systems, including new and renewable energy systems; and
   d) Coordinate energy plans sub-regionally and regionally and study the feasibility of efficient distribution of environmentally sound energy from new and renewable energy sources.

4.4 National EIA requirements

Under Article 29 of the Town and Country Planning Act (1992), an Environmental Impact Assessment is required for environmentally sensitive projects or activities. The Physical Planning Unit (PPU), which functions as the technical and advisory arm of the Physical Planning and Development Board (PPDB), has the legal authority for environmental management under this Act.

The PPU's authority includes determining the need for EIA, the level of EIA required, and leading the eventual review of the EIA produced. The scope of an EIA is determined through discussion between the project developer and the PPU. The PPDB has the remit to achieve the purpose and implement the provisions of the Act, and plays an important role in applying the provisions of the draft *Environmental Impact Assessment Regulations* (2009). Although not formally approved, these Regulations are informally applied by GoSVG and it requests all EIA development to follow the assessment and decision-making process established in the draft Regulations. The procedures, systems and institutional linkages are all in place to ensure smooth operation of the Regulations, for example, the National Environmental Appraisal Committee consisting of 15 members from various governmental departments has been formed. The PPU is responsible for ensuring development occurs within GoSVG environmental and social requirements. The EIA process as implemented under the 2009 draft *Environmental Impact Assessment Regulations* is shown in Figure 3. It should be noted that there is no limit on the age of data used in EIA studies in SVG.

Stakeholder engagement is regarded as an important element of the EIA process. However, requirements for stakeholder engagement are not specified in detail and are discretionary in nature as presented in Article 15, of the *Environmental Impact Assessment Regulations* (Draft, 2009), which state:

- At any time during the EIA process, the Board [PPDB] may invite written comments from interested persons concerning the environmental impact of the undertaking;

- The Board may forward the written comments to the developer who shall answer any pertinent questions raised in such written comments; and
- The procedure for public disclosure and involvement shall be determined by the Board.

Following submission of an EIA Report to the competent authorities, it should be made available for public review. Generally, the PPU advertise that the draft ESIA report is available at their offices for comment. The advertisement is published in 3 local newspapers and in a governmental gazette disseminated via governmental offices at the local level. A 14-day period is provided to the public for lodging questions and concerns. Public meetings are not normally held unless the National Environmental Appraisal Committee requests it.

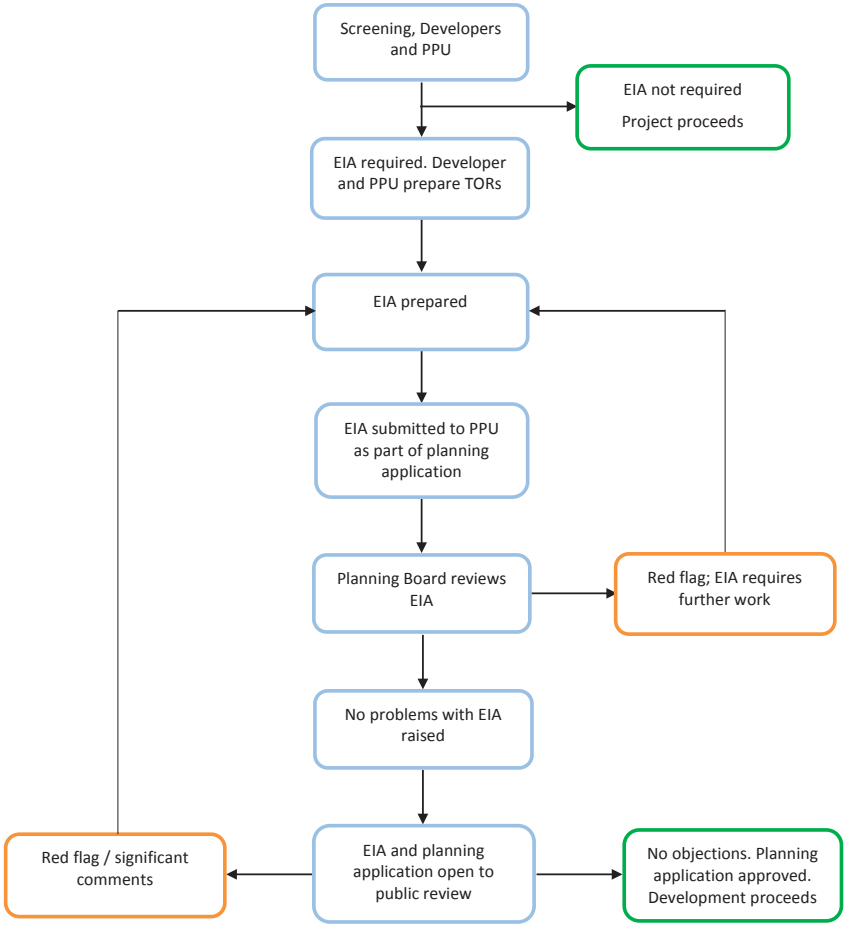


Figure 3: The EIA Process in SVG

4.5 International Requirements

Work to develop this Scoping Report and the subsequent ESIA work leading to preparation and submission of an ESIA report have been/will be in compliance with the suite of Performance Standards (PSs 1 to 8), issued in 2012, by the IFC. IFC, which is incorporated within the World Bank Group, invests in private projects. It is possible that the Consortium will apply for financial support to IFC or one or more commercial banks. Most large commercial banks are signatories to the Equator Principles which set requirements to be met by potential borrowers in terms of the environmental and social aspects of proposed projects. As compliance with the PSs helps meets the Equator Principles, an ESIA Report (and attendant documentation such as a Stakeholder Engagement Plan) that is compliant with these Standards will be considered acceptable by such banks.

The suite of IFC PSs comprises the following:

- PS1: Assessment and Management of Social and Environmental Risks and Impacts;
- PS2: Labour and Working Conditions;
- PS3: Resource Efficiency and Pollution Prevention;
- PS4: Community Health, Safety and Security;
- PS5: Land Acquisition and Involuntary Resettlement;
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- PS7: Indigenous Peoples; and
- PS8: Cultural Heritage.

Certain of these PSs apply to all prosed projects whereas the applicability of others is determined early in the ESIA process. This Scoping Report is the written output of the first stage (scoping) of the ESIA process and thus at the beginning of scoping work all PSs were deemed too be applicable. Subsequently, the results of the scoping work have confirmed that all PS except for PS7 on Indigenous Peoples remain applicable.

In considering the potential applicability of PS7 potential candidate ethnic groups were considered, including the criterion of self-identification. Only one such group - the Garifuna (Black Caribs) - was identified and information on this group was analysed and considered against the set of criteria presented in PS7, for identifying Indigenous Peoples.

At the time of settlement of the islands of St Vincent by Africans and Europeans, the Carib people were well established (they had earlier settled in the island and had displaced the existing Amerindian people from most parts of the island). The Garifuna are the descendants of miscegenation between the Carib people and Africans and currently mostly live in communities in the northern part of St Vincent. In recent years there has been a revival of Garifuna culture both in SVG and in other countries of the Caribbean where populations exist.

Garifuna communities in St Vincent do not exist within the Area of Influence (AoI) established for the proposed Project and thus will not be affected directly by the Project. Also, consideration of other PS7 criteria resulted in a decision that the Garifuna could not be considered to be indigenous within the meaning of PS7 as they do not:

- Exhibit a collective attachment to geographically distinct habitats or ancestral territories in the project area [AoI] and to the natural resources in these habitats and territories;
- Maintain customary economic, social, or political institutions that are separate from those of the mainstream society or culture (however, it should be noted that the Garifuna do maintain customary cultural features/institutions); and
- Speak a distinct language or dialect, different from the official language or languages of the country or region in which they reside.

Therefore, PS7 has been removed from the suite of potentially applicable PSs.

As PS3 on Resource Efficiency and Pollution Prevention is applicable to the Project then the World Bank Group (2007) General Environmental, Health and Safety (EHS) Guidelines, and the relevant accompanying Industry Sector Guidelines, also, are applicable[8]. PS3 makes specific mention that these Guidelines are to be used to address IFC's expectations regarding the pollution management performance of projects. They are designed to provide relevant industry background and technical information to support actions aimed at avoiding, minimising, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project. IFC uses the EHS Guidelines as a technical source of information during project appraisal activities. In addition to the General EHS Guidelines, the relevant Industry Sector EHS Guidelines, for this Project, are considered to be:

- Geothermal Power Generation (2007);
- Water and Sanitation (2007); and
- Waste Management (2007).

[8] All EHS Guidelines are available at: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines

5 PROJECT DESCRIPTION

5.1 Geothermal Power Production

Geothermal resources are concentrations of the Earth's heat, or geothermal energy that can be extracted for economic use. Where concentrations of thermal energy arise near the surface of the Earth (usually in areas of volcanic activity), they can be used as an energy resource.

All existing applications of geothermal energy use a circulating fluid to carry the heat from depth to its use at the surface. In most cases, that fluid originates in the geothermal reservoir, but where permeability is low or there is no *in-situ* fluid, cooler water is injected and circulated through natural or induced fractures in the rock to gain heat, prior to being returned to the surface for use.

Geothermal power generation therefore involves drilling deep exploration and production wells into the Earth's crust to harness the thermal energy contained in underground reservoirs. Wells are drilled in clusters with each cluster ("drill pad") typically comprising two to five wells. These wells bring a mixture of steam, gas and water (referred to as "brine") to the surface where the steam is separated and used to power turbines to produce electricity. Brine and condensate removed by separators are usually returned to the ground via reinjection wells.

Figure 3 shows how a generic geothermal power production system operates, and Figure 4 shows a schematic that approximates how the geothermal project in St. Vincent will function.

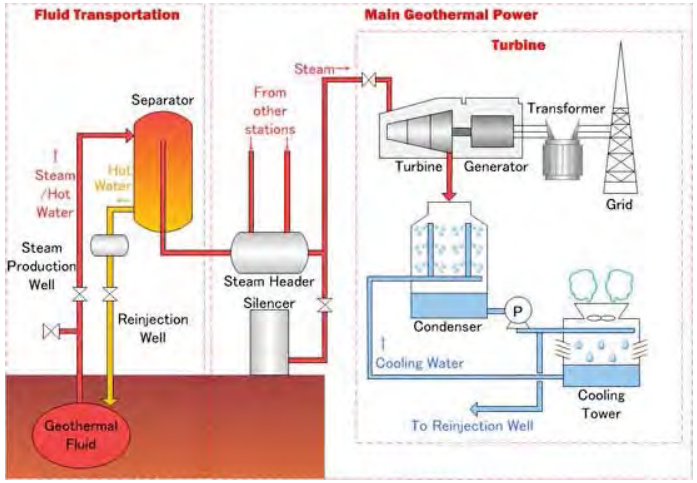


Figure 3: Schematic of Geothermal Power Production

Source: www.yokogawa.comindustryrenewable_energygeothermal_powerindex.htmnid=megadlist

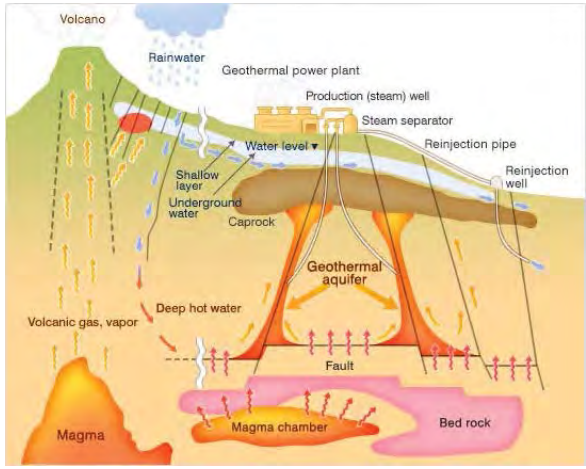


Figure 4: Geological Context of Geothermal Power Production

Source: https://www.mhi-global.com/discover/earth/technology/geothermal.html

5.2 The Geothermal Resource & Development of the Project

St. Vincent is a volcanic island and like other volcanic countries has the potential for clean, renewable energy from the geothermal resource. Geothermal energy presents an opportunity for St. Vincent to significantly reduce its reliance on imported fuel for power generation and achieve greater energy independence and security. Various studies and surveys (including resistivity testing and LiDAR) have been undertaken by the Proponent, and these have confirmed that the Soufrière area is very promising from a geothermal perspective, and it is expected that an exploitable >230°C geothermal reservoir is present. In parallel, analysis of the electricity demand on St. Vincent also indicates sufficient electricity need to make the project viable.

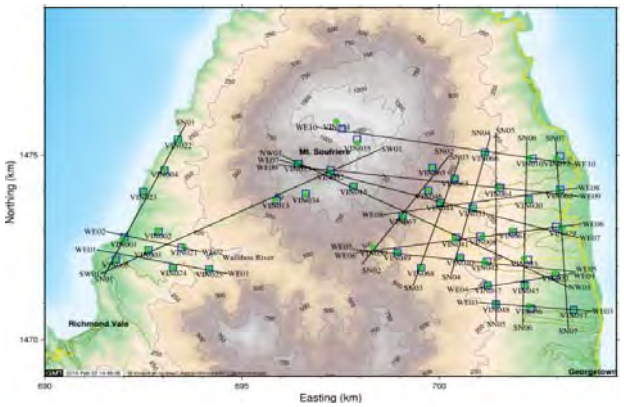


Figure 5: Location of Resistivity Test Points and Transects

The resistivity survey results allowed the Proponent to investigate the likely profile of the geothermal resource, and as a result, it was found that transect WE07 (see Figure 5 above) showed the greatest potential. The contact between the low resistivity cap and the high resistivity beneath denotes the 240°C temperature isotherm. This interface is at 1,000 meters depth under the area around the summit and half way down the slopes. As can be seen in Figure 6 below, the survey shows that the geothermal resource is closest to the surface at higher elevations, and that the resource is more favourable on the eastern side of the island.

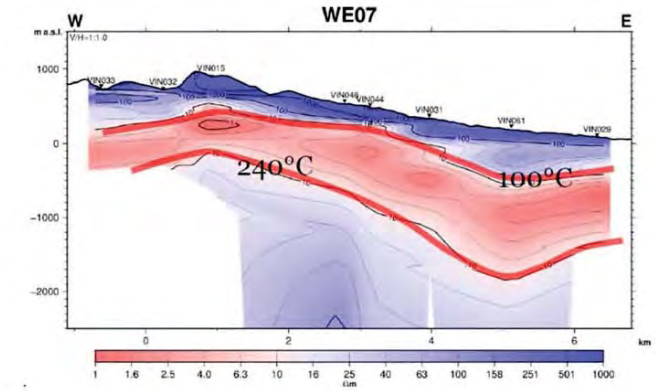


Figure 6: WE07 Cross Section with Temperature Isotherms

A LiDAR aerial survey was also carried out to determine the structural geology and define the location of geological faults. These fault lines are important locations for surface water to penetrate and enter the underground geothermal resource. Additionally, the LiDAR imagery allowed the identification of flat areas that could be suitable for the construction of the project infrastructure.

In parallel with the geological investigations, the proponents carried out a review of the existing infrastructure on the island to determine whether port facilities, access roads and other infrastructure is compatible with the project plans, and if not, what the likely works and costs would be to adapt/upgrade the existing infrastructure. The review concluded that due to the requirement for significant road upgrades and a marine landing site, potential drilling locations on the leeward (west) side of the island ought to be avoided. The same review determined that the access and infrastructure requirements for the potential drill sites on the windward side of the island were favourable, and only minor upgrades would be required (see Section 5.5).

The overall results of the geological investigations and infrastructure surveys therefore pointed towards an area for exploratory drilling on the eastern side of Soufrière, some 4 km inland from the settlement of Orange Hill.

5.3 Project Phasing

The two major phases of the Project are exploration and production. For the purposes of environmental and social studies, the project phasing is further divided, into exploration; construction; production and decommissioning.

5.4 Project Area

5.4.1 Introduction

St. Vincent and the Grenadines is an archipelagic state that forms part of the Windward Islands, themselves part of the Lesser Antilles, in the Southern Caribbean. St. Vincent and the Grenadines is neighboured by several other Caribbean island nations; St Lucia to the North, Barbados to the East and Grenada to the South (see Figure 1).

The total land area of the country is approximately 389 km^2 and the capital, Kingstown, is located on St. Vincent - commonly referred to as the mainland. St. Vincent is the largest and most populated island in the country and is located to the north of the archipelago. It is roughly elliptical in shape and is 29 km north to south and 18 km wide (west to east).

The Project will be located on the south-eastern slopes of La Soufrière volcano, some 4 km inland on the eastern side St. Vincent, and approximately 35 km by road from Kingstown. Figure 7 shows the wider project area.

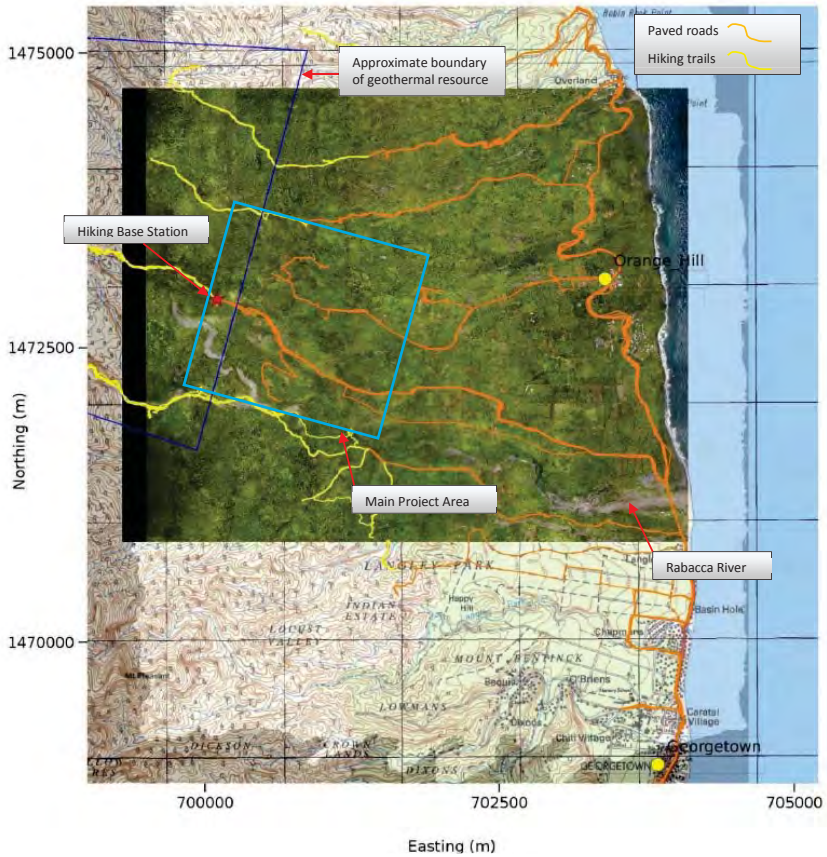


Figure 7: Map and Aerial Imagery Showing the General Project Area

5.4.2 Directly Affected Area

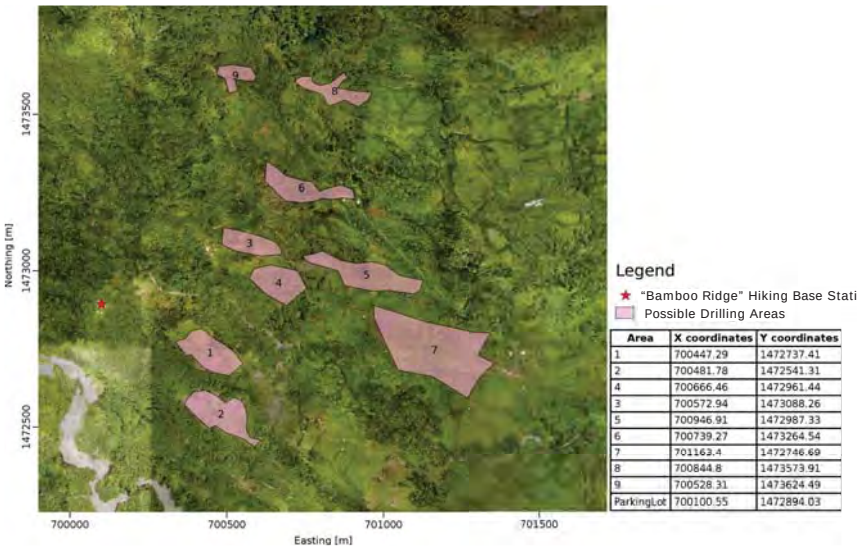
Recent geophysical surveying and infrastructure reviews have resulted in the selection of nine potential drill sites (allocated reference numbers from W1 to W9). These nine sites sit in a cluster within an area of approximately 2 km by 2 km (shown in Figure 7 above) at an altitude of around 300 m above sea level.

The sites are spread across a series of small ridges and valleys, and the area is accessed by three separate "feeder roads" (single-lane roads, generally surfaced with asphalt or concrete, and used for access to agricultural land and recreation) that climb in an easterly direction up towards Soufrière from the Windward Highway. The nine potential drill sites are shown in Figure 8.

Of the nine sites, W1 and W3 have been identified as the most suitable for exploration, and are considered to be the primary sites. It is currently expected that exploratory drilling will occur at either site W1 or W3, and likewise, it is expected that the exploration will be successful. If the exploration unfolds as expected, the area that will be directly affected by the drilling operations and eventual production facilities will be a fairly limited. It should be noted, however, that at the present scoping stage, the Proponents have indicated that, should exploration at sites W1 or W3 prove unsuccessful, it is possible that exploration activities will shift to one of the seven other sites (and if successful, production infrastructure would subsequently be installed in that area).

In view of the above possible scenarios, the present Scoping Study has considered the potential impacts of operations occurring in any one (or more) of the nine sites, whilst focussing on the likely eventuality that only sites W1 and/or W3 will in fact be directly affected by the Project. The directly affected area is, however, not limited to the distinct boundaries of the nine potential drill sites, as various other project activities or infrastructure may occur or be located outside of the distinct parcel boundaries:

- Sites W1 and W2 are accessed by the most southerly feeder road adjacent to the Rabacca River, which is also the road to "La Soufrière Cross Country Trail" hiking base station (referred to locally as "Bamboo Ridge"). The hiking base station has the potential to be affected by the project, and is therefore included in the directly affected area.
- Also included in the directly affected area is the Rabacca, Waribishy, Tourama and Camariabou Rivers, as these may be used at water sources for project operations (see Section 6.5 below).
- One or more HDPE pipelines may be required to be laid between the water source and the exploration drill pad.
- It is likely that any water storage pond will be constructed outside the 100 m x 100 m drill pad.
- It is possible that the project will employ reinjection as the method for disposal of used geothermal liquid. If this method is selected, an area of around 100 m by 100 m will be required approximately 500 m downhill of the drill pad.



Area	X coordinates	Y coordinates
1	700447.29	1472737.41
2	700481.78	1472541.31
4	700666.46	1472961.44
3	700572.94	1473088.26
5	700946.91	1472987.33
6	700739.27	1473264.54
7	701163.4	1472746.69
8	700844.8	1473573.91
9	700528.31	1473624.49
ParkingLot	700100.55	1472894.03

Figure 8: Aerial Photo of Main Project Area Showing the Nine Potential Drill Sites

- Due to the phasing of the project development being such that the siting and design of the eventual production infrastructure (such as generating station and substation) are not due to be determined until after the exploration phase has yielded results, it is not presently known precisely where the infrastructure will need to be located, nor exactly what form they will take.

As a result of the above factors, the Scoping Study has taken the conservative view that the entire area inside the blue boundary shown in Figure 7 above should be considered as the directly affected area. This area will be refined during the Phase 2 ESIA, once more details are known.

5.4.3 Area of Influence

The IFC's PS1 requires that the Project's AoI is determined based on the following guidance:

"Where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence. This area of influence encompasses, as appropriate:

- *The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.*
- *Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.*
- *Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.*

In the event of risks and impacts in the Project's area of influence resulting from a third party's actions, the client will address those risks and impacts in a manner commensurate with the client's control and influence over the third parties, and with due regard to conflict of interest.

Where the client can reasonably exercise control, the risks and impacts identification process will also consider those risks and impacts associated with primary supply chains, as defined in Performance Standard 2 (paragraphs 27–29) and Performance Standard 6 (paragraph 30).

Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate environmental and social impacts, the identification of risks and impacts will take into account the findings and conclusions of related and applicable plans, studies, or assessments prepared by relevant government authorities or other parties that are directly related to the project and its area of influence. These include master economic development plans, country or regional plans, feasibility studies, alternatives analyses, and cumulative, regional, sectoral, or strategic environmental assessments where relevant. The risks and impacts identification will take account of the outcome of the engagement process with Affected Communities as appropriate."

Based on the preliminary results of the ESIA scoping study, the Project's AoI has been determined, as follows:

- Areas of immediate Project footprint:
  - The 2 km by 2 km area that encloses the nine sites to be considered for the Project Phases I and II;
  - 100 m by 100 m areas approximately 500-metres downhill of each of the sites for optional location of reinjection well;
- The hiking base station at "Bamboo Ridge";
- Agricultural plots located along the existing two paved roads (going from the Windward highway to the Project sites) to be used by the Project for transportation of equipment and materials;
- Settlements located along the coastline approximately 3-4 km from the Project layout area, namely Sandy Bay, Orange Hill, Langley Park, Overland, Tourama, and Georgetown;
- Windward Highway (Kingstown – Sandy Bay section) and its immediate surroundings; and
- Areas required for construction of the transmission lines (to be determined in later stages of Project development).

5.5 Infrastructure & Equipment

5.5.1 Introduction

Due to the nature of geothermal project development, at the time of the Scoping Study, only approximate or outline details were known by the Proponent for many aspects of the eventual infrastructure and construction/operational procedures of the geothermal scheme. This is particularly the case for the production phase of the project, about which very little can be confirmed at present.

During the Study, the team gathered project design documents and questioned the Proponents regarding issues and components of the project that were not clear. The resultant picture of the project infrastructure has been further bolstered through additional research into other geothermal projects, and the description provided below is the most accurate description that is possible at this time. The description does, however, include some minor assumptions about the likely project infrastructure.

The eventual ESIAs for phases 1 and 2 will need to obtain and provide more up to date information on the project infrastructure, construction and operation, as it is likely to have significant influence on impact assessment and development of suitable mitigation measures.

5.5.2 Exploration Phase

Project Infrastructure required for the exploration phase is as follows:

- *Circa* 100 m by 100 m drill pad, on which will be located:
  - Drill rig, including generators and other ancillary equipment;

- Drilling mud mixing / separation facility;
- Discharge/test pond;
- Waste storage area;
- Potable water tank;
- Fuel tank(s);
- Office, laboratory and accommodation/mess units (depending on the preference of the selected contractor);
- Materials storage area (e.g. for lubricants and consumables, bentonite and chemical additives for drilling mud preparation, and 4 or 5 standard 12 m shipping containers for spare parts);
- Mechanical and electrical workshop container;
- Cementing Unit, including mixer and pumps;
- Vertical cement containers;
- Parking area;

- Drilling water pond (although a tank may be used);
- Access roads;
- Reinjection pad, including laydown area;
- Water intake system and pipeline;
- Warehouse containers for drilling materials;
- Mechanical and Electrical workshop container;
- Area for storing drilling materials (e.g. casing, bits, valves and accessories); and
- Cutting disposal area.

Equipment to be located at the drill pad includes:

- Several excavators for earthworks, digging of water ponds, etc.;
- 50 tonne crane (two may be used, depending on the contractor);
- Generator set;
- Pumps, (3 triplex pumps);
- Water tank;
- Mud tanks; and
- Mixing tank for mud.

Other equipment that will be needed includes:

- 4x4 vehicles for project workers; and
- Trucks (various types – e.g. articulated, lift truck and “low boys”) for transport of materials to site.

Further details of some of the key items of infrastructure and equipment for the exploration phase are provided below, and a general view of an example layout of a drill pad from a similar project in the Caribbean is shown in Figure 11.

Drill Pad

The drill pad(s) will be approximately 100 m by 100m in size, though the final size will depend on various factors such as the topography of the selected site, the specifications of the contractor’s equipment and their selected methodology. Stantec estimated that the available areas for conversion to the drill pad are 80 m x 125 m at site W1 and 55 m by 181 m at site W3. The pad will need to be level, so considering the undulating nature of the terrain in the project area (and despite the selection of the most level sites available), it will be necessary to excavate into the hillside to a maximum cut depth of 6 m. The uphill slopes of the pad will be sloped and possibly lined to improve stability. The base of the pad will require a 1 m layer of compacted hardcore or similar material, laid on a geotextile membrane.

A provisional design of the drill pad is provided in Figure 9.

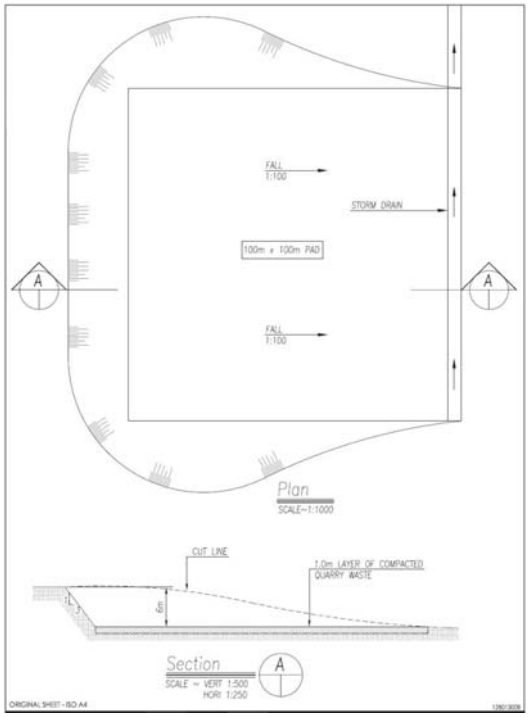


Figure 9: Preliminary Design of Drill Pad

Drill Rig & Well

The manufacturer and specification of the drill rig to be used is not known at present, and will be dependent on the eventual contractor's preferences. It is, however, likely that the rig will be a trailer-mounted hydraulic powered top drive rig driven by four hydraulic motors powered by a diesel engine with a total power of around 1,500 bhp. The rig mast will be around 20 to 25 m tall. The drill rig includes the above-mentioned engine and all hydraulic components, as well as all control equipment, mud pumps and mud separation system (including shale shaker, and desilter).

A cross section of the likely rig type is provided in Figure 10 below, and a photo of what the erected drill rig is likely to look like is shown in Figure 11.

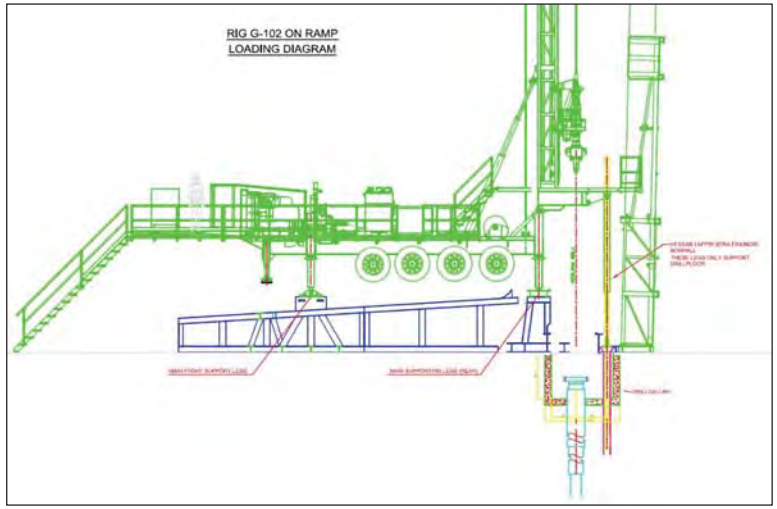


Figure 10: Cross Section of Installed Drill Rig

Figure 11: Typical Layout of Geothermal Drill Rig and Pad (in Montserrat)

Source: http://www.jardboranir.is/rig-sleipnir-in-montserat/

The wells will be approximately 60 cm in diameter at the well head, with the diameter decreasing in four stages as the well is sunk, to a final diameter of around 22 cm, as shown in Table 2 and Figure 12 below. The wells will have depths of around 2,500 m, though the final depth will depend very much on what the exploration reveals. A well head valve system will be installed to prevent blowouts and to control the flow of gases and geothermal liquid.

Table 2: Specification of Wells

Open Hole	1 Stage Surface Casing	2 Stage Anchor Casing	3 Stage Production Casing	4 Stage Perforated Liner
Hole Size, inches	24" – 26"	17 ½"	12 ¼"	8 ½"
Hole Depth, meters MD (Measured Depth)	0 – 150	0 – 790	0 – 1770	1740 – 2500
Vertical Depth, meters	0 – 150	0 – 770	0 – 1620	1590 – 2250
Casing and Liner	18 $^{5}/_{8}$" – 20"	13 $^{3}/_{8}$"	9 $^{5}/_{8}$"	7"
Drilling Duration, days, (estimated)	7	18	22	20

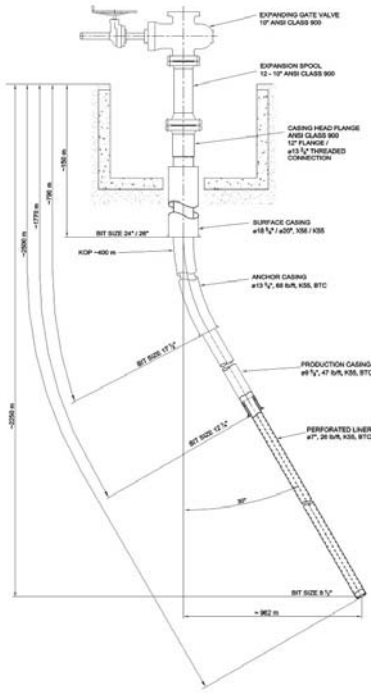


Figure 12: Schematic of Planned Well

Mud/Water Ponds/Tanks

The process of drilling the wells has a considerable requirement in terms of water and bentonite clay, which are mixed with other ingredients into a slurry known as "mud" and used for lubrication and other purposes. Although the drilling mud is recycled when possible, it is common to lose considerable amounts down the well during the drilling, and in the latter stages of drilling (when all fluids are lost to the well), water instead of mud is used to lubricate the drill bit. There is therefore a requirement to have a significant amount of water stored on site. It has been estimated that for the present project a pond of approximately 61 m by 61 m with a depth of 3 m will be needed to hold the required 8,640m^3 of water at each drill site. The pond will be lined with a 2 mm thick HDPE membrane to prevent leakage. The provisional design for the pond is shown in Figure 13. It is possible that the contractor will decide to use a tank for the process water rather than a pond, but a pond is more likely. It is also expected that the water pond would be built outside the drill pad area, most probably uphill of the pad.

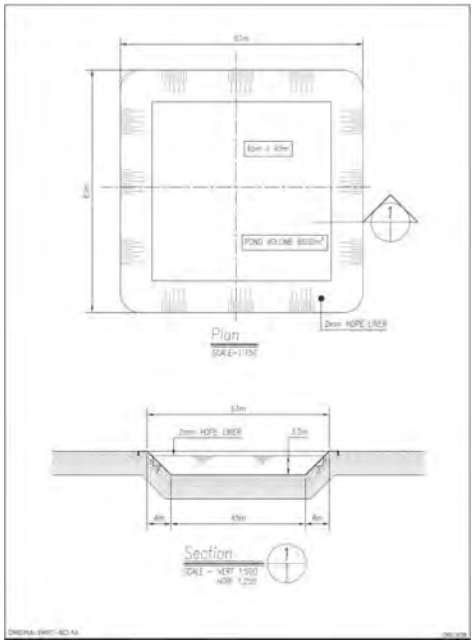


Figure 13: Preliminary Design of Water Supply Pond

In addition to the water pond for storage of process water, there will be a need for smaller ponds (or tanks) for storage of mixed drilling mud, and for used drilling mud and cuttings. These ponds will be located on the main drill pad. Figure 14 shows a common layout for the mud system, including a pond for receipt of waste material.

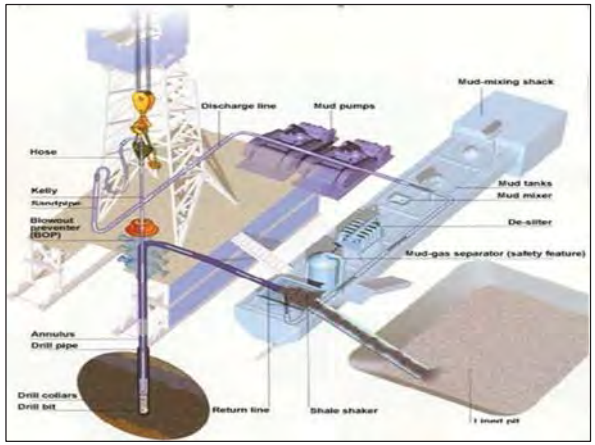


Figure 14: Common Layout of Drilling Mud System

Finally, a pond will be required for discharge of the geothermal liquid prior to testing (this pond is commonly used as a "multipurpose" pond – serving as additional capacity for drilling mud or waste process water). This pond will be similar in size to the water storage pond.

Water Intake System

A thorough investigation into the available water sources near the project area has not yet been carried out. As such it is currently unclear as to whether ground or surface water will be used, and if surface water is used (as is more likely), precisely where it will come from and what the capacity of that source will be. Furthermore, due to the high porosity of river bed materials in the area, the nearby rivers often have low or no surface flow. This means that it may be possible that some form of well and pump system will be required to extract water. Despite the current unknowns with regards to the water supply, provisional investigation indicated that there is sufficient flow in the Rabacca and Tourama Rivers to supply the drilling, but that a small concrete weir structure would be needed to facilitate water harvesting. A small diameter (i.e. below 25 cm) HDPE or steel pipeline will be required to convey the water from the intake point to the water storage facility.

Reinjection Pad

During the exploration phase, a limited volume of geothermal liquid will be produced. It is possible that this liquid will be disposed of at the main drill pad, if the ground/geological conditions allow, however it is most likely that a reinjection pad will be required. The design of the potential reinjection pad has not yet been developed, but it will likely be of similar dimensions and construction to the main drill pad, but located some 500 m or so downhill. A well would be drilled on this site for reinjection purposes, and a pipeline would run from the main drill pad to the reinjection pad. If a reinjection pad is employed for this project, it will likely also function as a contractor lay down / storage area, but will not require ancillary well equipment as will be found at the main drill pad(s).

5.5.3 Production Phase

As has been described above, until the extent and nature of the potential geothermal resource is known, the location and design of the production phase infrastructure cannot be finalised. This is particularly true of the location; whilst generic features of the production system are known, the location of the buildings and infrastructure cannot be determined at present. The description of infrastructure below is based solely on preliminary studies, and will require revision during the subsequent Phase 2 ESIA.

If exploratory drilling is successful, the final production geothermal scheme will likely be composed of the following key elements:

- The geothermal wellfield, expected to consist of three geothermal wells;
- A 10 to 15 MW electricity generating station, including:
    - Two "single flash" condensing turbine/generator units;
    - Cooling system/towers;
    - Lubrication system;
    - Hybrid gas extraction system;

    - Control room/SCADA system;
    - Office and accommodation;
    - Workshop, warehouse, stores etc.;
- Transformer yard/substation;
- Transmission lines to evacuate the produced electricity;
- A separator station;
- A reinjection pad;
- Pipelines from the wellfield to the generating station and reinjection pad;
- A pipeline from the generating station to the reinjection pad; and
- Access roads between the main road and the site, and between the main site components.

Further details of some of the key items of infrastructure and equipment likely to form the main production phase of the Project are provided below.

Wellfield

The location, design and layout of the wellfield cannot be accurately defined until exploration is complete. It is expected that three production wells will be drilled for the project:

- Two deep directional exploration wells (2500 metres);
- One deep vertical or directional production well (2500 metres); and
- One vertical reinjection well (1000 metres).

Although the current expectation is for three wells, it is possible that more will be required. Likewise, although the Proponent will be seeking to minimise the number of separate drill pads required to one, it is possible that two or more will be needed.

Assuming that the exploration is successful, however, the existing exploration wells at sites W1 and/or W3 will simply be converted to production wells, without the need for additional drilling. This conversion is essentially a tidying up procedure during which most of the equipment at the pad is removed, leaving only the valves on the wellhead and the pipes carrying the geothermal liquid to the separators/generating station.

Generating Station

The generating station building will consist of a turbine hall of 41 m by 14 m that will house the turbines, generators, condensers, pumps and gas extraction system, and an annex building that will house control and electrical equipment and staff facilities. The turbine hall will be equipped with an overhead crane for maintenance and a large door at one end with a service area in front, for laying down large equipment during maintenance. Adjoining the generating station will be the cooling towers. The preliminary layout of the generating station is shown in Figure 15.

The cooling towers are is assumed to be of induced draft counter flow type. This type of cooling tower distributes the hot water in small droplets from the top of tower, against a draft of colder air rising from the bottom of the tower that is created by a fan at the top of the

tower. As the droplets fall slowly and against a cool air current, they cool down as they fall. It is likely that the design will also include a concrete water basin for storage of cooling water.

Geothermal steam contains some non-condensable gases (NCG), and these will likely be removed via a combination of steam jet ejectors and liquid ring vacuum pumps (LRVP), known as a hybrid system.

H_2S detection equipment will be located in the power plant annex building. The annex building will have a ventilation system which will ensure that the facility receives pressurized and filtered air. H_2S levels will be monitored and maintained below 1 ppb. The design of the H_2S removal system will depend on the H_2S content of the geothermal resource, and cannot therefore be accurately predicted at this stage.

A fire detection and extinguishing system will be installed in all areas containing electrical equipment, or as required by local fire authorities. A custom designed fire extinguishing system (expected to be of foam type) will be installed at the turbines. It is foreseen that, even for the non-electrical areas, a fire fighting system including water storage and pumps will be required due to the fairly remote location of the site.

Lubrication System

The lubrication system provides lubrication to the bearings of the turbines and generators and remove heat. It consist of a small oil tank, oil filters, pumps, heat exchangers, and pipes, and will be positioned adjacent to the turbine/generator units.

Substation

It is expected that the project will require a sub-station consisting of three transformers, which will be located adjacent to the generating station. The main step-up transformer and two distribution transformers, (one for each generating unit) will be oil-immersed transformers, with oil coolers, pressure relief devices, oil level switches and temperature detectors with alarms.

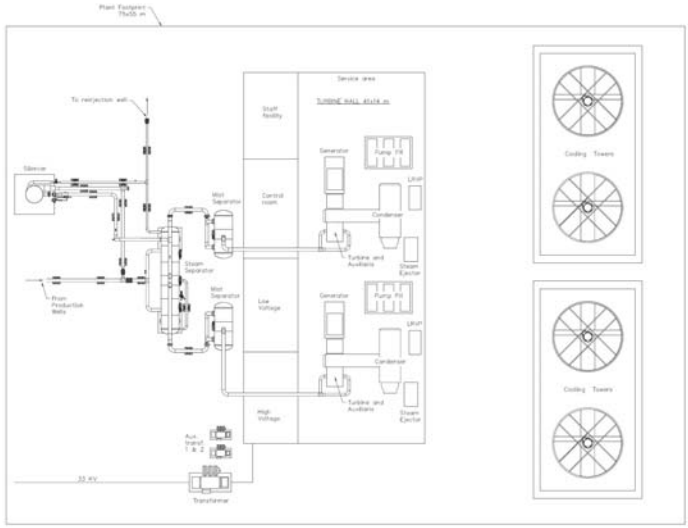


Figure 15: Preliminary Layout of Generating Station

The connection terminals to the main grid will be at the main step-up transformer's high voltage terminals. Voltage transmitters and surge arresters will be connected to the transformer. It is assumed that VINLEC will install the 33 kV grid connection, either by open-air connection or by cable-end connection.

In countries with high incidences of electrical storms (such as SVG), it is common to install lightning protection devices.

Transmission Lines

Two 33 kV transmission lines are planned for the project. Having two lines capable of carrying 100 % of the electricity produced by the Project will ensure reliability and complete redundancy.

At present, it is proposed by the Proponent that two separate circuits will be constructed along two separate alignments, as follows:

- A 16 km line between the geothermal plant and the South Rivers substation; and
- A 24 km line between the geothermal plant and Cane Hall substation.

The line to Cane Hall is proposed to largely follow the existing utilities corridor alongside the Windward Highway (along which the existing 11 kV distribution system is installed), whereas the line to South Rivers is proposed to follow a new alignment inland. Both provisional alignments are shown in Figure 16 below.

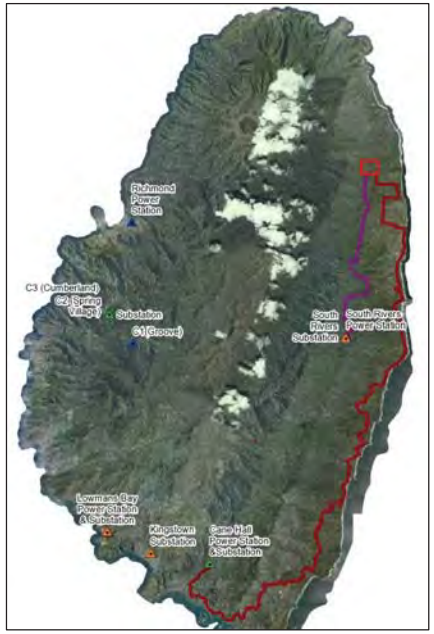


Figure 16: Possible Alignments for the 33 kV Transmission Lines

In a meeting with VINLEC during the Scoping Study, VINLEC confirmed that spare breakers exist at both the South River and Cane Hall substations, but they also voiced concerns about the provisional plan to have the transmission line to Cane Hall follow the existing coastal corridor. This is due to safety concerns for maintenance workers, and system continuity concerns (i.e. the 11 kV line may have to be shut down during maintenance of the higher 33 kV system). Other concerns that VINLEC had with regards to the coastal route were the corrosive environment, which could necessitate the use of copper cabling, which would significantly increase cost.

VINLEC confirmed that the design for the transmission lines has not yet begun, and funding for the same is yet to be secured.

The new alignment across the interior to South Rivers (and possibly on to Cane Hall) would clearly require considerable forest clearance, and likely some land acquisition. The use of towers to span valleys is likely to be considered.

Separator Station

The separator station will be a small pad close to the production wells where the two phase fluid is separated into steam and brine. The steam is sent to the turbines and the brine is sent to the reinjection wells. Other equipment and instruments are often found at separator stations, such as pneumatic control valves, silencers, and pressurized air tanks. Figure 17 shows a separator station at the Berlin Geothermal project in El Salvador.

Figure 17: Seperator Station at the Berlin Geothermal Project, El Salvador

Source: Molina (2011)

Reinjection Pad

Little in the way of infrastructure is required at the reinjection pad. It is highly likely that for this project, the reinjection process will be gravity-fed. If permeability in the reinjection well is found to be lower than expected, installation of high pressure pumps will be required.

Pipelines

Various small diameter pipelines will be laid across the Project area, including those carrying the geothermal liquid from the wells/separator station to the production facility, those carrying cooling and potable water, and the pipelines carrying the used geothermal liquid to the reinjection pad. The design and layout of these systems is as yet unknown, but will most likely bear a resemblance to the pipelines shown in Figure 18 below. The pipelines will be protected with insulating material to reduce heat loss and to protect workers from the risk of burns.

Figure 18: Pipelines at the Berlin Geothermal Project, El Salvador

Source: Henríquez, & Aguirre (2011)

Access Roads

The eventual production scheme will require reliable vehicular access between the main road and the site, and between the main site components such as the wellpad(s), generating station and reinjection pad. Single carriageway tracks or roads will therefore need to be installed. It is likely that these will be asphalted.

5.6 Construction

5.6.1 Exploration Phase

The exploration phase will begin with the upgrade of the existing feeder roads leading from the Windward Highway to the project site. A review of the specific upgrades required has not yet been carried out, but it is expected that the work will consist only of minor repairs, rather than any significant widening or drainage works; these repairs are unlikely to require land acquisition. Likewise, no bridges will be required, and no straightening of corners. If site W1

is used for exploration, no works will be required along the main Windward Highway, however if site W3 is selected, there is likely to be a need to modify the road at the 18th century aqueduct in Orange Hill (see Figure 41), to allow passage of Project Equipment.

The road upgrade works will be carried out either by local contractors, or directly by the Ministry of Transport, Works, Urban Development & Local Government. It is expected that the road upgrade works will require one or more small teams of labourers, one or two excavators, a grader, trucks for delivery of sub-base materials and asphalt, rollers, and possibly a paving machine. Due to the minor nature of the required upgrades, it is expected that sub-base materials and bitumen/asphalt will be stored / mixed off site in facilities owned by third parties.

Once the access roads are completed, the site(s) will be cleared of existing crops and plants, trees will be cut and grubbed, and any structures dismantled and removed. Earthworks will then commence; excavators will level the site(s) to create a flat working area with stabilised slopes around the uphill areas. Geotextile will then be laid over the pad area, and around 1 m of compacted hardcore or similar material will be laid on the membrane.

In addition to preparation of the drill pad, the earthworks will include the digging of the required water supply pond (if this option is selected by the contractor) as well as the mud ponds and geothermal fluid pond. It is likely that some rudimentary drainage structures will also be constructed at this point.

It is estimated that the total spoil production for site W1 would be around 70,000 m^3, of which approximately 30,000 m^3 would be reused on site, with the remainder requiring disposal (or reuse) off site. Site W3 earthworks are likely to produce 55,000 m^3, of which approximately 30,000 m^3 would be reused on site, with the remainder requiring disposal (or reuse) off site.

An example of the extent of likely earthworks is shown in Figure 19, which is a cross section of part of site W1.

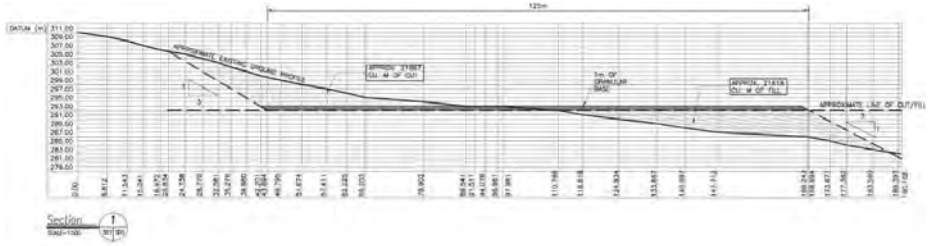


Figure 19: Cross Section of part of Site W1 Showing Required Cut & Fill

Whilst the road upgrades and drill pad earthworks are being carried out, the drilling contractor will organise for the delivery of the drilling rig and other equipment to St. Vincent. These will arrive at Kingstown Port, where the Stantec-authored review of infrastructure capacity states that sufficient space and facilities exist for the reception, unloading and temporary storage of the drilling rig and all other equipment. It is estimated that all the equipment will fit inside 70 standard 12 m shipping containers.

Once the drilling rig and other equipment is received at the port, and once the requisite transport plans and approvals have been confirmed, the equipment will be moved up to the Project site. Preliminary design information indicates that the heaviest item to be transported is 70 tonnes[9], and the dimensions of the drill rig in transport will be approximately 18 m by 2.5 m (see Figure 20), so whilst these items will pass along the highway, there will be a need for escort vehicles and staff to warn other road users and pedestrians. Assistance will also be required with the clearance of low hanging tree branches, overhead telecoms cables and power lines.

The Proponents are planning to move all the equipment up to site in one "train" of vehicles, however, as approximately 60 to 70 trips will be required, some of which will require "low boys" and cranes, it is expected that the transport of equipment will take several days.

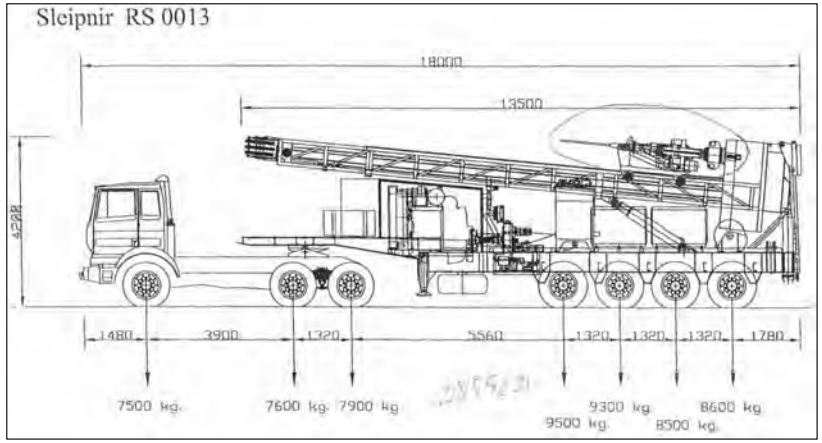


Figure 20: Cross Section of Drill Rig in Transport Mode

Once the drill rig and other equipment are on site, a period of setting out, erection and testing will follow. During this period, all ancillary equipment such as the water supply systems and mud system will be installed, and the office, laboratory and laydown areas will be established.

Following the installation of the drill rig and associated infrastructure, and once sufficient water has been collected for operation, the drilling phase will begin. Drilling is estimated to take 55-60 days including mobilization and demobilization. The drilling contract will include the supply of the drilling rig and associated equipment, suitably qualified and experienced personnel to operate and maintain the drilling rig and associated equipment for the drilling of the wells.

It is expected that three exploration wells will be drilled, and, assuming that they yield the desired level of resource, these will also be used as the production wells. At present it is expected that all three wells will be sunk on the same drill pad.

[9] It is suspected that this estimate is rather high

The wells will be drilled using conventional drilling technology. Tricone roller cone bits and possibly polycrystalline diamond compact (PDC) drill bits will be used for the drilling. It is planned that the directional drilling will be employed, as shown in Figure 12.

Around 5,500 litres of diesel will be required per day for drilling, and the drilling operations will continue 24 hours a day, seven days a week, and will therefore require the site to be flood lit. The final well depth will be decided as drilling proceeds, but is not expected to be greater than 2800 metres.

During the drilling, there will be regular crane activity on site, as casings and drill sections are moved and installed, and materials for mud and concrete production are shifted as required. The drilling will progress in stages, with progressively smaller drill bits being used as the sections become deeper (see Table 2 above). As each diameter drill section is completed, a casing "string" (made of steel) is inserted into the well to maintain its integrity, to protect the surrounding aquifer, and to maintain control of the drilling fluids (see below). After each casing string is inserted, cement is pumped in the annular space between the casing and the open hole. Cementing of casings bond the casing to the formation, and minimizes the danger of "blowouts" from deeper high pressure zones by isolating weaker shallow zones. This cement will be delivered to site in tanks (not in bags) and is mixed on site with silica flour, water and other chemical additives (to allow the cement to withstand high temperature and to delay the curing process).

The final string of casing to be inserted into the well will include a slotted design, to allow the geothermal fluid to flow into the well and up to the surface through inside the well (this final casing is not cemented, to allow for good flow of fluids). After the well is finished, a set of valves ("Christmas tree") is installed above the well.

Delivery of fuel, concrete, pipe casings and other consumables will occur throughout the exploration period, and will require several trucks to visit the drill pad on most days, probably from a warehouse in Kingstown if sufficient space is not available at the laydown area of the reinjection pad.

The drilling process requires substantial amounts of water for production of the drilling fluid referred to as "mud". Drilling mud is composed mainly of water and bentonite clay, but other ingredients are also included (such as polymers, lignite and other additives) to improve stability, viscosity and plasticity.

Drilling mud is constantly pumped into the well during the drilling operation. The purpose of the mud is as follows:

- To cool and lubricate the bit and drillstring during drilling;
- To remove the cuttings from the bottom of the hole as fast as they are created to ensure efficient drilling;
- To transport the cuttings to the surface;
- To control formation pressure and minimise formation damage ;
- To minimise corrosion of the drillstring and casing;
- To minimise contamination problems;
- To minimise torque, drag and pipe sticking; and

- To assist in well logging operations.

The Proponents have estimated that the drilling operations will require up to 50 l/sec (180m^3/hr) of water, and that a buffer storage tank or pond with at least 48 hours storage capacity is required to ensure a continuous water supply during drilling. Further investigation during the Scoping Study has determined that the water requirement is likely to be highly variable. This is due to a number of factors including the influence of the geology on loss of the fluid. Fluid is recycled as much as possible; the system is circulating, at least in the early stages of the drilling. The fluid is pumped down the centre of the drill to the drilling site, and it then flows back up the annulus to the surface, where it is cleaned of cuttings and other material, before being reintroduced to the well again. As the drilling progresses, increasing amounts of fluid can be lost to the surrounding rock, either due to its porosity or into fissures (referred to as "loss zones"). The amount of fluid required also increases due to the increasing distances that the fluid is required to travel. When a loss zone is encountered, cement is often injected to create a temporary seal.

The amount of water needed to support the production of drilling mud therefore varies greatly, and it is not unheard of for all fluid to be lost, with none being returned to the surface, during the final stages of drilling.

The diagrams below present very approximate scenarios for water use and water loss throughout the drilling process.

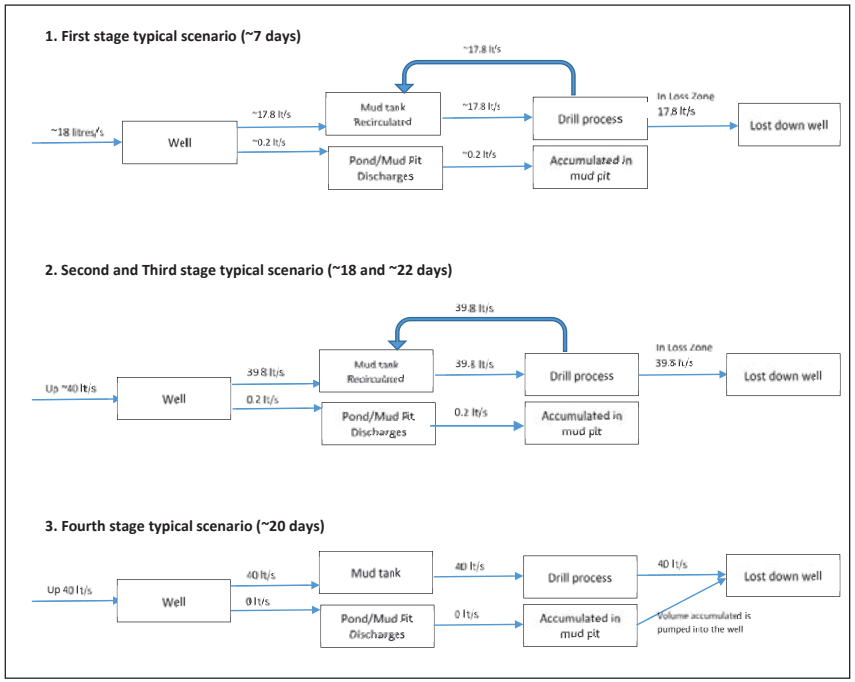


Figure 21: Water Use and Recirculation Scenarios

In addition to the water requirement described above, it is estimated that the amount of bentonite clay needed for the entire drilling procedure will be around 150 – 175 tonnes. Although the bentonite is reused as much as possible, and although some is lost to the well, inevitably a significant amount of spent mud will require disposal during the operation. There are various disposal options available (such as pumping down the well or removal to landfill) and the option to be used for this project will depend on the contractor and other factors.

The drilling process will create a source of noise (the nature of the noise created will depend on the drill rig type), and as previously mentioned, the drilling will be occurring around the clock. The blow testing period that follows drilling (see below) will also be a source of noise.

Noise during drilling is generally in the range of 70-100 dB(A) at a distance of 10 m from the source, depending on the equipment used. At 80 m from the drill rig, the noise level will drop to below 70 dB(A), and at 550 m (assuming flat terrain), the noise level will be below 45 dB(A).

After drilling, well head equipment is put on top of the well and a silencer is put in place prior to blow testing, which will occur for between one and three months to evaluate the characteristics of the geothermal reservoir. Noise from the well during testing is likely to be in the range of 70-110 dB(A) at a distance of 10 m (the level varies due to different ratios of steam and water), dropping to a maximum of 70 dB(A) at 100 m. At a range of between 1,000-1,400 m the noise level will be below 45 dB(A). Figure 22 below provides calculated noise levels from a generic geothermal drilling rig.

To date, vibrations from the drilling or blowout phases have not been a discernible cause of impact in geothermal drilling operations.

Formula: L(distance) = L(ref)-20*LOG10(D2/D1)

	Calculated Maximum value measured 1 meter from the noise source		Noise limits according to: NOM-081_SEMARNAT-1994 Residential areas which include some workshops & commercial business or residential areas near a highway	
	Reference value	MX rig	Day	Night
L - Reference	Max @ 1m	Measured values	6 a.m. - 10 p.m.	10 p.m. - 6 a.m.
Distance m	dBA	dBA	dBA max	dBA max
1	96,0		55	50
2	90,0		55	50
5	82,0		55	50
10	76,0		55	50
25	68,1		55	50
35	65,1		55	50
50	62,0		55	50
75	58,5		55	50
100	56,0		55	50
125	54,1		55	50
150	52,5		55	50
175	51,2		55	50
Residential 200	50,0		55	50
225	49,0		55	50
School 250	48,1		55	50
275	47,2		55	50
300	46,5		55	50
325	45,8		55	50
350	45,1		55	50
375	44,5		55	50
400	44,0		55	50
425	43,5		55	50
450	43,0		55	50
475	42,5		55	50
500	42,0		55	50

Figure 22: Geothermal Drill Rig Noise Production

As mentioned above, once the drilling is complete and the well head equipment and silencer are installed, a period of blow testing will commence. During this period of 1 to 3 months, the well will be left to vent in order to evaluate the characteristics of the geothermal reservoir. Testing will also provide information for the subsequent design work for a geothermal power plant if conditions are found feasible.

During testing, the water (brine) collected from the well is collected in the mud pond until the construction of the reinjection well (see below), if used, is completed. This brine is not suitable for discharge to surface waters due to high content of chemicals and minerals from the reservoir, so the water/brine is reinjected.

A diagram of the flow of geothermal liquid during the testing phase is provided below.

Figure 23: Test Phase Geothermal Liquid Flow

The drilling and testing phases will also produce gaseous emissions. The principal gases emitted during geothermal operations are CO_2, H_2S and N_2. During drilling the emissions are usually very low; some gases may be released from the well when a fracture connected with deeper zones is drilled. During blowouts (caused by the depth pressure being higher than the pump pressure and hydrostatic pressure of the mud), some gases can escape with the blown mud. To reduce the impacts of blowouts, Blow Out Preventers (BOP) are installed above the well and are closed rapidly when a problem is detected. The contractor's workers will be provided with H_2S safety equipment, and detection sensors will also be installed.

If reinjection is to be used during the phase 1 exploration, the reinjection well will probably not be drilled until after completion of the exploration wells. The reinjection well will be located some 500 metres downhill from the main drill pad, following similar construction methodologies as the main pad.

The level of staffing during the exploration phase will be dependent on the selected contractor's chosen methodology and equipment, and on his work plan, however approximate numbers can be estimated at present. The civil work elements will be carried out by around 10 to 15 workers, all of whom will be locally hired. The drilling work will be carried out by around 30 to 40 workers operating on a three shift rotation, with approximately 80 % being foreign specialists and 30 % being locally hired workers. Additionally, local workers will be employed for the road upgrade tasks, and as drivers, flagmen, etc.

Add end of exploration, and assuming no further drilling is required for the production facility, the drilling rig and other equipment will be returned to Kingstown Port for repatriation, following a similar procedure to when it was originally brought to site. If any site used for exploration is not then developed for the production phase, it will need to be properly reinstated in accordance with the ESMP and applicable local laws.

5.6.2 Production Phase

It is not currently possible to provide an accurate description of the construction process for the production facility. As it is expected that the exploration wells will be used for production, no further drilling will be required. The main works will therefore be civil works to install the access roads, improve the facilities and conditions at the wellfield, and construct the facility buildings and drainage. The most significant work for the production phase will be the import and installation of all the mechanical and electrical equipment necessary for the production and evacuation of power (such as generators, condensers, transformers, pipelines, SCADA, transmission lines and substation equipment). The civil works are likely to require significantly more materials than the exploration phase.

The level of staffing during the production phase, much like the exploration phase, will be dependent on the selected contractor's chosen methodology, as well as the eventual design of the facility. It is, however, expected that around 100 workers will be required, of which approximately half will be hired locally.

5.7 Operation

As has been highlighted already in the present document, only basic estimated details are currently available with regards to the construction and operation of the production facility. Until the location and extent of the geothermal resource is known, development of the project design cannot progress. There are numerous system options for the designers and contractors (if design and build is selected) to consider, including different turbine and generation options, different gas removal options and different cooling options. The below description of production facility operation should therefore be considered very much as provisional, and is based on the current expectations; the eventual Phase 2 ESIA will provide a more accurate and detailed account of the facility's planned operation.

A basic introduction to the operation of a generic geothermal plant has been provided in Section 5.1 above. The specific details of the expected design for the SVG Project are further elaborated below.

The geothermal fluid will be controlled by the wellhead valves, and when permitted to flow, will travel under its own pressure from the wells through the pipelines to the electricity production facility (unless the separator station is to be located near to the well pad). It is expected that, for this project, the fluid will be "two phase", i.e. both liquid and steam/gas. Upon arrival at the generation facility, the two-phase flow will be piped into a separator where the steam is separated from the geothermal water. The steam is then piped (via a mist eliminator, which consists of a wire mesh to remove condensate that has formed in the steam pipeline) to one of the two turbines, where the steam will turn the generator and generate electrical power. The expected turbine type for the present project is a "single flash turbine", illustrated in Figure 24 below.

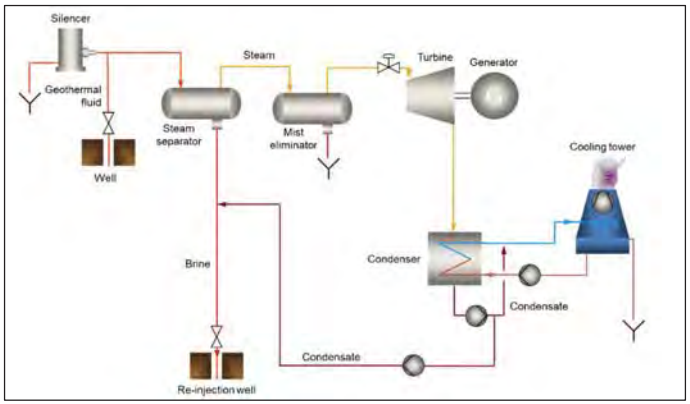


Figure 24: Single Flash Cycle Diagram

Once it has passed through one of the two turbines, the used steam will go into one of the two condensers where it will be condensed at sub atmospheric pressure. The condensers for this project are likely to be of shell and tube type. Shell and tube condensers allow for the recovery of condensate, which can then be mixed with the geothermal fluid for reinjection to minimize the risk of scaling. This is due to the fact that the clean condensate will have a diluting effect on the geothermal fluid that would otherwise be close to the saturation limit after separation. It is therefore expected that the geothermal water from the separator will be piped to the reinjection well.

In addition to the separation of condensate, the condensers will produce cooled gases (principally steam) which will be evacuated by vacuum pumps. Around 80 % of the non-condensable gases pass through the gas removal system; the remainder move with the condensate to the cooling tower. The gas will typically contain about 2% H_2S by weight. Several options exist for the safe and legal disposal /emission of the H_2S, but as the H_2S content of the Project's geothermal fluid is not yet known, it is not possible to describe what method will be employed. It is possible that the gas will be piped to the cooling tower fans to mix it with the steam plume from the cooling tower, or it may be released via a high chimney to maximise dispersion. It is also possible that the system may include a desulphurisation process or gas incineration prior to release to the atmosphere.

The condensers use cooling water drawn from the cooling tower basin, which in turn will have been pumped through the cooling tower. The source of the cooling water supply has yet to be identified, but is expected to be groundwater, which would also be used for potable water for those working on site. Cooling water supply for auxiliary equipment, i.e. generator coolers, oil coolers and the gas extraction system will be from the main cooling water circuit with pressure provided from the main cooling water pumps.

The above generation process is expected to operate on a 24/7 basis. The generating station will be permanently manned, and it is expected that a staff of around 10 will be required, most of whom would be hired locally.

In addition to the main process described above, the facility will have a number of other operational systems, such as a control room/SCADA system, and fire and gas detection

systems, though the details of these are currently not known. Likewise, maintenance routines are not presently known, and will need to be the subject of a more detailed description to be provided in the Phase 2 (Production) ESIA.

5.8 Project Schedule

In terms of the exploration phase, the Proponent's current expectation is for civil works for preparation of the drill pads to begin in March 2016, with exploratory drilling due to commence in mid-May 2016, and well testing due to take place between July and December 2016.

Once the extent of the geothermal resource is known, and assuming additional exploration is not necessary, design of the production facility and associated infrastructure is planned to begin in late 2016, with construction commencing in February 2017 and lasting until commercial operation begins in August 2018.

During the Scoping Study meetings with the Proponents, it became apparent that there is some minor slippage on the exploratory phase of the project; civil works for the exploration phase may now not start until around June or July 2016.

During discussions with VINLEC, it was mentioned that they expect design and construction of the transmission lines to take at least three years; considering that the finance source for the lines is as yet undecided and VINLEC had not started any serious work on the studies, this could be a potential area of delay.

The detailed overall Project Schedule is provided in Figure 25 overleaf.

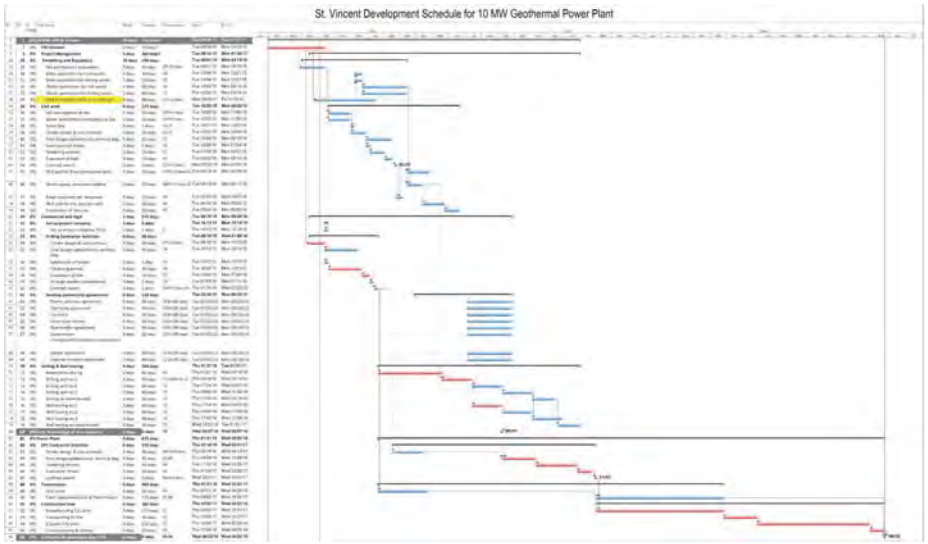


Figure 25: Overall Project Schedule

6 DESCRIPTION OF EXISTING ENVIRONMENT

6.1 Introduction

The existing biophysical and socio-economic environment in the project area has not been the subject of extensive study to date. Existing information is not generally specific to the project area, but the more general information was supplemented and updated during the Scoping Study by "walk over" scoping surveys which also served to determine potential areas of impacts and identify issues requiring closer analysis during the ESIA stage. This section therefore presents the latest biophysical and socio-economic features of the project area.

6.2 Geology, Soils and Seismicity

6.2.1 Geology

The geology, soils and landscape of St. Vincent are closely linked to its location in the Antillean Arc, an area of high volcanism; and volcanic rocks, landforms and landscapes dominate the island. St. Vincent is geologically young at no more than 50 million years old. Its geology is predominantly volcanic in origin, part of which formed as long as 3 million years ago, with the youngest rocks being formed during the 1979 eruption of la Soufrière volcano. Structurally, St. Vincent has a central north-south mountain chain with numerous valleys that drain to the narrow coastal belt. The mountains consist primarily of pyroclastics dating back to two major volcanic eruptions during the Pleistocene Era.

The exposed geology of the island falls into four main types: basalts; basaltic-andesites; andesites, and xenoliths. Basalt is most abundant in the southern parts of the island while basaltic-andesites dominate further north. Basaltic magmas are most common during the early stages in the evolution of St. Vincent's volcanic centres and andesites are most common as dykes and as the last stage dome or central plugs, which occupy the vent at some centres. The entire island consists of consolidated rocks (lava flows and dykes) or unconsolidated materials ('volcaniclasts'). Apart from recent alluvial deposits such as river and beach sands, and a few outcrops of sedimentary and marine deposits such as limestone and coral, only igneous rocks are found on the island.

St. Vincent is divided into four major geologic regions (see Figure 26), based on the volcanic centres: the South-East Volcanics, and the Grand Bonhomme, Morne Garu and Soufrière Volcanic Centres. The island's volcanic centres all evolved in a similar manner; eruptive activities were initially effusive (non-explosive) and produced a substructure of basaltic lava flows. The effusive eruptions were then followed by periods of phreatic (explosive) eruptions which produced large strato-cones by depositing layers of ash and scoria. The focus of this strato-volcanic activity and the creation of eruptive centres has migrated northward over the last 3 million years, culminating in the active volcano of la Soufrière in the north of the island. As can be seen in Figure 26, the underlying geology of the Project area is composed of the Soufrière centre pyroclastic deposits.

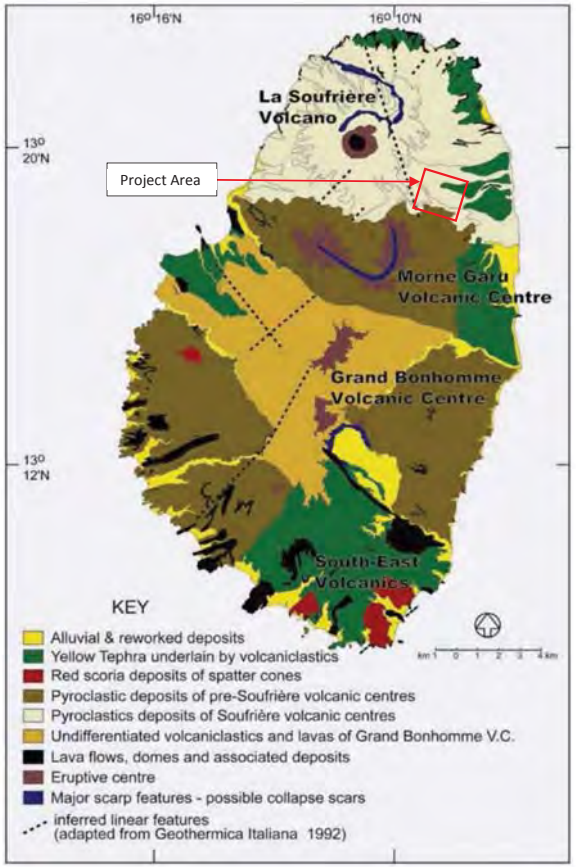


Figure 26: Volcanic Centres of St. Vincent and Dominant Geology

Source: Modified from Robertson (2003)

6.2.2 Soils

In common with the geology of the island, St. Vincent's soils are relatively immature, being largely derived from recent volcanic ash, cinders and rock fragments. Large volumes of coarse volcanic sand were deposited in the northern part of St. Vincent by major eruptions of la Soufrière Volcano in 1828 and 1902. The dominant soil type of the project area is "high level yellow earth soils" which are deeply weathered, leached and somewhat acidic due to their location in high rainfall areas. Despite the classification name, the soils encountered during the site survey were invariably dark in colour (whether in cultivated areas or not), as shown in Figure 27.

Figure 27: Example of Soil in the Project Area

The soils in the project area, in particular in the lower lying areas such as alongside the rivers, are somewhat sandy and highly permeable, with good drainage potential. This does tend to lead to excessive dryness in some areas, however. Due to the large amount of volcanic material that has fallen over the years, the soils of the island, and of the project area in particular, are also highly fertile (though lacking in phosphate and sometimes nitrogen).

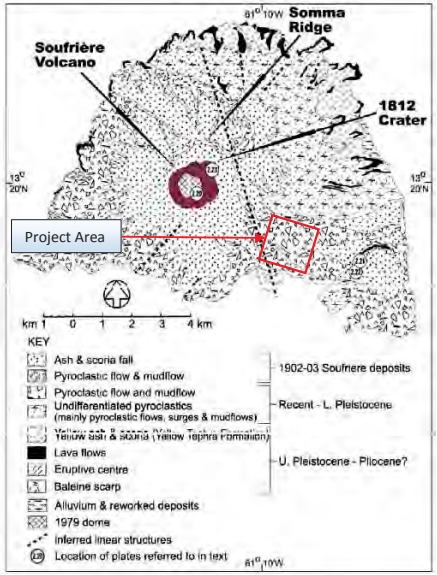


Figure 28: Soil Structure in the Project Area

6.2.3 Volcanism and Seismicity

La Soufrière, whose current height is 1,234 m, is the highest peak on the island, and is an active volcano. Its 1.6 km crater and dome dominate the northern quarter of St. Vincent, giving rise to its topography and modifying its climate.

La Soufrière has had five major eruptions since records began; in 1718, 1812, 1902, 1971, and most recently, in 1979. Most eruptions have been violent and accompanied by ash falls, mudflows, and pyroclastic flows. The 1812 eruption caused around 80 fatalities and the 1902 eruption caused around 1,600 deaths. Due to improved warning systems, the 1979 eruption was not responsible for any fatalities, but 20,000 people were evacuated from the northern part of the island. All eruptions caused widespread damage to properties and farmland, and the area in which the Geothermal Project is to be developed was severely affected by the last few eruptions.

All indications and studies point towards the likelihood of La Soufrière erupting again in the future, and it is extremely likely that the Project area would be hit by fairly widespread devastation, though the extent of the damage will depend greatly on the type of eruption that occurs, as well as other influencing factors. As can be seen in Figure 29, the project area is firmly within the "very high hazard" zone of the island.

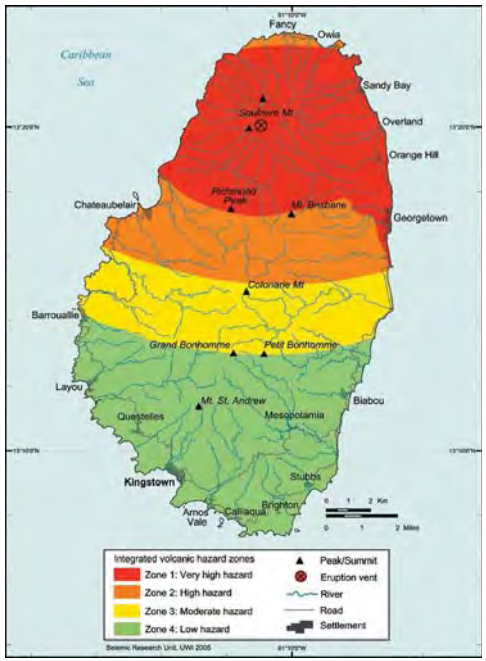


Figure 29: St. Vincent Volcanic Risk Zones

Source: Seismic Research Unit (2005)

The Eastern Caribbean is a seismically active area with hundreds of earthquakes occurring in the region each year. The majority of earthquakes are, thankfully, fairly minor, with many not being felt at all. St. Vincent has not been the epicentre of any recent significant earthquakes, but it has received significant earthquakes that centred on other Caribbean islands. The most recent significant earthquake experienced in the country measured 6.5 on the Richter scale, and occurred on 16th July 2015, with its epicentre off the coast of Barbados. In November 2007, an earthquake of magnitude 7.3 hit the island, causing significant damage.

6.3 Landscape, Geomorphology & Land Use

St. Vincent's geomorphology is typical of a Caribbean weathered volcanic landscape. The island's principal topographical feature is the axial series of volcanic mountains rising northwards towards La Soufrière. Numerous deeply incised valleys drain from the central ridge to the narrow coastal belt, more steeply on the leeward side of the island than on the windward side where the present project is located. Soufrière occupies most of the northern fifth of the island and is separated from the central mountain chain by a deep trough. Two rivers run through this trough – the Rabacca, which drains the Project area to the east, and the Walliabou, which drains to the west.

Volcanic materials that make up the island have been severely affected by erosion and are deeply weathered due to the tropical climate, the steep topography, and the unconsolidated nature of the materials.

The island is highly undulating; small and large hills rise all across the landscape, with houses perched up the hillsides on stilts, and very steep and twisting roads. It is estimated that 50 percent of the island consists of slopes greater than 30 percent and only 20 percent of slopes less than 20 percent.

The project is located at the base of the Soufrière hills where the more gently undulating coastal strip meets the very steep and rugged volcanic hills. The terrain in the project area is therefore fairly steep. Due to the requirements of the project for flat land for the drill pads and generating station, the nine potential drill sites selected by the proponents are among the flattest in the project area. The fairly flat sites are, however, divided by a number of small steep-sided valleys and ridges. Both the flat areas selected for the project and the steep topography between them can be seen in Figure 30 below.

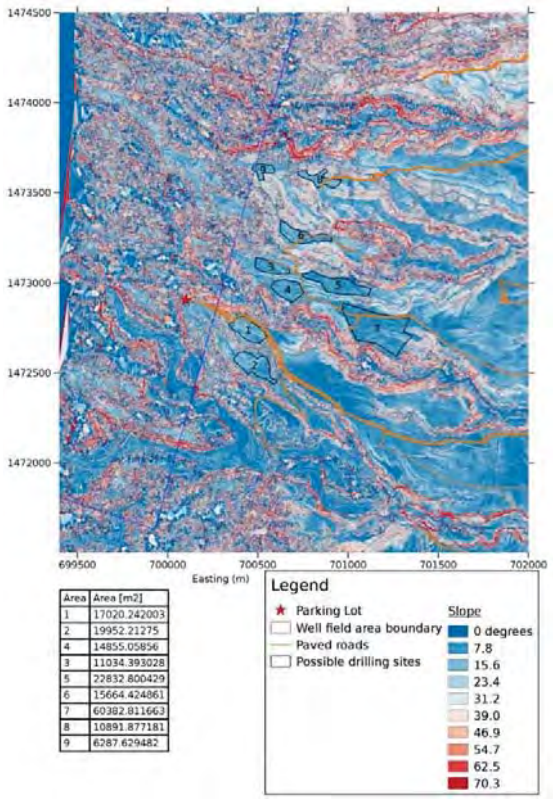


Figure 30: Slope Analysis in the Project Area

The general landscape in the project area is that of a typical tropical pastoral landscape; productive fields of crops such as banana, cassava, pigeon peas, sweet potatoes, yams and arrowroot give way to densely forested hills and valleys, all with the backdrop of Soufrière rising in the background. Some of the lower potential drill sites also have a wonderful view of the sea some 300 m downhill. Some typical landscapes of the Project area are shown in Figure 31.

Figure 31: Typical Landscapes in the Project Area: NW towards Soufrière nr site W7 (L) & SE towards the sea from site W6

Land use/cover in the project area is a mosaic of agriculture (divided into field crops and tree crops), wooded scrubland, grassy scrubland/pasture, and mature secondary forest. The land use of the nine potential drilling sites was observed during the Scoping Survey to be almost exclusively pasture, scrubland and agriculture, as shown in Table 3 below. Figures 32 and 33 show the official land use records for the project area.

Table 3: Land Use/Cover at the Potential Drill Sites during Scoping Survey

Potential Drill Site	Land Use Description
W1	• Entire site consists of banana plantation • Occasional mango & breadfruit tree
W2	• Mix of agriculture, tree crops and scrubland/pasture • Crops observed include sugar cane, passion fruit, banana, papaya and yam • Several cows grazing on site
W3	• House adjacent to W3, and W3 land is operated as a smallholding • Parcel consists partly of road and verge • Partly field crops (arrowroot, yams, sweet potato and other vegetables) • Partly scrub/pasture interspersed with tree crops such as citrus, banana, mango and coconut
W4	• Entire site is pasture interspersed with tree crops; principally citrus • Several cows grazing
W5	• Most of site is pasture with two cows grazing • Occasional thickets of trees such as coconut, breadfruit, breadnut and trumpet tree • Very edge of the parcel encompasses part of a steep-sided banana plantation
W6	• Parcel consists partly of road and verge • Farm buildings immediately adjacent to site • Most of the parcel is pasture/scrubland interspersed with various tree crops such as starfruit, cocoa, and citrus.
W7	• Large area of mainly commercial agriculture with some livestock raising • Fields are divided up by “hedgerows” of tree crops such as soursop and Golden Apple (*Spondias dulcis* – referred to locally as “plum”) • Pigs and some cattle present • Field crops include pigeon peas, taro, cassava & arrowroot
W8	• Dry grassland area with occasional citrus trees • Evidence of grazing but no animals present
W9	• Mainly forest and scrubland

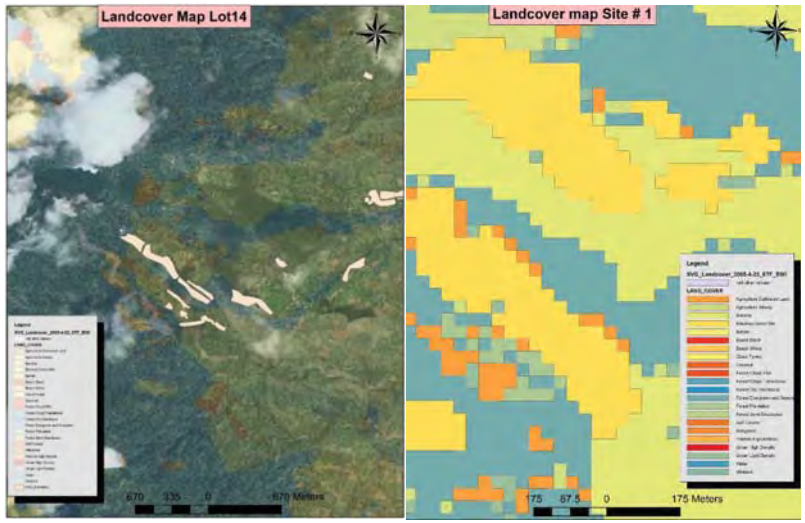


Figure 32: Land Cover in the Project Area

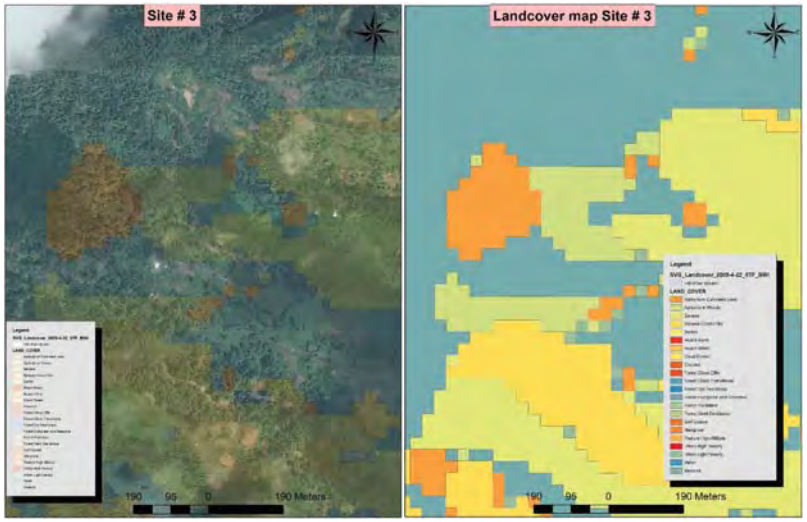


Figure 33: Land Cover at Site W3

6.4 Climate

St. Vincent has a tropical climate with a distinct seasonal rainfall pattern; the rainy season is from June to December, with the remainder of the year being fairly dry across most of the island; only 30 % of the annual rain falls between January and May. However, annual rainfall varies from 1450 mm in the south and south-west to more than 5000 mm in the mountainous northern part of the island and in particular on the windward side where the present project is to be located. Low clouds often cover Soufrière, just behind the Project area, and rain in the project area is thus more frequent, even during the dry season. Average rainfall in St. Vincent and the Grenadines is shown in Figure 34 below, and average rainfall in the project area is shown in Table 4.

Despite the high annual rainfall, drought conditions are not unheard of on the island, and during Scoping meetings with CWSA and the Ministry of Agriculture, it became apparent that 2016 is likely to experience significant drought during the dry season, resulting in problems for water supply.

Whilst St Vincent has a generally hot, humid (>70 %) climate, as a result of the higher rainfall and cloud cover in the project area, average humidity is expected to be higher still than elsewhere on the island.

Flash floods during tropical rainstorms and hurricanes are particularly problematic in the project area, and the zone immediately downhill from the project, between Orange Hill and Georgetown, was hit hard by the flooding (and associated landslides and mudflows) in December 2013; at the time of the Scoping Survey reconstruction works were ongoing (the bridge in Georgetown reopened during the visit).

Temperatures usually range from 18 to 33 °C, but are generally fairly constant and above 25 °C for most of the year; the average yearly temperature is 26.7 °C. The Diurnal variation is low, at around 3 ° C to 5 ° C), but temperatures are generally cooler at higher elevations.

Figure 34: Average Rainfall & Temperatures in St. Vincent and the Grenadines between 1900 and 2012

Source: World Bank
(http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Latin%20America&ThisCCode=VCT)

Table 4: Average Rainfall in the Project Area

Station[10]	Rainfall (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Soufriere	155.0	152.1	249.4	411.7	403.1	224.6	253.7	315.2	276.7	468.5	356.1	290.5	3556.6
Rabacca	0	3.9	25.7	160.3	163.1	173.8	188.3	148.2	128.5	49.7	106.2	115.8	1263.2

The North East Trade Winds blow all year round and have a moderating effect on the fairly high temperatures and elevate evapo-transpiration. The winds blow more strongly on the coast, and unsurprisingly the windward side of the island bears the brunt of the south westerly winds, which blow at 15-25 knots for most of the year, rising to 30 knots at times between December and February (known locally as the "Christmas winds").

The period from mid-May to mid-December (roughly coincident with the rainy season) is characterised by tropical waves, depressions and hurricanes. Tropical Storms and hurricanes have been responsible for much devastation in St Vincent in recent years; the island has been affected by 14 major hurricanes between 1900 and 2013. Hurricane Janet in 1955 was responsible for 122 fatalities and widespread damage to property and crops. Hurricane Emily (in 2005) caused significant damage to over 500 houses and hurricane Tomas in 2010 damaged over 1,200 properties and caused significant damage to infrastructure and crops (thankfully only two people were injured). The flood in December 2013 resulted in particularly high damage in the project area and the estimated cost of the disaster was over 108 million USD, equivalent to 15% of the country's gross domestic product.

As an island, St. Vincent is by its nature vulnerable to the effects of climate change, in particular rising sea levels. Whilst the island is not low-lying, the majority of development is coastal (the main population centres, housing 85 percent of the population, lie on a narrow coastal strip less than 5 m above sea level and less than 5 km from the high-water mark) and would therefore be affected by even relatively minor sea level rise. Furthermore, physical retreat from the coastal strip would be problematic due to the steep terrain of the island's interior.

The SVG initial communication to the IPCCC reports that average erosion rates are around 0.5 m per year, but that erosion is significantly more problematic in the Project area; along the stretch of coast at Orange Hill, erosion rates have been 5 m per year. Climate change impacts other than sea level rise could also be problematic for St. Vincent, as agriculture is a significant source of income, and water supply is largely rain-fed.

St. Vincent's greenhouse gas inventory showed low overall emissions, but the energy sector accounts for 42 percent of total CO_2 emissions, while transport accounts for 36 percent.

6.5 Hydrology & Water Supply

6.5.1 Groundwater

The volcanic formations on St. Vincent are mostly pyroclastic deposits with some basaltic and andesitic lavas. These deposits make excellent aquifers as they can store and transmit considerable quantities of water. The main aquifers on St. Vincent are described below.

[10] Soufriere Rainfall Station: alt. 855 m. E: 489241 N 1473129
Rabacca Rainfall Station: alt. 227 m. E: 491284 N 1471038

The main aquifer unit (permeable pyroclastic deposits): the younger, less weathered pyroclastic deposits to the North of the island forms the main aquifer unit. These deposits are highly permeable due to the significant layers of volcanic material, resulting in the "sinking" of rivers in the project area, which generally cease to flow at low elevations due to rapid infiltration into the river bed.

Late Pleistocene air fall deposits are present over some areas of the island. These deposits are likely to be permeable, at least in some areas, and form useful aquifers, particularly in the northern part of the island where the formation is thick and coarse and weathering is incomplete.

A number of springs flow from this main aquifer in the general project area. These are "contact springs", produced at the contact between a less permeable lava horizon forming a local base, and the overlying permeable air fall deposits. The spring flows are quite small (1 to 3 m^3/h) but are constant throughout the year, which indicates significant aquifer storage.

The local aquifer unit (agglomerates and coarse rock debris): the agglomerates and coarse rock debris that mantle the flanks of the volcanic centres are likely to yield significant groundwater resources. The major rivers on the island rise within or close to the old volcanic craters, which is evidence that their perennial flow is derived from groundwater base-flow.

The Aquitard unit: the remaining geological formations on the island consist of a mixed assemblage of lavas and pyroclastic associated with the older volcanic centres, and these are collectively considered to form limited and localized aquifers.

All water supply on St. Vincent is currently from surface sources. The main watersheds currently used by CWSA are shown in Figure 35 below. There are no water supply intakes in the project area; an intake previously existed on the upper Rabacca River (see below) in close proximity to Sites W1 and W2, but the flood damage destroyed the facility some years ago.

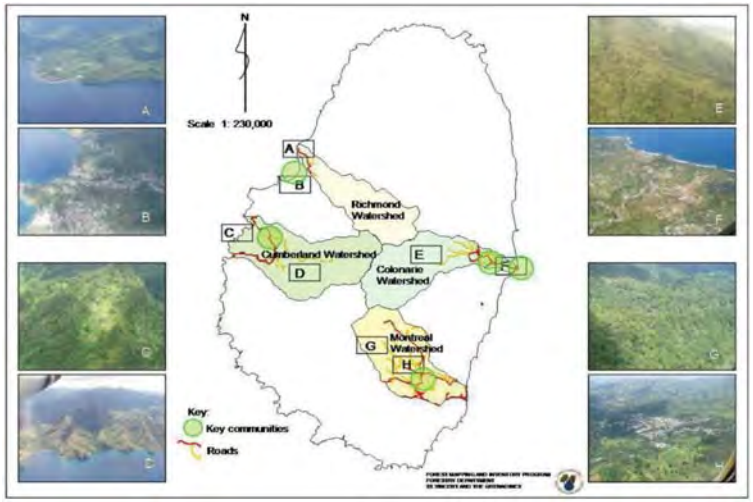


Figure 35: Major Watersheds used for Water Supply in St. Vincent

Source: ECLAC (2011)

Whilst all of CWSA's supply system is based on surface water, the increasing incidence of drought (as discussed earlier) on the island means that CWSA is expecting to need to consider the harvesting of groundwater in the not-too distant future. This requirement is supported by the conclusions of the ECLAC's (Economic Commission for Latin America and the Caribbean) study of the economic impact of climate change on the water sector in St. Vincent. Plans for exploration of groundwater sources do not yet exist, but the CWSA will be following with interest the results of any drilling carried out during the present project.

Figure 36: Destroyed CWSA intake on the Rabbaca River in the Project Area

6.5.2 Surface water

The island of St. Vincent has an abundance of surface water in rivers and streams. Drainage from the centre of the island occurs via steep river valleys, and flows are considerably reduced during the dry season than those of the wet season; many rivers are perennial. The major rivers on the island are the Richmond, Rabacca, Cumberland, Colonaire, Buccament, and Yambou, all rising at high elevations.

The main rivers in and around the Project area are the Rabacca (commonly referred to locally as the "Rabacca Dry River"), Ms. Jane, Waribishy, Tourama and the Camariabou. These are all shown in Figure 37 below; those with immediate relevance to the project are the Tourama, Waribishy and Rabacca, as they have been identified as the most likely sources of process water for the project.

Due to minor declines in precipitation recent years, coupled with anthropogenic factors such as deforestation and construction as well as population growth, surface water flows on the island are reported to be dropping. Whilst the Miss Jane River apparently does not flow for the greater part of the year, the Rabacca River does usually flow during the rainy season. The Scoping visit occurred during the rainy season; and at that time the upper Rabacca was flowing (a visual estimate of flow at the location close to the destroyed intake was of the order of 20 cubic metres per minute) but the river was dry at the bridge adjacent to the beach. Likewise, the Tourama River was bone dry at the point at which it meets the windward highway (see Figure 38).

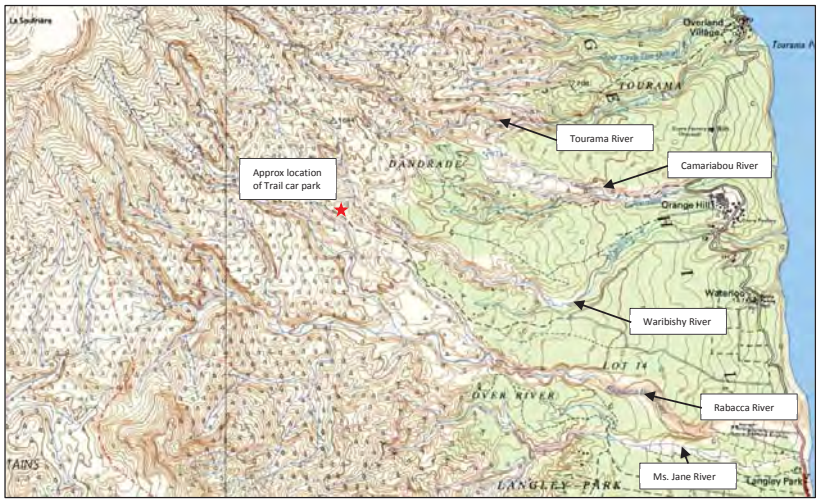


Figure 37: Rivers in the Project Area

Figure 38: Tourama River in October 2015

Figure 39: Upper (L) and Lower (R) Rabacca River in October 2015

It was reported during the Scoping meetings that rivers form an important cultural focus in St. Vincent, and that a concern was the potential impact of the project on downstream river use for recreational/cultural activities. During the field survey, the lower reaches of all rivers were dry, and were therefore not being used for anything other than aggregate extraction (at the Rabacca). Likewise the upper reaches that were visited by the survey team were not near to any communities and were therefore not under any obvious use. It should, however, be noted that plans exist to develop the lower Rabacca area into a new multi-use park development. A master plan for the project has been developed, and construction of the first minor phase (a picnic area in the grassed area adjacent to the highway is expected to commence in 2016).

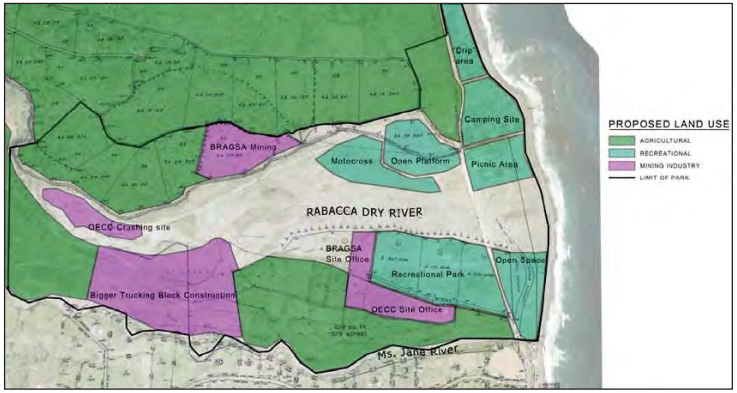


Figure 40: Proposed Rabacca Park Development

As has been described earlier, the highly permeable nature of river beds in the project area makes estimating the current flows of the rivers difficult. Some sources explained during the scoping exercise that the rivers maintain a base flow just below the permeable surface sediments, but no literature investigating this issue was located during the study. The previous baseline survey provides some data on river flows in the project area, however the data is unclear and potentially unreliable; sampling points and methodologies are not provided, units are unclear in places, and the data is incomplete. During the Scoping Study an attempt was

made to gather more useful information, but was not successful. The available flow data is provided in Tables 5 and 6 below.

Table 5: Average Monthly Discharge of Rabacca River

River	Average Discharge (cumecs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rabacca	0.177	0.078	0.317	0.211	0	0.242	0.061	0	1.025	0.293	0.327	0

Table 6: Maximum Monthly Water Level of Rabacca River

Year	Maximum level (m)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	-	0.043	0.046	3.147	-	-	-	-	0.255	0.259	0.294	-
2010	0.371	0.233	0.235	0.399	0.039	0.297	-	-	-	-	-	-

6.6 Water & Air Quality

6.6.1 Water Quality

As with flow data, available water quality data for the project area is very patchy and of little use/reliability. Groundwater quality from boreholes in Buccament and Overland is shown in Table 7 below.

Table 7: Groundwater Quality in the Project Area

Borehole	Parameter													
	Cond-uctivity	pH	TDS	Tot. Hardness	Ca	Mg	Na	K	HCO_3	SO_4	Cl	Fe	Mn	NO_3
	µs/cm		Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l	Mg/l
Buccament	321	7.5	157.5	108.4	220	13	26	1.7	153.3	4.84	17	0.768	0.016	10.2
Overland	229	8.1	112.9	71.2	17	7	17	2.9	93.9	9.16	16.3	3.121	0.122	3.3

The results indicate generally good quality groundwater in the area, though both boreholes have fairly high levels of nitrites/nitrates, as well as iron and (in the case of Overland), Manganese. The high levels of iron are, however, to be expected in a volcanic area.

Surface water quality information was not obtained during the Scoping Study, however as the river water is rain/spring fed and travels only a short distance from river sources, through an area of very low human activity, it is expected that the water quality of all the rivers in the project area is good. Field testing of the Upper Rabacca returned a result of around pH 6.5, which supports this expectation.

6.6.2 Air Quality

No data was available for air quality in the project area, however as the area receives frequent rains and breeze, is agricultural, backing on to a large area of forest, and with no industrial or even residential areas in proximity to the site, air quality is expected to be very good. There are no significant sources of emissions to the atmosphere other than from the few vehicles driving to and from the agricultural area and the hiking base station. As the roads are predominantly paved, and the verges covered with vegetation, dust generation is also low. Perceived air quality during the survey was good at all times.

Of course, during eruptions, the situation in the project area would be very different; with very high levels of particulates and gases such as sulphur dioxide, hydrogen sulphide, steam, and carbon monoxide and dioxide.

6.7 Noise & Vibration

The island of St. Vincent is generally a highly tranquil place; there is little in the way of industry, no major highways, no large settlements, and very little other noise-generating activities. What little noise that is generated is quickly dissipated by the many steep valleys and dense vegetation.

The project area is no different; the area sits several kilometres above the windward highway, which is fairly lightly trafficked beyond the Rabbaca River, and is at the top of the several small "feeder" roads used to access the Rabacca Estate agricultural area. There is therefore very little traffic noise, and no other significant anthropogenic sources of noise or vibration (other than seismic activity).

The principal Noise Sensitive Receiver (NSR) in the Project area is the Soufrière Trail Base Station at Bamboo Ridge, just uphill from site W1. Aside from the Base Station, there are no other significant NSRs in the project area.

6.8 Transportation

As mentioned in the Project Description, the equipment and much of the materials needed for exploratory drilling and eventual construction of the generating station and transmission lines will arrive at Kingstown Port. The Stantec-authored review of infrastructure capacity states that sufficient space and facilities exist for the reception, unloading and temporary storage of the drilling rig and all other equipment. Although a visit to the port and a meeting with the port authority was requested during the study, it was not granted, so little else can be added to the above; it is not known whether the port operates an environmental / social management system.

The quality of the Windward Highway between Kingstown Port and the Rabacca River/Orange Hill is generally very good; it has recently been upgraded and the surface asphalt is in good condition, with very few potholes. There are a lot of inclines and tight corners on the route, but it is understood that these are not likely to be overly problematic to project traffic. Transportation in St Vincent is largely by three means; personal vehicles (largely cars and trucks originating from the Japanese second-hand market), small, privately operated minibuses (which are a very common sight on the roads), and motorbikes. As there are only a limited number of roads on the island, traffic can become fairly congested in Kingstown during peak periods, as well as on the road between Kingstown and Arnos Vale. It is understood that car ownership is increasingly rapidly in the country.

Figure 41: Kingstown Ferry Terminal with Port Facilities Behind (L) & Typical View of the Windward Highway

Sites W1 and W2 are accessed by the most southerly feeder road adjacent to the Rabacca River, which is also the road to the "Soufrière Cross Country Trail" hiking base station (referred to locally as "Bamboo Ridge"). Sites W3-W7 are accessed from a feeder road some 2 km further north, on the northern side of the settlement of Orange Hill. Sites W8 and W9 are both accessed from the final feeder road, another 1.5 km to the north. The access roads to sites W1 to W7 are surfaced with asphalt whereas the road to W8 & W9 is surfaced with concrete. It should be noted that the road to sites W1 and W2 also serves as the access road to the Soufrière Trail Base Station at Bamboo Ridge, and as the Facility lies above the potential drill sites, access to through the site will need to be maintained during the works. All three of the feeder roads are in fair condition, but have degraded sections that will require repair for access by project traffic.

Figure 42: Orange Hill Aqueduct (L) & "Feeder" Road to Sites W1 & W3 (R)

6.9 Flora & Fauna

6.9.1 Flora

The natural vegetation of St. Vincent exists in several stages of development and/or disturbance caused by human and natural (volcanic) interventions. The concentric variations of rainfall with elevation give rise to similarly concentric variations in vegetation. The slopes of La Soufrière volcano have been subject to the effects of volcanic eruptions, which periodically destroys wide areas of vegetation and wildlife.

The principal forest types commonly used in the literature to describe St. Vincent's eco-systems are as follows:

- **Elfin Woodland**: Found on exposed summits above 500 m on both sides of the central mountains. They consist of pure stands of dwarfed trees about three meters in height, covered with epiphytes.
- **Rain Forest**: Confined to areas in the upper Colonaire, Cumberland and Buccament Valleys between 300 and 488 m.
- **Palm Brake**: A sub-climax type typically at elevations over 500 m arising after disturbances such as landslides or tree-falls (opening up the forest canopy). The land is covered initially by mosses, then by small tree ferns and heliconias followed by the characteristic Mountain Cabbage Palms (*Prestoea acuminate*).
- **Secondary Rain Forest**: Forests arising after disturbances from volcanic eruptions, hurricanes and human activity. The largest areas lie around the Soufriere Mountains. The vegetation ranges from almost bare soil on the upper slopes of the Soufriere volcano to significant stands forest at lower elevations.
- **Deciduous Seasonal Forests/Cactus Scrub**: On the dry southern and southwestern coasts of St. Vincent and the Grenadines where the soils are extremely thin, deciduous to semi-deciduous and xerophytic species predominate.
- **Littoral Woodland**: This type of vegetation is characterized by manchineel, button mangrove, sea grape and similar species. They exist as small narrow strips along the eastern coastline on St. Vincent and on a number of the islets and cays of the Grenadines. This type of vegetation is fast disappearing as development takes place along the coast.
- **Mangrove Swamp**: Only small areas of swamp occur in St. Vincent. These exist in the southern section of the main land. The typical species found in these areas are Red Mangrove, Black Mangrove, White Mangrove and Button Mangrove.

Forests in St. Vincent are rich in biodiversity and can exhibit more than 100 species of trees per hectare. A national forest inventory conducted in 1993 reported that 38 % of St. Vincent's land area is covered by forest, about 10 % of which was mature, mostly undisturbed primary forest (4,308 hectares). The remaining forest is mainly secondary rainforests, dry scrub woodland, and forest plantations.

The forests of St. Vincent were significantly cleared by the British and French settlers in the early 19th century to make way for sugar plantations. Forests in St. Vincent covered an estimated 14,038 hectares in 1949 and an estimated 12,690 hectares in 1993. Deforestation was estimated to average 17 hectares per year, and the results of several forest inventories are shown in Table 8, demonstrating the loss of forest. Clandestine cultivation of marijuana occurs in the roughest terrain on the slopes of La Soufrière and other mountainous areas, and is an emerging major cause of deforestation and land degradation.

Table 8: Results of Three Forest Inventories of St. Vincent

Source: Simmons & Associates (NBSAP) (2011)

Forest Type	Hectares of Forest / Inventory Year		
	1949	1984	1993
Primary Rainforest	-	-	*4,308*
Secondary Rainforest	-	-	*3,451*
Total Rainforest	8,218	9,208	7,759
Dry Scrub Woodland	1,491	1,326	2,179
Elfin Woodland	207	952	457
Palm Brake	4,122	1,734	518
Regeneration	-	-	1,776
Total	**14,038**	**13,220**	**12,689**

At the species level, St Vincent and the Grenadines has 1,150 species of flowering plants and is home to 16 endemic flora species. None of the endemic plant species in St. Vincent are listed in the IUCN red list as endangered, but there are a number of rare / endangered species on the island, such as Big Leaf Mahogany (*Swietenia macrophylla*), Caribbean Mahogany (*Swietenia mahagoni*) and Lignum vitae (*Guaiacum officinale*). Table 9 provides a list of vascular plants endemic to the country.

Table 9: Endemic Vascular Plants of St. Vincent

Linnaean Name	Vernacular	Range
Begonia pensilis	None	Unknown
Besleria elongata	None	Unknown
Acalypha vincentina	None	Unknown
Clidemia vincentina	None	Unknown
Lobelia brigittalis	None	Unknown
Gonolobus youroumaynensis	None	Unknown
Odontocarya smithiorum	None	Unknown
Peperomia vincentiana	None	Unknown
Selenicereus innesii	None	Unknown
Spachea perforata	Soufriere tree	Unknown
Solanum urens	None	Unknown
Tibouchina cistoides	None	Unknown
Trigynaea antillana	None	Unknown

The project area is at the upper end of what used to be the 2,500 acre Orange Hill Estate, a sugar plantation under British Ownership, and once the largest plantation on the island. In 1902 the estate was decimated by the eruption of Soufriere, and the estate was then sold to the Barnard family of St. Lucia, who converted the majority (1,700 acres) of the estate to coconut cultivation, with small areas of banana (85 acres) and citrus (55 acres). The 1979 Soufriere eruption again decimated the plantation, and in 1985 the estate was sold to Windward Properties Ltd, an incorporation of four companies whose directors were four Vincentians and four Danes. Due to protest at the sale to foreign owners, the government subsequently repurchased the land and formed Rabacca Farms ltd. to manage the subdivision of the estate in line with the wider land reforms going on at that time. The estate was divided into small farms of between 3 and 7 acres and provided to local residents on a lease to buy arrangement.

Due to the above history, much of the project area consists of small fields, plantations and areas of pasture and herbaceous scrub, dotted with occasional citrus and other trees. Around the agricultural areas, principally on the steep sided valleys, areas of secondary tropical forest are becoming increasingly well-established since the 1979 eruption. Common trees observed on the edges of the agricultural plots (and potential drill sites) include Mango (*Mangifera* sp.), Breadfruit (*Artocarpus altilis*), Breadnut (*Artocarpus camansi*), Mapou (*Pisonia fragrans*), buttressed forms of Eucalypts (sp. unknown), large *Ficus*, Neem (*Azadirachta indica*), Coconut (*Cocos nucifera*) and other palms such as "gru" (Acrocomia aculeate), Bamboo, Wax Apple (*Syzygium samarangense*), Trumpet tree (*Cecropia schreberiana* – not to be confused with *Tabebuia aurea*), and Guava (*Psidium guajava*). Climbers and vines are very common growing on the shrubs and trees in the project area, and ferns were frequently seen on the forest floor. None were identified during the Scoping Survey, but the EIA for Argyle airport reports that *Cissus verticillata* is a common climber species on the island.

Figure 43: Site W1: Banana plantation with occasional breadfruit and palms, surrounded by secondary forest. Visible on the fringe of the site are mango, palms, bamboo and eucalypts

It is not known whether there are any rare or endemic plant species in the project area (the team conducting the scoping survey did not include specialists in the local ecology) but it can be said that should any exist, they are likely to be in the thickets and forest areas between the drill sites rather than on the sites themselves; with the exception of some areas herbaceous scrub the drill sites are predominantly cultivated or grazed.

Figure 44: Trumpet Tree on the edge of site W2

6.9.2 Fauna

The terrestrial faunal biodiversity of St. Vincent is fairly well studied; the 2000 National Biodiversity Strategy and Action Plan (NBSAP) to the Convention on Biodiversity (CBD) lists 43 species of butterflies, 153 species of birds, 20 species of amphibians and reptiles, and 15 species of mammals (9 of which are bats)[11]. The 2009 National Parks and Protected Areas System Plan 2009 – 2014, lists 17 species of mammals (12 of which are bats), 25 species of reptiles and amphibians and 190 species of birds.

Of the six non-bat mammals, five are introduced to the island; the Agouti (*Dasyprocta agouti*), Mongoose (*Herpestes auropunctatus*), Rats (*Rattus* and *Rattus norvegicus*), Mice (*Mus musculus*), Opossum (*Didelphis marsupialis*) and the Armadillo (*Dasypus novemcinctus*).

The amphibians and reptiles of St. Vincent include the Green Iguana (*Iguana iguana*), the endemic St. Vincent Tree Anole (*Anolis griseus*), the endemic Saint Vincent Bush Anole (*Anolis trinitatis)*, the Smooth-Scaled Worm Lizard (*Gymnophthalmus underwoodi*), the Cane Toad (*Bufo marinus*), and the Turnip-Tailed Gecko (*Thecadactylus rapicauda*).

St Vincent, in common with other Caribbean islands, has a high level of endemism among its fauna species, some of which are not only endemic to the island but also have restricted ranges within the island. Furthermore, a number of these endemic species are also threatened/endangered. Table 10 provides a list of endemic species, and includes their conservation status where available.

[11] It should be noted that different sources provide varying numbers of species for certain groups

Table 10: Endemic Fauna of St. Vincent (list likely incomplete)

Linnaean Name	Vernacular	Conservation status
Mammals		
Micronycteris buriri	St.Vincent Big-eared Bat	-
Oligoryzomys victus	St.Vincent Pygmy Rice Rat	Believed to be extinct
Birds		
Troglodytes aedon	St. Vincent House Wren	Least Concern
Catharopeza bishopi	Whistling Warbler	Endangered
Myadestes genibarbis	Rufous-throated Solitaire	Least Concern
Amazona guildingii	St. Vincent Amazon Parrot	Vulnerable
Herpetofauna		
Chironius Vincenti	St. Vincent Black Snake	Critically Endangered
Eleutherodactylus shrevei	Piping frog	Endangered
Corallus cookii	Cook's Tree Boa	-
Anolis griseus	St. Vincent Tree Anole	-
Anolis trinitatis	St. Vincent Bush Anole	-
Pristimantis shrevei	St. Vincent Frog	Endangered
Invertebrates		
Tethlimmena basalis	Long horned beetle	-
Tithonus lunelli	Long horned beetle	-
Rybaxis geminata	-	-
Lorelopsis pilosus	Darkling beetle	-
Oxycopsis frontalis	False blister beetle	-
Cyclocephala vincentia	Masked chafer	-
Serrotibia obrieni	Narrow-waisted bark beetle	-
Peridinetus silacea	Weevil	-
Pseudolycaena cybele	St. Vincent Hairstreak	-
Nesonotus superbus	(grasshopper)	-
Zethus woodruffi	(wasp)	-
Tityus pictus	(scorpion)	-
Tapinauchenius sanctivincenti	(Tarantula)	-
Simonoonops princeps	goblin spider	-
Plekocheilus aurissileni	(snail)	-

The habitats of the Project area are highly influenced by anthropogenic activity (more so for the nine potential drill sites than the surrounding pockets of secondary forest), but are still home to numerous animal species. Various birds, butterflies, insects and reptiles were observed by the study team, including cattle egrets (*Bubulcus ibis*), Chicken hawks (*Buteo platypterus*), flycatchers (sp. unknown), purple crested hummingbirds, green iguana, and the St. Vincent bush anole. No mammals were observed. The only endemic species identified by the team was the St. Vincent Hairstreak, which was seen at site W4.

Figure 45: The Endemic St. Vincent Hairstreak (*Pseudolycaena cybele*) at Site W4

During discussions with the Forestry Department, it became clear that several of the endangered and/or endemic animal species are likely to be residents in or visitors to the Project Area.

Figure 46: The St. Vincent Bush Anole (*Anolis trinitatis*) in the Project Area

The project area is a known habitat for the St. Vincent Amazon Parrot (*Amazona guildingii*), which is IUCN category VU, is endemic to St. Vincent, and is also the sovereign bird. Around 600-700 individuals are thought to exist, and the Forestry Department has a dedicated conservation programme for the species. It is known to inhabit the project area, but no inventory has been carried out to formerly document its presence. The St. Vincent Amazon Parrot is currently increasing its range further from its core habitat, drawn down from the mountainous areas by a combination of the maturation of secondary forest since the 1979 eruption, and the increase in fruit cultivation; indeed, it is only in the last decade that the Parrot has extended its range to encompass the Project area.

The Whistling Warbler (*Catharopeza bishopi*) is also expected to be occasionally present in the upper project area, though again, this has not been formally confirmed. The Whistling Warbler is IUCN category EN, and is also endemic to the island. There have also been sightings of the St. Vincent blacksnake (*Chironius vincenti*) in the general area of the project. This snake is endemic to St. Vincent and also critically endangered according to IUCN classification.

Whilst none of the species discussed above were seen during the field visits[12] subsequent online research, as well as discussion with local farmers, indicated that the presence of the St. Vincent Amazon Parrot is almost certain, and presence of the Whistling Warbler is highly likely (see Figure 48).

Figure 47: Awareness-raising Poster for St. Vincent's Rare & Endangered Species

[12] The lack of sightings is not necessarily an indication of scarcity; the visits did not included dedicated fauna surveys, and were relatively short, occurring during the middle of the day, when many species are not active.

Figure 48: Known Range of the Whistling Warbler

Source: http://www.birdlife.org/datazone/speciesfactsheet.php?id=9124

It should be noted that an additional concern of the Forestry Department is that due to a lack of sufficient surveys and studies, and due to a number of recent new descriptions of species, it is thought that a number of as yet undescribed species may be present in the project area.

Whilst the marine biodiversity of St. Vincent is reasonably well studied, the freshwater biodiversity of its rivers and streams has received little attention to date, and comparatively little is therefore known about this area. According to the scoping meetings held with various local specialists, the Rabacca River and possibly some of the other rivers in the project area are host to the Sirajo Goby (*Sicydium plumieri*), the juvenile of which are known locally as "tri-tri" and are fished with enthusiasm. It is understood that the tri-tri fishery is informal and largely based on tradition, with seasonal catches being celebrated as a social event.

According to the Forestry Department, the Upper Rabacca is also an important habitat for a local freshwater crayfish (*Macrobrachium crenulatum*), however no formal survey of the river has been carried out to date. As with tri-tri, crayfish are an important traditional food, and are heavily fished, especially at Easter time.

6.9.3 Protected Areas

The Project Area does not fall within an official Protected Area. The closest protected area is the Mount Pleasant Forest Reserve, which lies around two km to the south/south-west of the Project Area (see Figure 49 below).

The Mount Pleasant Forest Reserve is a dedicated reserve for the St. Vincent Amazon Parrot and is equivalent to an IUCN Category IV protected area.

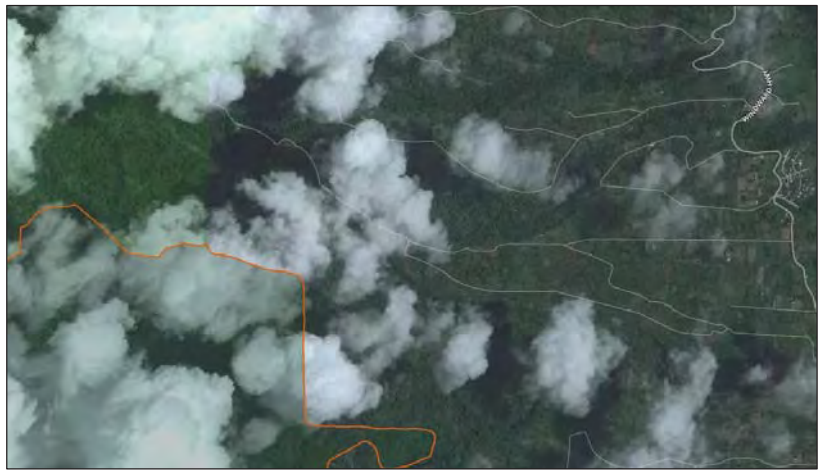


Figure 49: North-Eastern Boundary (shown in orange) of the Mount Pleasant Forest Reserve near the Project Area

Source: http://www.protectedplanet.net/555576501

There have been plans for some years to designate a new National Park (The Soufriere National Park – IUCN Category II) which would likely have its eastern boundary close to the Project area. An application for UNESCO World Heritage status is also being considered. Various sources consider this area to already be a national park, and the Forestry Department currently treat it as such, but the area has not been formally gazetted to date.

Figure 50: Map of St. Vincent Forest Reserves Showing Proposed Soufriere National Park

6.10 Socio-Economic Environment

6.10.1 Approach

This section provides an outline of socio-economic conditions in the Project Area of Influence (AoI)[13]. The main aspects covered in this section include basic demographic and health parameters, traditional economic activities, land use, ethnicity, social infrastructure, cultural heritage, and a number of other aspects.

This section has been developed based on secondary information contained in EIA materials prepared for other project facilities/activities implemented in St. Vincent and the Grenadines in recent years; documents provided by the Consortium; socio-economic reports developed by the local government and various agencies prepared under requests of the local government; and other relevant data received from public sources. It is also based on information obtained from semi-structured interviews with four respected and informed members of local settlements/communities who live and conduct their activities in the AoI. Those community members interviewed were:

- Male, Pastor and Manager of the local radio station, Overland;
- Male, Community Development Officer, Orange Hill;
- Male, Teacher, Sandy Bay; and
- Male, Farmer, Sandy Bay.

The interviews were carried out using a questionnaire consisting of a set of 50 questions, including both 'closed' and 'open' questions. The questionnaire included items related to basic social and demographic characteristics; type of occupation/employment; basic means of subsistence; standards of living, local infrastructure; health; transport; and perceptions of the Project. The results of the interviews are presented by topic in the relevant subsections of this chapter.

6.10.2 Population and Demography

As mentioned above, the Project area is located on the south-eastern slopes of the La Soufrière volcano, some 4 km inland on the eastern side of St. Vincent, and approximately 35 km by road from Kingstown.

Administratively, the Project is located within two districts: Georgetown district - From Byera River to Karo River next to Sandy Bay; and Sandy Bay district - From Karo River to Booby Rock at Fancy. The nearest permanent substantial settlements to the Project area are settlements located along the coastline approximately 3-4 km from the Project layout area, namely Sandy Bay, Orange Hill, Langley Park, Overland, Tourama, and Georgetown.

Statistical information for SVG is limited; the most recent official figures date back to 2001. Results of the 2012 Population and Housing Census are still not aggregated. However, preliminary estimation of the overall population of SVG for 2012 is 108,570 people. The following data were obtained for the Sandy Bay and Georgetown districts (see Tables 11 & 12). The populations are small and males outnumber females in both districts

[13] Please see definition of the AoI in section 5.4.3

Table 11: Sex Distribution and Total Population for Georgetown District (2012)

Sex		
Male	Female	Total
3,613	3,436	7,049

Table 12: Sex Distribution and Total Population for Sandy Bay District (2012)

Sex		
Male	Female	Total
1,334	1,242	2,576

As noted in the EIA Report for Argyle airport, there has been a locally complex migration pattern with variations in time and space. First, relatively poor people involved in small-scale farming have continued to leave the area for larger settlements such as Kingstown. However, increasingly rich urban dwellers and returning overseas St Vincentians have sought housing in the Sandy Bay/Georgetown area as it is located in an attractive rural landscape, but relatively close to the facilities of Kingstown, especially with the continuing improvements of the Windward Highway. The net "outcome" of these changes has been a relatively stable population, punctuated with periods of growth and decline[14].

Interview results indicate that communities are characterized by social cohesion, a strong community spirit and sense of civil consciousness. Cultural traditions and practices are strong and promoted by schools and churches. Crime and violence does not pose serious threats or cause concerns, however, unemployment is rising rapidly (it was near 21.5 % in 2012) as well as abuse of drugs and alcohol, particularly in the streets/public areas. This may be a result of the availability of the illegal substances and unemployment. Unemployment was identified as the main negative factor affecting the quality of life in Sandy Bay/Georgetown.

6.10.3 Health

Recent basic health indicators for St. Vincent and the Grenadines have been positive[15]. The performance on key health indicators is summarised in Table 13.

Table 13: Key Health Indicators for SVG

Indicators	Scores	Most Recent Year
Life Expectancy	72	2009
Infant Mortality Rate per 1000	16.8	2010
Maternal Mortality Rate per 1000	1.1	2010
Fertility rate (child/woman)	1.8	2008
Peri-natal Mortality rate per 1000	32.5	2010
Registered Nurses per 1,000 population	25.8	2010
Physicians per 10,000 population	6.6	2010
Hospital beds per 1000 population	2.8	2010
Births attended by Skilled	98.3%	2010
Total Expenditure on Health	$55.4 m	2010
% Health Expenditure of GDP (factor cost in	3.7	2009
Calories consumed per day	2,660	2004
Population with access to drinking water(mainland)	96.0%	2008

[14] Source: Argyle International Airport Project Environmental Impact Assessment, 2008.
[15] Source: SVG National Economic and Social Development Plan 2013-2025

Access to medical facilities is considered to be at a satisfactory level for a country with SVG's level of development, with 95 percent of births being attended to by skilled personnel and 25.8 nurses registered per 1000 population. Primary health care is available to all Vincentians through district hospitals, community clinics and roving Family Nurse Practitioners who are primarily responsible for school health and diabetic and hypertensive care. There is full immunisation coverage for the under-5 age group and maternal deaths (per 1000) are low. Fertility rate is at a stable 1.8 children per woman with an average life expectancy at birth of 74.3 years; comparable to that of developed countries.

Despite relatively positive health indicators, SVG has recorded a rapid increase in lifestyle-related diseases over the past several years. These primarily chronic non-communicable diseases are now the leading causes of mortality (accounting for more than 80 % of deaths in 2004 in both males and females). Non-communicable diseases feature as the primary health threat to the people of St. Vincent and the Grenadines and are an important focus of attention for the health sector. Although the social and economic impact has not been fully assessed, the financial burden alone is tremendous, with most human and technical resources being used in the treatment of these diseases[16].

Table 14: Number of Persons Reporting Chronic Illnesses (2012)

Location	Illness type/No. of Reports													
	Diabetes	Sickle Cell Anaemia	Arthritis	Asthma	Hypertension	Heart Disease	Stroke	Kidney Disease	Cancer	Lupus	Carpal Tunnel Syndrome	Glaucoma	None	Other
Georgetown	479	68	362	335	718	62	32	20	17	2	2	45	5300	179
Sandy Bay	169	34	163	168	326	36	8	10	9	8	0	4	1813	103
Total	648	102	525	503	1044	98	40	30	26	10	2	49	7113	282

[16] Source: SVG National Economic and Social Development Plan 2013-2025

The interviews with the local community members confirmed that diabetes, hypertension, arthritis and heart diseases are among the most common illnesses in Sandy Bay/Georgetown area.

6.10.4 Housing and Public Infrastructure

Concrete blocks are the most common home building material, even among the poor. Individual houses owned by the occupants is the Vincentian norm; housing structure, size and location is a function of socioeconomic status of the owner/occupier. The very poor may construct their own houses from plywood or material salvaged from demolished structures.

The interviews have confirmed that electricity is available and accessible to the entire population. Everyone is entitled to access potable water in their homes with free connection. About 98 % of the households have piped water in their homes and the other 2 % uses natural spring water or rain water. About 90 % of the residents have indoor/flushing toilets; where there are no water closets, pit latrines are developed under the supervision of the public health authorities. Bottled gas is accessible to more than 95 % households. Domestic waste collection is undertaken once per week.

Almost 50 % of the population have a landline phone connection; more than 90 % have cell phones. Public facilities such as post office, bank, food market, schools, hospital/clinic, police station, and recreation facilities are located in Georgetown and/or Sandy Bay. Churches and small grocery shops are available in smaller villages.

6.10.5 Traditional Economic Activities and Land Use

Livelihoods in the Project area can be sub-divided into three broad types. First, those livelihoods that depend, wholly or in part, on local natural resources; secondly, those that are based on local commercial enterprises (shop keepers and vendors) or those based on waged/salaried employment in nearby settlements (public service: police, medical services and the education system); and, finally, the third – those who survive by irregular daily work or are involved in illegal practices (mainly related to marijuana growing). The interviews demonstrated that those belonging to the second and third types are not very numerous.

Most livelihoods in the area are agriculture-based. At present, banana, cassava, pigeon peas, sweet potatoes, yams and arrowroot are the main crops produced in the area[17]. Banana is still the predominant crop although its importance has declined significantly, and there has been an increase in the cultivation of root crops. The Government has been implementing a series of structural reforms to promote greater investment in the agricultural sector through restructuring of the banana industry and agricultural diversification, with a series of fiscal incentives and farm support services. Fishing is not widespread amongst community members. Most community members fish opportunistically (e.g. seasonal fresh-water fishing for crayfish), and utilize the catch for domestic consumption and, sometimes, to supplement incomes by selling a portion of the catch 'commercially' by the roadside or in local markets. Reportedly, there is hunting for Opossum ("Manico"), Armadillo and certain birds undertaken during an 'open' season (October-January), although it is more of a recreational, rather than subsistence activity.

From the legal perspective, most of the land in the Project area still belongs to the State. As described in Section 6.9 above, as a result of a land reform of 1980s-1990s, the previous large

[17] More details on specific crops growing on each of the potential Project sites are provided in section 6.3.

estate, which owned most of the land in the Project AoI, was divided into small farms of between 3 and 7 acres. The parcels were distributed to farmers on a leasehold basis. The lease had an option to purchase, so that if the lessee paid the rent according to the schedule of payments, when all payments were completed, they would have earned a freehold title. To date, less than 10 % of lessees have obtained freehold titles, and in most cases, the other lessees pay no rent[18]; in reality they have become squatters.

The Project sites W1 and W3 are located on four different land plots as follows (see Figure 51):

- **W1:** Land plot C.884 (Plot 1) was never leased and is in state ownership. The whole area of W1 to be used by the Project appears to be within the boundaries of this single plot;
- **W3:** Land plot C.881 (Plot 6) is leased; no annual lease payments were ever made by the initial lessee (except for initial payment). This land is currently used for agricultural activities by other people;
- **W3:** Land plot C.881 (Plot 7) is leases; the initial lessee made one annual lease payment after initial payment. This land is currently used for agricultural activities by other people;
- **W3:** Land plot C.881 (Plot 8) is leased, however, at some point the initial lessee passed it over to another user who afterwards paid all the lease payments in full. Nevertheless, the land title has not been obtained so far. Currently the 'new' land user farms on this plot. In addition, a residential structure[19] and several farm structures have been erected – see Figure 52.

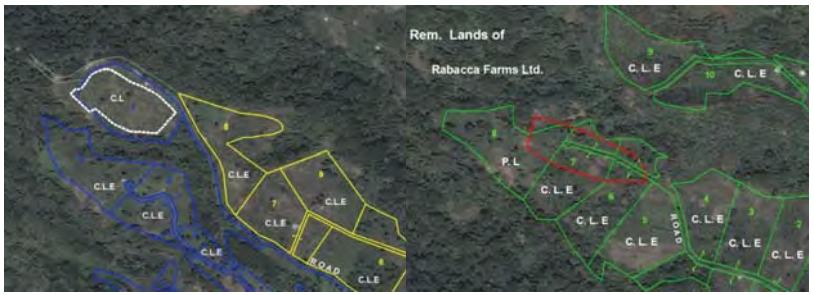


Figure 51: Land Plots Superimposed with Boundaries of Sites W1 & W3

[18] Land title in each particular case can be identified through the land ownership register.

[19] As per the survey plan, this land has farming land status. It is prohibited to establish residential structures in this area.

Figure 52: Residential and Farm Structures on Site W3.

There are also some structures (reportedly, temporary farmhouses) located near/on the W6 and W7 sites. The exact location and ownership of these structures will need to be defined during the ESIA phase.

Figure 53: Structures near/on Sites W6 (L) and W7 (R)

In case all or some of these parcels/plots need to be acquired for the Project, it will need to be acquired in compliance with the SVG legal procedure for land acquisition and resettlement, as well as IFC's Performance Standard 5[20].

[20] See also Chapter 4.

6.10.6 Ethnicity

Culturally, the Rabacca area is known as one of the Carib settlements on the island of St. Vincent. With colonisation and the presence of the Europeans, the Carib villages were abandoned and Caribs moved towards the north and the island's interior where miscegenation with Africans occurred which resulted in the formation of the Black Caribs or Garifuna. Therefore, the Rabacca area maintains a position as being the gateway to those Garifuna communities along the north windward coast[21].

Representatives of the Ministry of National Mobilization, Social Development, Family and Gender interviewed during stakeholder consultations reported that Black Caribs do live further to the North, around Sandy Bay, however, they are well assimilated/integrated into the society and do not consider themselves to be a minorities.

6.10.7 Vulnerable Groups

The main vulnerable groups are people with disabilities and poor people. The recent study on poverty (2008)[22] stated that the Georgetown and Sandy Bay area followed by Chateaubelair (on the Leeward coast) is one of the poorest in SVG.

6.10.8 Community Safety and Security

Natural hazards in the region are primarily associated with seismic and volcanic activity of La Soufrière – all indications and studies point towards the likelihood of La Soufrière erupting again in the future. It is likely that the Project AoI will be hit by widespread and serious disruption, though the extent of the damage will depend greatly on the type of eruption that occurs, as well as other influencing factors (see section 6.2.3 for more details).

6.10.9 Transport Infrastructure

As described in Section 6.8, transportation in St Vincent is largely provided by personal vehicles, small, privately operated minibuses, and motorbikes.

The Windward Highway is the main north-south axis of the island. Most of the other roads, which are motorable to varying degrees, are oriented east-west and intersect with the Windward Highway. They provide important means of access to people living in the inland areas. However, roads located further inland tend to be at a higher altitude and are of poorer quality, so that access can be a problem for certain localities.

The Project area is accessed by three separate "feeder roads" (single-lane roads, generally surfaced with asphalt or concrete, and used for access to agricultural land and recreation) that climb in an easterly direction up towards Soufrière from the Windward Highway. (See sections 5.4.2 and 6.8 for more details).

6.10.10 Tourism

The Project area is not a prime location for either tourism or local recreational activities.

However, sites W1 and W2 are accessed by the road also used for accessing the "Soufrière Cross Country Trail" hiking base station. The hiking base station is composed of a parking area and several wooden buildings, including an information centre, toilet, picnic area, etc. (see

[21] Source: Rabacca Park Master Plan Report, Millenia Consulting Ltd., November 2010.
[22] Source: Kairi. St. Vincent Country Poverty Assessment: living conditions in a Caribbean Small Island State; 2007/2008

Figure 54). According to the information provided by local sources during the scoping study, there were 3,318 visitors to La Soufrière crater in 2013 and 4,503 visitors in 2014.

Figure 54: The "Soufrière Cross Country Trail" Hiking Base Station

Some time ago there was an initiative developed by the St. Vincent and the Grenadines National Parks, Rivers And Beaches Authority to establish a Youromei Heritage village in Orange Hill[23] – a park, little museum and a hotel to celebrate the local history. However, nothing has actually come to fruition to date. As described in Section 6.5, the Ministry of Tourism is planning to create the Rabacca Park recreation area about 1 mile north of Georgetown. The Park is expected to be sited at the Rabacca Dry River Estuary area that includes a significant portion of the lower stretches of the Rabacca Dry River, Rabacca Dry River beach front, and adjacent lands along the northern and southern banks of the river (see Figure 40). A master plan for the project has been developed, and construction of the first minor phase (a picnic area in the grassed area adjacent to the highway) is expected to commence in 2016.

6.10.11 Cultural heritage

Information regarding cultural heritage is based on two sources: a scoping consultation meeting with the St Vincent and the Grenadines National Trust (SVGNT)[24] and a report submitted by the GoSVG to UNESCO in March, 2013. This document requests the declaration of the Soufrière area as protected national heritage site.

There have been only limited cultural heritage surveys in the AoI. It is known that the early inhabitants of the island had a healthy respect for the Soufrière Mountain and settled as far away from it as possible. It was their defeat by the colonists that forced them to settle in the north of the island around Sandy Bay. Even then they did not venture often onto the mountain except to hunt. The volume of volcanic deposits dropped on the mountain over the last three centuries has acted to cover any items of cultural heritage and to make finding them more difficult. There are no spiritually or ritually important sites in the area.

Two important sites are the 18th century aqueduct (see Figure 42) and an old battery station – both located near Orange Hill.

[23] Source: A National Parks and Protected Areas System Plan for 2009 – 2014.

[24] As per the legislation in force, the National Trust is empowered to identify, document and preserve buildings, monuments and places of historic and architectural interest, including the acquisition of property and the raising of funds for the management of such property.

Contradictory information is contained in the report submitted by the SVGNT to UNESCO in March, 2013. This document requests to declare La Soufriere a protected national heritage site. Although cultural heritage items are not common, according to the GoSVG report to UNESCO, there are some archaeological sites within the La Soufrière area, which contain very early and very late prehistoric pottery, petroglyphs, boulders with cup-holes and, also, the ruins of a colonial sugar plantation and processing factory.

The earliest known inhabitants of SVG are believed to have arrived from northern Venezuela bringing their distinctive pottery with them. This pottery has been found on nine sites in very close proximity to La Soufrière. Cultural remains at these sites have also confirmed the arrival of the Carib people, the last prehistoric group to colonize St. Vincent.

7 KEY ENVIRONMENTAL AND SOCIAL IMPACTS AND ISSUES OF LOW CONCERN

7.1 Introduction

The environmental and social effects of the geothermal project will be investigated by the main ESIA studies. The *potential* impacts as they are presently envisaged are described below. Not all of these potential impacts will ultimately be confirmed as likely in the ESIA report.

7.2 Geology, Soils and Seismicity

7.2.1 Summary of Potential Impacts

The scoping site survey and data review suggests that the construction and operation of the Project will have few negative impacts on geology, soils and seismicity. In the areas where negative impacts may potentially occur, the impacts are generally related to the construction process, and are therefore likely to be temporary, and able to be reduced using carefully selected mitigation measures.

A concern exists among local residents that the drilling is likely to induce volcanic eruptions or earthquakes; in fact drilling has no contributing effect on eruptions, and almost no effect on earthquakes. The fractures released by modern drilling are too small to initiate earthquakes.

The three negative impacts identified as being most likely are:

- Soil erosion/landslides;
- Soil pollution; and
- Spoil disposal issues

The potential impacts identified above are further discussed below.

7.2.2 Exploration/Construction phase

Potential impact: Soil erosion / landslides

Due to:

- the heavy machines / earthworks that will be required for the exploration drilling and subsequent construction of the Project;
- the nature of the underlying soils and rock that will be exposed once vegetation is cleared; and
- the high rainfall in the project area,

the risk of erosion and landslides is a potential negative impact. If earthworks are carried out during the rainy season, slopes are not properly compacted or shored up, and drainage channels not sufficiently well constructed, erosion or loss of stability (and eventual landslides/collapse) may result.

For the Phase 1 ESIA, no further survey work or other activities are required, beyond desktop assessment of impacts and development of corresponding mitigation measures.

Potential impact: Soil Pollution

Localised soil pollution is a possible negative impact that could occur during exploration and construction if equipment is poorly maintained and incorrectly used, and if suitable arrangements do not exist for storage and use of hazardous materials such as fuels and lubricants. However, the risk, likelihood or significance of this potential impact is low compared to many projects and is easily mitigated using "standard" measures via the Environmental and Social Management Plan (ESMP). Further field investigation relating to this potential impact is therefore not necessary during the Phase 1 ESIA.

Potential impact: Spoil Disposal

Site clearance and earthworks during the preparation of the drill pads and ponds may generate significant amounts of spoil. The amount to be produced will depend on which & how many site(s) are selected for development; the topography and therefore the cut and fill balance varies at each of the sites.

As with the two preceding potential impacts, whilst the issue should be considered during the Phase 1 ESIA, the potential impact is not considered sufficiently significant as to require any further field investigation.

7.2.3 Operation phase

Of the above potential negative impacts possible during exploration/construction, only soil pollution is likely during operation. As with during the construction phase, soil pollution impacts are easily avoided if simple mitigation measures are employed.

7.3 Landscape, Geomorphology & Land Use

The Project area is a tranquil, verdant and bucolic, and whilst the drill pad sites are not considered to be natural environment, the presence of the exploration activities and, ultimately the power station infrastructure, will affect the local landscape and land use.

Two negative impacts identified as being possible are:

- Land use conversion; and
- Reduction in landscape quality/visual impacts.

Conversion of agricultural land (and potentially some small areas of scrub and secondary forest) to power generation facilities is an unavoidable result of the project development. The physical footprint of the Project is, however, small.

The exploration phase and operation phase will both affect the landscape; in particular the operational phase will permanently alter the look and feel of the area, with both infrastructure, and the steam rising from the cooling towers. Whilst the area is not generally in a prominent zone that receives many visitors, site W1 is close to the "Bamboo Ridge" hiking base station, and is immediately adjacent to the access road. Whether or not the completed infrastructure represents a negative impact on the existing pastoral and natural landscapes, or a tasteful representation of modern sustainable energy generation (as has been the case in Iceland and elsewhere) is a subjective matter. The eventual installation of the transmission lines is likely to have an impact on landscapes, and this will need further assessment during the Phase 2 ESIA.

Neither potential impact requires further field study during the Phase 1 or Phase 2 ESIAs, but mitigation measures should be considered to minimise the impacts (e.g. sympathetic architecture, & "green" screens). For the Phase 2 construction it may also be necessary to consider the creation of offsets for any lost habitats to ensure that the IFC principle of "no net loss" is upheld. Whilst being linked to land use change, this is more of a biodiversity-related impact.

7.4 Climate

Exploration and construction of the geothermal scheme cannot be expected to affect the weather or climate, on local, national or international scales. There will inevitably be some releases of greenhouse gases during the drilling phase but these will be insignificant at the climate level.

Operation of the scheme will also produce some GHG emissions, however once the offset emissions from the diesel power production that is currently the major source of electrical energy on the island is considered, the overall impact on climate will be overwhelmingly positive due to a significant net reduction in GHG emissions.

7.5 Hydrology & Water Supply

7.5.1 Summary of Potential Impacts

The scoping site survey and data review suggests that impacts of the construction and operation of the Project could potentially have significant negative impacts on hydrology in the Project Area, and further investigation of the potential impacts is required during both the Phase 1 and Phase 2 ESIAs.

At present, only preliminary study has been carried out on the availability of process water for both exploratory drilling and for operational needs such as cooling. Likewise, until the exploration is completed, the arrangements/design for potable water, and for effluent, waste water and sewage disposal, are unknown.

The key potential negative impacts identified in this area are:

- Over-abstraction of surface water; and
- Changes to downstream hydrological regime.

The potential impacts identified above are interlinked and are further discussed below.

7.5.2 Exploration/Construction phase

The Rabacca, Waribishy and Tourama Rivers have been preliminarily identified as the most likely water sources for the significant exploration water requirement of up to 45 litres per second. At present there is very little reliable data about the flow rates of the rivers, but during the scoping survey, which took place during the rainy season, the upper Rabacca had an estimated flow of 20 cubic metres per minute, which equates to 333 litres per second; around a sixth of the total flow. This shows an unreliable "best case" scenario for water abstraction. Between May and August (when the exploratory drilling is most likely to occur), flows of all rivers are significantly reduced[25], so it is possible that the process water requirement at that time may exceed 50 % of the total flow. Whilst there are no villages downstream depending on the river for domestic use, such a large reduction in flow could have significant negative

[25] As previously noted, further aggravating the situation is CWSA's expectation that 2016 will be a drought year

impacts on the aquatic ecosystem. Indeed, it is conceivable that the flow of the upper Rabacca could even fall below 45 litres per second at certain times of the year.

The above example is for largest of the rivers that have been identified as potential water sources; clearly the potential negative impacts would be more significant on rivers with lower flows than the Rabacca.

Further complicating the situation is the high porosity of the river beds in the project area; as described earlier in the present report, the scoping team were informed on more than one occasion that the lower reaches of the rivers are often dry on the surface, but flowing just below the surface through the highly porous volcanic material.

Due to the lack of available information on hydrology during the scoping survey, this issue should be further investigated during the Phase 1 ESIA. Fortunately, the consortium is intending to carry out a water resources investigation in the near future; this means that a physical survey during the ESIA is probably not required, but it will be critical for the results of the planned water resources investigation to be provided to the ESIA team to use during the impact assessment.

In addition to the concerns described above relating to over-abstraction of surface water other concerns exist with regards to the downstream flow regime. For example, at present the methods of disposal of liquid waste from the exploratory drilling and operation of the plant are not yet clear. Whilst it is possible that the effluents be reinjected or reused, the possible requirement to discharge significant quantities of water cannot be ruled out. Quite how much, and to where it would be discharged is currently unknown, but there is potential for negative impacts on hydrology. This latter concern may later be found to be needless once designs progress, but at the time of the scoping survey it is certainly something requiring further study during the ESIA work.

7.5.3 Operation phase

During the operation phase the same concerns as above exist with regards to the discharge of waste water and other liquid effluents.

Additionally, it is possible that the operational water needs will be provided for by sinking a well (or wells) for groundwater abstraction. This could have unforeseen negative impacts on the local aquifer and/or geology, and the issue should be considered again during the Phase 2 ESIA, by which time sufficient further information should be available upon which to draw some meaningful conclusions.

7.6 Water & Air Quality

7.6.1 Summary of Potential Impacts

The Scoping Study suggests with a high level of confidence that the water and air quality in the Project Area is good, and that no further baseline analysis is required during the subsequent ESIA work. The exploration, construction, and operation of the scheme are, however, expected to cause some localised negative impacts on water and air quality. The potential negative impacts provisionally identified are as follows:

- Contamination of ground and surface water; and

- Deterioration of air quality in the immediate vicinity of the Project, with particular concern for the hiking base station and the potential impact on the St. Vincent Amazon Parrot and other species.

7.6.2 Exploration/Construction phase

Potential impact: Contamination of ground and surface water

There is a risk of contamination of ground water during drilling, however this risk is fairly low as the lining and grouting of the wells should contain the majority of the liquids. If reinjection is the selected disposal method for waste drilling water and other liquids, this may also provide an opportunity for contamination of ground water, particularly if various liquid wastes are mixed in the ponds (e.g. geothermal liquid, wash water, mud, chippings).

As has been described above under "Hydrology", it is possible that the effluents be reinjected or reused, but the possible requirement to discharge significant quantities of potentially contaminated water cannot be ruled out. Quite how much, and to where it would be discharged is currently unknown, but there is potential for negative impacts on surface water quality.

The provisional investigations suggest that the risk of contamination of both ground and surface water is fairly low, and the significance of a contamination event is also likely to be low. This issue is therefore not deemed to be significant, however as the risk of impacts will be present, some further consideration of potential impacts is needed during both phases of the ESIA, once further design decisions are made.

Potential impact: Deterioration of air quality

During exploration and construction there is potential for some localised deterioration in air quality as a result of the construction plant, machinery and traffic. This includes dust generation from project traffic and earthworks, and emissions from vehicles, plant and in particular, generators. This potential impact is common for all infrastructure projects and a number of well-established mitigation measures (such as damping of access roads, covering haulage vehicles with tarpaulins, ensuring only new/well maintained machinery is used, and carrying out regular air quality monitoring) are likely to prevent significant problems.

More specific to geothermal developments is the potential for gases released from the geothermal reservoir during drilling to cause a reduction in air quality. Of particular concern is the potential for H_2S released during drilling to have a deleterious effect on the nearby Parrot population. To determine whether this concern is a real risk will require improved weather (in particular wind) data for the project site, a formal evaluation of the presence of Parrots in the project area, and characterisation of the gases that will be released (until the reservoir is tapped, the gaseous composition is unknown).

7.6.3 Operation phase

Potential impact: Contamination of ground and surface water

There is a low concern for contamination of ground and surface water during operation. If the scheme is suitably designed, and operated with a robust ESMP, it is unlikely that harmful agents will be released into the local water courses and aquifer. Geothermal fluids used for electricity are injected back into geothermal reservoirs using wells with thick casing to prevent cross-contamination of brines with groundwater systems Provision for avoiding the standard

impacts associated with operation of a geothermal power plant should be considered during the Phase 2 ESIA, but no further field investigations are required.

Potential impact: Deterioration of air quality

It is difficult to properly consider the likely emissions of the operational system until the characteristics of the geothermal resource are known, and until the design of the various components of the generating station are finalised.

At this preliminary stage, it can, however, be said that the typical levels of production of key gases of concern such as H_2S, CO_2, SO_x and particulates for geothermal energy are extremely low in comparison to equivalent diesel of coil powered facilities. The frequent rains and almost constant winds in the Project area will also increase the mixing/removal of pollutants in/from the air. Assuming modern pollution abatement technology is installed, the operational emissions of the Project are therefore not expected to be of significant concern to the air quality in the project area. As with water quality issues, whilst no significant study of this issue is required at this stage, the situation should be reviewed once the characteristics of the resource and the provisional design of the facility are known.

7.7 Noise & Vibration

Noise and Vibration production during the exploratory drilling is discussed in Section 5.6. At 80 m from the drill rig, the approximate noise level will drop to below 70 dB(A), and at 550 m (assuming flat terrain), the noise level will be below 45 dB(A). This temporary noise is not considered to be a likely cause of significant negative impacts at most of the potential drill sites, as there are very few NSRs in the project area. There is, however, some concern relating to the possible impacts on the Soufrière Trail Base Station at Bamboo Ridge, just uphill from site W1. The Base Station is an important site for tourism and conservation activities, and significant noise from the exploration activities is likely to cause deterioration in the character of the facility and the experience of those using it.

It is therefore proposed that the Phase 1 ESIA includes a baseline noise survey and computer modelling of the likely noise contours to obtain a clearer picture of the significance of the noise levels likely to be experienced at the Base Station.

There will also be increased noise generation along the supply routes to site (principally the Windward Highway and "feeder" roads) during exploration and construction. This can be mitigated against to some extent via standard mitigation measures to be developed during the Phase 1 ESIA.

During the construction phase, the installation of the transmission lines may cause noise and vibration impacts, but as the alignments have yet to be determined, this possible impact will require examination during the Phase 2 ESIA.

During operation of the scheme there will be some noise generation, mainly from the cooling towers. The level of noise is likely to be below that of the exploration phase, and is also of a different, less intrusive nature. The eventual location of the generating station will have a significant influence on how the noise travels from the point of generation, but is likely that production phase noise will not cause significant negative impacts on the few NSRs that exist in the Project Area. This issue is therefore not deemed a key issue for follow-up, but should be re-examined during the Phase 2 ESIA, once further information on the location and design of the facility are known.

7.8 Transportation

As was described in the baseline section, there will be a significant increase in the traffic along the Windward Highway during the exploration and construction phases of the project, and to a lesser extent, during operation of the power station. The main negative potential impacts of this increase in traffic are:

- Increased noise levels for residents in proximity of the road;
- Air pollution; principally dust;
- Accidents;
- Increased wear; and
- Inconvenience and increased congestion.

As the above impacts are not considered to be highly significant and can be easily mitigated, no further survey work is required on these transportation issues, however some additional research into the traffic statistics is needed. The ESIAs should, however, further consider transportation impacts and develop corresponding mitigation measures.

Due to the narrow roads at the potential drill sites, without due consideration for scheduling of traffic movements, parking and unloading arrangements, it is possible that landowners and tourists (in the case of work at sites W1 and W2) may experience difficulties in passing the exploration site. It is therefore critical that the Phase 1 ESIA includes consideration of the maintenance of access during the exploration and construction phases.

A positive impact on transportation will likely be that the farmers operating in the Project Area will eventually receive improved access roads to their land parcels.

7.9 Flora & Fauna

7.9.1 Summary of Potential Impacts

The Scoping Survey has determined that, although the areas for project development are small and heavily influenced by existing human activity, the surrounding project area is likely to be considered as "critical habitat" in accordance with IFC PS6, and there is a possibility that the project activities could have serious negative impacts on flora and fauna. Further study is required, but the following potential impacts are provisionally identified as concerns:

- Loss of critical habitat for endangered/endemic species (and resultant impacts on species numbers/range);
- Loss of potentially unrecorded species; and
- Minor loss of ecosystem services such as soil stability/erosion and flood prevention.

7.9.2 Exploration/Construction phase

As has been described earlier in this report, all nine potential drill sites are in agricultural plots with varying intensity of cropping, pasture and scrub. Some of these areas were observed to hold significant numbers of birds and insects, but this appears to be with a lower abundance and diversity than the surround areas of forest. The loss of the small areas of vegetation needed for development of the drill pads is provisionally not likely to have a significant negative impact on the resident species of flora and fauna, and as the endangered/endemic species identified earlier in this report are not expected to be resident on the drill pad areas, there is not likely to be direct impacts on them from the site clearance.

Nevertheless, it is expected that there will be some disturbance of the forested areas that surround the drill sites in the project area during the exploration phase (e.g. during the laying of water supply lines). The exploration and construction activities also have the potential to generate more generalised negative impacts on flora and fauna; for example disturbances due to noise and light (the drilling will be a 24 hr operation) and as already discussed, due to diminished air quality.

The Scoping Survey revealed strong evidence that the project area is regularly frequented by the St. Vincent Amazon Parrot, and may also be an area of habitat or visitation by the Whistling Warbler and the St. Vincent blacksnake. It is also possible that as yet undescribed species exist in the forest areas. To maintain IFC PS compliance, a full biodiversity survey ought to be carried out prior to the commencement of work, and, depending on the results, the development of mitigation and/or offset measures may be necessary.

IFC PS6 requires that "for sites with potentially significant impacts on natural and critical habitats and ecosystem services, the baseline should include in-field surveys over multiple seasons and conducted by competent professionals and external experts, as necessary".

In view of the urgency to start exploratory drilling, carrying out the above surveys for the Phase 1 ESIA is problematic. Following discussions within the survey team and with IFC P6 specialists, it has been determined that it would be acceptable to carry out a less comprehensive biodiversity study during the Phase 1 ESIA, on the proviso that a more extensive survey be carried out as part of the Phase 2 ESIA once the final location and extent of the proposed facilities are known (unless the results of the Phase 1 Survey strongly suggest that further work is not necessary). To maintain PS6 compliance, it would also be necessary to adopt a precautionary/conservative prediction of potential impacts during the exploration phase. Further details on the proposed work required during the Phase 1 ESIA is provided in Appendix D. The Phase 2 ESIA will not only need to examine the potential impacts on flora and fauna of the immediate project site (once the exploration phase determines where this will be) but also the alignment of the transmission lines. As one of the two sets of lines is provisionally planned to take an inland route, it is likely that significant areas of forest will be lost.

7.9.3 Operation phase

The operation phase is unlikely to have significant impacts on flora and fauna; the principal concern is with the location and extent of the facilities, and the clearance/construction works.

Nonetheless, the Phase 2 ESIA should give full consideration to the potential for operational impacts, once the biodiversity survey(s) has determined the level of significance of the habitats and species in the Project Area.

7.10 Socio-Economic Environment

The site visit, reconnaissance overview of the AoI and scoping consultation results (See section 8) suggest that there are a number of positive and negative impacts on the socio-economic and cultural heritage environment, arising from both the exploration/construction and operations phases of the Project, which require assessment and evaluation during preparation of the ESIA Report. In addition, 7 out of 8 IFC Performance Standards are applicable to the Project (and hence the ESIA work) and some of these Performance Standards specify risks/impact issues that need to be addressed to help secure financing. Some of these risks/impact issues, but not all, are best addressed in an ESIA report.

Many, but not all, of the impacts relate to the exploration/construction phase and are likely to be temporary. It is expected that the negative impacts will be minimized, to levels likely to be deemed acceptable, by using carefully selected mitigation measures. Again, this needs to be considered and then demonstrated in the ESIA Report.

This section outlines first the key potential socio-economic and cultural heritage impacts associated with the Project. They are identified and described briefly by phase (exploration/construction and operations). This is followed by an account of those impacts that are considered to be of lower significance and which can be 'scoped out'.

7.10.1 Exploration/Construction Phase

The following negative impacts are expected to occur:

- Land acquisition and involuntary resettlement (from the establishment of the Project infrastructure and upgrading of transport routes) resulting in:
  - Physical and economic displacement affecting agricultural livelihoods;
- Community Health, Safety and Security risks, specifically:
  - Increased community exposure to adverse health effects, such as risks associated with the potential introduction of communicable diseases due to the presence of the non-local Project construction workers;
  - Increased community exposure to pollution-related health threats (such as those arising from discharges to air and to water);
  - Increased community exposure to accident risks arising from project-related transportation and hazardous material use, transport and management;
  - Potential changes to certain ecosystem services resulting in adverse community health and safety impacts, for example, reduction in ecosystem services that maintain soil structure, slope stability, erosion levels and flooding potential;
  - Potential for conflict situations to arise between local people and non-local workers in those communities where the workers are likely to be accommodated[26];
  - Potential for conflict situations to arise from certain interactions between community members and security personnel deployed to guard project personnel and physical assets (it is known that there are informal agricultural practices involving marijuana production in the project area); and
- Other Livelihoods:
  - Recreation and tourism - reduced number of visitors to the Soufrière hiking trail and hence, possibly, to nearby communities thus reducing visitor 'spend' affecting local business viability with consequences for profit/investment and employment levels and future opportunities;
- Risks to Workers' Health, Safety and Rights;

[26] Most workers re expected to find accommodation in Georgetown, but some may be accommodated in settlements nearer the Project site

- Influx (unplanned in-migration) impacts: the potential inflow of non-local people/economic migrants into the Project area, in search of employment and business prospects;
- Tourism and recreational impacts; and
- Cultural heritage.

The main positive impacts are expected to be:

- Increased job opportunities (temporary): and
- Enhanced opportunities for local enterprises to grow.

A brief description/synopsis of these key impacts is provided below.

Land acquisition and involuntary resettlement

There is a key distinction between two types of involuntary resettlement:

- Physical displacement - where individuals, households and communities must be moved to a new location because their dwellings will be affected by a proposed project in such a way that makes continued habitation impossible; and
- Economic displacement - where assets are lost or damaged or access to assets is restricted in such a way that the livelihoods of individuals, households and communities can be affected adversely.

It is expected that the Project will involve both kinds of displacement, as the family currently residing adjacent to W3 will have to be resettled. Also, acquisition of this and other land plots is likely to result in disturbance of farming, animal rearing and small-scale agricultural processing activities currently undertaken by some local community members. Project implementation (especially its linear facilities such as roads and transmission lines) may also result in hindered access to the farming lands. Fishing/hunting are not expected to be significantly affected as these activities are not widely spread within the local community and have more of a recreational nature, rather than play a subsistence role.

It is also very likely that privately owned land will be acquired for construction of the transmission lines and new access roads. Initial discussions with the VINLEC representatives indicated that the realignment route would be selected with the aim of minimizing displacement/avoiding resettlement and would be based on discussions with the landowners. Even in case of state ownership of required land there will likely be the need for compensation for certain assets such as crops.

Land-related livelihood impacts will be assessed and evaluated in the ESIA Report and details of how they will be managed and livelihoods of affected individual/households improved (or at minimum restored) will be presented in standalone Resettlement Action Plans or Livelihood Restoration Plans (as appropriate). The impacts will be assessed in line with the international good practice of managing land acquisition and involuntary resettlement (IFC Performance Standard 5) and the existing SVG statutory requirements. All Resettlement Action Plans or Livelihood Restoration Plans and their livelihood restoration measures, such as allocation of land of financial compensation measures, will be developed through informed consultation and participation with the affected individuals/households.

Community Health, Safety and Security Impacts

Community health, safety and security impacts and risks will be localised to the Project AoI and in particular in the area of exploratory drilling, transportation of materials and equipment and construction/operation of the Project main and associated facilities. Community members who work or travel near the project site and/or along near the access roads will be most exposed to these impacts and risks. Those residing in the communities and only visiting the vicinity of the project or travelling along the access roads intermittently will be less exposed. The nearest permanent residential area is located 4 km from the future Project site boundaries.

During construction and operation of the Project, potential community health, safety and security impacts and risks will be primarily associated with the following activities/everts/project characteristics:

- **Active construction and operation areas:** Areas of active construction with operating equipment and on-going works, as well as operational sites pose a risk to the public if access is not adequately controlled;
- **Noise and air emissions associated with construction and operation activities:** Health impacts on local communities may occur due to changes in ambient pollution levels, for example, elevated noise levels and air emissions;
- **Road traffic:** Increased traffic associated with construction, including the delivery of materials and personnel as well as localised movements of the equipment and machinery will pose an enhanced safety risk to other users in the area as traffic-related accidents will be more likely;
- **Major accident hazards:** The assessment of risks associated with major accident hazards during the Project works will include consideration of risks to any third party land users in the vicinity of the Project facilities. Specifically, such third parties will need to be addressed within the Project's emergency response and preparedness plans;
- **Community exposure to diseases:** There are potential risks associated with introduction of communicable diseases due to the presence of the Project construction workers and unplanned in-migration (influx);
- **Interactions between local people and non-local workers:** This could give rise to short-term and sporadic conflicts; especially if there is a concentration of workers in one community as appears likely to occur (Georgetown seems to be the nearest settlement with sufficient spare accommodation capacity to house these workers). It appears that these workers will rely on local health service facilities and, therefore, the capacity of the local health facilities and practitioners to cope with the anticipated demand may be affected;
- **Interactions between security providers and community members:** There is a risk of conflicts and tensions due to the presence of security services on site, including a potential for disproportionate use of force or intrusive stop-and-search practices. The presence of 'informal' agriculture (marijuana growing) in the nearby area adds to the potential for problems to arise.

Risks to Workers' Health, Safety and Rights

This issue is increasingly important for projects seeking financing from institutions that are signatories of Equator Principles III. Thus, compliance with IFC Performance Standard 2 on "Labor and Working Conditions" is a key requirement. This Performance Standard contains a number of risks, and consequent requirements to avoid them, relating primarily to occupational health and safety and to the welfare of workers (including contractors and suppliers). These risks are not considered appropriate for detailed inclusion within the ESIA Report. Instead, the Consortium will issue a set of policies and procedures that comply with this Performance Standard to ensure that certain key risks are avoided (for example, limited or no employment of child labour and a prohibition on forced labour) or managed (for example, via an employee Grievance Mechanism). These policies and procedures will be included in in the Environmental and Social Management System (ESMS) that the Consortium will develop and implement, in line with appropriate standards (such as those of the ISO), prior to early works occurring. The ESIA (including the ESMP) will identify requirements and a mechanism that ensures an ESMS, with the appropriate policies and procedures, is adopted.

Threats to workers' health, safety and rights are only outlined here. The Consortium intends to hire local workers where possible. Estimated numbers of workers are, as follows:

- Civil works: 10 workers, all local;
- Drilling: 30 workers, near 25 workers to be non-local;
- Construction of the plant: About 100 workers maximum, approximately 50 workers to be non-local; and
- Operation of the plant: About 10 workers, all local. A few expatriates are anticipated to participate in training of local employees.

There will be a wide range of general and activity-specific occupational health and safety risks associated with all stages of Project implementation. This may involve risks related to various types of work: welding and/or cutting, work with hazardous substances, work on cranes and lifting equipment, working at heights, electrical maintenance, excavation, pressure systems, work in confined space, etc. These risks will vary between different exploration/construction activities and also over time.

Approximately 50 non-local workers will require accommodation. Stakeholder consultation indicate that there is no capacity in the nearest settlements to house this number of Project workers; local communities are small and already overcrowded. The best option appears to be to rental accommodation in Georgetown. The following impacts may arise from this accommodation option:

- Sanitary and hygiene risks; and
- Standards of worker behaviour and cultural differences.

Influx

Project implementation may attract opportunistic economic migrants from other SVG localities (in fact this may occur prior to early works if it seems that the project will proceed). Such in-migrants are likely to be young single males or and/or young women (some of whom may be sex workers). Thus, this influx may create a potential for competition, conflicts and tensions between these individuals and the local host community/ies.

For medical assistance the local health facilities are planned to be used. It will unlikely pose a risk of significant overloading the local health infrastructure but more likely a temporary pressure on the facilities in the short term. As mentioned above, probability of community exposure to adverse health effects, such as potential risks associated with introduction of contagious or non-endemic human diseases as a result of the Project implementation is considered low.

Tourism and Recreational impacts

The main recreational and tourist attraction in the AoI is "la Soufrière Cross Country Trail" which leads to the crater. Sites W1 and W2 are accessed by the same road also used for accessing the Trail base station (referred to locally as "Bamboo ridge"). The importance of maintaining access to the trail is a stakeholder concern.

Use of local roads simultaneously with the potential implementation of the Youromei Heritage village (if resumed) and the Rabacca Park recreational project may have a negative influence on the schedule of these projects, as well as resulting in potential localized traffic congestion. The ESIA Report will elaborate on this matter as part of a wider consideration of cumulative impacts.

Cultural Heritage Impacts

Although no archaeological items or cultural heritage items are known to exist in the AoI, there is a possibility that tangible cultural heritage items (i.e. physical sites, structures, features, and objects) may be found. There is one historical item of cultural heritage; the 18th century aqueduct at Orange Hill. Some adjustments to the Windward highway may be required and these may affect the overhead masonry of this aqueduct.

Baseline work and stakeholder consultations indicate that there are no natural landscape features that have historical, ethnographic, spiritual, and cultural value. Disturbance of intangible cultural heritage practices (traditional skills, customs, rituals, spiritual ceremonies and traditional specialist knowledge) is also not expected. Nevertheless, the presence/absence of cultural heritage elements needs to be further determined during the ESIA work. Irrespective of the results of ESIA investigations, the ESMP will include, at minimum, a Chance Finds Procedure to ensure that, in the event of previously unknown cultural heritage items being discovered, they will be appropriately managed.

Enhanced Job opportunities and benefits for local businesses

There will be an increased number of temporary job opportunities in the local area including both direct employment with the Project/main contractor and additional indirect and induced job opportunities in a) the supply chain and b) in local businesses benefiting from the increased amount of money circulating in the local economy as result of Project CAPEX expenditures. These job opportunities will be available to local people with and without training being required. In addition, there will be enhanced business opportunities for local suppliers of goods and services with resulting benefits for business viability and employee security.

7.10.2 Operations Phase

There are fewer positive and negative impacts compared to the exploration/construction phase. The key negative impacts to be assessed and evaluated are:

- Community Health, Safety and Security, specifically:
  - Increased community exposure to pollution-related health threats (such as those arising from discharges to air and to water);
  - Increased community exposure to major accident hazards: similar to construction phase, this will include consideration of risks to any third party land users in the vicinity of the Project facilities. Specifically, such third parties will need to be addressed within the Project's emergency response and preparedness plans;
  - Increased community exposure to accident risks arising from project-related transportation and hazardous material use, transport and management; and
  - Potential for conflict situations to arise from certain interactions between community members and security personnel deployed to guard project personnel and physical assets (it is known that there are informal agricultural practices involving marijuana production in the project area); and
- Agricultural Livelihoods:
  - Future agricultural development - reduced likelihood of renovation of the damaged irrigation network and potential air quality changes.

The key positive impacts can be divided into expected changes in macro-level economic development and those that pertain to the local level. The latter are similar to those expected from the construction phase. The positive impacts are:

- Macro-level economic change: reduced fossil fuel import costs, cheaper energy costs, enhanced economic development and reduced greenhouse gas (GHG) emissions; and
- Local-level economic change: many are similar to those expected from the construction phase except the scale, duration and significance is likely to be altered, particularly as the Project will be operating for many years.

A brief description/synopsis of these key impacts is provided below.

Community Health, Safety and Security

The specific impacts are similar to those of the exploration/construction phase. The scale and significance may vary, for example, traffic flows are expected to reduce in the operations phase, but will remain at levels higher than the current baseline.

Agricultural Livelihoods

There are GoSVG initiatives underway to improve agricultural production and the quality of products. There is some concern about the potential effects of air quality changes on agriculture (see Table 18 in section 8). Also, in the Project area there is a non-functioning irrigation network. This is a resource which, if functioning, might be able to play a role in enhancing agricultural production. The existence of the Project might adversely affect the likelihood of the irrigation network being renovated. Together, the presence of the Project plus environmental changes (specifically air quality, but also potentially water availability and quality), arising from its operation, may reduce the probability for agriculture reaching its full potential in the local area to the detriment of the livelihood of current farmers. The water issue will remain a potential threat irrespective of whether the irrigation network can be renovated.

Macro-level Economic Change

At present, SVG is highly dependent on imported petroleum products such as gasoline (for transport), diesel (transport and electricity generation), kerosene (cooking), and butane /LPG (cooking, water heating, and industry). Until very recently, the high costs of imported fossil fuels led to increasing electricity tariffs and the high carbon content of fossil-fuel based electricity production resulting in significant *per capita* GHG emissions. As it will exploit a renewable energy resource, the Project is expected to bring the following benefits:

- Guarantee clean, reliable and more affordable energy supply to customers;
- Strengthen the national economy by reducing the dependence on import of fossil fuels;
- Reduce expenditure on imported fossil fuels thus 'freeing' money for other socio-economically beneficial purposes; and
- Reducing GHG emissions.

Local-level: Economic Change

At the local level the positive impacts are expected to be:

- Improved road infrastructure;
- Increased number of job opportunities in the local area including both direct employment with the Project and additional indirect and induced job opportunities in a) the supply chain and b) in local businesses benefiting from the increased amount of money circulating in the local economy as result of Project OPEX expenditures;
- Potential for a capacity development programmes to be put in place to train suitable local people for work as project 'operators';
- Continuing higher level of business opportunities for local suppliers of goods and services with resulting benefits for business viability and employee security; and
- Leveraging of rural development opportunities via the operating facility acting as growth pole for attracting increased level of investment.

7.10.3 Social Impacts of Low Concern

Based on the results of the scoping study certain potential impact issues, considered at the beginning of scoping work, are believed to be of low concern and can be 'scoped out'. Table 15 presents these impact issues with the reason for 'scoping out'.

Table 15: Social Impacts of Low Concern/'Scoped out' with Reasons

Impact	Reasons for 'Scoping Out'
Increased pressures on local infrastructure (such as water, electricity, roads, and health centres) from construction workers in settlements close to the project site	Workers are likely to be housed in Georgetown not in settlements close to the Project site. If small numbers do find accommodation in these settlements then the numbers will be small and not likely to cause any adverse infrastructure impacts
Threats to vulnerable groups (for example, disabled, elderly)	Non-discriminatory employment policies will be applied. Local inflation (which can affect people on fixed incomes, such as the disabled and elderly) is not expected to occur as workers will be housed in Georgetown and the local economy is considered to be capable of accommodating the extra demand for goods and services without resulting in significant inflationary pressures.
Impacts on fishing and hunting	These activities are not widespread within the local communities and do not have a subsistence role. The Project is not expected to affect them adversely as the area to be occupied is small.
Impacts on indigenous peoples	PS7 is inapplicable – see Chapter 4 for more details.

7.11 Cumulative Impacts

No significant cumulative impacts of the proposed development are identified at this preliminary stage. A potential minor cumulative impact could be increased localized traffic congestion/accidents if the Project activities clash with the Youromei Heritage village (if resumed) and the Rabacca Park recreational projects. Cumulative and induced impacts will be reassessed during the Phase 1 and Phase 2 ESIAs.

7.12 Assessment of Alternatives

It is usual within an ESIA to consider alternatives, which may be alternatives of location, design, construction, and/or operation. As has been described above, the Project is likely to have significant positive impacts on the environment and economy of St. Vincent. The "no Project" alternative is likely to perpetuate the current situation of a reliance on high cost imported fossil fuel sources for electricity production. This would likely result in:

- Slower economic development;
- Continued consumption of and probable increase in imported petroleum products;
- Continued fluctuation of electricity prices due to fluctuation of oil prices; and

- Sustained (and probable increase in) levels of greenhouse gas emissions from diesel-powered electricity generation.

The “no Project” alternative is therefore not preferable from the perspectives of social and economic development and the environment.

Alternative renewable energy sources could be considered other than geothermal, but whilst solar power is feasible at the household level in St. Vincent, the country lacks sufficient open, flat areas suitable for the technology. Other renewables resources might be possible, but the development of geothermal is the obvious choice given the expected availability of the resource and the success of other recent geothermal developments in the Caribbean region.

Having discussed the “no Project” alternative, alternatives “within” the project should be discussed. Assuming, therefore that a geothermal project would proceed, the proponent undertook a multi-phase assessment of alternatives. The first phase of the assessment examined the two alternatives for the wider project area; whether the exploration should take place on the leeward or windward side of the island. This decision was made via a combination of the expected availability of the geothermal resource coupled with issues such as access, transport and cost. This stage of the alternatives selection process resulted in the selection of a site on the windward side of the island. The next stage of the alternatives assessment was to examine which of the nine windward sites provisionally identified were most suitable. At this stage the selection criteria were widened to include issues such as availability of process water, and environmental and social considerations. The outcome of this phase was that sites W1 and W3 were the favourites, as shown in Figure 55 below.

ST. VINCENT GEOTHERMAL PROJECT - Site Selection Criteria — Site No.

CRITERIA	Measure	Weight (%)	1	2	3	4	5	6	7	8	9	Comments
Geothermal Resource												
Geothermal Resource - distance from site to resource	Distance to resource	25										
Geothermal Resource - depth to the resource from site	Depth to access resource											
Geological stability of area												
Cooling Water												
Drill water (50 liters/second peak for perhaps 5 days of drilling)	Availability - cu.m per day											
Drill water (50 liters/second peak for perhaps 5 days of drilling)	5 to access											
Water storage (pond / tank) close to wellpad	5											
Cooling water during plant operation	Availability - cu.m per day											
Risk												
Environmental Impacts and Mitigation	—											
Social Impacts and Mitigation	—											
Land Availability / Ownership	5											
Emergency /Temporary surface exhaust of geothermal fluid.												
Volcanic Risk	Hazard Map	5										

ST. VINCENT GEOTHERMAL PROJECT - Site Selection Criteria — Site No.

CRITERIA	Measure	Weight (%)	1	2	3	4	5	6	7	8	9	Comments
Constructability of Well Pad / Plant												
Wellpad for 3 production wells (90x100 meters) + mud pit												
Available area for well head Power Plant												
Available Area for Power Plant (downhill from wellpad)	sq. m.											
Wellpad for 1 re-injection well (downhill from prod.well and Plant)												
Number of wells that may be required	#											
Number of well pads that may be required	#											
Well design(diameter)requirements (assuming there may be some variability between sites)	Sq. m.											
Well design of reinjection well. (Vertical?, shallow?)												
Size / weight of drill equipment required	Dim.											
Estimated drilling costs	$											
Constructability of Well Pad / Plant												

Figure 55: Proponent Site Selection Matrix

Once exploration takes place and more is known about the geothermal resource there will be further rounds of alternatives assessment/optioneering focusing on the design/type of the generating station, cooling system etc., and relating to the transmission line route and support type.

8 STAKEHOLDER ENGAGEMENT

8.1 Introduction and Approach

Figure 3 presents the EIA process in SVG. The first set of activities after a decision has been made that an EIA Report must be submitted to the regulator, is the preparation of ToR for the ESIA work. Implementing a scoping study to identify and define the key risks and impacts is an important early activity whose results play an important part in determining the "scope" of the ToR and ensuring that the ESIA Report only focuses on significant issues. Obtaining and considering the views of stakeholders during scoping, on the key risks and impacts from their perspective, is an important contribution to scoping work.

The following stakeholder engagement activities were undertaken during preparation of this Scoping Report:

- Preparation of the SEP (v01) to guide scoping consultation and disclosure activities;
- Desktop review (secondary baseline information/data; project description and results of previous stakeholder consultation activities). The focus was on the July 2015 set of consultations as they provide the clearest indication of stakeholder concerns/impact issues compared to earlier consultations undertaken for the Project. This work was followed by a site visit (project area, area of influence and main transport routes);
- Stakeholder consultations and disclosure of project information and;
- Preparation of a summary of key questions and concerns/impact issues identified during consultations.

8.2 Previous Stakeholder Consultations

As reported in the SEP (v03), the Consortium undertook a range of stakeholder consultations, in July 2015, prior to the initiation of the scoping study being presented in this Scoping Report. A list of the questions concerns/impact issues that arose (as opposed to queries relating to the technical aspects of the Project[27]) is provided below in Box 1. Consultations undertaken to assist preparation of this Scoping Report are described below in Section 8.3. As will be demonstrated below, unsurprisingly there is close correspondence between the results of the July and the October (both 2015) stakeholder consultations.

Box 1: July 2015 Stakeholder Consultations Questions/Concerns/Impact Issues

- Consideration to be given to the habitat of the National Bird [St Vincent Amazon Parrot (*Amazona guildingii*)] being in that region, how will this be treated in the ESIA?
- Are there any chemicals used in drilling?
- Will drilling cause earthquakes?
- What will be the source of water for drilling?
- What is done with the material that is removed?
- Will the resulting levels of H2S gas be dangerous?
- What is the impact on electricity tariff?
- How will local infrastructure upgrades be managed?
- Did the ESIA take into account the local wildlife, water and air quality?
- Are there any land acquisition issues?
- Elaborate on the need for water for drilling?
- What is the environmental impact of noise and light during plant operation on endemic species?
- Costs of road development
- Is there potential for the use of plant output water?

[27] The full list is presented in the SEP v03

8.3 Consultation and Disclosure Activities

8.3.1 Consultations

The SEP identified five categories of stakeholders:

- Affected communities;
- Regulatory and executive governmental bodies at national level[28];
- NGOs and interest groups;
- Mass media; and
- Internal stakeholders (e. g. Consortium employees/labour unions).

For the scoping consultations attention focused on the first three stakeholder categories. The media and internal stakeholders were not included in consultations since the former are engaged primarily via information disclosure (such as press releases and briefings) and the latter did not 'exist' at the time of the scoping work).[29]

All consultations had two main objectives: identification of potential concerns and impact issues and obtaining baseline data. In the case of regulatory and executive government entities, gaining an understanding of the regulatory, policy and institutional framework, also, was important.

Three consultation methods were used according to the stakeholder category, as follows:

Affected communities: a 'cluster' meeting, in Sandy Bay, with selected members of three communities: Orange Hill, Overland and Sandy Bay. The members were selected to provide a range of perspectives (by sex, age and livelihood). This meeting was held on 24 October, 2015, facilitated by NK LAC consultants and attended by 7 community members. Figure 56 shows the meeting in progress.

[28] There are no local government administrations in SVG.

[29] The mass media will continue to be engaged by a range of disclosure mechanisms and via invitations to attend certain future ESIA phase consultation meetings; and internal stakeholders will be involved in consultation activities once employees and, potentially, labour union/s are in place.

Figure 56: Affected Communities Meeting, Sandy Bay, 24 October, 2015

Regulatory and executive government entities: a series of face-to-face meetings were arranged at the offices of each stakeholder. All meetings were attended by the NK LAC consultants. Thirteen (13) meetings were held during the period 16-29 October, 2015. As appropriate, separate meetings were held with specific departments/agencies, responsible to Ministries, as well as the 'parent' Ministries.

NGOs and interest groups: a workshop was organized and 21 organizations invited, in writing, to send members/representatives to attend. This workshop was held on 29 October, 2015, but was attend by only two organizations, one of which was the National Emergency Management Organization, a government body and not an NGO.

8.3.2 Disclosure

Due to time constraints it was not possible to provide information on the project and the scoping study in advance of the meetings. Many stakeholders had attended previous consultation meetings and those who had not attended such meetings were aware of the project and the intended "general" location (if not the actual alternative sites being considered for specific project activities) as a result of media coverage over the past two years. Prior to each meeting there was a brief introduction to update the stakeholders on the project's current status, future intentions and, also, the status and role of the scoping study in ESIA/planning process. When applicable, a brochure prepared earlier by the Consortium, and distributed to many stakeholders previously, was made available to help inform stakeholders of the project and its intended location. At each meeting time was allocated so that stakeholders could seek clarification/additional information following the introductory presentations. The disclosure materials and all consultation meetings were in the English language as this was spoken and read fluently by all stakeholders.

8.4 Consultation Results

Results of the consultation meetings are presented for each stakeholder category.

8.4.1 Affected Communities

As shown in Table 16 most concerns impact issues related to socio-economic matters such as land take/compensation, water availability/use, and employment/socio-economic development. However, there is a recognition of the threats to biodiversity and the potential of increased geomorphological and seismic risks.

Table 16: Affected Communities: Questions/Concerns/Impact Issues

Stakeholders	Questions/Concerns/Impact Issues[30]
Sandy Bay	Regarding site W3 will the owner/occupier be supplied with replacement land?
Overland	Will recent graduates be trained to be able to operate the facility?
Orange Hill	Will existing roads need to be widened to enable access to the project? How much land might be needed?
	Impacts on the volcano; seismic risks
	Impacts of drilling on the 'loose' soil in the project area
	Water abstraction and potential impacts on agriculture
	Impact on wildlife
	'Social' impacts of use of the Windward highway – public safety, additional load on the road during transportation of the equipment from Kingstown to the site
	Reduced electricity costs
	Increase socio-economic development opportunities' for local communities

8.4.2 Regulatory and executive government entities

The concerns and impact issues are grouped together, in Table 17, under general headings to assist easier comprehension of the results of these consultations. Most concerns/impact issues relate to biodiversity, agriculture and recreation and tourism and the hydrological regime. To help gain an insight into the relative importance of specific concerns/impact issues the number of 'mentions' for each item considered to be a concern/impact issue is recorded in the Table.

[30] The minutes of the meeting in Sandy Bay, 24 October 2015, are provided in the SEP v03.

Table 17: Regulatory and Executive Entities: Concerns/Impact Issues

Stakeholders	Concerns/Impact Issues (*number of times each item was mentioned*)
Central Water & Sewerage Authority (Water Division)	**Air Quality** Impact on air quality (*1*)
Central Water & Sewerage Authority (Solid Waste Management Unit)	**Impacts on Agriculture/livelihoods** Effects of air pollution on quality of agricultural products. Hydrogen sulphide (H_2S) is a particular concern (*1*)
Ministry of Agriculture, Industry, Forestry, Fisheries and Rural Transformation	Project water inputs and outputs, environmental flows, and effects on agricultural use of water downstream from the project (*1*)
Ministry of Agriculture, Industry, Forestry, Fisheries and Rural Transformation (Forestry Department)	Impacts on farming (*1*) **Biodiversity** Habitat destruction/disruption and adverse effects on biodiversity in the project area (*2*)
Ministry of Health, Wellness and the Environment	Impacts on rare and endemic species in the project area (*1*)
Ministry of Health, Wellness and the Environment (Environmental Management Department)	Effects of H_2S emissions on the parrot population downwind [St Vincent Amazon Parrot (*Amazona guildingii*)] (*1*) [Transmission lines] - Impact on forest and effect of electromagnetic field on fauna (*1*)
Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning,	**Recreation and Tourism**
Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning (Physical Planning Unit)	Impacts [negative] on the Soufriere cross-country trail and mitigation needed to ensure that the trail should remain open to the public (*3*) Improved road access, possible supply of water to the base station, and even [more] tourism to the geothermal facility itself (*1*)
Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning (Lands & Surveys Department)	**Hydrological regime** Water issues - abstraction and discharges (*1*)
Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth	Effluents and wastes from the [project] operation having an impact on the watershed/aquatic environment (*1*) Silting of watercourses (*1*)
Ministry of Tourism, Sports and Culture (National Parks, Rivers and Beaches Authority)	Increased commercial aggregate extraction operations in the Rabacca River bed (*1*) **Geomorphological issues** Effect on soil stability, landslides and erosion potential (*1*)
Ministry of Transport, Works, Urban Development & Local Government Office of the Prime Minister (Energy Unit)	**Communities** Post-closure impacts (*1*) Effects on communities (*1*)

8.4.3 NGOs and interest groups

Although 21 organisations were invited only 2 attended. The concerns and impact issues raised are shown in Table 18 below.

Table 18: NGOs and Interest Groups: Concerns/Impact Issues

Stakeholders	Concerns/Impact Issues
Chamber of Commerce National Emergency Management Organization[31]	Impacts on local businesses (for example, change in electricity prices, stimulation of business activity and provision of new opportunities for business development (including tourism) Also, environmental impacts which may be felt by local businesses and potentially affecting their activities Potential Interactions between the project, its workforce and 'alternative farmers' (people who grow marijuana) needs careful management

[31] Although a government body the National Emergency Management Organization attended the NGO/Interest Group meeting so its input to the scoping study is reported here.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

9.1.1 Study Implementation

The Scoping Study has been carried out in accordance with SVG law and IFC Performance Standard 1. The study was successful in identifying the key environmental and social impacts that are likely to result from the Project and which require further study during the subsequent ESIA work. Some of the potential impacts had not previously been identified. It has also been possible to identify issues of low concern that do not require significant further study.

During the Study the team received a good level of cooperation from the Geothermal Consortium, and all other stakeholders. Likewise, access to the site was facilitated by the Consortium and the field visits were therefore successful. The main difficulty encountered during the Scoping Study was the uncertainty relating to the location and design of the facility. This is largely due to the nature of geothermal developments, i.e. that the design and location of the plant cannot be developed until the nature of the geothermal resource is known and the location of the production wells is confirmed. Although the lack of information on the production phase facility was expected, it was somewhat surprising that more firm information was not available on the exploration phase; several issues (such as water supply, reinjection, and selection of drill site) were still uncertain at the time of the Scoping Survey.

9.1.2 Major Potential Negative Impacts

The Scoping study has confirmed that overall, the Project is likely to have significant positive impacts on the socio-economics of SVG by, *inter alia*, reducing reliance on imported energy, creating jobs and improving local technical capacity, improving local infrastructure, stabilising/strengthening the economy, and reducing energy costs, which is expected to stimulate the economy (particularly the manufacturing sector).

In addition to the positive socio-economic impacts, the geothermal development will generate a significant reduction in SVG's greenhouse gas emissions due to the offset diesel generation from the move to sustainable geothermal production.

Nevertheless, a number of potentially significant areas of negative impact have been identified by the Scoping Study. These require substantial further investigation during the Phase 1 and Phase 2 ESIAs. The main issues are as follows:

- Water supply/over-abstraction, river flows, environmental flows and effluent management;
- Biodiversity, ecology and endangered/endemic species;
- Noise issues, particularly with respect to "Bamboo Ridge" Hiking Base Station;
- Air Quality; and
- Physical and economic displacement.

Whilst the above issues are the key areas of concern for further detailed investigation during the ESIA work (and are therefore the subject of "specialist" studies in the ToR provided in Appendix D), various other potential impacts of a more "standard" nature (i.e. common impacts across many infrastructure projects such as landscape impacts and population influx impacts) will require consideration during the ESIA work, and possibly development of

corresponding mitigation measures, but these areas do not require any further field surveys/ investigations.

9.1.3 Issues of Low Concern

The issues of low concern that can be largely "scoped out" of further significant investigation[32] include:

- Impacts on geology, geomorphology, and soils;
- Impacts on seismology and volcanology[33];
- Impacts on climate and meteorology;
- Impacts on local infrastructure pressures;
- Impacts on fishing and hunting;
- Impacts on vulnerable groups; and
- Impacts on indigenous people.

9.1.4 Other Conclusions

In addition to the key focus of the Scoping Survey on potential negative environmental and social impacts, a number of important conclusions have also been drawn with respect to other issues:

- The EIA Process and laws in SVG are not particularly onerous, and it is not expected that the Project will experience any significant difficulty in obtaining the domestic approvals required to construct and operate the Project.
- Likewise, the SVG laws on land acquisition and resettlement are not likely to pose a problem for the Geothermal Consortium; it is the compliance with IFC PSs for both environment and social issues that is the key challenge for this Project.
- During the stakeholder meetings, several government stakeholders felt that the Consortium was not doing enough to share information and involve other government entities in the Project. The members of the public consulted also felt that the Energy Unit should do more to engage with the local population in the AoI; particularly with respect to their fears of the Project activities leading to increased volcanism.
- It was originally intended that the present Scoping Report would apply equally to the exploration and construction/operation phases of the Project. Likewise it was expected that ToR would be produced for both the Phase 1 ESIA (covering exploration) and the Phase 2 ESIA (covering construction/operation). However, it became clear during the scoping work that there is such a significant degree of uncertainty with respect to the likely location, footprint, and design of the eventual generating station (if, indeed, the Project progresses beyond exploration), that the present study has

[32] Whilst these issues are scoped out of significant further work during the ESIA phases, they should not be ignored completely; there is still some potential for negative impacts if a robust ESMP is not developed and followed, and any further changes to project designs, methodologies or strategies may increase the likelihood of these potential impacts becoming more significant.

[33] No further study is required on this issue, but it is important that the Consortium increase engagement with stakeholders on this issue (see Section 9.2).

inevitably focussed on the exploration phase. ToR can only be prepared for the Phase 1 ESIA at this stage (see Appendix D).

9.2 Recommendations

The following recommendations are made at this initial stage of the project:

- As the consortium has a very tight schedule in place and hopes to start exploratory drilling in mid-2016, it is critical that the land acquisition issues discussed in Section 7 be properly handled in compliance with the IFC PS5 as soon as possible. In the meantime, in view of the current land use situation, it is advisable to start the Project works on site W1 (assuming noise impacts will not be deemed to be too significant).

- Considering the Consortium's schedule, it is possible to carry out a "Rapid Biodiversity Survey" as part of the Phase 1 ESIA whilst still maintaining IFC PS6 compliance, but only if this initial rapid survey is followed up with a more significant biodiversity survey (and associated mitigation/offsets, if required) during the Phase 2 ESIA, once the final project location and design are known. Failure to do so is likely to endanger compliance with IFC PS6.

- The Consortium should also be aware that a precautionary estimate of impacts may mean that Phase 1 can move swiftly, but is also likely to cost more in the long-term (in offset liability under PS6).

- VINLEC indicated that they expect design and construction of the transmission lines to take at least three years and that they are currently doing little in the way of study on the required transmission lines. This expected duration could have significant impacts on the overall Project schedule, and the Consortium is therefore advised to follow up with VINLEC.

- The Consortium is advised to increase the level of cooperation with government stakeholders; in particular the Forestry Department and the National Emergency Management Organization (NEMO). It was clear during the Scoping exercise that these and other organizations have considerable interests in the development of the project, and their closer involvement is likely to facilitate the environmental and social management of the project (for example, by advising on design issues and terms of reference for surveys, and assisting with monitoring and awareness-raising). The cooperation will simultaneously improve the information held by other departments and assist with their sectoral work, and will improve governmental awareness and understanding of the project's environmental and social issues.

- Moreover, due to the concerns highlighted in this report with regards to endangered species, it would be mutually beneficial for the Geothermal Consortium and credible conservation organisations/academic institutions to develop ongoing partnerships. This would also help towards compliance with IFC PS6.

- The meetings held during the Scoping exercise (both public and governmental) revealed that there is considerable concern that the Project will trigger earthquakes or the eruption of Soufrière. The Consortium is advised to increase efforts to raise awareness of the scientific basis for why this understandable fear is unfounded. This will ultimately be beneficial for the consortium as it is likely to increase the level of support for the Project.

- The Consortium may wish to explore the feasibility of carbon finance. This could provide an additional revenue stream, and it is considerably easier to verify offsets, credits, and permanence with emission avoidance projects than with sequestration, afforestation and other similar projects.

APPENDICES

A: Additional Photographs

Site W1

Hiking Trail Base Station

Site W2

Site W3

Site W4

Site W5

Site W6

Site W7

Site W8 (foreground) & W9 (background)

B: Minutes of "one on one" Meetings

MEETING MINUTES

Date: 21th October 2015

Location: Office of Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning (HILP)

Time: 10:30-11:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Anthony Bowman (AB)	Chief Technical Officer, HILP
Mr. Loftur Gissurarson(LG)	Head of Quality & HSE, RG
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Katya Sladkova

Item	Description	Action
1	**Introductions** Introductions were made. RM & LG provided an initial introduction to the scoping report study and NK team.	
2	**Study Purpose** PD explained the background and purpose of the study	
3	**Lands status in the Project area** AB explained that most of the land in the Project area belongs to the State and, as a result of a land reform of 1980s-1990s, the previous large estate, Rabacca Farms Co. ltd., was divided into parcels (3-acres each), each of them having an individual reference number in a survey plan. As per the survey plan, this land has a status of a farming land. Thus, it is prohibited to establish permanent residential structures in this area. Legal grounds for using this land may be, as follows: - Lease; - Ownership (purchase can take place only after certain time period of leasing the land parcel has passed). -Cabinet can also authorise buildings on a case by case basis AB noted that many people use this land without any legal grounds. KS asked if this land can be used for industrial purposes and what would be the procedure for obtaining a permission to do that. AB answered that, due to the Project's high national importance, this can be allowed if appropriate mitigation measures are in place.	
4	**Acquiring the land** AB described various possible options for acquiring the land: -If it belongs to the Government and nobody uses this land, there should not be any problems with formalising the land use rights – the Project can either lease it or purchase it depending on the agreements reached; -If it belongs to the Government and someone uses this land for farming activities, the land users should be compensated for lost crops according to the methodology developed by Ministry of Agriculture; -If the land is in private ownership, the Chief Surveyor can acquire it by 2 means: • Negotiations • Compulsory acquisition with providing compensation on a market value. (this process includes right of appeal) The latter is regulated by a Land Acquisition Act No 241.	
5	**Steps to be undertaken by the Project** KS asked what would be the steps for the Project to obtain up-to-date information on land use in the Project AoI. AB answered that a request should be submitted to the Chief Surveyor with providing the survey plot numbers of the parcels to be acquired. After this, the Chief Surveyor will issue an official response.	*LG to check the status of negotiations on the land use issue*

Item	Description	Action
6	**Nearest settlements** The nearest settlements to the Project area are, as follows (listed in order of proximity): - Tourama; - Orange Hill; - Overland Village; - Georgetown; - Landy Park. KS asked if there is additional capacity in the settlements to house Project workers, if needed. AB answered that the local communities are small and already overcrowded. The only option would be to rent in Georgetown. AB confirmed that there are no municipalities or local government in St Vincent.	
7	**Issues of concern** AB emphasized that the Project should provide for appropriate mitigation measures to ensure that the hiking path to the volcano remains open for public. In addition, in case the Project plans construction of an Accommodation Camp near the site, it was advised to undertake advance checks on the status of this land.	
8	**Data** KS enquired about availability of demographic data. AB responded that data is available with the statistics office, but that it is very broad, and not organised by town. The last census was in 2012. PD asked about whether there is a limit on the age of data used in ESIAs. AB responded that there is no specific requirement.	

MEETING MINUTES

Date: 21st October 2015

Location: Central Water & Sewerage Authority - CWSA (water division)

Time: 13:00-13:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	*Position / Organisation*
Mr. Brian daSilva (BS)	Engineering Manager, CWSA
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**CWSA Involvement to date** BS explained that CWSA has not been involved very much in the project development to date and knows little about the project. PD therefore gave a summary of the project features, phasing, etc.	*Geothermal Consortium to involve CWSA in future meetings*
4	**CWSA responsibilities and system** PD enquired as to the specific responsibilities of CWSA due to some lack of clarity on this. BS explained that CWSA is the sole water utility in SVG, responsible for supply and sewerage. It is also responsible for Solid Waste Management. However, as there is no water management authority in SVG, CWSA's remit goes beyond that of a water utility – they are involved in catchment management and monitoring flow rates etc for surface water. BS explained that all CWSA's water is provided from surface water. Intakes are run of river with small dams, with small treatment plants and tank storage.	
5	**Coverage** PD enquired as to water and potable water coverage on the island, as well as sewerage. BS informed the team that potable water coverage is approaching 100% - either piped to house (majority), with some stand pipes. Fees are standard tiered tariff, with SWM fees included. Sewerage coverage is only in Kingstown and Arnos Vale – elsewhere is all septic tank/soakaway.	
6	**Permits** PD enquired about the need for water abstraction permits, dewatering permits, & effluent discharge permits. BS replied that no permits are required for these activities.	
7	**Rivers in Project Area**	

Item	Description	Action
	PD enquired about CWSA intakes near the project. The closest are in Georgetown and Sandy Bay. BS could not remember the rivers used, but they are outside the project area and CWSA don't use eg the Tourama or Rabacca. BS was unsure as to fisheries in the area; not CWSA's responsibility. PD enquired about flow data for the project rivers, and quality data. A Mr Valentine is apparently responsible for monitoring data and can supply if needed, however he warned that he has recently provided data to Takahashi's team so we should check that first.	*Takahashi to advise on data already provided by CWSA.* *Murray to coordinate with Valentine for further data if needed*
8	**Drought** BS warned that this year has seen very little rain, and drought conditions are therefore expected in 2016. This could have an impact on the drilling.	
9	**Key concerns** PD asked BS if he has any particular concerns for this project regarding the ministry and its activities. BS responded that there are none in particular relating to his technical area, but he would like CWSA to be kept abreast of the project. He also mentioned that if the project drills for groundwater for water supply, CWSA would be very interested, due to his expectation that CWSA will eventually need to turn to groundwater for their supply.	*Consortium to involve CWSA in project, particularly with regards to groundwater development.*

MEETING MINUTES

Date: 21st October 2015
Location: Physical Planning Unit
Time: 13:45-14:45
Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Mr Shelford Stowe (SS)	Deputy Director, PPU
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed. As Mr Stowe has been involved in the previous environmental studies, PD carefully explained the background to this new study.	
3	**PPU responsibilities** PD enquired as to the specific responsibilities of PPU due to some lack of clarity on this. SS explained that the PPU is responsible for all physical planning in SVG – principally via the planning application process, for the smallest house to the largest infrastructure developments.	
4	**ESIA Legislation** PPU's guiding Legislation is the 1992 Town & Country Planning Act, Art. 29 of which prescribes ESIA, however it does not provide the detail on the ESIA process. The 2009 draft ESIA Law specifies the ESIA process, but remains a draft. It is preferred that developers follow the act, but it is not obligatory. It is hoped that the Act will become formalised in 2016; it is currently before the Attorney General. SS advises that the present project ought to follow the provisions of the 2009 draft act. PD enquired as to whether the process provisions of the act are in place – eg review panel, screening approvals, etc. SS confirmed that the systems are in place, and that the National Environmental Appraisal Committee consisting of 15 members from various governmental departments has been formed.	
5	**Status of repeat work** PD understood that the previous Scoping Report and ToR has been approved by the PPU and asked what the situation should be for the present study. The response was that there is no requirement for a second approval, but that the PPU wishes to be provided with copies of the outputs to be kept in the loop, and to be given an opportunity to comment. SS highlighted that PPU understands the nature of the project and will facilitate it as much as is possible, within the bounds of good environmental practice.	
6	**2 x ESIA** PD understood that PPU has already approved the 2 x ESIA approach (SS confirmed) but enquired as to whether any specific agreement had been made (or expectation in existence) over the precise format of this arrangement – ie 2 separate reports, one report and an addendum etc.	

Item	Description	Action
	SS replied that there has been no agreement other than the first ESIA would be minor and the second an expansion for the construction / operation phase. PD agreed, but explained that, whilst the significant survey work, impact assessment and ESMP elements would be for the second phase, much of the other ESIA elements in the second phase would simply be repetition of the first phase, and enquired as to whether an addendum would be acceptable for the second phase. SS confirmed that this approach would be acceptable to PPU.	
7	**Disclosure** KS enquired about the process for ESIA disclosure. SS explained that PPU advertise that the draft ESIA is available at their offices for comment. The advertisement is published in 3 local newspapers and in a governmental gazette disseminated via local authorities' offices. A 14-day period is provided to the public for lodging their grievances, questions and concerns of any kind. Meetings are not normally held unless the review panel requests it.	
8	**Licencing/permits** PD enquired as to the requirement for environmental permits, operational permits, licences, fees etc. SS explained that no dedicated environmental permit is required, although "environmental clearance" is issued on completion of a project. In terms of construction/operation, the planning application approval is the sole requirement. It was further explained that the ESIA is simply one element of the overall planning application process, so it is possible that an application with an acceptable ESIA can be turned down due to other planning concerns (architecture, location etc). Only when all areas are in order is the application granted, and this is therefore equivalent to an environmental permit (though without any expiry, fees and so on).	
9	**Monitoring** SS explained that PPU would be responsible for monitoring during construction/ operation. This would be based on the provisions of the ESMP/ESIA rather than any requirements set by law (reports, monitoring frequencies..). However there appears to be some overlap with the environmental department of the ministry of health and environment, as they are also responsible for environmental monitoring, setting standards, inspections and so on. When asked, SS stated that there are some SVG standards for water quality but that they are minimal, with discussion ongoing over bolstering the standards, and determining responsibility and process for enforcement. There are no water discharge standards.	
10	**Cumulative impacts** SS explained that, due to having 15 people on board representing various ministries and agencies, potential cumulative Project impacts are also addressed/kept under control.	

MEETING MINUTES

Date: 21st October 2015

Location: Ministry of Transport, Works, Urban Development & Local Government

Time: 11:20-12:00

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Nedd Hudson (NH)	Permanent Secretary, MoTUDLG
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**Ministry Involvement to date** NH explained that he has fairly good knowledge of the project due to his past involvement in a number of cross-ministerial meetings and the proponent engagement process.	
4	**Ministry responsibilities** PD enquired as to the specific responsibilities of the Ministry. NH explained that the ministry is no longer responsible for housing or energy but is responsible for oversight of all public infrastructure (although PPU formally issues the consents). The Ministry's Chief Engineer sits on the ESIA review panel. The ministry also provides government and public with technical advice on physical development, and the ministry is also responsible for all roads.	
5	**Project use of roads** PD enquired regarding any restrictions or considerations of the project relating to use of public roads for equipment delivery/materials, and relating to upgrade of existing access roads (licences, permits, road safety requirements, surveys, etc). NH explained that there are no specific requirements or provisions required by law. The Chief Engineer's act does, however ban any use of the roads that would damage it, such as use of tracked vehicles. There would also be concern that bridge load limits are not exceeded. PD asked about axle /weight limits, width/length restriction etc. NH confirmed that there are no legal restrictions on this, however a transport management plan ought to be submitted to the Chief Engineer, who will consider it and may require changes to the plan. The Plan should specify characteristics of cargo to be transported, vehicles/roads to be used, timing for transportation (low/high traffic periods). The CE will also put into place the requirements in terms of assistance from the Gov't to implement the plan (e.g. police outriders). A public notice will also be issued by the ministry in advance of the transport plan being implemented, but this is at the developer's cost. PD enquired as to the timing of the submission of the plan. NH responded that it should be after ESIA and prior to movements, however priority would be given to fast tracking a project of this nature.	

Item	Description	Action
6	**Road repair/upgrade and new roads** PD enquired about the contractor's need to upgrade roads, and whether local firms would do this, or the ministry, and whether materials and machinery are available. NH responded that he understands that the gov't has pledged to provide all road upgrades or new access roads as part of the gov't stake in the company, so all this work will be provided and dealt with by the gov't internally.	
7	**Safety** KS enquired again about safety – specific provisions that may be required eg at crossing points, schools, etc. RM advised that all schools have traffic wardens present. NH confirmed that no special measures would be required, other than perhaps sensitisation. NH also noted that the police force participates in reviewing the transport management plan and come up with additional requirements on safety measures, if deemed necessary. PD enquired about noise/dust. NH responded that this is outside the scope of his ministry.	
8	**Public use of roads** KS wondered about alternative uphill routes that may be used by the public, except for the two existing roads. NH/RM answered that there are few more, although they are undeveloped roads/walking paths rather than roads which can be used for vehicles movement.	
9	**Borrow areas** PD enquired about the presence of existing borrow areas/disposal areas/stockpiles, yards etc for "piggybacking" to reduce impacts. NH is not aware of any suitable areas for piggybacking in the project area, however there are other projects ongoing and this possibility could be possible and should be considered closer to the time.	
10	**Key concerns** PD asked NH if he has any particular concerns for this project regarding the ministry and its activities. NH responded that there are none in particular relating to his technical area, but he did voice some other concerns during previous meetings, such as impacts on wildlife and silting of watercourses.	

MEETING MINUTES

Date: 22th October 2015

Location: Office of the Chief Surveyor

Time: 13:30-14:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Keith Francis (KF)	Chief Surveyor; Ministry of Housing, Informal Human Settlements. (Lands & Surveys Department)
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Katya Sladkova

Item	Description	Action
1	**Introductions** Introductions were made	
2	**Study Purpose** PD explained the background and purpose of the study KF confirmed that he was familiar with the Project and had visited the sites	
2	**Lands status in the Project area** KF confirmed that most of the land in the Project area belongs to the State. As a result of a land reform of 1980s-1990s (Agricultural Rehabilitation & Diversification Project), the Rabacca Farms Co. ltd. Estate's land was subdivided into farm parcels that were afterwards offered to the local population for a long-term (20 years) lease with the right to buy the land after this period passes (on the condition that all lease payments are made). However, at the end of the 20 year period in 2012, 95% of the parcels had outstanding payments. Some of the initial lessees had also illegally passed the plots to other people for them to use. All land parcels have status of a farming land. Restrictive covenant of the lease agreement says that this land "cannot be used for any other purposes but agriculture". The Ministry has a detailed plan for each plot in the area, indicating structures located on it, roads passing through (if any), etc.	
3	**Status of the land on which Project sites W1 and W3 to be located** KF noted that the two potential Project sites W1 and W3 are located on 4 different land plots: -Land parcel C.884 (Plot 1) was never leased and is in state ownership. The whole area W1 to be used by the Project appears to be within the boundaries of this single plot. -Land parcel C.881 (Plot 6) is in lease; no annual lease payments were ever made by the initial lessee (except for initial payment). This land is currently used for agricultural activities by other people. -Land parcel C.881 (Plot 7) is in lease; the initial lessee made one annual lease payment after initial payment. This land is currently used for agricultural activities by other people. -Land parcel C.881 (Plot 8) is in lease, however, at some point the initial lessee passed it over to another user who afterwards paid all the lease payments in full. Nevertheless, the land title hasn't been obtained so far. Currently the 'new' land user do farming on this plot. In addition, a residential structure has been erected there (which is technically illegal).	
3	**Acquiring the land/Implications for the Project** KF explained that, according to the legislation, land users of Plots C.881 (Plot 6) and C.881 (Plot 7) who do farming on this land and do not own it can be evicted from the area after a 6-month notice. If the land users are requested to leave earlier, they should be compensated for lost crops. The case of Land parcel C.881 (Plot 8) is more complicated, however, there is a hope that it will be resolved amicably through negotiations. KF has not yet received any instructions from the Government to start formal negotiations (however, preliminary discussions have already started). Change of land status (from farming to industrial) should be done via the Cabinet and normally takes some time, however, it's more a formality rather than a real obstacle to the Project. Re the land required for transmission lines construction, KF advised to carefully check the legislation. However, as far as he is aware, land for utilities can be acquired without paying compensations to current land users.	*KS/RM to check the law on land acquisition*

MEETING MINUTES

Date: 23th October 2015

Location: Office of Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth

Time: 09:00-10:00

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Ms. Bernadine Dublin (BD)	Senior Assistant Secretary, Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth
Mr. Roger Young (RY)	Community Development Supervisor, Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Katya Sladkova

Item	Description	Action
1	**Introductions** Introductions were made	
2	**Study Purpose** PD/KS explained the background and purpose of the study	
2	**Areas of Ministry's responsibilities** KS asked what the Ministry is responsible for. BD answered that the Ministry has various programmes in the following fields: -Community development and mobilization undertaken on the local level. This is implemented via community development officers. The Project area (with its 5 communities) is covered by two officers (*Reynold, please insert names*). The officers help to mobilize communities in case of need, arrange help and assistance when required; -Poverty (incl. targeted help to the most poor) and assistance in solving other livelihood problems. The Ministry has a database of all people who access the services seeking for help (with indication of type of problem, personal details of the visitors, etc.); -Programmes for youth (e.g. YES project - Youth Employment Service that involves providing internships to 400-500 young people annually). KS asked if the Ministry sometimes functions as an "employment bureau", connecting candidates and potential employers. BD answered that they can advise a person to register with the Ministry of Labour and then it goes beyond their responsibilities. -Gender issues (e.g. domestic violence, equality); -Single parents programme, and a few other initiatives.	
3	**Local Communities in the Project Area** KS wondered if the Ministry collects/has on hand any information on the settlements (health indicators, demography, levels of poverty, etc.) and, if so, could it be shared with the consultants. BD answered that such data is not collected, although in 2008 there was a study on poverty, which demonstrated that this area is one of the most poor in SVG. The 2008 UN study is no longer current, but is the most useful resource. RM added that this was the main source for the present baseline report. RY added that community profiles exist for certain areas and the consultants could probably use them. RY promised to check if they are available for the indicated communities. KS wondered if there are any distinguishing features or issues of these communities: any 'ref flag' issues/ problems to be resolved, etc. BD answered that there is nothing to mention in this regard in particular. Almost every family has access to basic utilities, basic healthcare, primary education, etc.	*RM to follow up on availability of the community profiles*
3	**Indigenous Peoples and other vulnerable groups** KS asked about presence of indigenous population in the Project area (Black Caribs/Garifuna?).	

Item	Description	Action
	BD and RY responded that representatives of this group live further to the North, around Sandy Bay, however, they are well assimilated/integrated into society, do not consider themselves minorities and do not require special protection of any kind. A group that is more vulnerable than the others, is people with disabilities. There is a Programme for Disabled developed by a Family Services Division.	
5	**Issues of concern** BD and RY emphasized that the Project should provide for appropriate mitigation measures to ensure that the hiking path to the volcano remains open for public. Also, BD emphasized that, due to the fact that communities heavily depend on farming, the Project should do as much as possible to minimize its impacts in this field. KS enquired as to whether the ministry could advise on possible community outreach projects that the geothermal project may wish to initiate or become involved in. BD confirmed that they would be happy to be involved / advise.	

MEETING MINUTES

Date: 23rd October 2015

Location: National Parks, Rivers and Beaches Authority (NPA), Ministry of Tourism, Sports and Culture

Time: 10:00-11:00

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Andrew Wilson (AW)	Director, NPA
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**NPA Involvement** AW explained that he is quite familiar with the project, as he has sat on the project development committee and was present at the presentation to cabinet several months ago. The NPA park ranger was also involved in the previous field surveys.	
4	**NPA Responsibilities** The NPA is a much younger body than other related agencies, having been formed in 2007. Its main objective is overall management of national parks and protected areas, but with a focus on tourism/recreation, and overall management. They work closely with the other agencies (eg Forestry dept, CWSA etc) who are responsible for managing specific resources, so the NPA have an oversight and coordination role. They also try to leverage funding and support. The NPA reports directly to the minister for tourism. They are guided by the 2001 Nat. Parks Act 9and 2010 update) but the most useful document is the "SVG National Park & Protected Areas system Plan 2010" – this contains info on protected areas, plans, responsibilities, etc. This document also contains a list of 25 'cultural landmarks', but none of them are located in the Project area. KS asked if this area could be considered important from the archaeological point of view. The NPA answered that ancient settlements' traces might be found close to the rivers or coast (some remains found during Argyll airport works), however, not in upper areas. Nevertheless, a Chance Find Procedure would be required.	*Andrew to email the plan to the team*
5	**Concerns about project** The NPA is concerned about the possible impacts on the Soufriere cross-country trail, however they also recognise that there could be potential for positive impacts – eg improved road access, possible supply of water to the base station, and even tourism to the geothermal facility itself. AW also mentioned that the forest clearance aspect itself is not a big concern as he understands that most sites are in clearings. AW thinks the project would be very positive, and should go ahead, providing that access to the trail is not blocked, there are no public safety issues, and that the trail is not directly affected by the work. AW also has some concerns about the water issues and he has not yet understood the plan for abstraction or discharge. Post-closure is also of minor concern.	*Consortium to consider water supply possibilities to base station in future studies*

Item	Description	Action
6	**Endangered/endemic species** PD asked if NPA has any information on the location of the 4 species discussed in the forestry dept. – are they in the project area? AW responded that the area is certainly a habitat for some or all of these species, but he doesn't have any specific data on this. He added the concern that it is expected that there are a number of as yet undiscovered/undescribed species in the area. There are plans afoot to develop an inventory but nothing has happened yet. However, primary impacts on the fauna are likely to be fairly small, as the main populations are higher up. The master plan for the Rabacca farm park development has some good info on local species.	*Andrew to email the plan to the team*
7	**River** PD enquired about NPA responsibility for river management. AW explained that NPA has no mandate for direct river management, despite the name! They only have some influence when a river is in a national park, in which case they work closely with the relevant authorities.	
8	**Rabacca Park** When asked about the aggregate extraction in the Rabacca, AW showed the "Rabacca Park Master Plan" (Millenia consulting). This is a small park/recreation area and visitor centre at the lower part of the rabacca river. Not yet developed but the first 100k of 30 million or so has been budgeted, and the work for a small picnic area is due to start next year. The MP has lots of good information. Aggregate extraction will continue inside the park, but will be better controlled.	*Andrew to email the plan to the team*

MEETING MINUTES

Date: 28th October 2015
Location: National Trust Building
Time: 10:30-11:15
Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Ms. Deirdre B. Millington-Myers (DM)	Deputy chairperson, National Trust
Mr. La Verne Bentick Phillips (LVP)	Manager, National Trust
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist
Rapporteur:	Katya Sladkova

Item	Description	Action
1	**Introductions** Introductions were made	
2	**Study Purpose** PD/KS explained the background and purpose of the study. DM and LVP confirmed that they had heard about the Project.	
3	**CH sites in the Project area** DM and LVP are not aware of any CH sites in the Project area. The nearest sites, which are interesting from the cultural/historical point of view, are the aqueduct and a battery station – both are near Orange Hill. KS asked how far uphill the aqueduct might go. DV answered that unlikely more than several hundred meters. Also, some time ago there was an initiative coming from the National Properties unit (part of the Ministry of Housing) to establish a Youromei Heritage village in Orange Hill – a park/little museum/maybe hotel to celebrate the local history. However, nothing has actually been done since then. DM and LVP asked if the consultants were aware of the La Soufrière heritage park. PD answered that they knew about the national park, which has not yet been formally created, but which is being treated as such by the Forestry Dept. DM and LVP said they could provide more information on the boundaries of this area and its main characteristics.	*KS to follow up on the national (heritage) park.*
4	**Steps to be undertaken by the Project to minimise impacts** KS wondered which steps the Project should undertake to minimise potential CH impacts. DM answered that the best thing would be to involve the National Trust in the Project at an early stage. They would like to have a site visit, talk to local people and try to get additional information from them. No formal approvals from the National Trust are required by the Project to proceed. In general, any CH artefacts found during the works belong to the nation. If chance finds occur, the Project should stop the works and immediately notify the National Trust. The National Trust will then inspect the site and advise on the required course of action. They may even appoint a cultural officer to constantly be on site and control the process (as happened for the Argyle airport project). KS asked if there might be a need for undertaking additional CH studies/surveys during the ESIA stage. DM answered that there was no such need. Timely involvement of the National Trust is the main thing.	
5	**Cooperation with scientific institutions** PD asked if the National Trust cooperated with any scientific organisations.	KS to send a request for the full list of their partners

Item	Description	Action
	DM answered that they cooperated with Calgary University, Leiden University, and some others.	
6	**Status and funding** The National Trust is part funded by government and part funded by charitable donations and other sources. There is a full time staff of four. The board meets monthly. The NT owns and operates several cultural sites, but plans to expand this in coming years.	

MEETING MINUTES

Date: 28th October 2015

Location: Ministry of Health, Wellness and the Environment

Time: 09:00-10:00

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	*Position / Organisation*
Mr. Luis de Shong (LS)	Permanent Secretary, Ministry of Health, Wellness and the Environment
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** RM & PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**Health Dept. Involvement** LS explained that he is quite familiar with the project.	
4	**Health Dept/Ministry Responsibilities** The ministry is responsible for management and coordination of all health related issues in SVG. This includes management and operation of all clinics and hospitals. LS mentioned that other departments of the ministry (eg env. health) would perhaps be of more interest to the team. LS assigned Ms. Finley to support the team and act as the Ministry's focal point.	
5	**Data / Info** LS explained that he would rather not provide health data in the meeting as it would not be accurate, but he said that if the team puts a request in writing for specific information (by email), he will ensure that the data is provided. However, LS mentioned that the key health problems in the project area are the most common non-communicable diseases, eg cancer, diabetes, hypertension, etc. PD asked about prevalence of HIV. LS responded that the cases are fairly low, and getting lower due to a government drive. This is also the case for TB. All healthcare is free in SVG, though there are some small fees for certain things (e.g. lab tests, x-rays etc). Old and young receive totally free treatment. A private healthcare system is also in place in parallel.	*KS to prepare the request*
6	**Potential Project impacts** KS enquired as to whether foreigners are covered by the health system. LS responded that they are not covered unless they have residence status, however cases would be considered on a case by case basis. Approval of the Cabinet may be required for provision of free healthcare to the Project workers. KS asked what measures should be in place to minimise project's impacts on public health. LS responded that all foreign workers arriving to the area should undergo medical checks in advance and be able to provide medical certificates.	

MEETING MINUTES

Date: 28th October 2015

Location: Ministry of Agriculture, Rural Transformation, Forestry, Fisheries and Industry

Time: 15:00-15:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	*Position / Organisation*
Mr. Raymond Ryan (RR)	Permanent Secretary
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Katya Sladkova

Item	Description	Action
1	**Introductions** Introductions were made	
2	**Study Purpose** PD/KS explained the background and purpose of the study. RR confirmed that he had heard about the Project.	
2	**Land use in the Project area** RR confirmed that the area of interest is currently used by the local population for agriculture and agro tourism. Some land parcels are more actively used than others; some are not used at all.	
3	**Issues of concern** RR noted that the main (and probably the only) issue of concern in terms of Project's impacts on agriculture is the potential effects of air pollution on quality of agricultural products. Any sort of pollution should be controlled and avoided. H_2S is a particular concern. To keep the quality high the Ministry performs/is planning to intensify testing of agricultural products for pesticides, heavy metals, bacteria, etc. Testing is undertaken by the Standards Bureau, a new developing laboratory and the CRRL. This is especially important in terms of keeping high quality of the production that is exported (there are farms in the area working on a cooperative basis and producing fruits/vegies for export). RR confirmed that the products grown in the project area are generally for export, via two cooperatives. RR is keen to know what kind of pollutants and in which concentrations will be emitted.	
4	**Irrigation** PD mentioned that the team had seen pipe heads and pumps in the project area, and assumed that the irrigation system is no longer operating due to flood damage. RR confirmed this, but stated that there is a project to reinstate the irrigation system in the area. PD explained that the water needs of the project are significant during exploration and enquired when the irrigation project would go ahead. The answer was that it may proceed within the next year or so. It was suggested that the ministry provide the team with project details/coordinates for infrastructure, to check for possible clashes (and possible impacts of the geothermal project on irrigation water needs).	*Ministry to provide project location details*
5	**Fishing**	

Item	Description	Action
	KS asked if there was fishing in the area. RR answered that there was seasonal fresh-water fishing for crayfish. However, it has recreational/traditional nature rather than being performed for subsistence/commercial purposes. More fishing is done on the marine side.	

MEETING MINUTES

Date: 22nd October 2015

Location: Solid Waste Management Unit

Time: 09:30-10:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Ms. Jean Ryan (JR)	PR Manager, SWMU
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**SWM in SVG** PD made various enquiries relating to the general SWM characteristics of St Vincent. SWMU's description: • SWMU responsible for all domestic collection and disposal in SV • Businesses are responsible for collection/transport, usually via private companies • Disposal is at one of two unlined "sanitary" landfills (at Diamond and Belle Isle). All wastes are accepted at these sites. Hazardous waste is immediately buried. • LFs have leachate collection systems and evaporation. Daily cover is employed at the LFs. • No tipping fees apply. • SWM collection and disposal fees are included in water rates. • Collection is kerbside, once a week. More or less 100% coverage. • Twice yearly, collections ae made for white goods and other large items. • Medical waste is autoclaved at the hospital	
4	**SWMU** SWMU is responsible for collection and disposal, but the Public Health Dept. is responsible for SWM overall in SVG. Governed by the SWM Act.	
5	**Project Requirements** PD enquired as to the requirements that the project would have to follow in terms of planning, permits, and arrangements for SWM. SWMU responded that the project would need to employ a local contractor to transport and dispose of the wastes in accordance with the law. There is no need for special permits for industrial operations, or for special wastes. There is no requirement for a SWM Plan, but the SWMU would, however, appreciate being informed in advance about the types and amounts of waste to be generated by the project.	
6	**Final concerns** SWMU general concerns about the project were with respect to the commercial aggregate extraction operations in the Rabacca River bed, the effects on communities, the impact on air quality, and the impacts on the hiking trail.	

2

MEETING MINUTES

Date: 22nd October 2015

Location: Forestry Department, Ministry of Agriculture, Forestry, Fisheries, Rural Transformation and Industry

Time: 10:30-12:00

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Mr. Cornelius Richards(CR)	Senior Forestry Officer, Forestry Dept.
Mr. Brad Latchman	Forestry Officer, Forestry Dept.
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**Forestry Department Involvement** CR explained that they know a fair bit about the project, but yet they feel very much as though they have been excluded from the development process. They feel as though they could have been provided with more project details so that they could advise on likely impacts/concerns, and assist with site selection etc. This sentiment was echoed at numerous times during the meeting. Apparently the department provided support staff to the resistivity surveys but were not provided with the results.	*Consortium to share more info with Forestry department and develop partnership for mutual benefit.*
4	**Forestry Department Responsibilities** The department is principally concerned with the conservation of SVG's flora and fauna. (NPA is principally concerned with the tourism and recreation side of things, although their legal mandate is in fact very similar – a MOU is under preparation to clarify their positions).	
5	**Concerns about project / rare & endemic species** There is significant concern about the project's impacts on rare and endemic species in the project area. The project area is a known habitat for the St Vincent Amazon Parrot (*Amazona guildingii*), which is IUCN category VU, is endemic to SVG, and is also the sovereign bird. It is known to inhabit the project area, but no inventory has been carried out. The whistling warbler (Catharopeza bishopi) is IUCN category EN, and is endemic to SVG, is also expected to be present in the project area. The whistling frog (*Eleutherodactylus johnstonei*) is also a species of concern, which has been affected by citrate fungus. There have also been sightings of the Saint Vincent blacksnake (*Chironius vincenti*) in the general area of the project. This snake is endemic to SV and also critically endangered according to IUCN classification. The upper Rabacca is an important habitat for crayfish and other aquatic species such as eels. The project is close to the Soufriere forest reserve. PD enquired as to the status of this as had previously heard it was not yet gazetted – CR responded that this is correct, however it is currently managed as a forest reserve. SVG amazon parrot is spreading population into agricultural areas (drawn by fruit cultivation, and tree recovery/growth since 1979 eruption) – dept. have been experimenting with techniques to direct them back inland.	*Consortium to discuss implications for Phase 1 ESIA*

Item	Description	Action
6	**Concerns about project / emissions & noise** CR voiced concerns about H_2S emissions on the parrot population downwind. Information not received or invitation to consult.	*Consortium to discuss implications for Phase 1 ESIA*
7	**Concerns about project / transmission lines** PD explained transmission line plan. CR has concerns over impact on forest and electromagnetic on fauna. The new alignment to South Rivers is the main concern. They have received no information or invitation to consult on this.	
8	**Concerns about project / effluent & watershed** CR said that the dept. is concerned about the effluents and wastes from the operation having an impact on the watershed/aquatic environment	
9	**2 x ESIA approach** PD recognised that ideally a biodiversity survey ought to be carried out in the project area. However, recognising the political/financial/temporal constraints, would a 2 stage ESIA be acceptable to the department, and what mitigation measures would they be keen to implement. CR responded that of course, they would far prefer a proper survey to be carried out prior to breaking of ground, however given the circumstances, the dept would accept a superficial first ESIA for exploration, provided that it was followed up with a full and comprehensive survey during the second ESIA, including extensive mitigation/monitoring and offset plans. Also, the department should be fully included in this process, assisting/advising on the inventory and monitoring. CR strongly emphasised that the department is fully behind the project and behind renewable energy as a whole for the island. They are not in any way against the development, however as their mandate is the protection of ecology, they are obviously very keen to ensure that the development is carried out with due care and attention to the environment.	
10	**Ecosystem services and Non-Timber Forest Products (NTFP)** CR explained that aside from hardwood and bamboo, the forest has an important role in soil stabilisation, and NTFPs include palm leaves and palm hearts.	
11	**Hunting/Fishing** Hunting takes place in the 'open' season (Oct-Jan) for Opossum ("Manico"), Armadillo and birds in the project area. No significant poaching problem in this area. Easter is an important time for crayfish catches, and in this area there is a problem with harmful fishing techniques causing pollution and unsustainable catches. Hunting and fishing are of more recreational/cultural nature rather than make significant contribution to livelihoods.	

Item	Description	Action
12	**Forest Clearance** PD enquired as to any rules (replanting ratios, permits etc) for tree clearance. Apparently section 51 of the forestry act prohibits cutting and burning of forest.	*RM to research this further.*

MEETING MINUTES

Date: 23rd October 2015

Location: Environmental Management Department, Ministry of Health and the Environment

Time: 12:00-12:30

Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	***Position / Organisation***
Ms. Janelle Findlay (JF)	Director, Env. Mgt. Dept.
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**EMD Involvement** Jamille was aware of the project, but not the details, so a full explanation was provided.	
4	**EMD Responsibilities** EMD has no official mandate for ESIA in SVG. They therefore have no formal input to ESIA ToR or review process. The health department does however sit on the Board. EMD is not happy with this situation and is pushing for change, which is expected. The main responsibility of the EMD is management of multilateral agreements (CBD, UNFCCC etc). The health department is responsible for food safety, sanitation, vectors, & water quality. In fact the two departments were recently merged but they still operate as separate entities. EMD also provides technical advice and support to other agencies as required. (health department does some water quality monitoring but it is understood to be minimal. Likewise, there are no specific standards for ambient/discharge – the dept follows int'l standards). The draft environmental management act includes numerous provisions for ESIA, review, standards, etc, but this is not yet in force – expected in next year or two.	
5	**Concerns about project** The EMD is concerned about habitat destruction/disruption and biodiversity in the project area. Apparently EMD raised this concern in the previous public meeting and the response given was that this concern would be adequately dealt with and steps would be taken to safeguard the biodiversity, however no information was provided on what those steps would be. EMD is also concerned about the water inputs and outputs, environmental flows, and agricultural use of water downstream from the project. PD responded that this is a concern of the Scoping team and that we are looking into this issue to determine the potential significance. EMD is also concerned about soil stability, landslides and erosion. KS asked if local population practice fishing in this area and if this can be an issue of concern. EMD answered that she didn't think so and that fishing is not widely practiced.	

MEETING MINUTES

Date: 28th October 2015
Location: VINLEC offices, Cane Hall Power Station
Time: 13:30-14:00
Project: Scoping Study for ESIA for Geothermal Development in SVG

Attendees

Name	*Position / Organisation*
Mr. Elrias Williams	Senior Transmission Distribution Engineer, VINLEC
Mr. Mitra Malcolm	Transmission Distribution Engineer, VINLEC
Mr. Pirran Driver (PD)	JICA/NK team – Environment Specialist
Ms. Katya Sladkova (KS)	JICA/NK team – Social Specialist
Dr. Reynold Murray (RM)	JICA/NK team – Local Specialist

Rapporteur: Pirran Driver

Item	Description	Action
1	**Introductions** Formal introductions were made.	
2	**Study Purpose** RM & PD explained the background and purpose of the study, and described the broad methodology to be employed.	
3	**VINLEC Involvement** VINLEC explained that they are familiar with the project due to their close association with it. They are also aware of the transmission line element. However, the main coordination between VINLEC and the Energy Unit is at a higher level.	
4	**Transmission Lines** VINLEC confirmed that they will be responsible for the design, construction and operation of the transmission lines. A tentative scheme exists for the lines, but precise alignments have not been determined. There are numerous issues to consider. In fact, the lines may not even follow the two provisional routes already given (ie one along existing coastal corridor to Cane Hall, and another new alignment to South Rivers). Factors to consider include: • Existing coastal alignment already has an 11 Kv system. Having a higher 33 Kv system in place would be an issue for worker safety/maintenance. • Existing coastal alignment is a corrosive environment due to the sea and prevailing wind. This means that Cu would need to be used ($) and the extra weight of the cu would require more supporting structure ($). • Public safety with high voltage line, plus vehicle collisions into support structures. • If towers are needed for the 33 Kv line, land would become an issue on the coastal route It is possible that there will therefore be two new alignments through the interior of the island. However the new alignments come with their own issues/impacts: • New access roads may be needed if helicopters are not used (a recently built 33 Kv line on SV did not use helicopters and needed new access roads) • Although much land would be gov't, there will likely be compensation issues for crops • Alignment requires clearing of forest (to be maintained clear during operation) • Possible impact on wildlife PD enquired about funding for the lines. VINLEC confirmed that they would be responsible but that they don't yet know where the funds would come from. PD asked if it would likely be an IFI, and they responded that it would. PD enquired about likely timelines. VINLEC estimated at least 3 years for design and construction. (this seems to be problematic with regards to the planned start of geothermal power production in 2018).	

Item	Description	Action
5	**Environmental and social management** PD enquired about whether previous VINLEC projects were subject to ESIA. VINLEC responded that only the generation stations – none of the transmission lines to date have been the subject of ESIA studies. Instead they use a process of consultation. PD enquired about whether VINLEC employ environmental and social management plans or EHS plans. VINLEC responded that they use EHS manuals in their work.	
6	**Ownership** PD enquired about whether VINLEC would be the beneficiaries of the geothermal project once the JV arrangement finishes. VINLEC responded that it may, but that it would be presumptuous to say for sure so far before the event.	

C: Stakeholder Engagement Plan

The Stakeholder Engagement Plan developed during the Scoping Survey is provided overleaf. The SEP is a live document, and ownership has been passed to the Geothermal Consortium.

DATA COLLECTION SURVEY FOR GEOTHERMAL DEVELOPMENT IN SAINT VINCENT AND THE GRENADINES

GEOTHERMAL DEVELOPMENT PROJECT IN SVG

STAKEHOLDER ENGAGEMENT PLAN – VERSION 02

NOVEMBER 2015

NIPPON KOEI

Geo-E GEOTHERMAL ENGINEERING CO.,LTD.

SRED

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ABBREVIATIONS AND ACRONYMS

ADF	Abu Dhabi Fund
AoI	Area of Influence
API	Agency for Public Information
CARICOM	Caribbean Community
CARILEC	Caribbean Electric Utility Services Corporation
CDB	Caribbean Development Bank
CLO	Community Liaison Officer
CWSA	Central Water & Sewerage Authority
EC	Emera (Caribbean) Incorporated
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GoSVG	Government of St Vincent & the Grenadines
ICP	Informed Consultation and Participation
IFC	International Finance Corporation
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
LOI	Letter of Intent
LPH	Light & Power Holdings
NBC	National Broadcasting Corporation
NGO	Non-Governmental Organization
NTS	Non-Technical Summary
PPU	Physical Planning Unit
PPDB	Physical Planning Development Board
PS	Performance Standard
QHSE	Quality, Health, Safety, and Environment
RG	Reykjavik Geothermal
SEP	Stakeholder Engagement Plan
SR	Scoping Report
SVG	St Vincent & the Grenadines

1 INTRODUCTION

1.1 Background

This document is Version 02 of the Stakeholder Engagement Plan (SEP) which forms part of the Phase I Environmental and Social Impact Assessment (ESIA) of the Geothermal Development Project in St. Vincent. Version 01 was prepared prior to the beginning of the Scoping stage and this version was prepared immediately following its completion. Thus, this version provides an account of Scoping stage consultations and provides more details on the planned Phase I ESIA stakeholder engagement activities.

Stakeholder engagement in the ESIA context focuses primarily on information disclosure and consultations (two-way communication) between the Project developer(s) and stakeholders and is a cornerstone of the ESIA process. It ensures that impacts are identified, assessed and addressed, with input from key stakeholders such as communities affected by the Project (Affected Communities), and that the mitigation and enhancement measures are devised with due consideration of stakeholder input.

A Letter of Intent ("LOI") for the proposed project was signed on May 13, 2014 by the Government of St Vincent & the Grenadines (GoSVG) and a consortium of Reykjavik Geothermal ("RG"), based in Iceland, and Emera (Caribbean) Incorporated ("EC") formerly Light & Power Holdings ("LPH") based in Barbados (collectively, the "The Geothermal Consortium"). The project involves evaluation of the geothermal resource, drilling and testing of geothermal wells, construction of a 10 to 15 megawatt geothermal power plant, construction of new transmission lines to connect the power plant to the grid, and the operation of the power plant (collectively, the "Project"). Phase I involves resource evaluation, drilling and testing of thermal wells. A decision will be made as to the viability of the Project and, if the decision is positive, then Phase II will involve construction of the power plant and associated facilities, followed by operation.

This SEP covers the following aspects:

- National requirements and good international practice which will govern the stakeholder disclosure and consultations;
- Identification of stakeholders;
- Strategy and actions for stakeholder consultation and information disclosure;
- The Geothermal Consortium's resources and management structure for implementing the SEP;
- A Grievance Mechanism setting out the procedure for lodging and addressing grievances from stakeholders, and
- Means of reporting on the engagement activities undertaken.

This SEP draws upon the previous engagement activities that have been undertaken by the Geothermal Consortium to date (including Scoping stage consultations) and, will also present plans for stakeholder engagement during the remaining Phase I ESIA activities and for the Phase I Project implementation. Should the exploration phase be successful and a Phase II ESIA be implemented for the construction, commissioning and operation phases of the Project, a new Phase II-focused SEP will be prepared.

1.2 Scope of Application

The SEP applies to all activities and facilities that fall under the Geothermal Consortium's direct jurisdiction and control. Activities relating to associated facilities are not covered in this SEP. This is due to the fact that the Geothermal Consortium will not act as funders or operators of such facilities and therefore cannot assume a leading role in the related engagement process.

2 PROJECT DESCRIPTION

The SVG Government, recognizing the potential for the development of geothermal energy, is advancing plans for the development of a geothermal power plant in the vicinity of La Soufrière volcano in the north of St Vincent. This project is expected to transform the energy situation in SVG and is in line with national climate, energy and economic objectives. It will move the country from a dependency on high-priced diesel fuel to a sustainable energy path based on an indigenous, stable and affordable resource. Figure 1 shows the location of the Project.

Figure 1: Project General Location

Source: Created using maps found at: http://en.18dao.net/Map/Saint_Vincent_and_the_Grenadines & http://alabamamaps.ua.edu/contemporarymaps/world/americas/index2.html

The Project will be located on the south-eastern slopes of La Soufrière volcano, some 4 km inland on the eastern side St. Vincent (see Figure 1). The technical and economic analysis that has been undertaken indicates that the Project would help achieve the goals of price stability and economic sustainability for St Vincent & the Grenadines (SVG).

The Project is now about to enter the phase of exploratory drilling (Phase I) which not only involves siting and operation of drilling rigs, but also involves planning and development of required infrastructure such as access roads. This work will take place commencing in early 2016 and will extend into 2017. If the exploratory drilling results are favourable, the Project will then enter the next phase of drilling additional wells, design, construction and commissioning of the generation plant and associated facilities such as a substation and transmission lines to connect power to the national grid (Phase II). The overall target is to have the Project in commercial operation by 2018. Proactive stakeholder engagement will continue through all phases of the Project.

Geothermal power generation involves drilling deep exploration and production wells into the Earth's crust to harness the thermal energy contained in underground reservoirs of geothermal waters or steam. Wells are drilled in clusters with each cluster ("drill pad"), typically comprising two to five wells. These wells bring a mixture of steam, gas and water (referred to as brine) to the surface where the steam is separated and used to power turbines to produce electricity. Brine and condensate removed by separators are usually returned to the ground via reinjection wells.

Common negative environmental and social impacts[1] associated with the operation of geothermal developments include:

- Water quality issues;
- Geophysical effects of fluid withdrawal;
- Thermal effects;
- Chemical pollution;
- Air quality and climatic effects;
- Noise;
- Ecological impacts;
- Geological disturbances;
- Land-use and landscape change;
- Land acquisition and resettlement;
- Tourism and recreational impacts;
- Unplanned in-migration (influx) and consequent socio-economic impacts (such as competition for jobs with local residents);
- Physical and social Infrastructure capacity exceeded and service delivery constraints increased; and

[1] The presence / significance of these negative impacts are currently unknown and are under investigation as part of the ESIA process

- Increased traffic and consequent increase in risk profile for community exposure to accidents.

However, Project benefits are also expected. They may include, but not be limited to the following:

- Creation of jobs; local workers will be hired and national partners chosen whenever possible;
- Technical training will be provided to local staff and expertise passed on to local entities; this transition will include training and education of local experts and cooperation with regional institutions and local contractors and consultants;
- UN University geothermal programs will be introduced and utilized to develop the competence of employees and partners with respect to geothermal energy production;
- Improvements to existing roads, and construction of new roads leading to and around project sites;
- Production of clean, cost-effective renewable energy. the Project will play a role in reducing overall greenhouse gas emissions in SVG;
- Sustainable use of the geothermal resource will result in the needs of the present to be met without compromising the ability of future generations to meet their own needs;
- Decrease in reliance on imported energy, and thereby energy sovereignty increased;
- Stronger and more stable economy for the communities and region overall;
- Potential export of energy to neighbouring countries;
- The supply of electricity will enable the rural economies to modernize and thereby producing higher output and increasing their income; and
- Potential investment opportunity for different economic sectors such as food, chemical, and metallic and non-metallic industries.

3 PROJECT AREA OF INFLUENCE

The International Finance Corporation's (IFC) Performance Standard (PS) 1: Assessment and Management of Environmental and Social Risks and Impacts (2012) requires that the Project's Area of Influence (AoI) is determined based on the following guidance:

"Where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence. This area of influence encompasses, as appropriate:

- *The area likely to be affected by: (i) the project and the client's activities and facilities that are directly owned, operated or managed (including by contractors) and that are a component of the project; (ii) impacts from unplanned but predictable developments caused by the project that may occur later or at a different location; or (iii) indirect project impacts on biodiversity or on ecosystem services upon which Affected Communities' livelihoods are dependent.*
- *Associated facilities, which are facilities that are not funded as part of the project and that would not have been constructed or expanded if the project did not exist and without which the project would not be viable.*
- *Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.*

In the event of risks and impacts in the Project's area of influence resulting from a third party's actions, the client will address those risks and impacts in a manner commensurate with the client's control and influence over the third parties, and with due regard to conflict of interest.

Where the client can reasonably exercise control, the risks and impacts identification process will also consider those risks and impacts associated with primary supply chains, as defined in Performance Standard 2 (paragraphs 27–29) and Performance Standard 6 (paragraph 30).

Where the project involves specifically identified physical elements, aspects and facilities that are likely to generate environmental and social impacts, the identification of risks and impacts will take into account the findings and conclusions of related and applicable plans, studies, or assessments prepared by relevant government authorities or other parties that are directly related to the project and its area of influence. These include master economic development plans, country or regional plans, feasibility studies, alternatives analyses, and cumulative, regional, sectoral, or strategic environmental assessments where relevant. The risks and impacts identification will take account of the outcome of the engagement process with Affected Communities as appropriate."

Based on the preliminary results of the ESIA scoping study, the Project's AoI has been determined, as follows:

- Areas of immediate Project footprint:
    - The 2 km by 2 km area that encloses the nine sites to be considered for the Project Phases I and II (see Appendix A);

- 100 m by 100 m areas approximately 500-metres downhill of each of the sites for optional location of reinjection wells;

- The hiking base station for the path to La Soufrière crater;
- Agricultural plots located along the existing two paved roads (going from the Windward highway to the Project sites) to be used by the Project for transportation of equipment and materials;
- Settlements located along the coastline approximately 3-4 km from the Project layout area, namely Sandy Bay, Orange Hill, Langley Park, Overland, Tourama, and Georgetown;
- Windward Highway (Kingstown – Sandy Bay section) and its immediate surroundings; and
- Areas required for construction of the transmission lines (to be determined in later stages of Project development).

4 STAKEHOLDER ENGAGEMENT: NATIONAL AND INTERNATIONAL REQUIREMENTS

The stakeholder engagement process will be implemented in accordance with the requirements enshrined in SVG legislation, and those of the IFC as presented in its Performance Standard 1.

4.1 National Requirements

St. Vincent & the Grenadines has legislation in place to address environmental and social issues arising from developments. The Town and Country Planning Act (No.45, 1992) was enacted to guide planning and falls under the jurisdiction of Ministry of Housing, Informal Human Settlement, Lands and Surveys, and Physical Planning. Under the Act's Article 29 an Environmental Impact Assessment (EIA) is required for environmentally sensitive projects or activities. The Physical Planning Unit (PPU), which functions as the technical and advisory arm of the Physical Planning and Development Board (PPDB), has the legal authority for environmental management under this Act.

The PPU's authority includes determining the need for EIA, the level of EIA required, and leading the eventual review of the EIA produced. The scope of an EIA is determined through discussion between the project developer and the PPU. The PPDB has the remit to achieve the purpose and implement the provisions of the Act, and plays an important role in applying the provisions of the draft *Environmental Impact Assessment Regulations* (2009). Although not formally approved, these Regulations are applied by GoSVG and it requests all 'EIA' development to follow the assessment and decision-making process established in the draft Regulations. The PPU is responsible for ensuring development occurs within GoSVG environmental and social requirements. The EIA process as implemented under the 2009 draft *Environmental Impact Assessment Regulations* is shown in Figure 2.

Stakeholder engagement is regarded as an important element of the EIA process. However, requirements for stakeholder engagement are not specified in detail and are discretionary in nature as presented in Article 15, of the *Environmental Impact Assessment Regulations* (Draft, 2009), which state:

- At any time during the ESIA process, the Board [PPDB] may invite written comments from interested persons concerning the environmental impact of the undertaking;
- The Board may forward the written comments to the developer who shall answer any pertinent questions raised in such written comments; and
- The procedure for public contact and involvement shall be determined by the Board.

Following submission of an EIA Report to the competent authorities, it should be made available for public review. Article 17 of the Regulations elaborates further on stakeholder engagement:

- A developer who has submitted an EIA Report shall publish a notice in a newspaper in general circulation in St Vincent & the Grenadines, and there shall be a deadline and address for filing comments on the conclusions and recommendations of the EIA Report.

Overall, the EIA process should be open, public and transparent, and project planning to be conducted in cooperation with the PPU and the PPDB.

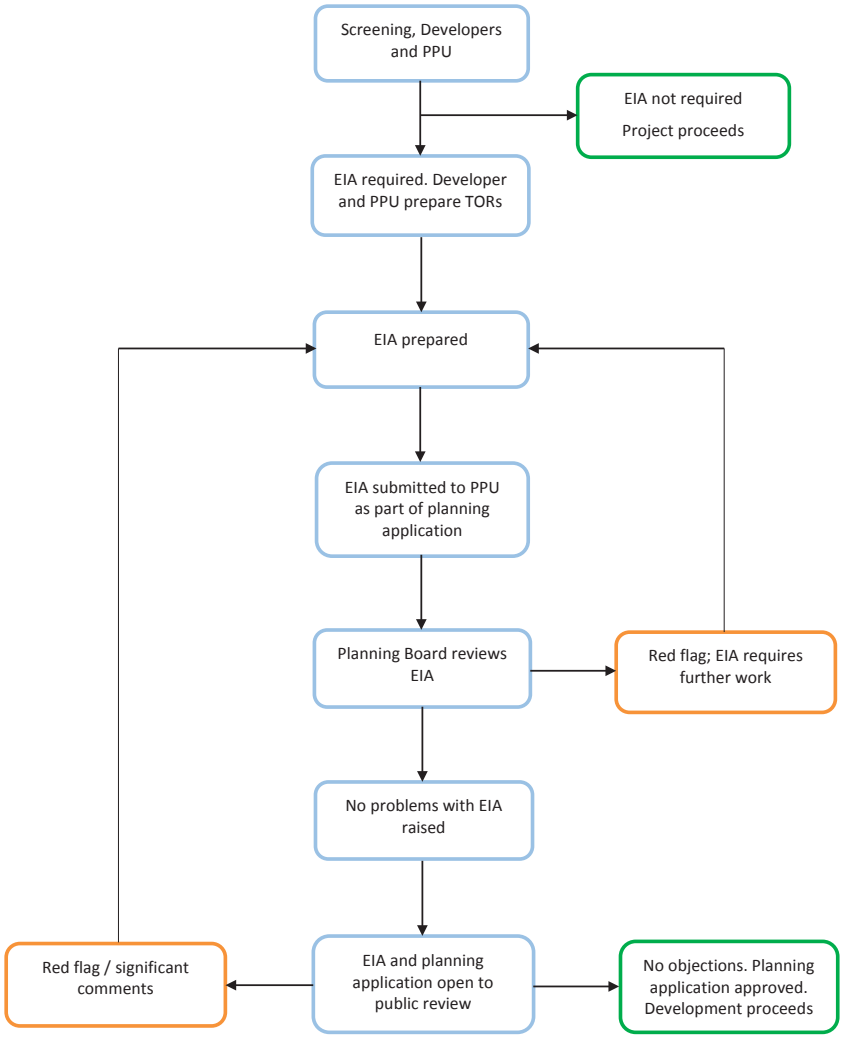


Figure 2: The EIA Process in SVG

4.2 International Requirements

IFC, which is incorporated within the World Bank Group, invests in private projects not guaranteed by the national governments, and assists in attracting investments from other sources. IFC's PS 1 sets out the following objectives/actions with regard to stakeholder engagement for ESIA work that is undertaken in compliance with its requirements:

- To promote and provide means for adequate engagement with Affected communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated;
- To take account of the outcome of the engagement process with Affected communities in the identification of risks and impacts associated with the project;
- To maintain stakeholder engagement as a continuous process that involves stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and the on-going reporting to Affected communities;
- To identify the range of stakeholders that may be interested in project activities and to facilitate a dialog with all stakeholders through a process of external communications;
- To provide affected communities with access to relevant information on: (i) the purpose, nature, and scale of the project; (ii) the duration of proposed project activities; (iii) any risks to and potential impacts on such communities and relevant mitigation measures; (iv) the envisaged stakeholder engagement process; and (v) the grievance mechanism;
- To undertake a process of consultation in a way that provides the Affected communities with opportunities to express their views on project risks, impacts and mitigation measures, and allows the client to consider and respond to them;
- For projects with potentially significant adverse impacts, to conduct an Informed Consultation and Participation (ICP) process that will result in the affected communities' informed participation. This process should be documented, in particular the measures taken to avoid or minimise adverse impacts on affected Communities, and will inform those affected about how their concerns have been considered; and
- To establish a grievance mechanism to receive and facilitate resolution of stakeholders' concerns and complaints about a client's [an IFC client] environmental and social performance.

5 PROJECT STAKEHOLDERS

IFC's Performance Standard 1 defines stakeholders as

"...persons, groups or communities external to the core operations of a project who may be affected by the project or have interest in it. This may include individuals, businesses, communities, local government authorities, local nongovernmental and other institutions, and other interested or affected parties".

In line with the principles of IFC's PS 1, stakeholders are divided into two types:

- Affected communities - persons, groups and other entities within the Project Area that are directly influenced (actually or potentially, positively or adversely) by the Project and/or have been identified as most susceptible to change associated with the Project, and who need to be closely engaged in identifying impacts and their significance, as well as in decision-making on mitigation and management measures; and
- Non-community stakeholders who may be able to influence decisions on the Project, or have an interest in the project.

In order to develop an effective SEP, it is necessary to identify stakeholders and understand their needs and expectations for engagement, and their priorities and objectives in relation to the Project. This information is then used to tailor engagement to each type of stakeholder. As part of this process it is particularly important to identify individuals and groups who may find it more difficult to participate and those who may be differentially or disproportionately affected by the project because of their marginalised or vulnerable status.

It is also important to understand how each stakeholder may be affected – or perceives they may be affected – so that engagement can be tailored to inform them and understand their views and concerns in an appropriate manner.

Identifying stakeholders is a continual process. A list of the potential stakeholders identified to date is presented below. Prior to the scoping stage consultations a longer list was prepared, but during scoping it was found that some were not relevant or no longer existed. These have been excluded from the list below[2]. It should be noted that this document focuses on stakeholders who do not have formal relationships with the Geothermal Consortium and who, as a result, may wish to use this document for information and guidance. Mechanisms for engagement with customers, contractors, shareholders and lenders, with which the Geothermal Consortium has regular contact in the course of its business, are not addressed in this document.

Affected local population

- Populations residing in the nearest settlements to the Project sites (Sandy Bay, Orange Hill, Langley Park, Overland, Tourama, and Georgetown);
- Owners/occupiers/users of land likely to be acquired by the Project;

[2] In Table 2 there is mention of stakeholders that were on the original stakeholder list, but were later found to be not relevant or not to exist.

- Owners/occupiers/users of land located along the existing three paved roads (going from the Windward highway to the drilling areas);
- Owners/occupiers/users of land located along the Windward Highway (Kingstown – Sandy Bay section);
- Local people occasionally using areas within the Project's AoI for traditional or recreational activities (fishing/hunting/hiking); and
- Owners/occupiers/users of land located in the transmission lines' corridor (to be defined during later stages).

Regulatory and executive governmental bodies at a national level

- Office of the Prime Minister (including the Energy Unit);
- Central Planning Division;
- Ministry of Agriculture, Industry, Forestry, Fisheries and Rural Transformation;
- Ministry of Housing, Informal Human Settlements, Physical Planning, Lands & Surveys and Physical Planning (including Physical Planning Unit);
- Ministry of Transport, Works, Urban Development & Local Government;
- Ministry of Tourism, Sports and Culture (including National Parks, Rivers and Beaches Authority);
- Ministry of Health, Wellness and the Environment (including Environmental Management Department);
- National Reconciliation, the Public Service, Labour, Information and Ecclesiastical Affairs;
- Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth;
- CWSA – Central Water & Sewerage Authority (including Solid Waste Management Unit);
- Transport Police; and
- National Emergency Management Organization (NEMO);

NGOs and interest groups

- The St. Vincent National Trust;
- The Nature Conservancy - SVG branch;
- The Soufrière Monitoring Unit;
- Windward Island Farmer's Association (WINFA) - SVG branch;
- Chamber of Commerce;
- North Leeward Tourism Association;
- SVG Rotary Club and Rotary Club of St. Vincent;

- SVG Hotel & Tourism Association;
- National Youth Council and youth groups;
- Community Development Officers;
- The Orange Hill Development Organization;
- Church-based groups in the Project area; and
- School for Continued Studies;

Mass media

- National Broadcasting Corporation (NBC);
- Government Agency for Public Information (API); and
- Local press/radio;

Internal Stakeholders

- Employees of the Geothermal Consortium; and
- Labour Union(s) – if employees are wholly or partly unionized.

6 SUMMARY OF PREVIOUS STAKEHOLDER ENGAGEMENT ACTIVITIES

Two phases of previous stakeholder engagement have occurred. First, engagement with national and local stakeholders by, initially, RG/EMERA and then, the Geothermal Consortium. Secondly, scoping consultations as part of early ESIA work for survey/exploratory activities. The scoping consultations were undertaken in accordance with the first version of this SEP (October, 2015). As this is the second version of the SEP an account of the scoping consultations is provided here, preceded by a brief description of earlier RG/EMERA and Geothermal Consortium consultations.

6.1 Previous RG/EMERA and Geothermal Consortium Stakeholder Engagement

Several stakeholder engagement events have been held over the past two years, including community meetings (referred to in Project documents as 'town hall' meetings) that took place in late 2013 and a presentation to the GoSVG Cabinet in February 2015. The objectives of these sessions were, as follows:

- Build broad support for the project and understanding of geothermal energy;
- Increase public awareness and acceptance of the potential for geothermal energy;
- Manage public expectations;
- Create confidence that an experienced team (RG / EC) is committed to the project:
- Enable the GoSVG to assume the role as champion for the project; and,
- Build an understanding of community and stakeholder issues.

Table 1 below presents selected previous stakeholder engagement activities in more detail[3]. Not all stakeholder engagement activities are included, for example, the local community/town hall meetings held in 2013 as there are no records of the proceedings of these meetings.

[3] As Table 1 presents previous engagement consultations it includes some stakeholders that are classed as Project customers, contractors, shareholders and lenders and which are not included, therefore, as stakeholders in other sections of this SEP.

Table 1: Selected Previous Stakeholder Engagement Activities

Stakeholders / Audience	Potential Concerns, Issues & Sensitivities	Objective / Desired Outcome	Current Status
Prime Minister of St. Vincent and the Grenadines	▪ High oil prices impacting electricity consumers and causing a drain on foreign reserves. ▪ Positive message of economic development opportunity for SVG through more stable electricity rates Renewable energy & sustainability leadership. ▪ Elections due in 2016. No date has been set. Energy, electricity prices and the project are expected to be election platform issues. ▪ Delays or uncertainty regarding the project could cause political challenges.	Continue to build public support for the project and confidence in EC / RG capability. Provide information and assurances on a timely basis. Assistance in ensuring that all government agencies are engaged, especially in regard to obtaining the necessary permits and regulatory support.	*Several meetings have been held and presentations made to the PM and members of the GoSVG.*
Government officials	Legislative requirements, policy requirements, general project support.	Identify potential roadblocks/issues before they cause project risk.	*Several engagements have taken place at the general and detailed level – e.g. Port Authority; Planning Department; Attorney General's Office, etc.*
VINLEC CEO: Thornley Myers	Implications of a geothermal project on VINLEC staff, operations and business. Recovery of cost of existing investment in generation. Opportunity for VINLEC to participate – investment; management; staff; operations; maintenance.	Build confidence in the project and provide opportunity for open discussion on the future. Also negotiate Power Purchase Agreement for the benefits of all parties and the people of SVG.	*Thornley Myers has been an active supporter of the project and participated in the Town Hall meetings that took place in 2013.*
VINLEC Managers	As above. Impact on them and their staff.	Build confidence in EC; provide opportunity for open discussion on the future and for VINLEC to participate in the project.	*VINLEC representatives are actively engaged on the project. EC/RG has met with VINLEC on several occasions.*

Stakeholders / Audience	Potential Concerns, Issues & Sensitivities	Objective / Desired Outcome	Current Status
Media – St. Vincent	Electric utility rates; environmental issues, community acceptance; cost of project	Keep media informed. Enable understanding/context for project development and continued support.	*Media has covered the project with TV interviews with senior RG representatives.*
IRENA / Abu Dhabi Fund (ADF)	ADF has committed USD15 Million to the project. Would want to be associated with a successful project.	Ideal if we can use this funding to support the infrastructural development and drilling phase of the project.	*Loan agreement to be negotiated and signed.*
Inter-American Development Bank	Financial strength and integrity of EC. Potential for growth and new investments and improvement in regional utility operations. Great interest in RE projects. Working with Caribbean Development Bank (CDB) to establish a geothermal fund.	Provide information about EC/RG plans and build confidence. Financial support for the drilling phase of the project in the first instance.	*Preliminary discussions were held with the IDB/CDB in early June. They are preparing a funding mechanism. A summary of the project has been submitted to the CDB/IDB.*
Caribbean Development Bank (CDB)	Ditto	Ditto	*Ditto*
Japan International Cooperation Agency (JICA)	Ditto	Ditto plus the opportunities for supply of Japanese services and equipment	*Met with Nippon KOEI, consultants to JICA, on May 23, 2015*
European Investment Bank (EIB)	Financial strength and integrity of EC Opportunity to be involved in a regional RE Project.	Provide information about EC/RG plans and build confidence.	*Preliminary discussions have been held.*
Caribbean Community (CARICOM) Ambassador	EC becoming a regional business and response of people in the region to this initiative.	Keep Ambassador informed and avoid any misunderstandings. Reinforce that EC is building a Caribbean business.	*Meeting held in 2013, but not since*

Stakeholders / Audience	Potential Concerns, Issues & Sensitivities	Objective / Desired Outcome	Current Status
Caribbean Electric Utility Services Corporation (CARILEC) and Regional Utilities	Interest in the implications for their businesses. Development of Independent Power Producers	Provide information and build confidence. Reinforce that EC is building a Caribbean business. Emphasize RG expertise in geothermal energy.	*Information has been shared on an informal basis. No formal discussions have taken place.*
EC / EC Board	EC is becoming a regional business; response of people in the region to this initiative. Alignment with EC strategy. Future regional opportunities.	Support for the project and ensure adequate resources.	*Board has been updated on a regular basis.*
RG / RG Board	Growth of the business. Future regional opportunities	Support for the project and ensure adequate resources.	*Board has been updated on a regular basis.*
EC Employees	Reinforce that EC is building a Caribbean business. Career opportunities.	Understanding of the project and its alignment with the EC strategy.	*EC employees have been kept informed through the company's regional newsletter.*
EC Shareholders	EC becoming a regional business and response of people in the region to this initiative.	Ensure support.	*Information has been shared in the EC Annual Report.*

The most recent Geothermal Consortium-led stakeholder engagement activities were undertaken in July, 2015 and included meetings with:

- The Prime Minister and the Cabinet;
- VINLEC Management Team;
- GoSVG Energy Unit;
- Press /Media outlets;
- API – Government Information System;
- Development Banks and Agencies (such CDB and JICA);
- SVG Rotary Club;
- NBC Community Service;
- Chamber of Commerce; and
- Representatives of opposition parties, NGOs, youth groups and church groups.

A list of issues raised during these meetings is provided at Appendix B with a copy of a leaflet which has been used as part of information disclosure for a range of previous stakeholder engagement meetings (Appendix C).

6.2 Scoping

Scoping is a key stage for stakeholder engagement as it allows for the early inclusion of stakeholder views/issues/concerns into the design of the ESIA work programme. In late October, 2015, scoping consultations occurred with certain categories of stakeholders (Affected communities, national government [ministries/departments] and NGOs). Media were excluded at this stage; however, they will be involved during the ESIA stage. As no exploratory drilling work has started there is no workforce. Those currently employed by RG and EC will be briefed and consulted via current internal procedures for workforce information disclosure/engagement. Scoping consultation meetings are presented in Table 2 below (17 meetings held in total[4]).

[4] Minutes of the 'Affected communities' scoping meeting are presented in Appendix D. Minutes of other meetings may be provided upon request addressed to the Geothermal Consortium (contact details are given in the Section 10.2 below).

Table 2: Scoping Stage Stakeholder Engagement Activities

Stakeholder category	Stakeholder Engagement and Methods	Timetable	Disclosure: materials disclosure mechanism and timing	Location/s
National government: Ministry of Agriculture, Forestry, Fisheries, Rural Transformation and Industry Forestry Department of the Ministry of Agriculture, Forestry, Fisheries, Rural Transformation and Industry Water Division of the CWSA – Central Water & Sewerage Authority Solid Waste Management Unit of the CWSA – Central Water & Sewerage Authority Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning Physical Planning Unit of the Ministry of Housing, Informal Human Settlements, Lands & Surveys and Physical Planning Environmental Management Department of the Ministry of Health, Wellness and the Environment Ministry of Health, Wellness and the Environment	Several face-to-face meetings attended by representatives of selected Ministries and their subordinate authorities and departments. The objective of these meetings was to present the Project, discuss the ESIA process and the potential Project impacts.	21/10/2015 – 29/10/2015	Verbal discussions of the Project	Kingstown, offices of the respective authorities and agencies

Stakeholder category	Stakeholder Engagement and Methods	Timetable	Disclosure: materials disclosure mechanism and timing	Location/s
Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth Ministry of Transport, Works, Urban Development & Local Government National Parks, Rivers and Beaches Authority of the Ministry of Tourism, Sports and Culture				
Population/communities residing in the immediate vicinity of the Project's planned facilities and infrastructure / using the Project AoI for delimiting presence/absence of livelihood activities such as farming and fishing.	A group of community representatives was selected (7 people in total). The community representatives attended a small meeting / focus-group. The objective of the meeting was to present the Project, discuss the ESIA and the current (and future) stakeholder engagement processes, and to find out if there are any concerns related to the Project. Please find a list of attendees and list of issues discussed in the Minutes of Meeting (Appendix D).	24/10/2015	Leaflet on the Project (see Appendix C)	Sandy Bay
NGOs and interest groups **Invited parties:** SVG Hotel & Tourism Association SVG Rotary Club LIME WINFA SVG	A meeting to present the Project, discuss the ESIA process and the potential Project impacts/concerns was held.	29/10/2015	Leaflet on the Project (see Appendix C)	Kingstown, Conference room of the Environmental Management Department

Stakeholder category	Stakeholder Engagement and Methods	Timetable	Disclosure: materials disclosure mechanism and timing	Location/s
North Leeward Tourism Association Rotary Club of St. Vincent Methodist dramatist Catholic Youth Movement SVG Chamber of Commerce FLOW Maritime Tomlin Voss & Associate NEMO School for Continued Studies **Attended parties:** National Emergency Management Organization (NEMO) Chamber of Commerce				
The SVG National Trust (organized separately from the NGO-focused meeting)	Face-to-face meeting attended by a Deputy Chairperson and a Manager of the National Trust. The objective of the meeting was to present the Project, discuss the ESIA process and the potential Project impacts.	28/10/2015	Verbal discussions of the Project	Office of the SVG National Trust

7 FUTURE CONSULTATION ACTIVITIES

Stakeholder engagement will occur at the following stages:

- ESIA implementation (two rounds of consultations due to the two ESIA studies planned); and
- ESIA Report Disclosure (two rounds of consultations following submission of the two ESIA Reports to the competent authority).

However, due to the current Project uncertainties, this version of the SEP covers only the Phase I ESIA stage (Q1-Q4 of 2016).

7.1 ESIA Phase I Implementation

Consultations during the ESIA Phase I implementation stage will be occur in accordance with the following sequence: 1) soon after the beginning of ESIA work, disclosure of a copy of the Scoping Report and the SEP (version 02) to all those who were consulted in the Scoping stage plus selected stakeholders who expressed an interest in being kept informed on scoping/ESIA progress; and 2) on completion of baseline studies and formulation of preliminary ESIA results/identification of mitigating and enhancement measures, the provision of information on ESIA progress and preliminary ESIA results. This is also a stage when it may be clear that certain impact issues are more, or less, important than first thought and, indeed, that new impact issues may be identified that need investigation. This stakeholder engagement will only occur when sufficient information on likely impacts and mitigation measures is available to enable meaningful consultation to occur with stakeholders on the expected risk/impacts and the ways in which they will be managed and, if appropriate, monitored. The consultation results will be incorporated into the work programme leading to preparation of the ESIA Report.

For the engagement process to be effective and meaningful, a range of techniques will be applied that are specifically tailored to the identified stakeholder groups. The format of every consultation activity will meet general requirements on accessibility, i.e. the consultation events will be held at venues that are easily reachable for all representatives of the community, do not require entrance fees, and are culturally appropriate (with due respect to the local customs and norms). The consultation activities will also be based on the principle of inclusiveness, i.e. engaging all segments of the society, including disabled persons, the elderly, minority groups, and other vulnerable individuals. If necessary, logistical assistance may be provided to enable representatives from the remote areas, persons with limited physical abilities and those with insufficient financial and transportation means to attend public or other meetings.

The PPDB plays a role in the determining the extent and type of consultations for EIAs on a case-by-case basis. It will be important for the Geothermal Consortium to liaise with the PPDB to reach agreement on stakeholder engagement activities that meet both SVG legal requirements and are compliant with PS 1.

The suggested approach to the Phase I ESIA implementation consultation activities is presented in the Table 3 below.

Table 3: ESIA Implementation: Disclosure of Scoping Report and Stakeholder Engagement Plan (Version 02)

Stakeholder Category	Stakeholder Engagement Methods	Timetable/ Location(s)	Disclosure Materials
All stakeholders consulted during scoping stage plus other stakeholders who a) have expressed an interest in receiving a copy and b) stakeholders recommended as being appropriate recipients of the Scoping Report ((SR)	By email and/or hand-delivery Request for comments on SR and the planned engagement activities for the Phase 1 ESIA as presented in the SEP (version 02)	Early in Q1, 2016	• Copy of SR and SEP • Feedback Forms/Comments sheet

Table 4: ESIA Implementation: Interim/Preliminary Results

Stakeholder Category	Stakeholder Engagement Methods	Location(s)/ Timetable	Disclosure Materials	Means of Advance Notification
Affected Communities: • Population residing in the nearest settlements to the Project sites (Sandy Bay, Orange Hill, Langley Park, Overland, Tourama, Georgetown); • Owners/occupiers/users of land likely to be acquired by the Project; • Owners/occupiers/users of land located along the existing three paved roads (going from the Windward highway to the layout areas); and • • Local people occasionally using areas within the Project's AoI for traditional	One public meeting ; and Two clustered focus groups: each consisting of representatives from three of the Affected communities, Public meeting in central location between Kingstown and Sandy Bay	Orange Hill or Georgetown (depending on adequacy of facilities) ; and A location in two of the Affected communities End Q2, 2016	• Scoping Report (SR), SEP available in publicly accessible locations in advance of the meetings • Leaflets summarizing risks/impacts and management measures distributed to each household • PPT presentation on the Project progress and design changes (if any). PPTs will be presented at the beginning of the meeting	• Local radio, television and newspapers • Facebook page • Posters in prominent publicly accessible locations in each settlement as well as in publicly accessible locations along the Windward Highway. • Government Agency for Public Information • Community Development Officers • Personal invitations to attend the meeting will be delivered to

Stakeholder Category	Stakeholder Engagement Methods	Location(s)/ Timetable	Disclosure Materials	Means of Advance Notification
and recreational activities (hiking/fishing/hunting). • Owners/occupiers/users of land located along the Windward Highway (Kingstown – Sandy Bay section)	Discussion on preliminary impacts results, mitigating measures and seek feedback on progress and to help identify gaps/issues which may need to be addressed in more detail or new concerns /issues that need to be investigated *de novo.*		• Feedback forms	the owners/occupiers/users of land likely to be acquired by the Project • Assistance from local churches
National government: Ministries/Agencies	One round-table meeting. The objective of the round table meeting will be to discuss the preliminary ESIA results (impacts/mitigating measures), seek feedback on progress and to help identify gaps/issues which may need to be addressed in more detail or new concerns /issues that need to be investigated *de novo.*	Kingstown End Q2, 2016	• Dissemination of electronic copies of the SR and SEP in advance of the meeting. • PPT presentation on the Project progress and design changes (if any). PPTs will be presented at the beginning of the meeting and form the basis for discussion.	Invitation by letter.
NGOs and interest groups:	One round-table meeting for NGOs and members of the interest groups. The objective of this meeting will be to discuss the scoping study results and the preliminary ESIA results (impacts/mitigating measures), seek feedback on progress and to help identify gaps/issues	Kingstown End Q1, 2016	• Dissemination of electronic copies of the SR and SEP in advance of the workshop • PPT presentation of project design changes and ESIA results to date. PPTs will presented at beginning of workshop and form the basis for discussion. • Leaflets	Targeted invitations by letter and email.

Stakeholder Category	Stakeholder Engagement Methods	Location(s)/ Timetable	Disclosure Materials	Means of Advance Notification
	which may need to be addressed in more detail or new concerns/issues that need to be investigated *de novo*.		• Feedback forms	
Media: • National Broadcasting Corporation (NBC); • Government Agency for Public Information • Local radio/newspapers.	Media will be kept informed by regular press releases, press and post-meeting media briefings and press conferences as to Project/ESIA developments	Periodic	Press releases and Project status updates	Targeted invitations to media briefings/press conferences.
Workforce: • Employees of the Geothermal Consortium; and • Labour Union(s) – if employees are wholly or partly unionized.	Staff members/employees will be kept informed and engaged to promote clarity and prevent unrealistic expectations being raised in communities. Special focus will be given to staff working on the project including especially Community Liaison Officer/Community Contacts.	Periodic	Internal briefing notes and newsletter	N/A

7.2 ESIA Phase I Disclosure

In early Q1, 2016, liaison will occur with the PPDB to agree the disclosure and consultation activities to be undertaken at this stage. It is expected that they will be similar to those outlined below, but some specific details may change. Should there be a change then this will be reflected in an updated version (v03) of this SEP.

The Phase 1 ESIA report, including an Environmental and Social Management Plan (ESMP), will be made available for public review for a period of 60 calendar days. Subject to disclosure will also be a Non-Technical Summary (NTS) which will convey the main findings and impact mitigation measures in a readily understandable manner, as well as the version of the SEP that is current at the time of ESIA report disclosure. The NTS will be released in the public domain simultaneously with the ESIA report and will be available for stakeholder review during the same period of time, i.e. 60 days.

Disclosure of materials will occur by making them available at venues and locations frequented by the community and places to which the public have easy access.

Printed copies of the ESIA report, NTS and the SEP in English will be made accessible for the general public at the following preliminary locations:

- The Project office in Kingstown;
- The Project public reception office in Orange Hill/Georgetown (should it be decided to open such an office).

Electronic copies of the ESIA, the NTS and SEP will be placed on the Project web-site. This will allow stakeholders with access to internet to view information about the planned development and to facilitate their involvement in the consultation process. The web-site will be equipped with an online feedback feature that will enable readers to leave their comments in relation to the disclosed materials. This SEP will be updated periodically and will remain publicly available on the Project web-site.

A number of meetings will be organised by the Project to discuss the conclusions of the ESIA report and the impact mitigation measures proposed therein. The following meetings are planned, at a minimum:

- Two public meetings: one for Affected communities (as defined above in the AoI subsection) and one in in Kingstown (as this is a Project of national importance);
- Round table meeting with the regulatory and executive governmental bodies; and
- Round table meeting with NGOs and interest groups.

Media will be invited to a briefing session after each of the two meetings.

The mechanisms that will be used for facilitating input from stakeholders and inviting them for the meetings will include press releases, announcements and notifications published in the media, dissemination of information through the community development officers, as well as the local churches and posting of information in prominent community locations such as shops, post office and community noticeboards.

7.3 Indicative Timeframes

The disclosure process and consultation activities for Phase 1 of the Geothermal Development Project will be implemented within the following indicative timeframes:

- Making Scoping Report and SEP (version 02) available to those stakeholders already consulted and others identified during scoping consultations – early Q1 2016;
- Consultation meetings to present and discuss the preliminary ESIA results and mitigation and enhancement measures –early Q2 2016;
- Consideration of stakeholder comments/suggestions in drafting of ESIA Report f–Q2 2016;
- Placement of the ESIA Report package (including ESIA Report, NTS and SEP) in the public domain – early Q3 2016;
- 60-day disclosure period for the ESIA package – Q3 2016; and
- ESIA package consultations to inform government decision-making – early Q4 2016.

8 GRIEVANCE MECHANISM

This section describes a transparent procedure that the Project will employ to deal with concerns and complaints received from affected communities, groups or individuals and other stakeholders. Once received they will be scrutinized and decisions will be taken on whether they will be treated as grievances to be dealt with under the Grievance Mechanism.

This Grievance Mechanism is intended for use by external stakeholders and is separate from the employee Grievance Mechanism. This SEP does not address the management of employee-related grievances as this will be dealt with as part of the Project's Human Resources policies and procedures or as part of its ESMP. The Grievance Mechanism presented below will remain an important element of the SEP throughout the Project's entire lifespan.

8.1 Grievances

Grievances can result from either real or perceived impacts of Project activities. The following criteria may be applied in order to distinguish grievances from other types of communication received from these stakeholders:

- Reports about harmful impacts, disturbance, disruption, injury and damage caused by the Project activities, including contractor operations (such as noise, traffic, pollution, restricted access to natural resources without prior notification, damage to common amenities and private assets, sustained losses, impacts on the natural environment and community health);
- Dissatisfaction with outcomes of the compensation process as part of land acquisition for the Project purposes (if no dedicated Resettlement Action Plan or Livelihood Restoration Plan is in place);
- Dissatisfaction with some aspects of the Project recruitment and hire process (e.g. limited number of positions available to the local population, insufficient advertising of vacancies); and
- Reports about misconduct by the Consortium's personnel, security or contractor workers.

The above list is not exhaustive and does not exclude other types of communications that the Consortium's staff may categorise as a grievance.

8.2 Procedure

[HOLD – information to provide the details missing below will be inserted when available]

Incoming concerns and complaints and enquiries can be submitted through the following means:

- An online facility for placing any stakeholder input on the Project corporate website: ____;
- A dedicated telephone number enabling contact with the designated Project staff (_____);
- By electronic mail to ___@___;
- By post _____;

- Via information leaflets on the Grievance Mechanism (Appendix E) – which will include a grievance form (see Appendix F) placed in _____; and
- Via grievance boxes installed in prominent public places and the Project's offices in ____ that will be established in ____.

When a concerns or complaints are received, these will be managed through a series of pre-determined steps. Receipt of the concern or complaint will be acknowledged to an initiating party and, later, the decision as to whether it is categorized as a grievance. Timescales for the provision of corrective actions to achieve resolution will depend on the complexity of the issue raised; however, normally it will not be later than 30 calendar days after receipt, except for complex cases where it may take up to 45 calendar days.

All incoming concerns or complaints will be logged in a dedicated grievance register and assigned an individual reference number. The grievance register is used not only to track the status of an grievance, but also to analyse the frequency of concerns or complaints arising, their geographic distribution, typical sources and causes of complaints, as well as identifying prevailing topics and any recurrent trends.

The grievance register will contain the following information:

- Unique reference number;
- Date of receipt;
- Location where the concern/complaint was received/submitted and in what form;
- Complainant's name and contact details (in case of non-anonymous enquiries and grievances);
- Nature of the concern/complaint;
- Date when categorized as a grievance and reasons;
- Identification of Project staff members responsible for addressing and resolving the grievance;
- Dates when the investigation of the grievance was initiated and completed;
- Results of the investigation and decision;
- Information on proposed corrective actions to be sent to the initiating party (unless it was anonymous) and the date of the response sent on measures of redress;
- Date of close-out and record (signed by both parties) showing that the resolution is acceptable; and
- Outstanding actions for non-closed grievances.

The Project will appoint responsible staff for collating and registering grievances, maintaining the grievance register, coordinating responses and managing the process of grievance resolution.

Where a resolution cannot be provided within the specified timescales, designated staff will inform the initiating party accordingly. Once all necessary investigations have been completed, the responsible staff will contact the aforementioned person to discuss further actions and to agree on a possible resolution.

Parties initiating a concern or complaint will also have an opportunity to lodge it in a confidential manner. In this case the name and contact details of the initiating party will not be disclosed without their consent and that only the team directly working on the investigation of the issue will have access to such information. In cases when an investigation necessitates passing some or all of the information on to third parties for the purposes of resolving the situation (e. g. when it is ascertained that the grievance resulted from certain actions by a contractor company), the complainant's agreement to information disclosure will be sought in an appropriate manner.

The Grievance Mechanism will not prevent complainants from seeking alternative legal remedies in accordance with the applicable SVG laws and regulations.

An outline of the Procedure is shown in the flow diagram presented in Figure 3. The responsible staff member/s will strive to complete the process of investigating the incoming concerns or complaints and identifying a resolution within 30 calendar days, and in more complex cases – within 45 calendar days of the receipt of a grievance. The complainant will be informed, before the elapse of 30 calendar days, if a decision has been made to extend the complaint processing period for complex cases.

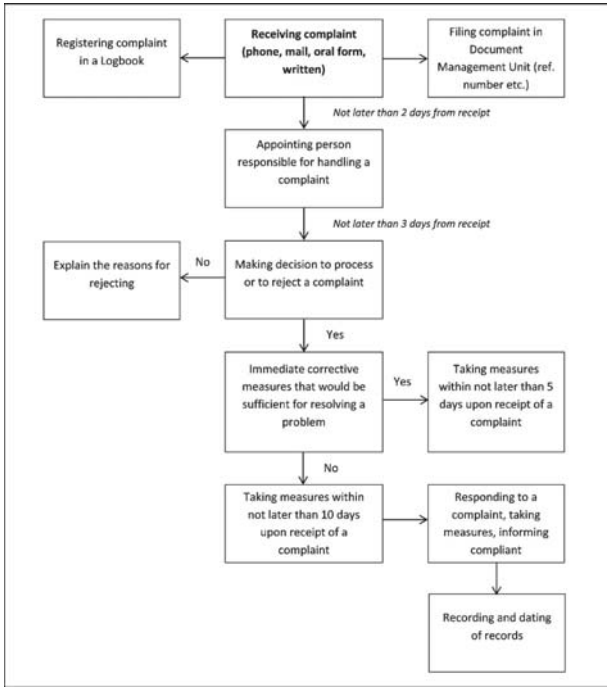


Figure 3: SVG Geothermal Development Project Grievance Mechanism Procedure[5]

[5] In this procedure the term 'complaint' is used instead of 'grievance'.

8.3 Disclosure of Grievance Mechanism

The grievance mechanism will be disclosed to local community stakeholders by means of posters and a leaflet (an example of text for such a leaflet is shown in Appendix E). Copies of the poster will be displayed in prominent external and internal locations, where there is easy public access in each village. Also, copies of a leaflet (in English) explaining the grievance mechanism with a 'tear-off' form for lodging a grievance will be distributed to every household in each village (see example of such a form at Appendix F).

9 MONITORING AND REPORTING

This SEP will be periodically revised and updated as necessary in the course of Project implementation. This will help to ensure the validity and adequacy of the information presented herein, and that the identified methods of engagement remain appropriate in relation to the legislative requirements and specific phases of the Project development. Any major changes to the Project activities and to its schedule will be duly reflected in the [then] current SEP.

Information on stakeholder engagement activities undertaken by the Project is also planned to be conveyed periodically to the external stakeholders, at a minimum with an annual frequency. In cases of significant changes to the Project design and/or operations, impact mitigation approaches or to the management plans (under the ESMP), affected communities will be informed as part of the Project's on-going interaction with those communities and other stakeholders.

A number of key performance indicators will also be monitored by the Geothermal Consortium, on a regular basis, in relation to stakeholder engagement measures, including the following parameters:

- Number of consultation meetings and other public discussions/forums conducted within a reporting period (e.g. monthly, quarterly, or annually);
- Number of grievances received within a reporting period (e.g. monthly, quarterly, or annually); number of those resolved within the prescribed timeline and the reason for non-resolution of grievances within the prescribed timeline and trends;
- Geographic origin in of grievances and trends;
- Type of public grievances received and trends; and
- Number of Project-related press materials published/broadcast in the local and national media and analysis of content: proportion that is favourable, unfavourable, neutral, and trends.

Summarised quarterly reports on grievances received from stakeholders, including information on the on incidents and events that resulted in grievances, will be collated by the responsible staff and referred to senior Project managers. These internal summaries will be accompanied by the information on the implementation status of associated corrective and preventative actions.

10 MANAGEMENT FUNCTIONS

In this section the proposed organizational structure and management functions for stakeholder engagement within the Consortium are described. While the Consortium may decide to adapt this structure according its needs, it is emphasised that the various components listed and then described below should be represented in the organizational structure in order to successfully implement the SEP:

- 'Social' Manager (or person with an equivalent function), who is responsible for overseeing and coordinating all activities associated with stakeholder engagement;
- Community Liaison Officer (CLO), who will be responsible for implementing community engagement activities; and
- Administration, who will be responsible to manage all activities related to database, documents and logistics; and integration/support, which relates to the interaction with other departments.

The focus below is on the posts/roles of Social Manager and Community Liaison Officer.

10.1 Social Manager

The Social Manager (or a similar function) needs to oversee all planned stakeholder engagement activities or in process of being implement. Furthermore, this Manager needs to ensure that all stakeholder engagement aspects are a permanent item on all high-level management agendas, and that all actions arising from management decisions are implemented. Hence, it is important that the Social Manager reports directly to the General Manager and is able to interact freely with key decision-makers in the organization i.e., HR Manager, QHSE Manager, Engineering Manager, Site Manager and Corporate Affairs Manager. Responsibilities of the Social Manager include the following:

- Develop, implement and monitor all stakeholder engagement strategies/plans for the Project/ESIA;
- Oversee all stakeholder engagement related activities for the Project (Administration, CLO);
- Manage the Grievance Mechanism;
- Interact with related and complementary support activities that require *ad hoc* or intensive stakeholder engagement (community development and land acquisition/resettlement planning and implementation);
- Act as mediator between the Consortium and stakeholders;
- Liaise with other managers to ensure that stakeholder engagement requirements/protocols are understood; and
- Proactively identify stakeholders, project risks and opportunities and inform the General Manager / senior management to ensure that the necessary planning can be done to either mitigate risk or exploit opportunities.

10.2 Community Liaison Officer

The main purpose of the CLO is to engage with communities on a continuous basis in an effort to strengthen relationships between the Geothermal Consortium and affected communities. Responsibilities include the following:

- Providing feedback to the Social Manager on concerns raised by the community members;
- Providing feedback to the community members on Project developments, concerns raised or important decisions taken by the Consortium but in accordance with agreed protocols;
- Identifying potential grievances or project risks / opportunities;
- Assisting the Social Manager with management of grievances lodged;
- Assisting the HR Manager during the local labour recruitment process by assisting with drafting local hiring policy and procedure, and, as required, soliciting community requirements;
- Identifying community needs for social development or engagement requirements; and
- Management of stakeholder engagement logistics (such as collecting suggestions/ grievances from suggestion boxes, placing communication materials on notice boards, and arranging community meetings).

The CLO will be employed and preferably have an office on site from where he/she will operate. The CLO will provide feedback to the Social Manager on a weekly basis by means of a structured field report. Proposed content of the field report includes: consultations undertaken, attendance registers (where applicable), concerns raised, requests raised, concerns resolved, potential risks, grievances or opportunities identified.

10.3 Integration and support

Due to the fact that stakeholder engagement activities will influence other departments or require their inputs, the Social Manager needs to ensure the various managers are included or kept informed on the stakeholder engagement process. Decisions taken by managers might have a direct or indirect impact on communities which would need to be communicated at the appropriate time, e.g. the Project's Engineering or Site Manager might decide to construct additional access roads which could potentially have an impact on communities. Anticipated stakeholder engagement roles for the various decision-makers are outlined below:

- Corporate Affairs Manager: this manager will be responsible to sustain relationships and communicate with Government entities and the media. These engagements will be required throughout the Project's life and decisions taken as a result of these engagements could potentially impact the Consortium's relationships with communities e.g. site selection or compensation agreements;
- HR Manager: opportunities for employment is likely to be a key concern for community members. This requires that a defined process of employment be developed and clearly communicated to community leadership and members;
- Site Manager: the Site Manager is responsible for 'on the ground' day-to-day decisions and actions that can result in problems for local stakeholders. This manager may need to be sensitized to understand the importance of 'healthy' stakeholder relations, even if it requires construction/production stoppages due to the need to resolve outstanding grievances quickly and amicably;
- QHSE Manager: how the Project interacts with the environment will have a direct bearing on stakeholders' perceptions. The SHEQ Manager needs to be able to interact

with the regulators and/ or environmental NGOs freely, providing the needed information on the Project's environmental and social policies and procedures and how they are being implemented; and

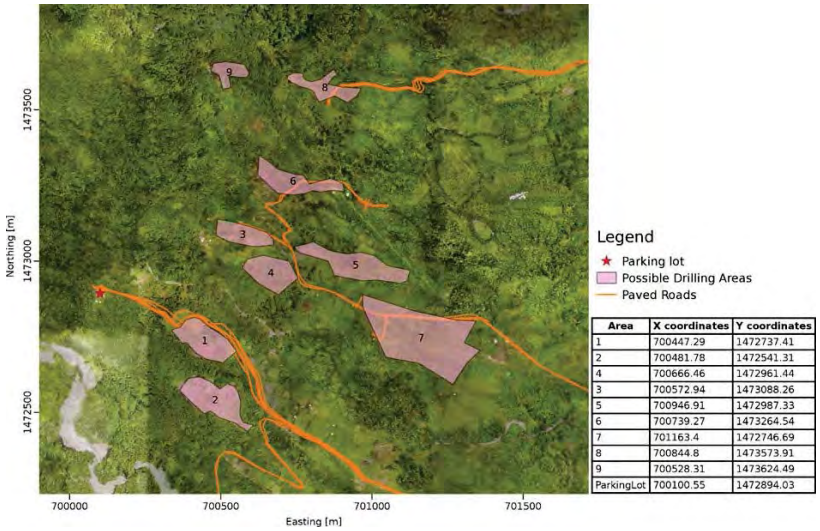
- Engineering/Project Manager: such managers are often driven by completion/production targets and, like the Site Manager, may need to be sensitized to understand the importance of 'healthy' stakeholder relations, even if it requires construction/production stoppages due to the need to resolve outstanding grievances.

Below contact information is provided to allow stakeholders to get in touch with the Project:

[HOLD – details to be inserted when known]

APPENDICES

A: Possible Drilling Areas (Nine sites)



Area	X coordinates	Y coordinates
1	700447.29	1472737.41
2	700481.78	1472541.31
4	700666.46	1472961.44
3	700572.94	1473088.26
5	700946.91	1472987.33
6	700739.27	1473264.54
7	701163.4	1472746.69
8	700844.8	1473573.91
9	700528.31	1473624.49
ParkingLot	700100.55	1472894.03

B: Queries and Issues raised during the July 2015 stakeholder meetings

Media Queries:

- Number of jobs to be created by the Project;
- Project impact on retail price of electricity;
- Proportion of financing which will come from the GoSVG;
- Level of annual savings to the SVG economy;
- The role of the Clinton Foundation;
- Effects from drilling on the La Soufriere volcano or any seismic effects.

Cabinet Queries:

- Volume of material to be removed in well drilling;
- Consideration given to the habitat of the National Bird being in that region, how will this be treated in the ESIA;
- What are the technical reasons for not pursuing slim hole drilling?
- A verification of the estimated impact of transmission costs on the tariff of 1.5cents/kWh was requested;
- Fundamental differences between the Business plan and the Geothermal Resources Exploration and Development Bill in its current form (if any).

Key Stakeholder Session Queries:

- Are there any chemicals used in drilling?
- What is the drilling process?
- How are hard geological formations dealt with?
- Will drilling cause earthquakes?
- What will be the source of water for drilling?
- What is done with the material that is removed?
- Will the resulting levels of H2S gas be dangerous?
- What are the resource advantages of the Windward side vs the Leeward side?
- In the event of damage to the plant due to volcanic activity, what short term or long term measures are in place for an alternative electricity supply, given the relative contribution of the geothermal plant to the VINLEC grid?
- Possibility of interconnection to the Grenadines, or St Lucia?
- Has the EPC contract been awarded?
- Impact on electricity tariff?
- What is the distance of the plant from the volcano?
- How will local infrastructure upgrades be managed?
- Were surface studies done?

- Did the ESIA take into account the local wildlife, water & air quality?
- Are there any land acquisition issues?
- Are there test wells? Why not?
- Will the geothermal plant be compatible with the existing technologies already on the VINLEC grid?
- How does the geothermal resource in SVG compare to that in other countries?
- What is the potential for export of energy?
- Elaborate on the need for water for drilling?
- What is the environmental impact of noise and light during plant operation on endemic species?
- Request for clarity on the role of the Ministry of Transport & Works and the costs of road development.
- Is there potential for the use of plant output water?

Records on the responses provided by the Consortium are unavailable.

C: Information Disclosure Leaflet

RG Reykjavik Geothermal

The Government of St. Vincent and the Grenadines

Emera Caribbean

ST. VINCENT & THE GRENADINES GEOTHERMAL ENERGY PROJECT

Project Description

The project involves the evaluation of the geothermal resource, the drilling and testing of geothermal wells, the construction of a 10 to 15 megawatt. geothermal power plant.

LA SOUFRIERE

Goals and Objectives

The primary objective is to reduce and stabilize electricity prices to VINLEC customers, reduce greenhouse gas emissions and increase energy security.

Geothermal Opportunity

Geothermal energy presents an opportunity for St Vincent to significantly reduce its reliance on imported oil and achieve greater energy independence and security for the island.

Geothermal Drill Plan

A geothermal drill plan has been prepared that includes the drilling of two exploration wells and one production well for the 10 to 15 MW power plant.

Geothermal Power Generation

An assessment of the electric system operated by VINLEC indicates that a plant in the range of 10 to 15 megawatts is a best match for the electricity demand on the island.

Final Site Selection

Subsequent field visit by RG has confirmed two preferred sites for drilling, in the general area to the west of Orange Hill community.

RG Reykjavik Geothermal

The Government of St. Vincent and the Grenadines

Emera Caribbean

Environmental Management Plan

Emera Caribbean and RG are committed to operating in a manner that protects the environment and promotes a sustainable future. A plan will be presented for approval to mitigate any environmental impacts related to geothermal development.

GEOTHERMAL ENERGY PROJECT

Investing in a Cleaner Future Today

Emera Caribbean (EC) and its parent company, Emera Inc. of Nova Scotia, Canada have significant utility sector experience, including substantial experience in financing major capital projects.

Reykjavik Geothermal (RG) has extensive experience in geothermal energy, including resource assessment and development. RG has been involved with the development of over 3000 MW of geothermal projects in over 30 countries.

The Clinton Climate Initiative is assisting with providing a transparent negotiation process as well as legal and financial advise.

Every stage of the project is appropriately planned. Time schedules are therefore made and adhered to without compromising the integrity of the project.

The intention and effect of the project is to enhance those natural and other developed attractions.

Geothermal Energy is known to be a clean and renewable form of energy thus fitting well with the island's image and can boost the eco-tourism product.

The geothermal energy development can and will become an added tourism attraction and can be included as part of existing tours for residents and visitors alike.

The geothermal fluid will be re-injected into the reservoir. The reinjection well serves a dual purpose, to re-inject the fluid into the reservoir preventing contamination of water sources as well as to recharge the reservoir, allowing the re-injected fluid to be reheated and reused.

Geothermal Plant designs provide for abatement systems such as scrubbers or chemical treatments that will reduce the H_2S content and that of other gases to acceptable levels according to international standards or placing it back into the geothermal fluid and then re-inject it into the reservoir.

Noise can be controlled by installing muffler systems and sound proof barriers around the plant. The sounds coming from a production well is equivalent to a few persons speaking in a residential home, and the sound at a geothermal power plant is equivalent to that of a transistor radio playing loudly.

The Geothermal plant will be fitted with seismic monitoring systems set to certain sensitivity, and designed to shut down automatically if necessary.

Drilling into or near La Soufriere will not trigger a volcanic eruption. Geothermal developments in Iceland and Hawaii have drilled into lava, and the fluid used during drilling rapidly cooled the lava and turned it into glass, therefore there was no eruption or lava coming up to surface level

D: Minutes of the community-level scoping meeting

La Soufrière Geothermal Power Station: Exploration Phase – ESIA Scoping Study

Settlement/Affected Community Scoping Consultation Meeting

Notes of meeting in Sandy Bay, 24/10/2015

Settlement/Affected Community Name	Orange Hill, Over Land, Sandy Bay
Date ***(day/month/year)***	24/10/2015
Start time	02.45 pm (45 minutes later than planned)
End time	04.15 pm
Facilitator	Katya Sladkova
Note Taker	Katya Sladkova
Company representative	Under Proponents' request, Dr. Reynold Murray kindly agreed to present the Project during the meeting.
Others	Mr. Pirran Driver (PD) - JICA/NK team – Environment Specialist Ms. Katya Sladkova (KS) - JICA/NK team – Social Specialist Dr. Reynold Murray (RM) - JICA/NK team – Local Specialist Mr. Marvin Rose (MR)

Affected Community Attendees:

No.	Name	Sex	Occupation (plus status/position in community, if relevant)
1.	Ms. Denise Lewis	Female	Farmer, Orange Hill
2.	Mr. Brandon Child	Male	Head teacher of Sandy Bay Primary School and member of National Youth Council
3.	Mr. Adam Billingy	Male	Orange Hill, Farmer and President of the Orange Hill Development Organization
4.	Mr. Melford Pompey	Male	Over Land, Minister of Religion and Radio Announcer
5.	Mr. Grastom Lavia	Male	Orange Hill, Community Development Officer

No.	Name	Sex	Occupation (plus status/position in community, if relevant)
6.	Mr. Winston Williams	Male	Sandy Bay, works on a local radio
7.	Mr. Morris	Male	Farmer

Part 1: Introduction

RM made a brief presentation of the Project (the participants also had 2-page leaflets for their information).

PD/KS introduced themselves and background of the scoping study.

Part 2: Questions and Answers

1.

Q: There is a family living on Site 3. Will a new land parcel be provided to them?

A: The Proponents have an intention to implement the Project in compliance with the international standards (IFC Performance Standards) which include recommendations on how to undertake resettlement in a responsible manner. Amongst others, it includes the requirement for fair compensation to people to be relocated as a result of the Project implementation.

2.

Q: Will the Project train recent graduates for them to be able to 'operate' the plant later on?

A: At the moment we can't answer this question, the Project proponents will be in a better position to respond. However, hopefully, some social programmes may be expected to result from the Project. The consultants will pass the suggestion on training to the Project Proponents. We should point out that after the contractual period of joint operation is up, it is intended that the Project will revert to 100% SVG ownership.

3.

Q: Will the Project widen the roads? Will it require additional land?

A: Certain improvements of the roads will take place, however, acquisition of additional land for this purposes is not anticipated.

Mr. Grastom Lavia assumed that current roads already have the capacity required for transportation of the Project equipment and materials.

4.

Q from KS: Do you think that, in case of need, Project workers can be accommodated in Orange Hill?

Answer from various participants: It is unlikely that Orange Hill can accommodate Project workers, better to consider Georgetown.

5.

Q from KS: What would be the best way to invite people to the meetings in future? Best channels for communication with local community? What would be the most convenient way for the community members to contact the Project?

Answer from various participants: Radio, television and local newspapers could be used. Also, the Project could cooperate with the Government Agency for Public Information and the community development officers. Finally, a very good way to notify people is to disseminate information through churches.

For contacting the Project, local people could use a dedicated phone number and, as most people have internet access, the Project could create a Facebook page.

6.

Q from KS: Are there any sites/locations that have spiritual value to local population? Which are visited for religious/spiritual purposes? Any cultural places?

Answer from various participants: Only cemeteries, but they are all located along the coastline. Nothing else can be mentioned in this regard.

7.

Q from KS: Do local people know much about the Project? What are their opinions?

Answer from various participants: Some people do know a bit, however, they have very limited understanding of the Project nature (incl. what geothermal development involves) and they have concerns on potential Project impacts on the volcano.

8.

Q from KS: Is there fishing in the area of future Project implementation?

Answer from various participants: No, there is not. There is hunting during an 'open' season (Oct-Jan), although it is more of a recreational nature, rather than a subsistence activity.

9.

Q from KS: What are the main problems of the community?

Answer from various participants: The main problems are unemployment and poverty.

10.

Q: How will the Project impact soils? I am concerned that the loose soils in the area will be mobilized due to drilling.

A: Drilling is not anticipated to result in perceivable impacts on surface soils, though land clearance and earthworks for drill pads and other surface infrastructure may result in some impacts on land.

11.

Q: Where the Project will take water from? How it may impact agricultural activities?

A: There are few water intake options, which are being considered now. Impacts resulting from the Project's water use will be closely examined as part of the ESIA study.

12.

Q: PD – Is there much wildlife in the Project area, and do you think the Project could have an impact on it?

A: There is some wildlife in the area (including parrots), but as they are mobile they will simply move away from the area during the works and then return later. The parrots mainly live higher up but come down to feed. Not so many snakes as mongoose are common.

Part 3. Project Impact issues/Concerns

NB: The participants were not very enthusiastic/initiative in sharing their concerns and thoughts of the Project impacts.

Concerns expressed:

- Impacts of the Project on the volcano, seismic risks;
- 'Social' impacts of use of the Windward highway – public safety, additional load on the road during transportation of the equipment from Kingstown to the site.

Overall attitude: Supportive, positive - due to expectations that the Project will reduce electricity costs and bring development opportunities for the local communities.

E: Grievance Mechanism Leaflet

Grievance Mechanism for External Stakeholders

[HOLD – details for completion of the text below will be inserted below when available]

SVG Geothermal Development Project ("the Project") is striving to ensure that its activities and operations do not cause any problems for those living near to the Project facilities and associated infrastructure or for other potentially affected stakeholders. However, we would like to hear about any concerns or particular complaints that you may have in relation to the activities of the Project, so that any of those issues can be noted and duly addressed.

What kind of enquiry can I lodge?

Anyone can contact the Project if they feel that its activities and operations are negatively affecting them, their place of residence, their assets and property, or the environment. Examples of grievances could include:

- Negative impacts on local residents (such as excessive noise, traffic, and other types of disturbance);
- Damage to private and common assets and properties;
- Environmental damage resulting from construction or operations activities as part of the Project;
- Practices or technologies that endanger the health, safety and security of Project employees and/or local population.

How can I contact the Consortium?

Anyone can submit a grievance to the Consortium in the following ways:

- By phone to: ___.
- By e-mail on: ___
- Via the Project's website at: ___
- Via the grievance boxes located in ___
- Via the Project's offices in ___.
- By completing the attached grievance form and posting it to/dropping it in person at the following addresses:

___

How will the Consortium deal with my enquiry?

The Consortium will go through the following steps to deal with your issue:

Step 1: Acknowledgement: Project staff will contact you to acknowledge and, where possible, to inform you of a resolution to the issue raised (unless the enquiry was anonymous) within the following timescales:

- Immediately for a verbal complaint; and
- Within 3 to 5 business days from the receipt of a written complaint.

This acknowledgment will include a reference number for your enquiry, the person responsible for tracking your case, and the expected date for completing the investigation of the issue raised (where appropriate).

Step 2: Investigation: An investigation into your grievance will then be set up. We may need to contact you during this investigation.

Step 3 Resolution: When we have completed the investigation of your issue we will contact you with our findings and our proposed response. If our investigations find that the issue raised does not relate to the Project activities, we will explain this in writing to you. Otherwise, we will propose a response to address the issue raised in your enquiry. If you consider our response and its implementation to be satisfactory we will ask you to sign a statement of satisfaction if you are happy to do so. If you are not satisfied with our response we will have further discussions with you to see if there are other possible steps which can be taken to resolve the grievance.

Step 4 Follow up: Project staff may contact you at a later stage to confirm that our activities pose no further problems.

Confidentiality: If you would like your enquiry to remain confidential, we will ensure that your name and contact details are not disclosed without your consent and that only the Project team directly working on the investigation of your case will have access to such information. If it is not possible for the team to fully investigate or resolve the problem without revealing your identity or the contents of your enquiry (for example, if you are required to give evidence in court), the Project staff directly working on your case will have prior discussions with you on how you would prefer to proceed.

Anonymity: If you would like to lodge an enquiry anonymously, please indicate so in the attached form. The subject of your enquiry will in any case be examined, however it may be more difficult for the Consortium to conduct the investigation and we will not be able to give you feedback on the result of our examination of the issue that you raised.

F: Form for Lodging a Grievance

[HOLD – details for completion of this Form will be inserted when available]

<table>
<tr><th colspan="5">Form for Lodging a Grievance</th></tr>
<tr><td colspan="5">Reference Number [to be filled in by responsible person ___]:</td></tr>
<tr><td>Full Name
Note: If you prefer so, you could keep this field anonymous or request non-disclosure of your identity information to a third party (tick an appropriate box)</td><td colspan="4">I request non-disclosure of my identity information.
I would like to submit an ANONYMOUS grievance.</td></tr>
<tr><td rowspan="4">Contact Details</td><td colspan="4"></td></tr>
<tr><td colspan="4">Address:</td></tr>
<tr><td colspan="4">Tel:</td></tr>
<tr><td colspan="4">e-mail:</td></tr>
<tr><td>How would you prefer to be contacted? Please tick a box</td><td>By post</td><td>By phone</td><td colspan="2">By e-mail</td></tr>
<tr><td colspan="5">No. of your ID document:
[this field is optional]</td></tr>
<tr><td colspan="5">Details of your grievance: [Please describe the problem, whom it happened to, when, where and how many times, as relevant]</td></tr>
<tr><td colspan="5">What is your suggested resolution for the grievance, if you have one:</td></tr>
<tr><td rowspan="3">How to submit this form</td><td colspan="4">By Post to:</td></tr>
<tr><td colspan="4">By hand: please drop this form at the addresses specified above</td></tr>
<tr><td colspan="4">By e-mail: Please email your grievance, suggested resolution and preferred contact details to:</td></tr>
<tr><td>Signature</td><td colspan="2"></td><td>Date</td><td></td></tr>
</table>

D: Proposed Terms of Reference for Phase 1 ESIA Study

Introduction

Below is a provisional Terms of Reference (ToR) for the Phase 1 ESIA. Note that the ToR are not "Tender-ready" in that they focus on the technical scope of work, omitting much of the peripheral information that would normally be expected in a formal ToR, such as introductory material, desired phasing and schedule, and contractual issues. The Geothermal Consortium will therefore need to expand on the below ToR if a formal tender is to be issued.

Objective

The objective of the Phase 1 ESIA is to ensure that all potential negative environmental and social impacts of the exploratory phase of the Project are identified and quantified, and that suitable corresponding mitigation measures are developed, thus ensuring that the exploration activities proceed with minimum negative impacts on the environment and socio-economics of the Project area. The study will be carried out in compliance with the IFC Performance Standards, as well as local SVG law.

Although the ultimate aim of the combined Phases 1 & 2 ESIAs is to produce a fully compliant study and outcome, there is a degree of recognition that the Consortium wishes to commence exploratory activities in the near future, and that as a result the Phase 1 ESIA work will have a limited scope, but a corresponding increase in the level of precaution in predicting impacts. This will ensure that likely negative impacts are satisfactorily mitigated during the exploration phase, and prior to the more significant studies that will take place during the Phase 2 ESIA.

Proposed ESIA Team

The suggested core team for the Phase 1 ESIA is as follows:

- EIA Specialist / Team Leader
- Social Specialist
- Physical/Economic Displacement Specialist
- Biodiversity Expert
- Reptile Expert
- Air Quality & Noise Specialist[34]
- Hydrologist/Water Specialist
- Local Environmental Specialist
- Local Ecologist
- Local Sociologist

General Approach

The general approach to the ESIA shall be to build upon the considerable amount of work that has been carried out in preparing the Scoping Survey; further studying the issues of concern highlighted by the Scoping Study, without repeating the investigations, data collection and meetings held in other areas[35]. It is important that, in addition to assessing impacts and

[34] If a specialist in both fields is not available, this position should be split into two positions; Air Quality & Noise
[35] However, some meetings with key stakeholders such as the PPU will be required

developing corresponding mitigation measures, the Phase 1 ESIA includes stakeholder engagement, so as to maintain compliance with IFC PS1.

As mentioned above, the Phase 1 ESIA will fall somewhat short of a "full" ESIA (for example, operational and decommissioning impacts will not be assessed), but within this limitation, the study will be comprehensive. It will include an assessment of potential positive and negative impacts, review alternatives to the proposed Project and provide an Environmental and Social Management Plan (ESMP) that outlines measures to avoid or mitigate impacts, as well as provisions for monitoring.

Although the Scoping Study has highlighted areas of particular concern requiring further study (e.g. biodiversity), the ESIA team will still need to assess the impacts in the lower-risk areas (e.g. landscape and transportation), using the information already available and any further information collected during the ESIA work.

Specialist Studies

It is expected that the Phase 1 ESIA will include a c. 5 week[36] field visit to SVG. This visit will be an opportunity for the team to follow up on the information that was not known at the time of the Scoping Survey (e.g. final site selection, developments in design/methodology, the results of the water supply study, and various social uncertainties), to carry out the required stakeholder engagement activities, and to carry out the following specialist studies proposed:

<u>Biodiversity</u>

The Phase 1 biodiversity studies shall include the following key tasks:

- Desktop data review;
- Desktop screening of potential Critical Habitat-qualifying biodiversity in the project area[37];
- Interviews (using photo cards) of local farmers and hunters;
- Rapid ground surveys to document habitats and identify species;
- Mapping of habitats and species present in the Project Area;
- Assessment of likely impacts on biodiversity during the exploration phase of the Project;
- Development of mitigation measures for exploration that is appropriate to all potential "Critical Habitat"-qualifying biodiversity identified during the data review and field surveys.
- (The limited scope for Phase 1 surveys requires a precautionary estimate of impacts and in the development of the corresponding mitigation measures).
- Preparation of a field survey report;
- Written inputs to the overall Phase 1 ESIA Report, e.g. baseline environment, assessment of impacts, ESMP, etc.

[36] Based on the team described being deployed; if the team is smaller, the duration of the survey is likely to be longer
[37] The geographical extent of this survey will depend on the Consortium's strategic decision-making as to whether to cover all possible exploration sites, or only the one or two most likely sites.

Water

The Phase 1 Water studies shall include the following key tasks:

- Desktop data review and further research into hydrology of Project Area;
- Obtain and review planned Project water resources study;
- Site visit to rivers in Project Area. This should include reconnaissance along several kms of the rivers to identify flows and other conditions, to assess the health of the rivers and to assess users and possible off-take points;
- Review proposed water supply and discharge planning for exploration, and assess whether there is sufficient available water to satisfy the plans whilst permitting an "environmental flow" and sufficient water for downstream users, if identified;
- Likewise, the proposed diversion and holding infrastructure (dams, pipelines, ponds) should be assessed for negative impacts;
- Assessment of other likely impacts on hydrology and water quality of the drilling activities;
- Development of mitigation measures for exploration;
- Preparation of a field survey/modelling report; and
- Written inputs to the overall Phase 1 ESIA Report, e.g. baseline environment, assessment of impacts, ESMP, etc.

Noise

The Phase 1 Noise studies shall include the following key tasks:

- Desktop data review and identification of NSRs;
- Baseline noise survey using handheld or portable noise meter;
- 2D modelling of noise contours;
- Assessment of likely impacts of noise on the "Bamboo Ridge" Hiking Base Station and other NSRs identified;
- Development of mitigation measures for exploration in consultation with the Biodiversity Expert;
- Preparation of a field survey/modelling report; and
- Written inputs to the overall Phase 1 ESIA Report, e.g. baseline environment, assessment of impacts, ESMP, etc.

Air Quality

The Phase 1 Air Quality studies shall include the following key tasks:

- Desktop data review;
- Installation of meteorological station and conduct of one month's readings[38];
- Basic modelling of likely dispersion/plume of drilling gases;
- Assessment of likely impacts on air quality during the exploration phase of the Project;
- Development of mitigation measures for exploration in consultation with the Biodiversity Expert;
- Preparation of a field survey/modelling report; and
- Written inputs to the overall Phase 1 ESIA Report, e.g. baseline environment, assessment of impacts, ESMP, etc.

Socio-Economics and Cultural Heritage

The following socio-economic and CH aspects require collection of additional information/performing additional tasks:

- Traffic composition in Project area;
- Traffic flow data in Project area;
- Statistics on traffic-related incidents and aggregated quantitative or qualitative information on main cases of traffic-related incidents;
- Inventory of sensitive locations on the Windward highway (schools, churches, crossing points, highway sections of active pedestrian usage, public transport stops, etc.);
- Cultural Heritage: walkover survey with trial pits.

Involuntary Resettlement (Physical and Economic Displacement)

As the Project involves physical/economic displacement, a RAP and/or an LRP will be prepared which, *inter alia*, will cover the following:

- Comparison between national laws/regulations and PS 5 and identification of gaps/differences;
- Confirmation of land boundaries of the area to be acquired by the Project and of the land plots to be affected;
- Collection of socio-economic baseline data on the affected individuals/ households/ communities;
- Undertaking a survey of all assets to be affected and valuation at replacement/compensation costs;

[38] Wind direction and speed is the primary area of interest

- Description of the Grievance Mechanism;
- Undertaking consultations with affected individuals.

Impact Assessment

Following the completion of the field surveys, a full assessment of potential impacts will be undertaken. It is important that the consultant undertakes tangible assessments of the situation on the ground in key representative locations, and consequently suggests appropriate and sustainable mitigation measures for any potential negative environmental and/or socio-economic impacts. These should be followed, wherever possible [39], with measures to enhance any environmental / social benefits of the project, and environmental and social improvements that can be conceived as a part of project implementation.

The ESIA should identify and assess the positive and negative biophysical and socio-economic impacts likely to result from the proposed exploration activities, including:

- Potential direct, indirect and cumulative effects on ecologically sensitive areas and/or internationally or nationally recognized protected areas, including the natural habitats of threatened and/or endemic species;
- Potential impacts on threatened and/or endemic species;
- Potential effects on the physical / biophysical environment and land use, including areas of land to be occupied or acquired for the temporary accommodation of the workers, contractors' offices, materials storage sites, etc;
- Potential effects on human and animal populations due to noise, light, and deterioration of air quality;
- Potential effects on river flows and water quality during drilling activities;
- Potential effects of the project on poverty / poverty reduction (especially for women, youths, widows, elderly people and other vulnerable groups);
- Land acquisition and involuntary resettlement (physical and economic displacement) impacts;
- Community Health, Safety and Security risks, including:
    - Active construction and operation areas risks;
    - Road traffic;
    - Major accident hazards;
    - Community exposure to diseases;
    - Interactions between local people and non-local workers;
    - Interactions between security providers and community members;
- Risks to Workers' Health, Safety and Rights;
- Influx (unplanned in-migration) impacts;

[39] It is recognised that opportunities for enhancement are likely to be limited during exploration

- Tourism and recreational impacts (in particular on the "Bamboo Ridge" hiking base station);
- Impacts on agriculture;
- Impacts on cultural heritage;
- Positive socio-economic impacts, including potential effects on the various economic sectors;
- Identification of any other significant environmental and social impact not mentioned in this ToR.

The assessment of impacts should be quantitative where possible, and should distinguish between positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts. The likelihood, extent, duration, reversibility and significance of impacts should be described, and any residual negative impacts following implementation of mitigation measures should be identified.

Following identification and quantification of impacts, corresponding mitigation measures should be developed. As has been described above, where the full extent of likely negative impacts are not known due to the limited surveys to be undertaken, the development of mitigation measures should be done in a precautionary way. Mitigation measures should include feasible and cost-effective measures to prevent significant adverse environmental and social impacts or reduce them to acceptable levels. Each mitigation measure should be described in as much technical detail possible. The type of impact to be minimized and the conditions under which it is required should be described, along with clear objectives for mitigation methods, equipment selection and performance criteria.

Outline ESMP

A plan should be designed for the implementation of the mitigation measures and the monitoring of the project's actual impacts during exploration. This document, the Outline Environmental & Social Management Plan (ESMP) should include at least the following sections:

1. Introduction
2. Management Responsibility and Contacts
3. Project Description
4. Environmental & Social Legislation
5. Environmental & Social Management Plans
6. Environmental & Social Monitoring Plan

The "Environmental & Social Management Plans" section shall include a general management plan followed by specific plans for key areas of concern, such as waste management, health and safety and water. The main summary of mitigation measures should be in tabular format and should indicate the locations, frequencies, and responsibilities for implementation.

The Environmental & Social Monitoring Plan shall include comprehensive details on the required monitoring during exploration activities, such as determinands to be measured, locations of sampling stations, and monitoring frequencies. Also to be provided is a tabular resource/cost estimate table indicating all required manpower, equipment and materials for the required monitoring.

ESMS

The ESIA shall include the preparation of an Environmental and Social Management System (ESMS) consistent with IFC PS1. A review of the applicability of each PS shall also be undertaken.

Consultation and Disclosure

Consultations during the ESIA Phase I implementation stage will be in accordance with the following sequence: 1) soon after the beginning of ESIA work, disclosure of a copy of the latest SEP to all those who were consulted in the Scoping stage plus selected stakeholders who expressed an interest in being kept informed on the ESIA progress; and 2) on completion of identification of preliminary ESIA mitigating and enhancement measures, involving provision of information on ESIA progress and preliminary ESMP results. This is also the stage when certain impact issues are by and large clear, other issues may be more important than first thought and new impact issues may be identified that need investigation. The consultation results will be incorporated into the work programme leading to preparation of the ESIA report.

The suggested approach to the Phase I ESIA implementation consultation activities is presented in more detail in Tables 1 and 2 of the SEP.

Reporting

A full ESIA report shall be produced for the Phase 1 ESIA. The report should include the most recent information on the environmental and social baseline and on the project description and design. The ESIA report should present all the technical data, their sources or any other information used for assessing the impacts. Summary data should be presented in the main report, with detailed tables of data and survey reports presented in the appendices. The scientific reliability of the research and the predictions should be indicated, including an estimate of the degree of certainty or, if possible, the level of statistic certainty, when appropriate. The report should include a discussion of issues for follow-up during the Phase 2 ESIA.

The Phase 1 ESIA Report should include as a minimum the following main sections:

1. Non-Technical Summary
2. Introduction
3. Methodology
4. Legal, Policy and Institutional Framework
5. Project Description (Limited to Phase 1 activities/infrastructure)
6. Environmental and Social Baseline
7. Assessment of Potential Impacts & Corresponding Mitigation Measures
8. Analysis of Alternatives
9. Environmental and Social Management Plan
10. Stakeholder Engagement
11. Conclusions & Recommendations
12. Appendices (to include the study reports for areas of high concern)

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添付資料-4　プレゼンテーション資料

DATA COLLECTION SURVEY FOR GEOTHERMAL DEVELOPMENT IN SAINT VINCENT AND THE GRENADINES

INCEPTION PRESENTATION

MAY 2015
In Kingstown

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANTS;
NIPPON KOEI CO., LTD.
JMC GEOTHERMAL ENGINEERING CO., LTD
SUMIKO RESOURCE EXPLORATION AND DEVELOPMENT CO., LTD

OUR TEAM

Name	Responsible for	Firm
TAKAHASHI Shinya	Team Leader/ Geothermal Energy Development/ Reservoir Assessment	NK
AKATSUKA Takashi	Vice Team Leader/ Geology/ Drilling Planning	Geo-E
FUKUDA Daisuke	Geochemistry	Geo-E
KAWASAKI Kiyoshi	Geophysical Survey	SRED
TERAMOTO Masako	Environmental Social Consideration	NK
KIKUKAWA Takeshi	Electricity Policy/ Investment Policy	(NK)
MOMOSE Yasushi/ YOSHIDA Satoshi	Civil Engineering Planning	NK

NK: Nippon Koei Co., Ltd.

Geo-E: JMC Goethermal Engineering Co., Ltd.

SRED: Sumiko Resource Exploration and Development Co., Ltd.,

BACKGROUND: International Partnership

1. IDB and JICA entered in the agreement on "Cofinancing for Renewable Energy and Energy Efficiency (CORE scheme)" in 2013.

2. IDB, JICA and CDB entered in the Memorandum aiming at building a new partnership to promote Renewable Energy and Energy Efficiency in Eastern Caribbean Region in 2014,

BACKGROUND: Project Identification by JICA

1. JICA conducted a preliminary survey in 12 CARICOM countries to identify projects regarding renewable energy and energy conservation in 2014;

2. Saint Vincent and the Grenadines has been identified as one of the potential countries for geothermal development.

OBJECTIVES

1. To collect and review existing data and information regarding geothermal development;
2. To conduct field surface survey if necessary;
3. Thereby, to identify geothermal development project/s which JICA could extend its assistance through the international partnership;

➔ Based on the above, another JICA Survey may be implemented to formulate specific cooperation programs for geothermal development.

PRESENT SITUATIONS - OUR UNDERSTANDINGS

1. A consortium of private firms, Emera Inc. and Reykjavik Geothermal Ltd., have already conducted surface survey including geophysical survey;
2. The surveys are said to be sufficient for the initial phase before test well drilling;
3. The consortium is preparing a business plan that is to be delivered in June 2015;
   Implementation framework (i.e. implementation organization, financial arrangement and etc) is yet to be decided;
4. A concessional loan (USD 15 mil) from IRENA to the Government has been approved;

OUR ACTIVITIES (for 1st visit)

1. To collect relevant data and information; a questionnaire has already been sent to the Energy Unit;
   The information includes the business plan to be delivered by the private consortium;
2. To conduct field survey if judged necessary and approved;
3. To discuss implementation framework, financial arrangement and others as necessary for geothermal development;
4. To have a wrap up meeting on 22nd May 2015.

Schedule for the 1st Visit

May, 2015		Team Leader	Development /Investment	Geology/ Drilling	Geo-chemist	Environment	Geo-physics	Coordination	Civil Eng.
16	Sat	Arriving							
17	Sun	Preparation							
18	Mon	Kick-off meeting							
19	Tue	Discussions with relevant organization							Arr.
20	Wed	Data Collection							
21	Thu	Data Collection							
22	Fri	Wrap-up Meeting							
23	Sat	Data review and evaluation							
24	Sun	Moving		Site survey			Leaving St. Vincent		
25	Mon	JICA in Dominican Rep.		Site survey					
26	Tue	Moving		Evaluation					
27	Wed	IDB in US		Summarizing					
28	Thu	Leaving St. Vincent		Reporting					
29	Fri			Leaving St. Vincent					

Surveys to be conducted for the 2nd visit, if judged necessary

1. Analysis of remote sensing data,
2. Geological field survey and laboratory analysis,
3. Geochemical field survey and laboratory analysis,
4. Geophysical field survey and/or 2-D inversion analysis,
5. Scoping for Environmental and Social Impact Assessment (ESIA), Gap analysis of guidelines for ESIA,
6. Survey and analysis on electricity policy and investment policy,
7. Others as necessary

Overall schedule

No.	Position	Name	2015										2016		
			3	4	5	6	7	8	9	10	11	12	1	2	3
1	Team Leader/Geothermal Development Plan/Reservoir	Shinya TAKAHASHI			■	■	■	■	■	■	■	■		■	
2	Sub-Team Leader/Geology/Drilling Engineer	Takashi AKATSUKA			■	■	■	■	■	■	■	■		■	
3	Geochemistry	Daisuke FUKUDA			■	■	■	■	■	■	■	■			
4	Geophysics	Kiyoshi KAWASAKI			■	■	■	■	■	■	■	■			
5	Environmental and Social Considerations Evaluation	Masako TERAMOTO			■	■	■	■	■	■	■	■			
6	Energy Policy Analysis/Project Finance Policy Analysis	Takeshi KIKUKAWA			■	■	■	■	■	■	■	■		■	
7	Civil Engineering Planning	Yasushi MOMOSE/ Satoshi YOSHIDA			■	■	■	■	■	■	■	■			
Report				△ IC/R			△ PR							△ DF/R	△ F/R

*Intermittent: Detailed survey plan will be made after the discussion.
IC/R: Inception Report, P/R: Progress Report, DF/R: Draft Final Report, F/R: Final Report

Deliverables

1. Inception Report: May, 2015
2. Progress Report: August 2015
3. Draft Final Report: February 2016
4. Final Report: March 2016

Remarks

- This JICA survey will be conducted in close communication with IDB and CDB, for possible cooperation in geothermal energy development in St. Vincent.

DATA COLLECTION SURVEY FOR GEOTHERMAL DEVELOPMENT IN SAINT VINCENT AND THE GRENADINES

We appreciate
your understanding and cooperation

Thank you
Arigatou

DATA COLLECTION SURVEY FOR
GEOTHERMAL DEVELOPMENT

Financial Aspect in Geothermal Development

St. VINCENT and the GRENADINES

MAY 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CONSULTANTS;
NIPPON KOEI CO., LTD.
JMC GEOTHERMAL ENGINEERING CO., LTD
SUMIKO RESOURCE EXPLORATION AND DEVELOPMENT CO., LTD

Today's Presentation

Part-I: Overview of Geothermal Project Risk

Part-II: Finance Options for Geothermal Development

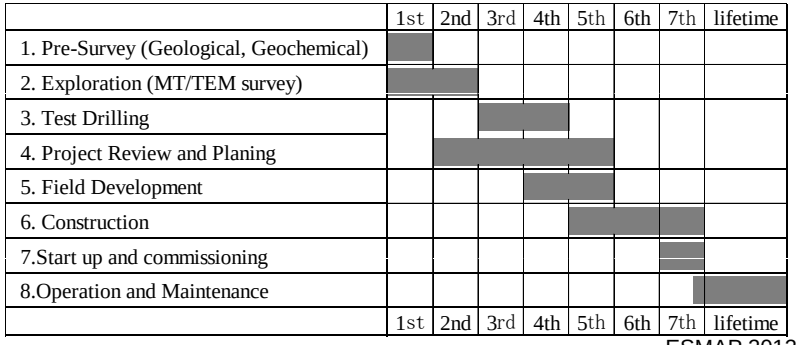
PART-I

- Overview of Geothermal Project Risk

1. Geothermal Project Development Schedule
2. Geothermal Project Risk Identification
3. Project stage and Project Risks
4. Experiences in the World

Geothermal Project Development

(for a Unit of Approximately 50 MW)



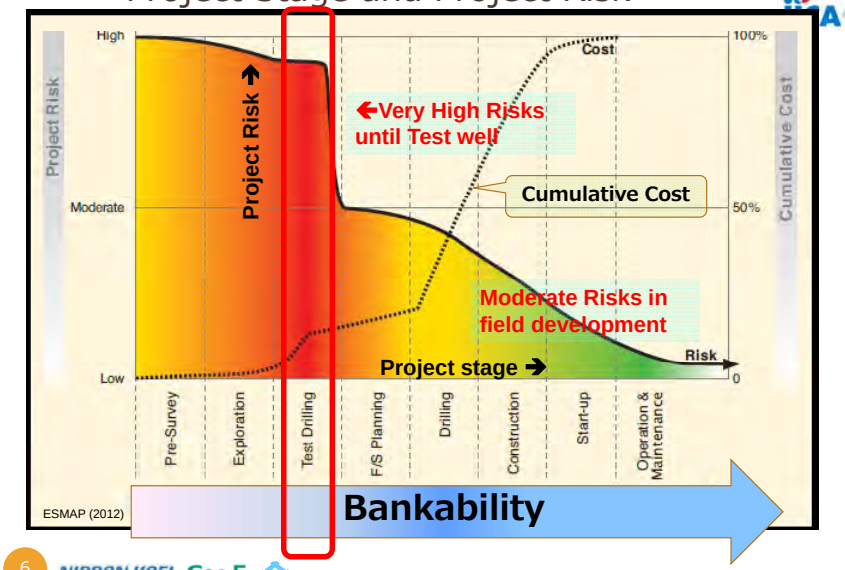
ESMAP 2012

It needs approximately six years to a start up and commissioning.

Geothermal Project Risk Identification

1. **Financing Risks**, due to a High Upfront Cost and a Long Lead Time
2. Resource or Exploration Risks
3. Completion or Delay Risks (due to difficult geology)
4. Risk of Over-sizing the Power Plant (due to resource over estimation),
5. Operation Risks (due to steam field operation and maintenance)
6. Off-take Risk and Price Risk
7. Regulatory Risk

Project Stage and Project Risk



Experiences in the World

Project stages

	1 Preliminary Survey	2 Surface Exploration	3 Test Drilling, F/S	4 Field Development	5 Power Plant Construction	6 O&M	Note
	Early Stage			Middle Stage	Late Stage		
1	A Fully integrated single national public entity						Public Entities: Kenya (Olkaria), Costa Rica, Indonesia (before), NZ
2	Multi national public entities (Early stage by one entity and subsequent stage by other/s for an example)						
2'	Public entity (CFE)				Private Contractor	CFE	Mexico (OPF model)
3	National and municipal public entities						Iceland (before)
4	Fully integrated JV partially owned by the government						El Salvador (LaGeo + Enel Green Power), Japan(recent)
5	Public entities			Private Developers			Japan (before)
5'	Public entity (PNOC EDC)				Private Developer	NPC	Philippines BOT model;
5"	Public entities (GDC in Kenya, Purutamina in Indonesia)				Public entities (Steam production)		Kenya (KenGen + GDC), Indonesia (before), Philippines (before)
					Private Developers (power generation)		
6	Public entities			Private Developers			US, Turkey, NZ, Guatemala, others
7	Public entities		Private Developers				US, Nicaragua, new Chile
8	Private Developers						Private Developers: New Philippines, New Indonesia, Italy, others

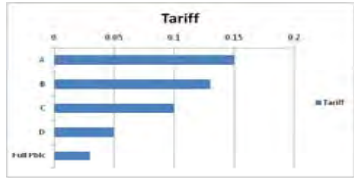
ICE: Instituto Costarricense de Electricidad, Costa Rica; CFE: Federal Commission for Energy, Mexico; PNOC EDC: Philippines National Oil Co.,-Energy Development Corporation, Philippines; NPC: National Power Corporation, Philippines; GDC: Geothermal Development Company, Kenya;

(Original Source: ESMAP 2012, modified by JICA Team)

Business model & Tariff Level (an example)

Business Model	Preliminary Survey	Exploration	Test drilling	F/S & planning	Field development	Plant construction	Operation: Field	Operation: Plant	Tariff ($/kWh)	Remarks
A	Public	Private							0.15	
B	Public		Private						0.13	
C	Public			Private					0.10	
D	Public				Private		Public	Private	0.05	
Full Public	Public								0.03	

(Source: JICA Team)



PART-II

Financial Options for Geothermal Development

1. Options for Financial Arrangement
2. Capital Structure vs. Success of Project
3. JICA Projects
   in Indonesia, in Bolivia, in Costa Rica
4. IDB Facility for Geothermal Development
5. Loan Guarantee by IFC
6. Geothermal Development Facility (GDF)

Options for Financial Arrangement

Arrangement for Implementing Organization -Options from viewpoints of financial arrangement-

Possible Options	Development Stage					
	Preliminary Survey	Surface Exploration	Test Drilling	Field Development	Power Plant Construction	O&M
Option-1	VINLEC	VINLEC	VINLEC	PPP (RG)	PPP (RG)	PPP (RG)
Option-2	VINLEC	VINLEC	VINLEC	VINLEC	PPP (RG)	PPP (RG)
Option-3	VINLEC	VINLEC	VINLEC	VINLEC	VINLEC	PPP (RG)
Option-4	VINLEC	VINLEC	VINLEC	VINLEC	VINLEC	VINLEC

note) PPP: Public Private Partnership

Possible Financing Sources for Development

Possible Financing Sources	Development Stage					
	Preliminary Survey	Surface Exploration	Test Drilling	Field Development	Power Plant Construction	O&M
Government Budget	N/A (already arranged)			TBC	TBC	TBC
Guarantee Scheme (ex. IDB Facility)				✓	TBC	TBC
Concessional Loan (e.g. ODA)				✓	✓	✓
Commercial Loan				TBC	✓	✓

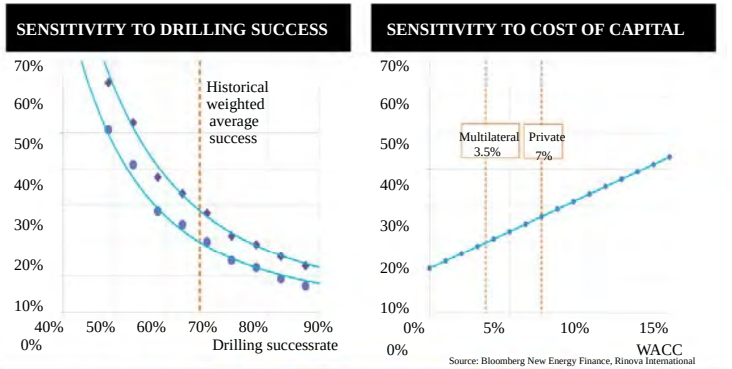
Risk Management and Financial Facility

	Iceland	Indonesia	Japan	Mexico	New Zealand	Philippines	Turkey	USA
Drilling Failure Insurance							X	
Government-led Exploration	X	X	X	X	X	X	X	
Cooperative Agreements								X
Grants	X		X					
Lending Support Mechanism		X						X
Loan Guarantees								X

Source) Geothermal Development Workshop, IFC (2014)

Capital Structure vs. Success of Project

INTEREST RATES CHARGED TO SUCCESSFUL PROJECTS



Source) Bloomberg New Energy Finance

JICA Project in Indonesia

Engineering Services for Kamojang Geothermal Power Plant Extension Project

1. Overview

The Project aims to develop the geothermal power plant (60MW). The loan is allocated for the engineering services for design and the test drilling.

2. Loan

Amount;	JPY 995 mil.
Interest Rate;	1.5%
Amortization;	30 years
Grace Period;	10 years

3. Implementing Agency

PT PLN (Persero) (state-owned power utility)

JICA Project in Bolivia

Laguna Colorada Geothermal Power Plant Project (1st Phase)

1. Overview

The Project aims to develop the geothermal power plant (50MW), the transmission line and the substation . The loan is allocated for the engineering services for design and the field development.

2. Loan

Amount;	JPY 2,495 mil.
Interest Rate;	Main Work 0.65%, Engineering Services; 0.01%
Amortization;	40 years
Grace Period;	10 years

3. Implementing Agency

Empresa Nacional de Electricidad (state-owned power utility)

JICA Project In Costa Rica

Guana Caste Geothermal Development Sector Loan

1. Overview

The Project aims to develop the multiple geothermal power plants. The loan is allocated for the engineering services for design, the field development, and the civil works for power plants.

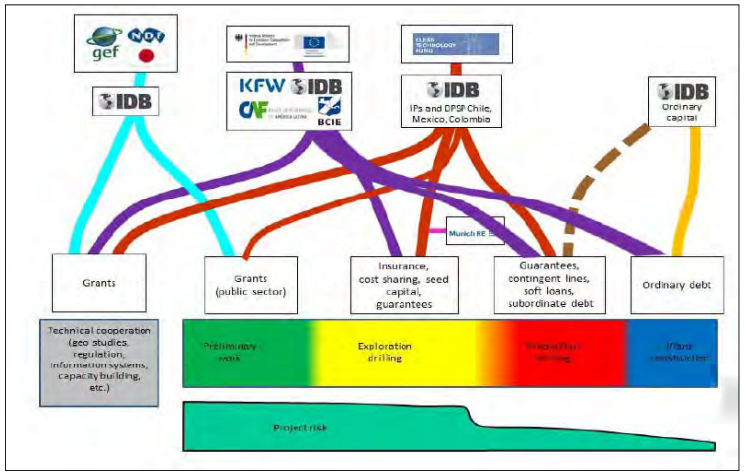
2. Loan

Amount;	JPY 16,810 mil.
Interest Rate;	Main Work 0.60%, Engineering Services; 0.01%
Amortization;	40 years
Grace Period;	10 years

3. Implementing Agency

Instituto Costarricense de Electricidad (state-owned power utility)

IDB Facility for Geothermal Development



Source) IDB Web Data

IDB Facility for Geothermal Development

1. Grants to finance technical assistance
   (e.g. Prefeasibility studies, such as surface studies, hydro-chemical and hydrogeological studies, electromagnetic studies, modeling , Design of Public Private Partnership (PPP) schemes)
2. Direct loans to governments of the Region
   (for developing geothermal projects, through public utilities or private players)
3. Corporate or project finance to private developers
   (For projects in advanced phases, IDB can provide a range of financial instruments for late stage exploration, production wells and cost overruns.)
4. Lines of credit to development banks to provide geothermal financing to developers
   (During each and every stage of a geothermal project, the IDB facilitates the provision of structured finance tailored to each project, seeking to provide flexible financing terms aligned to the expected cash flow of the project.)
5. Access to international concessional finance
   (Opportunity to offer risk mitigation instruments such as loans convertible to grants, insured loans, cost-sharing schemes for the early exploration phase, loan guarantees, or insurance premiums.)

Loan Guarantee by IFC

<Overview>

- National government underwrites loan taken on by developer
- Allows developer to access debt
- Government repays to bank in case of failure
- Developer pays fee for guarantee
- Impact on tariff

<Pros>

- Simple to structure/ administer through national development bank
- Project risk lower
- Can be a self-sustained fund

<Cons>

- Impact on government balance sheet
- Possible limits for guarantee

Geothermal Development Facility (GDF)

The GDF constitutes the first multi-donor initiative to promote geothermal energy on a continental scale. It will provide at least USD 75 million in grant-based risk mitigation instruments and USD 1 billion in tailored financing to geothermal projects in a range of Latin American countries

- The GDF seeks to incentivize at least 350 MW of geothermal generation capacity.
- Under the Risk Mitigation Fund public and private developers will be able to apply from early 2016 onwards for a Contingency Grant that will cover up to 40% of the cost of up to three early exploration wells.
- Grants received will only have to be repaid in case of a successful exploration.
- Developers will further be able to refinance grant repayments through the provided Bridge and Investment Financing Lines for geothermal power plants.

DATA COLLECTION SURVEY FOR GEOTHERMAL DEVELOPMENT IN

Thank you
Arigatou

Project risk and Mitigation

添付資料-5　収集資料リスト

Appendix-5 Collected Data/収集資料

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添付資料-6　容積法計算式

Improvement of Calculating Formulas for Volumetric Resource Assessment

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ABSTRACT

The USGS volumetric method is used for assessing the electrical capacity of a geothermal reservoir. The calculation formulas include both underground related parameters and above-ground related parameters. While primary variability and uncertainty in this method lay in the underground related parameters, electric capacity calculated is also a function of the above-ground related parameters. Among those parameters, the fluid temperature of the reservoir will be the key parameter for the volumetric method calculation when used with Monte Carlo method, because this temperature is the variable (uncertain) underground related parameter which affects the steam-liquid separation process in the separator - an above-ground related parameter. Conventional calculation methods do not deal with the steam-liquid separation process being affected by fluid temperature as a random variable when used together with Monte Carlo method. In order to fix up this issue, we have derived calculation formulas by introducing "Available Exergy Function", thereby, the fluid-temperature-dependant separation process can be included in the equations together with the fluid temperature as a random variable. This paper presents the electricity capacity calculations formulas that can be used for the volumetric method together with Monte Carlo method. In addition, a comparison is also made between the proposed method and the USGS method. The theoretical background of the proposed formula has eventually proved to be as same as USGS method except for a few parameters adopted.

Keywords: triple point temperature; single flash power plant; steam-liquid separation process at separator; available exergy function; adiabatic heat drop at turbine

1. INTRODUCTION - ISSUES OF THE CALCULATION METHODS BEING AVAILABLE

The USGS (1978) defines the reservoir thermal energy available under a reference temperature by the following equation.

$$q_r = \rho C V (T_r - T_{ref}) \quad \text{[kJ]} \quad \text{(Eq. 1)}$$

Where q_r is geothermal energy that is stored in geothermal reservoir and is able to be used under reference temperature conditions, ρC is volumetric specific heat, V is reservoir volume, T_r is reservoir temperature and T_{ref} is reference temperature. It describes that the reference temperature (15 ℃) is the mean annual surface temperature and for simplicity is assumed to be constant for the entire United States. A set of calculation equations are presented, on the basis of the second law of thermodynamics, to estimate electric energy to be converted from geothermal energy available under the reference temperature. Parameters required for the calculation of the electric generation capacity by using the USGS method are summarized below.

Table 1 Classification of Parameters for USGS Method (1978)

A. Underground related parameters	**B.** Above-ground related parameters
a-1. Reservoir volume: V [m^3]	b-1. Reference temperature: T_{ref} [℃]
a-2. Reservoir temperature: T_r [℃]	b-2. Utilization factor: η_u[-]
a-3. Volumetric specific heat: ρC [kJ/m^3 − K]	b-3. Plant life: L [sec]
a-4. Recovery factor: R_g [-]	b-4. Plant factor: F [-]

While primary variability and uncertainty in this method lay in the underground related parameters, considerations have also been directed to above-ground related parameters. The USGS method defines 'utilization factor' to convert heat energy to electric energy, giving 0.4 (USGS 1978). It was updated to 0.45 by USGS (2008). USGS (1978) states the given utilization factor is applicable only for the case that the reference temperature is 15 ℃ (the average ambient temperature in the United State) and the condenser temperature is 40 ℃. On the other hand, S. K. Garg and J. Combs (2011) pointed out that the utilization factor depends on both power cycle and the reference temperature; the available work (calculated electric energy) is a strong function of the reference temperature. This suggests that type of power cycle has to be defined to obtain valid results when practicing the volumetric method.

We consider here a single flash condensing power cycle as a typical plant. Electric energy to be generated is calculated by well established calculation processes for turbine-separator-condenser performance in accordance to thermodynamics; the electric energy generated is principally dependent on fluid temperature sent to separator together with separator temperature and condenser temperature; a set of each fixed temperature may be given into the calculation process. However, these conventional calculation methods are not applicable when practicing the volumetric method together with Monte Carlo method because the fluid temperature shall be dealt as a random variable due to its uncertainty and the steam-liquid separation process is a fluid-temperature-dependant process. Calculation equations for the volumetric method need to satisfy those two requirements when used with Monte Carlo method. In order to provide this issue with a solution, we have derived calculation formulas by introducing "Available Exergy Function", thereby, fluid-temperature-dependant separation process can be included in a equation together with the fluid temperature as a random variable for the use with Monte Carlo method.

With the concept above, Takahashi and Yoshida (2015 a, 2015 b) proposed a simplified calculation formula, assuming a single flash condensing power cycle of the separator temperature 151.8 ℃ and condenser temperature 40 ℃; the formula includes fluid temperature as a random variable and the function that reflects the fluid-temperature-dependant steam-liquid separation process;

that can be used with Monte Carlo method. We herein refined the proposed method and expand its application to various combinations of separator and condenser temperatures assuming a single flash condensing power cycle.

Discussions on other important subjects of the underground related parameters are out of the scope of this paper. We believe the proposed equations will provide clearer ideas on the reservoir potential once the underground related parameters are properly defined.

2. SUMMARY OF THE PROPOSED CALCULATION EQUATIONS

The key points of the proposal are described below. A detailed explanation on how the equations have been derived are presented in Chapter 3 for verifications by readers.

1. We placed the "triple point temperature" in the equation-2 for the place of the reference temperature of the equation-1 of USGS (1978). The equation-2 represents the heat energy potentially stored in the geothermal reservoir, whereas the equation-1 defines the heat energy available in the reference temperature condition out of the heat energy potentially stored in a geothermal reservoir. This is because the fluid recovered at well head is sent to the power plant before exposed to any of reference conditions.

2. We adopted the concept of the "exergy" at a single flash condensing cycle by the equation-5 or -6 (adiabatic heat drop) in accordance to thermodynamics. This equation is eventually proved to be the same as the one given by USGS (1978) as the "Available Work" (Chapter-11).

3. We defined the "Available Exergy Function" by the equation-7. This represents the ratio of the exergy at a turbine-generation system against the total heat energy recovered at well head. Inclusion of the function in the calculation formula is the key idea of this paper.

4. By using the Available Exergy Function, the electricity to be generated is given by the equation-10. "Exergy efficiency", instead of "utilization factor", is included in the equation to tie up with the "exergy" adopted. This is the base equation from which approximation equations for application are derived.

5. For the separator temperature of 151.8 ℃ and the condenser temperature of 40 ℃ as an example; an approximation of the Available Exergy Function is given first as cubic polynomial as in the equation-21; this polynomial approximation is further simplified by the equation-23 for practical uses; Exergy efficiency is approximated in the equation-25, -26 based on 189 actual performance data; Electricity to be generated is given by the equation-27.

6. A comparison with USGS method is discussed in Chapter 8 and Chapter 11 for further reference. A discussion on the utilization factor defined by USGS is also given in Chapter-11

2.1 Application

We will first present the sets of equations in Table-2. Thereafter, the explanation is given on how those equations have been derived.

2.1.1 Underground Related Conditions

The underground related parameters listed in Table 1 shall be determined first. We referred to the USGS method (1978) for the definitions and applications of those parameters. For the proposed calculation method, those parameters can be random variables for Monte Carlo method as has been practiced in the past. Much attention and examination shall be directed to the determination of those parameters because primary variability and uncertainty lay in the underground related parameters. Discussions on how to determine those parameters are out of scope of this paper.

2.1.2 Geothermal Fluid Conditions for the Proposed Method

We assume the geothermal fluid is the single phase liquid conditions in the reservoir. This is because "a fluid that is all liquid has a smaller entropy value than a two phase fluid with same enthalpy; thus, the available work (exergy) value assuming liquid water is greater than any two-phase mixture of the same enthalpy and is an appropriate reference condition" (USGS 1978). The enthalpy of the fluid in the reservoir usually decreases when it comes up to the wellhead due to the partial or entire flashing, frictions, gravitational forces and/or others. We, however, assume the fluid enthalpy available at the wellhead should correspond to the enthalpy of the single phase liquid in the reservoir. The loss of enthalpy while the fluid comes up to the well head could be included in the recovery factor when practicing the volumetric method.

2.1.3 Above-Ground Conditions for the Proposed Method

A single flash condensing system is assumed, where separator temperature and condenser temperature shall be pre-determined. The combination of separator temperature and the condenser temperature will be the index for selection of the simplified calculation equation presented in Table 2. Discussions on how to determine the separator temperature and the condenser temperature in relation to geothermal fluid characteristics are out of the scope of this paper. The following presentation however may be helpful.

Figure 1 shows the relative power output to be generated by a power plant with the separator pressures ranging from 2 bar-a to 10 bar-a, with two cases of condenser temperatures of T_{cd} =40℃ or T_{cd} =50℃, for the geothermal fluid temperature raging from 200 ℃ to 350 ℃, (assuming $R_g \rho CV$=1 for the calculations of relative outputs). Power output may be maximum when the separator pressure of 5 or 6 bar-a for the fluid temperature of 250 ℃ - 275 ℃. These separator pressures may be recommended for an initial stage of resource evaluation if other conditions should allow to do so. Note that power output will be about 88 % when condenser temperature increases from 40 ℃ to 50 ℃ with the separator pressure of 5 bar-a just for a reference.

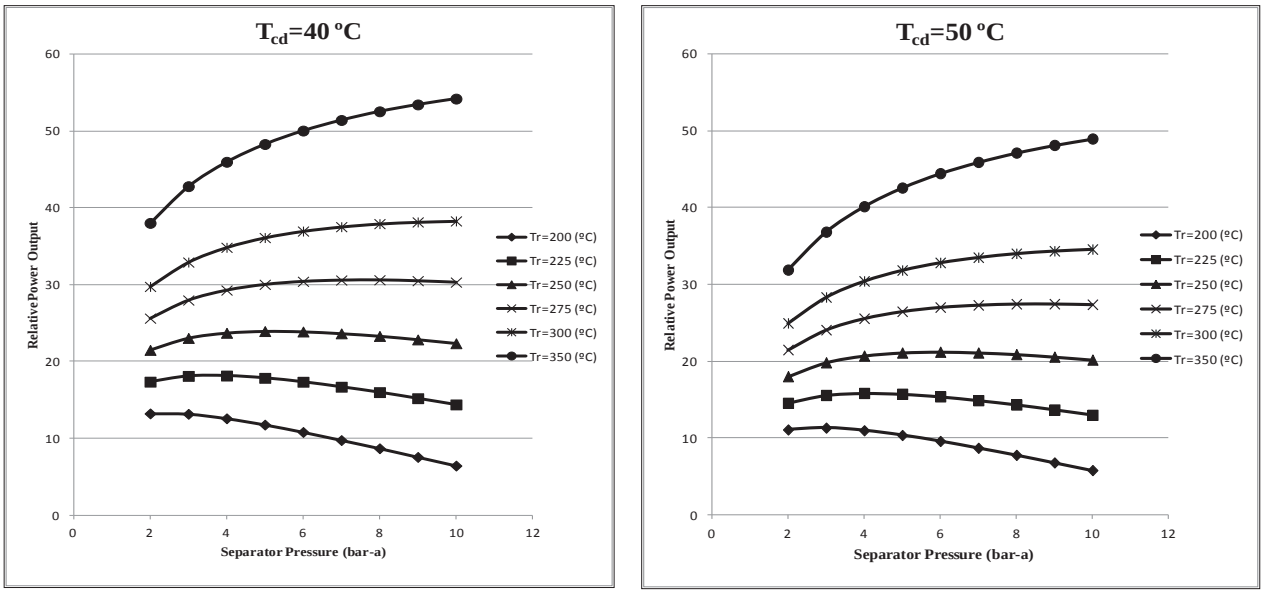

Figure 1 Relative Power Output for Various T_{sp} with T_{cd} =40 ℃ (Left) or T_{cd} =50 ℃ (Right)

2.1.4 A Note on "Reference Temperature" and "Utilization Factor"

For the proposed calculation method, we do not use such generalized temperature names as "reference temperature", "abandonment temperature" or "rejection temperature". Instead, specified temperatures as "triple point temperature", "separator temperature" and "condenser temperature" are used to avoid possible misunderstandings. We do not use 'utilization factor' either, because it is originally defined for the use exclusively in the United State. It is a rather region specific factor. Instead of the "utilization factor", we use plant specific "exergy efficiency" (defined by Equation-24) together with plant specific "exergy" (defined by Equation-5 or -6) at a turbine-generator. A brief observation on the "utilization factor" is given in Chapter 11.1 of this paper for further observation.

2.2 Calculation Equations

The sets of the calculation equations are presented in Table-2. Abbreviations appeared in the table are shown below.

E : Electric energy $[kJ]$
R_g : Recovery factor [-]
V : Reservoir volume$[m^3]$
T_r : Average reservoir temperature [℃]
$\rho C = (1-\varphi)C_r\rho_r + \varphi C_f\rho_f$: Reservoir volumetric specific heat [kJ/m^3 − K]
φ : Porosity [-]
C_r : Specific heat of rock $[kJ/kg]$
ρ_r : Rock density $[kg/m^3]$
C_f: Specific heat of fluid $[kJ/kg]$
ρ_f: Fluid density $[kg/m^3]$

A calculation equation is uniquely given by selecting a combination of the temperatures of the separator and the condenser. Numerical constants in the equations in Table-2 shall not be modified or changed in any case. These are the products from a series of approximation processes. Coefficients of the turbine-generator efficiency are included in the numerical terms in the equations based on information of actual power plants all over the world.

The average output capacity of the power plant in a designed plant life period is given as follows.

$$W_e = \mathrm{E}/(\mathrm{FL}) \qquad [kJ] \text{ or } [kW]$$

Where; "We" is the average output capacity of the power plant, "F" is the plant utilization factor, "L" is the plant life period (sec).

132 **Table 2 Proposed Calculation Equations for Volumetric Method**

Eq.-ID	Conditions				Electric Energy (kJ) Linear Approximation
	Separator		Condenser		
	P (bar-a)	T (℃)	P (bar-a)	T(℃)	
230	2	120.2	0.04	30	(0.19 ± 0.01) * $R_g\rho CV$ *(T_r - 120.2)
240	2	120.2	0.07	40	(0.17 ± 0.01) * $R_g\rho CV$ *(T_r - 120.2)
250	2	120.2	0.12	50	(0.14 ± 0.01) * $R_g\rho CV$ *(T_r - 120.2)
260	2	120.2	0.20	60	(0.11 ± 0.01) * $R_g\rho CV$ *(T_r - 120.2)
370	2	120.2	0.31	70	(0.09 ± 0.01) * $R_g\rho CV$ *(T_r - 120.2)
330	3	133.5	0.04	30	(0.23 ± 0.01) * $R_g\rho CV$ *(T_r - 133.5)
340	3	133.5	0.07	40	(0.20 ± 0.01) * $R_g\rho CV$ *(T_r - 133.5)
350	3	133.5	0.12	50	(0.17 ± 0.01) * $R_g\rho CV$ *(T_r - 133.5)
360	3	133.5	0.20	60	(0.14 ± 0.01) * $R_g\rho CV$ *(T_r - 133.5)
370	3	133.5	0.31	70	(0.12 ± 0.01) * $R_g\rho CV$ *(T_r - 133.5)
430	4	143.6	0.04	30	(0.25 ± 0.02) * $R_g\rho CV$ *(T_r - 143.6)
440	4	143.6	0.07	40	(0.22 ± 0.01) * $R_g\rho CV$ *(T_r - 143.6)
450	4	143.6	0.12	50	(0.19 ± 0.01) * $R_g\rho CV$ *(T_r - 143.6)
460	4	143.6	0.20	60	(0.17 ± 0.01) * $R_g\rho CV$ *(T_r - 143.6)
470	4	143.6	0.31	70	(0.14 ± 0.01) * $R_g\rho CV$ *(T_r - 143.6)
530	5	151.8	0.04	30	(0.27 ± 0.02) * $R_g\rho CV$ *(T_r - 151.8)
540	5	151.8	0.07	40	(0.24 ± 0.02) * $R_g\rho CV$ *(T_r - 151.8)
550	5	151.8	0.12	50	(0.21 ± 0.01) * $R_g\rho CV$ *(T_r - 151.8)
560	5	151.8	0.20	60	(0.19 ± 0.01) * $R_g\rho CV$ *(T_r - 151.8)
570	5	151.8	0.31	70	(0.16 ± 0.01) * $R_g\rho CV$ *(T_r - 151.8)
630	6	158.8	0.04	30	(0.29 ± 0.02) * $R_g\rho CV$ *(T_r - 158.8)
640	6	158.8	0.07	40	(0.26 ± 0.02) * $R_g\rho CV$ *(T_r - 158.8)
650	6	158.8	0.12	50	(0.23 ± 0.02) * $R_g\rho CV$ *(T_r - 158.8)
660	6	158.8	0.20	60	(0.20 ± 0.01) * $R_g\rho CV$ *(T_r - 158.8)
670	6	158.8	0.31	70	(0.18 ± 0.01) * $R_g\rho CV$ *(T_r - 158.8)
730	7	165.0	0.04	30	(0.31 ± 0.02) * $R_g\rho CV$ *(T_r - 165.0)
740	7	165.0	0.07	40	(0.28 ± 0.02) * $R_g\rho CV$ *(T_r - 165.0)
750	7	165.0	0.12	50	(0.25 ± 0.02) * $R_g\rho CV$ *(T_r - 165.0)
760	7	165.0	0.20	60	(0.22 ± 0.01) * $R_g\rho CV$ *(T_r - 165.0)
770	7	165.0	0.31	70	(0.19 ± 0.01) * $R_g\rho CV$ *(T_r - 165.0)
830	8	170.4	0.04	30	(0.32 ± 0.02) * $R_g\rho CV$ *(T_r - 170.4)
840	8	170.4	0.07	40	(0.29 ± 0.02) * $R_g\rho CV$ *(T_r - 170.4)
850	8	170.4	0.12	50	(0.26 ± 0.02) * $R_g\rho CV$ *(T_r - 170.4)
860	8	170.4	0.20	60	(0.23 ± 0.02) * $R_g\rho CV$ *(T_r - 170.4)
870	8	170.4	0.31	70	(0.21 ± 0.01) * $R_g\rho CV$ *(T_r - 170.4)
930	9	175.4	0.04	30	(0.34 ± 0.02) * $R_g\rho CV$ *(T_r - 175.4)
940	9	175.4	0.07	40	(0.31 ± 0.02) * $R_g\rho CV$ *(T_r - 175.4)
950	9	175.4	0.12	50	(0.28 ± 0.02) * $R_g\rho CV$ *(T_r - 175.4)
960	9	175.4	0.20	60	(0.25 ± 0.02) * $R_g\rho CV$ *(T_r - 175.4)
970	9	175.4	0.31	70	(0.22 ± 0.01) * $R_g\rho CV$ *(T_r - 175.4)
1030	10	179.9	0.04	30	(0.35 ± 0.02) * $R_g\rho CV$ *(T_r - 179.9)
1040	10	179.9	0.07	40	(0.32 ± 0.02) * $R_g\rho CV$ *(T_r - 179.9)
1050	10	179.9	0.12	50	(0.29 ± 0.02) * $R_g\rho CV$ *(T_r - 179.9)
1060	10	179.9	0.20	60	(0.26 ± 0.02) * $R_g\rho CV$ *(T_r - 179.9)
1070	10	179.9	0.31	70	(0.23 ± 0.01) * $R_g\rho CV$ *(T_r - 179.9)

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3. DERIVING THE PROPOSED EQUATIONS

We will describe hereunder how the proposed calculation equations have been derived. The key abbreviations used correspond to those in Figure 2.

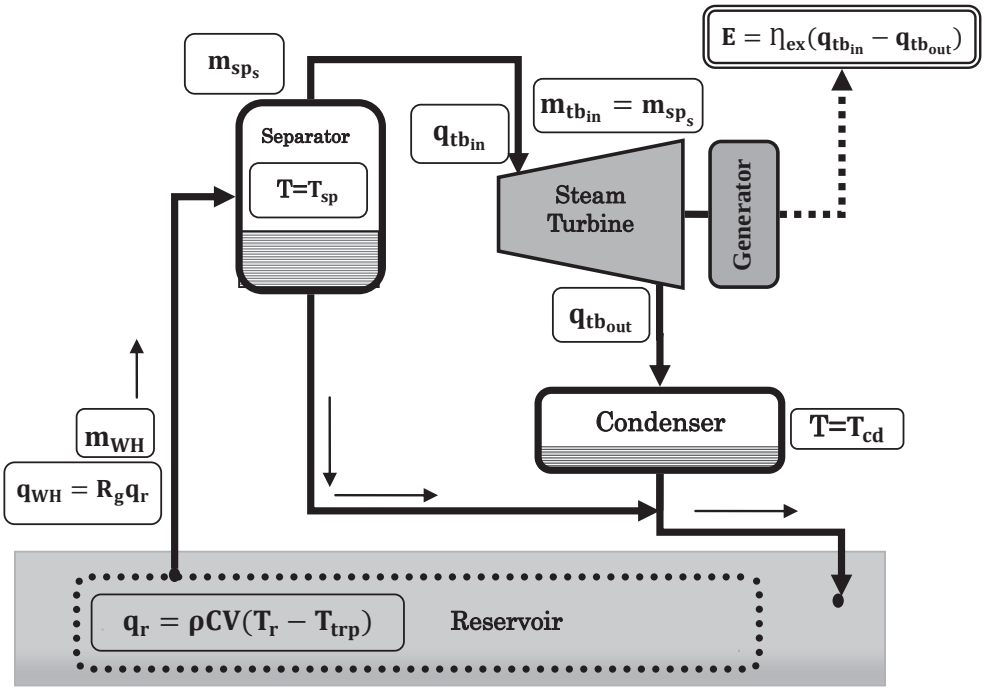

Figure 2 Simplified Single Flash Power Plant Schematic.

3.1 Thermal Energy Potentially Stored in Geothermal Reservoir

The thermal energy potentially stored in a geothermal reservoir is given as follows.

$$q_r = \rho CV(T_r - T_{trp}) \quad \text{[kJ]} \quad \text{(Eq. 2)}$$

Where T_{trp} is triple point temperature (T_{trp}=0.01℃ for pure water).

Note that we placed T_{trp} (triple point temperature) in the equation Eq. 2 for the position of T_{ref} (reference temperature) of the equation Eq. 1 given by USGS (1978). The equation-2 represents the heat energy potentially stored in the geothermal reservoir, whereas the equation-1 defines the heat energy available in the reference temperature condition out of the heat energy potentially stored in a geothermal reservoir. The process of utilization of the geothermal fluid stored in a reservoir is made through three steps; (i) First, the geothermal fluid having the heat energy potentially stored in the reservoir is recovered at the well head (with recovery factor to be considered. See section 3.2); (ii) Second, the recovered fluid is sent into a energy utilization system before exposed to any of ambient conditions; (iii) Third, the heat energy, after utilized, decreases down to the final state condition. The equation Eq. 1 represents the heat energy made available through these three steps. Here, we consider the heat energy of the geothermal fluid at the first step only, where the fluid is not yet exposed to any of reference conditions such as the ambient temperature; the geothermal fluid retains potentially available heat energy at this step. In accordance to thermodynamics, potentially available heat energy of geothermal fluid of temperature T_r ℃ is given by the equation Eq. 2 using the triple point temperature. The triple point temperature is the extreme minimum temperature for the reference temperature in thermodynamic. The potentially available heat energy is sent into the geothermal power plant.

3.2 Thermal Energy in the Reservoir, Recovery Factor

Since not all heat energy is recovered, the recovery factor is defined by USGS (1978) as follows.

$$R_g = q_{WH}/q_r \quad \text{[-]} \quad \text{(Eq. 3)}$$

Where R_g is the recovery factor, and q_{WH} is the heat energy recovered at the well head.

From the equations Eq. 2 and Eq. 3, the heat energy recovered at the well head is expressed by the following equation.

$$q_{WH} = R_g \rho CV(T_r - T_{trp}) \quad \text{[kJ]} \quad \text{(Eq. 4)}$$

This recovered heat energy is sent into separator through a adiabatic treated fluid transport pipe system without losing its energy to the ambient.

3.3 Electric Power Output from Turbine-generator

Electric power output generated by a steam turbine-generator system is expressed by the following equation using "adiabatic heat drop" between the heats at the turbine entrance and at the turbine exit (DiPippo 2008 or Hirata, et al 2008 or other references on thermodynamics).

$$E = \eta_{ex}\, m_{tb_{in}}(h_{tb_{in}} - h_{tb_{out}}) \quad \text{[kJ]} \quad \textbf{(Eq. 5)}$$

or

$$E = \eta_{ex}(q_{tb_{in}} - q_{tb_{out}}) \quad \text{[kJ]} \quad \textbf{(Eq. 6)}$$

Where η_{ex} is the turbine-generator efficiency (exergy efficiency), $m_{tb_{in}}$ is the mass of the steam at turbine entrance, $h_{tb_{in}}$ is the specific enthalpy at the turbine entrance, $h_{tb_{out}}$ is the specific enthalpy at the turbine exit, $q_{tb_{in}}$ is the thermal energy of the turbine entrance, $q_{tb_{out}}$ is the thermal energy of the turbine exit.

Note that the $h_{tb_{out}}$ is the heat energy at turbine exit under the condition when the heat at turbine entrance and heat at condenser (final state) are given, the explanation for this will be given in section 4.2.2; that the η_{ex} defined as the turbine-generator efficiency (exergy efficiency) is different from the 'utilization factor' defined by the USGS (1978). Also note that E defined by Eq. 5 is eventually proved to be the exergy energy (Available work) defined by USGS (1978) in Section 11 of the paper.

3.4 Definition of Available Exergy Function

We herein define the following equation. We name it "Available Exergy Function"

$$\zeta = (q_{tb_{in}} - q_{tb_{out}})/q_{WH} \quad \textbf{[-]} \quad \textbf{(Eq. 7)}$$

Where ζ is the Available Exergy Function.

This is the ratio of the heat energy that contributes to electric power generation (i.e. exergy) at the turbine-generator against the whole thermal energy recovered at the well head.

3.5 Deriving the Rational Calculation Equation

We reform the equation Eq. 7 to the following equation.

$$(q_{tb_{in}} - q_{tb_{out}}) = \zeta\, q_{WH} \quad \textbf{[kJ]} \quad \textbf{(Eq. 8)}$$

Combination of the equation Eq. 6 and Eq. 8 gives the following equation.

$$E = \eta_{ex}\, \zeta\, q_{WH} \quad \textbf{[kJ]} \quad \textbf{(Eq. 9)}$$

Further, q_{WH} in the equation Eq. 9 is replaced with the equation Eq. 4, resulting in the following equation.

$$E = \eta_{ex}\, \zeta\, \rho C V(T_r - T_{trp}) \quad \textbf{[kJ]} \quad \textbf{(Eq. 10)}$$

The equation Eq. 10 expresses the electric energy generated at a turbine-generator; the electric energy converted from the thermal energy sent into the turbine-generator of the efficiency η_{ex} (exergy efficiency).

4 CALCULATION OF THE AVAILABLE EXERGY FUNCTION

Although the equation Eq. 10 gives the electric energy to be converted from the thermal energy recovered at the well head, the equation is not ready for a practical calculation in field. This has to be expressed as an equation that shall be practically and user-friendlily used.

4.1 Assumptions

In order to convert the equation Eq. 10 to a calculable equation, we assume the following three conditions.

a. Geothermal fluid recovered at well head is assumed to have the enthalpy that corresponds to the enthalpy of the single phase liquid stored in the reservoir (as stated in 2.1),
b. Single flash condensing geothermal power plant is assumed for resource evaluation (as stated in 2.1),,
c. Dry steam sent into the turbine and wet steam exhausted from the turbine is assumed.

4.2 Deriving the Calculable Equation of "Available Exergy Function ζ"

The Available Exergy Function consists of thermal energies (i) at the well head, (ii) at the turbine entrance and (iii) at the turbine exit. Calculation processes of these three thermal energies are explained hereunder step by step.

4.2.1 Geothermal energy recovered at the wellhead (q_{WH})

The geothermal energy at the well head is expressed by the following equation[1].

$$q_{WH_L} = m_{WH_L}\, h_{WH_L} \quad \textbf{[kJ]} \quad \textbf{(Eq. 11)}$$

[1] Note that the equation $m_{WH} = q_{WH}/(h_{WH} - h_{ref})$ given by USGS(1978) is valid only when $h_{ref} = 0$.

Where q_{WH_L} is the geothermal energy recovered at the wellhead, m_{WH_L} is the mass of the liquid recovered at the wellhead, h_{WH_L} is the specific enthalpy of the fluid recovered at the wellhead.

4.2.2 Thermal energy at turbine entrance ($q_{tb_{in}}$)

The geothermal fluid recovered at the well head is sent into the separator, separated into steam fraction and liquid fraction; and the steam fraction (dry steam) only is sent into the turbine. The thermal energy of the dry steam sent into the turbine is first given by the equation Eq. 12 and Eq. 13; the Equations Eq. 12 and Eq. 13 are re-written using water/steam separation ratio (Eq. 14), as the equation Eq. 15 below.

$$q_{tb_{in}} = m_{sp_s} h_{sp_s} \quad \text{[kJ]} \quad \text{(Eq. 12)}$$

$$m_{sp_s} = \alpha_{sp_s} m_{WH_L} \quad \text{[kg]} \quad \text{(Eq. 13)}$$

$$\alpha_{sp_s} = (h_{WH_L} - h_{sp_L})/(h_{sp_s} - h_{sp_L}) \quad \text{[-]} \quad \text{(Eq. 14)}$$

$$q_{tb_{in}} = \alpha_{sp_s} m_{WH_L} h_{sp_s} \quad \text{[kJ]} \quad \text{(Eq. 15)}$$

Where $q_{tb_{in}}$ is the thermal energy sent into the turbine, m_{sp_s} is the mass of the steam fraction separated at the separator and sent into the turbine, h_{sp_s} is the specific enthalpy of the steam fraction separated at the separator and sent in to the turbine, α_{sp_s} is the ratio of the steam mass fraction separated at the separator, h_{sp_L} is the specific enthalpy of the liquid fraction separated at the separator.

4.2.3 Thermal energy at turbine exit ($q_{tb_{out}}$)

The dry steam sent into the turbine is losing its thermal energy being converted into electric energy. At the same time the dry steam is becoming to be wet steam. The thermal energy of the wet steam exhausted at the turbine exit is given in the following equation. Note the mass of the steam fraction at the turbine entrance is preserved at the turbine exit.

$$q_{tb_{out}} = m_{sp_s} h_{tb_{out_{SL}}} \quad \text{[kJ]} \quad \text{(Eq. 16)}$$

Where $q_{tb_{out}}$ is the thermal energy at the turbine exit, $h_{tb_{out_{SL}}}$ is the specific enthalpy of the wet steam fraction at the turbine exit.

Dryness of the steam exhausted at the turbine exit is given by the following equation (DiPippo 2008 and/or Hirata et. al 2008).

$$\chi = (s_{sp_s} - s_{cd_L})/(s_{cd_s} - s_{cd_L}) \quad \text{[-]} \quad \text{(Eq. 17)}$$

Where χ is the quality of steam (dryness of steam), s_{sp_s} is the entropy of the steam at the separator, s_{cd_L} is the entropy of the liquid at the condenser and s_{cd_s} is the entropy of the steam at the condenser. Using the equation E. 17, the specific enthalpy of the wet steam fraction exhausted at the turbine exit is given by the following equation.

$$h_{tb_{out_{SL}}} = h_{cd_L} + (h_{cd_s} - h_{cd_L})\chi \quad \text{[kJ/kg]} \quad \text{(Eq. 18)}$$

Where h_{cd_L} is the specific enthalpy of the liquid at the condenser and h_{cd_s} is the specific enthalpy of the steam at the condenser.

Combination of the equations Eq. 16, Eq. 17 and Eq. 18 gives the following equation.

$$q_{tb_{out}} = \alpha_{sp_s} m_{WH_L} h_{tb_{out_{SL}}} \quad \text{[kJ]} \quad \text{(Eq. 19)}$$

4.2.4 The Available Exergy Function (ζ)

Replacing the terms in the equation Eq. 7 (Available Exergy Function) with the equations Eq. 11, Eq. 15 and Eq. 19 gives the following equation.

$$\zeta = \alpha_{sp_s}(h_{sp_s} - h_{tb_{out_{SL}}})/h_{WH_L} \quad \text{[-]} \quad \text{(Eq. 20)}$$

An approximation equation of the Available Exergy Function will be derived by the equation Eq. 20 through specifying the combination of a separator temperature and a condenser temperature.

5 APPROXIMATION EQUATION (AN EXAMPLE) OF AVAILABLE EXERGY FUNCTION

5.1 Step One Approximation to Cubic Polynomial

In order to convert "Available Exergy Function" into a calculable equation, a set of a separator temperature and a condenser temperature has to be selected first. There are a number of combinations of the temperatures; among those one sample approximation equation is derived assuming a typical temperature combination.

a. Separator temperature : 151.8℃ (0.5 MPa)
b. Condenser temperature : 40.0℃ (0.007 MPa)

The correlation between the geothermal fluid temperature and the Available Exergy Function is presented in Figure 3 for this example. Figure 3 shows that the thermal energy contributing to electricity power generation in the turbine ranges from 8% to 16 % for the geothermal fluid temperature ranging from 200 ℃ to 300 ℃.

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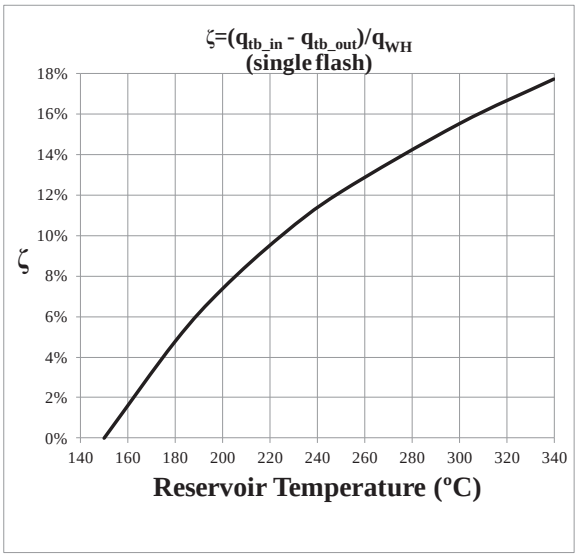

Figure 3 Available Exergy Ratio vs. Fluid Temperature (for T_{sp}=151.8 ℃, T_{cd}=40.0 ℃)

The approximation equation of the correlation is given by the following cubic polynomial.

$$\zeta = 0.0000000127\,T_r^3 - 0.0000124900\,T_r^2 + 0.0046543806\,T_r - 0.4591082158 \qquad \textbf{(Eq. 21)}$$

Note that the Available Exergy Function shall be zero ($\zeta = 0$) when the fluid temperature equals to the separator temperature according to the definition of the equation (see Eq. 7). For this example of the separator temperature T_{sp}=151.8 ℃ , ζ shall theoretically be zero ($\zeta = 0$). (However, this is not necessarily attained by the approximation although we specified ten digits after the decimal point for the coefficients.)

5.2 Step Two Appropriation to a Practical Equation for the Available Exergy Function

The equation Eq.21 as an approximation equation of the Available Exergy Function, is still somewhat too large to be used as a user-friendly calculation equation. Thus, a simpler and more user-friendly approximation equation is hereunder derived.

Figure 4 shows a lenear correlation between $\zeta(T_r - T_{trp})$ in the equation Eq. 10 on the vertical axis and $(T_r - T_{sp})$ on the horizontal axis. Since when $T_r = T_{sp}$, $\zeta = 0$, the correlation between $\zeta(T_r - T_{trp})$ and $(T_r - T_{sp})$ is expressed by the following equation.

$$\zeta(T_r - T_{trp}) = A(T_r - T_{sp}) \qquad [\text{-}] \qquad \textbf{(Eq. 22)}$$

Where A is a constant.

For this example of T_{sp}= 151.8 ℃ and T_{cd} =40 ℃ the equation Eq. 22 shall be as follows (Figure 4).

$$\zeta(T_r - T_{trp}) = 0.3155(T_r - 151.8) \qquad [\text{-}] \qquad \textbf{(Eq. 23)}$$

(For T_{sp}= 151.8 ℃ and T_{cd}=40 ℃ only)

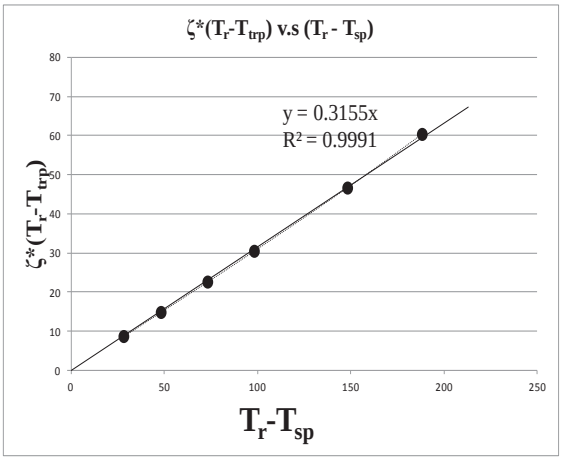

Figure 4 Linear Approximation $\zeta(T_r - T_{trp})$ and $(T_r - T_{sp})$ (for T_{sp}=151.8 ℃, T_{cd}=40.0 ℃)

6 TURBINE-GENERATOR EFFICIENCY (η_{ex})

The equation Eq. 5 defines the electric energy converted from the thermal energy, using the adiabatic heat-drop concept at a turbine. The equation includes the turbine-generator efficiency (exergy efficiency). The equation Eq. 5 is reformed to the following equation.

$$\eta_{ex} = E/\{m_{tb_{in}}(h_{tb_{in}} - h_{tb_{out}})\} \quad [-] \quad \text{(Eq. 24)}$$

We analyzed the correlation between turbine-generator efficiencies (η_{ex}), and temperature drops ($T_{tb_{in}} - T_{cd}$) of turbine entrance and condenser. We used 189 data of geothermal power plants all over the world (listed in ENAA 2013 in Japanese) resulting in the following correlation.

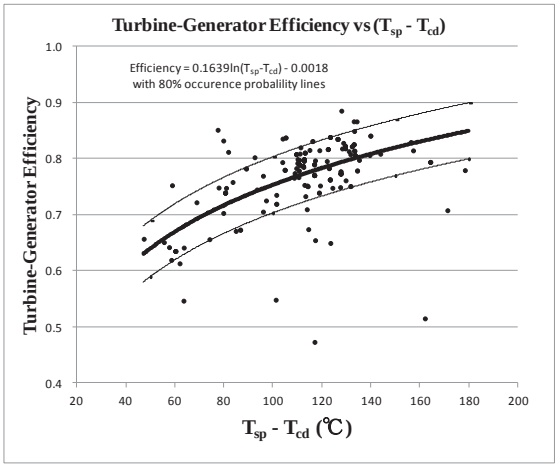

Figure 5 Turbine-Generator Efficiency from 189 data

$$\eta_{ex} = 0.164 \ln(T_{tb_{in}} - T_{cd}) - 0.002 \pm 0.05 \quad [-] \quad \text{(Eq. 25)}$$

Where $T_{tb_{in}}$ is the temperature of the turbine entrance and T_{cd} is the temperature of the condenser.

The actual efficiency of a turbine-generator system depends on many factors that include the efficiency of basic power plant design, resource temperature, concentrations of dissolved gases in the reservoir fluid, the condition of plant maintenance and so on. For this reason, we included an range of ± 0.05 in the approximation equation Eq. 25, which encompasses 153 data among the 189 data (approximately 80% occurrence probability).

For this example of T_{sp}= 151.8 ℃ and T_{cd}=40 ℃, the equation Eq. 25 is as follows.

$$\eta_{ex} = 0.77 \pm 0.05 \quad [-] \quad \text{(Eq. 26)}$$

(For the case of T_{sp}= 151.8 ℃ and T_{cd}=40 ℃ only)

7. A RATIONAL, PRACTICAL AND USER-FRIENDLY EQUATION FOR VOLUMETRIC METHOD

7.1 Approximation For the Example of T_{sp}= 151.8 ℃ and T_{cd}=40 ℃

Replacing $\zeta(T_r - T_{trp})$ and η_{ex} in the equation Eq. 10 with the equations Eq. 23 and Eq. 26 gives the following equation.

$$E = (0.24 \pm 0.02) R_g \rho C V (T_r - 151.8) \quad [kJ] \quad \text{(Eq. 27)}$$

(For the case of T_{sp}= 151.8 ℃ and T_{cd}=40 ℃ only)

The equation Eq. 27 above gives the electric energy converted in the geothermal power plant with separator of T_{sp}= 151.8 ℃ and condenser of T_{cd}=40 ℃. The other factors, i.e. recovery factor (R_g), Volumetric specific heat of the reservoir (ρC), reservoir volume (V) and average reservoir temperature (T_r) have to be given by the practitioners in charge.

7.2 Approximation Equations for Various Sets of Separator Temperatures and Condenser Temperatures

We have derived approximation equations for various sets of separator temperatures and condenser temperatures, so that practitioners may select one or some of those that may suite to their site conditions. The equations are presented in Table-2.

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8. A COMPARISON WITH THE USGS METHOD

A comparison is made between the proposed method and the USGS method.

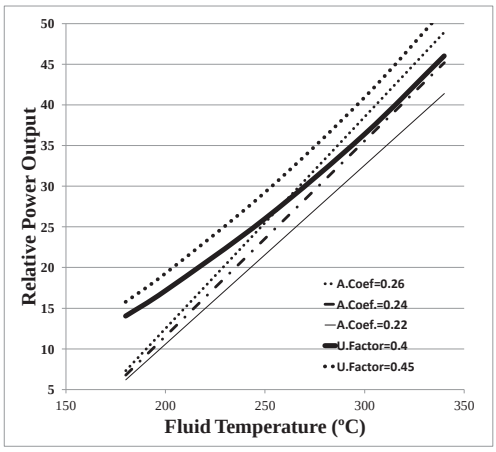
In theory, T_{ref} should be T_{trp} in USGS method when fluid is sent into a geothermal power plant directly. But, here T_{ref} = 15 ℃ is assumed because the utilization factors (0.4 and 0.45) might have been given with the assumption that the T_{ref} is the average ambient temperature of the USGS[2]. The conditions for the comparison is summarized in Table 3.

Table 3 Calculation Conditions for Comparison between USGS method and the Proposed method

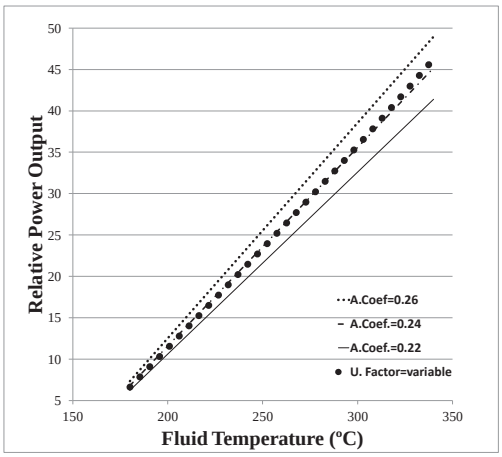
	USGS method	Proposed method (for T_{sp} = 151.8 ℃ and T_{cd} = 40 ℃)
Reference Temperature	Ambient temperature (15 ℃)	Triple point temperature for potential heat stored in reservoir (0.01℃)
Separator temperature	Not given	151.8 ℃
Condenser temperature	40 ℃	40 ℃
Factor in equation	Utilization factor (η_u) 0.40, 0.45	Approximation value of Exergy efficiency (η_{ex}) x Available exergy function (ζ) 0.22 (minimum), 0.24 (central value), 0.26 (maximum)
Reservoir related factors	($R_g \rho CV$) = 1 is assumed for this comparison	

Figure 6 (Left) shows that the USGS method gives slightly larger values than those of the proposed method; the USGS method with the utilization factor of 0.4 is in good agreement with the proposed method when fluid temperature is over 250 ℃ approximately.

While the USGS method treated the utilization factor as constant possibly for a practical reason, it shall be variable in theory. The utilization factors as variable is calculated in Section 11.1. We calculated the relative power output using "utilization factors as variable". The relative power output of the USGS method with variable utilization factor is shown in Figure 6 (Right). It demonstrates that the result of the USGS method is on the line of the proposed method with the approximation coefficient of 0.24.



Proposed Method (for $\mathbf{T_{sp}}$=151.8 ℃, $\mathbf{T_{cd}}$=40 ℃) and USGS method (fixed Utilization factor of 0.40 and 0.45, $\mathbf{T_{ref}}$=15 ℃ and $\mathbf{T_{cd}}$=40 ℃)



Proposed Method and USGS method with variable utilization factor (for both$\mathbf{T_{sp}}$ =151.8 ℃, $\mathbf{T_{cd}}$=40 ℃; only for USGS $\mathbf{T_{ref}}$=15 ℃)

Notes: A. Coef.: Approximation Coefficient of the proposed method, U. Factor: Utilization Factor of the USGS method

Figure 6 A Comparison of the Proposed Method with USGS Method

It has become evident that both of the USGS method and the proposed method are on the same theoretical basis (see the section 11.2). The major difference is that the USGS method defines the Utilization factor as a constant, whereas the proposed method deals all factors as dynamic variable factors. Thus, the proposed method is more 'accurate' than the USGS method although the method is expressed by approximation equations. Moreover, the proposed method is much simpler and therefore much more user-friendly, particularly when practiced with Monte Carlo Simulation.

9. NOTES AND DISCUSSIONS

It has been pointed out that the USGS method may have given larger resource estimations than that of reservoir resources actually available on site. Thus, the proposed method may also give excessive resource estimation than actual. In connection with this issue, one may be tempted to calibrate the equations by changing the constants in the equations of the proposed method. However, any of the constants shall not be changed, because the equations in Table-2 do not represent any of thermodynamic implications directly; the separator temperature in the second brackets acts only for zero-point adjustment; the constants in the first brackets are only the resultants of the approximations.

If the calculation results should not agree to the reservoir resource actually available, such reservoir related factors have to be reviewed as recovery factor (R_g), volumetric specific heat of the reservoir (ρC), reservoir volume (V) and average reservoir temperature (T_r). In particular, recovery factor (R_g) and reservoir volume (V) shall have to be examined prudently, because the two factors will give significant impacts on the resource assessment.

10. CONCLUSIONS

The USGS method is widely used for assessing the electrical capacity of a geothermal reservoir. While the under-ground related parameters will have significant impacts on the resource assessment, the electric capacity calculated is a strong function of the above-ground related conditions. The fluid temperature recovered at well head will be the key parameter for the volumetric method calculation when used with Monte Carlo method, because this temperature is the variable (uncertain) underground related parameter which affects the steam-liquid separation process in the separator - an above-ground related parameter. We have derived calculation formulas by introducing "Available Exergy Function", thereby, fluid-temperature-dependant separation process can be included in the equations together with the fluid temperature as a random variable for the Monte Carlo method. It is expected that this calculation method may provide clearer ideas on geothermal resources assessment because the above-ground related parameters are separately defined from the much uncertain underground related parameters. The proposed calculation formulas is proved to be on the same theoretical base of the USGS method (1978). They may thus give larger resource estimation than actually monitored on site if conventional underground related parameters should be selected. However, any of coefficients in the equations of the proposed method must not be changed or adjusted or calibrated. It is the underground related factors that shall be reviewed. In particular, recovery factor and/or reservoir volume have to be reviewed.

11. ADDITIONAL NOTES

11.1 About Utilization Factor of the USGS Method

The utilization factor defined by the USGS (1978) is as follows.

$$\eta_u = E'/W_A \qquad [-] \qquad \text{(Eq. 28)}$$

Where η_u is the utilization factor; W_A is the thermodynamically available energy produced at a thermo-engine, into which all energy of the recovered fluid at well head (originally under the ambient condition in the United State) is assumed to be sent in. E' is the electric power generated at the thermo-engine, into which only the steam fraction separated at the separator is assumed to be sent in.

The USGS has given the constants of 0.40 (USGS 1978) or 0.45 (USGS 2008) to the utilization factor as an empirical factor. However, the factor shall be a variable because W_A and E' are given by the following exergy equations, based on the USGS theoretical concept.

$$W_A = m_{WH_L}\{h_{WH_L} - h_{ref_L} - T^K_{ref_L}(s_{WH_L} - s_{ref_L})\} \qquad [kJ] \qquad \text{(Eq. 29)}$$

$$E' = \eta_{ex} m_{sp_s}\{h_{sp_s} - h_{cd_L} - T^K_{cd_L}(s_{sp_s} - s_{cd_L})\} \qquad [kJ] \qquad \text{(Eq. 30)}$$

Where $T^K_{ref_L}$, $T^K_{cd_L}$ are temperature of liquid in reference (i.e. ambient) condition and the condenser in K (absolute temperature) respectively; h_{ref_L}, h_{cd_L} are specific enthalpy of liquid in reference (i.e. ambient) condition and in the condenser respectively; s_{WH_L}, s_{ref_L} , s_{cd_L} are specific entropy of the liquid at the well head, in reference (i.e. ambient) condition and in the condenser respectively. The numerical utilization factors calculated by the equation Eq. 28, Eq. 29 and Eq. 30 for the case of T_{sp}=151.8 ℃, T_{cd}=40.0 ℃ and η_{ex}=0.77 are as shown in the table below.

Table 4 Utilization Factors as Variable (for T_{sp}=151.8 ℃, T_{cd}=40.0 ℃, η_{ex}=0.77)

Fluid temperature at Well head (℃)	Utilization factor (variable)
200	0.27
250	0.36
300	0.39
340	0.40

The utilization factor ranges from 0.27 to 0.40 in accordance to the temperatures of the fluid recovered at the well head. If the exergy efficiency η_{ex} could be larger than 0.77, the utilization factor would be larger than those calculated above.

11.2 Theoretical Background of the Proposed method

We presented first the adiabatic heat drop concept for the proposed method in the equation Eq. 5. The specific enthalpy of the turbine exit was expressed by the equations Eq. 16, Eq. 17 and Eq. 18. Among those, combination of the equations Eq. 17 and Eq. 18 gives the following equation.

$$h_{tb_{out_{SL}}} = h_{cd_L} + (h_{cd_s} - h_{cd_L})\{(s_{sp_s} - s_{cd_L})/(s_{cd_s} - s_{cd_L})\}$$

$$= h_{cd_L} + T^K_{cd_L}(s_{cd_s} - s_{cd_L})\{(s_{sp_s} - s_{cd_L})/(s_{cd_s} - s_{cd_L})\}$$

$$= h_{cd_L} + T^K_{cd_L}(s_{sp_s} - s_{cd_L}) \qquad [kJ/kg] \qquad \text{(Eq. 31)}$$

Further combination of the equation Eq. 5 and Eq. 31 gives:

$$\mathbf{E = \eta_{ex} m_{tb_{in}} \{ h_{tb_{in}} - h_{cd_L} - T^{K}_{cd_L} (s_{sp_s} - s_{cd_L}) \}} \quad \textbf{[kJ]} \quad \textbf{(Eq. 32)}$$

Where $m_{sp_s}=m_{tb_{in}}$, $h_{sp_s}=h_{tb_{in}}$

The equation Eq. 32 has been derived from the concept of the proposed method (adiabatic heat-drop at turbine), whereas the equation Eq. 30 from the USGS method (exergy exergy). The electric energy outputs of the two methods have become eventually to be expressed by the same equation. Thus, the two methods have been proved to be on the same theoretical basis

12. ACKNOWLEDGMENTS

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