Ministry of Public Utilities, Energy and Ports

Commonwealth of Dominica

Wotten Waven Geothermal Field
Commonwealth of Dominica
West Indies

FEASIBILITY STUDY

SMALL GEOTHERMAL POWER PLANT

4 X 3.5 MW FOR DOMESTIC MARKET

FIRST PHASE DEVELOPMENT OF NATIONAL GEOTHERMAL RESOURCE

Feasibility Report **FINAL DRAFT** **September 2013**

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List of Abbreviations

AC - Alternating current
AVG - Average Debt Service Coverage Rate
AFD - Agence Française de Développement
bara - bar absolute
barg - bar gauge
BHP - Bottom hole pressure
BHT - Bottom hole temperature
°C - Celsius degree
CapEx - Capital expenditure
cm - Centimeter
COD – Commercial Operation Date
CSG - Casing
CV - Control valve
dB - Decibel
DC - Direct current
DCS - Distributed control system
E - East
ECD - East Caribbean Dollar
EPC – Engineering Procurement Construction
ESA - Electricity Supply Act
ESE - East-south-east
FCRS – Fluid Collection and Reinjection System
FIRR – Financial Internal Rate of Return
FRP – Fibre Glass Reinforced Plastic
ft - Foot
GCB – Generator Circuit Breaker
GDP - Gross domestic product
GoD (GoCD) – Government of Dominica
GWh – Gigawatt hour
HFO - Heavy fuel oil
HHV – Higher heating value
Hz - Hertz
IDC – Interest during construction
II – Injectivity index
IPP – Independent Power Producer
IRC - Independent Regulatory Commission
IRR - Internal rate of return
K - Kelvin degree
kg - Kilogram
kJ - Kilojoule

km - Kilometer
kV -Kilovolt
kW - Kilowatt
kWh – Kilowatt-hour
L/s (l/s) - Liters per second
LAN - Local area network
lb - Pound mass
LGPP - Large Geothermal Power Plant
LHV – Lower Heating Value
Log - Logarithm (base 10)
LRVP – Liquid Ring Vacuum Pump
LV - Low voltage
m - Meter
m asl – Meter above sea level
Ma - Million years
MD - Measured depth
MF – Mass flow
mg - Milligram
mm - Millimeter
mMD – Meters measured depth
mmol - Millimol
MPa - Megapascal
µg - Microgram
µS - Microsiemens
MSV - Main stop valve
MT –Magnetotelluricsm
MVA - Megavolt-ampere
MW - Megawatt
MWe – Megawatt electrical
MWL - Meteoric water line
N - North
NCG – Non-condensable gas
Nm^3 - Normal cubic meter
NNW - North-north-west
NW - north-west
O&M – Operation and Maintenance
OBE – Operating basis earthquake
ONAF – Oil natural air forced
ONAN – Oil natural air natural
OpEx - Operating expenditure
ORC – Organic Rankine Cycle
P&ID – Piping and Instrumentation Diagram
Pa - Pascal
PCS – Production Casing Shoe

PLC - Programmable logic controller
PPA - Physical Planning Act
PPAs - Power purchase agreements
PT – Pressure-Temperature
PWC - Public Works Corporation
ROE - Return on equity
s - second
S - South
SCADA - Supervisory control and data acquisition
SGPP - Small Geothermal Power Plant
SH – Slimhole
SSE – Safe Shutdown Earthquake
SSI – Silica Saturation Indext
SSW - South-south-west
SW - South-west
T&D – Transmission and Distribution
TCL - Top of conductive level
TDEM – Time-Domain Electromagnetic
TDS - Total dissolved solids
TD – Total depth
TEWAC - Totally enclosed water to air cooled
TLC – Total Loss of Circulation
UPS – Uninterupted Power Supply
US$ (USD) - United States Dollar
VAT –Value Added Tax
VD – Meters vertical depth
VT - Voltage transformer
W - West
WACC –Weighted Average Cost of Capital
WBT - Wet bulb temperature
WHP – Wellhead Pressure
WHP - Well head pressure
WHT - Well head temperature
WNW - West-north-west
XRD – X-ray diffraction

1. EXECUTIVE SUMMARY

Introduction

The development of the geothermal resource, which early geoscientific investigations implemented by CFG has identified and slim hole drilling (three slim holes of depth ranging from 1200 to 1600 m have been drilled and tested from December 2011 to June 2012: WW-02 and WW-03 in the Laudat, and WW-01 in the Wotten Waven area) has confirmed in the Wotten Waven – Laudat – Trafalgar area, is planned to be undertaken in two stages:

Stage 1: a small scale development (up to 14 MW) to supply geothermal sourced electricity into the local Dominica power system (SGPP ‐ Domestic);

Stage 2: the full development of the project (nominally ~100 MW) to generate electricity for export primarily to the neighboring islands of Martinique and Guadeloupe through an inter ‐ island transmission interconnection (LGPP ‐ Export).

Although the project is planned to be developed in the two stages mentioned, it is important that the development of the first stage (SGPP ‐ Domestic) be undertaken in a way that will enhance the eventual development of the full project, and certainly that it should not result in sub ‐ optimal development of the second stage (LGPP ‐ Export). However, the first stage must be able to be developed and subsequently operated successfully in its own right in case there is any delay in the development of the second stage. A key feature of the overall planned development is that a single developer be responsible for the development of both stages, particularly for managing/operating the geothermal steam resource. This is to avoid potential problems with a “multiple tappers” scenario, whereby two independent users are trying to extract energy from the same geothermal resource/reservoir.

The present report analyzes the first stage of development (SGPP - Domestic). The development of this stage will take place in 2 phases, each comprising a net 7 MW power generation block of 2 units (3.5 MW each, condensing steam turbines). The size of the single units has been selected to match the existing grid-connected unit size, thus avoiding potential grid stability problems. The first phase will consider the commercial operation of the first 2 units at the end of year 2015 / beginning of year 2016, whereas the second phase is considered to start one year after the commencement of the first phase.

Sector Actors and Regulatory Framework

The electricity sector actors in Dominica are:

- Ministry of Public Works Energy and Ports of Dominica
- Independent Regulatory Commission
- DOMLEC (Concession holder)

The existing and pending laws and regulatory policies that establish the basis for geothermal development in Dominica consist of the following key items:

- The Physical Planning Act (PPA), 2002
- The Electricity Supply Act (ESA), 2006 contains rules governing the authorization to generate,
- The draft Geothermal Resources Development Bill, 2013 (‘the draft Bill’) seeks

The GoD is conscious that integrating in the short terms an investment that is relatively large in scale compared with the domestic power market and in the medium long term mobilizing large scale investments for an export oriented geothermal project that is comparable to the GDP of Dominica, will require a supportive legal, regulatory, and institutional set-up.

Some key areas that GoD is examining for further work and strengthen are:

- The draft Geothermal Resources Development Bill;
- The new environmental and planning regulations;

The Resource

The assessment of the geothermal resource of the Wotten Waven field has been based on the results of the geoscientific investigations conducted in the period 1984-2008 and of three boreholes drilled to a depth of 1200÷1613 m in the years 2011-2012 (WW-01, WW-02 and WW-03). The integrated analysis of the relevant data has allowed elaborating the ***conceptual model*** of the field, describing the general scheme of the geothermal system as well as the predicted parameters of the reservoir, as summarized hereinafter:

a. General Scheme of the Geothermal System

- The heat source of the geothermal system is deemed to be represented by the magmatic chamber responsible for the emission of the volcanic products of the Micotrin domes, intersected in the upper section of wells WW-02 and WW-03 and located in the northern sector of the Project.
- Such heat source appears to correspond to the sector of main upflow of the fluids. The possibility of another upflow zone in the Desolation Valley sector cannot be excluded at this stage, but this hypothesis should be verified through an extension to that area of the geoscientific investigations, and in particular the MT ones.
- At the present level of knowledge, higher temperatures recorded in WW-03 with respect to WW-01 point to a SSW flow from Laudat towards Wotten Waven, further confirmed by pressure logs showing lower static pressures in WW-01 than in the other two wells. This flow direction is probably controlled by the main structural trends which are associated with a higher secondary permeability. Accordingly, ascending fluids are expected to move from the Micotrin upflow sector laterally towards the zone of Laudat, Trafalgar and Wotten Waven.
- The presence of a hydrogeological barrier to the SW might be responsible for a restriction of the lateral flow in this direction.

- The reservoir is hosted in volcanic rocks, consisting of andesitic lava, tuff and breccia. An impervious layer (cap rock derived from argillification processes) is capping the reservoir in the Laudat and Wotten Waven sectors.

b. Predicted Parameters of the Reservoir

- The results of the MT survey and of the drilling campaign concur in pointing to a shallow depth of the reservoir, whose top is deemed to occur at an approximate elevation of 0 m asl. The presence of important circulation losses up to the final depth of the wells indicates a reservoir thickness of at least 1,000 m.
- The overall lateral extent of the reservoir, based on the results of the MT survey, can be estimated in a minimum surface of about 9 km^2. Such value may be classified, in accordance with the Australian Geothermal Reporting Code, as “inferred”, while the “indicated” sector, directly proved through drilling, covers a surface of about 3 km^2**.**
- Wells WW-02 and WW-03, drilled at elevations of about 571 and 543 m asl respectively, show a liquid-dominated pressure distribution below about -160 m a.s.l. On the other hand, well WW-01 shows liquid-dominated conditions almost up to the wellhead as the reservoir is locally over-pressured with respect to ground elevation.
- All three drilled wells proved a reservoir, characterized by a medium to high permeability and by measured temperatures in the liquid dominated section in the range 220 – 246°C.
- The permeability distribution seems not to be strictly correlated with specific lithologic horizons, as it can occur indifferently in lavic and pyroclastic products. According to injectivity and production capabilities, wells WW-01 and WW-03 tapped multiple high permeability feed zones.
- The liquid dominated reservoir contains a NaCl dominated brine with TDS ranging from 3200 to 5800 mg/kg, and reservoir pH between 5.3 and 6.1. Partial pressure of CO_2 at reservoir conditions is in the range 3 - 9 bar. These figures need to be confirmed by longer production tests than those already performed on the three drilled wells.
- Total gas content in separated steam ranges from 0.85 - 1.53 wt% for well WW-01, to 2.56 - 2.71 wt% for well WW-03.
- Simulation of fluid boiling indicates that: (i) precipitation of calcite is possible at any temperature, with the highest probability in the reservoir and in the deepest section of the wells, downstream of the flashing zone; (ii) performing liquid/vapour separation at pressures of 6 to 7 bar-a, there is no risk of silica scaling in the pressure separator. However, silica scaling might occur, upon further cooling of separated geothermal liquids, in reinjection pipelines and reinjection wells, as well as in the reservoir around the reinjection wells.
- Corrosion problems caused by separated liquids are expected to be negligible, whereas steam condensates may pose some corrosion problems, especially upon absorption of atmospheric O_2 and oxidation of dissolved H_2S to H_2SO_4.

The above described conceptual model of the field constitutes the base for the ***resource assessment***, which has been performed by using a volumetric method complemented with a probabilistic Monte

Carlo approach. The calculation has been carried out for both the indicated and indicated + inferred areas following the AGEG (2010) code for reporting about geothermal resource. The probabilistic distribution of thermal energy in place and power plant (gross) capacity for 30 years exploitation resulting from 10,000 Monte Carlo realizations is characterized by the parameters listed in Table 1.1.

Indicated Area	Thermal Energy in Place (kJ)th	Recoverable converted electric energy (MWe - 30 years)
P90	7.40E+14	25.5
P50	8.90E+14	41.0
P10	1.17E+15	60.5
Most frequent value	8.62E+14	37.5
Average value	8.63E+14	40.3

Indicated + Inferred Area	Thermal Energy in Place (kJ)th	Recoverable converted electric energy (MWe - 30 years)
P90	1.98E+15	57.0
P50	2.32E+15	91.5
P10	2.72E+15	123
Most frequent value	2.30E+15	93.4
Average value	2.30E+15	89.6

Table 1.1 - Results of Monte Carlo Analysis for thermal energy in place and the power capacity for 30 years exploitation for the indicated (left) and indicated + inferred (right) resource areas.

Thus, the approach followed suggests that:

- The indicated area which will be directly affected by SGPP development has P90 and P50 power plant capacity of 25 and 41 MW, respectively, definitely assuring that this area has enough capacity to support the planned 14 MW SGPP development.
- The indicated+inferred areas will support the SGPP and possible full field development. The combined areas have P90 and P50 power plant capacity of 57 and 91 MW, respectively.

The implementation of integrative geoscientific investigations, combined with additional drilling, are due on one side to convert part of the area presently classified as “inferred” into “indicated”, on the other side to finalize the value of the “inferred” area, presumably incrementing it.

At any rate, the presently available figures confirm that the Wotten Waven field has enough capacity to justify the installation of the SGPP and provide very promising indications in view of the full field development to support the local power needs of Dominica and supply electric power to neighboring islands.

Field Exploitation for the SGPP

Given the considerations on the field’s conceptual model and on the proven extension of the reservoir, the GoD decided to develop the northern part of the field in Laudat area and to drill the required production wells deviated from WW-03 drilling pad where the corresponding vertical slim hole was successfully drilled. This decision was supported by the analysis of different alternatives, as far as the location of both production and reinjection wells is concerned.

Consequently, the SGPP location has been selected in correspondence of the WW3 site in Laudat, in the north extension of the same well pad.

This basic choice to develop this part of the field has been taken by both logistic (wider area available for the further development) and social reasons whereas it remains technically viable from the resource exploitation point of view.

Two different power plant options were initially considered; however after an in depth analysis of the present situation and of the expected evolution of the power demand in Dominica and after consultation with the GoD, the option considered and developed in this report is based on 4 (four) single flash condensing unit of 3.5 MW net each, amounting to a total plant capacity of 14 MW.

On the basis of the estimated potential for a standard size well drilled from well pad 3, three production wells will be needed to supply the amount of fluid required by the total SGPP development (14 MW). If drilled from the same well pad, those wells shall be drilled directionally with suitable horizontal displacement and azimuth to reduce the interference among them.

A possible limitation of well deliverability is the scaling downhole because of flashing and cooling. According to available data, to be confirmed by those planned to be collected during testing of WWP1, calcite scaling seems to be possible because of conductive cooling from reservoir temperature and mainly as a consequence of flashing. If necessary, deposition of calcite can be mitigated by the injection downhole of suitable reactants and/or by treatment with acid solutions.

With reference to the reinjection wells, two wells will be needed by the total SGPP development and they will be drilled at the already selected site situated in Trafalgar area.

Plant Development Criteria

Based on the analysis of the present power system of Dominica and of its expected evolution, the solution proposed is to develop a power plant of approximately 4 x 3.5 MW condensing units with steam bypass to the condenser and 10% overload for one hour.

First two units to be into operation in the beginning of year 2016.

Project Configuration

Considering the location of the production wellpad (WW3) and the power plant, separators can be located at production wellpad collecting the two-phase fluid from the three production wells. Separated steam is conveyed from the separator station to the power plant area (north of WW3) through the main steam pipeline. The production wellpad is equipped with pressure steam separators, atmospheric flash tank and a pond for collecting all the flashed fluids.

The selected reinjection pad (WWR1) is located at lower elevation than the production wellpad and this configuration allow gravity injecting of the separated brine without reinjection pumps.

The technology chosen to exploit the energy content of the geothermal fluid is a traditional condensing steam turbine power plant. The power plant is composed of four (4) identical units, each one designed to deliver 3.5 MW to the electric grid.

Environmental Issues

The Project site is located in an area where the pristine environment has been partially modified by the human activity so that original Flora and Fauna is not affected in its immediate surroundings.

From the anthropic point of view, the entire Roseau valley is characterised by scattered settlements spreading all around the valley wherever the slopes are not too steep.

The main items in terms of impacts to the environment both during the development phase and during the operational phase have been examined and a simulation has been performed to evaluate the ground level concentration of H_2S in the surroundings of the geothermal power plant, together with a noise impact prediction. Proper mitigation measures have been identified, whereas the possible effects of the SGPP on the natural geothermal manifestations of the Roseau Valley and on induced seismicity or subsidence phenomena are considered very unlikely to occur and, in the case, they can be properly monitored and prevented.

Cost Estimate

Project cost estimate is the following:

3 x 3.5 MW Summary of Investment Cost (Million US$)	
Cost Items	
Drilling ad Testing of Production and Reinjection Wells	16.70
Supply and Erection of Fluid Gathering System	3.77
Supply and Erection of Power Plant	32.00
Upgrade of Transmission Line [not included in the financial cost]	9.00
Project Management	2.00
Total Cost of the Project	**63.47**

Contingencies equal to 15% of the overall CapEx have been added.

Electricity Market

For system stability and preventing a cascading blackout, no single unit should be larger than 20% of the system load. Applying the so called the N-2 calculation for Firm Capacity, the new Power Plant is designed to supply maximum load when the two largest units are down.

The analysis of the electric demand and the requirement of the grid, including spinning reserve, suggest that a plant of about 14 MW consisting of 4 x 3.5 MW units would be a practical size. Additional capacity above this would need to be studied carefully and in the framework of recovering demand presently served by self generators.

Considering hydroelectric plants as the least cost form of generation, it is reasonable to assume that the proposed geothermal plant would theoretically not be used to offset the hydro generation. However limited offset of hydropower generation may be envisaged to maintain more geothermal units in operation and avoid quite more expensive operation of diesel units.

Generation mix and dispatching rules shall allow for minimal operation of existing diesels.

Sufficient diesel capacity should be retained to meet the full demand in the event that the entire geothermal operation has to be shutdown. Contingency fuel supply arrangements will need to be made to ensure that fuel can be supplied at short notice in such an event.

Financial Analysis

As expected from a front end, capital intensive, technology the cost of financing plays an important role in defining cost recovery tariff.

Development Scenario	Preliminary Proposed Tariff	Other Costs to Government
public - mainly concessionary loan	6 / 7 US$ cents	The project pays the taxes.
private developer / operator without Government supported soft loan	12 / 13 US$ cents	The project pays the taxes.

Economic Analysis

The proposed SGPP solution appears having clearly dominant characteristics compared with the two alternatives analyzed and described in the following paragraphs i.e. “do nothing” and “wait for the full scale development”.

Risk Analysis

The table below refers to the base scenario i.e. the government lead development and shows an analysis of the level of each of risk as well as a brief mitigation arrangement.

Risk	Level	Mitigation Arrangement
Project performance (sponsor)	Low	Experienced partner with percentage of equity
Project Completion (delay)	Medium	Design Supply and Erection Contract / Performance obligations with penalty clauses
Project Completion (cost overruns)	Medium	Contingency and escalation amount in the cost estimate
Project Completion (site availability)	Low	Land right agreement / Land use agreement
Technology	Low / medium	Tried and tested technologies
Geothermal Resource	Low / medium	Follow good practices and phased approach
Skilled labor	Low / medium	Training provided by equipment suppliers and technical advisors

Market	Low / medium	Long terms purchasing contract specifying minimum quantities and prices
Payment	Low	Direct assignment of part of buyer revenues / escrow account
Finance (debt service)	Low	Use “worst case scenario” for financial planning / escrow account
Finance (other)	Low	Use “worst case scenario” for financial planning / International Donor Expertise
Accident / Loss	Medium	Insurance policies / force majeure provisions
Country Environment	Low / medium	Clear policy framework
Country Environment (legal framework)	Low	Clear legal framework / clear rules for arbitration
Country Environment (expropriation)	n. a.	-
Country Environment (environment)	Low / medium	Independent assessment / Guidelines, monitoring and reporting,

A different and extremely tailored analysis of the risks and their impact would be necessary for the GoD in order to conduct a negotiation with the potential developer of the full scale project to achieve an optimal outcome for the country while providing equitable terms for the developer so they can secure a return that is commensurate with the associated risks. The ultimate objective of the risk analysis is to allocate the risks to the parties that are best able to absorb them; so the project can achieve a sustainable outcome on risk management.

2. PROJECT BACKGROUND

The Wotten Waven geothermal field is located in the south-western part of the Caribbean island of Dominica, in the Roseau Valley about 5 to 6 km east of the capital Roseau.

Geothermal prospecting in the Roseau valley aimed at the identification of potential resources, given its geological and volcanic context, has been carried out since the early eighties, leading to the identification of Wotten Waven geothermal prospect, where detailed geoscientific investigations have been implemented, through a period of some 25 years, by CFG.

The results of these Investigations were presented in the following reports:

1) Field Report on Geothermal Exploration in Wotten Waven - March 2005 (CFG, 2005).
2) INTERREG III-B European Programme – Espace Caraibes. Tasks 2 & 3, Geological and Geochemical Analysis (CFG, 2008a); Task 4, Geophysical Analysis; Tasks 5 & 6, Exploration Well Program and Technical Synthesis – December 2008 (CFG, 2008b).

The latter report indicates the location of a potential area to be explored by deep drilling and the siting of 9 exploratory wells.

The extension of the prospective area delineated by the geoscientific investigation and particularly by the magnetotelluric survey (MT) induced to infer a potential resource in the order 100-120 MW, large enough to supply electricity to the neighboring islands of Guadeloupe and Martinique via submarine cable.

On the basis of these positive results, in the framework of the “INTERREG IV – B European Programme, Espace Caraibes”, the EU and AFD allocated on a grant basis certain financial resources to Dominica, for the drilling and testing of three deep exploratory wells and for the Technical Assistance to the GoCD during the implementation of the development program for the full exploitation of the resource.

ELC-Electroconsult of Milan, Italy, through a competitive bidding process, has been awarded the Technical Assistance Contract, starting its activity since November 2009.

The first task accomplished within the Technical Assistance Contract has been the choice, among the locations proposed by CFG (2008b), of three sites where to drill the planned exploratory wells. At the same time emerged the possibility, should the results of the exploratory wells be successful, to install a Small Geothermal Power Plant (SGPP) for the early exploitation of the resource for power generation, to replace the Dominica costly diesel generation power system.

Eventually this possibility was taken into consideration by all parties involved in the project and led to the extension of the Technical Assistance Contract with the scope of investigating the technical and economical "feasibility" of this option.

A first report, *Study for a Small Geothermal Power Plant*, prepared before the drilling and testing of slim holes, was submitted in January 2012; the study analyzed 16 different possible scenarios (related to the enthalpy of the geothermal fluid and to the permeability of the reservoir) in the case of a full-size production well drilled in the same well pad where the best of the three drilled slim holes is located, comparing for each case three different exploitation processes: back pressure turbine, condensing turbine, binary cycle.

The results of that analysis indicate that most of the considered cases would economically justify, under the Dominica's power market condition, the installation of a SGPP with a capacity ranging from 2-3 MW binary cycle to 8-10 MW condensing turbine.

The actual results of the slim holes (all three successful) were beyond the expectation with reservoir temperature (240 °C) higher than expected and good permeability. This success induced AFD to propose the financing for drilling two full size wells, one for production and the other for reinjection, taking advantage of the presence in Dominica of the drilling equipment of Iceland Drilling Company (IDC);-

At that stage, the installation of the SGPP became a real opportunity with private investors already expressing their interest in the development of the project for power generation and sales in Dominica. For this purpose, a preliminary Feasibility Study relevant to the installation of a 7 to 10 MW geothermal power plant was carried out and submitted to GoCD on November 2012.

At the same time, in view of the future possible full-scale exploitation of the Wotten Waven geothermal field, a **preliminary resource assessment** was conducted**,** based on the results of the three slim holes, using a volumetric method complemented with a probabilistic Monte Carlo approach, with the conclusion of a proven power capacity of 65 MW (90% probability), or 90 MW (50% probability), with possible further extension toward North and North-East of the proven area.

Finally, on July 2013 an analysis of two possible options for a total capacity of 15 MW (1 x 15 MW and 3 x 5 MW) was elaborated by request of GoD and debated with the WB Geothermal advisors. After in depth discussions amongst ELC specialists and GoD officials, it was decided to consider a 4 x 3.5 MW option, to better fit the peculiar demand diagram of the Dominica power system. The present Feasibility Report has been elaborated accordingly.

3. BRIEF ON DOMINICA AND PROJECT LOGISTICS

3.1. Geography

Dominica is an island located between the Caribbean Sea and the North Atlantic Ocean, about half way between Puerto Rico and Trinidad and Tobago.

Geographic coordinates	15 25 N, 61 20 W
Total Area	751 sq km
Land	751 sq km
Internal Water	Negligible (app. 0 sq km)
Coastline	148 km
Climate	Tropical; moderated by northeast trade winds; heavy rainfall
lowest point	Caribbean Sea 0 m
highest point	Morne Diablotins 1,447 m
Land use (2011)	arable land: 8% permanent crops: 24% other: 68%

Known as "The Nature Island of the Caribbean" due to its spectacular, lush, and varied flora and fauna, which are protected by an extensive natural park system; the most mountainous of the Lesser Antilles, its volcanic peaks are cones of lava craters and include Boiling Lake, the second-largest, thermally active lake in the world.

3.2. People and Society

Ethnic groups:

Black 86.8%, mixed 8.9%, Carib Amerindian 2.9%, white 0.8%, other 0.7% (2001 census)

The official language is English but population speak also French Patois. The population of the island is 73,286 (July 2013 est.) with a median age of 31.7 years (2013 est.) and a growth rate of 0.22% (2013 est.).

67% of total population lives in a urban contest (2010) with an annual rate of change of 0.3% (2010-15 est.). More the 90 % of total population has access to drinking water source and the sanitation facilities are available for more than 80 % of total population.

3.3. Government

The conventional long form of the country name is Commonwealth of Dominica but it is often shortened as Dominica. The government type is parliamentary democracy constituted on the 3rd

November 1978, where the chief of state is the president Eliud Williams (since 17 September 2012) and the head of government is the Prime Minister Roosevelt Skerrit (since 8 January 2004). Cabinet is appointed by the president on the advice of the prime minister.

Legal system is common law based on the English model.

3.4. Economy

The Dominican economy has been dependent on agriculture - primarily bananas - in years past, but increasingly has been driven by tourism as the government seeks to promote Dominica as an "ecotourism" destination. Moreover, Dominica has successfully developed an offshore medical education sector. In order to diversify the island's economy, the government is also attempting to develop an offshore financial sector and plans to sign agreements with the private sector to develop geothermal energy resources. In 2003, the government began a comprehensive restructuring of the economy - including elimination of price controls, privatization of the state banana company, and tax increases - to address an economic and financial crisis and to meet IMF requirements. Hurricane Dean struck the island in August 2007 causing damages equivalent to 20% of GDP. In 2009, the economy contracted as a result of the global recession and growth remains anemic. Economic growth in 2010-11 was about 1%. Although debt levels in 2012 continued to exceed pre-recession levels, the debt burden notably declined from 80% to approximately 70% of GDP.

Year	GDP (purchasing power parity)	GDP - real growth rate	GDP - per capita (PPP)	Gross national saving:
2012	$1.018 billion (est.)	0.4% (2012 est.)	$14,400 (2012 est.)	9.2% of GDP (2012 est.)
2011	$1.014 billion (est.)	1.9% (2011 est.)	$14,300 (2011 est.)	8.5% of GDP (2011 est.)
2010	$995.4 million (est.)	0.7% (2010 est.)	$14,100 (2010 est.)	7.8% of GDP (2010 est.)

note: data are in 2012 US dollars

The main agriculture products (13.6% of GDP) are bananas, citrus, mangos, root crops, coconuts, cocoa while the industrial production (15% of GDP) is focused on soap, coconut oil, tourism, copra, furniture, cement blocks, shoes. The remaining part of the GDP (71.4% of GDP) comes from services sector.

The most important exports partners are Japan 38.2%, Antigua and Barbuda 8.4%, Jamaica 7.4%, Guyana 7.1%, Paraguay 6.1%, Trinidad and Tobago 4.6% (2012).

The most important import partners are Japan 37.5%, US 14.9%, Trinidad and Tobago 14.2%, China 4.9%, Colombia 4% (2012) providing manufactured goods, machinery and equipment, food, chemicals.

Road system has a length of 780 km (393 km paved). There are two small airports in the island: the primary is Melville Hall Airport (DOM) which is on the northeast coast (about a 45-minute drive from Portsmouth) and second is Canefield Airport (DCF) (about 15 minutes from Roseau on the southwest coast). Furthermore in this two town (Portsmouth, Roseau) are located the major seaports.

As a result of poor infrastructure, limited air access, and a rugged terrain, Dominica has been unable to attract tourist revenues in the same manner as its neighbor countries. As of 2012, tourism in Dominica represented only 7% of GDP, which is only a slightly higher proportion than the 5% share it held three decades ago.

On the other hand Dominica has been able to successfully develop an offshore medical education sector, but this industry is not easily scalable, and therefore the economy still needs new sources of growth. As a result, Dominica has been falling behind other regional economies in terms of growth. Between 1985 and 2012 Dominica grew at a compound rate of 2.4% while the remaining regional economies grew at an average compounded rate of 3.4%. As a result of the lower growth, Dominica has the lowest per capita income in the Eastern Caribbean countries, and depends heavily on aid flows. The recent global financial crisis has only exacerbated the situation, with the Dominican economy in need of a further competitive edge and additional sources of growth.

4. SECTOR ACTORS AND REGULATORY FRAMEWORK

4.1. Sector Actors

Ministry of Public Works Energy and Ports of Dominica

The Ministry has the mission to institute policies and regulatory measures and execute programmes to improve the infrastructure in roads, utilities, ports, energy and better services in civil aviation, maritime and meteorological services administration sub-sectors to stimulate and support sustainable economic growth for the overall benefit of the people of the Commonwealth of Dominica.

Its vision is to excel in delivering policies and programmes towards better roads and ports and energy independence for the nation.

The Ministry is the part of the Government with the responsibility for planning, designing, implementing, monitoring and coordinating development activities in roads, air and sea ports, maritime, energy, civil aviation, meteorological services and in the operations of the Postal Services.

The Ministry is primarily made up of the following nine (9) functional units:

- Policy Formulation and Administration Unit
- Technical Services Division
- Electrical Division
- Energy Unit
- General Post Office
- Maritime Administration Unit
- Civil Aviation Administration
- Ports
- Dominica Meteorological Services

The Ministry is also responsible for three (3) statutory bodies, namely:

- Independent Regulatory Commission (IRC)
- Dominica Air and Sea Ports Authority (DASPA)
- Public Works Corporation (PWC)

Independent Regulatory Commission

IRC was established under the Electricity Act, Act 10 of 2006, which was passed into Law in October 2006. IRC effectively took off in June 1, 2007, following the appointment of its five Commissioners, and their subsequent inauguration on June 22, 2007. IRC has been set up as an independent regulator whose primary responsibilities and functions are as contained in the Act 10 of 2006. However, these functions will also include:

- Ensure orderly development of a competitive power market
- Ensure efficient, safe and adequate production of electricity
- Promote competition & private sector participation
- Protect consumers and the public interest
- Evolve standards & codes that measure with international best practice
- Evolve stable & equitable rates – cost reflective + reasonable profit
- License and regulate persons engaged in electricity business
- Settle disputes amongst industry participants
- Ensure expansion of access to rural and urban dwellers
- Establish and administer the Power Consumer Assistance Fund for subsidizing underprivileged consumers.

Structurally, IRC has a Chairman and four (4) Commissioners appointed by the Minister of Public Utilities, and the Commission will establish six divisions each headed by a commissioner namely:

- Legal Support and Licensing;
- Engineering, Safety & Standards;
- Market Competition & Rates;
- Finance & Support Services;
- Government & Consumer Affairs;
- Research & Development.

The Independent Regulatory Commission has as its objectives:

- To be an independent arbiter in all matters relating to the sale of electricity
- To establish rules and guidelines which will allow for consistency, predictability and transparency in the regulation of electricity supply in the nation
- To be a forum for customer appeals in their dealings with the service providers.
- To protect the health and safety of all persons affected by the operators in the sector.
- To support Government’s policy on the supply of electricity for national development.
- To engage and work with other agencies to promote, protect and enhance a sustainable environment.

Functions of the IRC are:

- Encouraging wider availability of electricity supply throughout Dominica.
- Ensuring that all reasonable demands for electricity are met
- Promoting efficiency in the generation, transmission, distribution, supply and use of electricity
- Establishing technical standards applicable to providing electricity service or installed on customer’s premises
- Protecting the interests of consumers
- Facilitating competition in the electricity sector
- Enabling the financial viability of efficient licensees
- Issuing, monitoring and amending licenses and collecting license and other fees
- Establishing and monitoring standards by which the efficiency of the service provision can be evaluated
- Inspecting and testing electrical plant and equipment owned by licensees as well as consumers
- Protecting the health and safety of all persons affected by the operations of the sector
- Protecting the national environment
- Advising the Minister on all issues relevant to the electricity sector
- Promoting wider regional cooperation in the regulation and operation of the electricity sector

Concession holder

The concession for supplying electricity in Dominica has been granted to the private operator, DOMLEC, which is regulated by the Independent Regulatory Commission (IRC) under the Electricity Law of 2006. Therefore, it is the main offtaker for the proposed small geothermal power plant for domestic use in Dominica (SGPP-Domestic).

Dominica Electricity Services Ltd (Domlec) is the sole electric utility for Dominica and it was established as a limited liability company on April 30th 1975, to deal with the business of electricity generation on the island of Dominica. The company operates a mixed hydro and diesel regime with total nameplate capacity of 23.5 MW (hydro 7.6 MW, diesel 15.9 MW) and firm capacity of 14.9 MW (hydro 3.2 MW and diesel 11.7 MW). There are two diesel-generating stations and two hydro-generating stations and a distribution system that serves over 34,000 customers- a figure which accounts for 96% of Dominican households and businesses.

The company was listed on the Eastern Caribbean Securities Exchange in July 2003.

The 2 major shareholders of Domlec are LPH, which now owns 52 percent of the company, and the Dominica Social Security Scheme, which owns 21%. the remaining is owned by other investors.

DOMLEC has reported that investment in new generating capacity will need to be made by year 2017 to cover increasing demand and provide system reliability. If geothermal is to be integrated into the electric system by 2019 or 2020, then DOMLEC would anticipate adding 5 MW of capacity. If a geothermal power plant is not developed, it is anticipated that 5 MW of capacity would need to be added plus certain existing engine generators would need to be replaced.

Figure 4.1-1 shows the key energy entities in Dominica's power sector.

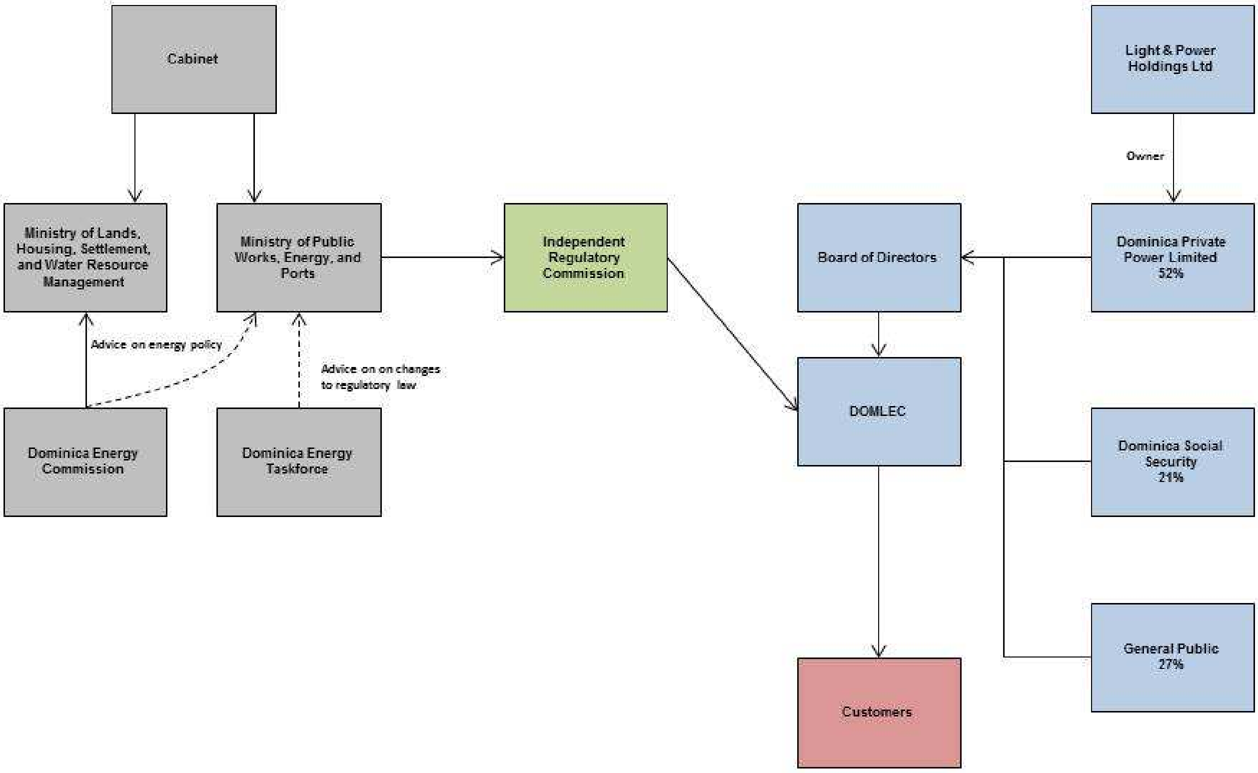

Figure 4.1-1 - Key Entities in Dominica's Power Sector ***(Source: Castalia)***

As system operator, DOMLEC will be responsible for generator dispatching, maintaining sufficient reserve margins, and balancing load flows across the grid after the geothermal plant is introduced. Given the integral role that DOMLEC will play, GoD is working with DOMLEC to ensure that DOMLEC's investment in generation is coordinated with geothermal development.

Indeed GoD is conscious that if the small domestic geothermal power plant (SGPP Domestic) is not properly integrated into DOMLEC's existing base of generation from both a technical and regulatory perspective, Dominica will not maximize its benefits and secure the best electricity tariffs through the introduction of geothermal power generation.

4.2. Regulatory Framework

Existing and pending laws and regulatory policies

The existing and pending laws and regulatory policies that establish the basis for geothermal development in Dominica consist of the following key items:

i. The Physical Planning Act (PPA), 2002 contains rules governing access to, and development of any site. Overall, these planning rules meet the required level of certainty required by an investor. The scope of these planning rules is wide enough to cover a geothermal development, although such developments are not specifically mentioned. These planning rules also provide a framework for protecting against intolerable impacts from any development on the environment and human health and safety.

ii. The Electricity Supply Act (ESA), 2006 contains rules governing the authorization to generate, transmit, distribute, and sell electricity. These rules contemplate multiple service providers, a framework for regulating the relationship between those service providers and the customers (including service standards and tariff setting), and the relationship among these service providers themselves, including the terms and conditions for grid connection and the conclusion of PPAs. These rules meet the required level of certainty required by an investor. The framework includes powers given to the IRC to develop detailed rules to govern matters like principles for PPAs, standards for grid connection and standards for tariffs that promote low cost of electricity to customers while protecting the financial viability of the utility. These rules have not all been made by the IRC.

iii. The draft Geothermal Resources Development Bill, 2013 ('the draft Bill') seeks to provide rules to fill in the following gap in the existing rules: there is no law in force currently in Dominica that Dominica Gap Analysis definitively defines a geothermal resource; who owns it; the process, agency, and legal instrument for granting the right to use it; and the attendant powers, privileges, conditions, and obligations of this right to use. The draft Bill also provides clarity in the potential confusion arising from an overlap of the planning rules and the electricity supply rules relating to the approval process, because geothermal development constitutes at the same time a development subject to the PPA, 2002 and the generation of electricity subject to the ESA, 2006.

iv. The draft Bill is supplemented by draft Environmental and Planning Regulations, 2010 that primarily seek to bolster the PPA, 2002 by establishing rules under that Act to provide protection against impacts that are specific to geothermal development.

GOD to improve laws and regulatory policies

The GoD is conscious that integrating in the short terms an investment that is relatively large in scale compared with the domestic power market and in the medium long term mobilizing large scale investments for an export oriented geothermal project that is comparable to the GDP of Dominica, will require a supportive legal, regulatory, and institutional set-up.

Some key areas that GoD is examining for further work and strengthen are:

- The draft Geothermal Resources Development Bill;
- The new environmental and planning regulations;

Moreover the capacity of several government entities will need to be strengthened to support their evolving role in overseeing the development and use of geothermal resources from technical, commercial, regulatory, and environmental perspectives.

The cost of developing the SGPP will need to be appropriately incorporated into the retail tariff regime through Dominica's regulatory process for electricity in a manner that is adequate for cost recovery (including for any investments required in transmission/distribution) and a reasonable return for investors, pass-on of savings to consumers, and continued service reliability.

For the medium and long terms development of the geothermal resource exceeding this SGPP, the GoD intends to ensure that developers will obtain certainty and clarity with regards to the rules that govern how it can obtain the right to use the geothermal resource to generate electricity, the right to access and develop the site, and the right to sell electricity.

5. THE RESOURCE

5.1. Geology

5.1.1 Geological Setting

The geological setting of the area, as derived from the CFG/BRGM studies and the ELC review, has been described in the "Inception Report: Review of Previous Studies and Planning of Exploratory Drilling" issued by ELC in December 2009. The results of the recently completed drilling campaign only marginally contribute in clarifying such setting and in some instances have actually provided conflicting information, especially with respect to the stratigraphy of the investigated sector. Hereinafter, the geological conditions of the Wotten Waven described in the Inception Report are illustrated, introducing those modifications as deemed opportune based on the data from the wells.

<u>Stratigraphy</u>

The basement of the Wotten Waven area consists of massive lava of Pliocene age, classified as "shield volcano" (which is quite surprising for a convergent-plate tectonic setting) and dated at 2 to 3 Ma. From the lithological point of view, the formation is defined as basaltic andesite to andesite, although the 3 chemical analyses available, with a SiO_2 content ranging between 57% and 62% and a $Na_2O + K_2O$ of 4%, would rather suggest a strictly andesitic composition.

The shield volcano products are overlain by Pleistocenic to Holocenic lavas and tuffs, mostly of acidic composition (SiO_2: 60-65%), which are important for reconstructing the volcanic evolution of the area, but are not expected to have any direct bearing on the nature of the geothermal aquifer formations. The main recent products correspond to the two coalescing domes of Micotrin, occurring in the northern sector of the Project area, while the formation underlying the shield volcano is expected to correspond to brecciated submarine formations (hyaloclastites, self-fragmented lava flows, pillow lavas).

The stratigraphic sequence was intersected by the three wells across a thickness of 900 to 1,100 m (no cuttings were recovered in the bottom portion of the wells due to total circulation losses). These wells form a triangle with short sides (1.5, 1.5 and 0.7 km), wherefore, even taking into account the strong lateral variations that characterize volcanic formations, the extreme stratigraphic differences registered in the wells are quite surprising.

In summary, the following sequences have been encountered:

WW-01 – 10-52 m: clay, sand and conglomerate; 52-408 m: alternating andesite and breccia in equal proportion; 410-882 m: andesite.

WW-02 – 10-152: ash flow deposits; 152-308: dacite; 308-900 m: lithified breccia and tuff with minor intercalations of andesite/dacite or diorite at 332-356 m, 468-484 m and 676-694 m.

WW-03 – 14-440 m: ash flow deposits, tuff and breccia; 440-586 m: igneous rocks (andesite/dacite or diorite) with breccia (40%) intercalations; 586-794 M: tuff and breccia; 794-920 m: andesite/dacite with some pyroclastic intercalations; 920-1174 m: tuff and breccia.

The analysis of the above leads to the following observations:

- In the upper portion of the two wells drilled along the SW flank of the Micotrin domes there is a predominance of ash flow deposits, presumably of very young age and deriving from the same magmatic chamber that fed the domes themselves.
- A 156 m thick level of dacite was intersected in WW-02, but not in WW-03, located only 700 m away, suggesting the existence of a small dome SSW of Micotrin, which has been covered by ash flows.
- In WW-02 and WW-03, below the ash flows and the dacite, a thick sequence of volcanic breccia and tuff with a few intercalations of decametric thickness of a rock alternatively defined as andesite/dacite or as intrusive body is found.
- Moving 1.5 km SW in well WW-01, alternating pyroclastics and andesite are found in the upper 400 m, being underlain by an almost 500 m thick sequence of andesitic lavas. It is interesting to observe that such thick sequence has not been encountered in the other two wells, where pyroclastic products are largely predominating.

It is not easy to explain these extremely sharp lateral differences. The upper section of WW-02 and WW-03 can be correlated by hypothesizing the presence of a small dacitic dome in correspondence of WW-02 covered by pyroclastic flows originating from one or more eruptive centers located NE of the two wells.

On the other side, the absence of a lavic basement in the northern wells could be due to an important downthrow of this sector related with the existence of a caldera, as mentioned in the following paragraph.

These lateral inconsistencies may be at least partly attributed to the fact that the analysis of the cuttings was carried out using binocular microscope examination only: such method is often associated with uncertainties in the lithological classification, especially when the rocks have been affected by intense hydrothermal alteration. Therefore, in order to clarify the issue and to acquire information about the clay typology, it is suggested to use petrological, XRD and Methylene Blue techniques over the available cuttings from the three existing wells.

At any rate it can be confidently stated that the permeability of the wells is only marginally affected by the lithological nature of the formations. In fact, it is observed that the main feed zones, as identified through the circulation losses and the results of the termination tests, can occur indifferently in lavic and pyroclastic products.

Structure

The unavailability of aerial photos of the Project area has hindered to a large extent the CFG structural interpretation, which has been mainly based on the topographic features. The main structural element is a caldera with a diameter of close to 3 km, centered around the Micotrin domes, while two smaller calderas are recognized in the sectors of the Du Mas Estate and of the Valley of Desolation. A very limited amount of faults has been mapped, being the most important one a NNW-SSE element that extends between the Valley of Desolation and the domes complex.

This fault has been confirmed by the analysis of a satellite image from Google, but several additional elements have been recognized, as shown in Figure 5.1-1. It can be noticed that the most prominent system has a NE-SW to NNE-SSW direction, in agreement with the main direction of the joints as mapped by CFG. Two more systems are observed, one running NNW-SSE to N-S (in agreement with the CFG fault) and the other E-W to ESE-WNW. It should be noticed that the almost total absence of lineations in the sector between the villages of Laudat and Wotten Waven is presumably due to the very young age of the pumitic products covering this sector. At any rate, it is recommended to integrate the existing structural interpretation derived from satellite imagery with aerophotogrammetric interpretation, which can provide more detailed information on the structural setting of the area and hence contribute in the selection of the azimuth for the new directional wells to be drilled.

The new structural interpretation based on satellite images does not disprove the CFG one, pointing to the presence of an important volcano-tectonic depression in correspondence with the main expected heat source, where large emissions of volcanic products, mostly pyroclastic flows and dacitic lavas intersected in the upper section of WW-02 and WW-03, took place in a very recent time. This hypothesis appears to be confirmed by the sharp stratigraphic differences registered between wells WW-02 and WW-03 on one side and well WW-01 on the other side, which suggest the existence of an important downthrow of the northern sector.

On the other hand, some lateral discontinuities recognized in the MT profiles might reflect the occurrence of faults, namely:

- The discontinuity registered between MT10 and MT28 on one side and MT02, MT13 and MT32 on the other side, with a downthrow of about 150 m of the western block, might reflect a fault of the N-S system.
- The discontinuity registered between MT22, MT24 and MT31 on one side and MT17, MT19, MT21, MT29 and MT30 on the other side, with a downthrow of 100-200 m of the western block, might reflect a fault of the NNE-SSW system.

5.1.2 Volcanic Evolution

The Project area is characterized by the widespread occurrence of volcanic events, associated with the emission of pyroclastic and lavic products of intermediate composition (andesite and andesitic basalt) during the Pliocene and Pleistocene and the evolution towards more acidic terms in recent times.

Some C^{14} age determinations were carried out over carbonized fragments collected in the latest pumitic flows and at the margin of the Micotrin domes. In the latter location an age of about 25,000 years was obtained for “a lithic pyroclastic flow located in Laudat, which could be a record of the erection of Micotrin”, while values of approximately 1,000 years correspond to the pumitic flows.

Some doubts can be raised on the reliability of these values, especially as refers to the attribution of the Laudat pyroclastic flow to the dacitic emissions. At any rate, it can be confidently stated that the Project area is characterized by the existence of an active magmatic chamber, which, on the base of the chemical composition of the emitted products and of their distribution, is deemed to be very shallow and to be centered in correspondence of the Micotrin complex.

In agreement with the CFG hypothesis, it is considered therefore that such chamber constitutes the main heat source of the area, to be taken as a basic element in the elaboration of the conceptual model of the field.

The results of the recently completed drilling campaign tend to confirm the above described scheme, by indicating the occurrence of acidic lavas and of pyroclastic flows rich in pumice only in the wells located closer to the inferred source of young volcanism, that is in the area of the Micotrin domes complex.

With respect to the "volcanic risk" referable to potential future eruptions, it is reminded that the latest activity registered in the area dates back to some 1000 years. While this fact does not absolutely exclude the possibility of a resumption of the volcanic activity within the next, say, 50 years, it points to the extreme unlikelihood of such event.

5.1.3 Correlation between MT Survey and Drilling Results

As detailed in the Inception Report, the signal quality of the 32 MT soundings carried out in the Wotten Waven area has been on the average poor, reportedly due to anthropic noises, mostly related to the existence of small hydroelectric plants and associated transmission lines, and to the very low solar activity. As a result of this, some soundings exhibit very scattered data (in particular MT05, MT07, MT09, MT15 and MT26) and records below 1 Hz were generally unusable, thus affecting the penetration depth. Such penetration is said to amount to 400-1,000 m, although, according to the resistivity profiles included in the CFG final geophysical report, it appears to be even lower, being usually in the order of 200-500 m.

Moreover, the MT survey was conducted over a limited portion of the area of potential interest, failing to cover the Desolation Valley to the east and the Micotrin Domes to the north, that is two sectors interpreted as potential candidates for geothermal fluids upflow.

It is therefore recommended that, in the framework of the full resources development, this gap is corrected through an extension of the survey to the uncovered zones and a repetition of the most critical among the already performed soundings.

Under this situation, a correlation between the electrostratigraphic sequence derived from the MT soundings and the lithology and secondary mineralogy inferred from the cuttings of the three wells becomes of limited significance.

Hereinafter, the main findings of the MT survey are summarized:

- Most soundings encountered a level of very high conductivity (less than 5 Ohm.m) at a depth of 150-300 m; this conductive layer becomes sub-outcropping in proximity of the main thermal manifestations (MT06, MT13, MT27, MT32).
- The top of the conductive level (TCL) occurs accordingly at an elevation of 250-350 m a.s.l. in the central portion of the investigated area, encompassing Wotten Waven and Laudat and exhibiting a gentle dip to the south.
- Moving eastward towards the Valley of Desolation a fairly sharp rise of the TCL is observed, up to the >500 m a.s.l. registered in MT21, MT29 and MT30. Similarly, moving westward the TCL drops rather abruptly to 120 m a.s.l. in MT10 and MT28.
- These geoelectrical lateral discontinuities may possibly be related to structural features, i.e. to two faults striking NNE-SSW and N-S respectively, although these directions are to be taken as purely indicative, due to the scattered nature of the MT soundings.

- It should be noticed on the other hand that the inferred southern border of the Micotrin caldera, expected to pass approximately in correspondence of soundings MT18 and MT22, has no geoelectrical expression.
- The thickness of the conductive level is poorly defined, since, due to the general low penetration, only few soundings (i.e. MT10, MT19, MT20, MT28, MT29, MT30) encountered the underlying resistive basement. Whenever this occurred, the thickness of the conductive layer was found to be in the range of 200-300 m, rising to 400 m in the western portion of the investigated area.
- The conductive layer can be obviously correlated with the strongly argillitic cap rock of the geothermal system. The resistivity value of this layer ranges in general between 1 and 7 Ohm.m and such value has been adopted as one of the criteria for defining the lateral limits of the reservoir (see paragraph 2.2).
- The underlying basement, whenever reached, occurs at a depth of 400-600 m and has a resistivity of 15-80 Ohm.m, which is fully compatible with a propylitic rock permeated with high salinity, hot fluids.

The three recently drilled wells fall in the central sector of the MT investigated area, where the TCL occurs at an elevation of about 300 m a.s.l. In particular [1]:

a. **Well WW-01 –** Soundings MT13, MT16, MT32. The TCL occurs at an elevation of 250-300 m a.s.l. and the level has a resistivity of 1-2 Ohm.m. Actually, in well WW-01 at an elevation of 270 m a.s.l. strong alteration starts almost from the well head and it extends through a thickness of about 250 m.

b. **Well WW-02 –** Soundings MT18, MT22, MT24. The TCL occurs at an elevation of 300-350 m a.s.l. and the level has a resistivity of 2-4 Ohm.m. In this well, located at an elevation of 590 m a.s.l., hydrothermal alteration is said to become fair at a depth of 250 m (340 m a.s.l.) and high at a depth of 350 m (240 m a.s.l.), while the beginning of a temperature in excess of 180 °C is set at about sea level.

c. **Well WW-03 –** MT04, MT23, MT24. The TCL occurs at an elevation of 350-380 m a.s.l. and the level has a resistivity of 3-4 Ohm.m (except for MT23, with a resistivity of 12 Ohm.m). In this well, located at an elevation of 560 m a.s.l., strong hydrothermal alteration starts at a depth of 240 m (320 m a.s.l.), while "great abundance of clay" is said to extend down to a depth of 440 m (120 m a.s.l.).

It can be seen from the above that there is an excellent correlation between the configuration of the TCL and the top of the strongly altered horizon, presumably corresponding to the roof of the cap-rock. Unfortunately, due to the very limited penetration of the MT soundings, it is not possible to verify whether such correlation applies also to the bottom of the cap-rock, which in principle might be associated with the assumed temperature of 180 °C identifying the passage from the smectite to the

[1] The following description of the electrostratigraphic sequence is based on the resistivity values indicated in Annex 7 of the BRGM geophysical report.

illite-smectite zone. In the profile of Figure 5.1-2 a thickness of the cap-rock of 300 m has been assumed, based on the data of the few soundings which intersected the resistive basement.

5.1.4 Secondary Mineralogy

The secondary mineralogy encountered in the wells was identified through binocular microscope analysis of the cuttings and only a qualitative estimate of the individual minerals content (abundant, minor, in traces…) was provided, except for calcite and pyrite. It should be mentioned that the exclusive application of this analytical method introduces significant uncertainties in the determinations, due to the difficulty of recognizing some of the most significant minerals, e.g. actinolite and some forms of epidote.

Moreover, some discrepancies are noticed between the description of alteration presented in paragraph 3.2 of the well logging reports by ISOR and the corresponding figures of secondary minerals distribution. For example, in well WW-03 it is said that “the hydrothermal alteration from 248 m and to about 440 m is characterized by great abundance of clay” (which incidentally corresponds very well to the extent of the highly conductive level), but this statement is not supported by the graphics of Figure 10 of the same report, where clay, subdivided into “clay, fine grained clay, coarse grained clay” is practically not appearing. In spite of the above, some useful elements can be derived from the analysis of the secondary minerals distribution:

1. On the whole, a sharp distinction is observed between WW-01 on one side and WW-02 and WW-03 on the other side. In the former case, hydrothermal alteration start almost from the well head, in the latter case from a depth of 250-300 m, as reflected by the first appearance of calcite and pyrite.
2. Such difference is registered also in the appearance of other minerals, e.g. of quartz, which was first found at 260 m depth in WW-01 and at about 500 m depth in WW-02 and WW-03.
3. Epidote, which is the most significant secondary minerals in terms of temperature of formation, was first recognized at 600 m in WW-01 and at 1060 m in WW-03, while it was not observed in WW-02 up to the final cuttings recovery depth of 900 m [2].
4. The distribution of clay, which at least partly is expected to correspond to the cap rock horizon, is not clearly expressed in the various logs. In WW-01 clay is said to be present “throughout the well”, in WW-02 to appear at 250 m (but no indication is given on its extent below this depth) and in WW-03 to be “abundant” between 238 m and 440 m.
5. In general, based on the secondary mineral assemblage, temperature estimates in the different wells are proposed (Figure 5.1-2), with the warning that these values not necessarily correspond to present temperatures, but may reflect fossil conditions:

[2] Actually, in the log of WW-02 presence of epidote was dubitatively reported at 680 m depth, but this attribution was later disproved in the following reports.

Well	Temperature		
	<180°	**180-240°C**	**>240°C**
WW-01	0-170 m	170-600	>600 m
WW-02	0-600 m	600->900 m	N.D.
WW-03	0-600 m	600-1050 m	>1050 m

It can be noticed that these estimates are on the whole in line with the temperatures actually measured in the wells shown in Figure 5.1-3.

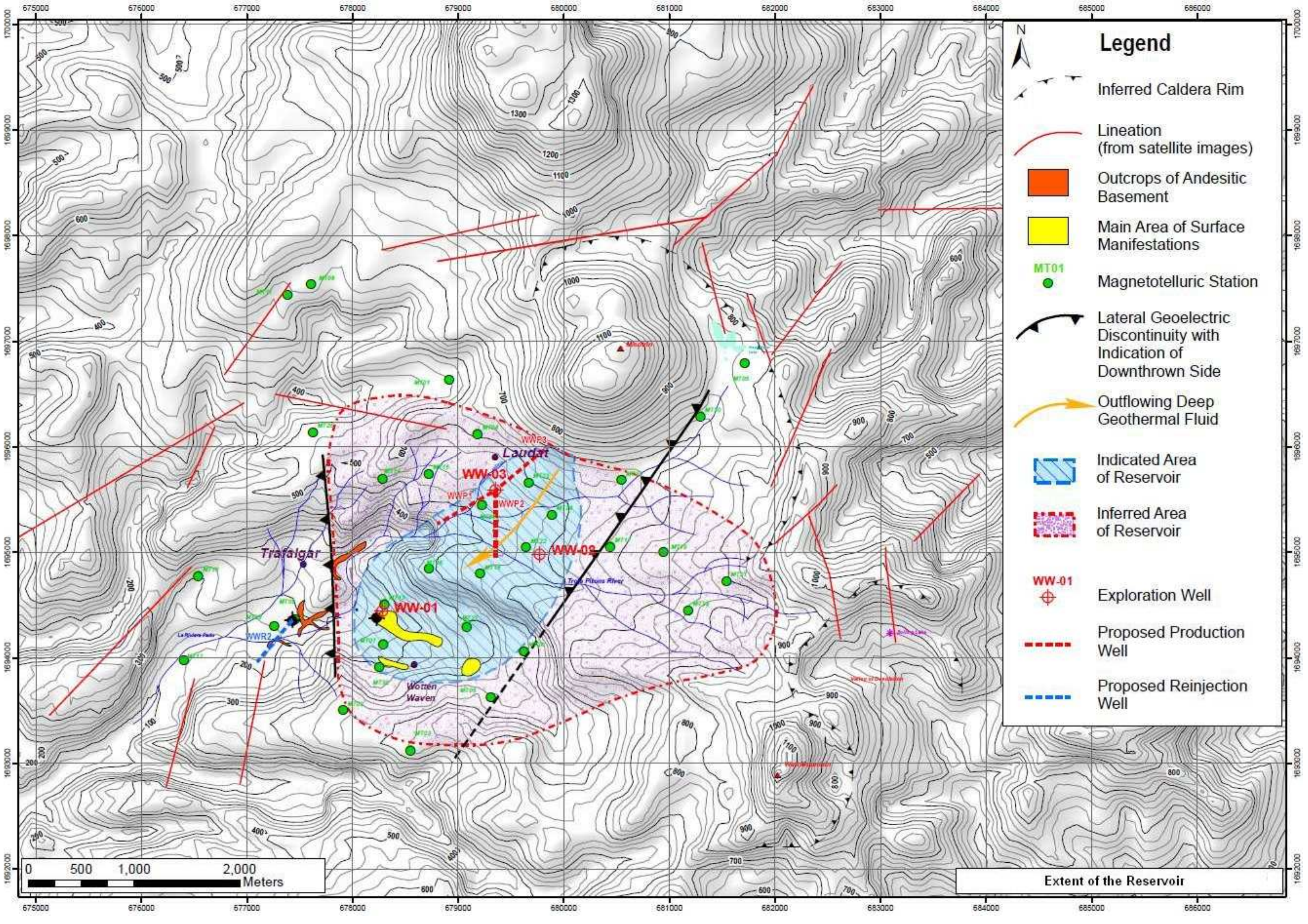

Figure 5.1-1: Extent of the Reservoir

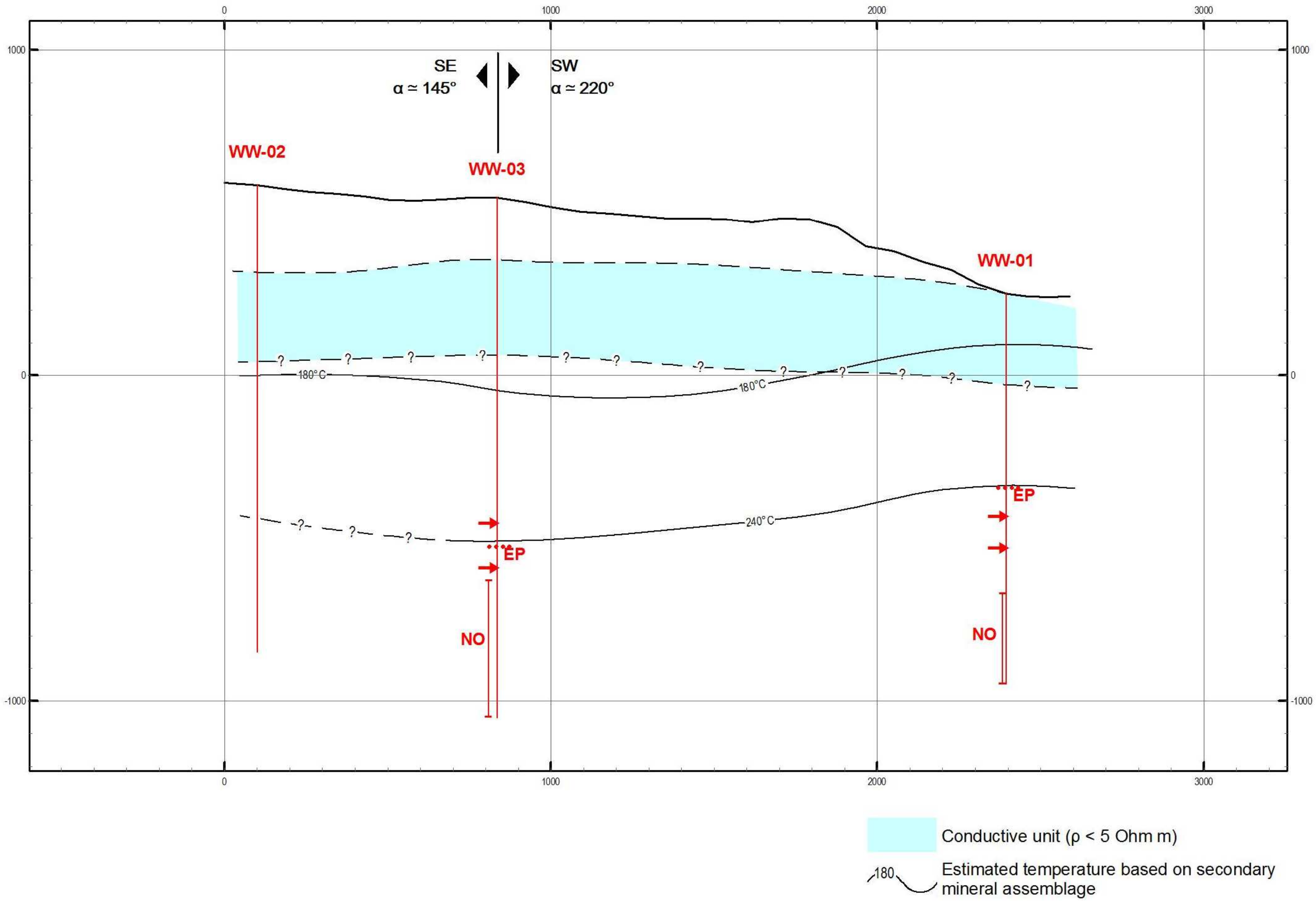

Figure 5.1-2: Extent of conductive unit and inferred underground temperature

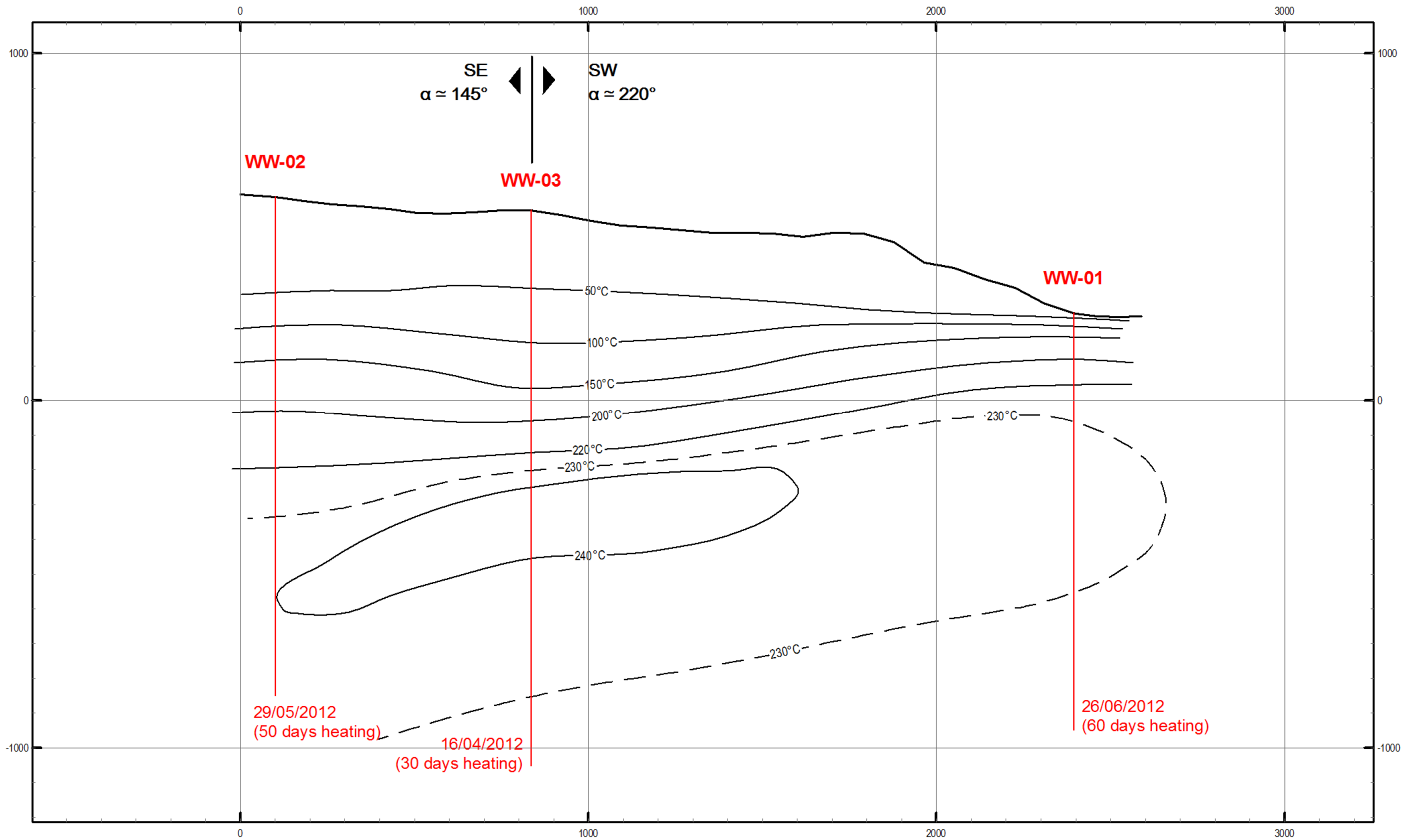

Figure 5.1-3: Temperature profile

5.2. Geochemistry

This section is aimed to present and discuss the chemical characteristics of the geothermal fluids encountered by wells WW-01, WW-02, and WW-03, including their scaling and corrosion potential, as well as to summarize the geochemical features of the numerous thermal manifestations situated in the Wotten Waven geothermal field.

First of all, it is worth to recall that knowledge of magmatic-hydrothermal systems is a never ending process, chiefly due to the time changes in magmatic activity and, consequently, in the chemical and isotopic characteristics of related fluids. As a matter of fact, geochemical surveillance is based on this axiom.

Second, it must be emphasized that it is very difficult to achieve the objectives that one may set from an ideal point-of-view, without considering the constraints that do exist in the real world, not only time and money, but also environmental care and protection. For instance, long-term tests of geothermal wells are highly desirable, again from an ideal point-of-view, to acquire a good knowledge of fluid chemistry *inter alias*. However, they are impossible to realize, in practice, if effluents cannot be properly disposed.

Third, we realize that our present state of knowledge on the geochemistry of the fluids of interest is still incomplete, but the only way to improve it is through synergistic efforts of the different actors involved in the project, also by means of constructive critiques, whereas destructive reviews are useless and have detrimental effects.

5.2.1 Chemistry of Surface Fluids

A comprehensive information is available on the chemistry and isotope chemistry of geothermal liquids discharging at the surface in the Wotten Waven geothermal field, including major dissolved constituents, minor components of geothermal interest, numerous traces, and several isotopic parameters (BRGM, 1985; Lasne and Traineau, 2005, 2008; Traineau et al., 2008). However, chemical and isotopic data on Boiling Lake and gas composition of fumarolic fluids were missing before the recent study by Erouscilla et al. (2011) and, unfortunately, carbon dioxide fluxes from soil were never mapped.

a. Thermal manifestations

The main zones of thermal manifestations present in the study area are (i) the River Blanc zone, in the middle part of the Wotten Waven depression, and (ii) the Boiling Lake - Valley of Desolation zone, east of Wotten Waven (Figure 5.2-1).

The ***River Blanc zone*** (between 200 to 300 m asl) is a large area of thermal manifestations comprising numerous thermal sites scattered all along the valley of the River Blanc. The most prominent thermal site is a solfatara situated on the left side of the valley at ~230-240 m asl, where several fumaroles, steaming grounds, mud pools and hot springs are present. Other smaller, less intense thermal sites are present upstream of it, whereas manifestations are less common downstream of it. However, several hot springs and fumaroles are present at the confluence of the River Blanc with the Trois Pitons River. Several hot springs discharging hot mineralized fluids (electrical conductivity >2,000 µS/cm) are found in the lower part of River Blanc (between the bridge and its confluence with the Trois Pitons River) and in the Roseau River.

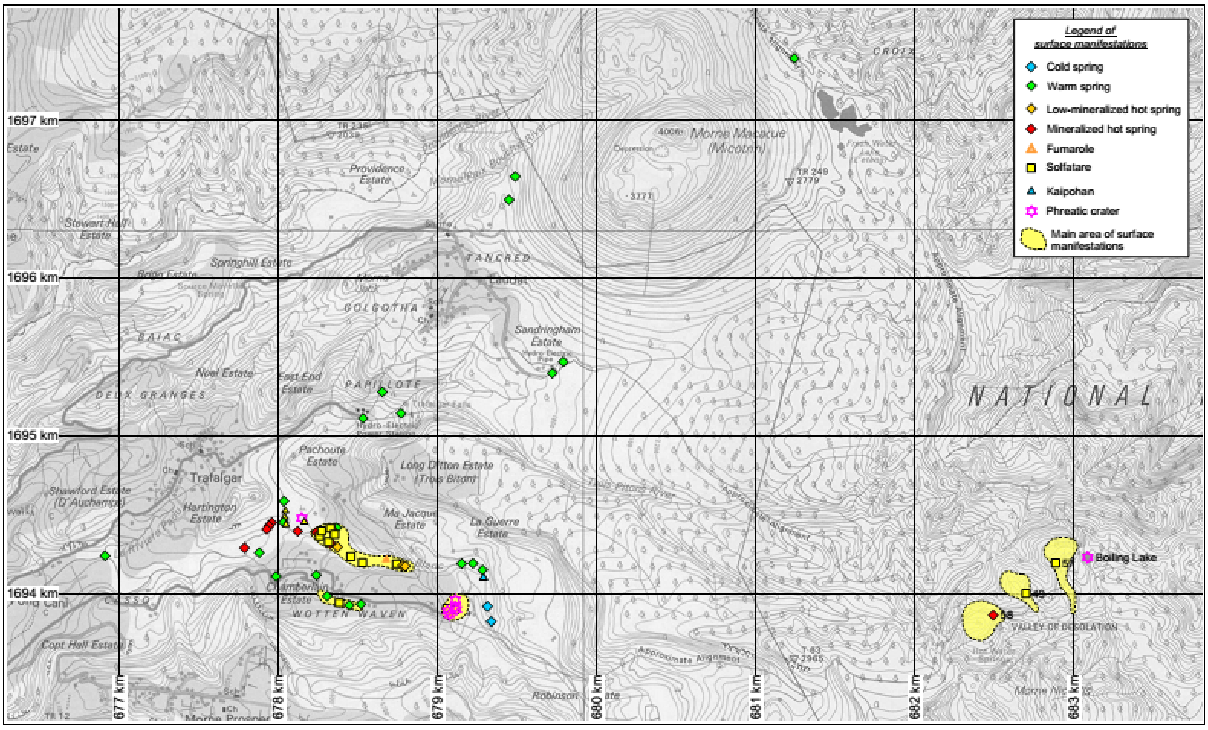

Figure 5.2-1 Location map of thermal manifestations of the Wotten Waven geothermal field (from Traineau et al., 2008). Coordinates in UTM WGS84. Elevation in feet.

The ***Boiling Lake - Valley of Desolation zone*** is situated at an average elevation of ~800 m asl and comprises four main thermal sites, in which numerous hot springs and bubbling pools (with outlet temperatures from 40 to 96 °C) and fumaroles (with discharge temperature from 91 to 99 °C) are present (Figure 5.2-2). Argillic to advanced argillic hydrothermal alteration is widespread with occurrence of sulfate minerals, elemental sulfur, silica, and clay minerals. The hot spring VD-1 (where sample DM26 was collected too) discharges a high-salinity aqueous solution with electrical conductivity of 13,000 µS/cm. Two historical hydrothermal eruptions occurred in the Valley of Desolation, in 1880 and 1997 as reported by Erouscilla et al. (2011) and references therein.

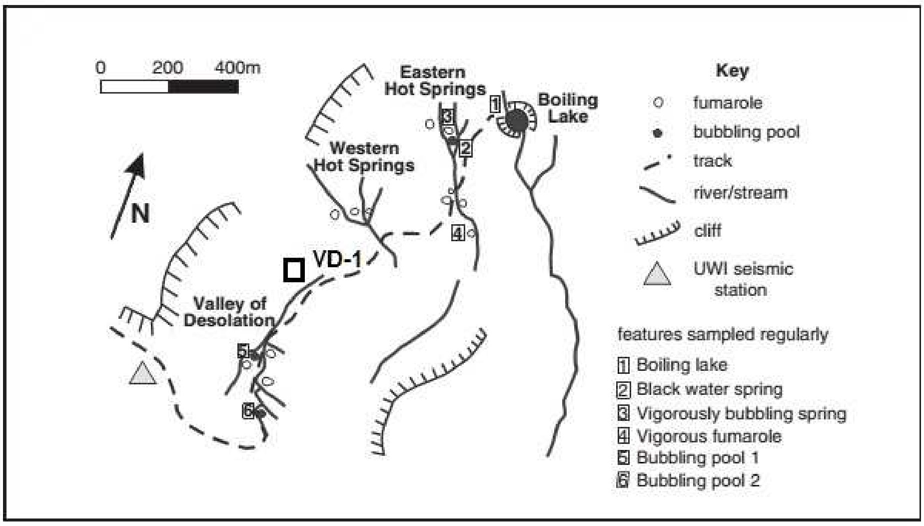

Figure 5.2-2 Location map of the thermal manifestations in the Boiling Lake - Valley of Desolation zone (from Erouscilla et al., 2011).

The Boiling Lake is a high-temperature volcanic crater lake of ~50 m × 60 m in size and 12 to 15 m in depth, with an estimated volume of ~1.22 $\times 10^4$ m^3 when it is filled (Erouscilla et al., 2011 and references therein). The vigorous gas upflow gives the impression of boiling. The crater possibly formed as a result of an hydrothermal or phreatomagmatic explosion. Both an inflow, on the northern side via a fresh-water stream, and an outflow, on the southern rim, are present. The inflow and outflow have nearly constant flow rate apart from periods of heavy rainfall, when both are temporarily increased. During the last 150 years, temperatures from 80 to 90 °C and pH from 4 to 6 were measured near the lake shores during periods of steady-state activity. However, the lake water level and temperature have experienced dramatic changes in the past, consisting in quick emptying followed by gradual refilling of the lake basin, likely due to either landslides or seismic activity. The most recent emptying event took place in December 2004, when a water level decrease of ~8-10 m was recorded, with concurrent drops in temperature (from 80-90°C to 30°C), Cl content (from 2000-6000 to 30-50 mg/kg), and SO_4 content (from 1500-4000 to 100-270 mg/kg), whereas pH changed from acidic to neutral (Erouscilla et al., 2011). These month-long variations were ascribed to a drastic decrease of hydrothermal input related to a perturbation in the lake, probably seismically induced, by Erouscilla et al. (2011). More specifically, "*the increase in temperature, and change in chemistry to a more acid sulphate type character when normal geothermal activity resumes is likely the result of heating of the shallow aquifer by the acidic fluids sourced from the boiling of a deep-seated hydrothermal system*". Therefore, there is no direct inflow of magmatic fluids in the Boiling Lake waters.

b. Water chemistry

In previous studies (BRGM, 1985; Lasne and Traineau, 2005, 2008; Traineau et al., 2008; Erouscilla et al., 2011), water classification was carried out by using the triangular Cl-SO_4-HCO_3 plot of Giggenbach (1988), several chloride plots and the classic δD-$\delta^{18}O$ diagram, to individuate the different chemical types of waters, mixing processes, and possible relationships between different waters. In this way, the following water types were recognized:

(i) Bicarbonate waters of Ca-Na-HCO_3 and Na-HCO_3-SO_4 composition and low salinity, corresponding to the peripheral waters of Giggenbach (1988), which are typically found on the edges and above the high-temperature geothermal reservoirs. These waters are originated through absorption of geothermal gases and/or steam in relatively shallow aquifers which, however, are not connected to the atmosphere. In the absence of oxygen inflow, H_2S is not oxidized to H_2SO_4 and bicarbonate is the dominant anion.

(ii) Acid-sulfate waters, corresponding to the steam-heated waters of Giggenbach (1988), which are typically found above the upflow parts of geothermal systems, where steam separation (boiling) occurs. The CO_2- and H_2S-rich separated vapor phase partly discharges through fumaroles, without any interaction with shallow or surface waters, and partly is absorbed in shallow groundwaters or surface waters to form steam-heated acid-sulfate waters. The chemistry of these waters is governed by oxidation of H_2S to H_2SO_4 driven by atmospheric oxygen. The H_2SO_4 thus produced is partly neutralized through interaction with rocks.

(iii) Neutral chloride waters of Na-Cl composition and salinity of 1.2-4.9 g/kg. These is the typical composition of the "mature waters" circulating in high-enthalpy geothermal reservoirs. In the study area, neutral chloride waters, affected by mixing with shallow waters, are discharged by the springs situated in the lower part of River Blanc (between the bridge and its confluence with the Trois Pitons River) and in the Roseau River.

(iv) Neutral chloride waters of Ca-Na-Cl composition and salinity of 9.4-10.7 mg/kg, discharged from hot spring VD-1 (where sample DM26 was collected too) and the neutral Na-Cl water, rich in Ca and

SO_4 of Boiling Lake, when it is close to steady state. The high Cl content of these waters is probably related to input of HCl-bearing magmatic gases in the aquifer of provenance. The high SO_4 of Boiling Lake may derive from oxidation of H_2S and disproportionation of SO_2 (e.g., Giggenbach, 1987). Different precipitation of sulfate minerals explains the different SO_4 contents of these two types of water. They possibly derives from mixing of arc-type magmatic water and shallow groundwaters, as indicated by isotopic characteristics and discussed in the next section.

c. Stable isotopes of water

Available data of surface manifestations are shown in the correlation plot of δD vs. δ^{18}O values (Figure 5.2-3), where the worldwide meteoric water line (MWL):

$$\delta D = 8 \cdot \delta^{18}O + 10$$

and the Guadeloupe MWL (Benauges, 198, quotation in Lasne and Traineau, 2005):

$$\delta D = 8 \cdot \delta^{18}O + 16,$$

are also displayed for reference, together with the "arc-type magmatic water" or "andesitic magmatic water", with δD of -20 ± 10 ‰ and δ^{18}O assumed to be equal to +8.5 ± 1.5‰ units (Giggenbach, 1992).

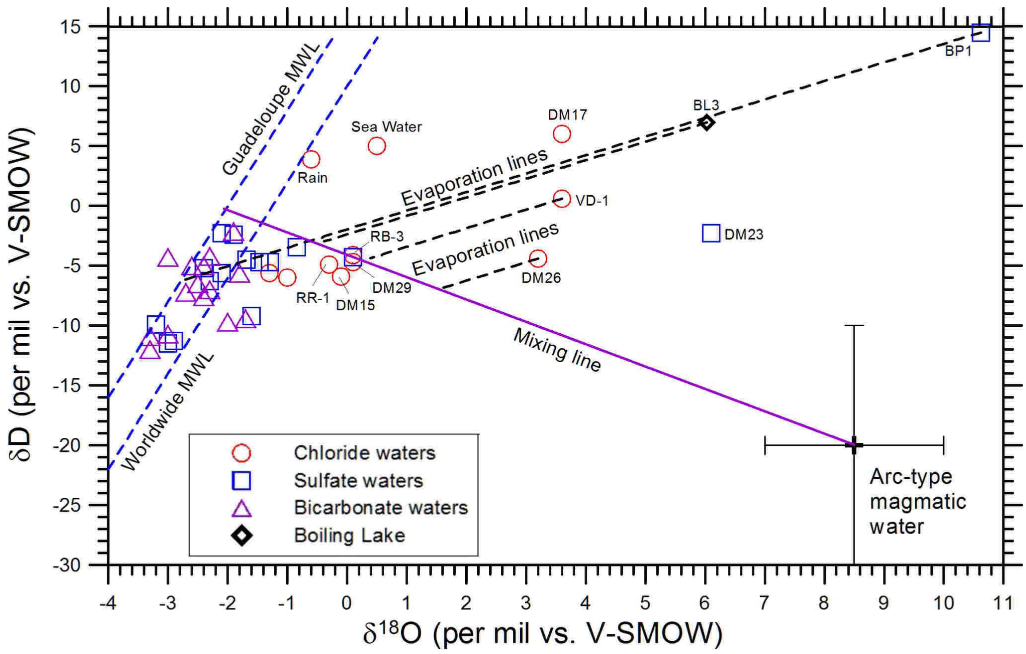

Figure 5.2-3 Correlation plot of δD vs. δ^{18}O values for the surface manifestations from the study area.

As expected, local bicarbonate groundwaters and the local rain sample are positioned between the worldwide MWL and the local MWL, in agreement with their meteoric origin.

Assuming that the neutral Na-Cl samples RB-3 and DM29 are representative of the Wotten Wawen geothermal reservoir liquid, this would be recharged by 80% meteoric waters and 20% of "arc-type magmatic water", as indicated by its position on the mixing line between meteoric water and "arc-type magmatic water".

Some acid-sulfate, steam-heated waters (e.g., BP1, DM23) present strong enrichments in heavy isotopes, especially in ^{18}O, likely due to non-equilibrium surface evaporation, as typically observed in these type of thermal manifestations. In particular, the bubbling pools of the Valley of Desolation (the most shifted of which from the local MWL is BP1, with $\delta^{18}O$ of 10.62‰ and δD of 14.5‰) define an evaporation line with a slope $\Delta\delta D/\Delta\delta^{18}O$ of 1.55.

Surface evaporation affects also Boiling Lake (sample BL3), as expected. The intersection of the evaporation line (of slope 1.55) with the mixing line between meteoric water and “arc-type magmatic water” indicates the underlying hydrothermal aquifer is recharged by by 14% of meteoric waters and 86% of “arc-type magmatic water”.

It is possible that evaporation processes also influences spring VD-1 (samples VD-1 and DM26). If so, the intersection of the evaporation lines (of slope 1.55) with the mixing line between meteoric water and “arc-type magmatic water” suggests that the aquifer of provenance of spring VD-1 is recharged by 21-33% of meteoric waters and 67-79% of “arc-type magmatic water”.

d. Water geothermometers

Since sodium-chloride waters are affected by mixing with shallow waters, it is advisable to use an iso-chemical geothermometric mixing model, following the approach of Chiodini et al. (1996) and Aguilera et al. (2005), to obtain the reservoir temperature and the chloride concentration of the geothermal endmember. The equilibrium temperatures computed for variable chloride concentrations by means of the Na-K geothermometer of Fournier (1979), the quartz geothermometer of Fournier (1973), and the K-Mg geothermometer (Giggenbach, 1988), converge for a chloride concentration of 2610 mg/L and a reservoir temperature of 203 ± 1°C. The equilibrium temperatures calculated for varying chloride contents by means of the Na-K geothermometer of Giggenbach (1988) and the silica geothermometer of Giggenbach et al. (1994) converge for a chloride concentration of 3900 mg/L and a reservoir temperature of 217°C, whereas the K-Mg geothermometer cannot be used as negative Mg contents are computed for Cl > 2700 mg/kg approximately.

Geothermometric results for the Ca-Na-Cl spring VD-1 show a disequilibrium condition, with a K-Mg temperature close to 115°C, representing a reasonable temperature for the aquifer of provenance.

The Boiling Lake sample closest to steady-state condition has Na-K temperature of ~175°C (geothermometer of Fournier, 1979) and K-Mg temperature of ~150°C.

e. Conceptual model

Based on available evidence summarized above, the conceptual geothermal model proposed by Lasne and Traineau (2005) appears to be the most likely one, introducing some changes, chiefly deriving from the new data of Erouscilla et al. (2011). The conceptual geothermal model assumes the presence of three distinct geothermal reservoirs.

Two, of limited size, are present below the Boiling Lake-Valley of Desolation zone, namely: (i) the aquifer discharging at Boiling Lake, which hosts a neutral Na-Cl water, relatively rich in Ca and SO_4, with temperature of 150-175°C, and (ii) the aquifer below Valley of Desolation and discharging at spring VD-1, which hosts a neutral Ca-Na-Cl water with temperature close to 115°C.

Another is developed in a larger area between Fresh Water Lake and Wotten Waven, comprising the Micotrin lava dome and hosts a neutral Na-Cl water. As indicated by the iso-chemical geothermometric mixing model, it has probably a chloride concentration of 2610 mg/L and a temperature of 203 ± 1°C, although the second possibility (chloride concentration of 3900 mg/L and reservoir temperature of 217°C) cannot be neglected.

The two geothermal aquifers present below the Boiling Lake-Valley of Desolation zone do not represent interesting objectives for commercial geothermal exploitation as they are of limited areal extension and volume. They appear to be totally unrelated with the geothermal reservoir discharging at Wotten Waven. Only the geothermal reservoir discharging at Wotten Waven is commercially-exploitable.

5.2.2 Chemistry of the Geothermal Fluids

The chemical composition of geothermal fluids under reservoir conditions was computed by means of the computer code WATCH, version 2.4 (Bjarnason, 2010), for available pairs of separated liquids and separated vapors from wells WW-01, WW-02, and WW-03. Obtained total concentrations of non-volatile constituents and TDS of the reservoir liquids are listed in Table 5.2-1, whereas the total concentrations of volatile constituents, carbonate speciation, and gas partial pressures are given in Table 5.2-2. Saturation index with respect to relevant minerals are listed in Table 5.2-3. Table 5.2-4 reports the molar fractions of gas species on a total discharge basis, computed according to Giggenbach (1980), that is considering vapor-liquid partitioning of gas species; vapor-liquid distribution coefficients were taken from Giggenbach (1980) for CO_2, H_2S, N_2, CH_4, and H_2, and from Naumov et al. (1974) for Ar. The following points must be underscored.

(1) In the case of liquids separated at 1 bar and vapors sampled at separation pressure greater than 1 bar, the composition of the vapor phases at 1 bar was computed by means of simple mass balances, again considering vapor-liquid partitioning of gas species. In fact, it is preferable to recalculate the composition of the vapor phase instead of that of the liquid phase, as it is not necessary to take into account speciation for the vapors, whereas speciation has to be considered for the liquids.

(2) The pH of 4.09 (at 24.1°C) of the separated liquid sample 866 from well WW-01 (separation pressure of 21 bar-a) seems to be affected by either occurrence of interfering processes (e.g., oxidation of dissolved H_2S to H_2SO_4) or analytical uncertainties. Adoption of this low pH value leads to a computed pH of 4.15 for the liquid separated at 1 bar. This computed pH is at variance with the values measured at the weir box during the flow test, ranging from 8.03 to 8.24. Therefore, a value of 6.62 was assumed for the liquid separated at 21 bar-a, based on the pH computed for sample 867 of well WW-01 at this separation pressure.(3) Very high gas concentrations are reported for the vapor samples of well WW-02, corresponding to total gas contents of 34 to 63 wt %, in the vapor separated at 4.7 to 4.9 bar-a, and of 5.4 to 10.1 wt% on a total discharge basis. Assuming that gases are initially dissolved into a single liquid phase, under reservoir conditions, leads to unacceptably high P_{CO2} values of 164 and 227 bar, for samples 826 and 820, respectively. The alternative explanation, namely inflow of gas into the well from a feed zone different from the liquid-contributing feed zones, appears to be more likely, in agreement with other indications. Gas concentrations in the reservoir liquid of well WW-02 were therefore computed assuming the same CO_2 content of well WW-01, at the same separation conditions, whereas H_2S contents were obtained through a H_2S vs. CO_2 correlation plot (not reported). Other gas species were neglected as values too high were estimated through a similar approach.

(4) Silica, total CO_2 and total H_2S contents are not available for the liquid sample 826 of well WW-02, which was collected at the weir box. A silica content of 468 mg/kg was estimated using the maximum-steam-loss quartz geothermometer (of Fournier, 1973), assuming that it provides the same temperature of the Na-K geothermometer (of Fournier, 1979). A total CO_2 concentration of 111.4 mg/kg and a total H_2S content of 5.98 mg/kg for this weir-box liquid were estimated based on the WATCH simulation for sample 820, also from well WW-02, at separation pressure of 1 bar-a.

Tables 5.2-1 and 5.2-2 show that geothermal reservoir liquids are aqueous solutions rich in Na (978-1757 mg/kg), Cl (1545-3091) mg/kg, and total CO_2 (1466-4539 mg/kg), with TDS ranging from 3195 to 5751 mg/kg. Reservoir pH varies between 5.3 and 6.1, with three values close to 5.7-5.8 pH units.

At these reservoir pH values, aqueous CO_2 is the dominant carbonate species, with concentrations of 1426 to 4499 mg/kg (almost coinciding with those of total CO_2), corresponding to CO_2 partial pressures of 3 to 9 bars under reservoir conditions. After CO_2, the second most important gas is H_2S, with total concentrations varying over 2 orders of magnitude, from 24.2 to 220 mg/kg, and aqueous H_2S largely prevailing over HS^- ion. Nitrogen and Ar are also highly variable (see Table 5.2-4), possibly due to varying contributions of atmospheric gases introduced by drilling fluids. However, oxygen was detected only in the first samples taken from wells WW-01 (code 868, 24.2 mg/kg) and WW-02 (code 820, 3.66% by volume, corresponding to 17345 mg/kg), whereas O_2 resulted to be absent in all other gas samples. Presence of O_2 implies that contents of reduced gas species are probably underestimated in samples 868 and 820.

Table 5.2-3 indicates that reservoir liquids are: (i) close to saturation with quartz and its microcrystalline variety (chalcedony) but undersaturated with respect to amorphous silica, as generally observed in geothermal systems; (ii) oversaturated with calcite, possibly due to occurrence of degassing under reservoir conditions; (iii) undersaturated with anhydrite, in line with the relatively low concentrations of Ca and SO_4; (iv) relatively close to saturation with respect to adularia, but generally departing from this condition with other typical hydrothermal Al-silicates (e.g., albite, Mg-chlorite, muscovite, prehnite, wairakite, and epidote). These deviations from equilibrium might be due to analytical uncertainties on Al concentration and Fe concentration, both showing significant changes from sample to sample.

The Na-Cl composition of geothermal reservoir liquids is clearly indicated by the triangular plots of major anions and major cations (Figure 5.2-4), also reporting the data of surface discharges for comparison.

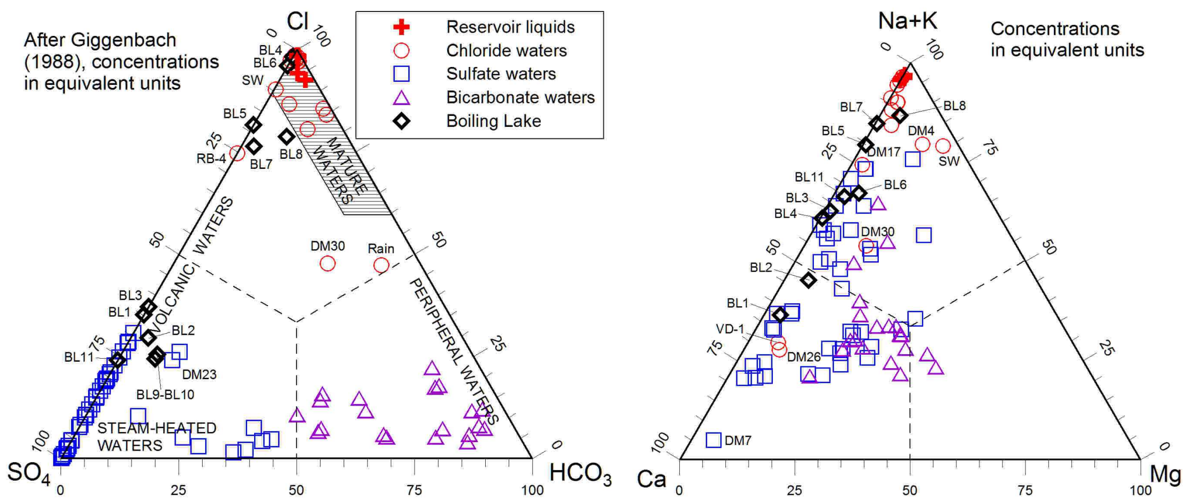

Figure 5.2-4 Triangular diagrams of major anions (left) and major cations (right) for the reservoir liquids of wells WW-01, WW-02, and WW-03, also reporting the data of surface discharges for comparison (SW is average seawater).

Table 5.2-1 Total concentration of non-volatile constituents and TDS, computed by means of WATCH, version 2.4 (Bjarnason, 2010), for the reservoir liquid phase tapped by wells WW-01, WW-02, and WW-03

Well	Sample	Date	Time	P_{sep}	T_{sep}	H	res. T	res. pH	B	SiO_2	Na	K	Mg	Ca	F	Cl	SO_4	Al	Fe	TDS
				bar-a	°C	kJ/kg	°C		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
WW-01	866	27.6.2012	14-16	21.0	214.9	1030	238.5	5.756	32.94	423.6	1544	214.6	0.042	57.89	0.631	2560	15.34	0.120	0.060	4889
WW-01	867	27.6.2012	16:30	1.0	100.0	1030	238.5	5.712	35.73	476.1	1757	244.3	0.033	65.11	0.824	3091	17.72	0.164	0.106	5751
WW-02	820	10.3.2012	14:00	3.7	141.0	986	229.0	6.068	19.60	349.6	1029	129.9	1.772	27.20	0.637	1625	42.14	0.080	0.442	3393
WW-02	826	13.3.2012	16:20	1.0	100.0	925	216.0	5.715	18.63	363.3	978.0	108.7	4.028	29.26	0.652	1545	59.30	0.220	1.707	3195
WW-03	835	17.4.2012	14:00	13.1	192.0	1062	245.0	5.323	30.64	449.2	1357	207.5	0.175	58.66	1.086	2425	23.11	0.297	0.008	4591

Table 5.2-2 Total concentration of volatile constituents, carbonate speciation, and gas partial pressures, computed by means of WATCH, version 2.4 (Bjarnason, 2010), for the reservoir liquid phase tapped by wells WW-01, WW-02, and WW-03.

Well	Sample	$CO_{2,T}$	$H_2S_{,T}$	$NH_{3,T}$	H_2	CH_4	N_2	$CO_{2(aq)}$	HCO_3^-	CO_3^{--}	P_{CO2}	P_{H2S}	P_{NH3}	P_{H2}	P_{CH4}	P_{N2}
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	bar	bar	bar	bar	bar	bar
WW-01	866	1466	24.2	nd	0.04	0.06	3.85	1426	39.6	0	2.95	0.0240	nd	9.47E-03	1.81E-03	9.15E-02
WW-01	867	2477	41.5	nd	0.08	0.10	6.02	2415	62.0	0	5.00	0.0413	nd	1.81E-02	2.73E-03	1.43E-01
WW-02	820	2549	52.7	nd	nd	nd	nd	2414	167.6	0.01	5.21	0.0485	nd	nd	nd	nd
WW-02	826	2102	65.6	nd	nd	nd	nd	2030	86.9	0	4.61	0.0660	nd	nd	nd	nd
WW-03	835	4539	219.6	0.53	1.1	0.71	83.02	4499	38.2	0	9.00	0.2240	7.47E-05	2.40E-01	1.89E-02	1.80E+00

Table 5.2-3 Saturation index with respect to relevant minerals and redox potential for the reservoir liquid phase tapped by wells WW-01, WW-02, and WW-03; calculations were carried out by means of WATCH, version 2.4 (Bjarnason, 2010).

Well	Sample	Anhydrite	Calcite	Chalcedony	Fluorite	Quartz	$SiO_{2(am)}$	Adularia	Albite	Muscovite	Mg-chlorite	Prehnite	Wairakite	Epidote	Eh H_2S (mV)
WW-01	866	-0.444	0.599	-0.11	-2.17	0.01	-0.464	-0.05	0.589	2.864	-7.949	1.579	1.027	-1.051	-447
WW-01	867	-0.431	0.727	-0.06	-1.98	0.06	-0.414	0.268	0.909	3.519	-8.587	1.865	1.465	-0.561	-444
WW-02	820	-0.446	0.933	-0.15	-2.51	-0.03	-0.521	-0.56	0.117	1.523	1.151	0.45	-0.162	-1.084	-469
WW-02	826	-0.308	0.258	-0.08	-2.38	0.053	-0.466	-0.05	0.658	3.627	-0.182	0.594	0.769	-0.395	-408
WW-03	835	-0.193	0.266	-0.11	-1.95	0.006	-0.457	0.309	0.914	4.719	-7.002	1.672	1.888	-2.116	-410

Table 5.2-4 Molar fractions of gas species on a total discharge basis for wells WW-01, WW-02, and WW-03.

Well	Sample	P_{sep}	T_{sep}	X_H_2O	X_CO_2	X_H_2S	X_Ar	X_N_2	X_CH_4	X_H_2
		bar-a	°C							
WW-01	868	18.9	209.4	9.992E-01	7.436E-04	1.277E-05	1.995E-07	1.574E-05	8.067E-08	4.485E-07
WW-01	869	18.5	208.5	9.993E-01	7.128E-04	1.611E-05	4.671E-08	3.182E-06	9.130E-08	4.615E-07
WW-01	866	21	214.9	9.994E-01	5.855E-04	1.322E-05	3.767E-08	2.574E-06	7.357E-08	3.716E-07
WW-01	867	21.8	216.8	9.991E-01	9.145E-04	2.043E-05	3.240E-08	3.627E-06	9.906E-08	6.385E-07
WW-02	820	4.9	142.7	9.623E-01	3.590E-02	1.438E-04	9.295E-06	1.227E-03	2.136E-04	1.920E-04
WW-02	826a	4.7	140.8	9.598E-01	3.867E-02	1.705E-04	5.914E-06	9.328E-04	2.263E-04	1.997E-04
WW-02	826b	4.7	140.8	9.778E-01	2.132E-02	1.031E-04	3.423E-06	5.413E-04	1.248E-04	1.140E-04
WW-02	826c	4.7	140.8	9.701E-01	2.875E-02	1.322E-04	4.415E-06	7.253E-04	1.698E-04	1.534E-04
WW-03	835	13	191.6	9.980E-01	1.869E-03	1.092E-04	5.650E-07	4.852E-05	7.780E-07	9.723E-06
WW-03	836	14	195	9.981E-01	1.749E-03	1.124E-04	6.511E-07	5.547E-05	7.747E-07	9.405E-06
WW-03	837	15	198.3	9.956E-01	4.074E-03	1.856E-04	1.211E-06	1.094E-04	2.364E-06	3.451E-05

The fluids of well WW-03 (sample 835) were also analyzed for water isotopes, obtaining a δD value of -10.1‰ and a $\delta^{18}O$ value of +0.15‰, for the liquid phase, and a δD value of -12.4 ‰ and a $\delta^{18}O$ value of -2.19‰, for the vapor phase. These data lead to $\Delta D_{Liq\text{-}Vap}$ of +2.3‰ and $\Delta^{18}O_{Liq\text{-}Vap}$ of +2.34‰, which are consistent with separation temperatures of 208 and 201°C, respectively, based on the liquid-vapor fractionation factors of Horita and Wesolowski (1994). These temperature values are slightly higher than the measured separation temperature of 192°C. Influence of dissolved salts on the liquid-vapor fractionation of oxygen and hydrogen isotopes of water (Horita et al., 1995) is negligible at the Na and Cl concentrations of the separated liquid of well WW-03. These isotopic data for the separated liquid and vapor phases were combined by means of a simple isotope balance, obtaining a δD value of -10.4‰ and a $\delta^{18}O$ values of -0.14‰ for the reservoir liquid.

In the correlation plot of chloride vs. $\delta^{18}O$ value (Figure 5.2-5, left), the reservoir liquid of well WW-03 plots close to the chloride thermal springs DM15, DM29, and RB-3, whereas among the other chloride waters: (i) samples RR-1 and RR-2 are mixtures between the Na-Cl geothermal endmember and isotopically light sulfate or bicarbonate waters; (ii) sample DM17 does not belong to this mixing trend being enriched in ^{18}O; (iii) samples VD-1, DM26, and DM4 describe a different trend characterized by an inverse relation between the $\delta^{18}O$ value and chloride, as they are ascribable to mixing between seawater and magmatic water (with some dilution in the case of sample DM4), as noted above. A similar spread of points is observed in the correlation diagram of chloride vs. δD value (Figure 5.2-5, right) apart from the position of the reservoir liquid of well WW-03, which has a δD value significantly lower than the chloride thermal springs DM15, DM29, and RB-3, probably due to analytical errors, a rather common problem in deuterium determination.

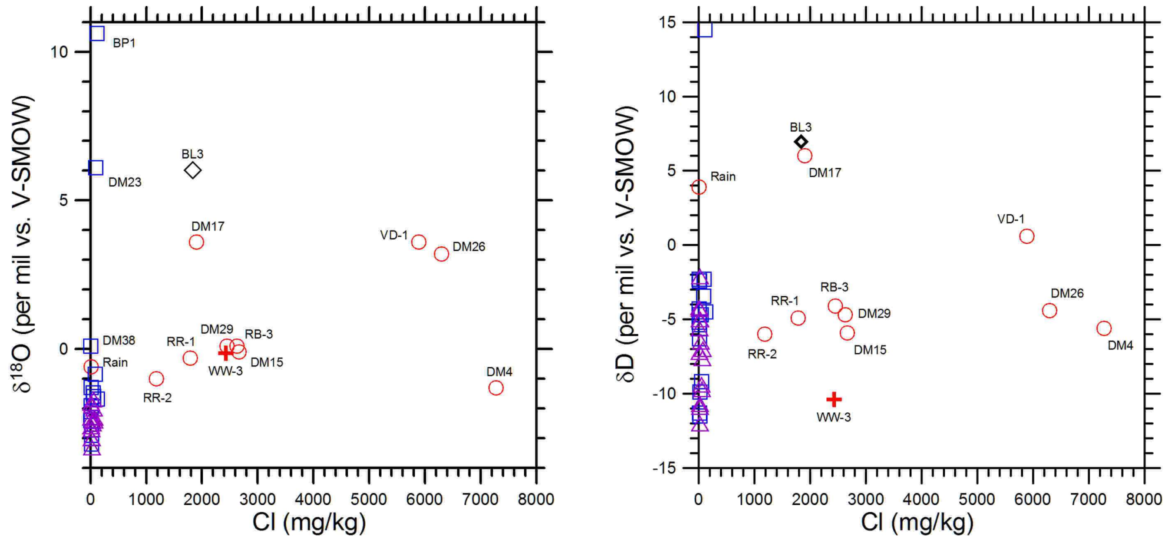

Figure 5.2-5 Correlation plots of chloride vs. $\delta^{18}O$ values (left) and chloride vs. δD values (right) for the reservoir liquid of well WW-03, also reporting the data of surface discharges for comparison. Symbols as in Fig. 4-1.

In the chloride vs. sodium diagram (Figure 5.2-6, left), the reservoir liquids of wells WW-01, WW-02, and WW-03 and all the chloride thermal waters (apart from sample DM17) belong to the same trend. Samples VD-1, DM26, and DM4 are excluded from the diagrams of Figures 5.6-6 and 5.2-7 as they do not come from the Wotten Waven geothermal reservoir (see above). This common trend is mainly controlled by mixing between a Cl-rich geothermal endmember (represented by the sample 867 of well WW-01, with Cl = 3091 mg/kg) and Cl-poor shallow groundwaters, although the possible influence of boiling cannot be excluded for some surface discharges (e.g., samples DM15 and DM29).

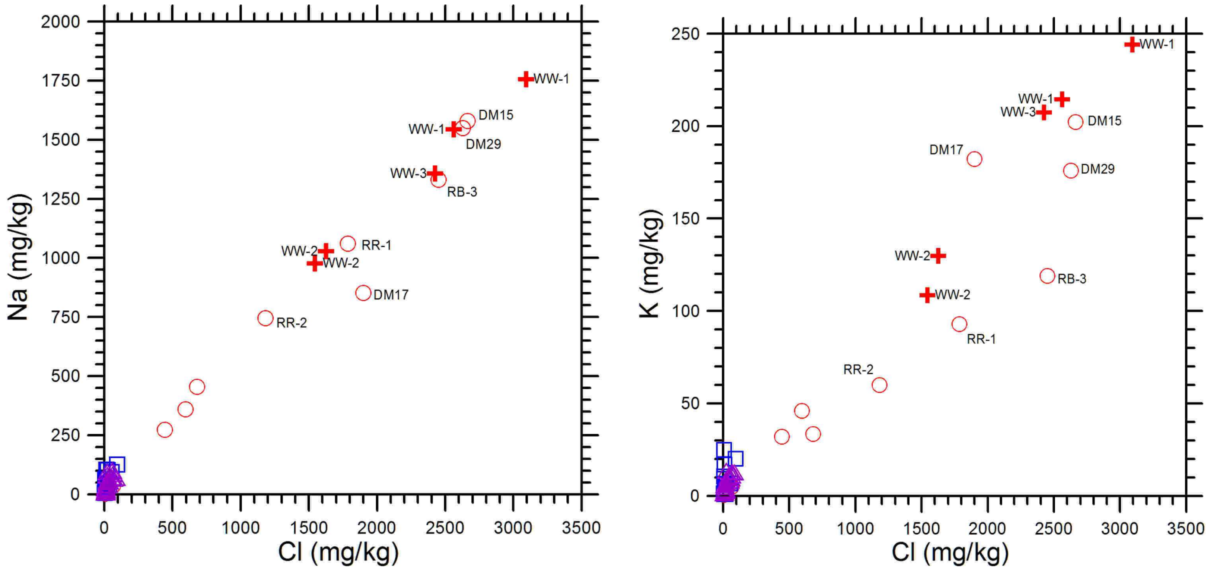

Figure 5.2-6 Correlation plots of chloride vs. sodium (left) and chloride vs. potassium (right) for the reservoir liquids of wells WW-01, WW-02, and WW-03 also reporting the data of surface discharges for comparison. Symbols as in Fig. 4-1.

This mixing trend (to which sample DM17 does not belong) is still recognizable in the chloride vs. potassium plot (Figure 5.2-6, right), although thermal waters plot below the deep geothermal wells, due to re-equilibration upon cooling leading to loss of potassium.

A similar spread of point is observed in the chloride vs. silica diagram (Figure 5.2-7, left), with the thermal waters positioned well below the deep geothermal boreholes and with a larger scatter (with respect to the Cl vs. K plot of Figure 5.2-7, right), possibly due to greater effects of re-equilibration at the progressively lower temperatures encountered by thermal waters along their upflow paths towards the surface discharges.

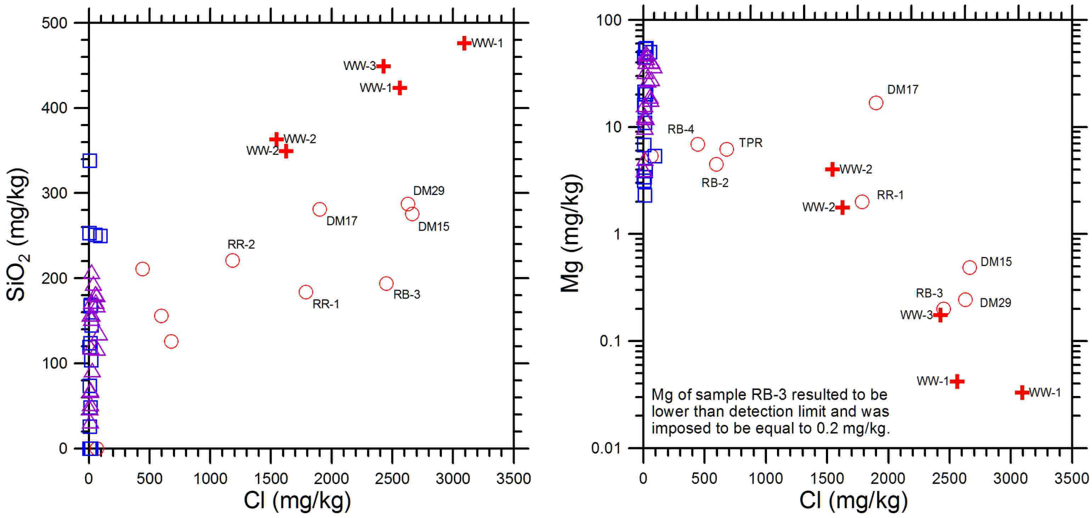

Figure 5.2-7 Correlation plots of chloride vs. silica (left) and chloride vs. magnesium (right, Mg content in logarithmic scale) for the reservoir liquids of wells WW-01, WW-02, and WW-03 also reporting the data of surface discharges for comparison. Symbols as in Fig. 4-1.

Occurrence of both mixing and re-equilibration upon cooling causes a progressive increase in dissolved Mg contents, as highlighted by the chloride vs. magnesium diagram (Figure 5.2-7, right; Mg content is in a logarithmic scale to accommodate values distributed over 4 orders of magnitudes). Again, the same pattern is clearly evident for the reservoir liquids of wells WW-01, WW-02, and WW-03 as well as for the chloride thermal waters (excluding sample DM17).

Summing up, there is little doubt on the occurrence of mixing between geothermal reservoir liquids and external waters. These might be drilling fluids in the case of well WW-01, considering that the second sample (code 867) is richer in Cl, Na, K, and SiO_2 and poorer in Mg than the first sample (code 866) which, however, is relatively similar to the only sample from well WW-03 (code 835). In the case of well WW-02, the external water may be represented by the cold inflow situated at 445 m depth, as reported in the ISOR report 120515, although it is likely that the main cause of mixing is related to the presence of drilling fluids.

5.2.3 Geothermometry of Geothermal Liquids

To obtain geothermometric indications, it is convenient to inspect the graphical tools proposed by Giggenbach and coworkers. In the triangular diagram of Na-K-$Mg^{1/2}$ (Giggenbach, 1988) of Figure 5.2-8 (left), analytical data are compared with the compositions expected for: (i) attainment of full equilibrium between the aqueous solution and the authigenic hydrothermal minerals produced by iso-chemical recrystallization of an average crustal rock (full equilibrium line); (ii) dissolution of granite, basalt and an average crustal rock. In particular, the full equilibrium line involves the Na-K geothermometer, which readjust slowly to temperature changes, and the fast-readjusting K-Mg geothermometer.

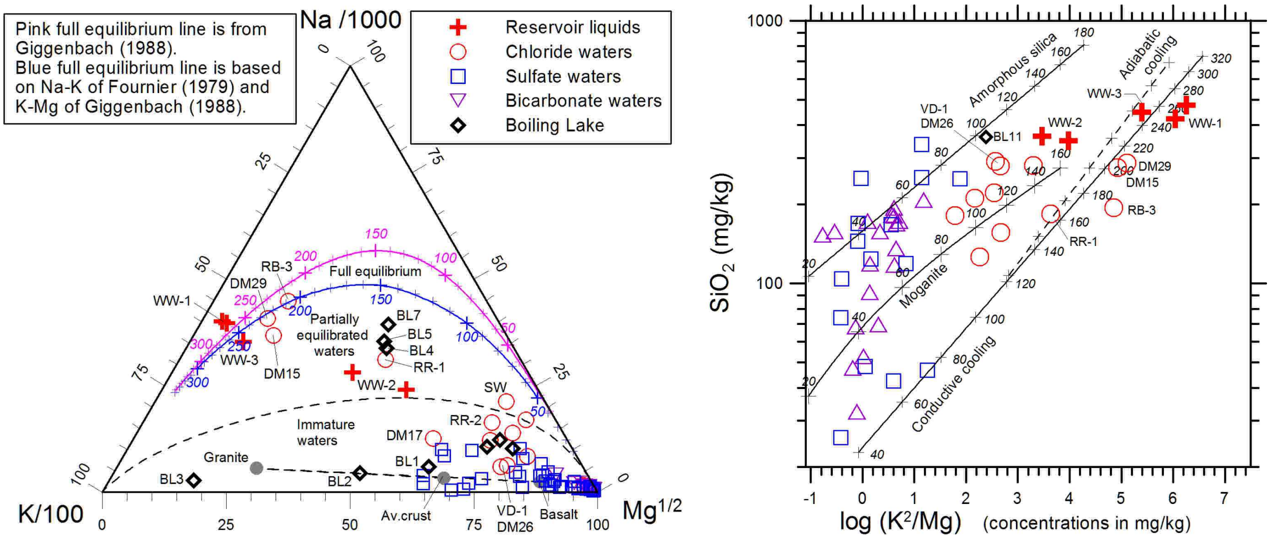

Figure 5.2-8 Triangular diagram of Na-K-$Mg^{1/2}$ (left, from Giggenbach, 1988) and plot of log(K^2/Mg) vs. log(SiO_2) (right, from Giggenbach et al., 1994) for the reservoir liquids of wells WW-01, WW-02, and WW-03 also reporting the data of surface discharges for comparison.

The correlation plot of log(K^2/Mg) vs. log(SiO_2) of Figure 5.2-8 (right), allows a similar comparison between analytical data and full equilibrium conditions (here indicated by the lines labelled conductive cooling and adiabatic cooling), but combining the two chemical subsystems responding most quickly to temperature variations, that is those based on dissolved silica and on the K^2/Mg ratio (Giggenbach, et al., 1994).

In both plots, samples from wells WW-01 and WW-03 plot close to the full equilibrium lines and can be considered representative of reservoir liquids, that is scarcely affected by interfering processes (i.e., mixing with drilling fluids and inflow of cold waters). In contrast, the two samples from well WW-02 are positioned relatively far from the full equilibrium lines, suggesting that they are significantly influenced by such undesired processes.

Also thermal springs DM29, DM15 and possibly RB-3 (for which a Mg concentration of 0.2 mg/kg was assumed, as Mg resulted to be lower than detection limit) are situated close to the full equilibrium line, although they indicate temperatures lower than reservoir liquids from deep boreholes, due to re-equilibration upon cooling (see above).

Incidentally, this re-equilibration process explains why equilibrium temperatures estimated by means of the iso-chemical geothermometric mixing model (203-217°C) are lower than measured temperatures of the Wotten Waven geothermal reservoir (240-250°C).

Equilibrium temperatures computed for the geothermal liquids of wells WW-01, WW-02, and WW-03 by means of different geothermometers are reported in Table 5.2-5, together with the corresponding measured reservoir temperatures. Na-K_A, Na-K_F, Qz_F, Qz_FP, Cha_F, and SiO_2_G equilibrium temperatures show limited deviations from measured temperatures. Na-K_G equilibrium temperatures are somewhat too high. K-Mg_G temperatures are too high for samples 866 and 867 from well WW-01 (possibly due to incorporation of Mg in precipitating calcite), too low for samples 820 and 826 from well WW-02 (due to mixing with external fluids), and acceptable for sample 835 from well WW-03.

Table 5.2-5 Measured reservoir temperatures and equilibrium temperatures computed by means of different geothermometers for the geothermal liquids of wells WW-01, WW-02, and WW-03. Na-K_A from Arnórsson et al. (1983). Na-K_F from Fournier (1979). Na-K_G and K-Mg_G from Giggenbach (1988). Qz_F and Cha_F from Fournier (1973). Qz_FP from Fournier and Potter (1982). SiO_2_G from Giggenbach et al. (1994).

Well	Sample	Res. T	Na-K_A	Na-K_F	Na-K_G	K-Mg_G	Qz_F	Qz_FP	Cha_F	SiO_2_G
		°C	°C	°C	°C	°C	°C	°C	°C	°C
WW-01	866	238.5	231.2	247.0	260.0	280.9	237.6	240.5	227.1	246.8
WW-01	867	238.5	231.2	246.9	260.0	296.4	247.9	252.4	239.7	261.0
WW-02	820	229.0	220.0	237.8	251.6	166.9	221.5	223.2	207.6	225.2
WW-02	826	216.0	206.0	226.2	240.9	145.5	224.6	226.5	211.4	229.4
WW-03	835	245.0	242.7	256.3	268.6	239.1	242.7	246.3	233.3	253.8

5.2.4 Geothermometry of Geothermal Gases

Geothermometry of geothermal gases is conveniently carried out by means of the plot of Figure 5.2-9 (from Giggenbach, 1980), in which the logarithm of the equilibrium constant of the reaction:

$$CH_4 + 4H_2O = CO_2 + 4\ H_2 + 2H_2O_{(L)} \qquad (1)$$

that is:

$$K_C = \frac{X_{H_2}^4 \cdot X_{CO_2}}{X_{H_2O}^4 \cdot X_{CH_4}} \qquad (2)$$

is reported against the measured reservoir temperature.

Samples from well WW-01 are situated on the liquid line, samples from well WW-02 are found between the vapor line and the line labelled y = 0.1 [where y is the mass vapor/(vapor+liquid) ratio in the gas equilibration zone], whereas samples from well WW-03 are positioned between the lines y = 0.1 and y = 0.01. This spread of points indicates that gas species attain chemical equilibrium in a single liquid phase in the case of well WW-01 and under two-phase conditions in the case of wells WW-02 and WW-03, that is in zones characterized by the vapor/(vapor+liquid) ratios specified in the diagram. However, data of well WW-02 can be interpreted also in a different way, namely assuming that gas equilibration occurs in a single vapor phase, at temperatures of 125-155°C, as indicated by the red lines with arrows. If so, gases would be contributed by a shallow feed zone, in agreement with other indications.

Unfortunately these inferences cannot be proven nor rejected on the basis of the ammonia dissociation reaction (see Giggenbach, 1980) due to the lack of data for this gaseous species.

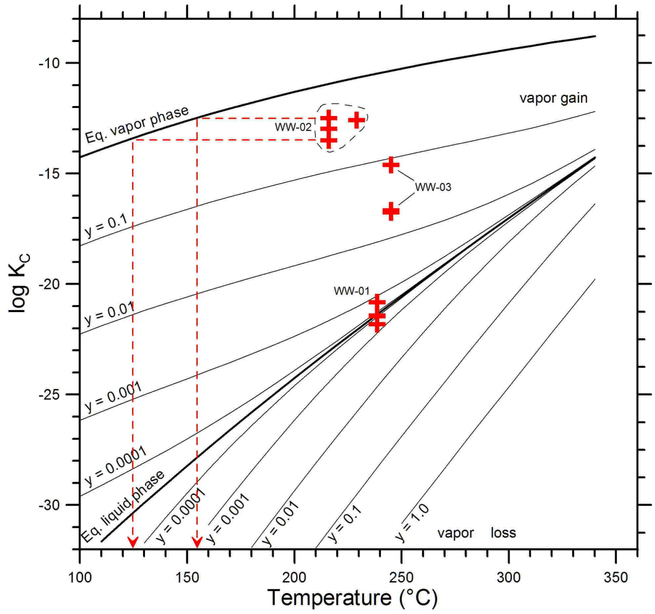

Figure 5.2-9 Diagram of log K_C vs. measured reservoir temperature for the gases discharged by wells WW-01, WW-02, and WW-03 (from Giggenbach, 1980); y is the vapor/(vapor+liquid) ratio in the gas equilibration zone.

5.2.5 Scaling Potential of the Geothermal Liquids

An appraisal of the scaling potential of the liquids circulating in the Wotten Waven geothermal reservoir is obtained through simulation of their progressive iso-enthalpic boiling (steam separation) at decreasing temperatures. This exercise was carried out by means of the computer code WATCH, version 2.4 (Bjarnason, 2010), for all the five reservoir liquid samples from wells WW-01, WW-02, and WW-03 which are listed in Table 5.2-1. Relevant results are shown in the diagrams of saturation indexes vs. temperature of Figures 5.2-10 and 5.2-11. The following considerations can be drawn from inspection of these plots.

(i) All five liquid samples are undersaturated with respect to anhydrite under reservoir conditions and become progressively undersaturated upon boiling owing to increasing solubility of anhydrite with decreasing temperatures (Figure 5.2-10, left). Therefore, there is no risk of anhydrite precipitation at any temperature of interest.

(ii) All the liquid samples are oversaturated with respect to calcite under reservoir conditions and become progressively oversaturated upon boiling (and CO_2 loss), with the saturation index attaining maximum values at temperatures of ~210-220°C for well WW-01, ~190-205°C for well WW-02, and ~220°C for well WW-03 (Figure 5.2-10, right). Below these temperatures, the saturation index decreases with decreasing temperatures (owing to increasing solubility of calcite), but all the liquids remain oversaturated with respect to calcite, even at 100°C. Therefore, precipitation of calcite is possible at any temperature of interest, with the highest probability in the reservoir and in the deepest parts of the wells, downstream of the flashing zone. This does not mean that calcite scaling will certainly occur. If necessary, deposition of calcite can be mitigated by use of suitable reactants and/or by treatment with acids.

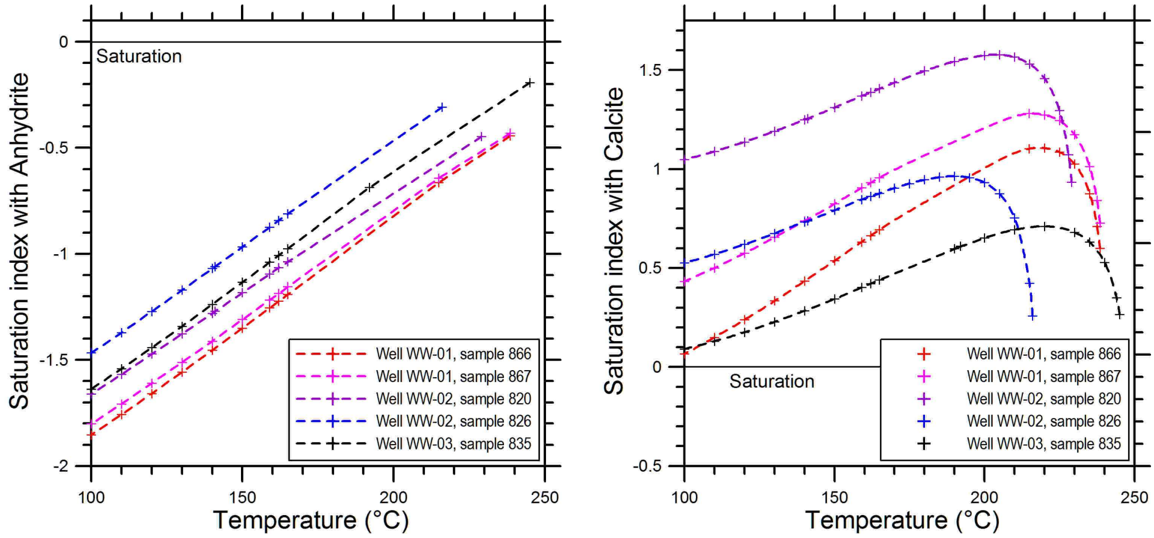

Figure 5.2-10 Diagram of the saturation index with respect to anhydrite (left) and calcite (right) vs. temperature during iso-enthalpic boiling (steam separation) of the reservoir liquids of wells WW-01, WW-02, and WW-03. Simulations carried out by means of the computer code WATCH, version 2.4 (Bjarnason, 2010).

(iii) The liquids samples of wells WW-01 and WW-03 are undersaturated with respect to pyrite under reservoir conditions, attain saturation at temperatures of ~190-205°C, and become progressively oversaturated upon further boiling and cooling (Figure 5.2-11, left). The liquids of well WW-02 are oversaturated with pyrite at any temperature, from the reservoir to 100°C, and the saturation index increases gradually with decreasing temperature.

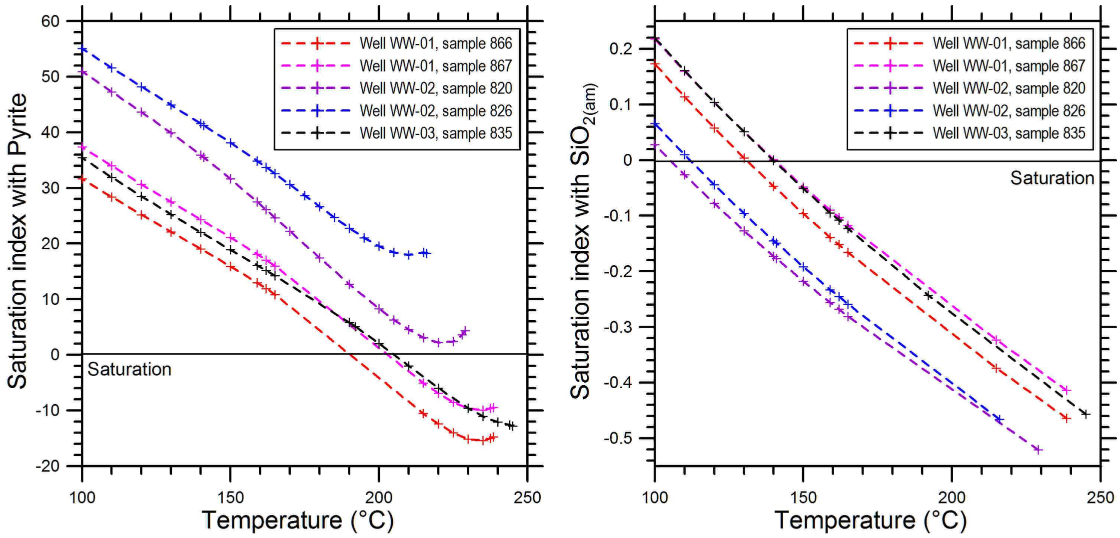

Figure 5.2-11 Diagram of the saturation index with respect to pyrite (left) and amorphous silica (right) vs. temperature during iso-enthalpic boiling (steam separation) of the reservoir liquids of wells WW-01, WW-02, and WW-03. Simulations carried out by means of the computer code WATCH, version 2.4 (Bjarnason, 2010).

Pyrite precipitation is therefore possible in a large temperature interval, but the amount of this solid phase possibly produced is expected to be low to negligible due to the small contents of dissolved iron.

By the same token, precipitation of sulfide and sulfosalt minerals of other elements (e.g., Cu, Zn, Pb, Cd, Hg, As) should not be a problem.

(iv) The liquids samples of wells WW-01 and WW-03 are undersaturated with amorphous silica under reservoir conditions, attain saturation at temperatures of ~130-140°C, and become slightly oversaturated upon further steam separation and cooling (Figure 5.2-11, right). The two liquids samples of well WW-02 show a similar trend, but saturation with amorphous silica is attained at ~105-110°C.

Performing liquid/vapor separation at pressures of 6 to 7 bar-a (corresponding to temperatures of 159 to 165°C, based on the thermodynamic properties of pure water), there is no risk of silica scaling in the pressure separator. However, the separated liquids are expected to attain saturation with amorphous silica upon cooling through heat losses. For instance, the liquid sample of well WW-03, upon boiling from the reservoir temperature of 245°C to 162°C (6.5 bar-a), followed by conductive cooling, attains saturation with amorphous silica at 134°C and the degree of saturation (Q/K) value of 1.1 at 124°C.

Alternatively, exploitation of geothermal fluids could be carried out adopting a binary cycle, involving a liquid/vapor separation temperature of 180°C (10.85 bar-a). In this second option, the liquid sample of well WW-03, upon boiling from the reservoir temperature of 245°C to 180°C, followed by conductive cooling, attains saturation with amorphous silica at 131°C and the degree of saturation (Q/K) value of 1.1 at 122°C.

Adopting the empirical value of 1.1 as upper threshold of the degree of saturation (Q/K) to avoid precipitation of amorphous silica, temperature should not go below 124°C (for a liquid/vapor separation temperature of 162°C) or 122°C (for a liquid/vapor separation temperature of 180°C) throughout the surface installations, including the reinjection pipelines and reinjection wells, as well as in the reservoir around the reinjection wells.

5.2.6 Corrosion Potential of Geothermal Fluids

A first appraisal of the corrosion potential of the fluids discharged by the Wotten Waven geothermal field is obtained by considering the boiling simulation of the reservoir liquid sample 867 from well WW-01 and focussing on:

(i) the liquid phase separated at 6.5 bar-a, 162°C and then cooled to 100°C;

(ii) the steam condensate produced through liquid/vapor separation at these P,T conditions followed by condensation at 100°C.

Speciation calculations carried out by means of the EQ3 computer code (Wolery and Jarek, 2003) indicate that the separated liquid phase cooled to 100°C has a pH of 7.04. Assuming that dissolved sulfides are converted *in toto* to sulfates, through O_2-driven oxidation, the computed pH becomes 6.90, a value which is only 0.14 pH units lower than that calculated for the separated liquid phase unaffected by oxidation processes. This nearly constant pH suggests that the buffer capacity of this aqueous solution is relatively high. Therefore, possible corrosion problems caused by separated liquids are expected to be negligible, even upon absorption of atmospheric O_2 and consequent oxidation of dissolved H_2S to H_2SO_4.

As shown by speciation calculations, the steam condensate produced through liquid/vapor separation at 6.5 bar-a, 162°C followed by condensation at 100°C results to be an aqueous solution containing 331 mmol/kg of aqueous CO_2 and 6.64 mmol/kg of aqueous H_2S. Since both aqueous CO_2 and aqueous H_2S are weak acids, they are scarcely dissociated and pH is 3.43.

In contrast, assuming total conversion of dissolved sulfide species to sulfates, through O_2-controlled oxidation, the computed pH becomes 2.16, which is significantly lower than the pH calculated for the initial steam condensate, unaffected by oxidation processes. The steam condensate results to be a diluted solution of sulfuric acid, with relatively high concentration of aqueous CO_2. In this aqueous solution, HSO_4^- ion (5.53 mmol/kg) prevails over SO_4^{2-} ion (1.12 mmol/kg), since pH is lower than the pH of iso-activity (= pK_a of HSO_4^- ion), which is 3.00 at 100°C.

There are some uncertainties on previous evaluations due to the lack of data on the concentration of ammonia in separated liquid and vapor samples. Since ammonia is a base, it can mitigate the acidity of the aqueous solutions of interest. However, if ammonia concentrations are low, steam condensate may pose corrosion problems, especially upon absorption of atmospheric O_2 and oxidation of dissolved H_2S to H_2SO_4. Suitable actions (e.g., addition of a base) might be needed to mitigate locally the acidity of steam condensate, before its disposal, e.g., through mixing with the separated liquid to be reinjected. In any case, amounts of steam condensate are expected to be relatively small.

5.2.7 Total Gas Content of Separated Steam

Total gas content in separated steam was computed through simulation (performed by means of the computer code WATCH, version 2.4) of iso-enthalpic boiling (steam separation) of the reservoir liquids of wells WW-01 and WW-03. Samples of well WW-02 where disregarded as they contain excess gases probably coming from a shallow feed zone. Obtained results are listed in the following table.

Well	**Sample**	**Total gas at 7.0 bar-a, 165°C**	**Total gas at 6.5 bar-a, 162°C**	**Total gas at 6.0 bar-a, 159°C**
		mg/kg	mg/kg	mg/kg
WW-01	866	9089	8796	8525
WW-01	867	15343	14848	14390
WW-03	835	27101	26305	25562

It shows that total gas content in separated steam ranges:

(i) from 0.85 to 0.91 wt% for sample 866 from well WW-01,

(ii) from 1.44 to 1.53 wt% for sample 867 from well WW-01,

(iii) from 2.56 to 2.71 wt% for sample 835 from well WW-03.

Since changes from sample to sample are higher than those dictated by differences in liquid/vapor separation conditions, it is advisable to take additional samples for determining the total gas content of separated steam.

5.3. Reservoir Engineering and Well Production

5.3.1 Introduction

All three drilled slim holes intercepted the same geothermal reservoir with producing temperatures in the range 230-245°C. Wells WW-02 and WW-03, located at elevations of about 571 and 543 m asl, respectively, intercepted a liquid dominated reservoir section below an elevation of about -160 m asl, beneath a two-phase zone with probably a vapour – static pressure distribution. Well WW-01 is drilled from an elevation of about 224 m asl. Despite similar reservoir pressures, well WW-01 seems to intercept liquid dominated permeable zones almost up to the surface, with probably boiling (or close to boiling) conditions from 200 down to 0 m asl.

The following paragraphs summarize the main results achieved with the review and interpretation of logging and production data recorded in the three slim holes by ISOR (2012c, e, f, h, k, e, o). The reported results are focused on the characterization of wells WW-01 and WW-03 production potential and on the evaluation of expected production and reinjection capabilities of WWP1 and WWR1 wells. These wells are planned to be integrated in the exploitation scheme for a small power plant of about 14 MWe to be installed in the proximity of the drilling pad from which well WW-03 has been drilled.

About well pads elevation, reference is made to the following measurements taken with a GPS during the ELC mission in July 2012:

- well WW-01 224 m asl;
- well WW-02 571 m asl;
- well WW-03 543 m asl.

5.3.2 Logging and Testing Methodology

All the logging and testing data have been collected by ISOR while field operations were supervised by GRG. Drilling operations were conducted by Icelandic Drilling.

Well logging was performed using a Kuster K10 geothermal PT (memory) probe. Accuracy and resolution in temperature measurements is ±0.25°C and 0.001°C. Accuracy and resolution in pressure measurements is 0.024% F.S and 0.0003% F.S., with a maximum pressure of 8,500 psi. Accuracy and resolution are then about 0.14 bar and 0.0018 bar, respectively.

Production tests were performed according to R. James method using a horizontal flow line equipped with a lip pipe discharging into an atmospheric separator (silencer). Separated brine is collected in a weir box, where the volumetric flow rate is measured using a V-shaped notch with an angle of 90°, and then discharged to a pond. Such ponds were of rather limited volume and constrained the duration of production tests which were limited to less than 10 hours. Despite the efforts of ISOR to collect as much data as possible both at surface and downhole, this limited duration of production tests rise several concerns on the reliability of acquired data, in particular with respect to stabilization of fluid composition and well deliverability.

5.3.3 Well WW-01

Well WW-01 is located in Wotten Waven, approximately 5 km east of Roseau, the capital of Dominica. According to ISOR (2012c) the geographical coordinates are as follows (GPS reading at drill site):

15° 19.277´ N,

61° 20.35´ W

Z= 224 m asl (ELC mission 2012, ~270 m a.s.l. indicated by ISOR).

The well was drilled from March 29th, 2012, to April 27th, 2012 using the Sleipner drilling rig by the Iceland Drilling Co. Drilling phases, borehole diameters and CSG diameters are listed in Table 5.3-1 (ISOR, 2012c).

Drill-Rig	Phase	Depth	Bit Size	Casing Type	Casing Depth
Sleipnir	Pre-Drilling	53.5 m	17½"	13⅜"	51.5 m
Sleipnir	1. phase	161.2 m	12¼"	9⅝"	160 m
Sleipnir	2. phase	303 m	8½"	7"	301 m
Sleipnir	3. phase	1200 m	6⅛"	4½" liner	269–1200 m

Table 5.3-1 - Well WW-01 drilling and casing depths. Depths are relative to Sleipnir rig floor, 5.8 m above ground level (after ISOR, 2012c).

WW-01 Permeable Zones

Permeable zones are identified from circulation losses or fluid inflows during drilling, and by the T logs during both injectivity and production tests. Following Table 5.3-2 is modified after ISOR (2012c).

Depth (mMD)	Feed pressure (bar)	Circulation Loss (l/s)	Remarks
170	18.8 @ 170 mMD	Inflow of 5 l/s	Over-pressurized zone. Temperature log, April 13th. Cement plugging, 145–212 m.
197	20.8 @ 197 mMD	No LOC	Increased amounts of pyrite, possible feed point.
303-350		T logs under injection	T logs April 26 and 27th. Inflow of hotter fluid.
716 -740		Total loss (≥20 l/s) @716 mMD	T logs April 26 and 27th; and June 27th.
846–850 (?)		Total loss (≥20 l/s)	Increased amounts of pyrite, possible feed zone.
886-946		Total loss (≥20 l/s) @886 mMD	T log, April 26 and 27th, and June 27th.

Table 5.3-2 - Well WW-01 inferred permeable zones. Measured depths highlighted in bold are relative to major feed zones open to flow (modified after ISOR).

Other minor permeable zones were inferred under injection at 1060 m and at BH, but logs performed under flowing conditions on June 27th suggest the well is impervious below 940 m bgl. Then, major feed zones open to flow are that at about 316 mMD, 720 mMD and 895 mMD, being that at 720 mMD the major one.

The upper zone at 316 mMD (310 m bgl) has static P&T in the order of 231.4°C and 33.0 bar a (assuming borehole pressure is representative), against a saturation pressure of 28.7 bara for local T. Pressure log shows a hydrostatic gradient up to about 40 m MD, with a gas column above and WHP in the order of 10.3 barg. Thus, all listed permeable zone should be in liquid conditions. The zone at 316 m MD could be in two-phase conditions only if the bubbling pressure of NCG is higher than about 4.3 bar.

T logs recorded by ISOR indicate a local maximum at 720 mMD of about 239.3°C, with a temperature inversion below. Static T at 940 m is about 232°C. Considering that under flowing conditions at 27 kg/s the flash temperature at around 435 mMD is about 238°C, the permeable zone at 720 m seems to be the major one.

The upper zone at 316 mMD gives small changes of P&T gradients under flowing conditions. It is located above the flash depth at 436 mMD. Flowing pressure at 27 kg/s discharge rate is about 24.4 bara, slightly lower than the saturation pressure of pure water for local reservoir T. Thus, it is likely that the upper feed zone discharges two-phase fluid, with a possible increment of mixture enthalpy with respect to that estimated at the flash T of 238°C.

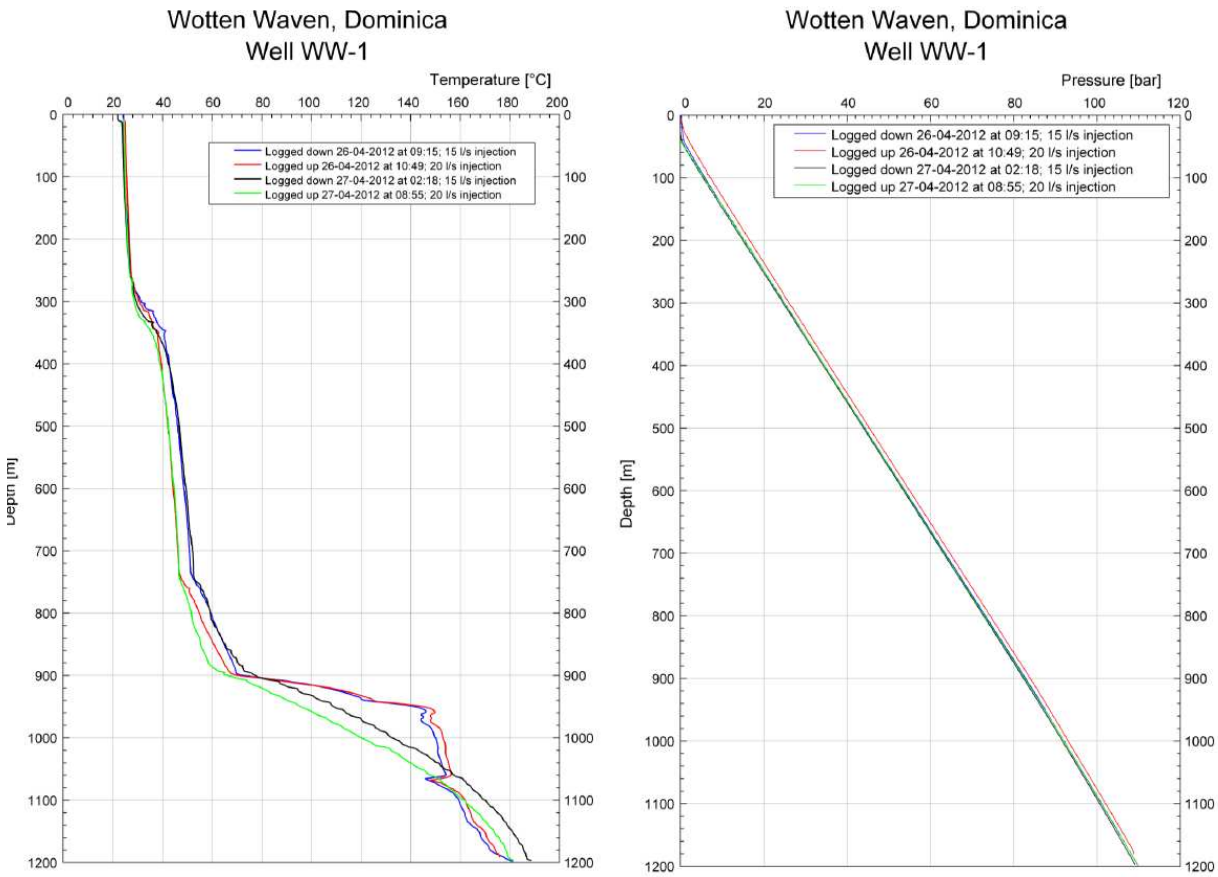

Figure 5.3-1 - Well WW-01 temperature logs (left) and pressure logs (right) recorded on April 26th and 27th 2012 under continuous injection. Depths are MD.

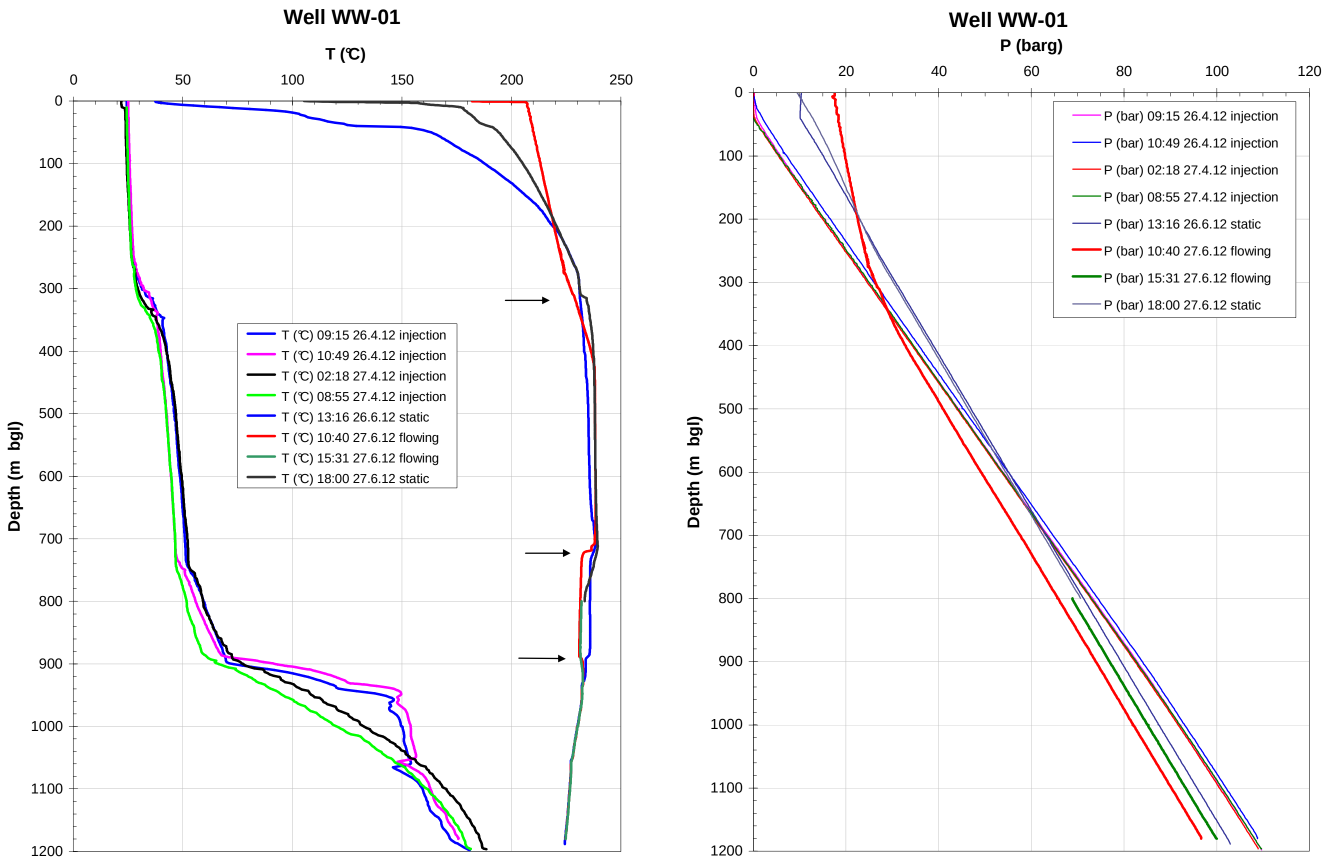

Figure 5.3-2 - Well WW-01 temperature logs (left) and pressure logs (right) recorded under injection (April 26th and 27th 2012) and during the production tests (June 26th and 27th, 2012). Depths are bgl.

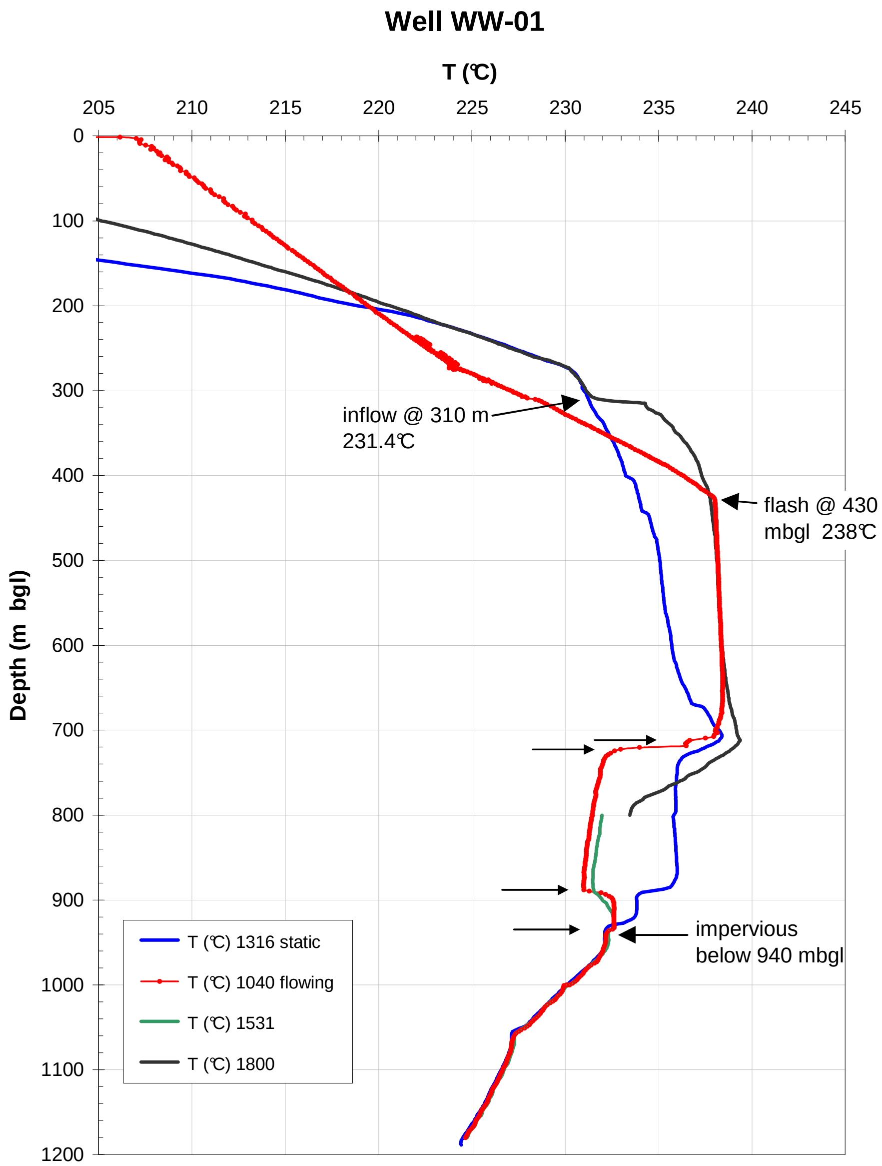

Figure 5.3-3 - Well WW-01 temperature logs recorded on June 26th (static log) and 27th (flowing logs plus a static log at the end of production tests). Depths are bgl.

Thermodynamic Conditions and NCG Partial Pressure

Bubbling pressure at flash depth is estimated from flowing P&T logs recorded on June 27th, at 35.3 barg at a flash temperature of 238°C (Figure 5.3-4). Partial pressure of NCG is then about 3.93 bar. Considering that CO_2 accounts for 97-98% of total NCG, the dissolved equivalent CO_2 content at flash conditions can be estimated in the order of 1760 ppm.

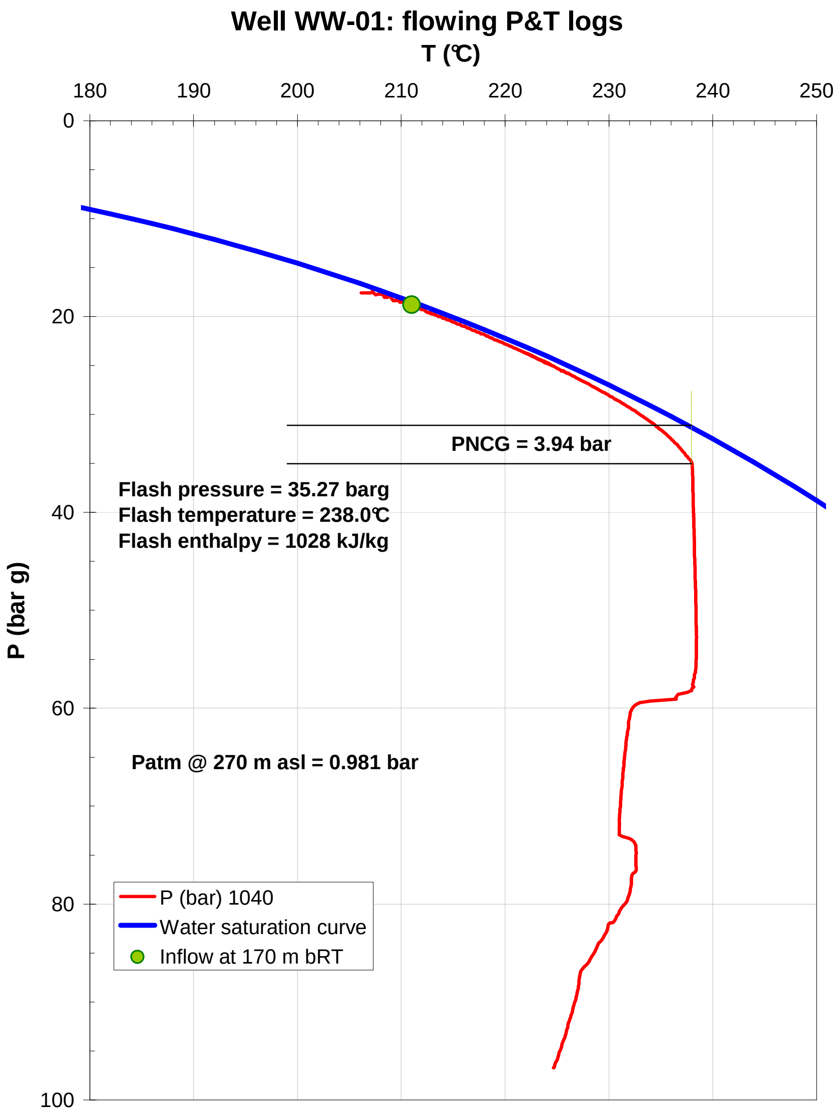

Figure 5.3-4 – Determination of partial pressure of NCG at the flash depth using the P&T flowing logs recorded on June 27th, 2012.

WW-01 Production Tests

Short production tests were performed on April 27, 2012 from about 8:55 to 18:00. Fluid was discharged through a horizontal production line equipped with a 3” lip pipe into an atmospheric separator (silencer). Brine flow rate was measured with a weir box with a 90° sharp V-notch. ISOR supplied measured WHP, lip pressure, and weir level and computed total mass rate and mixture enthalpy combining the lip pressure equation due to James (1962, 1976) with the iso-enthalpic flash at atmospheric conditions using the separated brine rate. The conventional James (1962) equation (Grant and Bixley, 2011):

$$W_T\,(kg/s) = 184\,\frac{A(cm^2)Plip^{0.96}(bar\ abs)}{H_T^{\ 1.102}(kJ/kg)} \tag{5.1}$$

is combined with the isoenthalpic flash to obtain:

$$\frac{W_L}{A\,Plip^{0.96}} = Y = 184\,\frac{H_S - H_T}{H_T^{\;1.102}\,(H_S - H_L)} \tag{5.2}$$

Y can be computed from field measurements, while H_T needs to be obtained by solving the right side of eq. 5.2. Grant and Bixley (2011) provide a regression equation valid for enthalpies in the range 800-2200 kJ/kg with a maximum error of 1.5%:

$$H_T = \frac{H_S + a\,Y}{1 + b\,Y} \tag{5.3}$$

where at 1 bar separation pressure a= 3329 and b=28.3. For well WW-01 a new regression was made in the range 900-1400 kJ/kg obtaining the following parameters a=2880.45 and b=27.706, with a maximum error of 0.13%.

The volumetric rate at the triangular weir box, having an angle of 90°, is here computed using the Kindsvater-Shen equation following ISO(1980), ASTM(1993) and USBR(1997):

$$Q = 4.28\,Ce\,tg(\frac{\theta}{2})(h + h_C)^{2.5} \tag{5.4}$$

where Q is the volumetric rate (ft^3/s), Ce is a discharge coefficient, θ is the V-notch angle (degree), h is the water level (ft) and h_C is a correction coefficient (ft). Both Ce and h_c are function of V-notch angle and are usually given in graphical form. For an angle of 90°, their value is :

$$Ce = 0.5779 \tag{5.4}$$

$$h_C = 0.0029\,ft \tag{5.6}$$

Table 5.3-3 lists the field measured data, computed total rate and enthalpy by ISOR and ELC. ISOR already pointed out that computed enthalpy is higher than the enthalpy evaluated from downhole flash temperature. Accounting for small enthalpy loss due to potential energy change and heat transfer, mixture enthalpy at wellhead should be about 1023 kJ/kg. Higher enthalpy values were estimated by ISOR using the combined lip pressure and weir box level readings, in the range 1100 – 1280 kJ/kg. This discrepancy can be due to one or a combination of the following reasons:

- the separator efficiency, as liquid water was discharged at the separator top (carryover), with an underestimation of liquid rate and an overestimation of mixture enthalpy. To obtain the enthalpy inferred from flash temperature the brine carried over the silencer should be in the order of 30% of that measured at the weir box, which seems definitely unlikely. The carryover was enhanced by the vigorous air flow which was sucked into the separator inlet pipe thanks to the holes drilled in the inlet pipe plate initially avoiding the air inflow. The air increases the gas phase velocity in the vertical separator pipe, then reducing the separation efficiency.

- high critical pressure at the James pipe, higher than the upper limit of 4.4 bara (64 psia) for which the method was calibrated at the field. At this respect it must be reminded that a theoretical assessment of James' method made by Karamarakar and Cheng (1980) showed that up to lip pressures of 150 psia (10.3 bara) the method shows the same deviation between empirical and theory results.

- the possible contribution of two-phase fluid from upper feed. If discharging pure steam at local temperature conditions (232°C) it should contribute for 5, 10 and 15% of total production to allow mixture enthalpy in the order of 1112, 1201 and 1290 kJ/kg, respectively. The shape of flowing P&T logs does not suggest an important contribution from the upper feed at 316 mMD.
- other non-identified measurement errors.

Time (hh:mm)	WHP (barg)	Plip (barg)	Hw (mm)	WL (l/s)	Hp (kJ/kg)	WT1 (kg/s)	WS @ 1bara (kg/s)	Remarks	WL (kg/s)	WL2 (kg/s)	WT2 (kg/s) using weir Hm=1023 kJ/kg	WT3 (kg/s) using lip and Hm=1023 kJ/kg	Hp (kJ/kg) lip+weir	WT4 (kg/s) lip+weir
8.55	4.5	5.5												
9.05	18	8	192	22.02	1087.63	31.25	9.26	Before opening	21.1	21.5	29.4	33.3	1098.6	30.7
9.14	18	7	179	18.51	1124.84	26.89	8.41		17.8	18.0	24.7	29.7	1136.2	26.4
9.25	17.8	7.7	172	16.77	1236.6	26.26	9.51		16.1	16.3	22.3	32.2	1249.0	25.8
9.45	17.8	7.8	168	15.82	1280.37	25.55	9.75		15.2	15.4	21.1	32.6	1293.3	25.1
10.00	17.9	7	168	15.82	1222.65	24.53	8.74		15.2	15.4	21.1	29.7	1235.0	24.1
10.15	17.9	6	165	15.13	1170.44	22.65	7.54		14.5	14.7	20.1	26.2	1182.2	22.2
10.30	17.5	8.5	172	16.77	1289.96	27.27	10.52	Opened more at 10:30	16.1	16.3	22.3	35.1	1303.0	26.8
11.18	17.5	8	164	14.91	1331.94	24.99	10.11	Tool RIH at 10:38	14.3	14.5	19.8	33.3	1345.6	24.6
11.40	17.5	8	175	17.5	1230.11	27.28	9.8	Tool at 800 m at 11.18	16.8	17.0	23.3	33.3	1242.4	26.8
12.25	17.5	7.7	166	15.36	1292.22	25.01	9.68		14.7	14.9	20.4	32.2	1305.3	24.6
12.45	17.5	7.9	182	19.29	1162.59	28.72	9.46	Throttled at 12:50	18.5	18.8	25.7	33.0	1174.2	28.2
12.55	17.9	7.5	172	16.77	1222.56	26	9.26		16.1	16.3	22.3	31.5	1234.8	25.6
13.15	17.9	7.5	177	18	1178.11	27.09	9.11		17.3	17.5	24.0	31.5	1189.9	26.6
13.50	17.8	7.8	182	19.29	1155.87	28.6	9.34		18.5	18.8	25.7	32.6	1167.4	28.1
14.15	17.7	7.3	178	18.26	1155.23	27.05	8.82		17.5	17.8	24.3	30.8	1166.8	26.6
14.45	19.4	4	147	11.38	1147.69	16.77	5.41	Throttled at 14:40	10.9	11.0	15.1	18.9	1159.2	16.4
14.55	20.2	3.9	151	12.16	1094.99	17.32	5.19		11.7	11.8	16.2	18.6	1106.0	17.0
15.05	20.2	4	145	11	1168.71	16.44	5.46		10.6	10.7	14.6	18.9	1180.4	16.1
15.25	20.2	3.9	145	11	1156.68	16.31	5.33	POOH 15:25	10.6	10.7	14.6	18.6	1168.3	16.0
15.45	20.3	3.9	150	11.96	1105.02	17.15	5.21	Tool at 800 m at 15:45	11.5	11.6	15.9	18.6	1116.1	16.8
16.02	20.8	1.4	110	5.57	1155.98	8.25	2.69	Throttled in at 15:57	5.3	5.4	7.4	9.3	1166.2	8.0
16.15	20.8	1.4	108	5.32	1184.1	8.03	2.72		5.1	5.1	7.0	9.3	1194.7	7.8
16.30	20.8	1.4	108	5.32	1184.1	8.03	2.72		5.1	5.1	7.0	9.3	1194.7	7.8
18.00							9.26	POOH from 800 m						

Table 5.3-3 – Well WW-01 discharge data: field measurements; ISOR computed results (yellow); ELC computed results (green).

Total rate WT2 is computed assuming the weir box level reading is correct and production enthalpy is 1023 kJ/kg. Total rate WT3 is computed assuming the lip pressure reading is correct and the same production enthalpy of 1023 kJ/kg. Finally, total rate WT4 is computed as made by ISOR using both lip pressure and weir box level readings.

Total rate WT4 and estimated enthalpy are in agreement with the values computed by ISOR. Rate WT2 is underestimated with respect to ISOR & WT4, as excess steam is not accounted for. Rate WT3 is overestimated with respect to ISOR & WT4 because with a lower enthalpy a higher rate is obtained at the same lip pressure.

Attempts to understand the reason for the discrepancy between computed enthalpy and that estimated from flash depth were not conclusive. Most likely rate values should be bounded by WT1 - WT4 and WT3 values. In the remaining part of this document reference is made to WT1 values, those already computed by ISOR, as far as the rate is concerned, while the enthalpy considered is that estimated from flash temperature.

Figure 5.3-5 shows the recorded WHP and lip pressure as function of time and the computed total mass rates (WT1-WT4). Looking at WHP and rate history, 5 production steps can be identified. The first one is characterized by the transient conditions following the well start-up, in particular with respect to computed flow rate. The second and the third one still show non stable computed rates, while the last two steps, at lower rates, seem to be more stabilized. Anyway, the plot in Figure 5.3-5 clearly suggests that the very short discharge test was probably conducted without obtaining stabilized well conditions. Longer testing time was prevented by the constraint of separated brine disposal at surface. The same constraint was present for all three tested slim-holes.

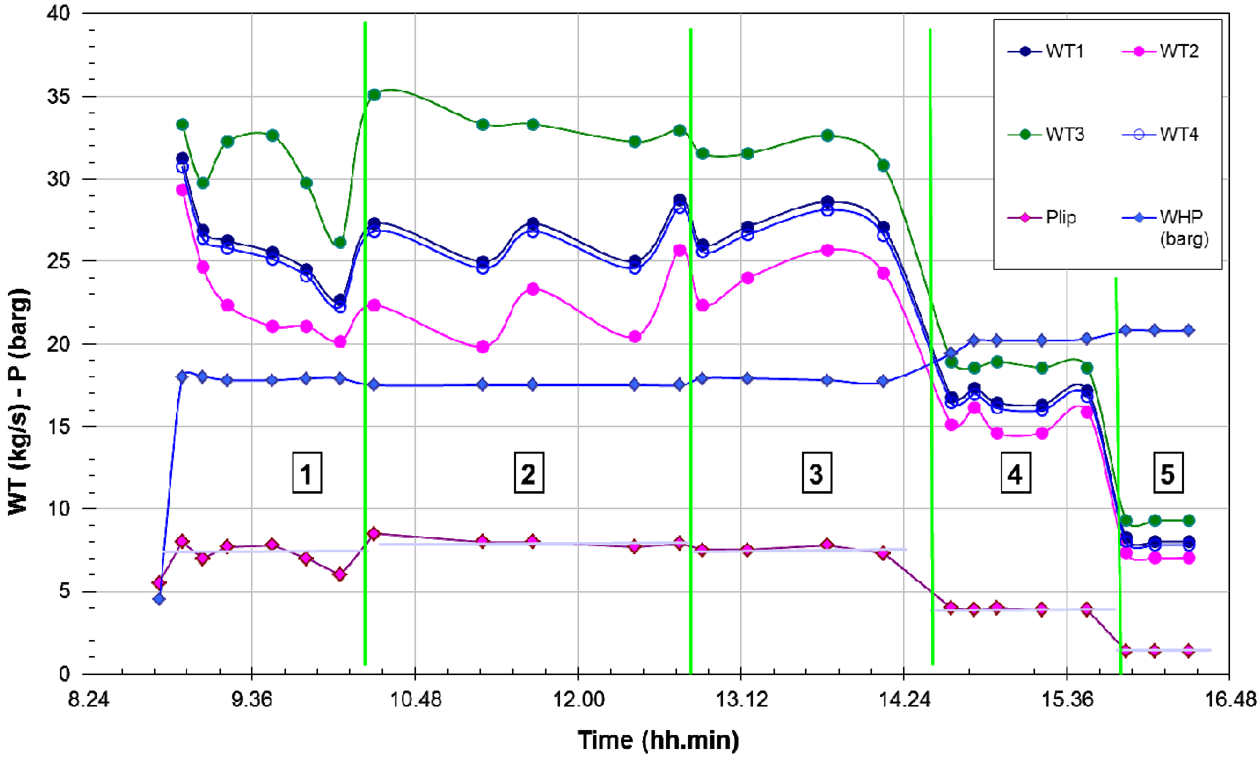

Figure 5.3-5 – Well WW-01 discharge data history on June 27th, 2012. 5 discharge periods can be distinguished.

WW-01 Injectivity and Productivity Index

The injectivity index (II) was estimated by ISOR (2012c) in the order of 11.4 (l/s)/bar with step rate injection tests performed at the end of drilling operations. The recorded pressure values at 900 mMD were declining with time during the injection tests suggesting the possible stimulation of well injectivity with time. Declining temperature shows also that some of the injected water was flowing below the 900 mMD at which the K10 tool was located, suggesting some permeability was present below that depth. The evaluated II represent probably a lower limit of actual well injection capacity.

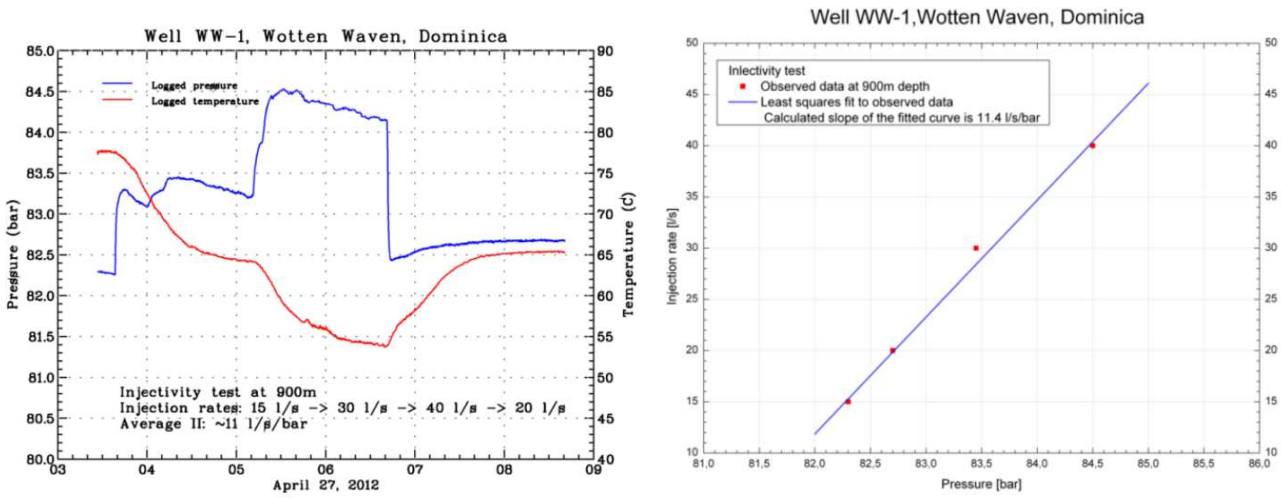

Figure 5.3-6 – Well WW-01 step rate injection tests at 900 mMD. Left: downhole P&T; right: interpreted injectivity index (ISOR, 2012c).

The productivity index (PI) can be evaluated looking at pressure drawdown as function of discharge rate at a fixed depth. Figure 2 of ISOR Memorandum shows recorded pressure logs at shut-in condition and under discharge at about 17 and 27 kg/s (rates computed by ISOR). Figure 5.3-7 shows a plot of BHP at 900 m bgl vs discharge rate. Drawing a regression line through field data a PI of 5.4 (kg/s)/bar can be estimated, which is lower than expected from computed II. A parabolic regression has also been made to account for non-Darcy pressure losses at high rates.

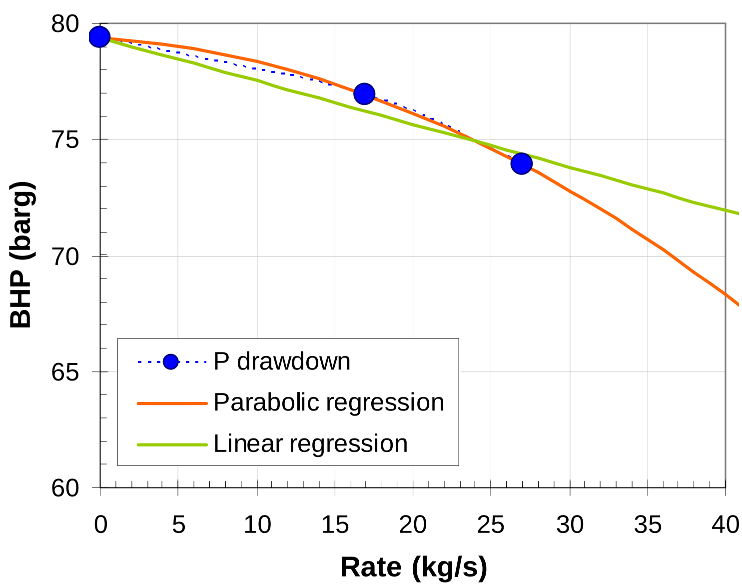

Figure 5.3-7 – Pressure drawdown @ 900 mbgl.

<u>WW-01 Output Curve</u>

Considering the discharge data listed in Table 1 of ISOR (2012d), and taking average values of WHP and rates for the different discharge periods, a tentative output curve can be drawn as shown in Figure

5.3-8. The shape of the output curve suggests there is a margin for increasing the discharge rate by lowering the WHP down to values in the order of 10 bara, which are compatible with the feeding of a pressure separator. Because of low diameter of both production CSG (7”) and slotted liner (4 ½”), a sharper decline of WHP at rates higher than those tested can be expected, because of the increasing pressure losses under two-phase conditions.

At a production rate of 27 kg/s and WHP of 17.8 barg, assuming a separation pressure of 6.5 bara and a fluid consumption for a 3.5 MW single-flash condensing unit in the order of 15.3 (kg/s)/MW, the potential electric power is 1.8 MW. This is a good result for a slim hole producing from a reservoir with temperatures in the range 235.3-240°C.

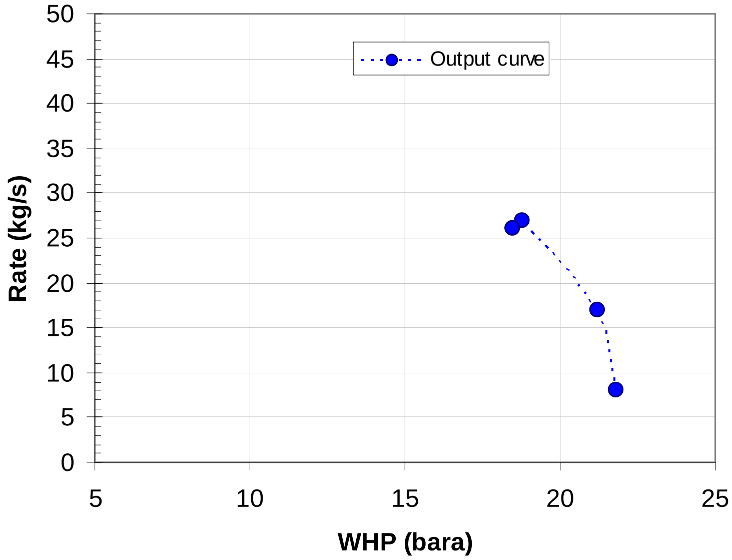

Figure 5-8 – Tentative output curve of well WW-1.

<u>WW-01 Wellbore Flow Simulations</u>

An attempt to estimate the shape of the output curve at lower WHP is performed by means of wellbore flow simulation. First, to be conservative, the regression of BHP at 900 mMD is performed using a parabolic fit as shown in Figure 5.3-7. This regression gives lower BHP at higher rates, resulting in a more conservative estimation of well discharge at low WHP. The drawdown coefficients are then used to compute the drawdown at 719 m bgl, where the main feed zone is located.

A wellbore flow model is built and calibrated to reproduce the flowing P&T logs recorded at the discharge rate of about 27 kg/s. The mixture has a NaCl content of 6000 ppm, while the CO_2 content was adjusted at 1760 ppm to match the flash pressure of 3.93 bar. A single feed zone is simulated at 719 m bgl with production T of 238.65°C and static formation P of 64.69 barg. Well completion diameters are taken from ISOR (2012c) drilling report on well WW-01. Simulations are performed with PROFILI wellbore simulator (Battistelli, 2010). Results of matching of P&T logs are shown in Figure 5.3-9. Main problem is the higher pressure gradient simulated in the liner section which produces a slight lowering of flash depth and then slightly higher WHP and WHT than measured. The inside diameter of 4 ½” slotted liner was used in the simulation , while a fraction of flow could be through the annulus between the open hole diameter of 6 1/8” and the 4 ½” slotted liner.

Then, using the parabolic regression of BHP vs rate shown in Figure 5.3-7, the output curve at higher rates has been simulated until choked flow conditions are encountered at approximately 40 kg/s. Simulated and measured output curves are shown in Figure 5.3-10. As anticipated before, when wellbore pressure declines in the upper section, the two-phase mixture flow velocity increases substantially because of increased volumetric steam flow rate. As a consequence, two-phase pressure drops increases and the WHP rapidly declines with flow rate. At 38 kg/s the equivalent power production with fluid consumption for a 3.5 MW single-flash condensing unit in the order of 15.3 (kg/s)/MW at a separation pressure of 6.5 bara is about 2.5 MW.

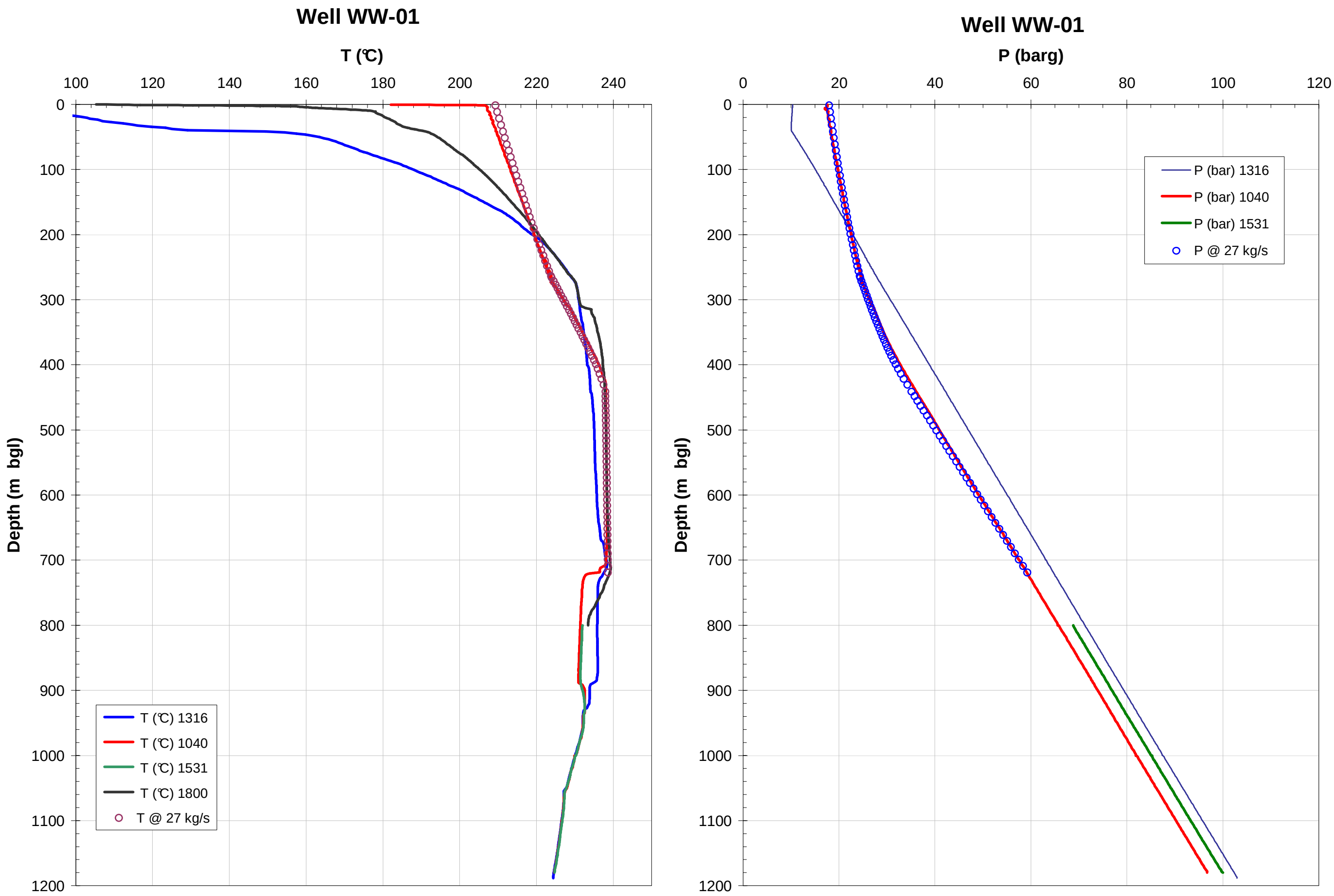

Figure 5.3-9 – Left: matching of T log; right: matching of P log. PROFILI results are superimposed on measured WW-01 flowing P&T logs.

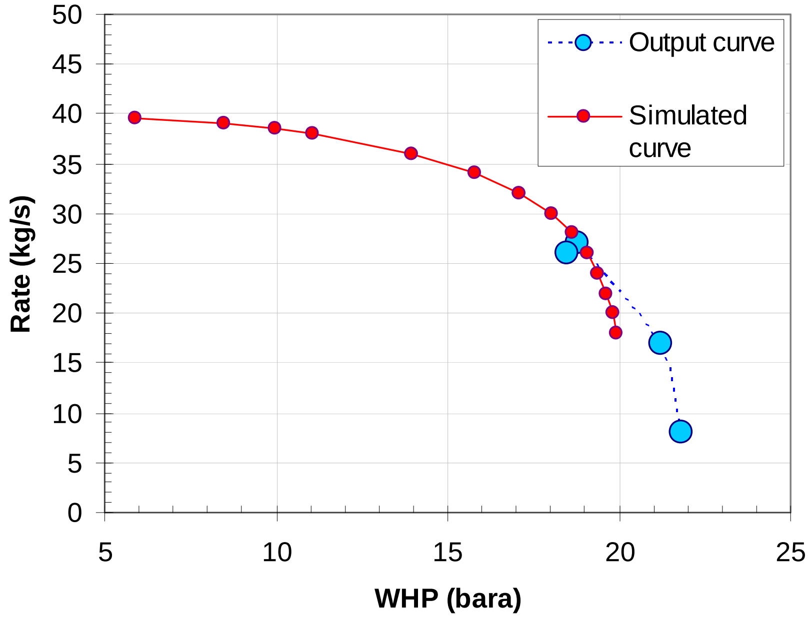

Figure 5.3-10 – Measured and simulated output curve of well WW-01.

WW-01 Pressure Transients

The first pressure transient is that recorded on April 27th, 2012, at 900 mMD during the step rate injection shown in Figure 5.3-12. The test was used by ISOR to evaluate the II. The pressure was declining in time during injection, suggesting a possible stimulation of permeable zones and/or some wellbore effect linked to temperature transients (more than 25°C temperature decline at 900 mMD during the test). Because of this spurious effect, this pressure transient cannot be interpreted to evaluate the reservoir transmissivity.

The second pressure transient was recorded on June 27th, 2012, from 11:43 to 15:30 during the execution of discharge tests with Kuster K10 set at 1180 m bgl. Due to environmental constraints, related to the small volume of ponds available for the disposal of separated brine, the discharge tests were very short. Moreover, in order to evaluate the output curve the rate was changed several times. As a consequence, well discharge is suffering for an insufficient stabilization of production parameters, which makes the interpretation of pressure transient cumbersome.

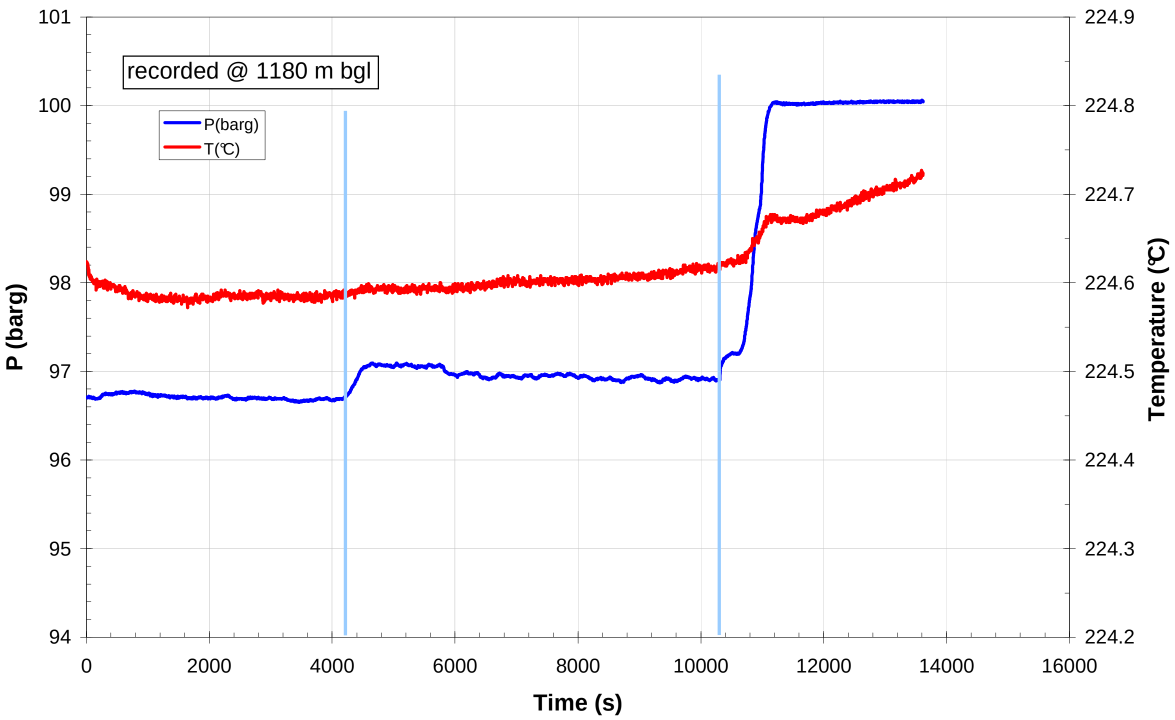

Figure 5.3-12 – Well WW-01. Second pressure transients recorded at 1180 m bgl on June 27th, 2012. Two pressure increments are linked to reduction of rates.

The third pressure transient was recorded on June 27th, 2012, from 15:50 to 18:00 during the execution of discharge tests with Kuster K10 at 800 m bgl. Recorded P and T are reported in Figure 5.3-13. A first rate change is a reduction from about 17 to 8 kg/s, while the second is the final well shut-in. In both cases after the initial fast increment, pressure declines with time, while an increment would be expected, in particular for the final build-up. An attempt to look at the log-log plot of pressure difference vs elapsed time is made in Figure 5.3-14 and 5.3-15 for both pressure transients. Early data show the conventional unit slope, but the pressure difference (DP) declines at late times instead of increasing. Because of this unusual behaviour no further attempts to interpret the pressure transient have been made.

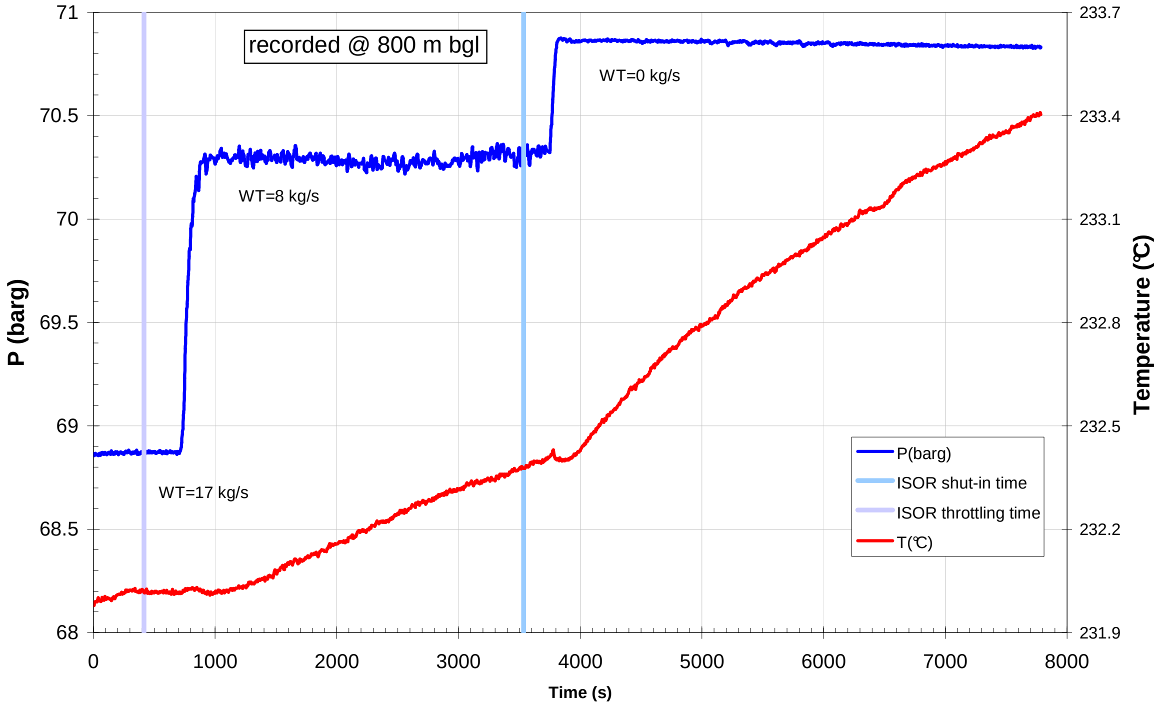

Figure 5.3-13 – Well WW-01. Third pressure transients recorded at 800 m bgl on June 27th, 2012. First pressure increment is linked to a reduction of pressure from about 17 kg/s to 8 kg/s. The second pressure increment is the build-up at well shut-in. Time of rate change reported by ISOR does not correspond exactly with recorded downhole pressure history.

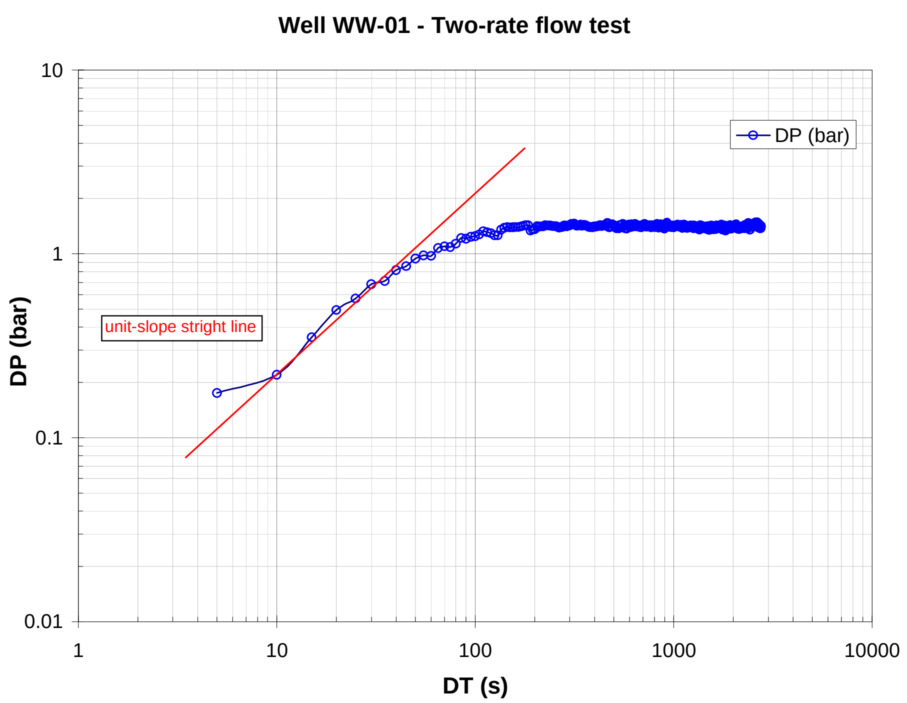

Figure 5.3-14 – Well WW-01. Log-log plot of two-rate pressure transient during the third pressure transients recorded at 800 m bgl on June 27th, 2012.

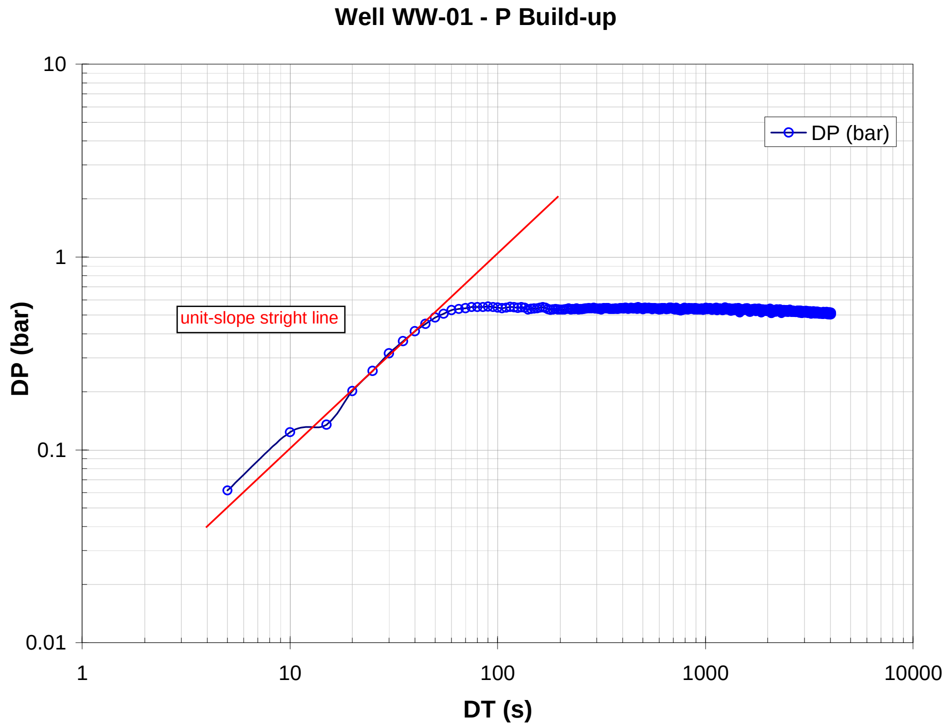

Figure 5.3-15 – Well WW-01. Log-log plot of pressure build-up during the third pressure transients recorded at 800 m bgl on June 27th, 2012.

WW-01 Expected Output Curve of a Standard Size Production Well at Pad 1

The results of the analysis of WW-01 test data discussed in the previous paragraphs make possible to simulate the discharge potential of a new standard size production well drilled from pad 1. The basic assumption is that BHP drawdown, production temperature and depth of feed zones are comparable to those measured or calculated in WW-01, and located at the same vertical depth. About the BHP drawdown, it would be lower in a well with the production section drilled with a 8 ½" instead of the 6 1/8" used in WW-01 slim hole.

The simulation considers a 9 5/8" (47 lb/ft) production CSG and a 7" slotted liner (23 lb/ft) set from 570 to 1500 mMD as shown in Figure 5.16 (ISOR, 2012). The reference well trajectory is computed as shown in Figure 5.3.16 with the following directional parameters:

- KOP @ 250 mMD;
- build-up 3°/30 m;
- maximum deviation angle 30°;
- final depth 1500 mMD.

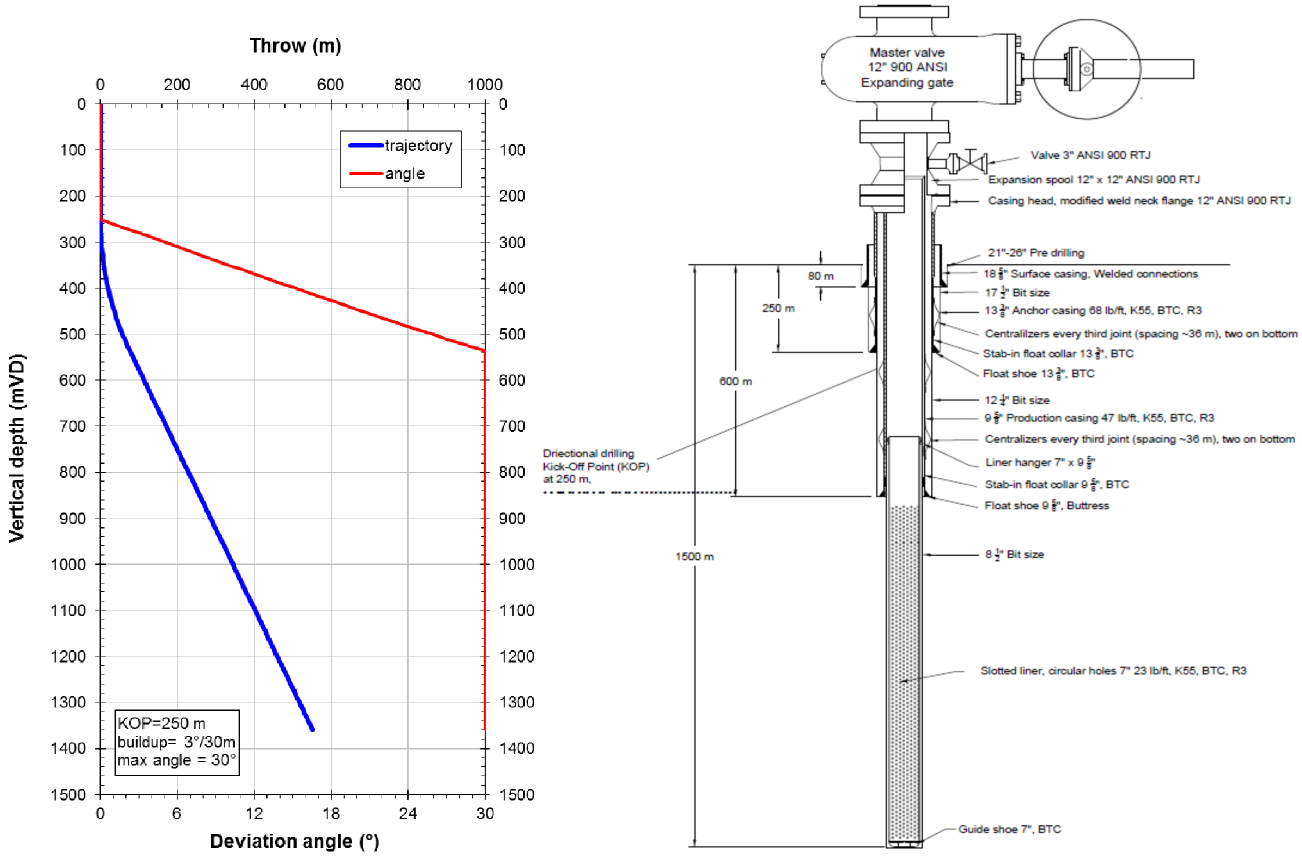

Figure 5.3-16 – Left: computed directional well profile as function of measured depth (MD). Right: planned CSG program for a standard size directional well (ISOR, 2012) Depths are MD along the wellbore axis.

A first simulation (curve #1) is performed assuming the same parabolic drawdown already used for the simulation of WW-01 output curve at low WHP. The maximum simulated rate, before choking conditions are reached, is 71.5 kg/s (257 t/h). At 67 kg/s two-phase conditions are already present at the feed zone at 719 m bgl. Simulated curve is shown in Figure 5.17. A rate of 70 kg/s corresponds to a power generation of about 4.6 MWe (single flash 3.5 MWe condensing units). This figure is conservative because of the severe BHP drawdown used for the standard completion production well, taken equal to that measured in the WW-01 slim hole.

A second simulation has been performed (curve #2) assuming a linear pressure drawdown estimated using the flowing pressure measured in well WW-01 at 27 kg/s. The pressure drawdown is 0.202 bar/(kg/s). If the pressure drawdown remains linear even at high rates, then much higher discharge rates can in principle be obtained by lowering the WHP, as shown by the simulated curve #2 in Figure 5.17. In this case chocked flow rate is about 112 kg/s, and liquid conditions are still present at the depth of feed zone at 719 m bgl. Producing at 110 kg/s, the corresponding power output would be 7.2 MWe. This figure is considered optimistic as at these high rates the pressure drawdown could be affected by non-linear pressure drops in the near wellbore area which would lower the actual well output.

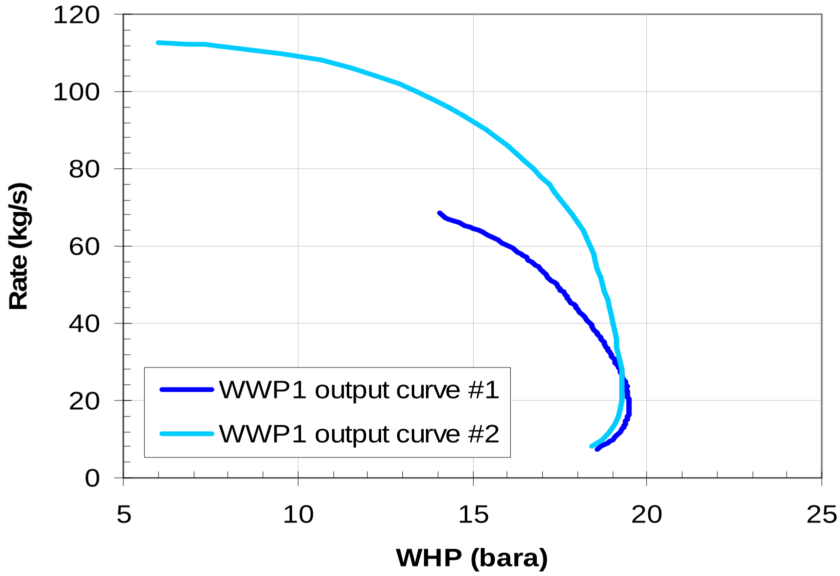

Figure 5.3-17 – Simulated output curves for a standard size well drilled from pad 1: curve #1 is computed using WW-01 parabolic pressure drawdown; curve #2 is computed using WW-01 linear pressure drawdown. Curve #1 is stopped at 68.5 kg/s, when two-phase conditions are present at the feed zones. Curve #2 has a chocked flow of 112 kg/s.

Thus, the power output of a standard size well drilled from pad 1 could be estimated in the range 4.6 – 7.2 MWe if reservoir hydraulic transmissivity encountered is similar to that found in well WW-01. Higher potential is unlikely; if initially available, it would any way produce a concentrated pressure decline which would probably affect considerably the well deliverability over time. In addition, pressure decline at depth would be transmitted also vertically with an impact in the area of surface manifestations which should be preserved for touristic and spas purposes.

5.3.4 Well WW-02

Well WW-02 is located approximately 6 km ENE of Roseau, the capital of Dominica, on the southern slopes of Mt. Micotrin. According to ISOR (2012f) the geographical coordinates are as follows (GPS reading at drill site):

15° 19.532′ N,

61° 19.507′ W

Z= 571 m asl (ELC mission 2012, ~590 m a.s.l. indicated by ISOR)

The well was drilled from December 17th, 2011, to January 28th, 2012 using the Sleipner drilling rig by the Iceland Drilling Co. Drilling phases, borehole diameters and CSG diameters are listed in Table 5.3-4 (ISOR, 2012f).

Drill-Rig	Phase	Depth	Bit Size	Casing Type	Casing Depth
Sleipnir	Pre-Drilling	25.5 m	17½"	13⅜"	24.5 m
Sleipnir	1. phase	80.7 m	12¼"	9⅝"	79.2 m
Sleipnir	2. phase	429 m	8½"	7"	427.5 m
Sleipnir	3. phase	1469 m	6⅛"	4½" liner	281.2-1337 m

Table 5.3-4 - Well WW-02 drilling and casing depths. Depths are relative to Sleipnir rig floor, 5.8 m above ground level (after ISOR).

<u>WW-02 Permeable Zones</u>

Permeable zones are identified from circulation losses or fluid inflows during drilling, and by the T logs during both injectivity and production tests. Following Table 5.3-5 is taken from ISOR (2012f). Apart for the circulation losses recorded in the cased section (production CSG shoe is set at 427.5 mMD), the first encountered in the open hole section was at 822 mMD. The permeable zone listed at 560 mMD was actually inferred from T logs, shown in Figure 5.3-16, recorded when this feed was producing a gas phase with a high NCG content responsible for an incipient well blow-out and gas kicks. The 560 mMD gas feed is characterised by a local T spike in Figure 5.3-16 (left) while the permeable zone at 822 mMD is marked by a cooling due to cold water injection.

Figure 5.3-17 shows T logs recorded under different injection rates on Jan. 19th and 26th, 2012. At a rate of 23 L/s cold water was basically flowing down to bottom hole to be probably injected in the inferred permeable zone at 1396 mMD. The other two profiles run on Jan. 26th at a lower injection rate of 13 L/s shows the injection takes place only down to depths of about 850 and 950 mMD. This was interpreted by ISOR as due to the presence of thick mud in the lower wellbore section which was not displaced by the injected water. This interpretation is supported by the measured P logs shown on Figure 5.3-17 (right). The pressure on Jan. 19th with an injection rate of 23 L/s was much lower than that recorded on 26th with only 13 L/s injection rate. The damage of well injectivity occurred between the two logs is evident. For the P log on Jan. 19th, an II of about 4.3 (L/s)/bar can be evaluated considering the static P recorded afterward.

Depth (m)	Circulation Loss (L/s)	Remarks
41	Total loss (≥20 L/s)	
61	Total loss (≥20 L/s)	
77,3	Total loss (≥20 L/s)	
81,6	Total loss (≥20 L/s)	Repeated cement plugging
c. 276	No LOC	Temperature log, January 2nd.
c. 379	LOC 20 L/s	
560	No LOC	Temperature log, January 11th, gas emission
822	Total loss (≥20 L/s)	
867	Total loss (≥20 L/s)	
903	Total loss (≥30 L/s)	
930	c. 32	Temperature log, January 26th.
c. 1100	c. 32	Temperature log, January 27th, injection test
1127	c. 33	Drop in pressure
c. 1396	c. 38	Drop in standpipe pressure, 19 bar
c. 1427	c. 40	Drop in standpipe pressure, 26bar

Table 5.3-5 - Well WW-02 inferred permeable zones. Depths are MD (after ISOR).

An injectivity test was performed after the running of slotted liner with the K10 tool set at 900 mMD. T&P logs recorded before and at the beginning of the test are shown in Figure 5.3-18. It seems that cold water was mostly injected at 1100-1105 mMD. The drop in pressure from the beginning of the test was interpreted as stimulation of permeable zones flushed by cold injected water. It can be observed that there was a water level at about 265 mMD at an injection rate of 20 L/s, while on Jan 19th with an injection rate of 23 L/s the water level was at about 440 mMD. Liner shoe was run only down to 1337 mMD, while BH is at 1469 mMD. The K10 tool was run down to a maximum depth of 1300 m after the running of slotted liner. Thus, it is likely that the deeper feeds at 1396 and 1427 mMD detected during drilling were probably plugged by rock cuttings deposited at bottom hole. As already recognized by ISOR, final well production capacity was then damaged by the plugging of deeper permeable zones.

Thus, the poor injection and production capabilities of well WW-02 should not be considered for excluding the pad 2 area for future drilling of development wells. A workover job could be performed to clean the lower well section within the 4 ½” slotted liner to remove thick mud and cuttings which might be left at bottomhole. Equipment for this workover was not available on site during drilling of WW-02 and will not be available during drilling of planned wells WWR1 and WWP1.

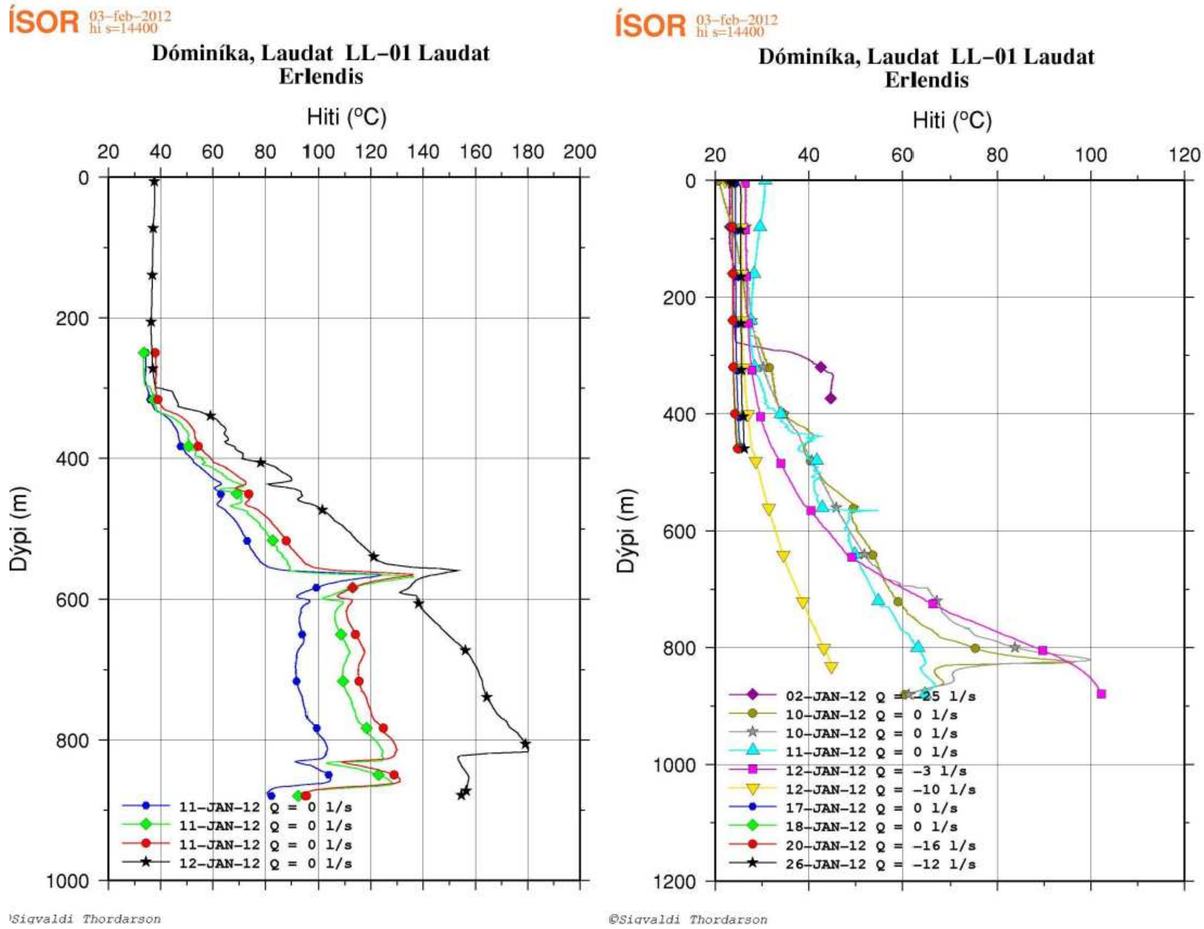

Figure 5.3-16 - Well WW-03 temperature logs recorded under shut-in condition on Jan. 11th and 12th, 2012 (left) and from Jan 2nd to 26th, 2012. (after ISOR, 2012f).

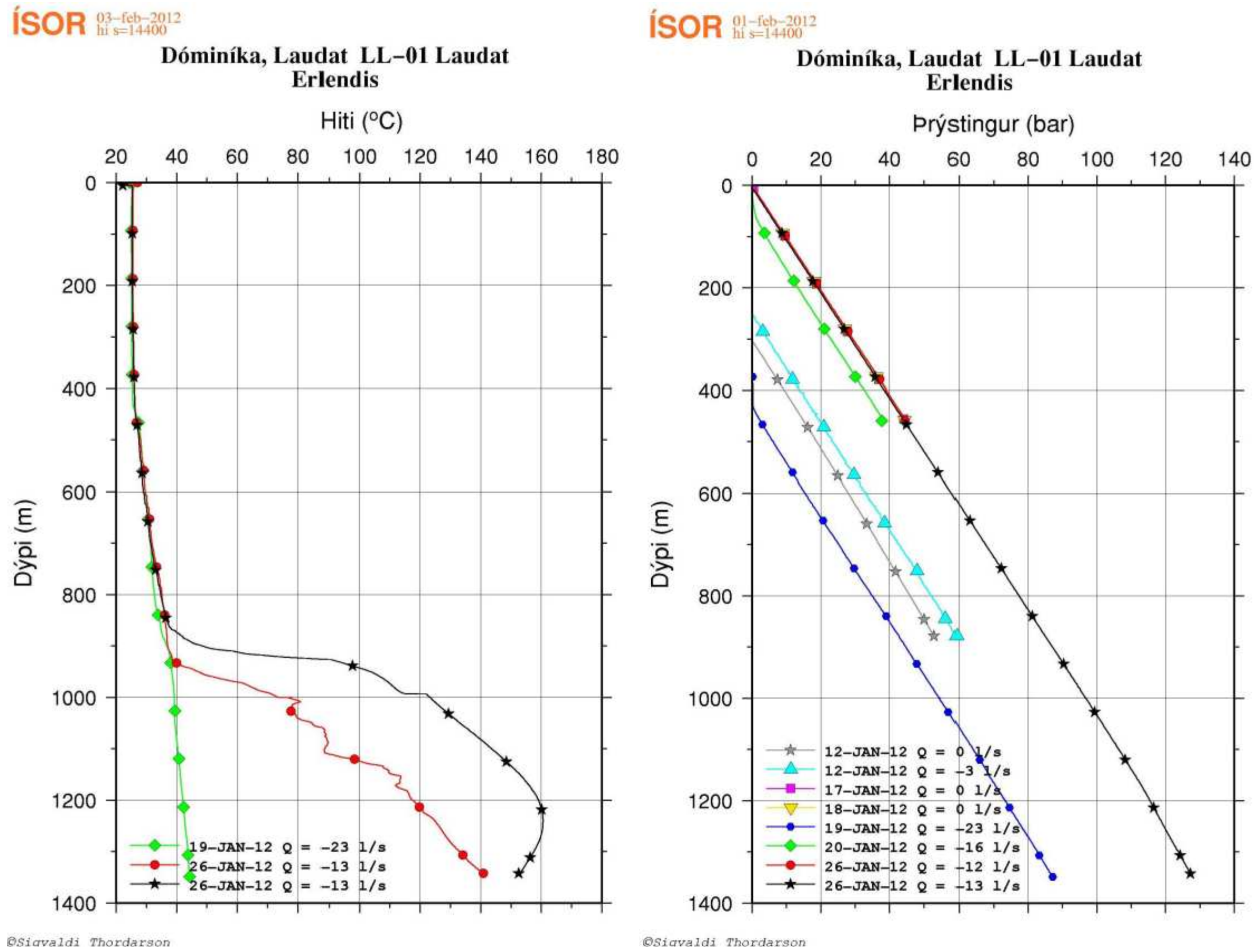

Figure 5.3-17 - Well WW-02 temperature logs recorded under injection on Jan. 19th and 26th, 2012 (left) and pressure logs recorded from Jan. 12th to 26th, 2012 (after ISOR, 2012f).

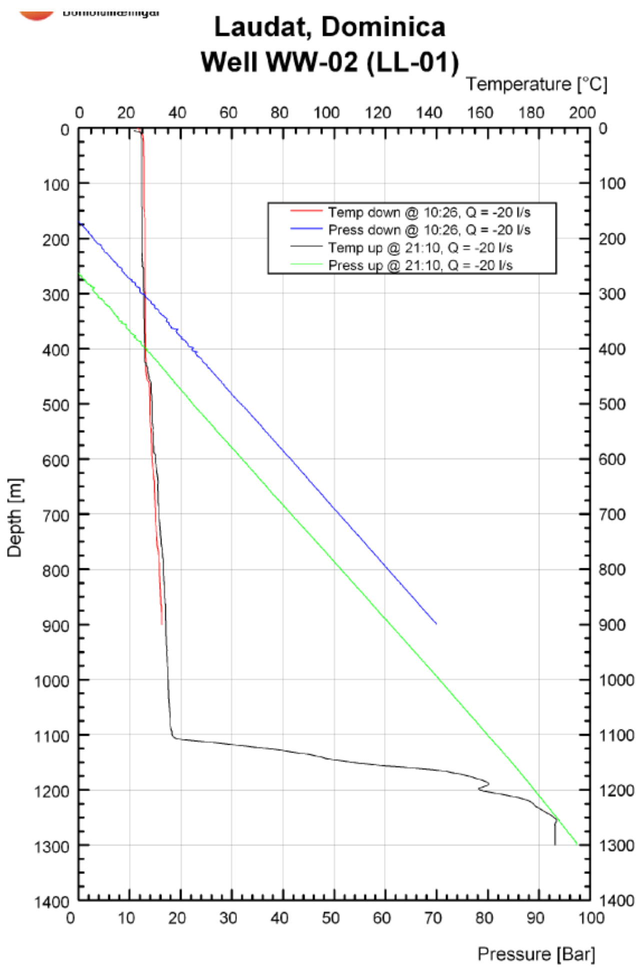

Figure 5.3-18 - Well WW-02 temperature and pressure logs recorded before and after the execution of the step rate injection test (after ISOR, 2012f).

WW-02 Thermodynamic Conditions and NCG Partial Pressure

Bubbling pressure at flash depth is estimated from flowing P&T logs recorded on March 10th, at 22.1 barg at a flash temperature of 199°C, as shown in Figure 5.3-19. Partial pressure of NCG is then about 7.9 bar. Considering that CO_2 accounts for 97-98% of total NCG, the dissolved equivalent CO_2 content at flash conditions can be estimated in the order of 3050 ppm.

Much higher partial pressure of NCG can be evaluated at the G-L level under shut-in conditions, in the order of 15 to 21 bar. These values do not necessarily reflects the NCG content in reservoir fluids. In fact, a declining partial pressure of NCG at G-L level is detected at different stages of well warm-up. The partial pressure evaluated at flash conditions during discharge is for sure more representative of NCG content in the liquid-dominated section.

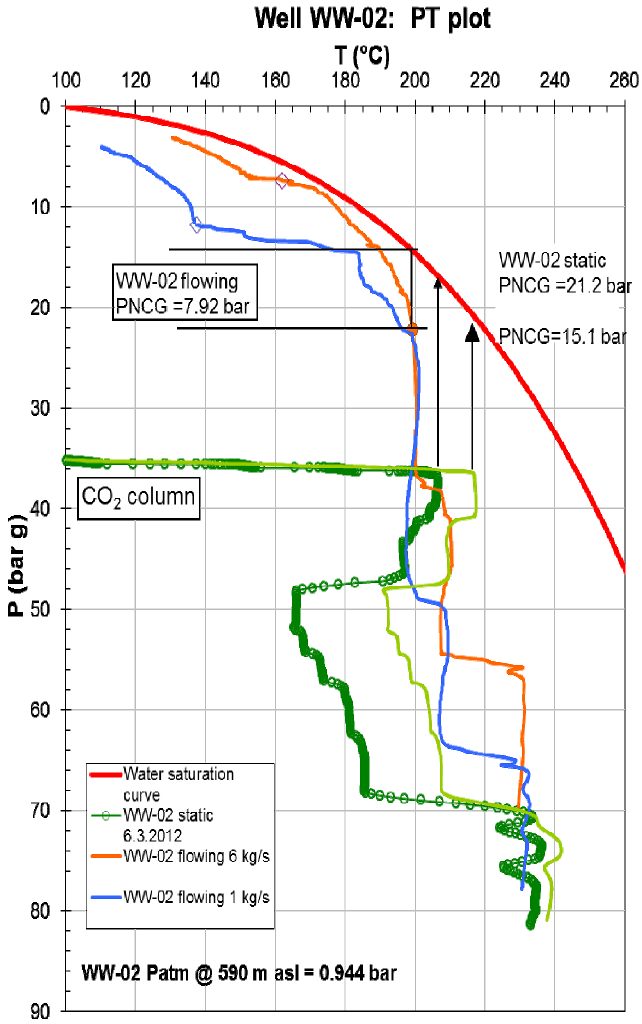

Figure 5.3-19 - Determination of partial pressure of NCG at the flash depth using the P&T flowing logs recorded on March 10th, 2012 and at the G-L level under shut-in conditions.

WW-02 Production Tests

Production tests were performed from about 11:00 on March 9th to 20:15 on March 10th, 2012. The gas cap was first discharged vertically to the atmosphere while the geothermal fluid was then discharged through a horizontal production line equipped with a 3” lip pipe into the atmospheric separator (silencer). Brine flow rate was measured at a triangular 90° weir box. ISOR supplied measured WHP, lip pressure, and weir level and computed total mass rate and mixture enthalpy combining the lip pressure equation due to James (1962, 1976) with the iso-enthalpic flash at atmospheric conditions using the separated brine rate.

Table 5.3-6 lists the field measured data, computed total rate and enthalpy by ISOR (2012g). Well WW-02 exhibited a very low production capability, with a rate of 6.4 kg/s at WHP of 3.8 barg. Estimated production enthalpy is in the range 800 – 960 kJ/kg, corresponding to saturation temperature of about 188 and 224°C, respectively. Figure 5.3-19 shows that the actual flash temperature was in the order of

199°C, within the above interval. This, despite the bottomhole temperature recorded just before the production tests is in the order of 230°C.

Considering the poor discharge characteristics of well WW-02 probably still affected by strong transients, no attempts to draw the output curve were made.

Table 5.3-6. Well WW-02 discharge data: field measurements and ISOR computed results.

Time	WHP [bar-g]	Lip pressure [bar-g]	Weir box [cm]	Flow [kg/s]	Water [l/s]	Steam [kg/s]	Enthalpy [kJ/kg]	Remarks
March 9th								
11:13	32.0							Gas discharged through a 2 inch pipe
11:15	27.0							Attached to the 3inch top valve
11:16	24.0							
11:17	20.0							
11:18	17.0							
11:19	14.0							
11:20	11.5							
11:21	9.8							
11:22	8.0							
11:25	6.5							
11:27	6.0							Dark liquid
11:29	5.0							Water and steam in the flow
11:30	2.0							Opened through flowline
11:32	2.0							
11:34	2.2		29.0					
11:35	2.2	0.05	29.8	5.4	4.4	1.0	830	
11:40	2.2							
11:44	2.5							
11:48		0.15	30.2	5.2	4.0	1.2	940	
11:55	2.3	0.24	30.0	5.5	4.2	1.3	950	
12:05	2.3	0.25	30.0	5.5	4.2	1.3	950	
12:30	2.1	0.15	30.2	5.2	4.0	1.2	940	
14:10	2.2	0.18	29.0	6.4	5.3	1.1	790	
14:35	2.2	0.21	29.0	6.4	5.3	1.1	800	
14:55	2.2	0.22	29.0	6.4	5.3	1.1	810	
15:30	2.3	0.24	29.0	6.4	5.3	1.1	820	
16:15	2.7	0.26	29.0	6.5	5.3	1.2	830	
March 10th								
08:30	3.7	0.50	29.3	6.5	5.0	1.5	960	
10:45	3.8	0.50	29.4	6.6	4.9	1.5	980	
15:10	3.8	0.50	29.2	6.6	5.1	1.5	940	
15:55	5.0	~0.1	33.5					Reduced flow, not critical
16:00	5.0				1.4			
16:05	5.0	~0	34.5					T/P tool at 1260 m
16:15	4.7	~0			0.9			
16:30	4.0	~0	35.2		0.7			
16:45	4.1	~0	34.3		0.9			
17:10	4.1	~0	34.3		0.9			
18:05	4.1	~0	34.3		1.1			
18:06	4.1							T/P tool out of well; Well closed
19:30	31							
20:15	32							Well closed
March 11th								
13:00	33.0							

Figure 5.3-20 shows the shut-in temperature and pressure logs recorded just before the discharge tests and after about 50 days. On the same figure P&T logs recorded under flowing conditions at about 6 and 1 kg/s are also reported.

Shut-in logs show an extremely low T below the 7" CSG shoe, in the order of 110°C which clearly indicates that CSG shoe depth at 427.5 mMD is insufficient. Both static T logs show a stepped profile from the CSG shoe down to 650 mMD suggesting the possible presence of permeable zones. This is confirmed at 560 mMD by previous logs. The step change of T at about 460 m does not corresponds to previous indications but T log run under flowing conditions at 1 kg/s show a remarkable decrement of T at that depth, suggesting low temperature fluid is entering at that depth. It must be observed that at 1 kg/s total estimated rate even a small inflow of colder fluid is able to affect well discharge. It must be pointed out that this inferred permeable zones are located in a two-phase section which is likely to discharge a relatively cold gas phase with a high NCG content. The T decrement at 6 kg/s at 460 m depth is much lower, indicating the colder gas inflow should have a low rate.

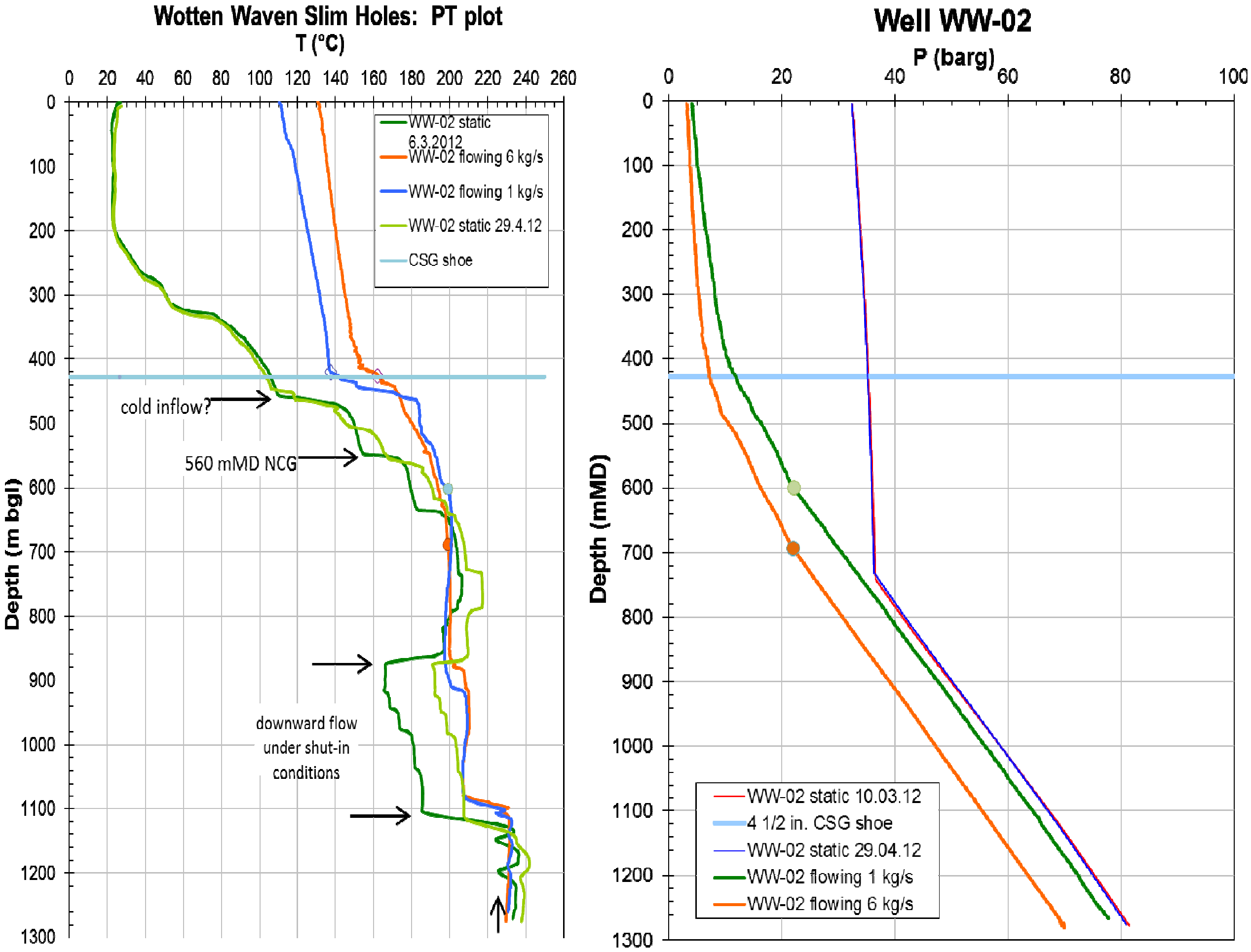

Figure 5.3-20. Well WW-02 : left: static and flowing T logs; right: static and flowing P logs.

Another important feature of shut-in logs is the strong cooling in the 860 – 1120 mMD section, where total circulation losses were detected during drilling. Even this section has a stepped T profile suggesting that under shut-in conditions reservoir fluids are entering the well starting at 860 mMD and are flowing down to the feed at 1105 mMD. The cooled section has not recovered even after the execution of production tests probably because of large volume of cold water injected during drilling because of blind drilling and the need to control gas kicks. The discharge tests were too short and of limited production rate to allow the warm-up of these permeable section.

Finally the comparison of shut-in and flowing T logs in the deeper part, below 1150 mMD, suggest that some production was also obtained from the feed zones that were almost blocked by drilling cuttings.

Under flowing conditions the T logs are affected by the inflow from multiple feeds still at different temperature. The result is a strange flowing T log shape with many step changes. The low flow rate probably enhances the effect of each feed contribution.

WW-02 Injectivity and Productivity Index

The injectivity index (II) was estimated by ISOR in the order of 2.3 (l/s)/bar with step rate injection tests performed at the end of drilling operations on Jan 27th, 2012. The recorded pressure values at 900 mMD were declining with time during the injection tests suggesting the possible stimulation of well injectivity with time. The P decline was considered in the interpretation of the test. The evaluated II can be considered a lower limit of actual well injection capacity. The estimated II using the P log recorded on Jan. 19th is 4.6 (L/s)/bar, which is twice that evaluated subsequently.

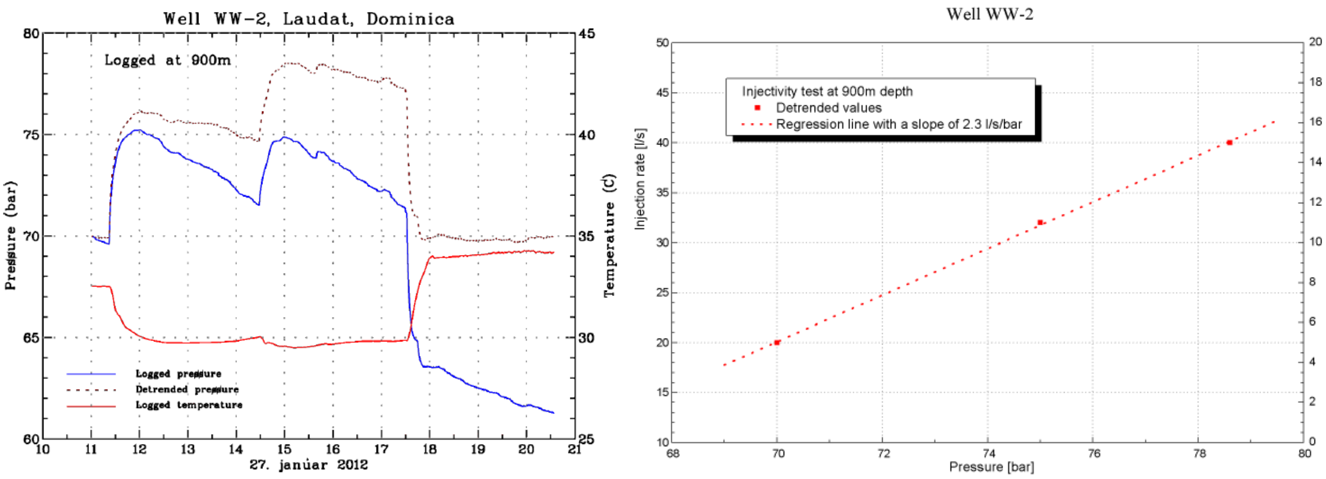

Figure 5.3-21 - Well WW-02 step rate injection tests at 900 mMD. Left: downhole P and T; right: Interpreted injectivity index (ISOR, 2012c).

The productivity index (PI) can be evaluated looking at P logs recorded under shut-in and flowing conditions. Pressure measurements at 1000 mMD were used obtaining a PI of 1.76 (kg/s)/bar, which is rather low as expected from the poor production characteristics of well WW-01. As inferred feeds deeper than 1200 mMD are probably blocked by drilling cuttings, this low PI is representative of the feed zones at present open to flow in the section 860 – 1120 mMD. The cold gas inflows in the two-phase section affected negatively the well output by reducing the WHP and then preventing the discharge at higher rates. But well discharge potential was any way limited by the low PI and low temperature of feed zones which have not yet recovered the formation temperature.

5.3.5 Well WW-03

Well WW-03 is located in Laudat, approximately 6 km ENE of Roseau, the capital of Dominica, on the southern slopes of Mt.Micotrin near the Domlec balancing tank. According to ISOR (2012h) the geographical coordinates are as follows (GPS reading at drill site):

15° 19.823 'N,

61° 19.681'W

Z= 543 m asl (~560 m a.s.l. indicated by ISOR).

The well was drilled from February 15th, 2012, to March 14th, 2012 using the Sleipner drilling rig by the Iceland Drilling Co. Drilling phases, borehole diameters and CSG diameters are listed in Table 5.3-7 (ISOR, 2012h).

Drill-Rig	Phase	Depth	Bit Size	Casing Type	Casing Depth
Sleipnir	Conductor casing	31.0 m	17½"	13⅜"	30.5 m
Sleipnir	Surface casing	158.0 m	12¼"	9⅝"	155.6 m
Sleipnir	Production casing	593.0 m	8½"	7"	590.6 m
Sleipnir	Production section	1613 m	6⅛"	4½" liner	569.6–1612 m

Table 5.3-7 - Well WW-03 drilling and casing depths. Depths are relative to Sleipnir rig floor, 5.8 m above ground level (after ISOR).

<u>WW-03 Permeable Zones</u>

Permeable zones are identified from circulation losses or fluid inflows during drilling, and by the T logs during both injectivity and production tests. Following Table 5.3-8 is modified after ISOR (2012f).

Depth (mMD)	Feed pressure (barg)	Circulation Loss (l/s)	Remarks
945		Small loss (≥5 L/s)	Observed when adding joint. Seen in temperature-log.
996		Small loss (≥5 L/s)	Increased loss.
1080 (1095)		Total loss (≥20 L/s)	Resumed to about 10 L/s. Seen in temperature-log.
1150		Influx	Noted in temperature log.
1173		Total loss (≥20 L/s)	Total loss, stand-pipe pressure dropped ~30 bar. Seen in temperature-log.
1179 (1181)		Total loss (≥20 L/s)	Stand-pipe pressure dropped further ~10 bar. Seen in temperature-log.
1500 (1505)		Total loss (≥20 L/s)	Temperature log, 13th of March.

Table 5.3-8- Well WW-03 inferred permeable zones. Measured depths highlighted in bold are relative to major feed zones open to flow (modified after ISOR, 2012h).

Detection of circulation losses during drilling after the first important loss is not an easy task. Useful data are also obtained looking to temperature profiles recorded during continuous injection. Figure 5.3-22 shows T logs recorded during injection on 12th, 15th and 16th of March, 2012. These stepped T log are characteristic of high permeability boreholes intercepting multiple permeable levels. In this case the wellbore P in the upper section is usually lower than reservoir pressure and permeable zones discharge hot fluid which is increasing borehole temperature. Bottom well section has a pressure higher than reservoir pressure and fluid flowing in the wellbore is then injected into the formation. This is clearly shown in Figure 5.3-23 where one of the injection P logs is compared with the static P recorded just before the well discharge test on April 16th, 2012. Thus, reservoir fluid is discharged into the well at depths of 965, 1095, and 1181 mMD, while the whole wellbore flow is then injected at a depth of about 1505 mMD. This means also that the II evaluated with the step injection tests is underestimated with respect to the actual well injection capacity.

No permeable zones were clearly detected either during drilling or water loss tests from the CSG shoe at 590 mMD down to 945 mMD, where the first circulation losses were encountered.

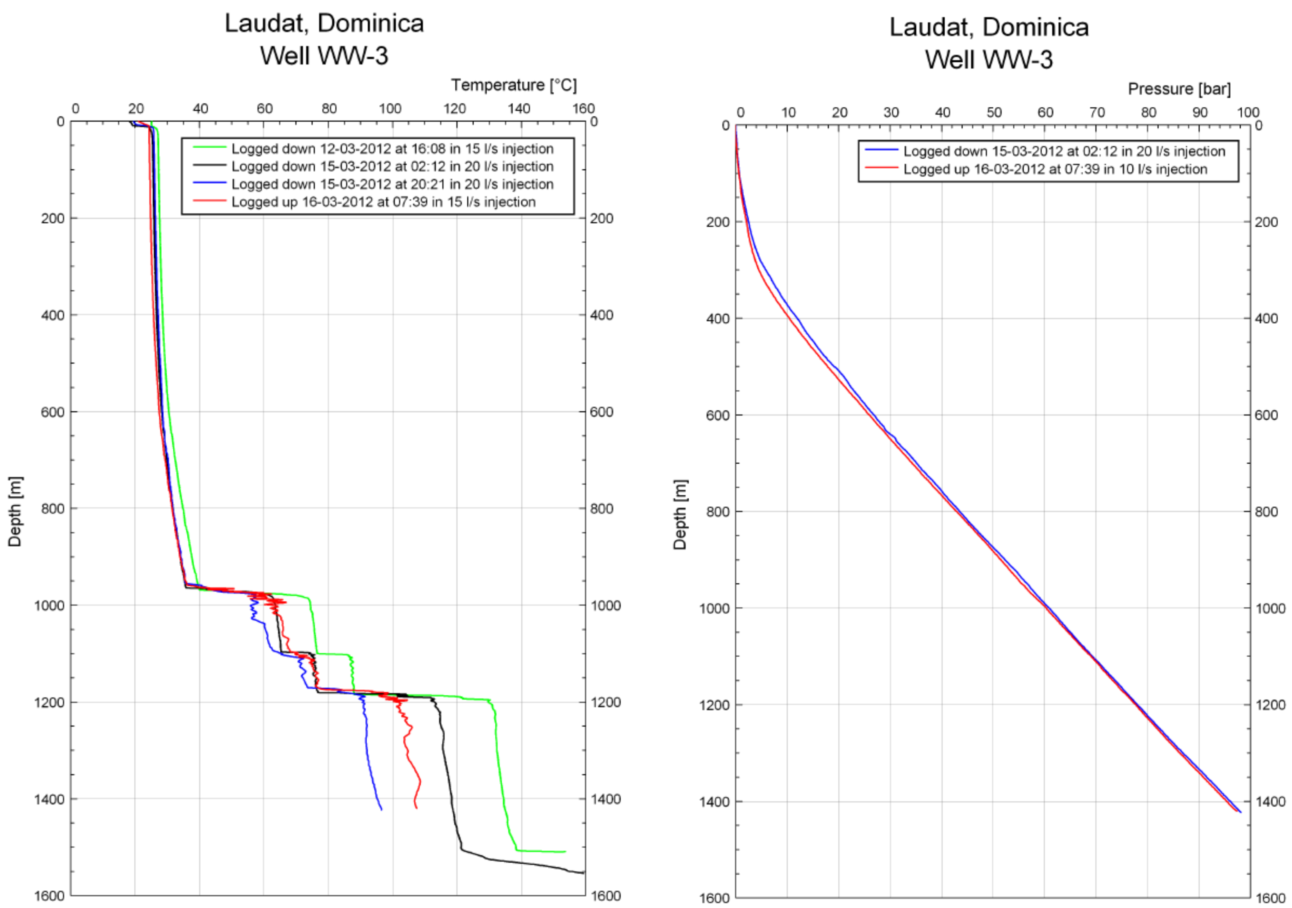

Figure 5.3-22 - Well WW-03 temperature logs (left) and pressure logs (right) recorded on March 12th 15th and 16th 2012 under continuous injection. Depths are MD.

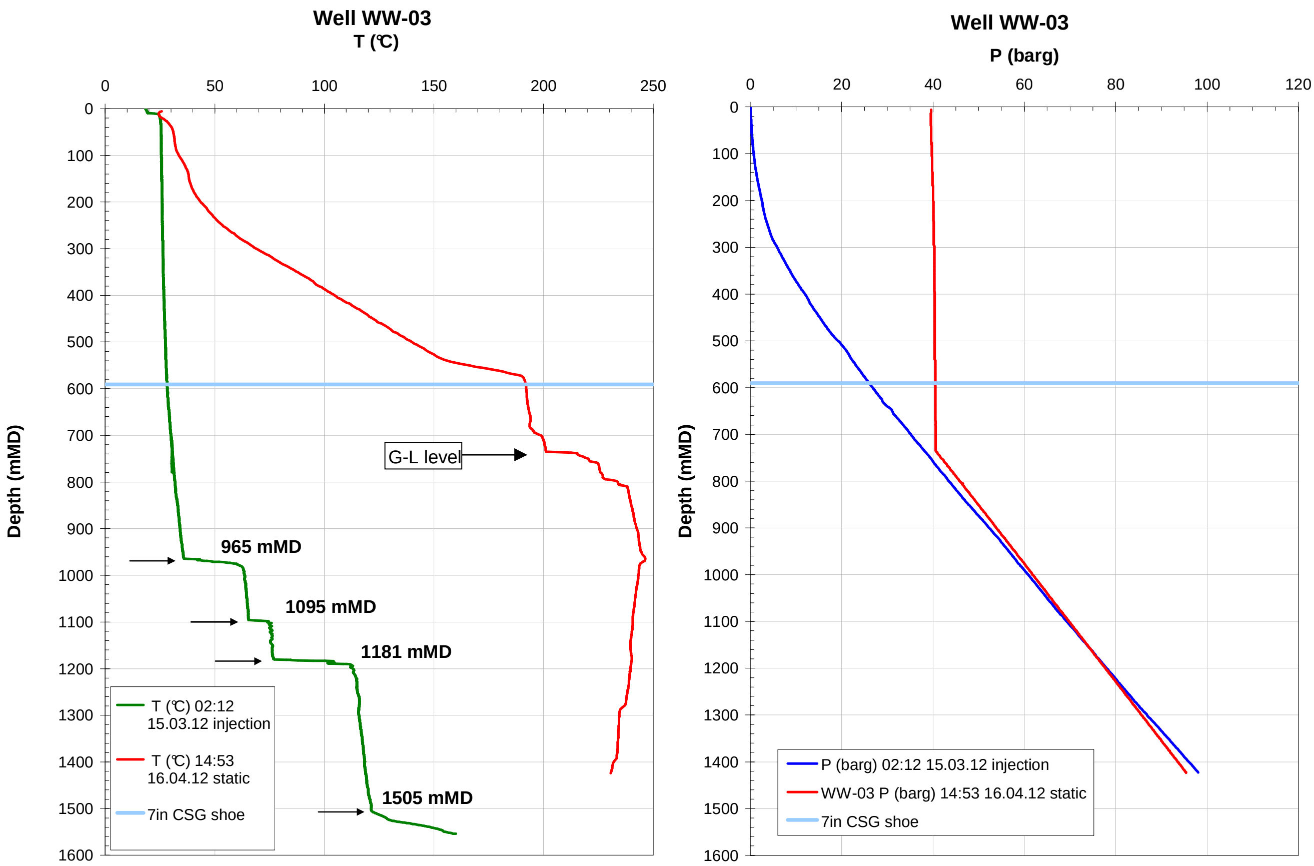

Figure 5.3-23 - Well WW-03 temperature logs (left) and pressure logs (right) recorded on March 12th and April 16th 2012 under continuous injection and static conditions. Depths are MD.

WW-03 Thermodynamic Conditions and NCG Partial Pressure

No flowing P&T logs were recorded on well WW-03 because of a CSG collapse occurred when the well was opened to flow. Thus, only static P&T logs can be used to look at thermodynamic conditions and NCG content. Figure 5.3-24 shows that a column of NCG (mainly CO_2) was present under shut-in conditions with a G-L level at 737 mMD, a pressure of 40.7 barg and a temperature of 212.5°C. The partial pressure of NCG at G-L conditions is about 18.8 bar.

This pressure does not necessarily represent the partial pressure of NCG in reservoir fluid as it is the results of NCG accumulation in the wellbore because of boiling in the upper two-phase zone which is present beneath the cap-rock. Condensation of steam in the upper cold well section under shut-in conditions allows the accumulation of NCG which displace downwards the liquid level.

The fast build-up of WHP as soon as cold water circulation is stopped may suggest that NCG content in the two-phase upper reservoir section is higher than in the liquid-dominated reservoir. Boiling within the reservoir at the two-phase –liquid interface may be responsible of NCG accumulation in the above two-phase zone.

The G-L level is also marked by a strong localised decrement of T which decreases down to 201°C. Feed zones of remarkable permeability were not detected in this two-phase zone during drilling and water loss tests. It is any way likely that under shut-in conditions boiling in minor permeability feeds present in the upper two-phase zone is responsible for the generation of low temperature, high NCG content steam.

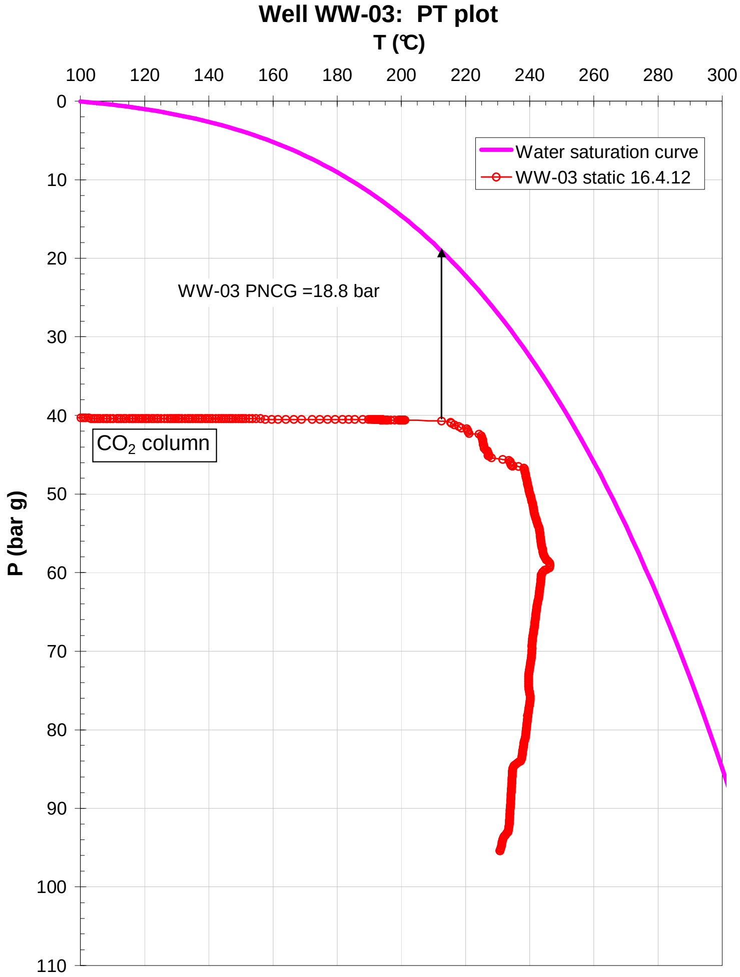

Figure 5.3-24 - Well WW-03 static T&P data plotted on the P-T plot against the saturation pressure of pure water.

<u>WW-03 Production Tests</u>

Very short production tests were performed on March 16th, 2012 from about 10:40 to 17:00. The same surface equipment already described for well WW-01 was used previously on well WW-03. Table 5.3-9 lists the discharge data collected by ISOR and related rates. The well showed good production characteristics with discharge rate increasing from 25 to 32 kg/s at a WHP of 12 – 13 barg. Once the K10 tool was ran for P&T logging, a CSG collapse, not present just before well opening, was found at a depth of 29 m bgl. This prevented the running of downhole P&T logging operations and also influenced the performance of discharge tests which were completed without obtaining even a rough figure of the output curve.

Time	WHP [bar-g]	Pc [bar-g]	Water height [mm]	Water flow [kgs]	Enthalpy [kJ/kg]	Total flow [kg/s]	Steam flow [kg/s]	Remarks
10:40	39							Top valve opened for bleed
10:47	8							Fully opened
11:00	9-11							Well cycles as expected
12:00	11-13							
13:00	11-13							Water becomes cleaner
14:00	11-13	5.3	180	18.8	980	24.9	6.2	
14:30	12-14	5.5	186	20.4	950	26.6	6.2	
15:45	12-14	5.8	190					Prepared for logging
16:00	12-14	6.0						
16:10								Tool stops at 29 m (tool tip)
16:15	12-14	6.5	203	25.3	900	32.2	6.9	
16:30	12-14	2.0	130	8.4	1030	11.5	3.2	Valve shut in to half
16:47	17	0.5	112	5.8	870	7.2	1.4	Valve shut in to 7/8
17:00	15	0.5	110	5.6	890	7.0	1.5	
17:30	14	0.5						
18:00	14	0.5						Sinker bar stops at 29 m
18:30								Well closed

Table 5.3-9 – Well WW-03 discharge data (after ISOR, 2012m).

Evaluated production enthalpy was in the range 870 – 1030 kJ/kg, corresponding to water saturation temperature of 204 and 238°C, with an average in the order of 222°C. Probably the incomplete well warm-up due to the very short production period can be an explanation for these temperatures which seems lower than that expected looking at the static temperature profile run just before well opening. Deep feed zones between 900 and 1200 mMD have static temperature greater than 230°C. A colder contribution can be linked to the deepest feed at 1505 mMD as shown by the static temperature profile, even though an incomplete stabilization could be the reason for the temperature inversion present below 970 mMD.

<u>WW-03 Injectivity and Production Index</u>

The injectivity index (II) was estimated by ISOR in the order of 53 (l/s)/bar with step rate injection tests performed at the end of drilling operations. The recorded pressure values at 1420 mMD were oscillating suggesting the possible cycling behaviour of one of the permeable zones intercepted. The recorded T was also changing as function of rate, showing that fluids were flowing below the setting depth of the K10 tool at 1420 mMD. In fact, an additional permeable zone is for sure present at 1505 mMD. The evaluated II represents for sure a lower limit of actual global well injection capacity. As observed before, a rate higher than that pumped at surface was probably injected only in the deeper feed zone during the step rate injection test.

The productivity index (PI) cannot be evaluated as no measurements under flowing conditions are available for well WW-03.

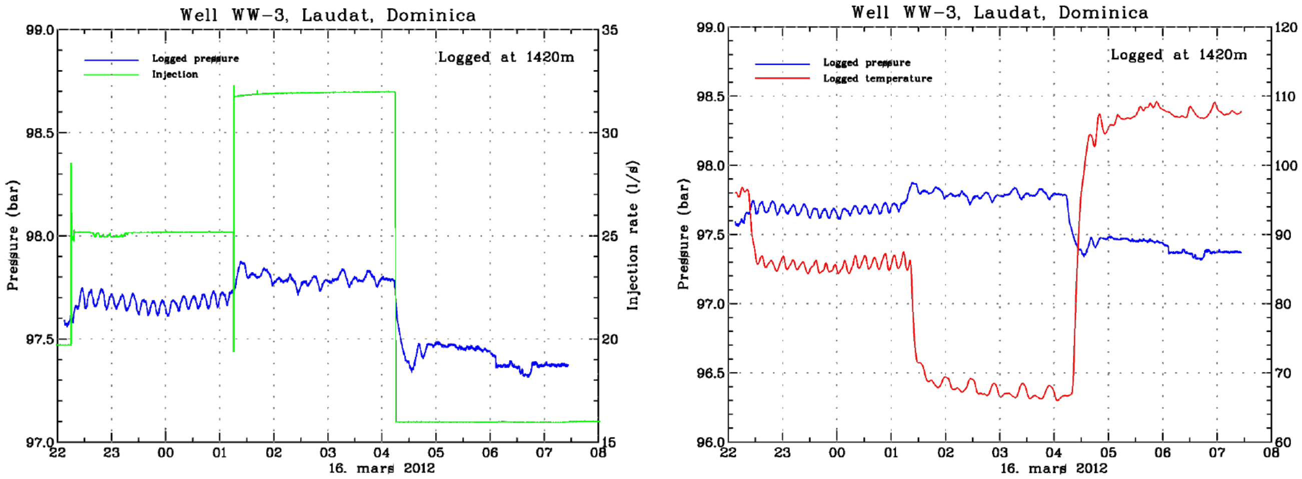

Figure 5.3-25 – Well WW-03 step rate injection tests at 1420 mMD. Left: downhole P and injection rate; right: downhole pressure and temperature (ISOR, 2012b).

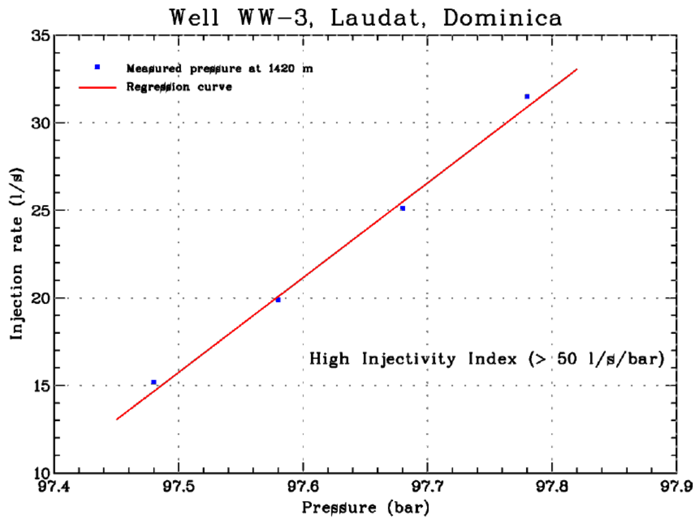

Figure 5.3-26 – Well WW-03 step rate injection tests at 1420 mMD. Interpreted injectivity index (ISOR, 2012b).

<u>WW-03 Output Curves</u>

The discharge tests on well WW-03 were too short to allow the recording of stabilized discharge rates at different production regimes. Recorded average WHP and total mass rates plotted on Figure 5.3-27 shows that they cannot be used to draw a reliable output curve. Only one point at 14 bara and 32 kg/s can be considered as roughly representative of well discharge capability.

At a production rate of 32 kg/s, assuming a separation pressure of 6.5 bara and a fluid consumption for a 3.5 MW single-flash condensing unit in the order of 15.3 (kg/s)/MW, the potential electric power is 2.1 MW. This is a good result for a slim hole producing from a reservoir with temperatures in the range 235-245°C.

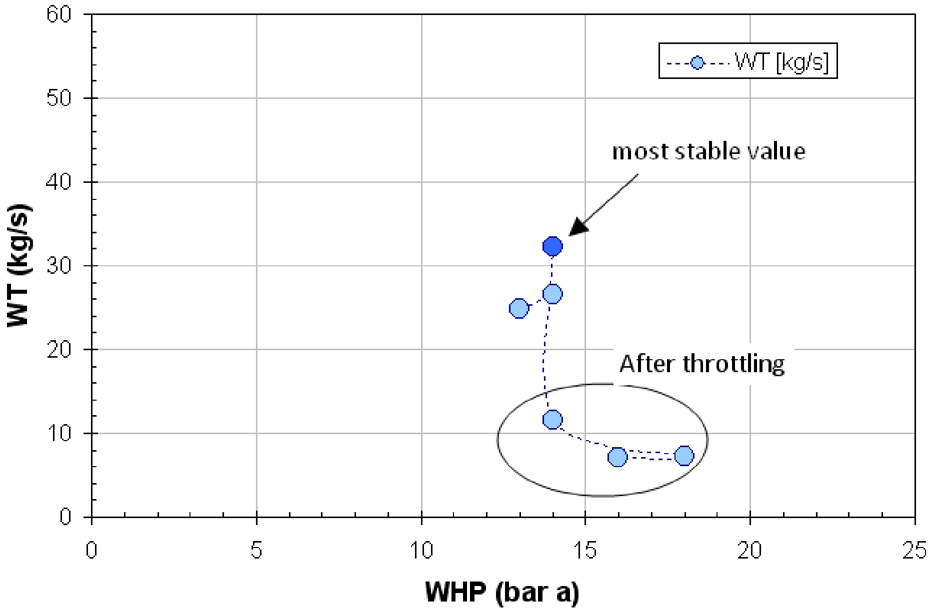

Figure 5.3-27 – Output values of well WW-03 on the P-rate plot. WHP was probably affected by additional pressure losses due to the CSG collapse at 29 mMD.

WW-03 Expected Output Curve of Standard Size Production Well at Pad 3

No downhole measurements are available to calibrate wellbore flow simulations. However, an attempt has been made in order to evaluate the possible production capacity of well WW-03 and of a standard diameter well producing from similar reservoir characteristics.

The simulation, performed with PROFILI code, uses the well completion listed in Table 5.3-7 and the following basic parameters:

BHP = 78.8 bara @ 1200 m bgl

BHT = 240°C @ 1200 m bgl

PI = 50 (kg/s)/bar

Rate = 32 kg/s

NCG content = 4100 ppm (P_{CO2} @ 240°C = 9 bar)

TDS = 6000 ppm

The simulation gives a WHP of 13.65 bar, against measured WHP oscillating between 13 and 15 bara. No further attempts to improve the match have been performed because of the uncertainties on measured WHP and rate. Fluid enthalpy at the bottom is 1030 kJ/kg, while at WH is 1005 kJ/kg, which is in the range of measured values.

Using the above parameters the hypothetical output curve of well WW-03 has been simulated. It must be pointed out that the PI used is a rough estimate made using the II which was estimated at 53 (L/s)/bar. The PI used is already so high that a further increase would not have a remarkable effect on the output curve. Simulated output curve is shown in Figure 5.3-28. Choking flow conditions are obtained at a total mass rate of 40 kg/s, when average mixture velocities above 170 m/s are present at wellhead. This result is close to that obtained for well WW-01 despite the much higher PI of well WW-

03. The reason is the elevation of well WW-03, 543 m instead of 224 m asl, which is responsible of higher gravitational pressure losses in well WW-03. The lower pressure also increases the volumetric flow rate and then the friction losses under two-phase flow conditions.

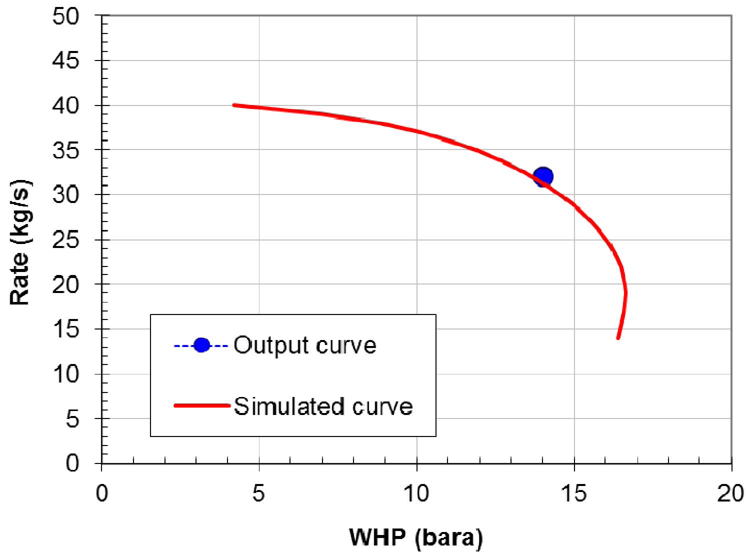

Figure 5.3-28 – Simulated output curve of well WW-03 assuming a PI of 50 (kg/s)/bar. The measured value at WHP = 14 bara and rate of 32 kg/s is also shown.

It is interesting to evaluate what could be the output curve of a vertical standard diameter well producing from the same reservoir area tapped by well WW-03. The same reservoir properties listed above are used. Now the well completion considered is that of a standard size well with a 9 5/8” (47 lb/ft) CSG set at 600 m and a 7” (23 lb/ft) slotted liner from 570 m down to BH. The simulated output curve is shown in Figure 5.3-29. The maximum rate is about 99 kg/s when choking flow conditions are reached at wellhead. The maximum discharge pressure is about 17.1 bara. With the high PI considered, even at chocked flow conditions the flash depth is above the upper feed zone identified in well WW-03 at 965 mMD. Thus, single-liquid conditions would be present in all the feed zones and a stable fluid enthalpy will be obtained. The assumption of a linear pressure drawdown is of course optimistic, as at high rates non Darcy pressure losses in the near wellbore zone could increase the pressure drawdown.

The possible output curve of a standard diameter directional well located in WW-01 well pad has been also estimated in paragraph 5.3-8. The curve simulated with a linear pressure drawdown for well WW-01 has a higher chocking rate of about 112 kg/s and a higher maximum discharge pressure of 19 bara, even though well WW-01 has a lower PI. This is due to the fact that reservoir pressure in WW-01 area is only 2 bar lower than in WW-03 area, but well pad elevation is at 224 m asl against 543 m asl. Producing from lower elevations at almost the same reservoir pressure allows to obtain better well deliverabilities.

The location of WWP1 in well pad 3 was considered in November 2012 as an alternative option if the foreseen reinjection well in Trafalgar would have shown insufficient reinjection capabilities. In this case, brine separated at WW-03 well pad could in principle be reinjected also in the existing well WW-01 by taking advantage of the 320 m difference in well pad elevations.

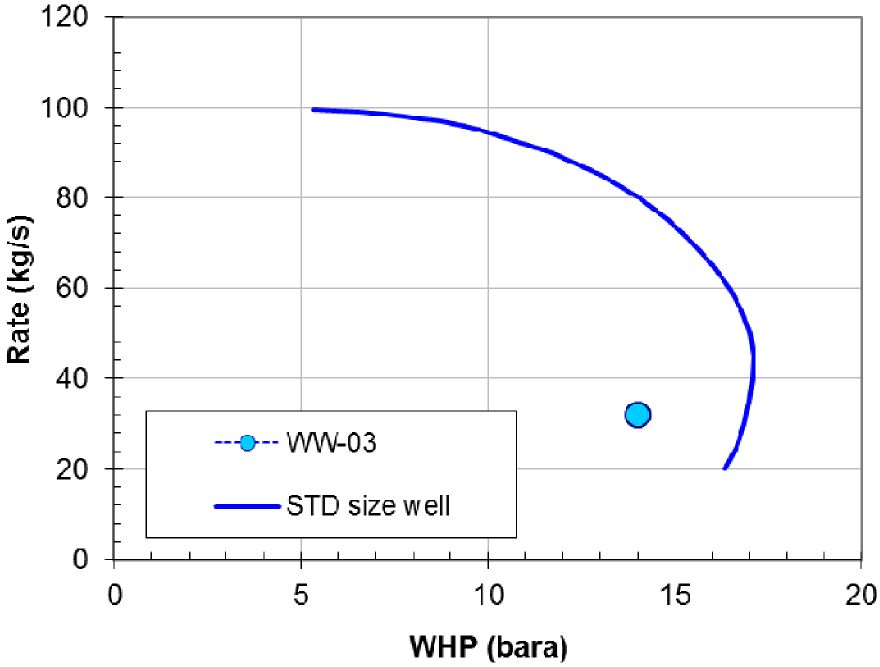

Figure 5.3-29 – Simulated output curve of a vertical standard size production well drilled from the same pad of well WW-03, assuming similar reservoir properties

5.4. Field Conceptual Model

5.4.1 General Scheme of the Geothermal System

The findings of the underground exploration have not significantly modified the conceptual model proposed in the Inception Report, but, through the direct measurement of the hydraulic, thermodynamic and chemical parameters, have allowed a better and more reliable definition of the characteristics of the reservoir. The main elements of the conceptual model are described here below:

- The heat source of the geothermal system is represented by the magmatic chamber which fed the emission of the dacitic products of the Micotrin domes and probably the very recent pumitic flows as well. The products have been intersected in the upper section of wells WW-02 and WW-03,
- Such heat source is located in the northern sector of the Project area, where the main up-flow of heated fluids is deemed to take place.
- Recharge of the system is deemed to correspond essentially to meteoric water. The contribution of sea water is expected to be negligible, in consideration of the relatively large distance from the shore line (about 6 km) and of the elevation of the geothermal reservoir. These expectations are corroborated by chemical and isotopic characteristics of geothermal fluids.
- Present reservoir pressures in the Laudat area, where wells WW-02 and WW-03 have been drilled, have equivalent water level at elevations of 300-320 m asl, thus well below ground level. Due to temperature and gas content, the geothermal fluid boils in the upper reservoir section and a two-phase zone with probably a steam-static pressure distribution is then present in the Laudat area. Because of boiling, an accumulation of NCG in the two-phase zone can be expected with respect to the brine in the liquid dominated section beneath.
- Higher temperatures recorded in WW-03 with respect to WW-01 seem to confirm a flow component from Laudat towards SSW (Wotten Waven). Same indication comes from pressure logs showing lower static pressures in WW-01 than in the other two wells. This flow direction is probably controlled by the main structural trends which are associated with a higher secondary permeability
- An impervious layer (cap rock derived from argillification processes) is capping the reservoir in the Laudat sector.
- The available information concurs in indicating the NE-SW/NNE-SSW structural trend as the most pronounced one. Accordingly, ascending fluids are expected to move from the Micotrin sector towards the zone of Laudat, Trafalgar and Wotten Waven.
- The presence of a hydrogeological barrier to the SW, possibly corresponding to the N-S oriented lateral geoelectric discontinuity, might be responsible for a restriction of the lateral flow to this direction.
- Upon reaching the River Blanc valley, where outcrops of the andesitic basement have been recognized, some fluids, elsewhere restricted in their vertical movement by a very effective cap rock, escape from the reservoir and up-flow to surface, giving rise to the main Na-Cl

manifestations. The presence of a hydrogeological barrier to the SW, possibly corresponding to the N-S oriented lateral geoelectric discontinuity, might explain the restriction to the lateral flow.

- The other thermal manifestations classified as "secondary waters", of bicarbonate or sulphate composition, derive from the emergence of shallow groundwaters, which have undergone either conductive heating or contribution of some steam escaping from the underlying reservoir.
- The above presented conceptual model strictly refers to the Wotten Waven reservoir. In fact, the extremely scanty information on the Desolation Valley sector (no MT survey and very limited number of samples from thermal manifestations) hinders any conclusive interpretation relevant to such sector.

As refers to the possibility that the main upflow of the system occurs to the east rather than to the north of the sector under investigation, in paragraph 2.3.4 of the Inception Report (ELC, 2009) the possibility that Wotten Waven and Desolation Valley are the expression of a unique deep reservoir was examined and analyzed. It was concluded that such possibility was unlikely in consideration of the chemical characteristics of the surface manifestations at the two sites. On the other hand, the temperature and pressure distribution registered in the three slim-holes drilled so far in the Wotten Waven area are compatible with a provenance of the geothermal fluid from the NE, that is to indicate that the main upflow of the system occurs in the general area of the Micotrin dome.

Anyway, it should be added that this is one of those aspects which would deserve clarification by means of integrative investigations, especially in consideration of the importance of this issue relevant to the possible existence of acidic fluids in the central part of the system. As mentioned in the previous paragraphs, the recommended integrative investigations should include:

a. Geology: Aerophotogrammetric interpretation of the prospect.
b. Geochemistry: Chemistry and isotope chemistry of fumarolic fluids and determination of CO_2 fluxes from soil.
c. Geophysics: Extension of the MT survey to the Desolation Valley and Micotrin Domes zones and repetition of some of the existing soundings.

On the basis of the results of the surface investigations and of the deep wells, the assumed characteristics of the reservoir, specifically referred to the Wotten Waven sector, are summarized in the following paragraphs.

5.4.2 Depth of the Reservoir

The results of the MT survey and of the drilling campaign, in particular with respect to the distribution of secondary mineralogy, concur in pointing to a shallow depth of the reservoir. The roof of the cap rock if found at an average elevation of 300 m a.s.l. and, assuming a thickness of 300 m of this unit (as suggested by a few MT soundings and by the first appearance of secondary quartz) its bottom, corresponding to the top of the reservoir, is expected to occur at an approximate elevation of 0 m a.s.l., that is at a depth ranging between 300 and 600 m.

5.4.3 Lateral Extent

All the three wells fall definitely within the reservoir, being characterized by a medium to high permeability and by a temperature well in excess of 200 °C.

For estimating the overall lateral extent of the reservoir, reference is made to the data of the MT survey, and specifically to the resistivity value of the conductive level. It may be observed that this value is in the order of 1-2 Ohm.m in a band that extends from Trafalgar in the west up to the eastern limit of the investigated area (MT19, MT21, MT29); it rises to 3-4 Ohm.m (with the exception of MT23) in the sector of Laudat, where WW-02 and WT-03 have been drilled; it further rises to ≥4 Ohm.m to the west (MT10, MT12, MT28), the NW (MT11) and NE (MT05, MT30, MT31).

By adopting a somewhat conservative criterion, only the sector where the resistivity of the conductive level is ≤4 Ohm.m has been considered as reservoir. This sector is delimited to the west by the N-S trending geoelectrical discontinuity and covers a surface of about 9 km^2 (see Figure 5.1-1). In accordance with the Australian Geothermal Reporting Code such sector can be classified as "inferred", while the "indicated" sector, directly proved through drilling, covers a surface of about 3 km^2 [3].

5.4.4 Thickness

No direct elements are available for defining the thickness of the reservoir. In fact, on one side the limited penetration of the MT soundings does not allow any interpretation of the possible depth of the horizon characterized by medium resistivity (15-80 Ohm.m) underlying the conductive level, which may be associated with the reservoir formation. On the other side, wells WW-02 and WW-03 encountered up to their final depth adequate hydrogeological conditions, in terms of good permeability reflected by important circulation losses. Well WW-01 shows a different situation with a temperature reversal and no permeability below about -720 m a.s.l., suggesting that the well could be located towards the reservoir boundary in a lateral outflow zone (Figure 5.1-3). Additional future temperature logging in all three slim holes will allow to obtain more stabilized borehole conditions.

Under this situation, in line with the conservative approach already adopted for estimating the lateral extent of the reservoir, the **minimum proved thickness** is assumed for preliminary resources estimation, that is the thickness actually crossed by the wells and amounting to approximately 1,000 m.

5.4.5 Thermodynamic Characteristics

Static temperature and pressure logs recorded in the three slim holes are plotted in Figure 5.4-1. It must be reminded that warming-up of these wells was not very long, in the order of 1 to 2 months. Thus, available logs are not necessarily showing true static formation temperatures.

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[3] The Geothermal Reporting Code – Second Edition (2010), elaborated by the Australian Geothermal Reporting Code Committee, defines the "indicated" geothermal resources as resources with sufficient indicators to characterize temperature and chemistry, although with few direct measures indicating extent. "Inferred" geothermal resources are associated with enough direct indicators to provide a sound basis for assuming that a body of thermal energy exists, estimating temperature and having some indications on extent.

Wells WW-02 and WW-03, drilled at elevations of about 571 and 543 m asl respectively, show a liquid-dominated pressure distribution below about -150 – -170 m asl with very similar pressures below -400 m asl. Both have a gas-liquid level (G-L) which is controlled by a column of NCG which developed soon after the stop of drilling fluid circulation and injection tests. This column of gas is produced by permeable two-phase feed zones located in the upper section of the reservoir, below the cap-rock.

On the other hand, well WW-01 shows liquid-dominated conditions almost up to the wellhead. Its wellbore pressure is slightly lower than that recorded in the other wells, supporting the conclusion that WW-01 is located downstream of WW-02 and WW-03 with respect to the hypothesized upflow area below the Micotrin Dome.

Reservoir temperature below -250 m asl is lower in well WW-01 with respect to well WW-03, in agreement with the hypothesized upflow zone north of well WW-03. Well WW-02 has also higher temperatures than WW-01 below -560 m asl. Its temperature profile shows the effects of strong cooling from -280 m asl down to -550 m asl still present at the time of log recording, about 38 days before well shut-in. Both wells WW-01 and WW-03 show a temperature inversion in the deeper well section. It is not clear if this inversion depends on an insufficient wellbore warm-up. If confirmed in well WW-01 by further T logs, this would confirm that WW-01 is located in a lateral outflow area. Considering that no permeable zones are present below about -720 m asl, this could give an indication also on the thickness of the lateral outflow. New logs to be recorded during the planned drilling campaign for WWP1 and WWR1 would give an answer to this issue.

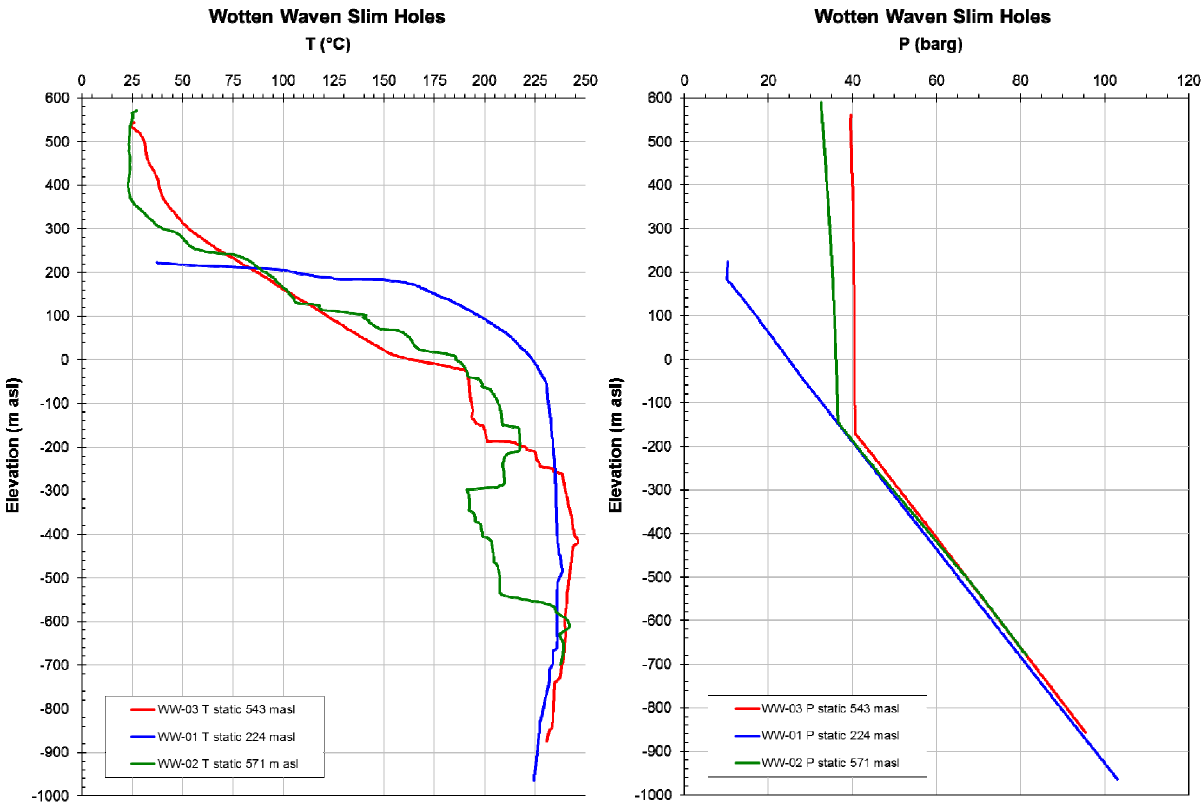


Figure 5.4-1 – Available static temperature (left) and pressure (right) logs recorded on slim holes WW-01, WW-02 and WW-03. Elevations above sea level (a.s.l.) are computed considering approximate well

pad elevations reported by ISOR: 270 , 590 and 560 m asl for the three slim holes, respectively. Well WW-02 is still affected by a strong cooling from -200 down to -550 m asl.

The thermodynamic conditions present in the borehole at the time of static P&T logs recording are better illustrated by plotting P&T values on a P-T plot together with the saturation pressure of pure water, as shown in Figure 5.4-2. WW-01 is in liquid conditions up to a pressure of 10 bara, but boiling conditions are probably present from 24 to 28 bara. The column of gas present in the three wells is always due to accumulation of NCG, likely CO_2, as clearly shown in the P-T plot.

The high WHP recorded in WW-02 and WW-03 are due to the two-phase permeable zones crossed by the well beneath the cap-rock. Boiling in the two-phase zone led to production of steam and NCG, with accumulation of NCG due to condensation of steam in the upper cold well section. The column of NCG displaces the liquid column downwards until the reservoir pressure is balanced. Figure 5.4-2 shows the evaluation of NCG pressure at the G-L levels in WW-02 and WW-03: 16.1 and 18.8 bar. This pressure does not necessarily represent the actual NCG partial pressure of reservoir fluids, but it is any way an indication that the two-phase zone can have a remarkable content of NCG. On the other hand, well WW-01 seems to have a lower content of NCG. This could explain why liquid conditions prevail in WW-01 even at higher elevations than in WW-02 and WW-03.

The production conditions in WW-01 well area are interesting because similar conditions can be found in planned WWP1 well. The upper feed at about 316 mVD found in WW-01 will be cased off in WWP1. Thus, the first major feed could be encountered around 720 mVD with static pressure in the order of 64 barg. For production temperature in the order of 240°C, a pressure drawdown of more than 31 bar will be allowed before boiling into the formation occurs. Thus, production enthalpy estimated from WW-01 discharge test in the order of 1020 kJ/kg can be expected for well WWP1 too.

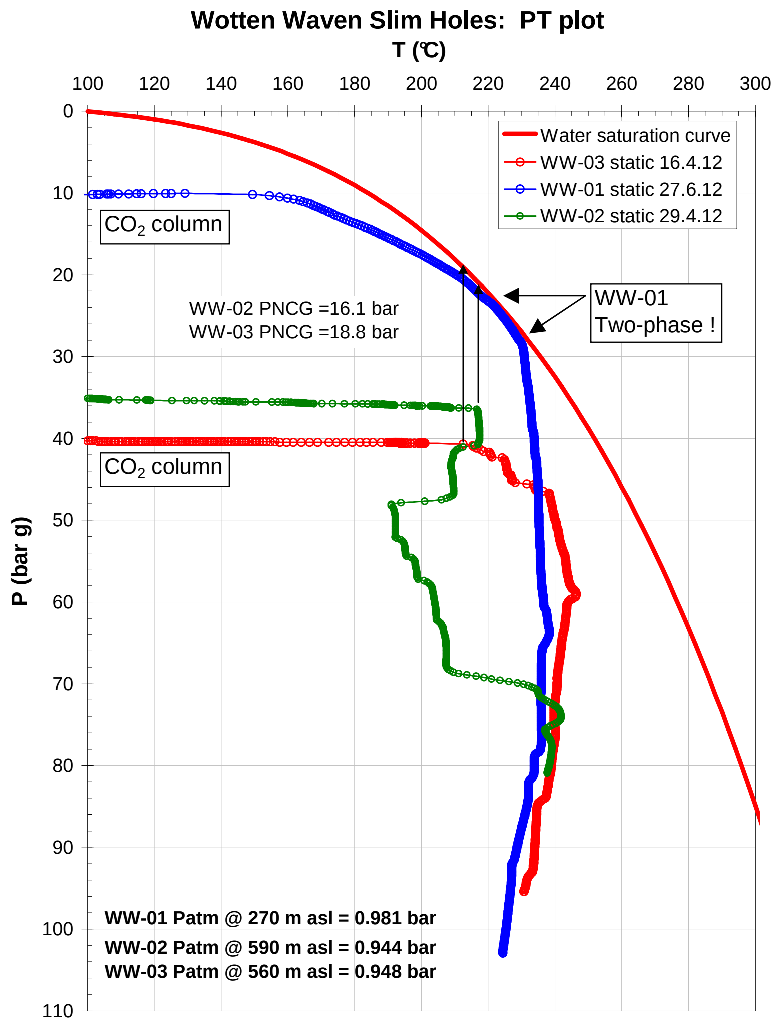


Figure 5.4-2 – Available static T&P logs recorded on slim holes WW-01, WW-02 and WW-03 plotted on T-P plot together with the saturation pressure of pure water. Well WW-02 is still affected by a strong cooling.

5.4.6 Hydraulic Characteristics

Permeable zones encountered by the three slim holes were detected during drilling by water circulation losses and further confirmed using water loss tests after well completion. In wells WW-01 and WW-02, where recording of P&T logs during discharge tests was possible, flowing temperature is also supplying useful data for the location of feed zones.

The identification of cap rock extension from temperature surveys in the different wells is not easy as available static T logs are probably still affected by insufficient stabilization. This is particularly true for well WW-02 which shows a very disturbed temperature profile. Both WW-02 and WW-03 have a low temperature and low gradient section from wellhead down to approximately 380 – 300 m asl, suggesting this upper well section is affected by surface circulation of groundwater. Below these depths, a rather high temperature gradient section is encountered, down to elevations of about -20 – -40 m asl. This could represent the approximate bottom of the cap-rock in wells WW-02 and WW-03. Down to -150 – -170 m asl, two-phase conditions seems to prevail in the reservoir, strongly affecting the stabilization of temperature profiles. Beneath this elevation, single liquid conditions are present and temperature distribution shows a low temperature gradient characteristic of a convective reservoir zone.

The situation is a bit different in the WW-01 area, where the top of the cap-rock seems to be right at surface (224 m asl) and the cap-rock bottom could be at about 0 m asl. Well WW-01 seems to have liquid-dominated conditions over the whole reservoir section with a low gradient characteristic of a convective zone.

As observed in paragraph 5.1, the permeability distribution seems not strictly correlated to specific lithological horizons, as it can occur indifferently in lavic and pyroclastic products. Indications about the permeability characteristics of reservoir formation can be obtained by the step rate injection tests (II, Injectivity Index), by the recorded drawdown under flowing conditions (PI, Productivity Index), and by the interpretation of pressure transients recorded either during step injectivity and fall-off tests or during discharge tests. II and PI values are shown in Table 5.4-1. Wells WW-01 and WW-03 shows better injection and production indexes in line with their better discharge characteristics, while well WW-02 is characterized by poor indexes.

Well	**II (L/s /bar)**	**PI (kg/s /bar)**
WW-01	11.4	5.4
WW-02	2.3	1.7
WW-03	54	*na*

Table 5.4-1 – Injectivity and productivity index of drilled wells.

Well transients recorded during injection testing cannot be interpreted because of spurious effects: a generally declining pressure during injection in wells WW-01 and WW-02 and a cycling behavior in well WW-03. Pressure transients during production tests were recorded only in wells WW-01 and WW-02. Both discharge tests were very short and were characterized by poorly stabilized conditions and several rate adjustments. Inspection of available data showed they are of limited reliability as far the pressure transient interpretation. Thus, no pressure transients are available for the evaluation of hydraulic transmissivity and skin factor of drilled wells.

5.4.7 Chemical Conditions

Geothermal reservoir liquids are aqueous solutions rich in Na (978-1757 mg/kg), Cl (1545-3091 mg/kg), and total CO_2 (1466-4539 mg/kg), with TDS ranging from 3195 to 5751 mg/kg. Reservoir pH varies between 5.3 and 6.1. At these reservoir pH values, aqueous CO_2 is the dominant carbonate species, with concentrations of 1466 to 4539 mg/kg, corresponding to P_{CO2} of 3 to 9 bars under reservoir conditions. The second most important gas is H_2S, with total concentrations from 24.2 to 220 mg/kg, and aqueous H_2S largely prevailing over HS^- ion. Nitrogen and Ar are also highly variable, possibly due to varying contributions of atmospheric gases introduced by drilling.

Geothermal reservoir liquids have chemical and isotopic characteristics comparable with those of chloride thermal springs DM15, DM29, and RB-3.

Samples from wells WW-01 and WW-03 can be considered fully representative of reservoir liquids, whereas the two samples from well WW-02 are significantly influenced by mixing with drilling fluids and/or inflow of cold waters.

Simulation of boiling indicates that: (i) precipitation of calcite is possible at any temperature, with the highest probability in the reservoir and in the deepest parts of the wells, downstream of the flashing zone; (ii) performing liquid/vapor separation at pressures of 6 to 7 bar-a, there is no risk of silica scaling in the pressure separator; in principle, silica scaling might occur, upon further cooling of separated geothermal liquids, in reinjection pipelines and reinjection wells, as well as in the reservoir around the reinjection wells. However, before precipitation of amorphous silica begins, there is an induction time or lag time, whose extent depends on the degree of oversaturation and pH. The induction time is high when the degree of oversaturation is low and pH is low (and vice versa). Since at Wotten Waven oversaturation is low, no major problems of silica scaling are expected.

Corrosion problems caused by separated liquids are expected to be negligible, whereas steam condensates may pose some corrosion problems, especially upon absorption of atmospheric O_2 and oxidation of dissolved H_2S to H_2SO_4.

Total gas content in separated steam ranges: (i) from 0.85 to 0.91 wt% for sample 866 from well WW-01, (ii) from 1.44 to 1.53 wt% for sample 867 from well WW-01, (iii) from 2.56 to 2.71 wt% for sample 835 from well WW-03.

5.5. Preliminary Resource Evaluation

Reservoir engineering and well production data evaluated in Chapter 5.3 were incorporated within the conceptual model of Wotten Waven prospect presented in Chapter 5.4. The conceptual model is the basis for the preliminary evaluation of Wotten Waven geothermal resource using the volumetric method complemented by a Monte Carlo probabilistic approach.

5.5.1 Methodology for a Probabilistic Approach

The evaluation of stored heat and of power plant capacity is usually performed in the preliminary stages of field exploration and development, as discussed by Sarmiento and Steingrímsson (2007). They argue why using a Monte Carlo approach the subdivision of reservoir volume into fractions of different properties is not strictly necessary. The Wotten Waven conceptual distinguishes two areas: the indicated one, corresponding to that directly proven by the drilling of slim-holes; the inferred one delineated by geological, geophysical and geochemical indications. The former one will be directly impacted by the field exploitation for the SGPP, while the former will be impacted by the full field development. Thus, resource and power plant capacity are evaluated for both the indicated reservoir extension and the indicated+inferred reservoir extension.

The heat energy contained in the geothermal system is here calculated with equation 5.1 in which the fluid internal energy is used, while the enthalpy is used by Sarmiento and Steingrímsson (2007). This choice is congruent with the thermal energy accumulation term considered in numerical reservoir simulators, like TOUGH2 (Pruess et al., 1999).

$$Q = Ah\{\lfloor C_r \rho_r (1-\varphi)(T_i - T_f)\rfloor + \lfloor \rho_{si}\varphi(1-S_w)(u_{si} - u_{wf})\rfloor + \lfloor \rho_{wi}\varphi S_w (u_{wi} - u_{wf})\rfloor\} \qquad (5.1)$$

where:

Q stored heat (thermal energy), J;

A reservoir area, m^2;

h reservoir thickness, m;

C_r rock grain constant volume specific heat, at reservoir temperature, J/kg °C;

φ rock porosity, dimensionless;

T_i initial reservoir temperature, °C;

T_f final reservoir temperature, °C;

S_w aqueous phase saturation, dimensionless;

u_{si} internal energy of steam, J/kg;

u_{wi} internal energy of liquid water, J/kg;

u_{wf} internal energy of liquid water at final temperature, J/kg;

ρ_{si} density of steam, kg/m^3;

ρ_{wi} density of liquid water, kg/m^3;.

ρ_r rock density, kg/m^3.

Internal energy and density of steam and liquid water are functions of temperature, pressure and composition. In the particular case of negligible salt and NCG contents and conditions close to boiling, these parameters can be calculated as function of the temperature only along the water-steam saturation line with minimum effects on the final results.

In order to estimate the possible size of power development, it is necessary to convert the stored heat into recoverable heat and then convert further the recovered heat into electric power generation. The equation 5.2 is here used:

$$E = \frac{Q R_f \eta_c}{F L} \times 1.0 \times 10^{-6} \qquad (5.2)$$

where:

E power potential, MWe;

R_f recovery factor, fraction;

η_c conversion efficiency, fraction;

F power plant capacity factor, fraction;

L power plant life, s.

Recovery factor. It refers to the fraction of the stored heat in the reservoir that could be extracted to the surface. It is dependent on the fraction of the reservoir that is considered permeable and on the efficiency by which heat could be swept from the permeable zone. A linear correlation between the recovery factor and the reservoir porosity has been proposed by Muffler (1978), which can be tentatively used for the evaluation of the recovery factor.

Conversion efficiency factor. The conversion efficiency takes into account the conversion of the recoverable thermal energy into electricity. Correlations with reservoir temperature have been proposed by Nathenson (1975) and Bodvarsson (1974). A linear regression line has been drawn through the two correlations for its use in spreadsheet calculations.

Power plant capacity factor. This factor refers to the plant availability throughout the year taking into consideration the period when the plant is scheduled for maintenance, or whether the plant is operated as a base-load or peaking load. The good performance of many geothermal plants around the world places the capacity factor to be within 90-97 % when plants are operated to satisfy the network base load.

Power plant life. The economic life of the project is the period it takes for the whole investment to be recovered within its target internal rate of return. This is usually 25-30 years.

The accuracy of the methods used in geothermal resources estimation depends on the type, amount, and quality of geo-scientific and engineering data, which are also dependent on the stage of development and maturity of a given field. Because of the limited data available in the early phases of reservoir development and uncertainty on the assumptions on reservoir parameters, some degree of cautiousness and conservatism is mandatory. The approach which takes into account the risk factor in the decision making can be implemented using Monte Carlo simulation. Unlike a deterministic approach, where a single value representing a best guess value is used, the probabilistic method is considered to account for the uncertainty on many variables in geothermal reserves estimation. The Monte Carlo simulation performs the calculation of stored heat and plant capacity and determines the estimate based frequency distribution of the random variables, which are dependent on the number of times a value is extracted from the uncertainty models of the input parameters.

The area and the thickness of the reservoir are usually assigned the triangular distribution because these parameters are obtained directly from drilling and well measurements, as well as (indirectly) from the findings of the geoscientific investigations. The porosity is usually assigned a log normal distribution following the observations of Cronquist (2001) and Kaufmann (1963).

Discretizing the reservoir into several blocks to capture the variation in temperature, porosity, permeability and productivity does not make the whole process more precise than when treating it as a single block in a Monte Carlo simulation. It is deemed not necessary because all of the values in a given range for every parameter are supplied as input in the calculation.

The reserves estimation can be done using commercial software that provides for a probabilistic approach of calculating uncertainty in the occurrence of events or unknown variables. Monte Carlo simulation can also be programmed using a spreadsheet, providing all the features required in a statistical analysis are made available. To obtain a good representation of the distribution, sampling is done through at least 1000 iterations with continuous calculation.

In our case, the use of a freeware code programmed in Excel spreadsheet, called Simulación 4.0© (http://www.ucema.edu.ar/u/jvarela/ index_eng.htm), is chosen. Simulación 4.0© was developed by José Ricardo Varela (2003) in VBA (Visual Basic for Applications) and it is compatible with Excel 97 and above. Equations 5-1 and 5-2 were coded into a Simulación 4.0© worksheet. Density and internal energy of water and steam are evaluated as function of temperature along the saturation line, from the triple point of water up to 350°C, using polynomial regressions of values computed using the REFROP7 data base made available on-line by NIST.

About the definition of resource and reserves and the degree of knowledge reached in their evaluation, no definite approach is universally accepted. Sarmiento and Steingrímsson (2007) define the resource and reserves and consider for the latter three categories: proven (P90, 90% probability), probable (P50, 50%) and possible (P10, 10%). Here reference is made to the Australian Code for reporting about geothermal resource (AGEG, 2010). It must be reminded that right now there is no single internationally recognized approach to geothermal resource and reserve estimation. For instance the Resource & Reserve Committee of IGA is trying to standardise global terminology and classification systems and a dedicated Workshop has been planned on this topic on Nov. 14, 2013. As the Australian Code has already been used as reporting standard for several geothermal project developments, it is here adopted for reporting about the preliminary resource evaluation of the Wotten Waven geothermal play.

The extension of the play area is evaluated in Chapter 5.4, dealing with the conceptual model, considering the geoscientific surveys, the structural evidences, and the results of drilled wells, for which P&T logs, discharge tests and chemical fluid analyses are available.

5.5.2 Input Data and Resource Assessment Results

The values of parameters considered for the preliminary evaluation of resource of Wotten Waven geothermal play are presented in Table 5.5-1 and discussed below, with reference to the most likely value for those parameters for which a probabilistic distribution is given.

Area. The indicated and indicated + inferred resource areas of **3** and **9 km^2**, respectively, evaluated in a conservative fashion in Chapter 5.4 are taken as the minimum values of geothermal play area in the Monte Carlo simulation.

Thickness. The two-phase zone found in WW-02 and WW-03 well areas is here discarded, to be conservative, because it is characterized by temperature lower than 220°C. Thus, a most likely thickness of **1000 m** is here considered.

Porosity. No direct porosity measurements are available for reservoir rocks in Wotten Waven. Porosity has a small effect on the stored heat but a remarkable effect on the recovery factor. An average value equal to **11%** is here assumed with a log normal distribution.

Cut-off temperature. It determines which reservoir volumes are to be included in the Resource assessment. It is the resource temperature below which well production become unfeasible at commercial rates. While it is not explicitly included in equations 5-1 and 5-2, it has an effect on the evaluation of reservoir volume. Here its effect is considered on the evaluation of reservoir thickness, by eliminating the upper reservoir section where temperatures below **220°C** have been encountered in wells WW-02 and WW-03.

Resource temperature. A most likely resource temperature of **240°C** is here considered, as higher values have been already measured in well WW-03 despite the insufficient wellbore warm-up. Higher temperatures are expected in the up-flow area, while production temperatures of about 230°C have been already detected in well WW-01 and WW-02. Minimum and maximum values of 235 and 255°C are then assumed with a triangular distribution.

Final (rejection) temperature. This is the final reservoir temperature at the end of field exploitation. It should be enough to allow the discharge of geothermal fluids at commercial production rates. For Wotten Waven, a natural convective system, exploitation will rely on natural permeability and self-flowing wells. Thus, this temperature is actually depending on several parameters like the reservoir thermodynamic conditions at the end of exploitation, the PI of production wells, the minimum WHP required to feed the power plant, the reservoir area swept by reinjection fluids, etc. A conventional value of 180°C is usually assumed (Sarmiento and Steingrímsson, 2007). For Wotten Waven, considering that full reinjection of fluids recovered at the end of their exploitation cycle is foreseen, we can assume a lower temperature in the order of **162 °C**, which is also approx. the temperature for a separation pressure of 6.5 bara which is considered for the single flash condensing unit option.

Recovery factor. It depends on the permeability structure and the development options implemented, including well density, reinjection options, etc., which allows a more or less efficient drainage of reservoir volume. Here the linear correlation between recovery factor and porosity proposed by Muffler (1978), for which the recovery factor is 2.5 times the porosity, is used. For an average porosity of 11% the recovery factor amounts to **27.5%**. This parameter is one of the most difficult to evaluate in a stored heat calculations which are not based on the results of numerical reservoir simulations.

Conversion efficiency. It depends on the characteristics of recovered fluids and the process chosen to convert fluid enthalpy into electricity. Here a regression as function of reservoir temperature through the curves proposed by Nathenson (1975) and Bodvarsson (1974), shown in Figure 5.5-1, is used. For a reservoir temperature of **240°C**, the conversion efficiency is **11.1%**.

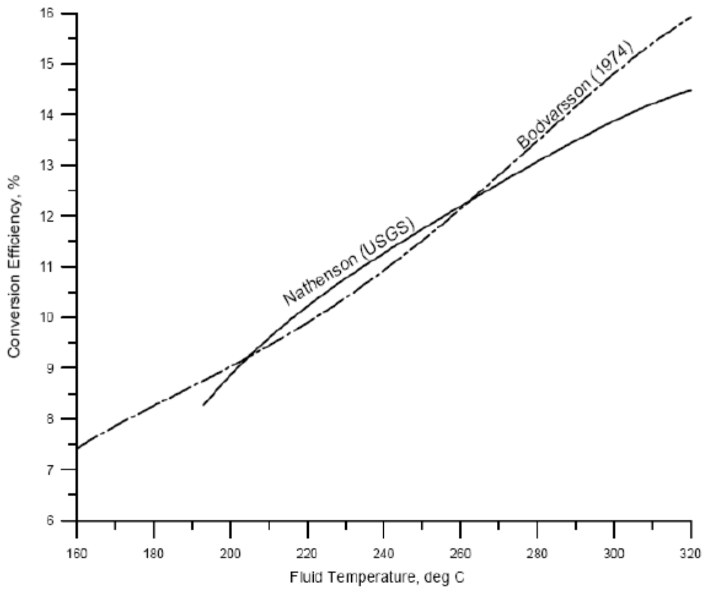


Figure 5.5-1 - Correlation between thermal conversion efficiency and reservoir temperatures (From Nathenson, 1975, and Bodvarsson, 1974).

Plant factor. Single-flash condensing steam turbines represent the most probable solution for the full field power development in Wotten Waven. A plant factor of **0.90** is assumed to be conservative in the calculation of plant capacity for the indicated+inferred area, as shown by equation 5-2. For the indicated area alone, which is going to feed the SGPP power plant, the plant factor over 30 years life will be probably changing with time and will be lower than that of power plants working at constant load. Here, a most likely value of **075** is assumed which is half way between the maximum of 0.90 and the minimum of 0.60 estimated in case of daily modulation of well production rate.

Economic life of the project. A conventional period of **30 years** is assumed.

Parameter	Unit	Value	min	max	STDDEV	Functions	Type
Indicated Area	m^2	4.000E+06	3.000E+06	5.000E+06		4000000	triangular
Inferred + Indicated area	m^2	1.000E+07	9.000E+06	1.300E+07		10666667	triangular
Inferred area	m^2	6.000E+06				6666667	
Thickness	m	1000	800	1200		1000.00	triangular
Porosity	fraction	0.11			0.03	0.117	log normal
Liquid saturation	fraction	1.00			0.00	1	constant
Water density	kg/m^3	809.0				809.0	f (TR)
Steam density	kg/m^3	17.9				17.9	f (TR)
Reservoir Temperature (TR)	°C	240	235	255		243.3	triangular
Rejection temperature (TF)	°C	162				162	constant
Water internal energy (TR)	kJ/kg	1047.6				1047.6	f (TR)
Steam internal energy (TR)	kJ/kg	2602.5				2602.5	f (TR)
Water internal energy (TF)	kJ/kg	684.3				684.3	f (TF)
Steam internal energy (TF)	kJ/kg	2569.8				2569.8	f (TF)
Rock density	kg/m^3	2600	2550	2650		2600.0	triangular
Rock specific heat	kJ/(kg K)	0.970	0.940	1.000		0.970	triangular
Recovery factor	fraction	0.275				0.292	f (porosity)
Conversion efficiency	fraction	0.111				0.113	f (TR)
Plant life	yrs	30				30	constant
SGPP factor	fraction	0.75	0.70	0.80		0.750	triangular
Full field plant factor	fraction	0.90	0.88	0.92		0.900	triangular
Rock energy	kJ					7.247E+14	
Water energy	kJ					1.373E+14	
Steam energy	kJ					0.000E+00	
Rock energy fraction	%					84.0738	
Water energy fraction	%					15.9262	
Steam energy fraction	%					0.0000	
Stored Thermal Energy	kJ					8.619E+14	output
Indicated Plant capacity	MWe					39.97	output
Rock energy	kJ					1.932E+15	
Water energy	kJ					3.661E+14	
Steam energy	kJ					0.000E+00	
Rock energy fraction	%					84.0738	
Water energy fraction	%					15.9262	
Steam energy fraction	%					0.0000	
Stored Thermal Energy	kJ					2.299E+15	output
Ind. + Inf. Plant capacity	MWe					88.83	output

Table 5.5-1 - Input parameters for Monte Carlo Analysis for the indicated and indicated + inferred resource areas.

The results obtained with 10000 Monte Carlo realizations are listed in Table 5.5-2 for both areas. For classes of power plant capacity the values of frequency and of cumulative frequency are given. The results listed in Table 5.5-2 are presented in graphical form in Figures 5.5-2 and 5.5-3 for the indicated and indicated + inferred areas, respectively.

Table 5.5-3 summarizes the results for the stored heat The gross plant capacity for P90 and **P50** is **25** and **41 MWe**, and **57** and **91 MWe** for the indicated and indicated + inferred areas, respectively. The P90 plant capacity of 25 MWe for the indicated area confirms that the planned SGPP development with a 14 MWe plant is supported by the available geothermal resource.

Class Mark	Frequency	Cum. Freq.	Frequency %	Cum.Freq.%	Probability (%)
0.00	1	1	0.01%	0.01%	99.99%
1.29	0	1	0.00%	0.01%	99.99%
4.91	3	4	0.03%	0.04%	99.96%
8.53	11	15	0.11%	0.15%	99.85%
12.15	37	52	0.37%	0.52%	99.48%
15.78	100	152	1.00%	1.52%	98.48%
19.40	190	342	1.90%	3.42%	96.58%
23.02	308	650	3.08%	6.50%	93.50%
26.64	555	1,205	5.55%	12.05%	87.95%
30.26	719	1,924	7.19%	19.24%	80.76%
33.88	899	2,823	8.99%	28.23%	71.77%
37.50	1,109	3,932	11.09%	39.32%	60.68%
41.13	1,061	4,993	10.61%	49.93%	50.07%
44.75	1,070	6,063	10.70%	60.63%	39.37%
48.37	968	7,031	9.68%	70.31%	29.69%
51.99	774	7,805	7.74%	78.05%	21.95%
55.61	625	8,430	6.25%	84.30%	15.70%
59.23	480	8,910	4.80%	89.10%	10.90%
62.85	356	9,266	3.56%	92.66%	7.34%
66.47	249	9,515	2.49%	95.15%	4.85%
70.10	187	9,702	1.87%	97.02%	2.98%
73.72	109	9,811	1.09%	98.11%	1.89%
77.34	54	9,865	0.54%	98.65%	1.35%
80.96	49	9,914	0.49%	99.14%	0.86%
84.58	42	9,956	0.42%	99.56%	0.44%
88.20	15	9,971	0.15%	99.71%	0.29%
91.82	11	9,982	0.11%	99.82%	0.18%
95.44	9	9,991	0.09%	99.91%	0.09%
99.07	6	9,997	0.06%	99.97%	0.03%
102.69	3	10,000	0.03%	100.00%	0.00%

Class Mark	Frequency	Cum. Freq.	Frequency %	Cum.Freq.%	Probability (%)
0.00	1	1	0.01%	0.01%	99.99%
3.53	0	1	0.00%	0.01%	99.99%
11.70	3	4	0.03%	0.04%	99.96%
19.87	14	18	0.14%	0.18%	99.82%
28.04	33	51	0.33%	0.51%	99.49%
36.22	98	149	0.98%	1.49%	98.51%
44.39	201	350	2.01%	3.50%	96.50%
52.56	338	688	3.38%	6.88%	93.12%
60.73	572	1,260	5.72%	12.60%	87.40%
68.90	774	2,034	7.74%	20.34%	79.66%
77.08	982	3,016	9.82%	30.16%	69.84%
85.25	1,110	4,126	11.10%	41.26%	58.74%
93.42	1,168	5,294	11.68%	52.94%	47.06%
101.59	1,048	6,342	10.48%	63.42%	36.58%
109.76	915	7,257	9.15%	72.57%	27.43%
117.93	780	8,037	7.80%	80.37%	19.63%
126.11	590	8,627	5.90%	86.27%	13.73%
134.28	444	9,071	4.44%	90.71%	9.29%
142.45	310	9,381	3.10%	93.81%	6.19%
150.62	212	9,593	2.12%	95.93%	4.07%
158.79	148	9,741	1.48%	97.41%	2.59%
166.97	113	9,854	1.13%	98.54%	1.46%
175.14	57	9,911	0.57%	99.11%	0.89%
183.31	31	9,942	0.31%	99.42%	0.58%
191.48	25	9,967	0.25%	99.67%	0.33%
199.65	14	9,981	0.14%	99.81%	0.19%
207.83	6	9,987	0.06%	99.87%	0.13%
216.00	9	9,996	0.09%	99.96%	0.04%
224.17	3	9,999	0.03%	99.99%	0.01%
232.34	1	10,000	0.01%	100.00%	0.00%

Table 5.5-2 - Results of Monte Carlo Analysis for the power capacity of the indicated (left) and indicated + inferred (right) resource areas. A total of 10000 realizations have been computed. 30 years exploitation is assumed.

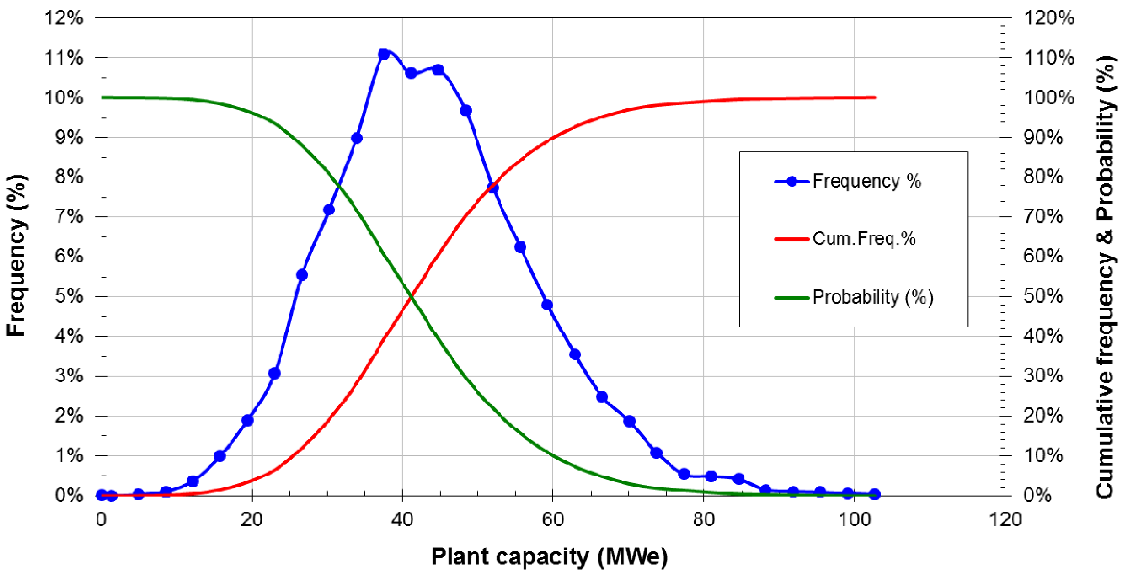


Figure 5.5-2 - Frequency and cumulative frequency distribution of Wotten Waven geothermal field power capacity for the indicated resource area (30 years exploitation).

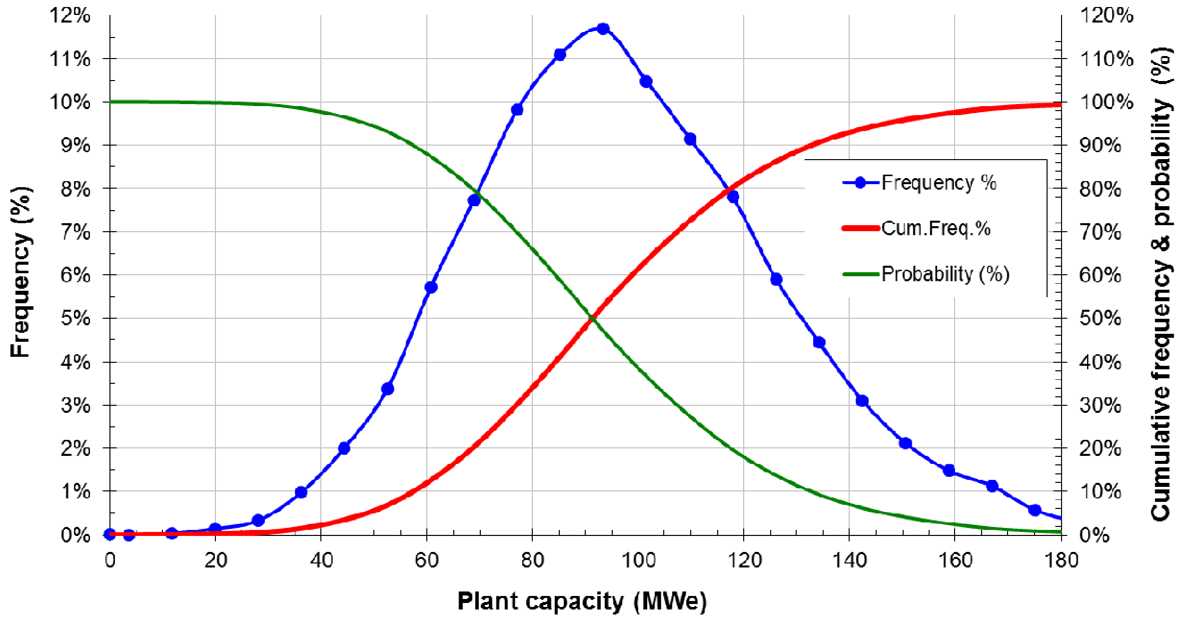


Figure 5.5-3 - Frequency and cumulative frequency distribution of Wotten Waven geothermal field power capacity for the indicated + inferred resource areas (30 years exploitation).

Indicated Area	Thermal Energy in Place (kJ)th	Recoverable converted electric energy (MWe - 30 years)
P90	7.40E+14	25.5
P50	8.90E+14	41.0
P10	1.17E+15	60.5
Most frequent value	8.62E+14	37.5
Average value	8.63E+14	40.3

Indicated + Inferred Area	Thermal Energy in Place (kJ)th	Recoverable converted electric energy (MWe - 30 years)
P90	1.98E+15	57.0
P50	2.32E+15	91.5
P10	2.72E+15	123
Most frequent value	2.30E+15	93.4
Average value	2.30E+15	89.6

Table 5.5-3 - Results of Monte Carlo Analysis for thermal energy in place and the power capacity for 30 years exploitation for the indicated (left) and indicated + inferred (right) resource areas.

The above results for the indicated + inferred area can be compared with the preliminary assessment of reservoir capacity performed by CFG (2008). The size of the reservoir area where high temperature fluids were thought to be encountered at depth, at temperatures in the range 250-300°C, was estimated by CFG to be about 15 km^2, thus higher than the conservative evaluation made in the present report The assessment of the reservoir capacity was done by CFG by estimating the number of wells which could be sited within the western half of the reservoir. Considering an average well spacing of 500 m, CFG estimated a total well number of about 50 vertical and directional wells, with a ratio of 3:2 between production wells and reinjection/unsuccessful. The average productive well power capacity was estimated in 4 MWe, arriving to a final reservoir capacity of 120 MWe.

Apart for the different approach followed, one of the main differences is related to the extension of the resource area which is 13 km^2, larger than that considered for the volumetric assessment. If we scale the most probable power plant capacity of 91 MWe obtained with an average resource extension of 11 km^2 (min 9 km^2, max 13 km^2) to the 15 km^2 considered by CFG, we obtain about 124 MWe, basically the same value estimated by CFG. The power density corresponding to the most probable power plant capacity is about 8.3 MWe/km^2, a conservative value with respect to those reported in the literature. In fact, for an average reservoir temperature of 240°C, the compiled filed data by Grant (2000) suggest a power density of 10 MWe/km^2. This conservative choice is deemed reasonable at this stage of field exploration considering that the maximum temperature recorded so far is only 246.4°C recorded at 960 mMD in well WW-03.

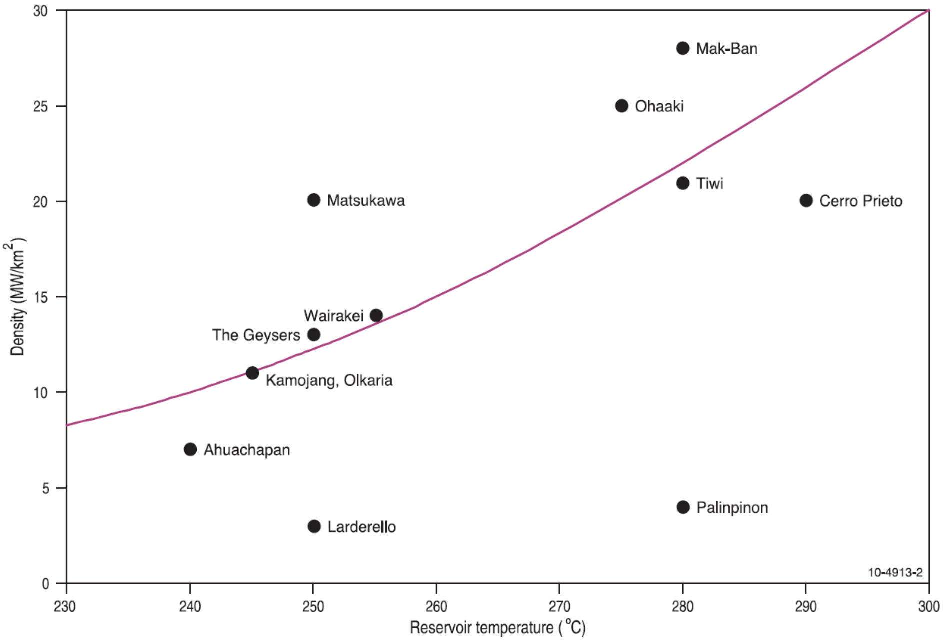


Figure 5.5-3 - Electrical Energy Power Density for Developed Fields, after Grant (2000), with best fit curve added by AGEG (2010).

6. FIELD EXPLOITATION FOR THE SGPP

6.1. Introduction

Given the considerations on the field's conceptual model and on the proven extension of the reservoir discussed in chapter 5 and in a previous report (ELC, Nov. 2012), GoD decided to develop the northern part of the field in Laudat area and to drill the required production wells deviated from WW-03 drilling pad where the corresponding vertical slim hole has been successfully drilled. This decision was supported by the analysis of different alternatives, as far as the location of both production and reinjection wells is concerned, made by ELC in a series of documents supplied to PMU (ELC memo No. 71 Nov. 23, 2012; memo No. 72, Nov. 27, 2012; ELC, 2012 Executive Summary).

Consequently, the SGPP location has been selected in correspondence of the WW3 site in Laudat, in the north extension of the same well pad.

This basic choice to develop this part of the field, different from the original recommendation of the Feasibility Report of November 2012 to develop the southern part of the field in the WW-01 site area has been taken by both logistic (wider area available for the further development) and social reasons but it remains technically viable from the resource exploitation point of view.

Two different power plant options were initially considered in July 2013: a single flash condensing unit of 15 MW; 3 single flash condensing units of 5 MW each. Considering the estimated deliverability for a production well drilled from WW-03 well pad, at least 3 production wells were estimated necessary, with average rates of 278-294 t/h (77.3 – 81.6 kg/s) to be delivered at a WHP of at least 7 bara. After an in depth analysis of the present situation and of the expected evolution of the power demand in Dominica and after consultation with the GoD, the options considered and developed in this report is based on 4 (four) single flash condensing unit of 3.5 MWe net each, amounting to a total plant capacity of 14 MW. The specific fluid consumption is comparable to that of initially considered 15 MW plant capacity. Thus, the considerations already made for the 15 MW plant hold for this new option as well.

Drilling of 3 production wells from pad 3 would make unlikely the use of WW-03 slim hole to contribute to overall fluid extraction. Its use as an observation well would be interesting, but this would require a workover operation to make again the borehole suitable for downhole logging operations.

On the basis of the estimated potential for a standard size well drilled from WW-03 pad 3, **three production wells** will be needed to supply the amount of fluid required by the SGPP development. If drilled from the same well pad, those wells shall be drilled directionally with suitable horizontal displacement and azimuth to reduce the interference among them.

The selection of separation pressure at 6.5 bara took into consideration also the potential risk of silica scaling. The study of silica equilibrium (ELC, 2012) from brine samples collected during WW-01 and WW-03 discharge tests pointed out that at separation pressure in the range 6 – 7 bara (temperatures of 159-165°C) the brine is undersaturated with respect to amorphous silica. Thus, no silica precipitation will occur at these pressure values in the separator and upstream of the separation station. On the other hand, precipitation might occur as a consequence of conductive cooling of separated brine down to temperatures of 130-140°C at which amorphous silica reaches the saturation. Excessive cooling in the reinjection line should then be avoided.

A possible limitation of well deliverability is the scaling downhole because of flashing and cooling. According to available data, to be confirmed by those planned to be collected during testing of WWP1, calcite scaling seems to be possible because of conductive cooling from reservoir temperature and mainly as a consequence of flashing. If necessary, deposition of calcite can be mitigated by the injection downhole of suitable reactants and/or by treatment with acid solutions.

6.2. Well Drilling

Considering the power plant options analysed and the results of field data evaluation, drilling of 3 standard size production wells and 2 standard size reinjection wells is required. Drilling of wells WWP1 and WWR1 was already decided by GoD on the basis of previous resource evaluation (ELC, Nov. 2012) and feasibility study for a 7-10 MW plant (ELC, Nov. 2012). Thus, drilling and completion programs for WWR1 and WWP1 are constrained by the fact that these wells have been already commissioned by GoD to Iceland Drilling Co.

Location of production and reinjection wells is shown in Figure 6.1. The trajectory of directional wells is also reported.

About the relationship between azimuths of the new production wells and location of the geological structures, it should be mentioned that no preferential tectonic trends which may control fracturing and hence permeability of the deep formations have clearly been recognized. Under this situation, the wells azimuths have been adopted according to different criteria, namely: (1) Opportunity to drill one well towards the inferred zone of upflow. (2) Opportunity to drill two wells in the sector of the reservoir surely proven, avoiding to investigate its western periphery for SGPP development. (3) Opportunity to drill wells in such a way as not to interfere with the WW-02 pad, which may in the future be utilized for additional field development. At any rate, the suggested azimuths for wells WWP2 and WWP3 can be further discussed and eventually revised after drilling of well WWP1 planned to start before the end of 2013.

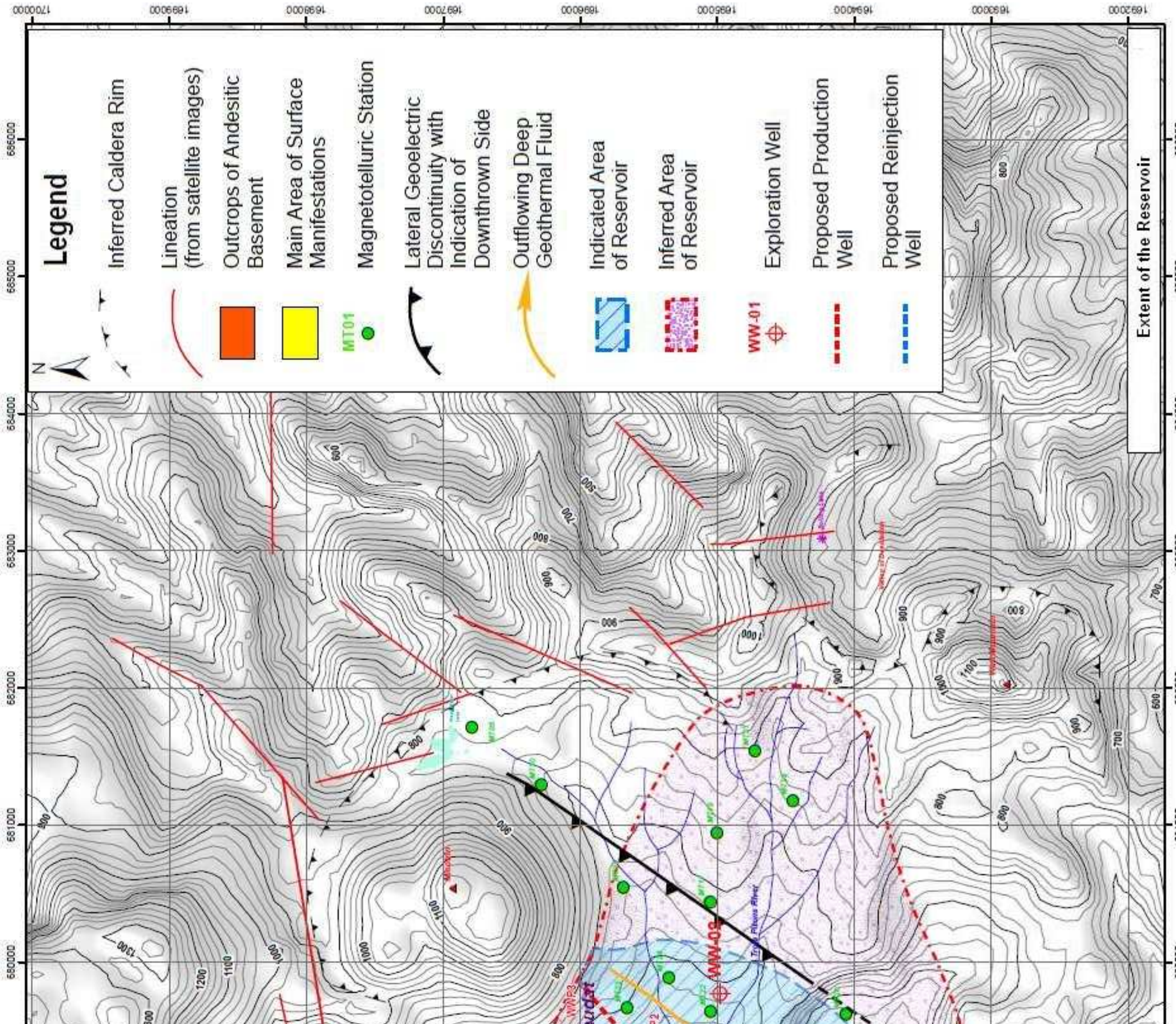


Figure 6.2-1 – Wotten Waven geothermal field: reservoir extent and location of existing and planned production (red) and reinjection (blue) wells.

6.2.1 Production Wells

The production wells WWP1, WWP2 and WWP3 will be drilled from well pad 3, adequately enlarged to accommodate the three wells. Looking at WW-03 drilling, logging and production data the following can be pointed out:

- low temperatures are associated to a two-phase upper zone, where high gas content was found from about 600 to 800 m MD. This section should be cased off by running the 9 5/8" CSG possibly at 800 m VD (about -250 m asl);
- feed zones were encountered at 945, 996, 1080 (TLC), 1150, 1173, 1505 mMD;
- as the deeper feed zone was encountered in well WW-03 at about 1505 mMD, a total VD of at least 1580 mMD is tentatively suggested.

Considering the need to have sufficient horizontal displacements, possible directional parameters for the 3 production and 2 reinjection wells are listed in Table 6.2. Wells locations and trajectories are shown in Figure 6.1.

Well	KOP (mMD)	Build-up (°/30m)	Max angle (°)	TD (mMD)	Production CSG shoe (mMD)	Azimuth (°)
WWP1	250	2	30	1740	840	N 240°E
WWP2	250	2	30	1740	840	N 180°E
WWP3	250	3	40	1900	890	N 50°E
WWR1	-	-	-	1500	600	-
WWR2	250	3	40	1600	700	N 230°E

Table 6.1 – Basic directional parameters for production & reinjection wells required for the SGPP development.

With these directional parameters, the 9 5/8" CSG shoe at 800 mVD should be set in WWP1 at about 840 mMD. At this depth the horizontal displacement for WWP1 would be only 185 m. Just to have an idea of the horizontal displacement among production zones encountered in different wells, if the total loss at 1080 mVD found in well WW-03 will be encountered at the same depth in WWP1, its horizontal displacement would be some 346 m from the wellhead projection. Bottom feed encountered at 1505 mVD in WW-03, would have a horizontal displacement of 591 m in WWP1. Thus, some interference among feed zones intercepted by producing wells drilled from the same well pad should be expected. Horizontal displacement of potential feeds is any way limited by the relatively shallow depth of the reservoir top.

The WWP1 and WWP2 well path is shown in Figure 6.2 as function of VD and elevation (Pad elevation 543 m asl; Rotary table elevation 549 m asl). The schematic well WWP1 completion program is shown in Figure 6.3. It is a slightly modified version of that already presented for well WWP1 by ISOR (2012) and subsequently considered by ELC (2012). It must be noted that the 12" expanding gate master valve proposed by ISOR (2012) and shown in Figure 6.3and 6.5 was chosen because of the shorter supply time of this valve diameter, while that for the corresponding 10" valve was not suitable for the timing of the planned WWP1 and WWR1 drilling project. With a 9 5/8" production CSG a 10" expanding gate master valve should be preferred for the additional wells (WWP2, WWP3 and WWR2) to be drilled for the SGPP field development program.

The proposed azimuth of the three production wells is listed in Table 6.1. Wells WWP1 and WWP2 are directed towards the proven area delimited by slim holes WW-01, WW-02 and WW-03. Well WWP3 is directed towards the hypothesized upflow beneath the Microtin dome.

During drilling of well WW-03 first circulation losses were encountered at 945 mMD. The main reported drilling problem was a soft formation rich in clay (alteration) made by tuff and breccia (found from 238 to 440 m). The section 390 – 410 m gave very low ROP and the drilling bit was found to be packed with cones blocked. This formation will be likely encountered within the build-up section of the directional drilling. Its presence should be properly accounted for in the drilling program and during directional drilling operations.

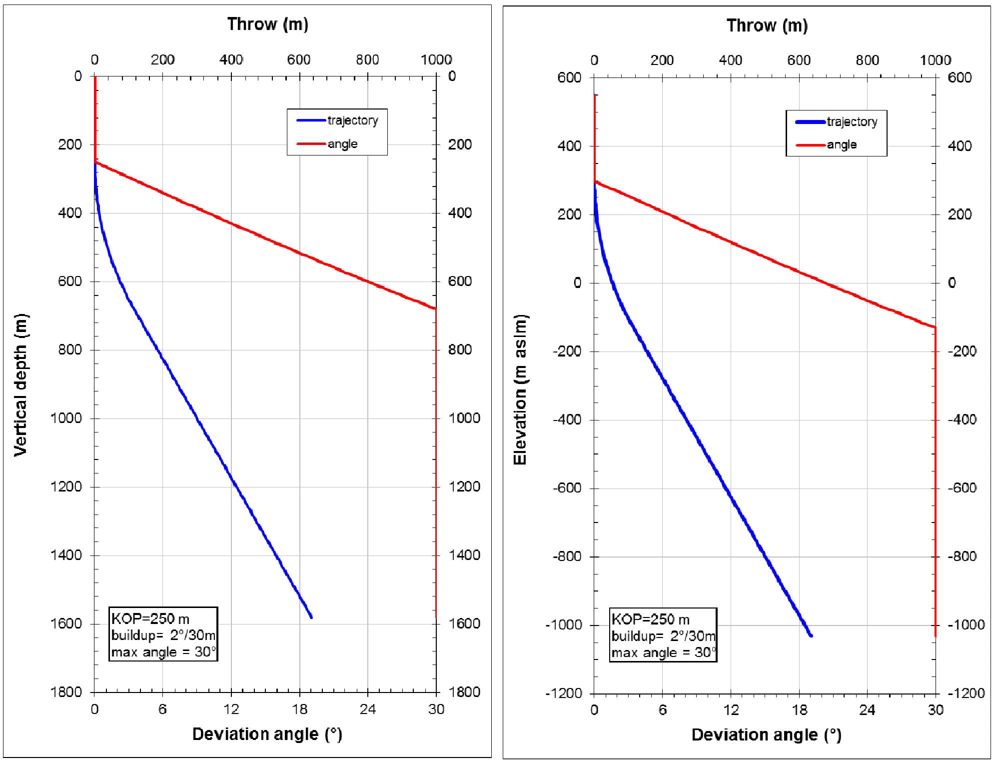


Figure 6.2 – Computed WWP1and WWP2 directional well profile as function of vertical depth (VD) and elevation a.s.l. Profile is computed for a total MD of 1740 m.

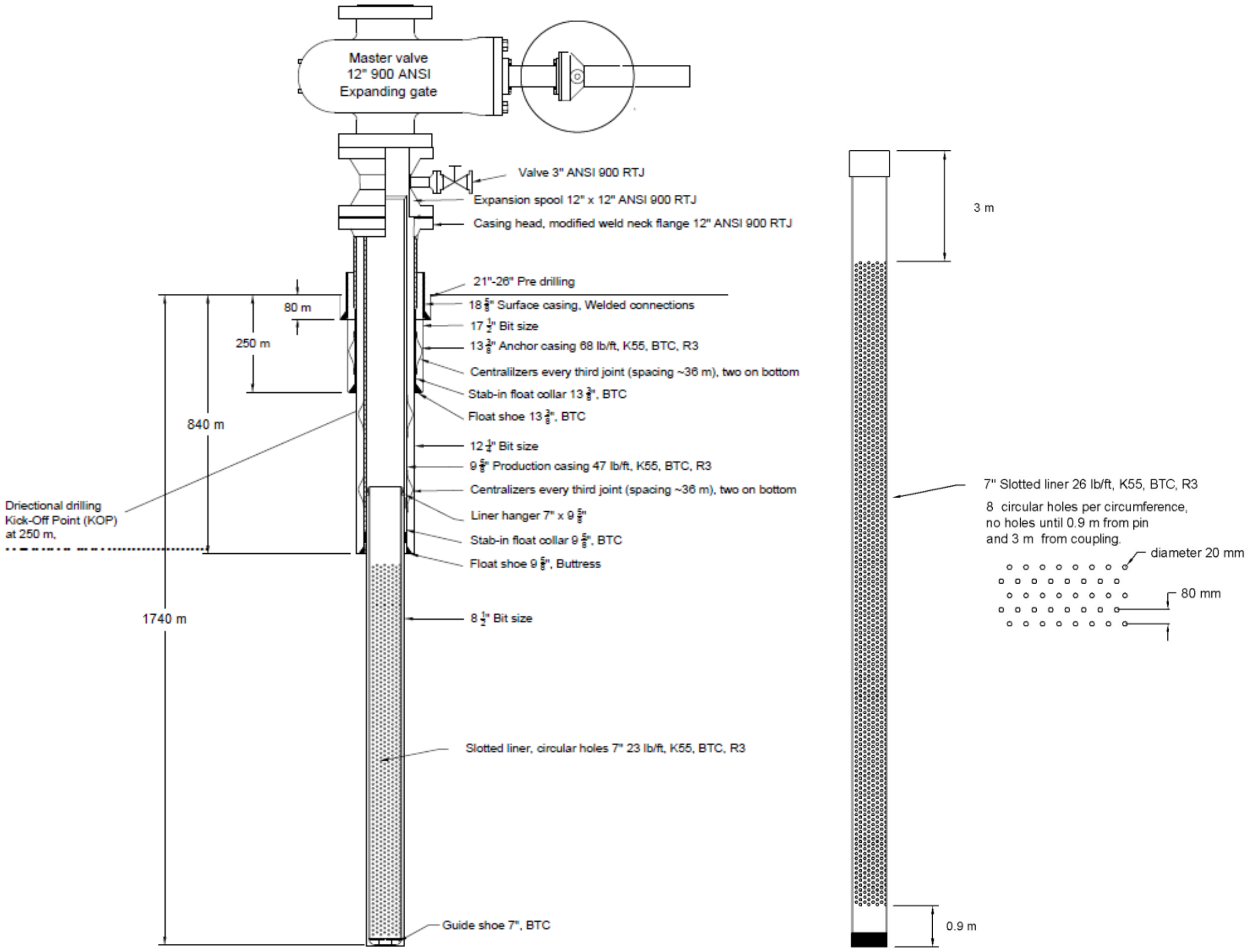


Figure 6.3 – Left: schematic Drilling and Casing program for production well WWP1 and WWP2. Apart for the the production CSG and total final depths, the same program basically applies also for well WWP3. A 10" expanding gate master valveand 10"-12" expanding spool can be used for wells WWP2 and WWP3.

Right: detail of liner slots (ISOR, 2013).

As WWP2 and WWP3 could be drilled with a new rig, their trajectory could be actually modified by choosing different directional drilling parameters. This opportunity is in particular suggested for well WWP3 directed towards the inferred upflow beneath the Micotrin Dome. The build-up can be increased from 2°/30 m to 3°/30 m, the maximum angle from 30° to 40°, and the total depth to 1900 mMD. Resulting well trajectory is shown in Figure 6.4. The 9 5/8" CSG shoe at 800 mVD should be set in WWP3 at about 890 mMD with a horizontal displacement of288 m. If the total loss at 1080 mVD found in well WW-03 will be encountered at the same elevation in WWP3, its horizontal displacement would be some 520 m. Bottom feed encountered at 1505 mVD in WW-03, would have a horizontal displacement of 880 m in WWP3.

Wells WWP1 and WWR1 have already been planned and their drilling is foreseen to start in the last quarter of 2013. Data collected during drilling and testing will be rather important for the better understanding of resource characteristics and the verification of actual injection and deliverability capacity of standard size wells.

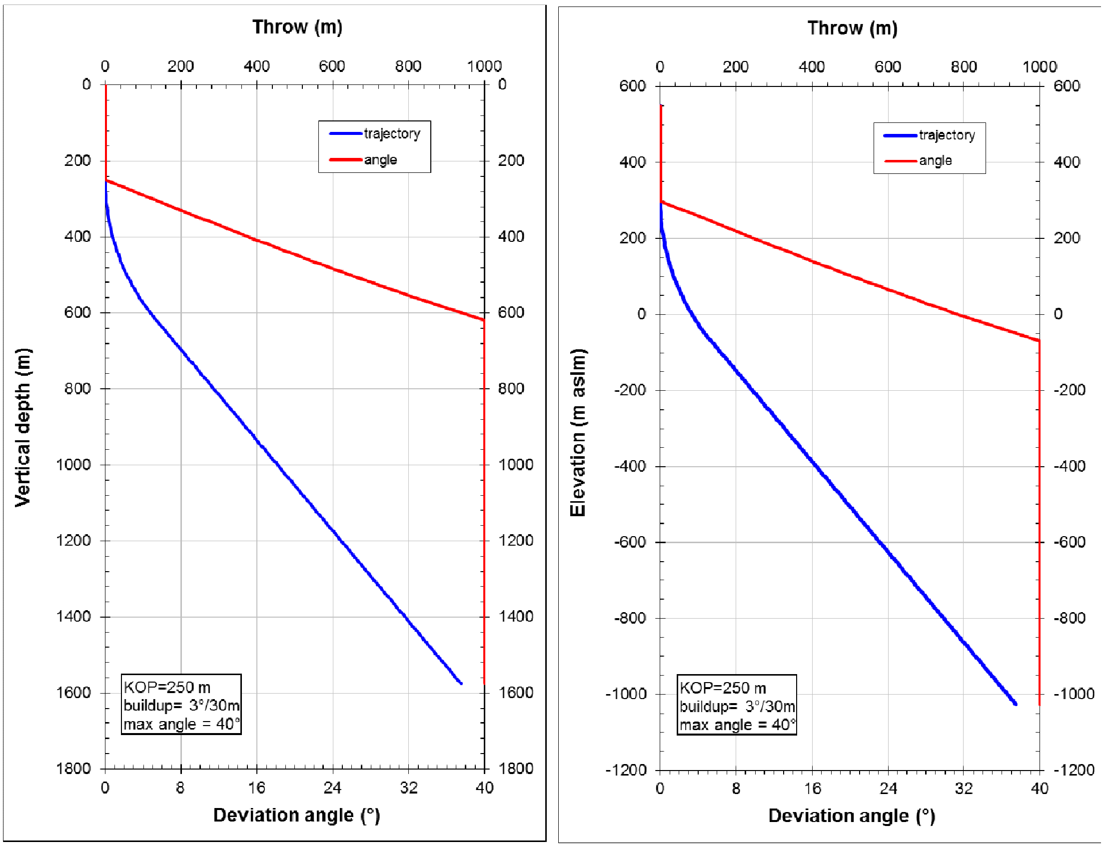


Figure 6.4 – Computed WWP3 directional well profile as function of vertical depth (VD) and elevation a.s.l. Profile is computed for a total MD of 1900 m.

Production testing of slim-holes was heavily constrained by rather limited volume of ponds used to dispose the separated brine. Possible options analysed for extending the production testing period of well WWP1 were:

i. Increment of pond volume;

ii. Discharge to surface stream;

iii. Connection of production well to the reinjection well with a temporary pipeline and brine transfer through pumping.

Option i. proved to be unfeasible because of the limited space available in drilling pads. Option ii. was also unfeasible because some of the chemical species contained in the separated brine were exceeding international standards even after considerable mixing with fresh water. Moreover, such a solution would also raise concerns about the public acceptance of such practice.

Options iii. is technically feasible, but was not allowed by the constraints of the budget available for the drilling and testing of wells WWR1 and WWP1. Efforts to optimize the collection of downhole data during well completion tests and short production tests were made and lead to the careful planning of logging and testing program for WWR1 and WWP1. Long production testing is extremely important for the acquisition of reliable well data and should be definitely foreseen in any future additional drilling campaign in WottenWaven field.

6.2.2 Reinjection Wells

Regarding the vertical reinjection well **WWR1**, its drilling has already been planned on the site situated in Trafalgar area. The drilling and casing program of WWR1 down to a total depth of 1200 mMD is shown in Figure 6.4.

To drill the second reinjection well **WWR2** in Trafalgar, in the area already selected and prepared for the drilling of WWR1, the drilling site need to be enlarged to accommodate the second well and, if needed, the pumping station.

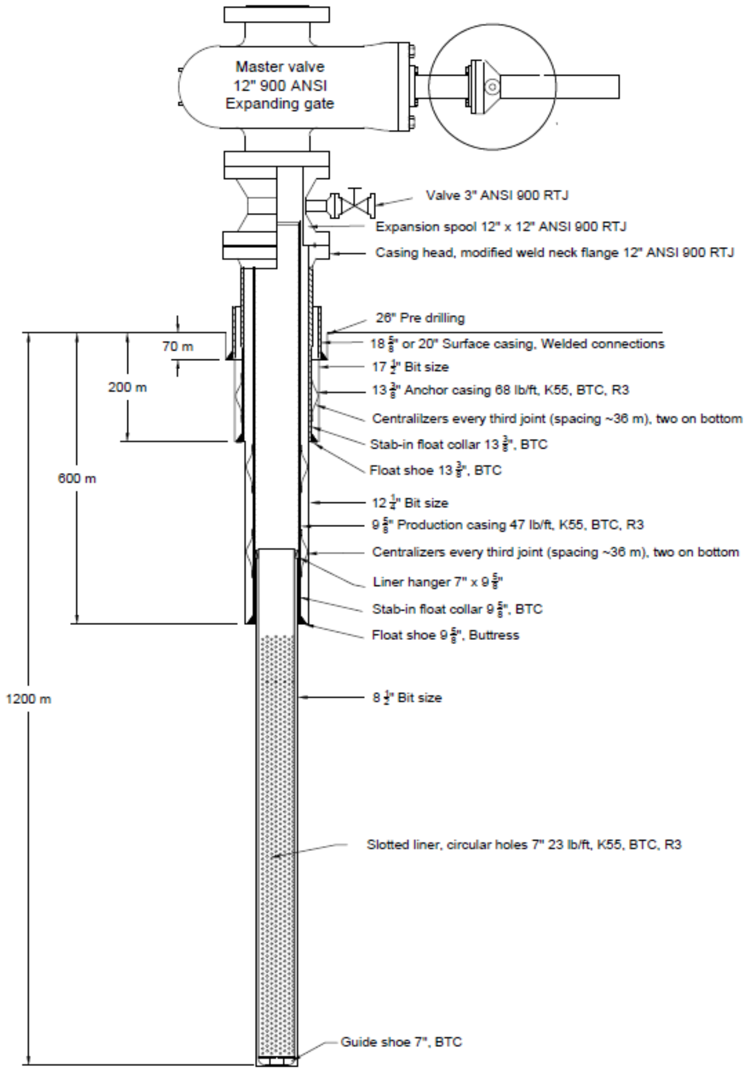


Figure 6.5 – Planned CSG program for vertical well WWR1 (ELC, 2012; ISOR, 2012).

Considering the need to have a consistent horizontal displacement between WWR1 and WWR2, the same directional parameters suggested for the production well WWP3 and listed in Table 6.1 can be considered also for well WWR2. The N 230°E azimuth is suggested to drill the well in the direction of the hypothesized lateral outflow to the SW.

With this directional parameters, the 9 5/8" CSG shoe at 700 mVD should be set at about 760 mMD. At this depth the horizontal displacement would be about 204 m. Bottom hole at 1600 mMD will be at 1346 mVD with a horizontal displacement of 745 m.

The wells path is shown in Figure 6.6 as function of VD and elevation (Pad elevation is 180 m asl; Rotary table elevation is 186 m a.s.l.). The well completion program is shown in Figure 6.7. It is a slightly modified version of that already presented for well WWR1 by ISOR (2012) and subsequently considered by ELC (2012).

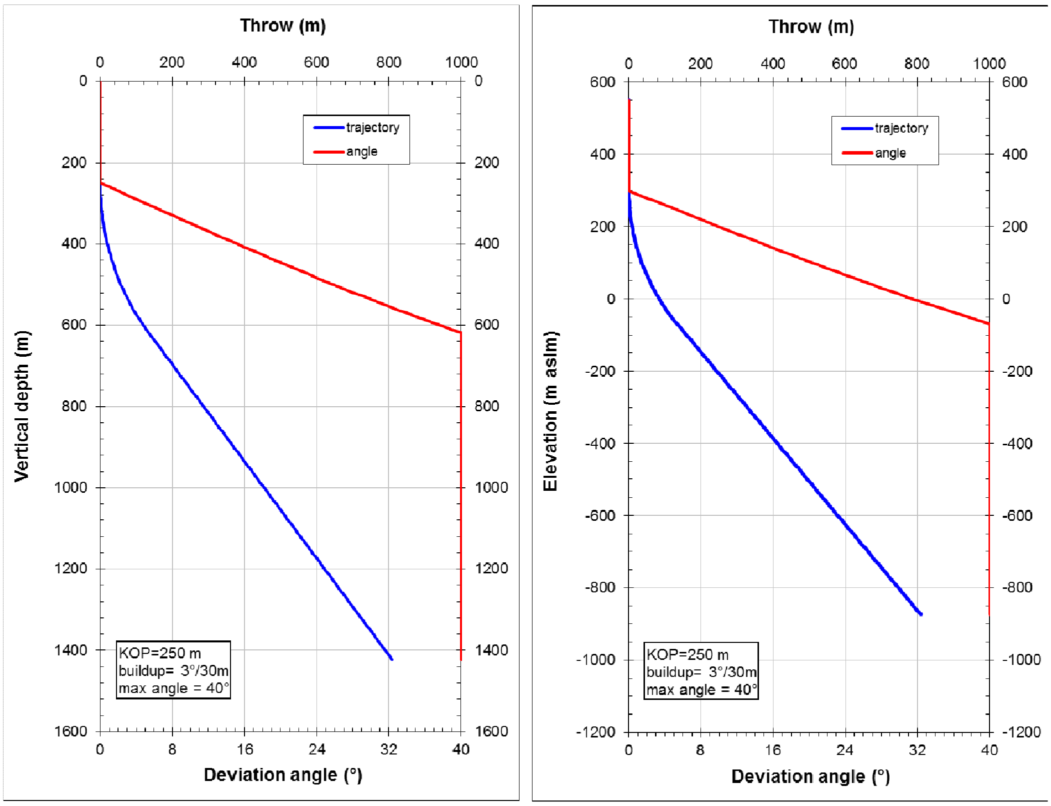


Figure 6.6 – Computed WWR2 directional well profile as function of vertical depth (VD) and elevation a.s.l. Profile is computed for a total MD of 1600 m.

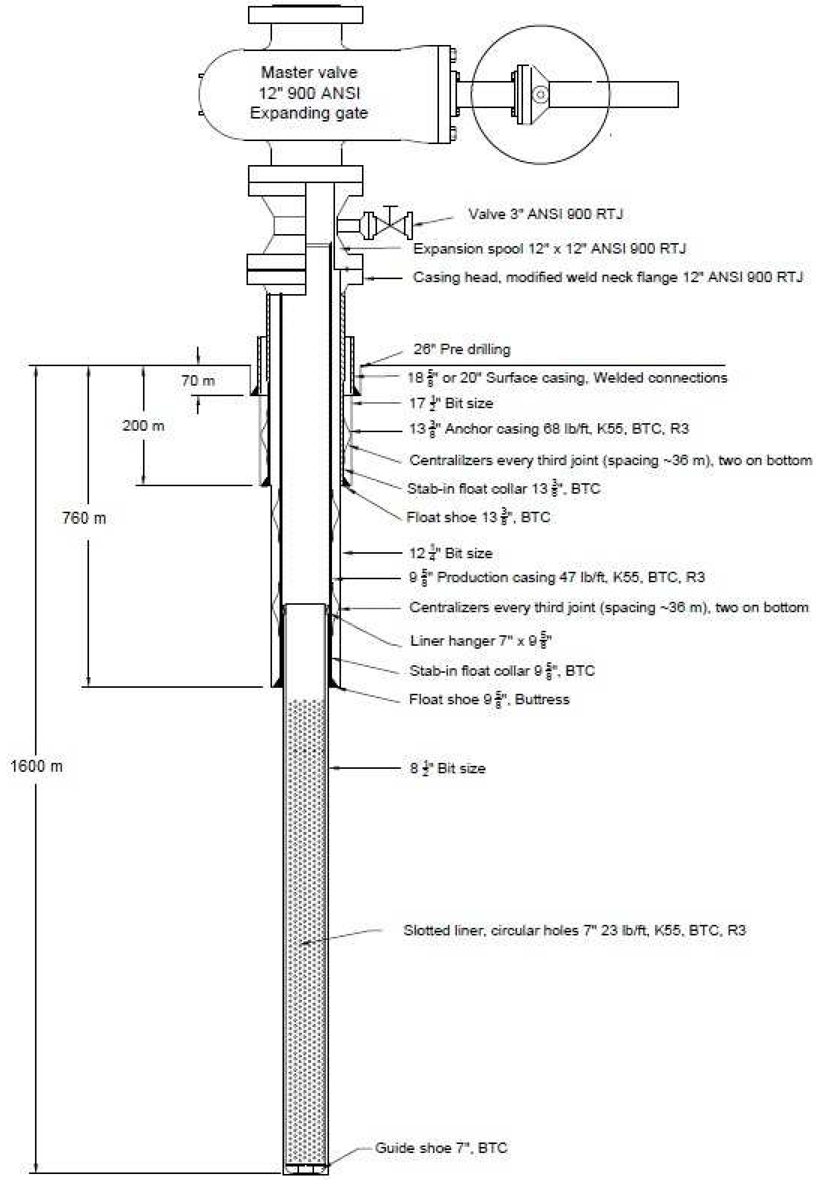


Figure 6.7 – Planned CSG program for vertical well WWR2 (modified after ISOR, 2012). A 10” expanding gate master valve and 10”-12” expanding spool can be used.

6.3. Expected Output of Production Wells

On the basis of reservoir engineering considerations (based on the assumption that hydraulic transmissivity, BHP drawdown, production temperature and depth of feed zones are similar to those measured or calculated in WW-03 and WW-01) **the cumulated power output of wells WWP1, WWP2 and WWP3 can be estimated in the order of 15 MWe**.

The possible output curve of well WWP1 with directional parameters listed in Table 6.1 and completion shown in Figure 6.3 has been simulated using the PROFILI numerical wellbore simulator. The assumption is that the same reservoir and wellbore parameters used for the simulation of the output curve of a standard size vertical well applies also for the directional well, with the main difference being the deeper setting of the 7” liner head in the latter. The results shown in Figure 6.8 are compared with the output curve of the vertical standard size well. Up to rates of about 60 kg/s, the directional well has the same output curve, while above this rate higher WHP are obtained because of the deeper setting of the 9 5/8” production CSG.

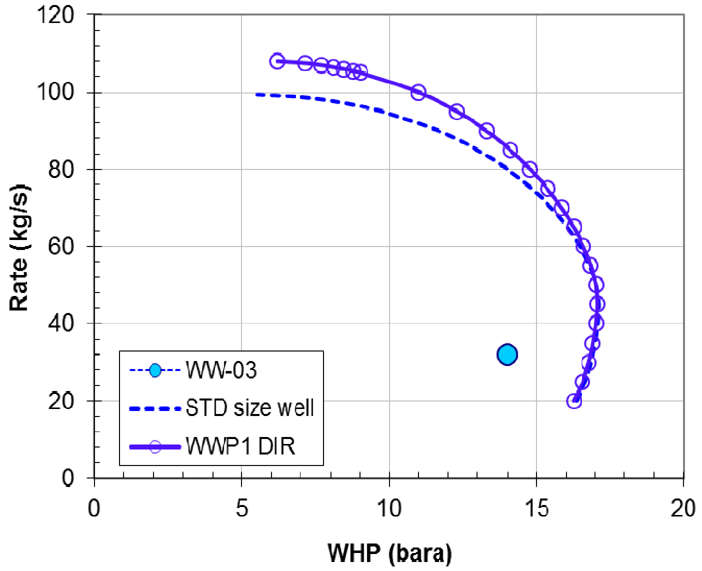


Figure 6.8 – Simulated output curve for well WWP1 with directional drilling parameters listed in Table 6.2 and the well CSG program shown in Figure 6.3. The curve is compared with that of a vertical STD size well with the same completion of WW-03 slim hole.

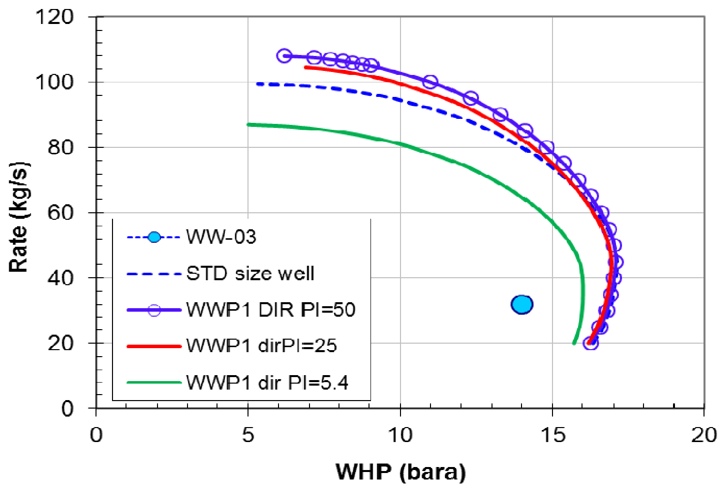


Figure 6.9 – Simulated output curve for well WWP1 : sensitivity on PI.

To account for the uncertainty on PI, the sensitivity of output curve on PI is evaluated considering a PI of 25 and 5.4 (kg/s)/bar, corresponding to 50% of the measured II on well WW-01, and equal to the PI evaluated in well WW-01, respectively. Results are shown in Figure 6.9. Reduction to 50% of PI has limited effects with a choked flow of 104.5 kg/s, while reduction to about 10% produces a consistent reduction of deliverability with choked flow of 87 kg/s. Considering the possible effects of interference between wells drilled from the same pad, the maximum production rate considered for WWP1 directionally drilled from pad 3 is 80 kg/s. For a conservative PI of 5.4 (kg/s)/bar, the WHP at this rate is about 10.3 bara.

Previous ELC reports did not consider the use of large diameter completions. Evaluations made by using wellbore flow simulations were aimed to assess the deliverability of standard well completions from production tests performed on slim holes. The November 2012 reports were based on the already decided project follow-up consisting in the drilling of WWR1 and WWP1 by using the DrillMec rig belonging to ID. Because of drilling rig limitations, large diameter completions (13 3/8" production CSG) were not examined because they are outside the drilling rig capacity.

Large diameters could in principle be considered for WWP2 and WWP3, even though higher production rates would make worse the potential issue of interference among wells. The evaluation of well performances with different diameters can be performed using wellbore flow simulation, but no flowing P&T logs were ran in well WW-03 because of the CSG collapse. Thus, flowing P/T logs are not available to calibrate a wellbore flow model and to estimate the PI. This makes less reliable the comparison of deliverability performances for different well completions. The results acquired with drilling and testing of well WWP1 would allow a more reliable evaluation of the large diameter option. Large diameter completions could eventually be considered for additional wells WWP2, WWP3 and WWR2.

6.4. Expected Absorption Capacity of Reinjection Wells

The use of slim hole WW-01 as a reinjection well was already evaluated (ELC memo 64, July 2012; ELC, Nov. 2012) as it could in principle save the costs related to the drilling of new reinjection well WWR1. The results obtained, when evaluating the feasibility of a condensing power plant of 7-10 MW, showed that due to the small diameter and overpressured conditions present in pad 1 area the use of WW-01 as a reinjection well was unfeasible because of too high WHP. Thus, drilling of a new standard diameter reinjection well WWR1 was considered mandatory. If WWR1 was drilled on pad 1, assuming the same II of well WW-01, it would have WHP in the order of **9.8** and **13.6 bara** for 7 and 10 MWe generation, respectively. In case of production from upper elevations, like from WW-03 well pad, it was estimated that reinjection of separated brine would not require pumping, at least in the initial phases of reservoir exploitation.

Considering that the area of slim hole WW-01 has good production characteristics, a different location in the Trafalgar area was recommended for the standard diameter vertical reinjection well WWR1.P&T logs recorded in well WW-03 and WW-01 suggest that a unique liquid dominated reservoir extends from Laudat to WottenWaven. Because of higher elevation, a two-phase zone above the liquid dominated reservoir is present in Laudat area, while it is absent in WottenWaven. No field information is at present available about the formation pressure in the lateral outflow area which is inferred in a S-SW direction, towards the Caribbean Sea. No surface manifestations are mapped in the Trafalgar area, where possible locations for reinjection wells were suggested by CFG (2008b) and reassessed by ELC (memo 64, July 2012) from logistic and environmental point of views. This might suggest that the lateral outflow from the reservoir is also capped and that an overpressure with respect to local hydrostatic is then possible.

Reinjection requirements for a SGPP development of 15 MW (one or 3 modular single-flash condensing units) have been already evaluated (ELC, 2012; 2013). The total amount of brine to be reinjected was about 700 t/h (194.5 kg/s) and 738 (205 kg/s) for the two options, respectively. Similar reinjection rates can be estimated for the SGPP development based on 3.5 MW modular Units. Thus, previous considerations do apply also for the present SGPP development.

Considering the brine rate to be disposed of, in order to avoid too high pressure build-up, and to dispose the cold injected fluid over a larger volume, drilling of another reinjection well (WWR2) is deemed necessary. This would also allow more flexibility in the management of the overall production & reinjection system, in particular in the case of installation of 4 x 3.5 MWe Units. Drilling of planned WWR1 will provide fundamental field data in order to confirm the above conclusion. In fact, higher or lower II than that observed in well WW-01 would make the reinjection of separated brine easier or worse with respect of the considered scenario.

Considering the elevation difference between the production pad in Laudat and the reinjection well pad, the inferred formation pressure in the reinjection area, and a separation pressure in the range 6.5 – 10.3 bara, the pressure difference available for pressure losses in the surface reinjection line, inside the wells and then into the reservoir would be about 26.8 – 30.6 bar.

Reinjection of 105 kg/s (in the range of the average reinjection rate per well) was simulated in order to evaluate the WHP requirements in WWR1. Simulations of wellbore flow were based on a set of assumptions: same injectivity index estimated by injecting cold water in slim-hole WW-01, 11.4 (kg/s)/bar; main injection zone at 1000 mMD with BHP similar to that recorded in WW-01 at the same elevation; WHT of 155°C and NaCl content of 7200 ppm.

The simulation of injection shows that a WHP of about 20 barg is necessary, which would in principle allow the injection of separated brine without pumping if the overall injection rate is shared between two wells (WWR1 and WWR2).

Unfortunately, no data about the injectivity of wells drilled in Trafalgar area are at present available. The II should increase with borehole diameter, even if the dependency is low; it should also increase for lower fluid viscosity. In principle, for the same reservoir transmissivity, the II could be about twice that recorded in WW-01 during the completion tests.

Drilling of planned WWR1 will provide fundamental field data in order to confirm if two reinjection wells will be actually able to dispose the expected separated brine. Considering that reinjection over the exploitation life of the field would increase the formation pressure over time in the reinjection area, it is possible that pumping could become necessary some time during reservoir exploitation. Then, for cost estimate purposes, **two reinjection wells** will be considered.

6.5. Production regulation and related issues

The considered SGPP development is providing more electric power than the present consumption and national network capacity in Dominica. For this reason a modular approach is chosen with four 3.5 MW units. Even with this approach, the need for a daily regulation of power output arise because of the daily changes of electric consumption in the Island. The modulation of power output could be obtained by either:

- produce at constant well output and discharge to the atmosphere the excess steam;

- regulate well production to fit with the changing power requirements.

The first option does not have particular impacts on wells management, but is deemed to have un unnecessary heavier environmental impact. The second one requires a daily regulation of production wells output and, consequently, of reinjection rates. The main issue with variable production / reinjection rates is the related temperature transients which generate cyclic changes of mechanical stresses on both CSG strings and cement sheaths.

Reinjection wells. Well head reinjection temperature will change only marginally with changes of reinjection rate. Similarly, thermal transients within the reinjection wells due to rate changes will be rather limited and are believed do not represent a major issue.

Production wells. The possibility to close and open every day one of the wells is discarded because of the complex operations required and the unacceptable temperature transients generated in producing wells. Thus, the rate regulation with discharge throttling is considered the only viable option.

Well deliverability is described by the output curve with WHT depending on WHP under two-phase conditions. If production rate is reduced, WHP and WHT increase; the flash depth also increases as well as the flowing temperature from the flash depth to wellhead. The amount of temperature increment depend on the required reduction of cumulative well rate. Production characteristics of wells WWP1, WWP2 and WWP3 are not readily available. Thus, the output curves evaluated through numerical simulation and shown in Figure 6.9 need to be considered. We can examine too extreme scenarios with ‘low PI’ and ‘high PI’ of 5.4 and 50 (kg/s)/bar, respectively. Evaluated discharge parameters at MDP conditions for ‘low’ and ‘high’ PI scenarios are listed in Table 6.2. Working too close to MDP conditions should be avoided because of possible instability of well discharge. Maximum throttling is tentatively estimated assuming that the minimum WHP should be at least 0.5 bar higher than MDP. Corresponding discharge rates are listed in Table 6.2 together with the % of throttling with respect to rates estimated at a WHP of 10.8 bara.

PI (kg/s)/bar	**MDP** (bara)	**MDP rate** (kg/s)	**Rate @ WHP = 10.8bara**	**Rate @ WHP = MDP-0.5bara**	**Throttled rate (%)**
low	16	36	78.6	51.5	65
high	17.1	45	100.5	60	60

Table 6.2 – Evaluated discharge parameters at MDP conditions for ‘low’ and ‘high’ PI. Maximum throttling rate is evaluated at WHP equal to MDP minus 1 bar.

Thus, the maximum throttling could be in the order of 65 and 60% for ‘low’ and ‘high’ PI scenarios, respectively.

Figure 6.10 shows the flash depth for the different PI values as function of rate. It is clear that temperature transients would affect in practice the entire production CSG with a suggested depth at 840 mMD. The maximum temperature change would be experienced at wellhead. Temperature changes with respect to the WHT at a WHP of 10.8 bara are listed in Table 6.3 as function of rate for the different PI considered. Blue values are those obtained within WHP of 10.8 bara and half a bar above the MDP. For maximum throttling the maximum WHT change is in the order of 19°C.

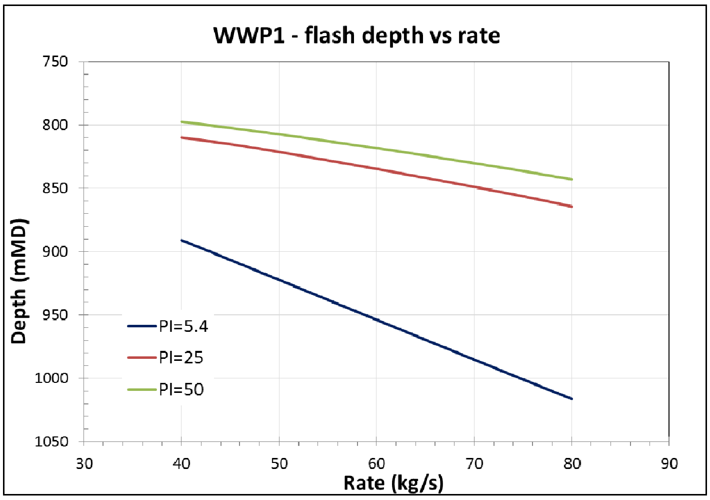


Figure 6.10 – Simulated flash depth vs rate for well WWP1 : sensitivity on PI.

Rate (kg/s)	PI=50	PI=25	PI=5.4
40	19.85	20.98	19.44
45	20.02	21.10	19.14
50	19.87	20.87	**18.34**
55	19.41	20.33	**17.09**
60	**18.69**	**19.51**	**15.39**
65	**17.74**	**18.43**	**13.15**
70	**16.55**	**17.10**	**10.20**
75	**15.10**	**15.46**	**6.14**
80	**13.33**	**13.46**	**0.00**
85	**11.18**	**10.96**	
90	**8.48**	**7.75**	
95	**4.95**	**3.38**	
100	**0.00**		

Table6.3 – WHT changes as function of rate for different PI with respect to WHT at a WHP of 10.8 bara.

Finally, the change of flowing T for the 'low' PI scenario is shown in Figure 6.11 for three rates covering the hypothetical range for daily modulation of well production. The maximum change is of course experienced at wellhead, while it decreases approaching the flash depth zone. It is not easy to assess if the evaluated temperature changes might be acceptable for the integrity of borehole completion, as field experiences of frequent well rate changes seems not to be available in the published literature.

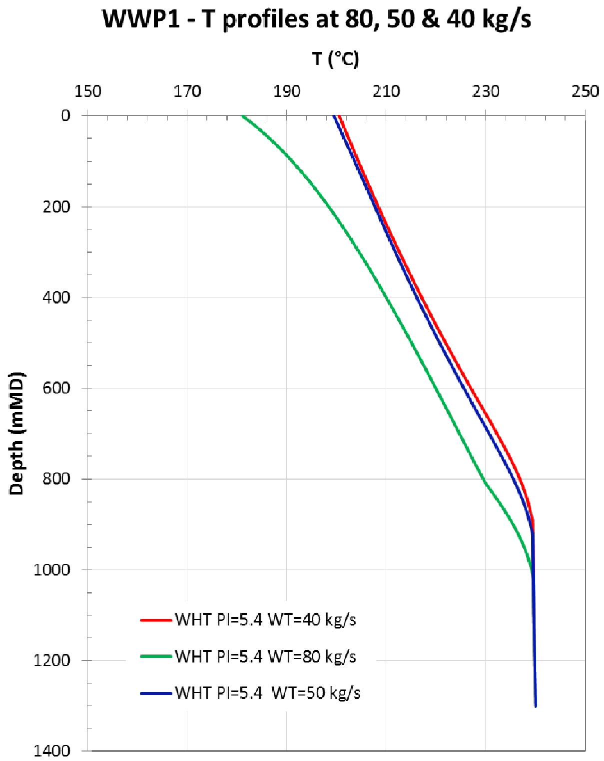


Figure 6.11 – Simulated flowing T profiles for well WWP1 at low PI : sensitivity on production rate.

7. POWER PLANT DEVELOPMENT

7.1. Introduction

The geothermal resource discovered in Wotten Waven field, as previously discussed largely exceeds the power requirements of Dominica, so that its exploitation for export is the main objective of the GoD.

Nevertheless the installation of a small power plant (SGPP, studied in depth in the last 2 years) for the generation of electricity to meet the relevant domestic demand of Dominica is a priority target of GoD , AFD and the WB to avail of the benefit of cheap energy, compared to the present prices of diesel generation.

Based on the analysis of the present power system of Dominica and of its expected evolution, the solution proposed is to develop a power plant of approximately 4 x 3.5 MW condensing units with steam bypass to the condenser and 10 % overload for one hour.

The technical reasons for such proposal are described in details in the subsequent chapters while next paragraph develops procurement related issues.

7.2. The Impact of Procurement Process

Despite evidences that condensing units are the most convenient solution it is worth mentioning that the bid for such plant may not see a high number of competitors and that a bid open to different technical solutions may not be ruled out, once the same bid includes technically sound and transparent evaluation criteria to ensure the alignment of the bids.

It is also worth mentioning stressing the importance of ensuring a power plant final configuration with four perfectly identical units so as to archive the economy of scale (operation and maintenance, spare parts management etc.) and of know how (allowing accumulation of expertise in only one manufacturer / product) even in a context where the mainly concessionary financing require international competitive bidding for each equipment. The development schedule proposed in the subsequent paragraph may accommodate a contractual arrangement with a firm contract for the first 2 x 3.5 MW units with an option for the second 2 x 3.5 MW units. Option may be exercised within a limited number of months after the commissioning of the first units, if judged beneficial to the project and with a small modification of the schedule, but it is recommended to avoid longer period that would make difficult maintaining the entire supply under a single contract for identical units.

7.3. Development Plan of 4 x 3.5 MW Units Power Plant

The implementation plan of the 4 x 3.5 MW power plant can be developed according to the tentative time schedule presented in the Fig. 7.1.

Such plan is based on the following criteria:

- **Drilling**: Wells WWP1 and WWR1 will be drilled in the fourth quarter of 2013 by Iceland Drilling on the basis of the existing contract. An extension of the existing contract should be negotiated (as option) for the drilling of WWP 2, WWP3 and WWR2, soon after the drilling of the first 2 wells will be completed (a certain delay may be also negotiated at no charge). Such opportunity will save the mob/demob cost that can be estimated in more than 1 million US$. The availability of all the wells planned would make possible the execution of a complete production testing campaign important also to update the reservoir assessment with a possible extension of the proven area with a further incentive to the full development of the field. The full drilling program, without delay, could be completed within July/August 2014.

- **Installation of Fluid Gathering System:** can be implemented at any time as to be completed at the moment of starting the first operation of the first units; an earlier installation may consent to run long term well testing and interference test. Given the relatively low cost it would be convenient to anticipate as much feasible such installation.

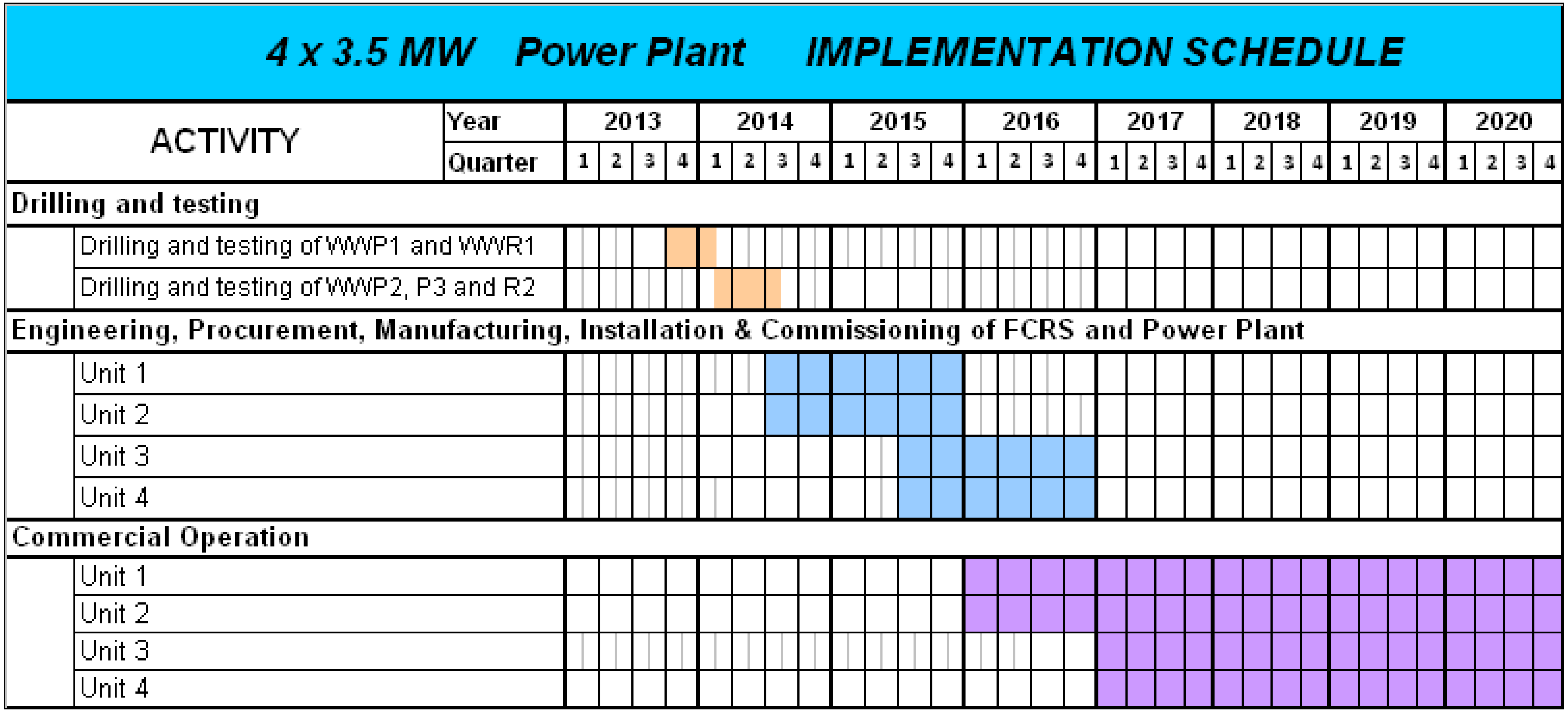
- **Installation of the Power Plant:** considering the intention of the GoD to have the first units in operation by early January 2016, one whole year has been allocated for the basic engineering and the procurement process, including the preparation of the tender document , the prequalification and invitation to bidders, bid evaluation and contract awarding. For the manufacturing a year and half have been allocated for manufacturing and erection of each one of the two pairs of units, with the second pair (units 3 and 4) delayed by one year, with the commercial operation of units 2 and 3 starting on January 2016 and that of units 3 and 4 starting on January 2017. This schedule has been designed to optimize the installation process, on the basis also to adjust the second set of units in case of need.

- **Upgrade of the transmission line:** at any time as to be ready for the starting of operation of the first 4 units.

To meet this program, the following urgent decisions must be taken, in order of priority:

1. Agreement among the Donors on the funding of the 4 x 3.5 MW project.
2. Approval of the project development scheme proposed.
3. Identification of the project implementing body.
4. Extension of the Contract with ID (+ GRG and ISOR) and relevant negotiations for the drilling and testing of the three additional wells (WWP2,WWP£, WWR1).
5. Procurement of the Engineering Services to assist the designated body to implement the development plan.

Fig 7.1: Project Implementation Schedule



8. PROJECT CONFIGURATION

8.1. Power Plant Conceptual Design

The power plant is composed of units in the range of size complying with the power system in Dominica; therefore the analyzed power plant consists of four (4) identical units, each one designed to deliver 3.5 MW to the electric grid. The following paragraph refers to the design of a single unit but all the technical considerations are applicable to each one.

8.1.1 Possible Plant Cycles

Hereinafter are listed the alternative cycles that may be adopted for the Wotten Waven geothermal field:

A. Cycle with Primary Steam separated from the geothermal fluid, at a certain pressure, expanded in the turbine and:

   A1. Discharged to the atmosphere.

   A2. Condensed and partially reinjected into wells.

B. Binary Cycle where the geothermal fluid is flashed in the separator and then the steam and the hot brine go to feed two different sections of the evaporator. The working fluid is only the organic one (Rankine cycle). In case that the geothermal fluid is not in two phase condition at the well head, an alternative configuration foresees to feed the evaporating section without separation, keeping the geofluid above its flashing temperature in order to prevent the breakout of steam and non condensable gas.

C. Combined Geothermal Cycle where the steam separated from the geothermal fluid is expanded in the turbine, condensed and reinjected. The hot water from the separator exchanges heat with an organic fluid which works in a Rankine Cycle. A further configuration foresees the use of both steam and brine into a single two stages evaporator (one fed by the steam and one fed by the brine).

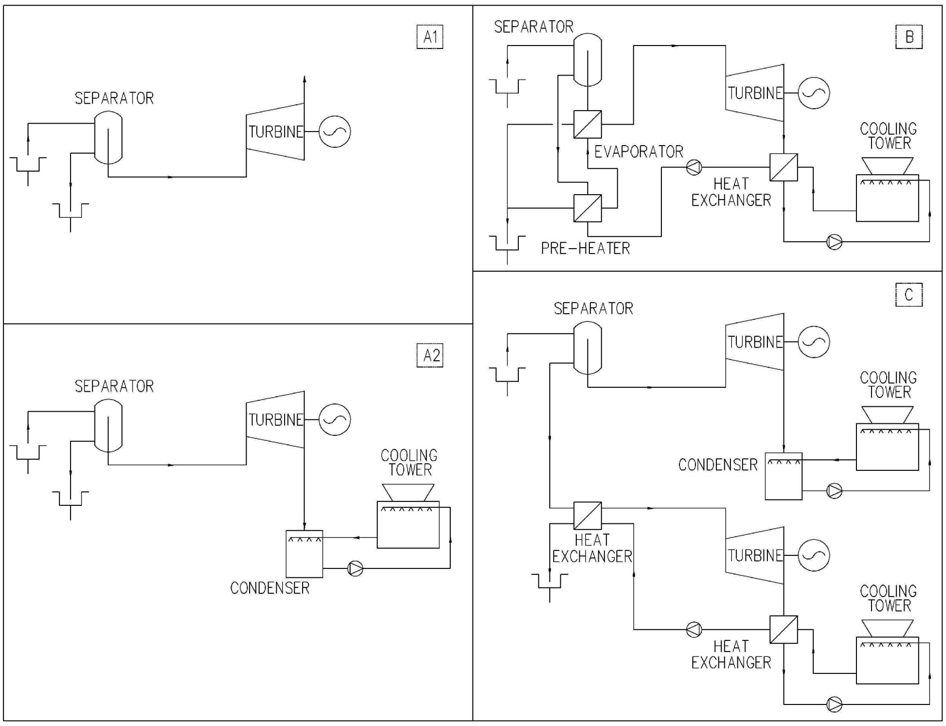


Figure 8.1-1: Geothermal cycle configurations

The choice of the most suitable cycle depends on several factors, but it is mainly function of the characteristics of steam and of economic considerations.

8.1.2 Selection of Thermal Cycle

Three alternatives can be considered and analyzed:

1. A single flash condensing cycle.
2. A double flash condensing cycle.
3. A binary cycle.

Based on considerations about the silica scaling potential, the minimum temperature of the hot brine would be around 122 °C[4]. This would lead to exclude the possibility of a second flash when considering

[4] The state of saturation with respect to a mineral phase can be described using either the degree of saturation, Q/K, or the saturation index, log (Q/K), where K is the equilibrium constant of the dissolution/precipitation reaction of interest and Q is the corresponding ionic product. In case of amorphous silica, Q is the concentration of dissolved silica in the water of interest and K is the concentration of dissolved silica in the water in equilibrium with amorphous silica.

There is no problem of silica precipitation if the water is undersaturated with respect to amorphous silica ($Q/K<1$ and $\log(Q/K)<0$) or even at equilibrium ($Q/K=1$ and $\log(Q/K)=0$), where "nothing occurs". When the water becomes oversaturated with respect to amorphous silica ($Q/K>1$ and $\log(Q/K)>0$) there is a risk of precipitation and the risk increases for increasing values of Q/K. The empirical value of $Q/K = 1.1$ is usually adopted as upper threshold of no precipitation risk, even though we are already in the field of oversaturation. However, in a new field, a new type of brine, etc., specific experimental tests are advisable to understand the kinetics of silica polymerization/precipitation and to reduce the related risk of scaling.

a double flash power plant. Furthermore such type of plant is characterized by a more complicated configuration, higher installation costs and a low flexibility of operation.

Considering a separation pressure of 6.5 bar a and a net generated power of 3.5 MW, a comparison between a binary cycle with brine reinjection at 122 °C and a condensing steam cycle (with P_{cond}=0.1 bar) can be developed by using the Net Specific Consumption of geothermal fluid as parameter of evaluation.

	Binary	**Condensing**
Geofluid Net Spec. Cons [t/h/MW]	56.0	56.4

The two alternatives are characterized by almost the same specific consumption; however the investment cost and the complexity of a binary plant are higher than the condensing one. In addition, due to the lack of water sources, the cooling section of the binary plant shall be equipped with air heat exchangers, with considerable land requirements.

For the Wotten Waven geothermal field, considering steam separation condition, steam characteristics, NCG mass percentage and other features of the geothermal fluids, the configuration allowing to exploit efficiently most of the energy contained in the geothermal fluid, with a reasonable value of specific cost of the plant, is the single flash condensing steam cycle (proven, world class technology).

8.1.3 Thermal Cycle parameters

Selection of Separation Pressure

The optimum separation pressure is the one producing the maximum net power output over unit of total flow rate. Considering the relatively low gas content and the presence of liquid phase in the reservoir, the so called “rule of thumb” may be applied as preliminary approximation. The rule states that the optimum separation temperature is roughly the average temperature between the reservoir (in this case 243°C) and the condensing temperature (about 50°C) giving a result of 147°C.

As a matter of fact it is good practice to maintain the separation pressure slightly higher than that one corresponding to the optimum temperature since the curve Power vs. Separation Temperature is almost flat and higher pressure allows savings in materials (higher pressure implies lower specific volumes and thus smaller diameters for pipes and valves; this advantage is not nullified by the increase of thickness for pressure equipment).

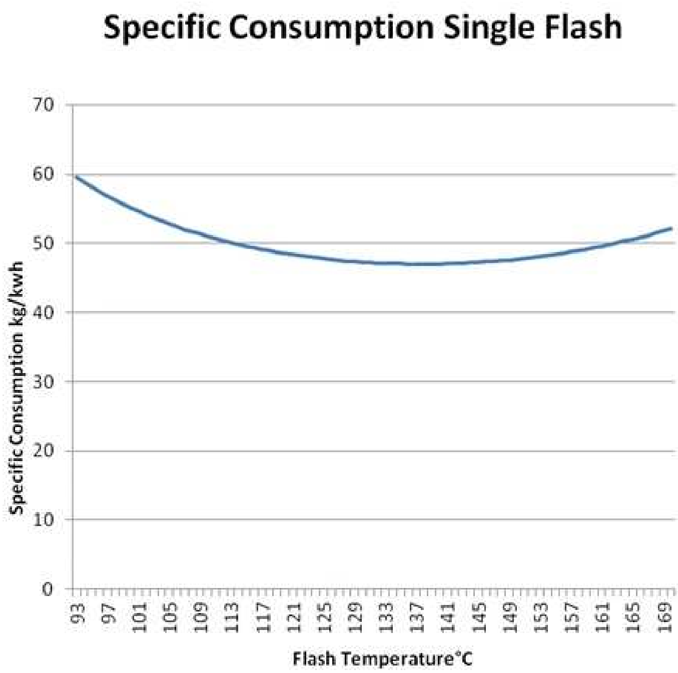


Figure 8.1-2: Specific consumption as a function of separation temperature

For the Wotten Waven field, a separation pressure of 6.5 bara is the reasonable compromise between an efficient exploitation of the resource and a saving in cost of material for piping and valves.

Once the separation pressure is determined, it is possible to calculate the pressure losses along the pipelines connecting the well-head separators and the power plant determining the turbine inlet pressure.

In this case the design value of turbine inlet pressure is 6 bar.

Selection of the Condensing Pressure

The condensing pressure is the main controlling factor of the turbine efficiency: the lower is this pressure the higher is the efficiency. Indeed the enthalpy drop through the turbine increases producing a greater specific work and then a higher generation.

On the other hand a lower pressure implies an higher consumptions of energy for the gas extraction and for the cooling system and greater heat exchange surfaces with higher cost

The optimum choice should take into account the following parameters:

- NCG content in the steam.
- Web Bulb Temperature trend during the year.
- Condenser and cooling tower features.
- Size of annulus discharge area of the turbine.
- Economic value of the electric power.

In geothermal power plants application, the common range of condensing pressure is included between 0.08 bar and 0.13 bar, considering that the lower value is function of the minimum available temperature of cooling water.

Considering a constant Net Delivered Power of 3.5 MW, a calculation to find the optimum condensing pressure is implemented by using the Net Specific Consumption of steam as parameter of evaluation.

The optimization is developed for a value of the Cooling Towers approach of 6 °C, assuming a NCG mass percentage of 2.5% (90% CO_2, 10% H_2S).

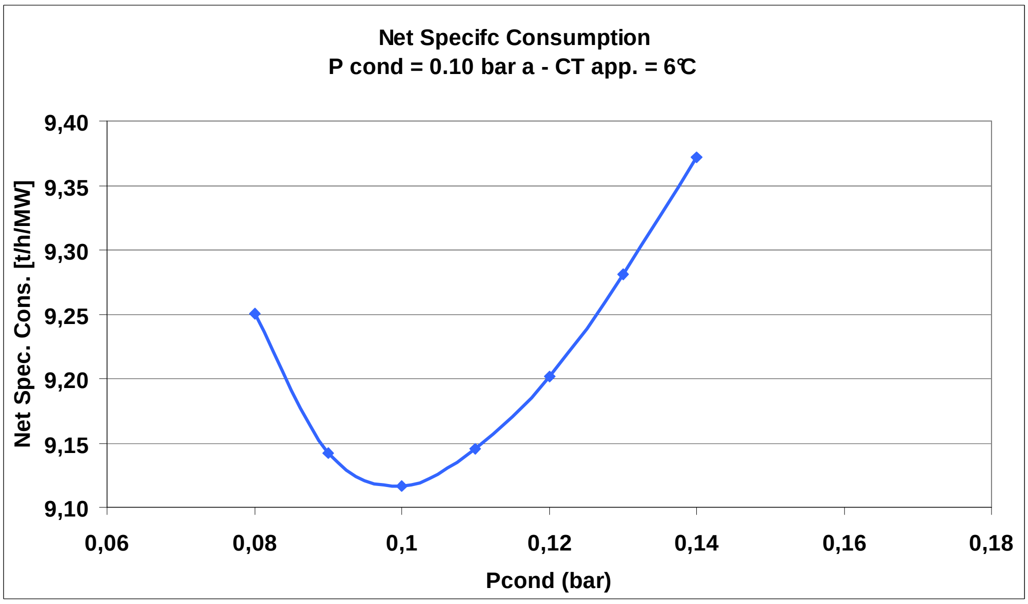


Figure 8.1-3: Net specific consumption as a function of condensing pressure

The minimum Net Specific Consumption is obtained at 0.10 bar (absolute), a common value for geothermal application, hence this can be reasonably assumed as design value of Condensing Pressure.

The Role of Wet Bulb Temperature

WBT is the "cold source" of the cycle and it is the theoretical limit to which the circulating water could be cooled by using an infinite cooling surface cooling.

A variation of WBT causes changes to power plant performances: the higher is the WBT, the lower is the power generated by the plant. For instance WBT is higher during the day compared with night, but this goes in opposition with the demand of electricity. This is why the choice of the design WBT is a delicate issue and a proper compromise must be adopted.

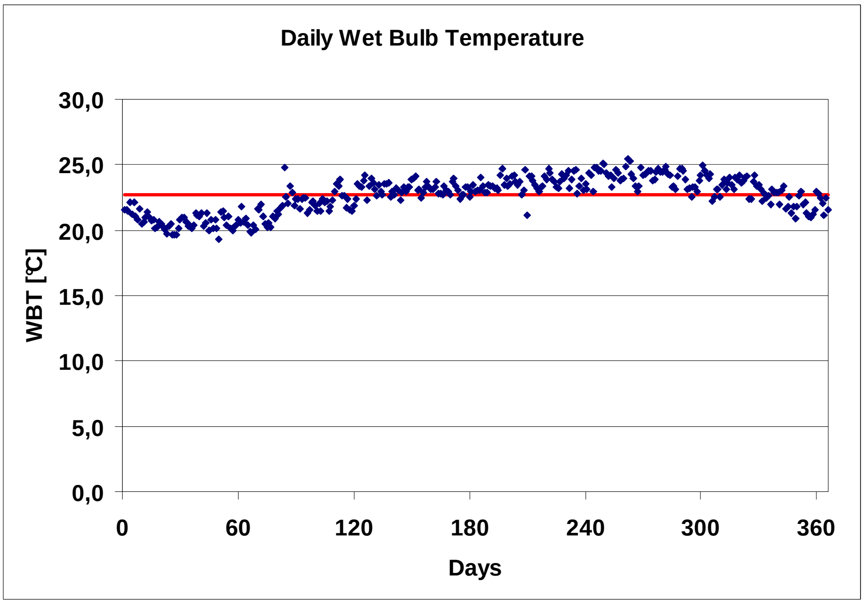
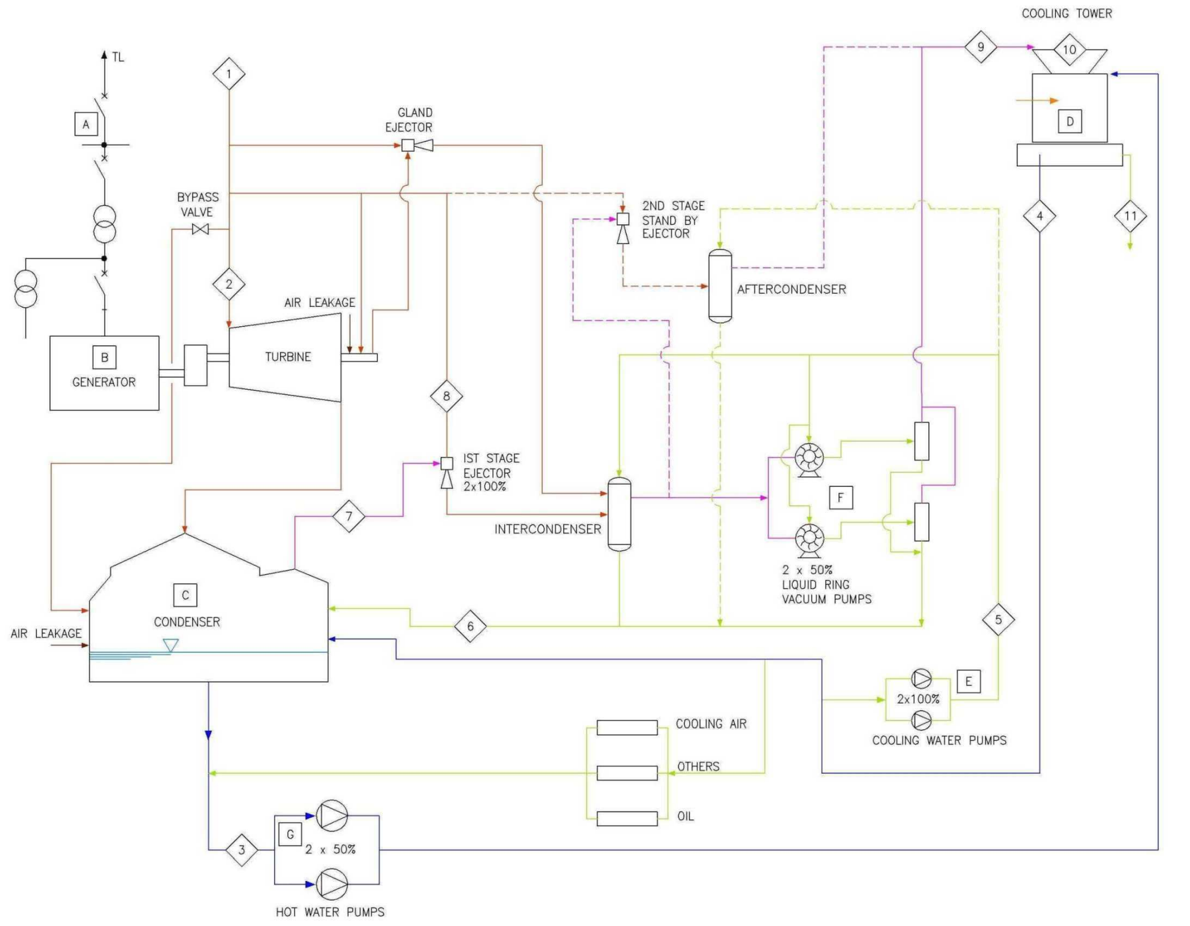


Figure 8.1-4: Daily wet bulb temperatures (2012)

Figure 8.1-4 shows the annual trend of the WBT recorded by the meteorological station of Canefield airport in 2012 giving an average value of 22.7 °C. The airport is located about 9 km far away from the plant site at sea level, so the obtained value is reliable but taking a conservative approach, the design value of WBT can be assumed as 24 °C.

8.1.4 Heat and Mass Balance

The following figure contains a schematic Heat and Mass balance of the plant where it is possible to find the characteristics of the main streams.



EQUIPMENT

VARIABLES		A	B	C	D	E	F	G
		DELIVERY POINT	GENERATOR	CONDENSER	COOLING TOWER	COOLING WATER PUMPS	LIQUID RING VACUUM PUMPS	HOT WATER PUMPS
POWER	kW	3500	4080	–	20x2	6x2	131x2	51x2
HEAT DUTY	MW	–	–	16.7	–	–	–	–
FLOW	kg/s	–	–	317	359	7	2	359
HEAD	m	–	–	–	–	20	–	20

LINES

VARIABLES	FLUID	UNIT	1	2	3	4	5	6	7	8	9	10	11
			SUPPLY TO POWER PLANT	STEAM TO TURBINE	CIRCULATING WATER SUCTION AT HOT WATER PUMPS	CIRCULATING WATER EXIT FROM COOLING TOWERS	COOLING WATER INTO GAS EXT. SYSTEM	COOLING WATER FROM GAS EXT. SYSTEM	GAS EXIT FROM CONDENSER	STEAM TO 1ST STAGE EJECTOR	GAS TO COOLING TOWER STACK	AIR OUTLET FROM COOLING TOWERS	COOLING TOWERS OVERFLOW
PRESSURE		bar a	6	6	1	1	3	0.22	0.096	6	1.05	–	1
TEMP.		°C	158.4	158.4	42.6	30.0	30.0	50	45.6	158.4	36.5	45 WET BULB	30
FLOW	STEAM	kg/s	8.86	8.16	–	–	–	–	0.094	0.365	0.006	–	–
FLOW	WATER	kg/s	–	–	358.63	351.45	17.38	17.82	–	–	–	< 0,1 DRIFT	1.45
FLOW	INC.GAS	kg/s	0.22	0.21	–	–	–	–	0.209	–	0.209	–	–
FLOW	AIR	kg/s	–	–	–	–	–	–	0.012	0.009	0.012	–	–

Figure 8.1-5: Unit heat and mass balance

8.1.5 Gross and Net Plant Output

The gross power output of the power plant will be 4 x 4.08 MW at the generator terminals. Power demand for the various plant auxiliaries is estimated in the table below and totals around 4 x 0.55 MW, resulting in a net plant output at the terminals of transformer of 4 x 3.5 MW. Each single plant unit has the following auxiliary consumption:

Hot Well Pumps	102 kW
Auxiliary Cooling Water Pumps	6 kW
Cooling Tower Fans	40 kW
Liquid Ring Vacuum Pumps	131 kW
Other Loads	270 kW
Total Auxiliary Power Demand	549 kW

8.1.6 Outline of the Process

Turbine inlet

The steam separated at separator stations flows to steam turbine through a common Steam Header, Mist Eliminator, Strainer, Main Stop Valve (MSV) and Control Valve (CV).

Steam Turbine

The steam turbine is the equipment converting the energy content of the steam flow into mechanical energy. The generator produces electric power thanks to the rotating movement of the turbine while the exhaust steam flow is discharged into the condenser through an exhaust duct. For sealing steam turbine gland, at start up or low load, main steam is used. At high load gland steam for turbine vacuum side gland is fed from turbine high-pressure (generator side) gland. Mixture of atmospheric air and gland steam are led to gland steam condenser.

The power plant is designed to be operated under almost constant steam flow consumption, as base load or using a turbine bypass system to maintain constant steam flow even at partial loads (and consequently with spinning reserve) by releasing the surplus of steam into the condenser. A hydraulic (or pneumatic) valve connected to the venting system is installed downstream the steam separator. This valve rapidly discharges steam when the turbine trips and also serves as back-up in case of malfunctioning of the turbine bypass control valve.

Condenser

Exhaust steam from turbine flows into condenser through the exhaust duct. Between turbine and condenser, an expansion joint is installed to handle erection allowance and thermal movement. Exhaust steam from turbine is condensed and extracted by hot water pumps, then sent to cooling towers. Most of the amount of turbine exhaust steam is evaporated or drifted in cooling tower to atmosphere.

Non-condensable gas is cooled in a specific condenser section to reduce accompanied steam amount and extracted by and hybrid gas extraction system equipped with a first stage ejectors system and a second stage liquid ring vacuum pumps system. Downstream the first stage, an intercondenser is installed to condense motive steam.

An automatic control system shall be foreseen to avoid an excessive drop of the condensing pressure under a fixed threshold when the power plant operates at reduced load (in case of remarkable partialization of the steam turbine, the condensing pressure may drop so low letting the last stages of the turbine operate in off design condition).

Gas extraction system

Gas extraction system removes non-condensable gases that are contained in the main steam from the condenser. The gas removal system can be equipped with steam ejectors, liquid ring vacuum pumps or centrifugal compressors depending on the NCG content. The motive steam for the ejector is drawn from the main steam line. Drains are led into the main condenser and the non-condensable gases are driven to the cooling tower exhaust and discharged into atmosphere.

Cooling tower

The water extracted from the condenser is sent to the top of the cooling tower by the hot well pumps with the aim of reducing its temperature. Cooling tower is multi cell mechanical draft wet type either cross flow or counter flow type. Cooling tower is equipped with maintenance stair and lifting facility. At the outlet of basin, and upstream the hot well pump, mesh screen is installed to eliminate leaves and further dirt from the system.

8.2. Power Plant Site

The SGPP location has been selected in correspondence of the WW3 site in Laudat, in the north extension of the same well pad as a consequence and for the same social and logistic reasons of the decision to develop the northern part of the field in Laudat area and to drill the required production wells deviated from WW-03 drilling pad where the corresponding vertical slim hole was successfully drilled.

The power plant will be located to the north of the existing wellpad WW3, about 50 meters from the balancing tank of the Trafalgar hydro power plant, at an elevation of about 550 m a.s.l. The power plant site will be accessible from Roseau through the main road from Roseau to Laudat and then from Laudat following to Titou Gorge Falls (or Aereal Tram). The roads are suitable for the transportation of the heavy loads foreseen for the erection of the power plant.

In addition to the land requirements for the wellhead equipment and the fluid collection and reinjection system, land requirements for the power plant will consist of the direct requirements of the power plant footprint plus any additional land for disposal of excess cut materials. It is considered that the area of the existing wellpad WW3 will be possibly enlarged to accommodate wells WWP1 and WWP2 as well.

Considering the preliminary observations of the geotechnical survey conducted by ELC in June 2011 and the geological logs of the exploration well WW3, no geotechnical issues are expected, however a detailed geotechnical investigation and assessment at the selected power plant site will be required.

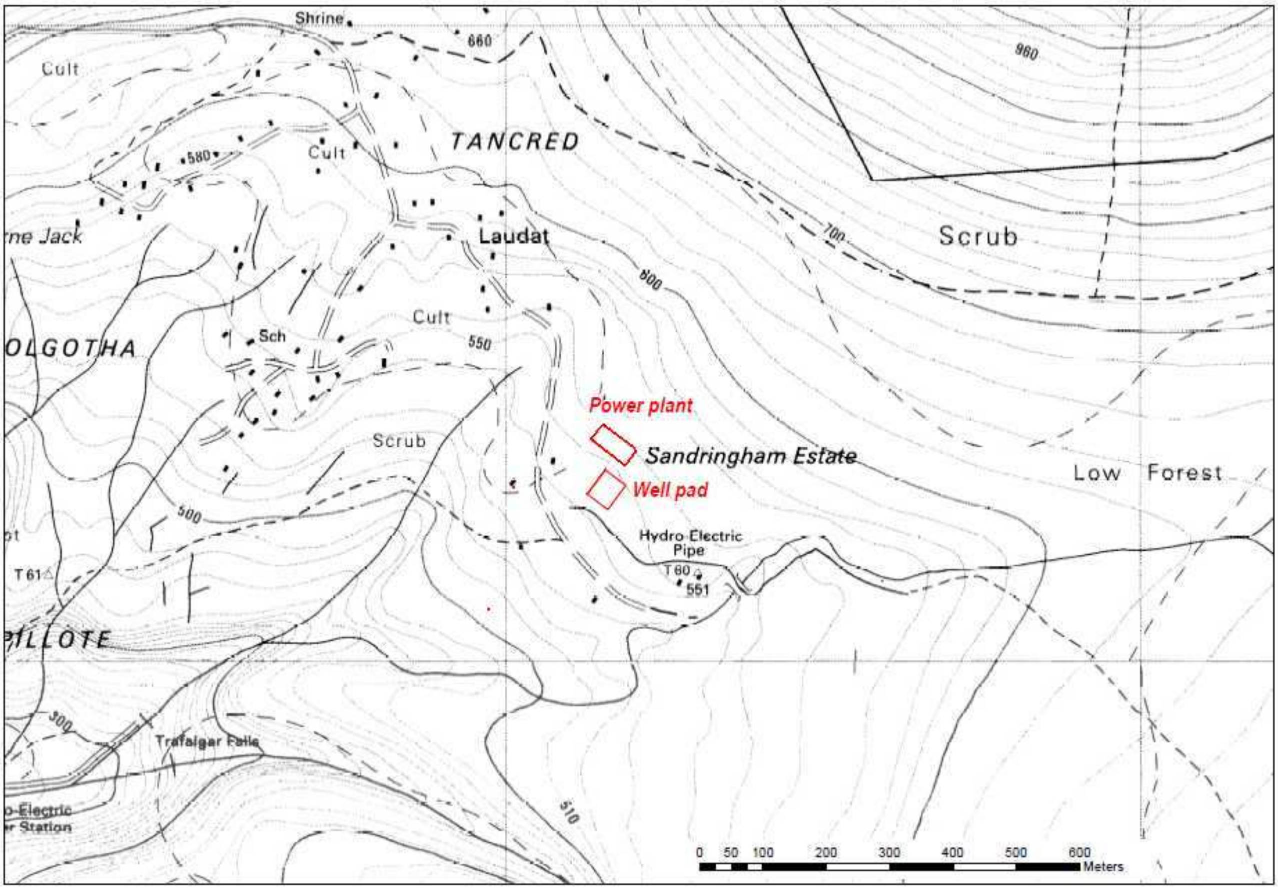


Figure 8.2-1: Project Location

A typical layout of the power station, composed of four generating units, is show in the figure. The site requirement for the generation plant and ancillary structures is approximately 170x50 m. The orientation of the power plant on the selected site may be controlled by the prevailing wind direction, if that is significant, for cooling tower efficiency, considering also the morphology to the north of the selected site.

The civil works will basically consist of concrete foundation slabs (e.g. for the electromechanical equipment and the switchyard), concrete ponds and steel structures, such as for accommodating the turbo-generators and for the electrical and control room, the workshop and warehouse and other possible ancillary buildings (guardhouse, emergency diesel room, etc.). The design of the civil and structural works will consider the applicable national and international design codes as far as seismic and wind loads are concerned.

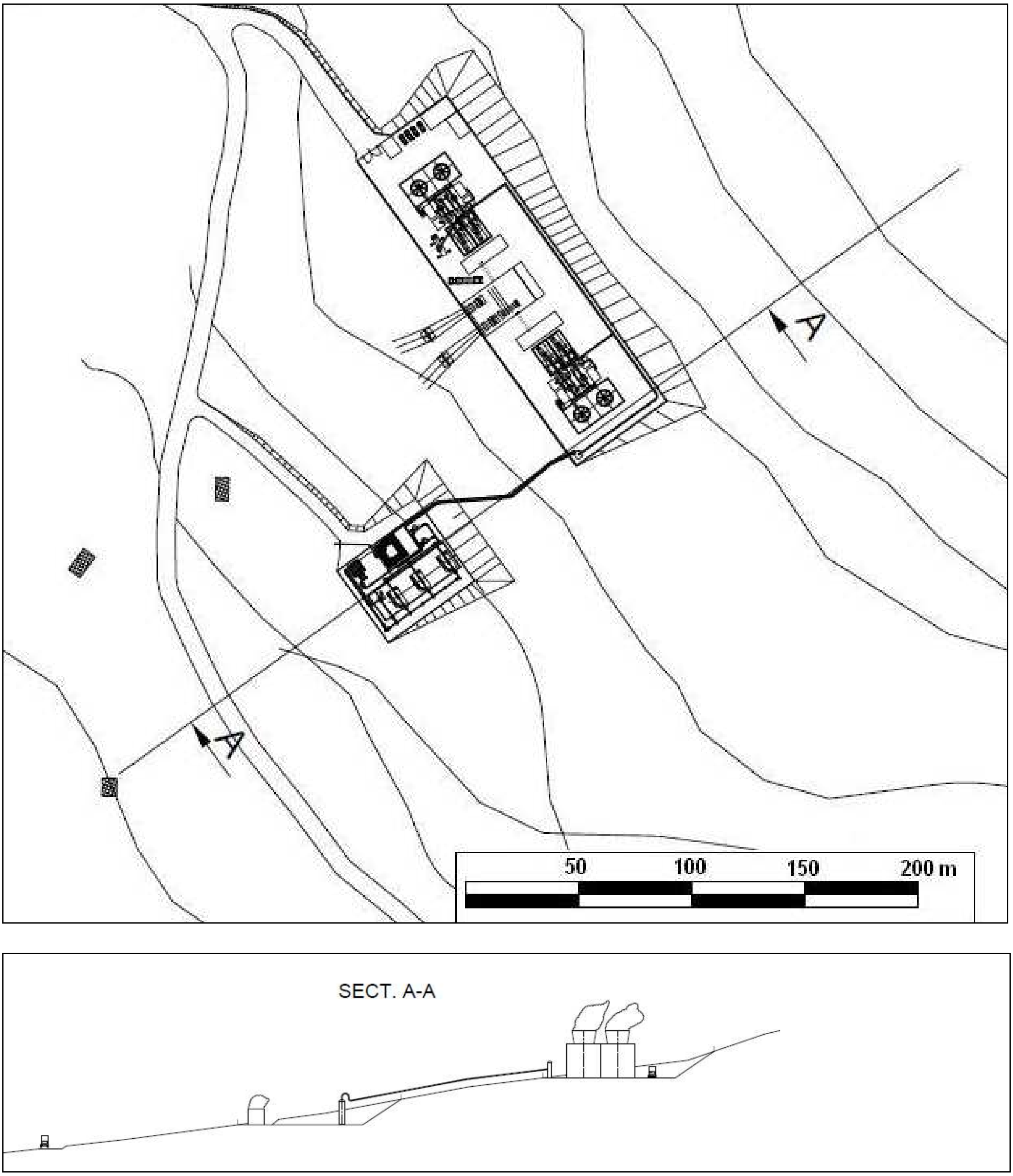
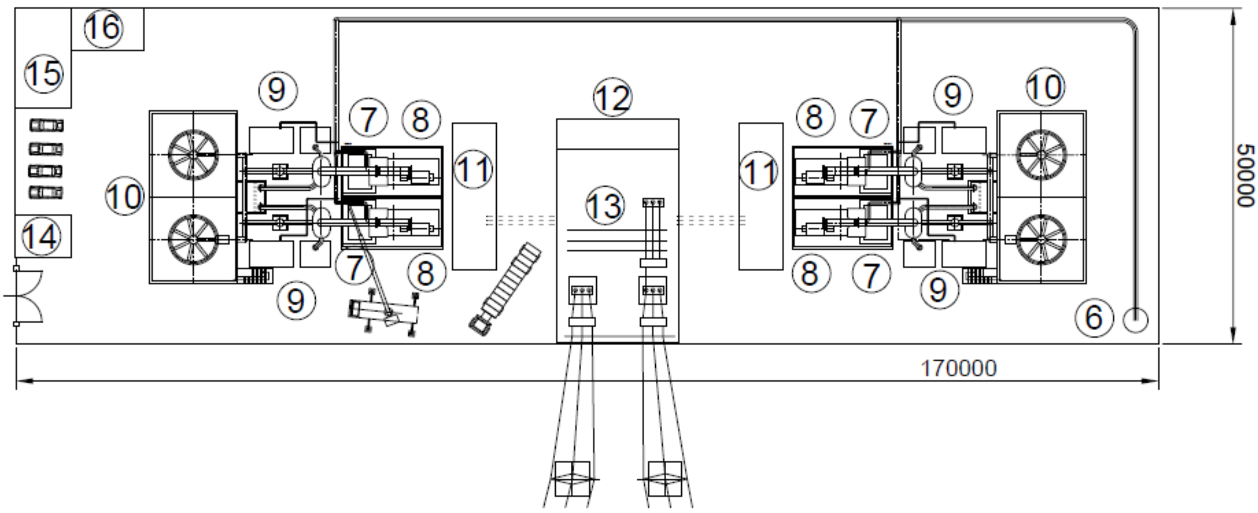


Figure 8.2-2: Project Layout



6	U-BEND DEMISTER	12	DIESEL GENERATOR
7	TURBINE	13	SWITCH YARD
8	GENERATOR	14	GUARD HOUSE
9	NCG EXTRACTION SYSTEM (EJECTORS)	15	WORKSHOP & WAREHOUSE
10	COOLING TOWERS	16	WATER TANK
11	ELECTRICAL AND CONTROL ROOM		

Figure 8.2-3: Power Plant Layout

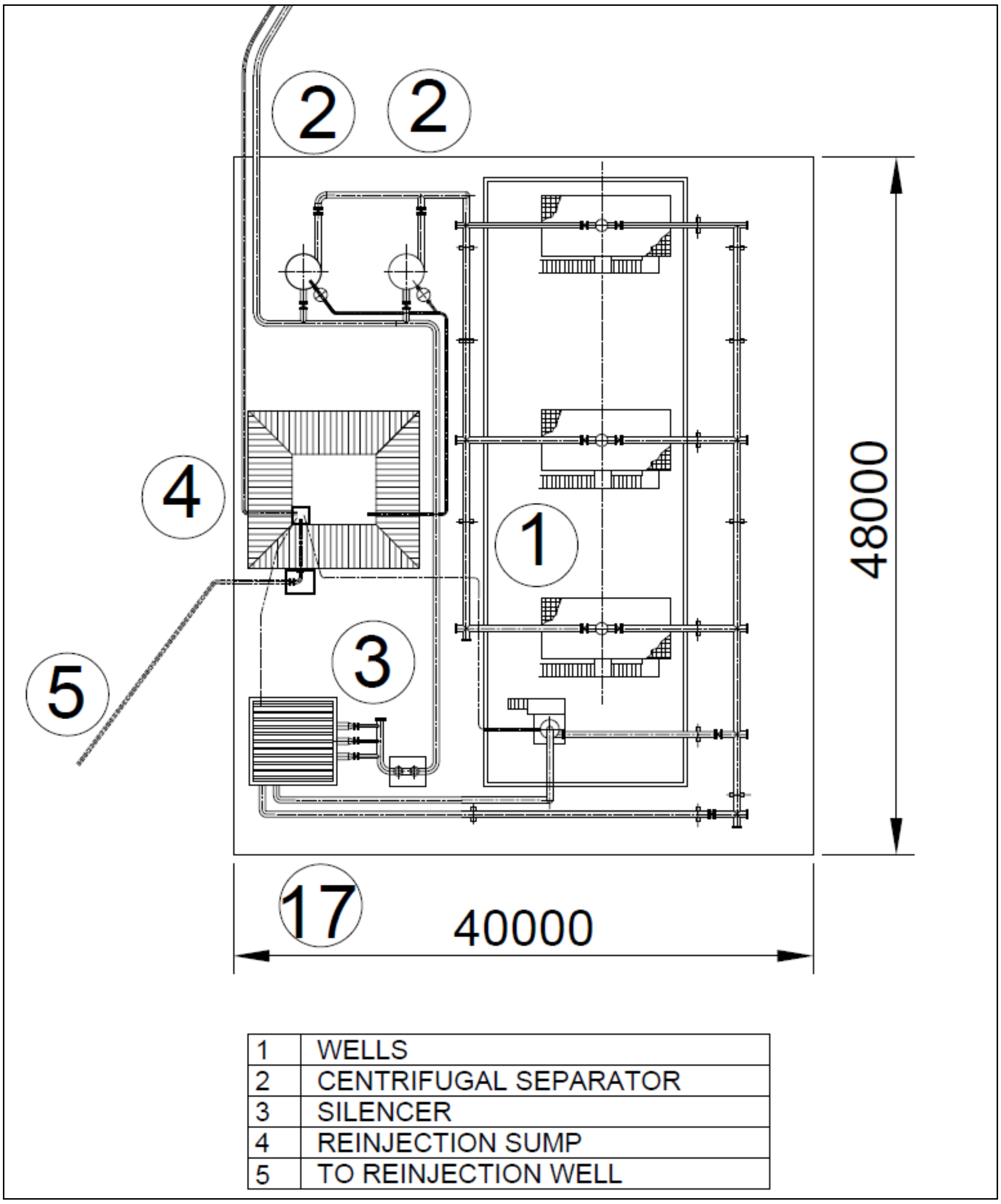


Figure 8.2-4: Production Wellpad Layout

8.3. FCRS and Power Plant Facilities and Systems

8.3.1 Type of Fluid Collection and Reinjection System (FCRS)

The geothermal field is a water dominated type and a pressure steam separator station is required to process the geothermal fluid rising from the wells.

Considering the location of the production wellpad and the power plant, the separators can be located at production wellpad, separated steam and brine will be conveyed to the power plant and the reinjection wells respectively, as shown in the relevant layout picture. The main characteristics of this schema are: reduced length of the two-phase lines, easy control of the separation pressure and possibility to convey the brines to the reinjection wells without reinjection pumps.

8.3.2 Layout of the FCRS and Pipeline routes

Location of the production wells, separators, new power plant and reinjection wells are shown in the figure. The two-phase system and reinjection line will be designed in consideration of future connection with additional wells.

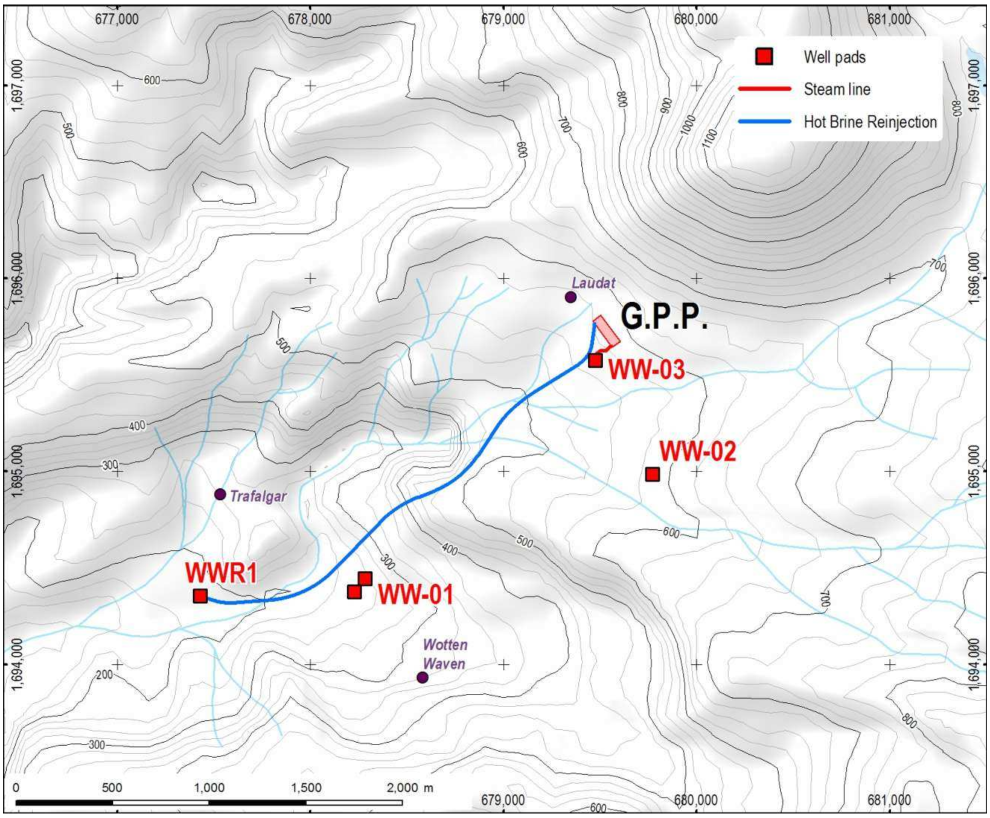


Figure 8.3-1: Layout of the FCRS

The production wellpad is WW3. Two-phase fluid from the three production wells is conveyed to the separator station located at the wellpad. Separated steam is conveyed from the separator station to the power station through the main steam pipeline connected to a steam header in the power plant area. The power plant will be located to the north of the existing wellpad WW3, about 50 meters from the balance tank of the Trafalgar hydro power plant, at an elevation of about 550 m a.s.l.; the reinjection well is located at 180 m a.s.l. to the southwest of wellpad WW3.

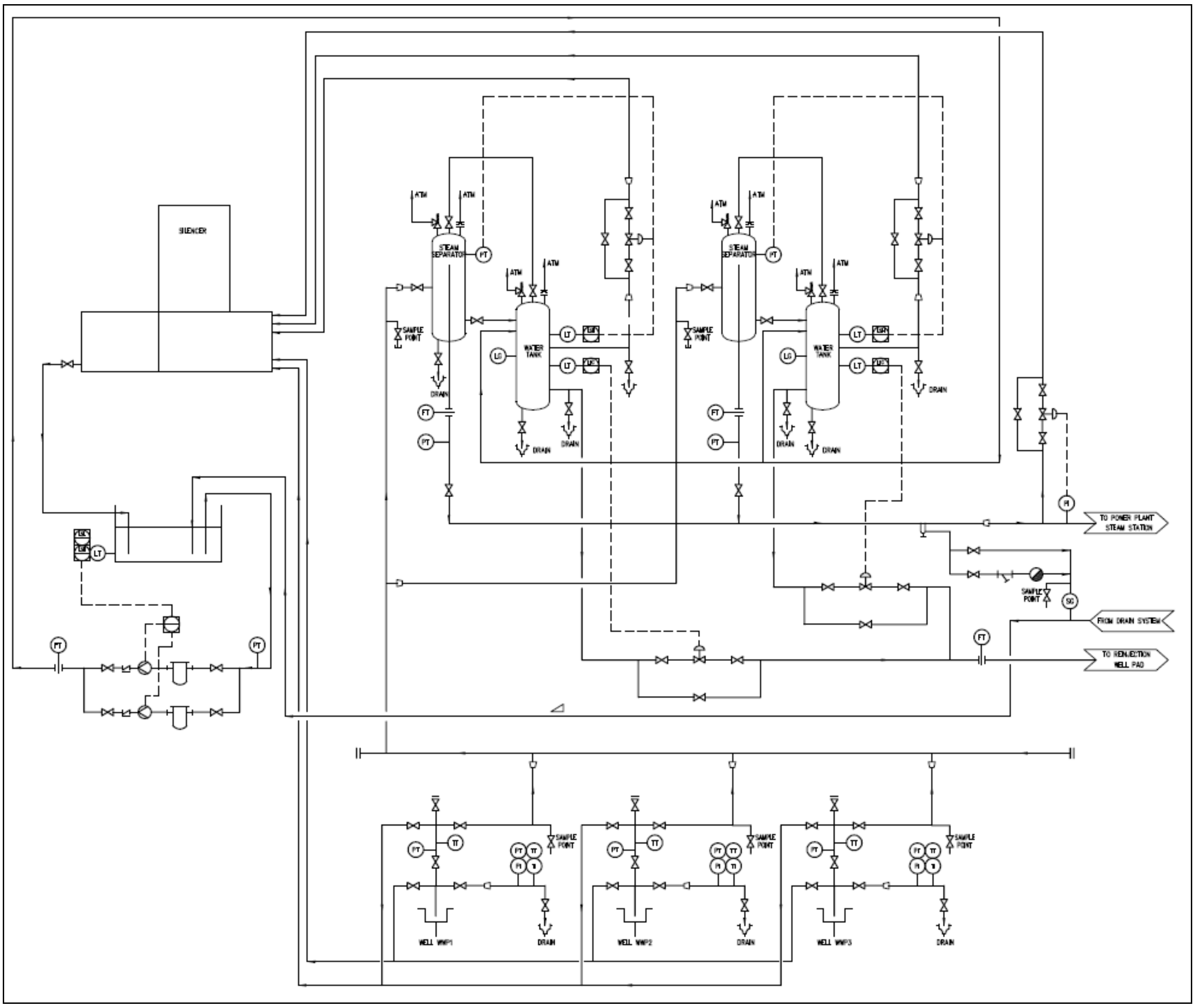


Figure 8.3-2: Basic P&ID of the Production Wellpad

8.3.3 Production well pad equipment

The layout of the wellpad is similar to conventional wellpad with pressure steam separators, atmospheric separator (silencer) and thermal pond. In order to extend the life of these wells, the line losses in well branch lines will have to be kept to a minimum and 2D long radius bends used on the wellpad. It is recommended practice to have large start up lines connected permanently to the well branch lines that in turn are connected together to flow into the wellpad atmospheric separator.

The wellpad will have a pond for collecting all the flashed fluids. The cold brine would be pumped into condensate, brine and two phase lines in that order of preference at a slow rate to mix with the fluid and reinjected.

8.3.4 Separator station

Pressure steam separator Webber type with a connected water drum will be selected. Two separators will be installed in the wellpad. The capacity of each separator is designed for 60% of total flow produced by the connected wells in nominal condition. In this way the design flow rate of each separator can be optimized in accordance with the flow rate of two steam turbines thus overcoming the scarce flexibility of steam separators. The level control method by control valve at brine outlet will be installed for the water tank of the separator.

An atmospheric separator with adequate silencing section will be provided for the discharge of steam to atmosphere in case of shut-down or emergency as described under paragraph 8.1.6; it will be nearby the separation station. The drain will be discharged into a pond.

8.3.5 Two-phase system

The two phase system conveys the geothermal fluid from each wellhead to the common manifold to balance flow and pressure and then splits it again to flow into the two separators.

8.3.6 Steam line

The steam lines will convey the separated steam from the wellpad to the Power Plant.

The steam lines leaving the separator station will be scrubbing lines running into a common header located within the power plant area. Two lines from this header flow into the mist eliminator (demister) at the power plant. The steam field system rupture discs are located on this line, most likely immediately downstream of the separator station.

The thermal insulation on the scrubbing line is reduced to encourage condensation of steam that is collected in condensate pots where it is discharged by means of steam traps to atmosphere via a small atmospheric flash tank. The flashed fluid is collected in an open drain to take it down to the thermal in the wellpad, from where it can be pumped to the reinjection system.

The steam line size will be designed according a steam velocity between 20 and 30 m/s.

8.3.7 Brine reinjection line

The selected reinjection pad will be located at lower elevation than the production wellpad and this configuration allow gravity injecting of the separated brine without reinjection pumps.

A level control valve is used to control the water level in the steam separator and it has the advantage of closing off the brine line when there is no fluid in the separator after depressurisation.

A brine emergency dump line is connected to the brine line near the separator station. This line has an emergency dump valve which will open when a very high level is reached in the water drum of the separator and brine will flash into a large atmospheric flash tank. The flashed fluid either flows into a pond for future reinjection.

On the reinjection wellpad, a rupture disc on the well branch will protect the brine line in the event the reinjection wells pressurise. The brine will be discharged into the wellpad flash tank with the flashed fluid flowing into a pond for future pumping back into the reinjection well. In a worst case scenario, the brine will rise inside the water drum of the separator until the emergency dump valve is actuated. Meanwhile a reverse flow alarm starts to close off the branch line downstream of the branch to the rupture disc and may prevent rupture if the system can react fast enough. With the well branch line closed, brine will have to continue to discharge into the atmospheric flash tank and an immediate steam field and plant shut will have to be implemented.

The pipeline size will designed considering a brine velocity in the range 2.0-2.5 m/s.

8.3.8 Power plant drain

The drains from cooling towers, condensers, other equipment, etc. will be collected into the reinjection pond and will be pumped into the pipeline to the reinjection wells.

8.3.9 Steam Turbine

The steam turbine inlet pressure is 6 bara; the turbine is provided with inlet strainers, stop valves and governing valves. The steam turbine is a single cylinder, single flow, multi stage, condensing type unit coupled to the generator by a reduction gear. Turbine exhaust pressure is 0.1 bara.

The turbine will be provided with AC motor driven turning gear and suitable equipment will be provided to allow regular on-line washing of turbine blades for removal of scale deposits. Turbine generator lubricating and control oil system will comprise main, auxiliary and emergency oil pumps, oil coolers, oil storage tanks and oil purifier.

To reduce the installation period significantly, skid-mounted construction will be employed for the turbo-generator and auxiliaries; other equipment will be skid-mounted or package-mounted as well.

8.3.10 Condensing System

The condenser is spray-jet, direct-contact, the most commonly used in geothermal power plants. The cooling water is sprayed directly into the condenser, mixing with and condensing the incoming exhaust steam. A small portion of the non-condensable gases in the steam are dissolved in the cooling water, and a further portion is oxidised. The hot water is then cooled in a cooling tower. More steam condensate is produced within the condensers than is lost through evaporation or drift from the cooling towers and the excess condensate would be reinjected. The condenser shell will be of austenitic stainless steel.

- Operating Pressure 0.10 bar a
- Cooling Water flow 317.4 kg/s
- Cooling Water Temperature 30.0 °C

8.3.11 Non Condensable Gas Extraction System

The gas removal system will extract non-condensable gases from the main condenser gas cooler section and discharge the gas into the cooling tower plume above the fan level. The amount of NCG in the separated steam is estimated at 2.5% by weight. At this level of non-condensable gas content in the steam the most economic and efficient system is a hybrid system consisting of steam ejectors (1^{st} stage) and liquid ring vacuum pumps (2^{nd} stage) plus intercondenser and water separators. A stand-by ejector with aftercondenser is foreseen to replace the liquid-ring vacuum pumps in case of failure.

8.3.12 Cooling System

The main cooling water system comprises hot well pumps, cooling tower and circulating water pipe work and valves. It is common practice to use two 50% capacity hot well pumps for geothermal power plants and these vertical type direct driven centrifugal or mixed flow pumps extract hot cooling water and condensate from the condenser hot well and return it to the cooling tower. Butterfly type isolation and control valves will be provided on the discharge of each pump. These valves will be pneumatically operated with the control valves linked to the condenser level control system. A start-up line is provided for each pump to allow starting the pump prior to raising condenser vacuum.

Fibreglass reinforced polyester (FRP) pipe, and associated stainless steel valves, filters, expansion joints and accessories will be provided to transport cooling water from the cooling tower to the condenser and back again. Cooling water will enter the condenser by gravity flow by utilising the static head available between the cooling tower basin and the sub-atmospheric pressure inside the condenser.

The cooling tower will be a mechanical induced draft types. The cooling tower structure, all structural decking and cladding components of the tower will be constructed in FRP, which has excellent corrosion resistance and fire retardant properties. The cooling tower basin may be constructed from reinforced concrete. Each cell will be equipped with a multi blade fan unit.

The cooling tower is located so that the long axis is parallel with the prevailing wind direction to minimise plume recirculation.

- Number of units	1
- Cooling Water flow	358.6 kg/s
- Inlet Water Temperature	42.6 °C
- Outlet Water Temperature	30.0 °C
- Design Wet Bulb Temperature:	24.0 °C

8.3.13 Electrical and Control Equipment

The electrical scheme is typical for small units in which the generators are connected in parallel to the same bar of the MV switchgear.

The Unit 1, 2 and Unit 3, 4 auxiliary loads are fed from the MV/LV Auxiliary Transformers.

Alternatively the LV Unit 1, 2 or Unit 3, 4 auxiliary boards can supply the common service LV board.

The common service board can be fed in emergency conditions by the Emergency Diesel Generator.

The voltage of the generator output is stepped up to 33 kV by the two Main Transformers and transmitted to Fond Cole Substation and Laudat Substations through two 33 kV line.

Therefore the electrical system will consist of:

- four Synchronous Generators consisting of the stator and rotor, cover, bearing, air-to-water cooler, etc. The stationary armature will be attached to and supported by generator base. The rotor will be supported by the bearings. Air-to-water coolers are mounted above the stator. The cooling system completely enclosed will prevent entrance of the dust and moisture (Totally Enclosed Water to Air Cooled: TEWAC). Specifications of the generator are as follows:
  - Type form: three-phase synchronous, brushless generator, horizontal coupled to turbine, rotating field, cylindrical rotor
  - Installation: Indoor
  - Nos of phase: 3
  - Nos of pole: 2
  - Rated Output: 5.1 MVA
  - Power factor: 0.8 lagging
  - Rated Voltage: 6 kV
  - Frequency: 50 Hz
  - Speed: 3000 r.p.m.
  - Cooling: Stator winding: Indirectly air cooled
    Rotor winding: Directly air cooled
  - Excitation system: Brushless excitation
  - Grounding: Neutral terminals Grounded through grounding resistor or grounding transformer;
- two 21.6 MVA 33/11 kV ONAN Main Transformers;
- one 33 kV Metalclad type switchgear provided with vacuum circuit breakers;
- one 6 kV Metalclad type switchgear provided with vacuum circuit breakers;
- two 6/0.4 kV resin insulated type Auxiliary Transformers,
- one 0.4 kV Switchgear split into three sections (Units 1 & 2, Common Service, Units 3 & 4),
- one Emergency Diesel Generators;
- DC System (Battery and battery Charger)
- one Uninterruptible Power System

Due to the harsh environment for the presence of H_2S the electrical boards will be lodged in an air filtered/pressurized room.

Single line diagram of the power plant is shown here below:

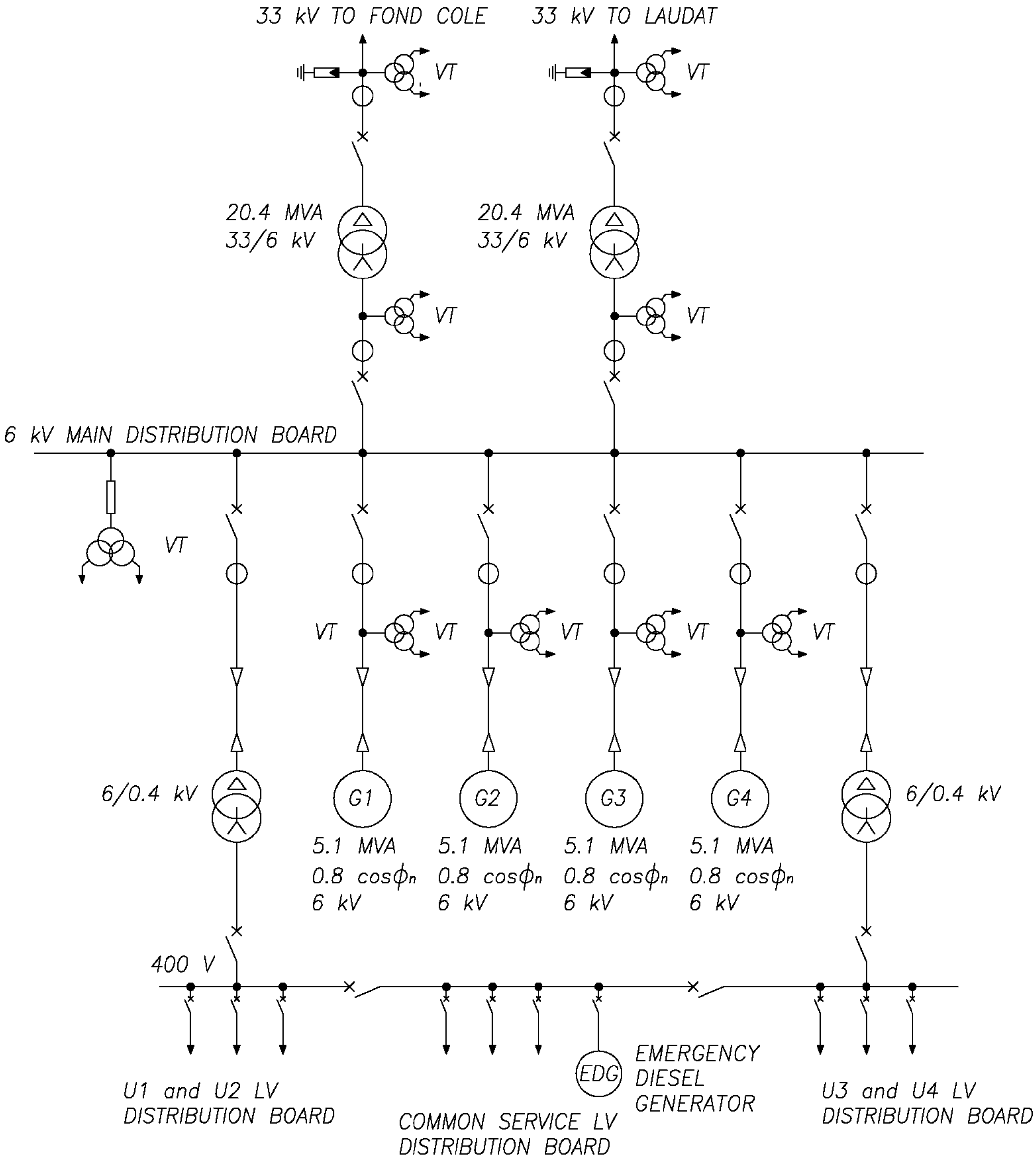


Figure 8.3-3: Power Plant Single Line Diagram

The SCADA will be Distributed System type, and PLC based.

One Control Board with two redundant PLCs will be provided for each unit.

One Control Board with two redundant PLCs will be provided for the Common Services.

The PLC will be connected together with a LAN and supervised by at least two Operator Stations.

One Engineering Station will be provided for the SCADA configuration and setting.

Due to the harsh environment the control boards will be lodged conditioned and air filtered/pressurized room.

9. ENVIRONMENTAL ISSUES

9.1. Introduction

In September 2011 an Environmental Report was prepared by ELC Electroconsult and submitted to the Dominica's Environment Authority, in order to supply the basic information about the project and its environmental implication.

Such analysis considered three different power generation options and three different power station locations on the basis of the information available at the time of the report preparation. During the following year three exploratory wells were drilled and the geothermal information updated. According to the results of the drilling campaign, in July 2012 a new layout of a 10 MW geothermal power plant was considered, taking into account the drilling of a full productive well in the location of WW-01 (Wotten Waven, Pachoute Estate).

The environmental analysis carried out in July 2012 aimed to establish the potential impacts of this new option, identifying the most suitable location for the power house and the reinjection well/s among the possible locations identified by the Reservoir Engineer.

Further considerations led to relocate the power plant in Laudat (Balancing Pond) and to increment the installed power from 10 to 14 (3.5 x 4) MW (as described in the previous sections).

9.2. The Project

The project includes the following components:

1) Three new production full size deviated wells (WWP1, WWP2, WWP3) located in Laudat in well pad WW3. In the same well pad two steam separation system will be installed to separate brines (sent to reinjection through the reinjection pipe system) and steam sent to the powerhouse;
2) One 4 x 3.5 MW condensing geothermal power plant located in the existing well pad WW3, close to the balancing pond and accessible by an existing road. Well pad WW3 will be consequently enlarged to accommodate all the necessary facilities including the Powerhouse itself;
3) The pipeline (∅ 16”) 2,450 m long, from the production well pad to the reinjection wells WWR1 and WWR2 (one vertical and the other one deviated);
4) The reinjection wells located nearby the existing soccer field in Trafalgar. This location is easily accessible without building a new road and does not need the creation of a new well pad. There will be some impacts on the soccer field during the drilling, but once the drilling is completed the area can be totally restored. The well heads (which can be located 10-15 m outside of the existing soccer field) will be fenced without creating any impact on the use of the soccer field;
5) The transmission lines (33 kV) to connect the powerhouse with the electrical grid;
6) The access road to the well pad (and relevant powerhouse) already exists. Regarding the reinjection pipeline (even if several accesses may be already available), some accesses will be needed for laying down the pipeline and at least a path should be left for control and maintenance activities.

9.3. Location

The power plant and associated production pipelines are located close to the Laudat village and close to the Domlec Balancing Tank in the eastern part of the Roseau Valley (see paragraph 8.2)

The Roseau Valley (about 1,500 hectares) is mainly covered by forest, while the eastern part of the valley tends to be agricultural land (in the direction of Wotten Waven and Laudat). The urban areas are particularly concentrated at the entrance and in the eastern part of the valley.

9.4. The legislative framework

The environmental feasibility study of the Wotten Woven project is subject to the national environmental regulations of Dominica, briefly reported in Table 9.4-1.

Table 9.4-1: Main laws regulating the management of natural resources on Dominica *(source: Caraibes Environnement – CE)*[5]

Department	Regulations	Responsibility
MINISTRY OF ECONOMIC DEVELOPMENT AND URBAN RENEWAL		
Economic Development Unit/Physical Planning Division	Beach Control Ordinance (No. 21, 1966)	Physical planning, Act. V, 2002 Responsibility for development control and physical planning; administers removal permits
Development & Planning Corporation Town & Country Planning Act (No. 17, 1975)	Development & Planning Corporation Act (No. 19, 1972)	Decision-making authority for planning and development control; Corporation has delegated much of its authority to a Technical Committee
MINISTRY OF AGRICULTURE AND THE ENVIRONMENT		
Agriculture	Agricultural Small Tenancies Ordinance (Cap. 74, 1953)	Forestry & Wildlife (Amendment) Act (No. 35,1982)
Pesticide Control Board	Pesticides Control Act (No. 15, 1974), as amended (No. 4, 1987) with Regulations on Labelling (1986) and Licensing and Registration of Pesticides (1987)	Enforcement of Pesticides Control Act and Regulations
Lands and Surveys	Crown Lands Ordinance (Cap. 169, 1960) (SRO No. 49, 1960; No. 28, 1961; No. 13, 1963)	Responsible for the survey and for the administration of Government lands, and for carrying out surveys for other Ministries
Forestry and Wildlife Division	Forests Ordinance, 1958 (Cap. 80) Forests Acts, Chap. 60: 01,1958 Forest Rules (SRO No. 17, 1972) Stewart Hall Water Catchment Rules (SRO No. 11, 1975) Forestry and Wildlife Act (No. 12, 1976) Botanic Gardens Ordinance (Cap. 166,1889) National Parks and Protected Areas Act (No. 16, 1975) Cabrits National Parks (SRO No. 54, 1986)	Protection and management of the nation's forest and wildlife; watershed management; environmental education; management of national parks

[5] Caraibes Environnement (CE) is the Engineering Consulting Company responsible for the Environmental Impact Assessment for the exploratory drilling activities of the Roseau Geothermal Project. In this role CE has submitted to the Geothermal Project Management Unit a progress report on the Environmental Impact Study at the end of April 2011. This report describes in details the environmental background of the project.

Department	Regulations	Responsibility
Fisheries Development Division	Fisheries Act (No. 11, 1987)	Promotion and management of fisheries; fisheries research; protection and management of marine reserves
MINISTRY OF TRADE, INDUSTRY AND TOURISM		
National Development Corporation	National Development Corporation Act (No. 17, 1988)	Promote and support tourism and industrial development
MINISTRY OF COMMUNICATION AND WORKS		
Ministry of Public utilities, Energy, Ports and the Public Service	Water and Sewerage Act (No. 17, 1989)	Issue water and sewerage licenses to the Dominica Water and Sewerage Company Ltd.
MINISTRY OF COMMUNITY DEVELOPMENT AND GENDER AFFAIRS		
Cultural Division National Culture Council	Culture Act (No. 22, 1981)	Promote an awareness of the country's cultural heritage and an appreciation of traditional folklore, arts and crafts
Village Councils	Village Councils Ordinance (Cap. 190)	Responsibility within their jurisdictions for sanitation, waste removal, nuisance abatement, beach control
Local Government and Community Development Division		Assist local governments in carrying out their responsibilities, including such areas as disaster preparedness

9.5. The Environment

Since the 4x3.5 MW SGPP will be installed in one of the drilling sites pads already analyzed from the environmental point of view by "Caraibe Environment" (CE), for baseline environmental data reference should be made to this document. Here below a synthesis of the main environmental features of the area is presented.

The geology of the area is characterized by the widespread occurrence of volcanic products (andesitic lavas), generally covered by allophanoid clay soils. From the seismic point of view, the project is located in the Lesser Antilles volcanic arc, which is quite active.

At site, although volcanic risk can be considered minimal (the products of the last volcanic activity known in the area have been dated 1,000 years), the seismic risk can be estimated as medium-high.

In spite of yearly rainfall up to 2000 mm/year, with the heaviest rains (as well as hurricanes and storms) occurring during the period from June to November, the site is not at risk of flooding and the risk of landslides and slope instability is minimal.

The site is located in an area where the pristine environment has been partially modified by the human activity so that original Flora and Fauna is not affected in its immediate surroundings.

From the anthropic point of view, the entire Roseau valley is characterised by scattered settlements spreading all around the valley wherever the slopes are not too steep.

9.6. The Impacts

The geothermal development may be divided in two main phases:

- Development phase (drilling and construction).

- Operational phase (fluid extraction, separation, transportation and disposal, power production).

The main impacts that have to be considered may be summarised as follows:

a) Development Phase

- Land take and vegetation removal

- Visual impact of drilling rig and access roads

- Noise induced by drilling operations and production tests

- Risks of spills and discharge of contaminant liquids

- Solid wastes disposal (drilling muds and other materials)

- Air pollution due to incondensable gas release during production tests and dust emissions during construction

b) Operational Phase

- Land take and vegetation removal

- Visual impact of power plants and gathering system

- Noise induced by power plant operations and wells production

- Water pollution induced by drains and possible spills

- Air pollution due to incondensable gas release

- Subsidence risk

- Seismic risk due to subsidence or reinjection operation

- Effects of geothermal exploitation on hydrothermal manifestations

The description of the Impacts arising from the Development Phase are out of the scope of the present chapter and were already well described in the EIS report prepared in the frame of Géothermie Caraïbes' project in the Roseau Valley in Dominica, part of the European cooperation programme INTERREG III-B.

In the following paragraphs we will examine briefly the main Impacts with particular reference to air pollution, noise and seismic risk. The Impacts derived by the construction of the relevant transmission line can be considered minimal (in the environmental legislation of all countries such kind of infrastructure does not need any Environmental Impact Assessment). Moreover the existing substation to which the proposed SGPP could be linked is quite close. Therefore this impact can be considered negligible.

9.6.1 Visual Impact

In Dominica, green tourism plays a very important role and the Roseau valley is one of the most visited sites by foreign tourists.

The natural scenery not affected by the presence of a power plant represents a value, for this reason the impact on landscape has been evaluated considering the following rules (see Table 9.6-1):

Table 9.6-1: Impact on landscape of the SGPP

Impact	Visibility
No Impact	No visibility
Low	The SGPP is visible only from less the 100 m far
Medium	The SGPP is visible from a distance between 100 and 1,000 m far
High	The SGPP is visible from more than 1,000 m far

The selected layout minimizes the visibility of the production wells site, because they will be located in an already existing well pad and shall not be significantly visible from the nearby road that leads to the aerial tram.

The power house will be located in the same pad of the wells, thus minimizing the landscape impacts of the gathering system. Although located nearby the road leading to the aerial tram, with proper mitigation measures (e.g. tree fences) it could be easily hidden from the view of tourists passing by.

The reinjection pipes will run in areas not visible from the road and from other locations, but mostly in areas of pristine forests.

The reinjection well will be located in a corner of the flat area where a soccer field is presently located, the relevant impact in terms of visibility can be considered minimal.

Therefore the overall visibility of the project can be considered not very significant and the relevant impact can be evaluated as low referring to the powerhouse location.

9.6.2 Water Pollution

In Dominica there are no waste water effluent standards. Therefore, to understand the potential impacts of discharging the water separated from the well into the surface water system, a comparison between the water presently separated from WW-01[6] and the surrounding surface water of the new wells (around the existing exploratory well WW-03) has been carried out, as reported in Table 9.6-2:

[6] The only one well, for which water analysis area available.

Table 9.6-2: Chemical characteristics of WW1 brines (at 100°C) and of the surrounding rivers

Components	WW1 at 100 °C	Trois Piton River east of WW-03		Trois Piton River downstream of WW-03	
Date		*13.03.2012*	*30.09.2012*	*13.03.2012*	*30.09.2012*
B	45.18 (mg/kg)	0.33 (mg/l)	0.21 (mg/l)	0.31 (mg/l)	0.20 (mg/l)
SiO2	580.93 (mg/kg)	91.6 (mg/l)	52.4 (mg/l)	76.6 (mg/l)	44.3 (mg/l)
Na	2117.18 (mg/kg)	21.5 (mg/l)	13.1 (mg/l)	20.2 (mg/l)	10.6 (mg/l)
K	294.34 (mg/kg)	3.6 (mg/l)	2.2 (mg/l)	3.1 (mg/l)	1.9 (mg/l)
Mg	0.058 (mg/kg)	29.1 (mg/l)	15.2 (mg/l)	25.3 (mg/l)	11 (mg/l)
Ca	79.39 (mg/kg)	38.6 (mg/l)	20.7 (mg/l)	34.7 (mg/l)	15.5 (mg/l)
F	0.865 (mg/kg)	0.27 (mg/l)	0.15 (mg/l)	0.20 (mg/l)	0.15 (mg/l)
Cl	3511.42 (mg/kg)	9.6 (mg/l)	8.1 (mg/l)	9.5 (mg/l)	7.2 (mg/l)
SO4	21.04 (mg/kg)	14.2 (mg/l)	10.2 (mg/l)	13.6 (mg/l)	10.6 (mg/l)
Al	0.1640 (mg/kg)	0.025 (mg/l)	0.028 (mg/l)	0.012 (mg/l)	0.029 (mg/l)
Fe	0.0829 (mg/kg)	0.074 (mg/l)	0.067 (mg/l)	0.012 (mg/l)	0.015 (mg/l)
TDS	6893.74 (mg/kg)	314 (mg/l)	172 (mg/l)	274 (mg/l)	141 (mg/l)

Without entering into details in the analysis, the data reported in the Table above clearly show that the water separated from the geothermal well has very different chemical characteristics compared to the surroundings surface waters. Therefore, the discharge of such water directly in the surface water system (even if after cooling) may significantly modify the surface water characteristics. For this reason, during the operation activities the separated water shall be reinjected into the reservoir through reinjection wells.

The problem may be significant (even if less important) also during the well testing phase. For this reason such water shall be properly stored in the existing pool already excavated for the small diameter wells and reinjected into the reservoir (once the reinjection pipe has been built).

Moreover, as stated in paragraph 5.2.6, “Corrosion Potential of Geothermal Fluids”, steam condensate may pose corrosion problems, especially upon absorption of atmospheric O_2 and oxidation of dissolved H_2S to H_2SO_4. Suitable actions (e.g., addition of a base) might be needed to mitigate locally the acidity of steam condensate before its disposal, e.g., through mixing with the separated liquid to be reinjected.

9.6.3 Noise

The potential impact of geothermal development on local noise level is dependent on several variables including the intensity of the noise source. This value will be used to assess the entity of the impact of the future activity, taking into account meteorological conditions, sound propagation conditions and background noise.

On the other side, noise can be considered a problem only if sensitive receptors are located close to the location of productive wells and power plant, (i.e. within a maximum radius of 800-1000 m).

a. Indicators

Back ground noise is generally described with the following noise indicators:

- Leq(T): noise equivalent A weighted sound level, i.e. the energy average of the A weighted sound pressure level evaluated over T time. The energy average is the constant noise level for T that has the same energy as the actual fluctuating level during the T time.
- L90: the weighted sound pressure level that is exceeded 90 percent of the time

The other noise indicator useful for disturbance evaluation is the differential noise, i.e. the difference between the noise level predicted after plant construction and the ambient noise before the plant construction.

b. Regulatory Limits

According to Article 40-99 of the Noise Abatement Act concerning noise control and abatement, the project will have to apply to obtain permit of operations. In the meantime some evaluation can be performed taking into consideration western standards.

Most of regulations fix a limit as maximum noise equivalent level to be not exceeded during the day (from 7 to 22) Leq (D.d) and during the night (from 22 to 7) Leq(D.n) and a maximum differential noise during the day LD,d and during the night LD,n.

Considering the touristic importance of the area, the maximum equivalent noise level in front of the nearest receptor should not exceed 50 dB(A) during the night with a maximum LDn lower than 3 dB(A).

c. Ambient noise

A noise monitoring campaign in the vicinity of the future power plant was carried out in the frame of Géothermie Caraïbes' project in the Roseau Valley in Dominica, part of the European cooperation programme INTERREG III-B.

In the frame of the above mentioned "Exploratory Drilling Environmental Impact Study, the ambient noise was measured in the environment of the site (April 2011) and resulted to be between 43 dB and 53 dB(A) (excluding the Aerial Tram's operations). As described in the EIS, this ambient noise is basically caused by the fauna, the wind in the vegetation and human activities close-by (stores, vehicles, houses, etc.).

The following chart shows the residual noise data per project station obtained from the measurements taken between 20th and 22nd April 2011. Measurements were taken over significant periods of 33 minutes in locations around the site selected for the future Power Plant:

Sites	Stations	Residual noise obtained (Leq A)
1. Pachoute Estate	1	53.6
	2	43.1
2. Laudat, Rain forest tram carpark	3	61.7
	4	44.3
3. Robinson Estate	5	45.6
	6	48.4
4. Laudat Domlec balancing tank	7	48.4
	8	46.1

The measured values (except for station 3, which was influenced by the tram noise) show noise levels typical of residential areas and may be assumed to be valid for all the houses present in the influence area of the power plant.

The nearest receptors are located at a distance of around 350-400 m from the power plant.

d. Impact prediction

Noise sources associated with geothermal power plant operation are specified in the following table, together with some typical values of sound pressure.

The reported values are based on personal measurements of typical equipment, but can vary depending upon the technical specifications of the equipment to be acquired.

Table 9.6-3: Noise sources associated with geothermal operation development (preliminary estimation)

Activity	Typical sound level at 30 m from geometric centre of the source dB(A)	Source Sound Power dB(A)
Turbine / generator building	60-70	100
Cooling tower	65	105
Unsilenced vent gas ejector	90-100	
Silenced gas ejector	70-80	105

Sound level at the receptor may be predicted by using the following relationship:

L = LO - DS - DA - DG - DE - DF

where:

L is the noise level expressed as Leq at the receptor in dB(A)

LO is the basic noise level of the source as shown in the above table

DS is the attenuation due to geometric spreading i.e.

DS = 20 Log(d2/d1)

where d2 is the distance of the receiver from the source and d1 is the distance at which L was measured, since wave divergence reduces sound pressure level by 6 dB every time the distance from the source doubles

DA is the attenuation due to air absorption

DG is the attenuation due to ground absorption evaluable as 0 for soft soils and -3 for hard soils

DE is the excess attenuation due to features such as natural or artificial barriers

DF is the correction to take account of sound reflection

The same formula can be modified as follows:

$$L = LW - 20 \, Log(d) - 11 - DA - DG - DE - DF$$

where LW is the source sound power and d is the distance from the source.

There are a lot of models using the above cited equation to evaluate sound pressure at receptors, although a first estimate may be given very rapidly: in fact, out of the cited factors which affect noise volume, the primary ones are distance and barriers. The effect of distance may be evaluated as above shown, the barriers generally abate noise level from 5 to 10 dB. The other above cited factors become significant when distances between source and receiver become large (more than 300 - 400 m). In these cases the utilization of more sophisticated models are necessary and the knowledge of emission spectra are required.

For a preliminary conservative evaluation we can consider two units operating during the night (most conservative situation). Each power plant can be schematised as a point source having a sound power of 108 dB(A) for a total of 111 dB(A). Assuming flat terrain and soft soil, the noise from the power plant should range as follows:

D (m)	**LeqdB(A)**
300	50,5
500	46,0
700	43,1
900	40,9

As a first estimation we can conclude that the noise emission can impact buildings located at a distance lower than 500 m from the power plant.

During final design, it will be therefore necessary to study noise mitigation measures such as barriers, low speed tower fans etc.

9.6.4 Air emission

a. General considerations

In the operational phase, the only pollutant of concern is hydrogen sulphide which is released from the cooling towers, rock mufflers and during the initial well testing phase.

The drift from cooling tower can be considered as another air impact, but the new drift eliminators and the low impact range should guarantee that the such impact is limited to a few tens meters from the towers.

According to the gas analyses performed during the well testing in WW-01[7], at power production conditions the NCG (Non Condensable Gases) content is shown in Table 9.6-4:

Table 9.6-4: NCG content at power production conditions

GASES	mg/kg	mg/Nm^3
CO_2	8927,04	1915,934
H_2S	136,62	29,32158
H_2	0,25	0,053655
CH_4	0,4	0,085849
N_2	24,61	5,281833
Total	9088,92	1950,677

The impact on air quality is due to the release of incondensable gases to the atmosphere and it is by far the most important possible cause of pollution, when waste water is properly managed and reinjected.

As mentioned above, among the incondensable gases in the Dominica's geothermal fluid, the most harmful as environmental pollutant is hydrogen sulphide, H_2S.

The effects of high concentrations of H_2S on human and animal health are well known. On the contrary long term effects of low concentrations are unknown: anyway no record exists of detrimental effects to health due to such low concentrations.

The impact of hydrogen sulphide on vegetation is much lower than that on humans and animals: it seems that high concentrations of H_2S reduce the photosynthesis.

On the contrary low concentrations are often beneficial to many plants.

In Dominica, at the time being, there are no standards on ambient air quality, so all the considerations have been made according to International Guidelines. The World Health Organization Guidelines indicate a level of 150 µg/m^3 for an averaging period of 24 hours. Therefore this guideline can be

[7] Well tests and relevant gases analyses have been conducted only on well WW-01, because in the other wells it was not possible to conduct sampling and relevant analyses

applied to locations where receptors can be reasonably expected to be located for this duration (i.e. residential locations, health care facilities, schools etc.).

Diffusional model results will be compared also to the odour threshold concentration that is 42 $\mu g/m^3$ for one hour, according to the “California Ambient Air Quality Standard” (CAAQS).

Moreover it is important to consider that the "American Conference of Governmental Industrial Hygienists" allows the following threshold limits values (TLV) for health safety in working spaces:

- 8 hours maximum exposure 1.4 mg/m^3 (time-weighted average - TWA)
- 15 minutes exposure 7.0 mg/m^3 (short-term exposure limit - STEL)

b. Estimated Emissions

As shown in the former_paragraphs, each one of the 3.5 MW units will be fed by about 30 t/h of steam, containing 2.9% in weight of incondensable gases. The average composition of non condensable gases is (in weight):

- Carbon dioxide 93.7%;
- Hydrogen sulphide 4.5%;
- Other gases 1.8%;

The total amount of gases released to atmosphere by the 3.5 x 4 MW power plant will be:

- Carbon dioxide 924.5 g/s;
- Hydrogen sulphide 44.4 g/s;
- Other gases 17.8 g/s

According to the design of the power plant, the gases extracted by the condenser through the vacuum system are fed to the cooling towers. The remaining part of the gases are absorbed by the cooling water in the condenser and later released by stripping in air flow in the cooling towers, where a share of H_2S is oxidized to colloidal sulphur by the atmospheric oxygen. Anyway, to be on the conservative side, no oxidation has been considered, and the discharge of total H_2S has been assumed.

c. Description of the Area

The distribution of gaseous pollutants is partially influenced by the morphology of the ground in the vicinity of the power station.

The site where the power plant will be located has an elevation of about 550 m a.s.l. and it is part of a plateau that has an average altitude variable in the range of 500-600 m.

The only exception is represented by a volcanic cone which is located on the North-East direction from the site at a distance of about 500 m (Micotrin dome), from where the mountain rises to reach an elevation of 1160 m a.s.l.

The surroundings of the area are poorly inhabited; the nearest isolated residential building is situated at a distance of 250 m from the power plant.

d. Meteorology

Dominica enjoys a typical wet tropical climate with high temperatures and heavy rainfall. The heat and high humidity are mitigated by the intermittent North-easterly trade winds that blow during the hurricane season.

Meteorological data recorded in 2012 at the Canefield Airport are reported in Table 9.6-5.

Table 9.6-5 Monthly averaged weather data recorded at the Canefield Airport for 2012

NO.	**MONTH**	**WIND**		**RAINFALL**	**RELATIVE HUMIDITY**	**TEMPERATURE**		
		Direction	**Speed**			**Max.**	**Avg.**	**Min.**
		(degrees)	(knots)	(mm)	(%)	(°C)	(°C)	(°C)
1	January	117	5	3	61	30	26	22
2	February	123	6	3	62	30	26	22
3	March	189	5	2	62	30	27	22
4	April	189	5	3	63	31	28	23
5	May	162	4	5	68	31	28	24
6	June	129	5	3	58	33	30	25
7	July	126	5	8	62	32	29	24
8	August	139	5	15	66	32	29	24
9	September	237	4	1	66	33	29	24
10	October	168	4	7	68	32	29	24
11	November	186	4	3	66	32	28	23
12	December	156	4	2	64	31	27	23
	Yearly	**160**	**5**	**4**	**64**	**31**	**28**	**23**

The **temperatures** and **winds** are influenced by the mountainous terrain. Ambient temperatures seldom vary, generally between 26°C during the daytime in January and 32°C in June. Temperature variations during the same day rarely exceed 3°C in most locations. At the highest elevations, the temperature can go down to 13°C.

Most of the **rainfall** is brought by the trade winds. Whilst the intensity varies according to the location on the island, rainfall occurs throughout the year. The heaviest rains are concentrated during the period from June to October.

Average annual rainfall is about 5,000 millimetres on the East coast (windward side) but can reach 9,000 millimetres on the most exposed mountains. Rainfall on the West coast (leeward side) is much lighter, about 1,800 millimetres per year. **Humidity** rates are closely linked to rainfall intensity, with the highest levels observed on the windward side (East Coast).

According to the rainfall chart in Dominica’s Biodiversity Strategy and Action Plan (see Figure 9.6-1), project sites 2, 3 and 4 receive between 200 and 250 inches annual rainfall (between 5,080 and 6,350 mm) and site 1 receives between 150 and 200 inches per year (between 3,810 and 5,080 mm). The period from January to June is considered to be the driest season of the year.

The heavy rainfall explains the island’s intense humidity and its amazingly abundant vegetation.

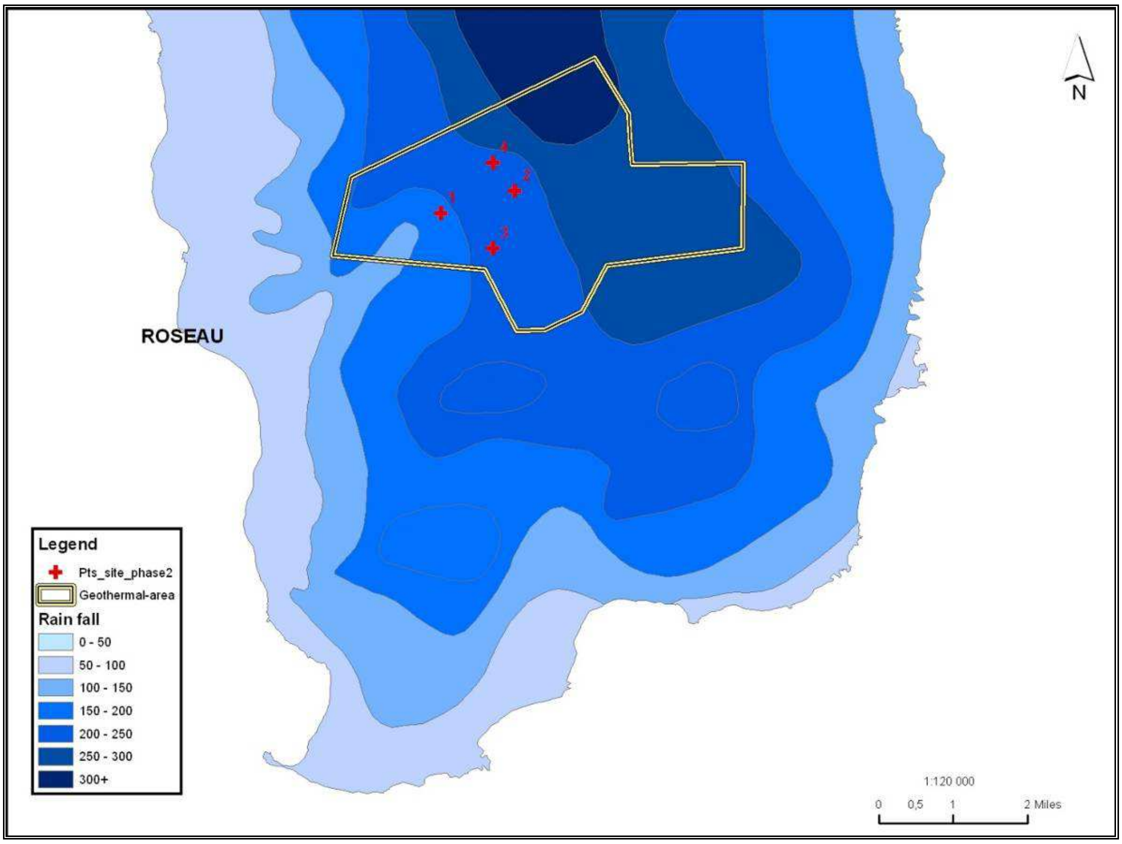


Figure 9.6-1: Average rainfall in the project area from “Roseau Valley Geothermal Project – Phase1: Exploratory drilling Environmental Impact Study – Township of Roseau, Dominica – 30 September 2011”

Hurricanes and **storms** occur generally during the months with the highest rainfall (June to October) and can sometimes cause serious devastations. For example, in August 1979, Hurricane David and Frederick left more than 40 dead and 2500 injured, destroyed many homes and ravaged crops. The following year, in August 1980, the harvest was again ruined by Hurricane Allen. Later, while in 1984 another storm destroyed 25% of the banana crop.

e. Climatological Parameters for Gaseous Pollution

The meteorology can play a major role on the air quality resulting from the emission of pollutant gases. This role can have effects in the local, regional and even continental scale. The main meteorological parameters are:

- Wind direction on a short term and its yearly variability;
- Velocity of the wind;
- Stability of the atmosphere;
- Solar radiation.

The wind direction determines the path of the pollutants. On very short terms, less than one hour, the direction may remain constant. During longer periods the wind direction generally changes, especially if the wind is weak. Many different sources can cause strong and sudden variations of the wind direction: the passage of a synoptic meteorological system, season variation or even the change from day to night.

The dispersion of the discharge from a polluting source depends strongly on the variation of the wind direction, during the period considered. The information on the statistical distribution of wind is therefore extremely important for the forecast of air quality.

The wind velocity determines the mixing of pollutants with the air of the environment. This mixing is caused by the air turbulence that is greater for greater wind velocities, and causes a dilution of the pollutant. Generally the pollutant concentration is inversely proportional to wind velocity.

The atmospheric stability is a general indicator of the quantity of vertical and horizontal movements occurring in the atmosphere, and therefore it is also an index of the existing "potential dispersion effect".

As far as the pollutant dispersion is concerned, a stability index was defined by Pasquill (1961) as a function of different parameters such as wind velocity, solar radiation and cloud covering, and it is characterized by lateral and vertical dispersion coefficients.

These indexes (called also categories) vary from A (very unstable) to D (neutral) up to F (very stable) and represent the atmospheric conditions that improve increasingly the movements of the pollutant gases, independently from dilutions due to vertical or horizontal dispersion.

The solar radiation, besides affecting atmospheric stability, induces photochemical reactions in the atmosphere itself. Such reactions are related to many different kinds of chemical compounds, including hydrocarbons and NO_x, and can produce a range of photochemical pollutants, including the peroxiacetylnitrate (PAN) and, more commonly, ozone (0_3).

f. SCREEN 3 Model Characteristics

To evaluate the ground level concentration of H_2S in the surroundings of the geothermal power plant, the SCREEN3 short-term dispersion Model (3.5.0 version) developed by EPA has been used.

SCREEN3 uses a Gaussian plume model that incorporates source related factors and meteorological factors to estimate pollutant concentration from continuous sources. It is assumed that the pollutant does not undergo any chemical reactions, and that no other removal processes, such as wet or dry deposition, act on the plume during its transport from the source.

SCREEN3 performs short-term calculations estimating:

- The maximum hourly ground-level concentrations at various distances from the source, incorporating the effects of building downwash on the maximum concentrations for both the near wake and far wake regions;
- Concentrations in the cavity recirculation zone;
- Estimating concentrations due to inversion break-up and shoreline fumigation;
- Determining plume rise for flare releases.

The model can incorporate the effects of simple elevated terrain on maximum concentrations, and can also estimate 24-hour average concentrations due to plume impact in complex terrain using the VALLEY model 24-hour screening procedure.

The SCREEN model can also calculate the maximum concentration at any number of user-specified distances in flat or elevated simple terrain, including distances up to 100 km for long-range transport.

SCREEN examines a range of stability classes and wind speeds to identify the "worst case" meteorological conditions, i.e., the combination of wind speed and stability that results in the maximum ground level concentrations.

The SCREEN model results also include the effects of buoyancy-induced dispersion (BID). The inclusion of BID in SCREEN may either increase or decrease the estimated concentrations, depending on the source and distance. For elevated sources with relatively large buoyancy, the inclusion of BID may be expected to decrease the estimated maximum concentration by as much as 25%.

g. Case Study Description

As stated in previous paragraphs, the simulation has been performed considering the conservative assumption that the physical absorption of gaseous H_2S by the liquid stream leaving the flash separator and by the cooling water stream is negligible. Consequently we suppose that the whole content of H_2S in the geothermal fluid will be emitted in the atmosphere, being mixed in the outlet air flow of cooling towers

Input Source data for the modeling simulation are the followings:

- Air flow rate: 4,000,000 m^3/h;
- H_2S Emission rate: 44.4 g/s;
- Emission source height: 10 m;

- Air exit velocity: 8.7 m/s;
- Air flow temperature: 40 °C;
- Ambient temperature: 28 °C.

The simulation has been conducted considering a simple flat terrain screening option and activating the “Full Meteorology” (all stability classes and wind speed) choice. The maximum ground level concentrations of H_2S were estimated on fixed discrete receptors located at various distances from the source to a maximum distance of 10 km.

h. Results of the Simulation Model

The following Table 9.6-6 shows the maximum hourly ground level concentrations at each receptor considered in the simulation.

We specify that the choice to use the "Full Meteorology" option allows the model to examine all the six stability classes (five for urban sources) and their associated wind speeds. Using full meteorology with the automated distance array (from the source to 10 km), SCREEN provides the 1-hour maximum concentration for each distance computed.

Rec. No.	**Distance from source (m)**	**Max hourly concentration (μg/m^3)**
1	1	0.0
2	100	8.8
3	200	9.2
4	300	51.0
5	400	125.9
6	500	177.0
7	600	199.0
8	700	202.0
9	800	194.8
10	900	183.0
11	1000	169.9
12	1100	156.9
13	1200	145.1
14	1300	134.4
15	1400	124.7
16	1500	117.1
17	1600	111.3
18	1700	105.8
19	1800	100.6
20	1900	95.7
21	2000	91.1
22	2100	86.8
23	2200	82.8
24	2300	79.0
25	2400	75.5
26	2500	72.3
27	2600	70.4
28	2700	68.5
29	2800	66.7
30	2900	64.9

31	3000	63.1
32	3500	57.7
33	4000	61.4
34	4500	63.5
35	5000	65.3
36	5500	67.2
37	6000	68.6
38	6500	70.1
39	7000	71.6
40	7500	72.8
41	8000	73.7
42	8500	74.3
43	9000	74.7
44	9500	74.9
45	10000	75.0

Table 9.6-6: Maximum 1-hour Ground Level Concentration (μg/m^3) at Discrete Receptors

Looking at Table 9.6-6 it is clear that the highest H_2S hourly concentrations occur in the range of 500 m to 900 m from the source; in particular, the maximum concentration is 202.5 μg/m^3 at a distance of 670 m.

It should be noted that the model output concentrations are hourly based, so the comparison between these values and the air quality threshold of 150 μg/m^3, which is based on 24 hour averaged concentration, could be not representative.

In spite of this, we can conservatively compare them and see that the H_2S fallout is generally below the limit admitted and, for the receptors where it is exceeded, we have to take under consideration all the conservative assumptions adopted in this study, including having considered the total amount of H_2S as dispersed through the cooling towers (i.e. without considering the fraction dissolved in water), and having neglected the wet H_2S removal from air due to the rainfalls, which is an important mitigation factor in pollutants air dispersion. In Dominica it is well known that the rainfall is heavy, so we can predict that the ground level concentrations will be actually lower than the model estimated value.

In any case, and for each distance from the power plant, the ACGIH time-weighted average (TWA) threshold limits value (TLV) for people (1.4 mg/m^3) is complied with, even more considering the fact that this comparison is conservative because the TLV-TWA is referred to an 8 hours exposure.

In case a more in-depth analysis would show that the ground level H_2S concentrations would exceed the odour threshold concentration stated by CAAQS; it may be necessary to evaluate whether to provide an H_2S abatement system or any other kind of mitigation measures to the power plant.

9.6.5 Induced Seismicity

Geothermal resources are generally located in areas of high heat flow along thinning crustal zones. Thus areas which are geothermally active also have a high likelihood of being seismically active. The major concern with induced seismicity is the potential for injury and loss of life as well as property damage resulting from an earthquake.

Although there is a debate about the possible relationship between geothermal activity and seismicity, some of the geothermal countries involved in reinjection of residual fluids set up microseismic monitoring system capable of detecting seismic events even if of very small magnitude. Permanent microseismic control networks are reported to be used in Italy and Japan, with the objective to interrupt reinjection, in case seismic activity exceeds some prefixed values

Episodes of induced seismicity are in principle possible in geothermal fields when reinjection is operating: reinjection may in fact open and lubricate existing fractures causing increased seismic activity. Induced seismicity is more probable when high overpressure acting at reservoir level is necessary to maintain reinjection activity.

As a general rule, in most of geothermal fields such as the present one the fluids circulation takes place without causing overpressures, as typical of the EGS (Enhanced Geothermal Systems) projects, which aim to create an artificial reservoir by injecting large volumes of water under pressure into hot, low permeability rocks, in order to induce slipping and enhance permeability of pre-existing fractures. It should be noted at any rate that even in the EIGS projects no cases are known of earthquakes induced by stimulation or high pressure injection, bringing about significant damages.

A review of the international experience relevant to induced seismicity in geothermal field has been recently carried out by Bromley (ref. Bromley C. "*Geothermal Induced Seismicity: Summary of International Experience*". IEA-GIA Environmental Mitigation Workshop Taupo, 15-16th June 2012). The main conclusions derived from Bromley on the review of the induced seismicity in geothermal fields at worldwide level are the following:

"Out of the hundreds of conventional geothermal reservoirs developed at worldwide level, only a few caused induced seismic events with a magnitude felt by people, during the normal operations of fluids extraction and reinjection. These events did not affect the operations in the reservoir."

"The experience shows that the induced seismic events are generally of small magnitude. Anyway, due to their shallow depth, the largest events are sometimes felt at surface, creating in some cases a public concern. This concern derives from the idea that larger events, possibly destructive, may take place as a consequence of future geothermal activities. At any rate, as of now there are no examples of significant damages caused by induced seismic events, wherefore the possibility of an increase of earthquakes does not generally constitute an important public concern, unless this perception is enhances by the press."

"Moreover, the frequencies generated by induced seismic events, typically in the range 100-300 Hz, are normally too high to cause structural damages, which require a frequency of <10 Hz".

9.6.6 Subsidence

Subsidence means sinking of part of the earth crust and may be caused by compaction of the soil and rock underlying an area following removal of a geofluid (oil, gas, ground water or geothermal fluids). In geothermal energy development, the main factors that influence subsidence potential are:

1) power plant design and operation, as they affect the distribution and quantity of withdrawal and of injection of the fluids

2) site geologic structure and geohydraulic characteristics.

Subsidence can take place under varied circumstances of geology, hydrology and tectonics, but it occurs most often when fluid is withdrawn from an aquifer which consists of a porous medium in compressible and / or fractured formations.

One of the best known examples of such subsidence occurred at Wilmington oil field (California), where vertical and horizontal displacement reached 8.2 and 3.7 m, respectively, while in geothermal energy field the most known example is Warakei (New Zealand), where subsidence rates of 40 cm/yr were reported.

High temperature vapour dominated sites are not as subject to subsidence, since the rock units in the reservoir must be competent in the first place. Even though this is generally true, a small subsidence rate is reported at the Geyser (2- 4 cm/yr).

On the contrary, in geopressured reservoirs subsidence is almost a certainty. Geopressured zones have such a high subsidence potential because the thick sedimentary sequences in which they are found are undercompacted and the water trapped in these sequences actually bears part of the lithostatic load. Withdrawing the water from a geopressured reservoir allows compaction of these rock units and results in subsidence. Steam dominated reservoir (the Geysers and Larderello) represent the two end of the spectrum. The resources with characteristics between these extremes will have variable potential for subsidence, depending on geologic structure and reservoir rock potential for compaction.

The plant design and withdrawal and reinjection strategies will determine the rate and the amount of subsidence.

A site specific monitoring might be useful to distinguish subsidence caused by geothermal development, other activities of man and natural subsidence.

Monitoring should start before geothermal development and continue throughout the development of resource. However methods of monitoring subsidence in geothermal areas are limited. For example temperature may be the limiting factor in instruments to measure changes at depth.

Furthermore a very good control technique may be employed to limit the amount of subsidence.

All the operators agree that reinjection of the withdrawn fluids is a viable control method and that it will limit the amount of subsidence experienced at and around the resource.

The developer of geothermal energy should any way account for subsidence in the design of the geothermal plant and field for both environmental and economic reasons.

For the specific case of the Wotten Waven geothermal field, the depth of the reservoir, the nature of the rocks and the (small) quantity of tapped fluid lead to exclude the possible occurrence of any significant subsistence phenomena.

9.6.7 Potential effects of geothermal exploitation on hydrothermal manifestations

Concern has been expressed by the local population on the effects that the operation of the geothermal plant can have on the hydrothermal manifestations (hot springs, fumaroles and spas), which dot the Roseau Valley. Such concern rests over a sound base, inasmuch as extraction of fluids, especially if from shallow depths, may reduce the pressure of the reservoir, thus limiting the possibility of feeding the surface manifestations and determining their reduction, as observed in several geothermal fields throughout the world.

In the specific case of Wotten Waven, the development foresees that fluids extraction shall take place in the Laudat sector, where the reservoir occurs at a relatively large depth and at fairly large distance from the manifestations, and that only a small fraction of the potential resources shall be exploited. Under these conditions, the possibility that the surface manifestations will be negatively affected by the plant operation is deemed to be negligible. However, the problem should be carefully assessed in the future, should the fluids extraction move southwards (that is closer to the manifestations and in a sector where the reservoir becomes shallower) and should the extent of fluids extraction become more significant.

10. COST ESTIMATE

10.1. Capital Expenditures (CAPEX)

10.1.1 General

The capital expenditures for the project include the following main components:

1. Drilling and testing of production and reinjection wells;
2. Fluid Gathering System from well pads to power plant including all civil works;
3. Power plant facilities including all civil works;
4. 20 kV Transmission line to the grid connection point.

A breakdown of capital expenditures for each of the above project components is given in the tables below from 10.1 to 10.5.

Allowances have also been considered in the cost estimates for the following items:

1. Land Acquisition and Rights of Ways;
2. Project management;
3. Contingencies.
4. Engineering Services

Engineering services and project management costs will not be included in the financial analysis because they are assumed to be covered by grants. Therefore for the items analyzed two tables have been included one with and one without the engineering cost (including supervision) and project management

10.1.2 Drilling and Testing of Production and Reinjection Wells

This item includes the cost of drilling and testing of the five planned production and reinjection wells and of the relevant Supervision services.

These costs are based on the actual prices of the Contracts in force with Iceland Drilling, ISOR and GRG respectively, and on the assumption that all the five wells will be drilled consecutively under the same contractual conditions of the two wells (WWP1 and WWR1) already committed.

Drilling of Production and Reinjection Wells (US$x1000)	
	total cost
Drilling of WW P1 (deviated)	3000
Drilling of WW P2 (deviated)	3000
Drilling of WW P3 (deviated)	3500
Drilling of WW R1 vertical	2500
Drilling of WW R2 (deviated)	3000
Well Testing	1000
Supervision	700
Total Cost of wells	**16700**

Table 10.1 - Drilling and testing Expenditures

10.1.3 Fluid Collection and Reinjection System

This item includes the whole system from the wellhead to the power plant and to the reinjection wells. The relevant cost, split in its components, is based on quantities and types of materials estimated from the technical indication of Chapter 8, is summarized in the following Table 10.2.

Fluid Collection and Reinjection System				*(US$x1000)*
Materials (Price FOB**)**				
	Ø	**US$/m**	**quantity**	**total cost ($x1000)**
Steel Pipes	30"	500	50	25
	22"	400	70	28
	16"	300	2500	750
	12"	200	80	16
Control valves	**type**	**US$/unit**	**quantity**	
	30"	180000	1	180
	22"	120000	2	240
	16"	60000	2	120
Vessels	separator	140000	2	280
	silencer	60000	1	60
	water tank	60000	1	60
Pumps	5 kW	5000	1	5
	30 kW	10000	1	10
Total cost of materials				1774
Shipping, civil works, erection, engineering, etc.				1500
Contingencies				500
Total				**3774**

Table 10.2 - Fluid Collection and Reinjection System (FCRS)

10.1.4 Cost of the Power Plant

As discussed in Chapter 6, the option selected is a power plant of 4 x 3.5 MW condensing units to be installed in 2 groups of two units with a delay of one year in their manufacturing and installation.

Units of comparable size have been already manufactured and are operating in small islands. They require limited supporting structures and minor civil works.

4 x 3.5 MW Units Power Plant (US$x1000)	
Cost Items	**total cost**
Land acquisition, access roads and site preparation	1000
Electromechanical equipment (supply, FOB)	21000
Electromechanical equipment (transportation and erection)	4000
Civil Works	2000
Engineering	2000
Contingencies	2000
Total Cost of Power Plant	**32000**

Table 10.3 - Capital Expenditures for the Power Plant

10.1.5 Transmission network update

The operation of the SGPP would require a relatively complex transmission network update that will partially overlap with the already expected extension of the network.

Indeed the double circuit distribution lines at 33 kV connecting Roseau (Western side of island) and Rosalie located in the Eastern side is already scheduled and it shall not be considered a project cost.

The process of evaluating the set of measure necessary will depend on DOMLEC and IRC technical and financial agreement.

Anyway the cost of the transmission network update is not a direct financial cost of the project.

Details of the current transmission network and of the latest, though preliminary, system update projection are in the annexes.

10.1.6 Summary of Capital Expenditures

The Capital Expenditures of the cost items for the two alternatives considered are summarized in the following Table 10.4.

3 x 3.5 MW Summary of Investment Cost (Million US$)	
Cost Items	
Drilling ad Testing of Production and Reinjection Wells	16.70
Supply and Erection of Fluid Gathering System	3.77
Supply and Erection of Power Plant	32.00
Upgrade of Transmission Line [not included in the financial cost]	9.00
Project Management	2.00
Total Cost of the Project	**63.47**

Table 10.4 - CAPEX of the 4 x 3.5 MW Power Plant

10.2. CapEx Contingencies

The innovative type of project for the Dominica electricity sector actors, the non repetitively and intrinsic nature of the geothermal projects as well as the relatively high value suggest a relatively high estimate for contingencies equal to 15% of the overall CapEx.

10.3. Operation & Maintenance (O&M) Cost

Operation and maintenance costs for the power plant and associated steam field facilities (wells, fluid gathering system) consist of the following components:

1. Fixed O&M costs
2. Major plant overhaul costs
3. Make up well costs

Fixed O&M costs include Operator general costs such as insurances, salaries for general staff, costs for routine steam field maintenance and head office expenses.

Routine steam field O&M costs include such items as periodic well measurements as well as maintenance of roads, wellpads and pipelines.

In our case the fixed O&M costs are estimated at US$ 1.5 million per year

Major plant overhaul costs are incurred on average every 4 years and involve the inspection of the entire power plant and fluid gathering system facilities expected to last about 3 weeks per unit and assumed to be carried out in sequence for all the four units. The cost for the overhaul is estimated in 150,000 US$ per unit with a total cost of US$ 0.6 million,

Make Up well costs will be incurred over the life of the plant. Assuming an average production decline of 3% per annum, to maintain the 15 MW generation capacity plus 10% reserve margin 5 wells shall be drilled during the 30 years life of the field at an estimated cost of US$ 4 million per well. Work-over of the reinjection well every time a new make up well is drilled, should allowed for, at a cost of US$ 1 million per well.

The O&M costs discussed above are summarized in Table 10.6 for the expected 30 year plant operating life.

4 x 3.5 MW Power Generation Project O&M Cost (US$ million)					
YEAR	**O&M Cost**	**Plant Overhaul**	**Make Up Wells**	**Reinject. well Workover**	**Total E&M Costs**
1	1.50				1.50
2	1.50		4.00	1.00	6.50
3	1.50				1.50
4	1.50				1.50
5	1.50	0.60			2.10
6	1.50				1.50
7	1.50				1.50
8	1.50				1.50
9	1.50				1.50
10	1.50	0.60			2.10
11	1.50				1.50
12	1.50				1.50
13	1.50		4.00	1.00	6.50
14	1.50				1.50
15	1.50	0.60			2.10
16	1.50				1.50
17	1.50				1.50
18	1.50				1.50
19	1.50	0.60			2.10
20	1.50				1.50
21	1.50				1.50
22	1.50				1.50
23	1.50	0.60	4.00	1.00	7.10
24	1.50				1.50
25	1.50				1.50
26	1.50				1.50
27	1.50	0.60			2.10
28	1.50				1.50
29	1.50				1.50
30	1.50				1.50
	45.00	3.60	12.00	3.00	63.60

Table 10.5: O&M Costs

11. ELECTRICITY MARKET

11.1. Existing Generation Facilities

The primary electrical load centers in Dominica consist of the cities of Roseau and Portsmouth and their surrounding areas. DOMLEC has installed electric generating capacity consisting of two diesel electric power plants which burn light distillate diesel fuel and three small hydro power plants.

The generation facilities of Dominica's power system are indicated in detail in the Table 11.1, provided by DOMLEC, representing the situation at the date of October 23, 2012, in a period of heavy rains.

Dominica Electricity Services Limited
GENERATION PLANT STATUS REPORT
October 23 2012

PLANT LOCATION	UNIT	CAPACITY INSTAL. (MW)	CAPACITY AVAILAB. (MW)
DIESEL UNITS			
FOND COLÉ	FC1	0,60	0,60
	FC4	0,75	0,60
	FC5	2,84	2,50
	FC6	1,75	1,50
	FC7	1,40	1,20
	FC8	1,40	1,30
	FC10	1,46	1,46
	FC11	1,46	1,46
	FC12	1,46	1,46
SUB-TOTAL FOND COLÉ		13,12	12,08
	SL3	1,35	1,00
	SL4	1,40	1,20
	SL5	1,40	1,20
	SL6	1,28	1,10
	SL7	1,40	1,20
SUB-TOTAL SUGAR LOAF		6,83	5,70
TOTAL DIESEL		19,95	17,78
HYDRO UNITS			
LAUDAT	LD1	1,24	1,00
NEW TRAFALGAR	NT1	1,76	1,76
	NT2	1,76	1,76
SUB-TOTAL NEW TRAFALGAR		3,52	3,52
PADU	PD1	0,94	0,70
	PD2	0,94	0,70
SUB-TOTAL PADU		1,88	1,40
TOTAL HYDRO		6,64	5,92
GRAND TOTAL		26,59	23,70

Table 11.1 - Generation facilities of Dominica

DOMLEC's three hydroelectric plants are arranged in series with Laudat Station located at the highest elevation, New Trafalgar at the intermediate position and Padu at the lowest position. Laudat is fed by a lake that provides flexibility for Laudat to be shut off for up to 24 hours while the level in the lake rises. Through this water storage option, Laudat can be taken off line during low demand periods and brought online during peak demand periods to shift generation timing without simply wasting the water energy through a bypass. New Trafalgar and Padu use the water that flows from Laudat as well as from other rivers that combine with the Laudat flow. As a result, Trafalgar and Padu are "run of river" generators that operate on a continuous basis without having the option to shift generation output to meet peak demand.

The installed hydro generation provides the least cost option for Dominica's power generation. As a result, the introduction of geothermal generation should be sized and operated to best take advantage of the hydro capacity and the flexibility that it provides for shifting power production between on and off peak hours and for load following.

11.2. Power System Characteristics

The situation of Dominica power system is completely described in this paragraph (Operating Statistics) extracted from Domlec Annual Report of the year 2011

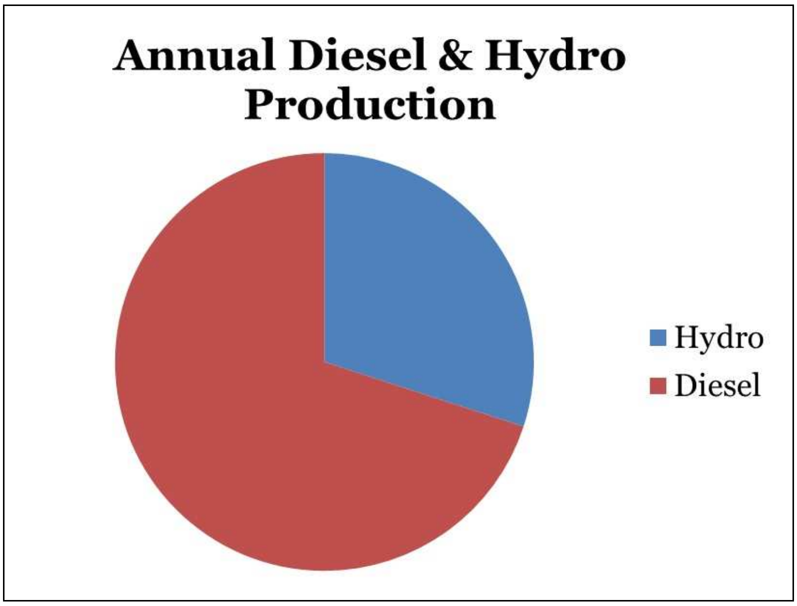


Figure 11.1 - Annual Diesel and Hydro Production in Dominica

DOMINICA ELECTRICITY SERVICES LIMITED

OPERATING STATISTICS (CONT'D)

ENERGY SOLD (kWh x 1000)	**2011**	**2010**	**2009**	**2008**	**2007**
- Domestic	**40,419**	39,473	36,369	34,051	33,732
- Commercial	**37,858**	35,537	32,280	30,278	28,788
- Industrial	**7,560**	7,449	7,877	6,004	5,600
- Hotel	**1,654**	2,769	2,339	2,028	2,002
- Lighting		0	0	0	1
- Street Lighting	**1,621**	1,547	1,443	1,325	1,298
Total	**88,842**	86,775	80,308	73,686	71,421
Growth (%)	**2.4**	8.1	9.0	3.2	2.7
OWN USE & LOSSES (kWh x 1000)					
Power Station Use	**2,714**	2,938	2,642	2,630	2,696
Office Use	**541**	540	522	559	451
Losses	**8,383**	8,928	9,249	10,623	11,814
Losses (% of Gross Generation)	**8.3**	9.0	10.0	12.1	13.7
Losses (% of Net Generation)	**8.6**	9.3	10.3	12.5	14.1
NUMBER OF CUSTOMERS AT YEAR END					
- Domestic	**29,838**	28,984	25,904	29,183	28,388
- Commercial	**4,027**	3,907	3,567	4,287	4,132
- Industrial	**29**	28	30	30	27
- Hotel	**28**	571	477	429	392
- Lighting		0	0	2	2
- Street Lighting	**469**	496	571	430	364
Total	**34,391**	33,986	30,549	34,361	33,305
Growth (%)	**1.2**	11.3	(11.1)	3.2	4.1

Table 11.2 - Operating statistics of Dominica power system

11.3. Characteristics of Load Demand

Base Year 2011 System Data				
Month	Demand in MW			Energy MWhs
	Minimum	Average	Peak	
Jan	5.74	10.53	13.86	7,854
Feb	7.53	11.00	14.46	7,393
Mar	4.83	11.04	15.33	8,215
Apr	7.44	11.06	15.37	7,960
May	7.06	11.65	16.73	8,665
Jun	8.33	12.39	16.89	8,923
Jul	7.06	11.84	17.33	8,809
Aug	4.00	11.51	16.21	8,560
Sep	4.99	11.72	16.56	8,440
Oct	8.24	12.05	16.76	8,963
Nov	7.74	11.86	16.22	8,537
Dec	7.10	10.92	15.89	8,127
			Total:	**100,445**

It is important to note that while in the year 2011 electrical system ranges from an annual low hourly demand of 4 MW to an annual high hourly demand of 17.33 MW more recent projection carried out by DOMLEC show higher low demand. This wide variation in demand presents significant problems from a perspective of system reliability and the amount of power absorption that can be attained when introducing a SGPP-Domestic into Dominica's electrical system.

The analysis of load curves which shows the percentage of time over the course of a full year that the demand exceeds a given value is shown in the annexes.

This analysis projects the impacts of load growth and demand growth. From this curve it is possible to then determine what plant is to be dispatched to what extent over the course of a typical year depending on the demand scenario.

Figure 11.2 illustrates the wide variation that occurs in Dominica's daily electrical demand. This is indicative of the wide daily demand swings that must be contemplated when evaluating the technical absorptive capacity as well as the commerciality based on ability to dispatch, when introducing new generation capacity.

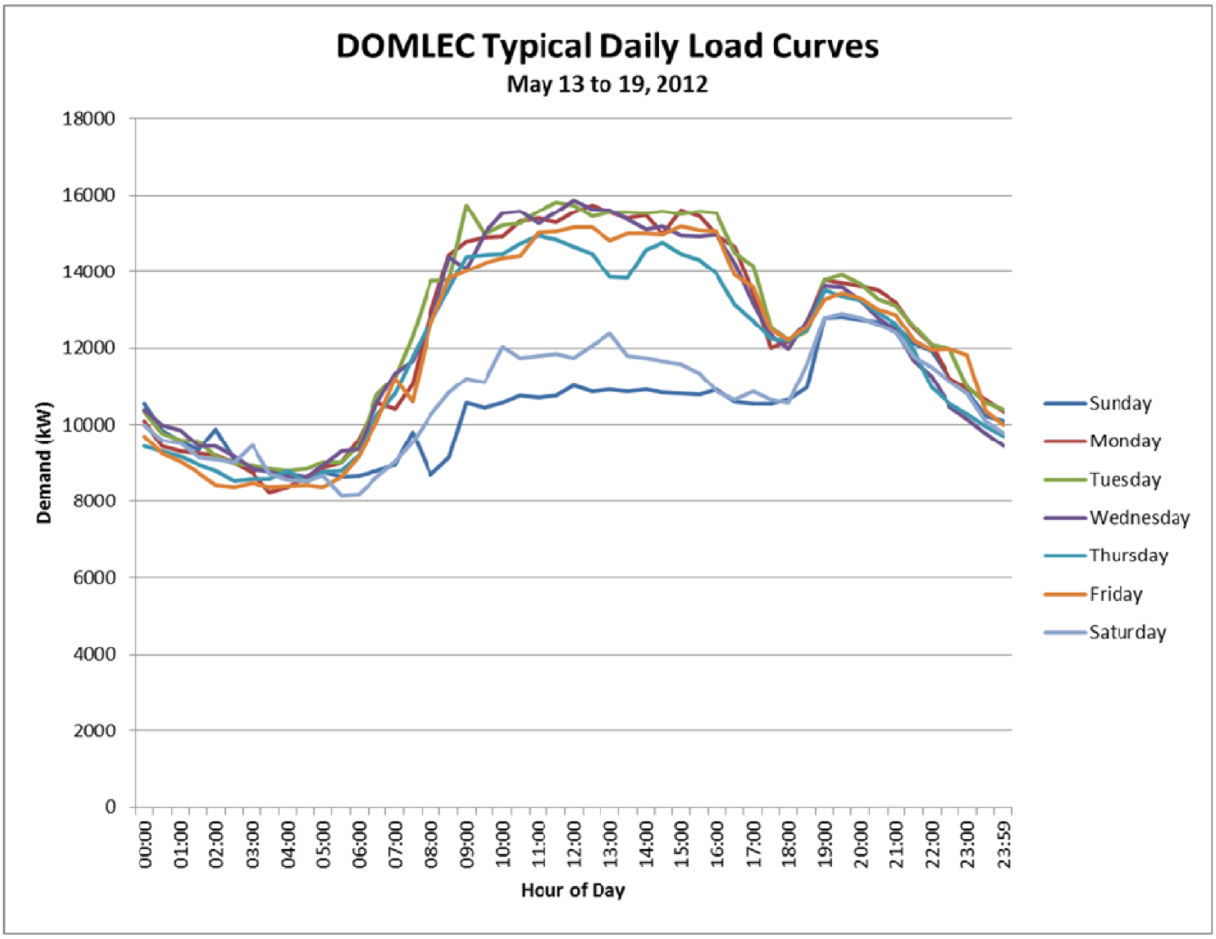


Figure 11.2 - Typical Daily Load Curves

11.4. Unserved Demand

ICR and DOMLEC have similar estimation for the nature and the level of unserved demand.

While the number of unserved potential customers due to unavailability of the network or of electricity to supply the network is assumed to be totally negligible, there is a peak demand of 3.4 MW relevant to big customers deeming to be in the condition to generate electricity with large diesel unit at a price lower than the one charged by DOMLEC. Among them: Colgate Palmolive DCP, Dominica Coconut Products, Hotel Fort Young and Hotel Garraway.

ICR estimates the total available capacity of reciprocating engines for self generation to the high value of 27/28 MW, most of them not in operation since several years and purchased at the time when DOMLEC service was unsatisfactory.

A significant part of such self generation may be recovered to DOMLEC when the geothermal development will reduce DOMLEC average generation mix cost and consequently tariff.

11.5. Tariff Structure and Level

DOMLEC tariff structure is relatively simple: a monomial cost per kWh.

Monomial basic tariff (i.e. without fuel surcharge) breakdown sees 45% of the tariff justified by generation cost while the remaining 55% covers transmission, distributions and supply. The proportion is more than reversed considering variable fuel surcharge.

The cost per kWh in August 2013 was approximately 43 cents of US$ per kWh with a basic tariff of 67 cents of West Caribbean Dollar per kWh and a fuel surcharge of 41 cents of West Caribbean Dollar per kWh.

The same surcharge, linked to the variable cost of diesel oil and to the availability of water for the hydropower plants, was only 33 cents of West Caribbean Dollar per kWh three months earlier.

11.6. Geothermal Power Plant Electrical System Load Tracking

A geothermal power plant is designed to load track (or load follow) the electrical system demand; however, unless specifically designed in an alternative way, it usually requires that the geothermal steam be vented to the atmosphere through a valves and rock muffler when system demand drops below the design output of the generator. This requirement is dictated by the need to keep a relatively constant pressure in the geothermal wells while more or less steam is sent to the steam turbine to match generated output with system demand.

Instead this feasibility study adopts and alternative technology, i.e.: 4 x 3.5 MW condensing units with steam bypass to the condenser and 10% overload for one hour.

Geothermal load tracking requirements will marginally increase the cost of the geothermal steam power plant. This solution has been preferred in this specific case to the production trimming valves on the well pads due to the necessity to avoid undesired consequences for the production wells.

In this case it does result in the energy being wasted through turbine bypass, although for a small plant on a large resource this is not normally an issue. However, it drives up the levelized cost of electricity for the overall geothermal operation, as previously noted (while preventing environmental issues associated with noise and release of steam into the atmosphere). The capability of the SGPP-Domestic to track load will have a significant influence on how effectively the SGPP-Domestic can be integrated with the electrical system.

11.7. Unit sizing criteria

For system stability and preventing a cascading blackout, no single unit should be larger than 20% of the system load. Applying the so called the N-2 calculation for Firm Capacity, the new Power Plant is designed to supply maximum load when the two largest units are down.

Furthermore there an adequate spinning reserves on the system shall be foreseen, equivalent to the largest dispatched unit to ensure reliability of supply and the daily load curves shows that the power demand is extremely variable between day, night, working and non-working days, so units are designed to guarantee a flexibly operation and possessing the all the technical features to be “turned down”.

Starting from actual demand data, system reliability can be maintained through typical spinning reserve requirements after which power absorption can be optimized by using multiple geothermal generators instead of a single generator. However the need to use hydroelectric generation to provide spinning reserve when hydro constitutes least cost generation is an additional issue that may be taken into consideration.

The value of maintaining high reliability in conjunction with high SGPP-Domestic power absorption rates was weighed against the installation of multiple turbine generators that can increase the overall SGPP Domestic project costs by 30% to 45%. In addition, installing multiple units will allow for some staggering of the installation of power generation units until the production steam availability is confirmed and also to accommodate increased consumer demand.

Both IRC and DOMLEC at this stage of project development prefer such solution.

Using typical spinning reserve requirements to maintain electric system reliability will significantly affect the amount of geothermal, hydro, and diesel generation that can be absorbed when using multiple smaller generators. Using typical spinning reserve requirements and multiple smaller geothermal generators reduces kWh cost of electricity by improving geothermal and hydroelectric absorption rates while reducing costly diesel generation. However, the use of multiple generators also increases the cost of the geothermal power plant and consequently the cost per kWh generated.

Considering hydroelectric plants as the least cost form of generation, it is reasonable to assume that the proposed geothermal plant would theoretically not be used to offset the hydro generation. However limited offset of hydropower generation may be envisaged to maintain more geothermal units in operation and avoid quite more expensive operation of diesel units.

Ministry IRC and DOMLEC supported by Elc Electroconsult are working to practical scenarios; latest revisions are in the annexes.

The analysis of the electric demand and the requirement of the grid suggest that a plant of about 14 MW consisting of 4 x 3.5 MW units would be a practical size. Additional capacity above this would need to be studied carefully and in the framework of recovering demand presently served by self generators.

Generation mix and dispatching rules shall allow for minimal operation of existing diesels.

Sufficient diesel capacity should be retained to meet the full demand in the event that the entire geothermal operation has to be shutdown. Contingency fuel supply arrangements will need to be made to ensure that fuel can be supplied at short notice in such an event.

12. FINANCIAL ANALYSIS AND DEVELOPMENT PERSPECTIVES

12.1. Context and Long Term Perspective

The Ministry of Public Utilities, Energy and Ports, Commonwealth of Dominica West Indies intends to develop this SGPP to guarantee the benefit to the country of a lower electricity tariff in the short terms while ensuring the long terms economic benefit for the country that may be obtained developing the overall project without the risk that the SGPP would interfere with the latest.

Therefore the Ministry has a clear preferred financial option for the development of Wotten Waven Geothermal Field: financing the bulk of the development with concessionary loan, as per IMF definition, while involving experienced private operators through a management contract for operation and maintenance.

The scenario would reach its optimal configuration if the [same] private operator assumes a limited role in financing capital expenditure and he has at least an interest to be one of the potential developed of the full scale project.

Such limited role in financing capital expenditures shall not give him the right to interfere with the long terms.

12.2. Definition of the scenarios

Above consideration clearly define the terms of the base scenario.

A second scenario has been added partially because it is the more realistic of several other scenarios examined during previous draft partially because it has attracted the interest of some investor and / or Donor.

Instead this analysis prefers to avoid developing intermediary scenarios; at this stage of project definition they should not add so much value, reducing clarity (output would be in between the output of the two scenarios).

The scenarios are:

1 Utilizing concessionary loan and develop the project with a limited involvement of a private developer / operator ; [base scenario - mainly concessionary loan]

2 Involving private developer / operator without financing a biggest part of the investment with a mix of grant and concessionary credit: [scenario private developer/operator without Government supported soft loan]

The following table summarizes merits and consequences of the two scenarios:

Development Scenario	Merits	Consequences
Base scenario - mainly concessionary loan	Cheap financing option with positive effect on the cost of the kWh.	Evaluate economic consequences (economic benefit for the countries of alternative utilizations) at national level of the Government to dedicate limited access to concessionary loans to the geothermal project; Need to identify suitable concessionary loans; Opportunity to access geothermal dedicated concessionary loans; Need to evaluate development risk associated with public development.
private developer / operator without Government supported soft loan	Economic benefit for the country of alternative utilizations of the limited access to grants and concessionary loans for other economic sectors; Reduced development and operation risk.	Need to verify compatibility with IMF policy for the country; Very expensive financing option with negative effect on the cost of the kWh

12.3. Main Differential Input of the Different Scenarios

The following table summarize the main differential input utilized in the analysis; the figure of the interest is assumed here to summarize interest value itself as well as any other fee such as commitment fee, negotiation fee etc.

Development Scenario	Main Differential Input in the Analysis
mainly concessionary loan	20 years duration, 5 years grace period; 3% yearly interest
private developer / operator without Government supported soft loan	30% Equities at 20% expected remuneration 15 years duration, 8% yearly interest

12.4. Other Significant Input and Model Assumptions

All inputs of the model are clearly readable on the upper part of the model itself; nevertheless other significant inputs are listed here below:

Taxation: 30%

US Inflation (yearly): 3.0%

Depreciation (yearly): 3.3%

Interest during construction: capitalized until end of construction

12.5. Financial Costs considered in the analysis

The investment costs were already examined in the corresponding paragraph; it is just worth mentioning that costs include power units, steam and fluids field system and ancillaries, and transmission and distribution lines and related works.

12.6. Financial Costs Not Allocated to the Project

The financial analysis Reflect the associated transmission connection needs including a single connection to the existing system (proposed to be at Trafalgar, but may need to be into Fond Colé), since this cost will impact the final cost of electricity to consumers irrespective of whether it is born initially by the developer or the utility. A similar consideration should also be given to the cost of the increased transmission up to Portsmouth.

Include the incremental cost of maintaining system reliability in the domestic power system once the geothermal operation is commissioned, including load tracking, SCADA and other dispatching controls necessary to interface geothermal operations with DOMLEC as the system operator.

Transmission costs should be clarified as to who financially bears the costs.

12.7. Financial Sunk Costs

The financial analyses does not account for the sunk costs, which have been incurred by the GoCD until the current phase of development of the project. Indeed the Government considered such costs, almost entirely covered by grants, as a part of advancing the development to its current state.

12.8. Output of the Financial Model

The financial model and the relevant results developed to produce detailed evaluation of the various financing and partnership options are in the annexes.

It shall be noted that the theoretical cost recovery cost of electricity is the lowest theoretical tariff for developing the project; however market forces play an important role as in any business.

The main results box at the top of the model shows, among other, the FIRR of the 3 main cash flows, as per the WB guidelines for reporting project financial statement:

- Pre-Finance, Pre-Tax C.F. IRR
- Pre-Finance, Post-Tax C.F. IRR
- Equity IRR or R.O.E [in other words the Post-Finance, Post Tax C.F.]

Other financial indicators are:

- Debt-Equity Ratio (8/9)
- Average Debt Service Coverage Rate (AVG)

Instead the main possible findings for the cost of electricity and costs to Government are summarized in the following table.

Development Scenario	Preliminary Proposed Tariff	Other Costs to Government
public - mainly concessionary loan	6 / 7 US$ cents	The project pays the taxes.
private developer / operator without Government supported soft loan	12 / 13 US$ cents	The project pays the taxes.

12.9. Conclusions and Recommendations

As expected from a front end, capital intensive, technology the cost of financing plays an important role in defining cost recovery tariff.

The appreciation of the risk of not letting a private experienced developer / operator as well as the decision of dedicating limited concessionary loan to the project relies on the political level and on the availability of donors.

13. ECONOMIC ANALYSIS

13.1. SGPP base case

While a quantitative economic analysis is not included in this feasibility report it is worth mentioning that some economic costs shall be added to the costs considered in the financial analysis of the previous Chapter.

They are:

- Cost of updating the transmission network
- Cost of reducing the hydropower plants exploitation to extend operating hours / reducing the use of the turbine bypass of the geothermal units.

The use of indigenous resources versus the use of imported fuel represents an additional economic benefit.

The geothermal option should determine a comparative wider use of non local skilled labor compared with the diesel option; however such negative economic benefit shall be marginal.

No major differences can be identified in the different breakdown among imported goods vs. local good and works among the alternatives.

Same consideration applies to the economic value of the electricity that doesn't change among alternatives and doesn't see unserved demand that may suggest application of differential willingness to pay.

The proposed SGPP solution appears having clearly dominant characteristics compared with the two alternatives analyzed and described in the following paragraphs i.e. "do nothing" and "wait for the full scale development".

13.2. Do nothing alternative

The do nothing alternative would see an extension and partial replacement of the diesel units, possibly evolving toward a wider utilization of medium and low speed diesel and, at a later stage, of HFO.

This alternative will not erase the burden for the medium and long term sustainable development of Dominica represented by high cost of electricity.

13.3. Wait for the full scale development alternative

The approach to wait for the full scale development alternative would result into:

- loosing the economic benefit of reducing the risk related to the resource knowledge for the full scale development;

- delaying the achievement of the benefit of cheaper electricity, at the same time jeopardizing alternative investments in the sector, due to the uncertainty of the development schedule of the full scale alternative.

14. RISK ANALYSIS

Risk assessment, especially when it is inherent in a sector such as geothermal, is an essential part of a sound investment decision.

It is therefore important to evaluate the impact of risks on the overall development of the project.

This evaluation is especially important in this project because lowering costs of electricity generated from the geothermal project is a major reason for the GoD support for the proposed project.

The risk areas that should be considered include the following:

- Project performance (sponsor)
- Project Completion (delay)
- Project Completion (cost overruns)
- Project Completion (site availability)
- Technology
- Geothermal Resource
- Skilled labor
- Market
- Payment
- Finance (debt service)
- Finance (other)
- Accident / Loss
- Country Environment
- Country Environment (legal framework)
- Country Environment (expropriation)
- Country Environment (environment)

It shall be noted that some of these risks are more relevance and more impacting to the developer than to the government; however the table below refers to the base scenario i.e. the government lead development.
The table here below shows an analysis of the level of each of risk as well as a brief mitigation arrangement.

Risk	Level	Mitigation Arrangement
Project performance (sponsor)	Low	Experienced partner with percentage of equity
Project Completion (delay)	Medium	Design Supply and Erection Contract / Performance obligations with penalty clauses
Project Completion (cost overruns)	Medium	Contingency and escalation amount in the cost estimate
Project Completion (site availability)	Low	Land right agreement / Land use agreement
Technology	Low / medium	Tried and tested technologies
Geothermal Resource	Low / medium	Follow good practices and phased approach
Skilled labor	Low / medium	Training provided by equipment suppliers and technical advisors
Market	Low / medium	Long terms purchasing contract specifying minimum quantities and prices
Payment	Low	Direct assignment of part of buyer revenues / escrow account
Finance (debt service)	Low	Use "worst case scenario" for financial planning / escrow account
Finance (other)	Low	Use "worst case scenario" for financial planning / International Donor Expertise
Accident / Loss	Medium	Insurances policies / force majeure provisions
Country Environment	Low / medium	Clear policy framework
Country Environment (legal framework)	Low	Clear legal framework / clear rules for arbitration
Country Environment (expropriation)	n. a.	-
Country Environment (environment)	Low / medium	Independent assessment / Guidelines, monitoring and reporting,

A different and extremely tailored analysis of the risks and their impact would be necessary for the GoD in order to conduct a negotiation with the potential developer of the full scale project to achieve an optimal outcome for the country while providing equitable terms for the developer so they can secure a return that is commensurate with the associated risks. The ultimate objective of the risk analysis is to allocate the risks to the parties that are best able to absorb them; so the project can achieve a sustainable outcome on risk management.

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ANNEXES

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Physical Planning Act No. 5 (2002)

Environmental and Planning Regulations for Renewable Energy (2010)

Geothermal Resources Development Act (2013)

ANNEX 2: Transmission Network Upgrade and Generation Dispatching Projection

ANNEX 3: Two Scenarios Financial Analysis

ANNEX 1: **Electricity Supply Act No. 10 (2006)**

Physical Planning Act No. 5 (2002)

Environmental and Planning Regulations for Renewable Energy (2010)

Geothermal Resources Development Act (2013)

COMMONWEALTH OF DOMINICA

ARRANGEMENT OF SECTIONS

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GENERAL

COMMONWEALTH OF DOMINICA

ACT No. 10 OF 2006

I Assent

LS

NICHOLAS J.O. LIVERPOOL
President

18 th January, 2007.

AN ACT TO REGULATE THE GENERATION, TRANSMISSION, DISTRIBUTION AND SUPPLY OF ELECTRICITY SERVICES AND FOR PURPOSES CONNECTED THEREWITH; TO ESTABLISH AN INDEPENDENT REGULATORY COMMISSION; AND TO REPEAL THE ELECTRICITY SUPPLY ACT 1996 [NO. 21 OF 1996].

(Gazetted 25th January, 2007.)

BE IT ENACTED by the Parliament of the Commonwealth of Dominica as follows:

PART I
PRELIMINARY

1. This Act may be cited as the - Short title

ELECTRICITY SUPPLY ACT 2006.

Commencement.

2. (1) This Act shall come into force on such day as the Minister may, by Order published in the *Gazette*, appoint.

(2) Except for Part II, the Minister may appoint different dates for the commencement of different provisions or parts of this Act.

Interpretation.

3. In this Act -

"ancillary services" means services which may be required from time to time for system security and stability and which are identified in a transmission code;

"appointing authority" means the Minister responsible for Electricity;

"Board" means the Board of the Independent Regulatory Commission;

"bulk supply" means the wholesale supply of electricity by an electricity producer to another electricity power producer or to a distributor or to any electricity supplier;

"Chairman" means the chairman of the Board;

"Commission" means the Independent Regulatory Commission established under section 4;

"Company" means the Dominica Electricity Services Limited;

"consumer" means any person, supplied with electricity by the Licencee;

"distribution" means the transport of electricity by means of a distribution system;

"distributing and supply licencee" means a licencee who has been granted a licence to distribute, supply and sell electricity to (other licencees or) consumers;

"distribution code" means the distribution code required to be prepared for and maintained by a licensed distribution system operator pursuant to the terms of its licence, which code prescribes standard technical rules to be observed by all those connected to a distribution system for the use and operation of that system;

"distribution system" means the system which consists, wholly or mainly of low voltage electrical lines and electrical plant and which is used for conveying electricity from a substation to final consumers;

"distribution system operator" means the operator of the distribution system;

"electricity" includes electric voltage, electric current, electric energy and any like agency;

"electric line" means any wire or conductor used or to be used for the purpose of conveying, transmitting, or distributing electricity, together with any casing, coating, covering, tube, pole, stay-wire, bracket, pipe or insulator enclosing, surrounding or supporting the same or any part thereof and any transformer, switch-gear or other works or apparatus connected therewith for the purpose of conveying, transmitting or distributing electricity or transforming its voltage and together also with any building or structure required to accommodate any such transformer, switch-gear or other works or apparatus;

"Engineer" means the Engineer (Electrical) in the Public Service;

"Executive Director" means the person appointed pursuant to this Act to carry out the executive functions of and to manage the affairs of the Commission;

"exemption" means an exemption from the requirement to hold a licence issued by the Commission pursuant to this Act;

"generation licencee" means a licencee who has been granted a licence to generate electricity;

"Government" means the Government of the Commonwealth of Dominica;

"Government Electricity Inspector" means the official for the time being who is appointed Electrical Inspector in the Public Service;

"land" includes any land under whatever tenure held and any easement, servitude, right or privilege in or over land;

"local authority" means any city council, an urban council, Carib Reserve Council, a village council, or a town council;

"licence" means a licence issued by the Commission pursuant to this Act;

"licencee" means a holder of a licence issued under this Act and except where a contrary intention appears, includes the company;

"Member" means an appointed member, who may also be the Chairman, of the Board of the Independent Regulatory Commission;

"Minister" means the Minister responsible for electricity;

"month" means calendar month;

"person" means any individual, partnership, joint venture, association, trust, company or corporation;

"premises" means any land, building or structure;

"Region" means the countries of CARICOM, OECS or other sub-groupings of CARICOM or OECS; or other countries to be specified by regulation.

"regulated activity" means any activity pertaining to the generation, transmission, distribution and supply of electricity services that is regulated by the Commission.

"road" means any road or street or part thereof and includes all bridges, culverts, embankments, approaches, drains, verges, pavements, curbs, footpaths, parapets and other works or things, forming part of any road or street;

"self supply" means the supply of electricity by a person to himself, his employees or his business within his private or business premises;

"supply" means, in relation to electricity, a supply through electric lines to final consumers for consumption;

"system operation" means the technical operation of the integrated transmission grid and the dispatch of generation and other facilities interconnected to such grid;

"tariff" means any rate or charge filed with and approved by the Commission;

"transmission" means the transport of electricity by means of a transmission system which consists, wholly or mainly, of high voltage lines and electric plant and which is used for conveying electricity from a generating station to a substation, from one generating station to another such station, or to or from any interconnector or to a final customer; but does not include any such lines which the Authority may, from time to time, specify as being part of a distribution system;

"transmission code" means the code required to be prepared for and maintained by any licensed transmission operator pursuant to the terms of its licence which prescribes standard technical rules to be observed by all those connected to a transmission system relating to the connection to, and the use and operation of, that system;

"transmission licencee" means a licencee who has been granted a licence to transmit electricity;

"tree" includes bush or shrub;

"unit" means one kilowatt hour.

PART II
ESTABLISHMENT OF THE INDEPENDENT REGULATORY COMMISSION

Establishment.

4. (1) There is hereby established a body to be known as the Independent Regulatory Commission ("the Commission") for the electricity sector in Dominica and for the purpose of performing the functions and carrying out the duties conferred on it under this Act.

(2) The Commission -

(a) is a body corporate with perpetual succession;

(b) shall have the power to enter into contracts;

(c) may acquire, hold and dispose of movable or immovable property;

(d) may sue or be sued in its corporate name; and

(e) shall perform the duties imposed on it and may exercise the powers conferred on it under or in pursuant to this Act.

(3) The Commission may operate -

(a) as a separate Regulatory Commission for electricity in Dominica; or

(b) as part of a multi-sector Regulatory Commission for Dominica; or

(c) as part of a multi-jurisdictional regulatory body serving Dominica and one or more other jurisdictions in the region, each as designated by the appropriate legal authority in such jurisdictions in pursuance to an agreement between appropriate jurisdictions.

(4) When the Commission decides to operate as a Regulatory Commission as envisaged in subsection 3 (b) or (c) the Minister may by Order subject to affirmative resolution in Parliament set out the powers and duties of the Commission in respect of the exercise of the functions under the subsections referred to above to the extent that they are not provided for in this Act but are necessary for the effective performance of those functions.

Composition of the Board and Appointment of Members.

5. (1) There shall be appointed a Board which shall exercise and perform the powers and duties conferred on the Commission by this Act or any other Act and authorize all activities of the Commission.

(2) The Board shall consist of five members appointed by the Minister, and the Minister shall appoint one of the members as Chairman.

(3) The Board shall appoint a full-time Executive Director, subject to the approval of the Minister.

(4) All appointments shall be through the competitive and transparent procedure set forth in this section.

(5) The Board shall invite prospective candidates for the position of Executive Director by public advertisement.

(6) The Minister shall invite prospective candidates to be appointed as members of the Board by public advertisement.

(7) The short-listing, evaluation and selection of candidates for each member position shall be undertaken by the Minister, and for the position of Executive Director shall be undertaken by the Board. All reasonable efforts (including, where necessary, further advertising of positions) shall be made to ensure that an adequate shortlist of candidates is prepared for each position that is vacant.

(8) The shortlist made pursuant to subsection (7) shall, where feasible, contain a minimum of two names for the position of Chairman, for the position of Executive Director and for each other vacant position of a member of the Board.

(9) The Minister shall, from the shortlists prepared pursuant to subsection (8), make one appointment for each of the Board positions.

(10) Subject to subsection 12, the appointment of a person as a member of the Board shall be for a period of three years, which may be renewed for one further term of three (3) years.

(11) At least three months before expiration of such first term, the Minister shall by written notice inform the Member whether he is to be reappointed or not and if the member is not written to by two months his appointment will be automatically renewed.

(12) The first Chairman shall be appointed for three (3) years; two of the first Board Members shall be appointed for a period of one (1) year and the other two first Board Members shall be appointed for a period of two (2) years.

(13) The appointment of the Executive Director shall be for three years and may be renewed for three-year periods thereafter.

(14) Persons who have previously served as Members for two consecutive terms are eligible as candidates for a

Member's position following a minimum period of three (3) years since the termination of their second term of the consecutive period.

Terms and conditions of Employment.

6. (1) The Minister shall determine the terms and conditions of employment of Board members in consultation with the Minister for Finance.

(2) The Minister shall publish the terms and conditions determined under subsection (1) in the Gazette and two local newspapers circulating in the State and other media as he thinks fit.

(3) The Board shall determine the terms and conditions of appointment of the Executive Director, subject to the approval of the Minister.

(4) The Board shall determine the terms and conditions of employment of other staff in consultation with the Executive Director.

(5) Appointments to the positions referred to in subsections (3) and (4) shall be by advertisement.

Qualification of Board Members.

7. (1) The Minister in appointing members of the Board, shall appoint persons who collectively have substantial experience and sound qualifications in as many as possible of the following areas: industry, commerce, law, accountancy, economics, engineering, electrical technology; information technology; and in any other field of experience relevant to the regulation of the electricity sector.

(2) The Minister shall use his best efforts to ensure that the Board shall comprise at least one member with substantial experience in electric system operation and management, one member with substantial experience in business and in electricity accounting or auditing, and one member with substantial legal or regulatory experience relevant to the electricity industry.

(3) A person shall be disqualified from being a member of the Board or Executive Director if he -

(1) is an unrehabilitated insolvent;

(2) has been convicted of a serious crime and/or sentenced to imprisonment;

(3) has any pecuniary interest, direct or indirect, in an undertaking by a licensed electricity operator otherwise than as a ratepayer;

(4) is an employee of a licencee or any off-grid operator or any person whose activities are subject to the provisions of the Act.

Resignation of Board Members.

8. (1) A Board member may, at any time, resign his office by giving not less than three months notice to the Minister and the Board simultaneously.

(2) A Board member shall be deemed to have given the notice referred to in subsection (1) if he fails to attend the meetings of the Commission for three consecutive meetings without giving a reason or an acceptable explanation for his absence to the Chairman within thirty days of each meeting the member has failed to attend.

Removal from office of Board Members.

9. The Minister shall have the power to remove any person from serving as a Board member on the proven grounds of -

(a) physical or mental incapacity which prevents that member from effectively carrying out his duties;

(b) conviction of a criminal offence and/or a sentence of imprisonment;

(c) serious financial misconduct of that member;

(d) personal bankruptcy;

(e) gross incompetence or maladministration in the exercise of his duties;

(f) possession of a pecuniary interest, direct or indirect, in an undertaking by a licencee otherwise than as a ratepayer; or

(g) employment by a licencee or any off-grid operator or any person whose activities are subject to the provisions of the Act.

Suspension of Board Members.

10. (1) The Minister shall, in writing, suspend from office a member of the Board against whom criminal proceedings are instituted for an offence in respect of which a sentence of imprisonment may be imposed.

(2) Where a Board member has been suspended on the grounds specified in subsection (1), such suspension shall be in force only until the final determination in such criminal proceeding.

Filling of vacancies on dealth, resignation or removal from office.

11. Where a vacancy occurs in the membership of the Board either due to the death, resignation or removal from office of a Board member, the Minister shall appoint a person to take the place of such Board member for the period that would otherwise have been served had such member not resigned, died or been removed.

Filling of vacancies on recusal., suspension or unavailaility tohear specific matters.

12. (1) Where any Board member has recused himself with regard to any one or more pending matters, or has been duly suspended for any reason, or is unavailable to hear any specifically designated matter due to any combination of recusals or suspensions, the appointing authority shall appoint a person with appropriate qualifications to hear such specifically designated matter in the place and stead of the recused, suspended or unavailable member.

(2) A person appointed pursuant to subsection (1) shall have all the power, authority and responsibility of the member recused or suspended or unavailable but only with regard to the matter specifically designated under subsection (1).

Internal delegation of functions.

13. (1) The Board may appoint employees and may establish sub-committees under the direction of individual members as it sees fit for the purposes of carrying out its duties under the Act.

(2) The Board may, for the efficient discharge of its duties, hire or otherwise receive the advice of expert advisors with regard to all matters relating to the functions of the Board.

Advisory committees.

14. (1) The Board may, for the efficient discharge of its duties, establish advisory committees which shall consist of persons possessing appropriate expertise to adequately advise on the matters under consideration and may include experts from other jurisdictions with appropriate international experience.

(2) Advisory committees established in accordance with subsection (1) shall advise Board members and staff of the Commission but shall not participate in final regulatory decisions.

Conduct of business.

15. (1) The Commission shall conduct its meetings in accordance with procedure determined by the Board and shall inform the Minister of such procedure. The procedure shall be published in the Gazette.

(2) The quorum of the Commission at any meeting shall be three members.

(3) All decisions shall be taken by a majority vote. In the case of a tied vote, the Chairman shall have the casting vote. In the event the Chairman is not able to vote, the decision of the Board shall be by unanimous vote only.

Determining its internal procedures.

16. The Commission shall, by consensus, determine its own internal procedures and management protocols and shall duly inform the Minister of the same and of any unresolved issues relating to such rules and protocols.

Funding of the Commission.

17. (1) The Commission shall have an independent budget proposed by the Chairman, to be approved by its Board, and laid by the Minister before Parliament.

(2) The funds of the Commission shall be generated by

(a) licence fees;

(b) other fees determined by the Commission;

(c) subvention provided by Parliament.

(3) Licence fees, other fees and levies shall require the prior approval of Cabinet.

Independence of the Commission.

18. The Commission shall be independent in the performance of its functions and duties under this Act and shall not be subject to the direction and control of the Government or of any person, corporation or authority, except that the Commission shall have due regard to the public interest and overall Government policy, as embodied in legislation.

PART III
POWERS, DUTIES AND FUNCTIONS OF THE COMMISSION

Exclusive powers of the Commission.

19. The Commission shall have sole and exclusive authority to regulate all electricity entities that are subject to this Act and shall have full powers to regulate all licencee with regard to all economic and technical aspects of regulation in accordance with this Act especially with regard to the determination of tariff or electricity charges.

General duties of the Commission.

20. (1) The Commission shall, without limiting the generality of this section, have a duty to perform and exercise its functions and powers under this Act in the manner which it considers best calculated to:

(a) encourage the expansion of electricity supply in Dominica where this is economic and cost-effective and in the public interest;

(b) encourage the operation and development of a safe, efficient and economic electricity sector in Dominica;

(c) ensure the security and efficiency of the supply of electricity in Dominica through the conduct of an efficient long-term supply planning process with due regard for future potential generation sources such as geothermal and wind energy;

(d) facilitate the promotion of sustainable and fair competition in the electricity sector where it is efficient to do so;

(e) protect the interests of all classes of consumers of electricity as to the terms and conditions and price of supply;

(f) ensure the availability of health and safety guidance in relation to electricity supply to the public;

(g) ensure that the financial viability of efficient regulated electricity undertakings is not undermined;

(h) facilitate the collection, publication, and dissemination of information relating to standards of performance by licensed operators and for the electricity sector in Dominica for use by the electricity industry and its consumers and by prospective investors in the sector;

(i) participate, in consultation with the Minister, in regional and international matters relating to the development and regulation of electricity in the region;

(j) assist the Minister in the analysis and advancement of initiatives to establish an effective regional regulatory entity for the region; and

(k) develop supply targets for the purpose of ensuring that electricity services are accessible to the widest number of electricity users.

(2) In exercising its duties referred to in subsection (1), the Commission shall have due regard to -

(a) national and international environmental standards as they affect the electricity sector and shall consult with environmental bodies in Dominica or in the region where necessary or expedient in relation to consumer and industry interests; and

(b) developments with respect to regional cooperation in electricity supply and regulation in the Region.

General functions of the Commission.

21. (1) The Commission shall -

(a) review the legislation relating to the provision of electricity supplies in Dominica;

(b) issue monitor, and amend licences.

(c) establish, maintain, review and amend as appropriate technical and performance standards for all types of facilities, including hydro facilities, in the electricity sector and shall monitor and enforce compliance with such technical standards;

(d) establish, maintain, review and monitor safety standards for all types of facilities, including hydro facilities, in the electricity sector and shall monitor and enforce compliance with such safety standards;

(e) establish, maintain, review, monitor, and amend, as appropriate, customer care standards;

(f) regulate prices charged to consumers of electricity where this is not supplied on a competitive basis, and the methods by which they are to be charged;

(g) approve, modify, monitor and enforce terms and conditions for the supply of electricity to consumers;

(h) review, approve and propose modifications to the transmission codes and to the distribution codes that govern sector entities;

(i) make rules, by-laws and orders as provided elsewhere in this Act;

(j) have the option to recommend to the Minister the establishment of a universal access development fund into which providers of electricity services shall pay any fees that the Commission may prescribe in consultation with licencees the proceeds of which shall be used, with the Commission's approval, solely for the development and expansion of electricity service infrastructure in areas where there are no services.

(k) advise the Minister on the generation, transmission, distribution and supply of electricity;

(l) collect all fees paid by licencees and other relevant parties;

(m) monitor the performance of licencees against mutually agreed targets and benchmarking standards;

(n) review the development plans, expansion programmes and fuel cost efficiencies of licencees;

(o) mutually agree with electricity providers and set operational and efficiency standards and benchmarks for licencees;

(p) review and report on the efficiency of asset utilization and optimization and the appropriateness and implications of rate structures; and

(q) take such other actions as the Commission deems necessary to fulfill its duties and functions under this Act or as are otherwise necessary to serve the public interest or to fulfill the objectives of other legislation or treaties relating to the electricity sector of the Commonwealth of Dominica.

(2). In relation to off-grid electrification, the functions of the Commission shall include -

(a) the monitoring and enforcement of technical standards;

(b) the overseeing of all contractual arrangements;

(c) the resolution of disputes;

(d) the facilitation of efforts to expand rural electrification; and

(e) assistance with analytical aspects of the tariff setting and collections processes.

22. In carrying out its functions under this Act, the Commission shall - Exercise of functions.

(a) act in as consistent a manner as practicable;

(b) impose on licensed operators the minimum restrictions which are consistent with the proper performance of their functions;

(c) take into account the need for licencees to finance and plan their businesses with a reasonable degree of assurance;

(d) ensure that, unless a specific Licencee's duties under this Act require otherwise, licences granted to different persons in relation to each type of regulated activity have substantially the same terms and conditions;

(e) wherever practicable to do so, consult relevant stakeholders prior to making final decisions;

(f) make public in writing the content of the Commission's decisions pertaining to application for licences; and filing, redress and resolution of complaints together with the Commission's reasons for reaching such decisions;

(g) have the power to collect, gather and extract information that is pertinent and relevant to the generation, transmission, distribution and supply of electricity services, from all parties involved in the energy and electricity sector in Dominica and such information shall not be unreasonably withheld; and

(h) have the authority to order a licencee to cease operating and to disconnect its apparatus.

PART IV
TARIFFS

Review and setting of tariffs for electricity supply.

23. (1) An electricity service provider shall not -

(a) offer service unless it has, prior to offering such services, filed its proposed tariffs with the Commission and such tariffs rates and charges have come into effect pursuant to section 24; and

(b) make changes on tariffs, or other terms of the service after proposed tariffs have been filed with the Commission, except as authorized under this section.

(2) An electricity service provider shall submit tariff proposals in conformity with this section in writing to the Commission with respect to the tariffs it intends to apply for the use of its systems, facilities and services.

(3) Proposed tariffs filed under subsection (2) shall contain all relevant information concerning rates and charges for services, including deposits, non-recurring charges and monthly charges as

well as terms and conditions applicable to the provision of services, including disputes or claims over billing or provision of services.

(4) A Licencee shall make tariffs available to the public by publishing such tariffs in the Gazette and in two local newspapers.

(5) All proposed tariffs filed with the Commission shall be kept complete, accurate and up to date.

(6) After a proposed tariff has been filed with the Commission and has come into force and effect, no changes may be made in the rates, charges or other terms of service relating to all the services provided under the tariff, except upon the filing and review of tariffs as provided in this Act.

(7) Proposed Tariffs shall:

(a) be accompanied by all accounting and costing information as the Commission may require; and

(b) comply with all other requirements and conditions as shall be applicable to the licensee concerned.

Review and approval of trariffs.

24. (1) All tariffs proposed by a licensee shall conform with the principles and provisions governing tariff formulation established by the Commission pursuant to the legislation for the time being and shall be submitted to the Commission for review as to their conformity with such principles and provisions.

(2) The Commission shall, within 60 days of the submission of a tariff proposed under subsection (1), make a determination to:

(a) approve the tariff without amendment;

(b) conditionally approve the tariff subject to amendments specifically proposed by the Commission being accepted by the licensee; or

(c) reject the tariff proposal outright, stating clearly in writing the reasons for such rejection, which

reasons may include a determination that the tariff is not ripe for review.

(3) In the event the Commission makes a determination under subsection (2) (b) the licencee maysubmit a revised tariff within 30 days of the determination; and the Commission shall make a new determination in accordance with one of the three options specified in subsection (2) within 30 days of such submission.

(4) In the event of an outright rejection of the proposed tariff under subsection (2) (c), the Licencee may file a new tariff at any time; or may file a petition to the Commission for reconsideration of such rejection.

(5) A petition shall be filed within 30 days of the rejection and shall state the Licencee's basis for reconsideration, which may include a fundamental change in circumstances from the conditions that prevailed when the tariff was originally rejected by the Commission.

(6) In the event the Licencee files a petition for reconsideration under subsection (4), the Commission shall act upon such petition within 30 days and make a determination in accordance with one of the three options set forth in subsection (2).

(7) If the Commission fails to act on a tariff submission pursuant to this section within the timeframes for determination specified in subsections (2), (3) and (6), the tariff shall be deemed approved until such time as the Commission makes a determination.

PART V
PUBLIC REGISTER AND REPORTING

Public register.

25. (1) The Commission shall maintain a register, which shall contain complete and relevant information on -

(a) every licence granted, including the details of the licence holder;

(b) every exemption of licence issued and the particulars thereof;

(c) every modification, verification, revocation or surrender of every licence granted;

(d) every requirement imposed, and consent or approval given to the licensee, by the Commission under the terms of licence; and

(e) every preliminary or final order of the Commission, and revocation of such order.

(2) In entering information into the register, the Commission shall take full account of the need to protect confidential and commercially sensitive information and shall, where necessary, suitably restrict disclosure of such information to achieve such goal.

26. (1) The register required to be maintained under section 25 shall be open for inspection by members of the public at such times and on such days as shall be determined by the Commission. Public inspection of register.

(2) Any person may, on payment of a fee to be determined by the Commission, require the Commission to supply such person with a copy or an extract, certified by the Commission as a true copy or extract, from any part of the register.

27. (1) The Commission shall, within three months of the end of each calendar year, prepare a written report to the Minister who shall place such report before Parliament within thirty days of receipt of the report. Reporting.

(2) The report made pursuant to subsection (1) shall contain but not necessarily be limited to the following -

(a) activities of the Commission during that year, including its finances and accounts;

(b) significant developments in the electricity sector or its regulation during that year with respect to matters that fall within the scope of the Commission's functions;

(c) compliance with the technical, safety, operational and efficiency standards set forth in this Act or Regulations, rules or by-laws made thereunder;

(d) major activities proposed for the following year;

(e) the development of private sector participation in the electricity sector;

(f) the progress of the electrification programmes throughout the country; and

(g) the projected finances, accounts and budgetary requirements during the next year and, as necessary, projections of future budgetary needs.

(3) The Commission shall make a copy of the report referred to in subsections (1) available, upon payment of such fees as the Commission may determine, to any person who may request it.

PART VI
LICENSING OF SECTOR FUNCTIONS

Licensing criteria.

28. The Commission shall -

(a) establish and keep under review specified objective criteria to ensure that all prospective licensed operators are fit and proper persons to be issued with a licence or exemption; and

(b) make a copy of the criteria available to any interested person who may request it on payment of such fees as may be determined by the Commission.

Requirement to be licensed.

29. (1) Subject to section 30, no person, unless authorized to do so by licence under this Act, shall engage in the operation of facilities or systems in order to carry out any of the functions of :-

(a) generating electricity, except in cases where such licencing requirement has been excluded or exempted pursuant to Section 31 (4) of this Act;

(b) transmitting electricity;

(c) distributing and supplying electricity.

(2) Where any difference or dispute arises as to whether any person is or is not engaging or about to engage in any of the functions set forth in subsection (1), the matter shall be referred to the Commission for determination.

(3) Any person who contravenes this section commits an offence and on conviction be liable for a penalty prescribed in accordance with Part XII.

(4) No proceedings shall be instituted in respect to an offence under this section except by or on behalf of the Commission.

Granting of licences by the Commission.

30. (1) The Commission shall, on application for a licence made in such form and by such process as the Commission may prescribe, and on payment of such fee as the Commission may impose to cover the cost of processing such application, make a determination as to granting a licence authorizing such person to operate facilities to-

(a) generate electricity;

(b) transmit electricity;

(c) distribute and supply electricity; or

(d) undertake any combination of functions identified in subsections (a) - (c) as the Commission deems appropriate for the most efficient operation of the sector.

(2) A person applying for a licence under subsection (1) shall submit to the Commission for publication by the Commission a notice of such application in the manner, and with the particulars,

prescribed by the Commission, and shall be subject to the following review procedure:-

(a) the Commission shall publish such notice within 14 days of the receipt of such application and notice.

(b) the Commission shall consider all objections to or comments on such licence application received within 60 days of such publication of such notice and shall within 30 days of the deadline for objections or comments act upon such objections or comments by either accepting them or rejecting them or remanding them to the applicant with a request for further information relevant to such consideration;

(c) any determination on such application shall be completed by the Commission within 90 days of the receipt of all information required for processing of the application, including all information necessary to review and evaluate objections; and

(d) in the event that the Commission does not act upon the application within the time frame and in the manner set forth in subsection (c) the Minister shall direct the Commission to act upon the application and if the Commission still fails to Act, the Minister shall make the determination on the said application.

(3) The Minister may revoke the appointment of the Commission for failing to act upon the application within the time frame and in the manner set forth in paragraph (c). The Minister shall have the power to appoint as members of the new Commission, persons who served on the previous Commission.

(4) A licence shall contain such terms and conditions as the Commission may require in order to carry out the functions under this Act.

(5) Without prejudice to the generality of subsection (3), conditions included in a licence by virtue of that subsection may require the licensee to: -

(a) enter into agreements with other persons for the use of electric lines, electrical plant and associated equipment operated by the Licencee (wherever situated and whether or not used for the purpose of carrying on the activities authorized by the licensee) for purposes consistent with this Act;

(*b)* comply with any direction given by the Commission as to such matters as are specified in the licence or are generically so specified;

(c) refer for determination by the Commission such questions arising under the licence as are specified or as are generically described for such determination in the licence; and

(d) refer for approval by the Commission such actions as may be required to be taken to fulfill the terms and conditions of the licence.

(6) All licencees shall comply with all relevant environmental laws and regulations of the Commonwealth of Dominica that are related to their operations.

(7) No licence shall be issued under this section unless the Commission is satisfied that the prospective licencee has the necessary legal capacity, financial standing, technical expertise and managerial competence to carry out efficiently the functions required by such licence.

General conditions relating to a generation licence.

31. (1) Generation licences shall be required for all generation facilities that are interconnected to the national grid, and are issued for the purpose of promoting safe, reliable and economically efficient operation of the national electricity system, and shall expressly state:

(a) the nature of the service to which the licence applies;

(b) the location of the generation facilities or group of generation facilities;

(c) the duration of the licence, which shall be related to the useful life of the generation facilities; and

(d) the conditions applicable to licence as are prescribed under this Act or Regulations made under the Act or prescribed by the Commission.

(2) All applications for generation licences shall be considered by the Commission.

(3) A generation licence shall be required for all generation sets of 20 Kilowatt or greater that are not connected to the national grid, and are issued for the purpose of promoting safe operation of the system.

(4) Subject to subsection (3) generation licences shall not be required for generation facilities utilized for domestic self-generation and which are not connected to the national grid.

(5) For generation facilities connecting directly or indirectly to the national transmission grid, the generation licencee shall make its generating facilities available to the transmission system operator for the safe and reliable dispatch and operation of the transmission system and connected facilities; and shall provide and receive compensation for such services as are directed by the transmission system operator.

(6) The Commission may establish standards based on minimum generation capacity, or such other criteria as it determines, for the exemption of generation facilities under this section.

32. (1) All transmission licences shall expressly state -

General conditions relating to transmission licence.

(a) the nature of the service to which the licence applies;

(b) duration of the transmission licence;

(c) the service areas or specific facilities to which the licence applies; and

(d) the conditions applicable to licence as are prescribed under this Act or Regulations made under this Act or prescribed by the Commission.
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(2) It shall be the duty of the transmission licencee to develop and maintain an efficient, coordinated and economical system of electricity transmission in the service territory designated in its licence.

(3) In issuing a transmission licence the Commission may specify the following conditions -

(a) that the transmission licencee shall provide transmission access and service, and interconnection access and service, on a nondiscriminatory basis on facilities that it operates, and as soon as practically possible in response to service requests by generation licencees or by distribution and supply licencees or by eligible customers;

(b) unless the Commission determines that a licencee is unable to satisfy a service request while maintaining service at rates or charges, and on such terms and conditions, as are consistent with the public interest; the transmission licencee, within

90 days of the issuance of the transmission licence, shall establish and make publicly available procedures governing requests for service connections and the transmission licencee's response to requests for service connections, which procedures shall be subject to review and, if so determined, modification by the Commission.

(4) A transmission licencee shall -

(i) make publicly available a tariff schedule that shall state the licencee's currently approved rates or charges and terms and conditions of service for transmission and interconnection service, as approved by the Commission.

(ii) impose no rate or charge other than its currently approved rates or charges as stated in its tariff schedule; and

(iii) impose no term or condition of electricity service other than the currently approved terms and conditions of electricity service stated in its tariff schedule or in such rules relating to transmission service as the Commission may promulgate.

General Conditions relating to a distribution and supply licence.

33. (1) A distribution and supply licence shall be issued for a term approved by the Commission and shall be subject to revocation only for violation of this Act or the terms and conditions of such licence, and shall expressly state:-

(a) the nature of the service to which the licence applies;

(b) the duration of the licence service authorized;

(c) area to which the licence applies; and

(d) conditions of licence as prescribed by this Act or rules, by-laws and regulations made thereunder.

(2) It shall be the duty of the distribution and supply licencee to develop and maintain an efficient coordinated and economical system of electricity distribution as to both the acquisition and supply of electricity service, and as to the physical distribution of such electricity, in the area assigned to it in its licence.

(3) A distribution and supply licencee shall establish and file with the Commission a proposed scheme for inviting, receiving, processing and responding to requests for service, and upon final approval of such a scheme by the Commission, the licencee shall within 90 days fully implement the scheme.

(4) A distribution and supply licencee shall

(a) make publicly available a tariff that states the licencee's currently approved rates or charges to consumers and the terms and conditions of distribution services and electricity supply to consumers, as approved by the Commission;

(b) impose no rate or charge other than its currently approved rates or charges as stated in its tariff; and

(c) impose no term or condition of electricity service other than its currently approved terms and conditions as stated in its tariff.

(5) A distribution and supply licencee shall, within 3 months of the issuance of the distribution licence, establish and publish notice of instructions governing:-

(a) standards and procedures for obtaining service;

(b) metering, billing and collection of the licencee's approved charges;

(c) remedies for non-payment, theft and use of electricity for purposes other than that for which the electricity was supplied; and

(d) procedures and standards for the reinstatement of service to a consumer in the event of a discontinuation of service;

(6) Instructions published by notice shall be consistent with the purposes and requirements of this Act and to be subject to the review by the Commission, which may make such modifications as it may deem appropriate in consultation with the licencee.

(7) A distribution and supply Licencee shall maintain and make available for public inspection in the Licencee's offices -

(a) the Licencee's approved tariffs;

(b) the Licencee's instructions governing procedures for obtaining and terminating service;

(c) the Licencee's instructions governing metering, billing and collection;

(d) descriptions of the performance standards applicable to the Licencee, including outage standards and the time required to connect new customers;

(e) complete maps and diagrams of the Licencee's facilities; and

(f) a manual explaining in layman's terms how the system operates.

Revocation of licences.

34. (1) The Commission shall revoke any licence issued for material failure of the Licencee to comply with the conditions of its licence; provided that, if the Commission finds that it is in the public interest not to revoke such licence, the Commission may, in lieu of revocation, apply to the High Court to order the Licencee to pay compensation for the damage that the material failure may have caused.

(2) The Commission, by regulation, may establish detailed procedures governing the revocation of licences, such procedures to include reasonable notice to the Licencee and an opportunity to respond to the alleged grounds for revocation. Before revoking a licence, the Commission shall provide the Licencee -

(a) with written notice of the Commission's intent to revoke, such notice to be provided at least 90 days before revocation would become effective and to state specifically the reasons for revocation;

(b) the opportunity to respond in writing to the notice within 30 days of issuance of the notice; and

(c) within 60 days of the issuance of the notice, the opportunity to comply with the conditions of its licence if the Commission, in its sole discretion, determines that such an opportunity is in the public interest.

(3) In the event the Commission revokes a licence under subsection (2), the Commission may undertake to locate a successor licencee as expeditiously as possible and the Licencee shall continue to operate the facilities covered by the licence in accordance with such licence until such successor licencee is able to take over operation of the licensed facilities.

(4) In the event of revocation, the Commission may, issue notice to the Licencee to sell the licensed facilities to the successor licensee for a fair compensation.

(5) Where the Licencee fails to comply with the notice within 90 days of the notice, the Commission may apply to the High Court for an order to compel the Licencee to sell the licenced facilities to the successor Licencee and the High Court shall determine the amount of compensation.

Amendment of licences.

35. (1) The Commission may, on application of a licencee, or otherwise with the Licencee's written consent, and where the public interest so permits, make such alterations or amendments to the terms and conditions of a licence as the Commission and the Licencee may agree upon.

(2) Where a licencee has made an application under subsection (1) proposing alterations or amendments in its licence, the following provisions shall apply:

(a) the Licencee shall publish a notice of the application in the manner and with the particulars required by the Commission; and

(b) the Commission shall not make any alterations or amendments to the application until all comments on the objections as to the application received by it within 90 days from the date of first publication of the notice have been considered.

(3) Before making any alterations or amendments in a licence otherwise than on the application of the Licencee, the Commission shall publish the proposed alterations or amendments and shall consider all comments or objections received by it with reference to the proposed alterations or amendments within 90 days from the date of the first publication of the notice.

(4) Upon receipt of all information including comments or amendments, the Commission shall, within 30 days after the period specified in subsections (2) (b) and (3) make the alterations or amendments in the licence.

PART VII
DUTIES AND FUNCTIONS OF TECHNICAL INSPECTORS

Appointment and duties of Technical Inspectors.

36. (1) The Commission shall, on such terms as are appropriate to serve the purposes of this Act, appoint qualified persons to be technical inspectors.

(2) Technical inspectors appointed in accordance with subsection (1) shall -

(a) inspect and test, periodically and in special instances, plant and equipment belonging to persons authorized by licence to conduct a regulated activity;

(b) examine, periodically and in special instances, the equipment for the generation, transmission, distribution and supply of electricity by licensed operators;

(c) inspect and test, where required, plant and equipment at a consumer's premises which are interconnected to a licensee's system;

(d) inspect and test all new electrical installations in all buildings prior to connection to the electricity distribution system;

(e) perform such other functions as the Commission may determine.

(3) Where probable cause exists to believe that a violation of this Act has been committed, the technical inspector or agent of the Commission appointed to carry out any inspection or investigation may, upon receipt of a written authorization issued by the Executive Director,

(a) enter the premises and carry out his inspection or investigation; and

(*b*) take or seize any document or information he may require from any person under inspection or investigation.

(4) Where inspection has to be carried out in residential premises the technical inspectors shall not enter such premises without a warrant issued by a magistrate.

(5) The existence of a probable cause referred to in subsection (3) shall be documented in writing before any inspection.

(6) Technical inspectors of the Commission shall be issued credentials, which they shall present upon seeking entry to premises.

(7) A person who impersonates a technical inspector of the Commission under this section commits an offence.

(8) The Commission may make rules pertaining to the conduct of technical inspectors in the course of their duties under this section.

Technical standards and equipment type approvals.

37. (1) The Commission may establish technical standards applicable to electricity equipment and to customer premises equipment in order to ensure against harm to the electricity networks or services or to public health and safety, or to the environment.

(2) The Commission may prescribe rules specifying the types of electricity equipment which may be used for providing an electricity service, for operating electricity equipment, or for connecting to the electricity grid or to an electricity generation, transmission or distribution system.

(3) A person who provides an electricity service or supplies electrical equipment shall not use or supply, as the case may be, any equipment that does not comply with the technical standards as prescribed by the Commission.

(4) The Commission may, by rules, approve electricity equipment by reference to a type approval used in another country.

Unrestricted access to inpsectors of all plants, equipment and premises.

38. A person conducting a regulated activity shall afford inspectors appointed in accordance with subsection 36(1) unrestricted access during normal business hours to all plant, equipment and premises used for the purposes of the regulated activity, on production of identification by such inspectors.

PART VIII
ENFORCEMENT AND ADMINISTRATIVE POWERS OF THE COMMISSION

Commission's duty to investigate.

39. (1) The Commission shall investigate any matter which appears to be an enforcement matter and which is the subject of a representation to it by a person having an interest in the matter in cases other than those in which it considers the matter frivolous or in which the Commission considers that such an investigation would not be beneficial to or appropriate in the public interest.

(2) For purposes of this section, an enforcement matter means any matter in respect of which any of the functions of the Commission under this Act are or may be exercisable and which requires enforcement.

Administrative orders.

40. The Commission may, without limiting its powers, issue such administrative orders and rules or take such actions as are necessary to:-

(a) appoint, remove, promote and discipline staff;

(b) conduct the administrative operations of the Commission;

(c) establish its own internal organization including creation of divisions and offices as it may deem necessary for the exercise of its powers;

(d) delegate its authority as to any regulatory matter under its jurisdiction, except matters relating to licensing or to tariff formulation, to the Chairman, Executive Director or divisions and offices of the Commission;

(e) grant, amend and revoke licences;

(f) set technical standards and procedures to monitor adherence to standards;

(g) contract for services of external professional consult ants and advisors as may be necessary and prudent to the conduct of the business of the Commission;

(h) establish and, as required, amend the fees and other charges applicable under this Act;

(i) investigate possible violations and otherwise enforce the provisions of the Act;

(j) make public through open sessions, hearings or publications, such matters within its authority as it sees fit, subject to legal requirements as to confidentiality of information; and

(k) establish formal and informal consultation processes, including open public meetings, with stakeholders, consumers and the general public.

Administrative orders relating to implementation of policies.

41. The Commission shall, by notice published, in the Gazette, issue such other administrative orders and rules as are necessary for exercising its powers and performing its duties in the implementation of policies under this Act.

Regulations.

42. (1) The Minister, upon consultation with the Commission, may make Regulations for the carrying out of the functions of the Commission including provisions for -

(a) the formulation of rules of conduct;

(b) the imposition and payment of administrative fees including licence application fees.

(2) Regulations made under subsection (1) may provide for the imposition of fines by the Court not exceeding five thousand dollars for contravention of the Regulations.

Rules and By Laws.

43. (1) The Commission may, with the approval of the Minister, make such rules and by-laws as it sees fit for the purposes set out in the Act, and such rules and by-laws shall be published in the *Official Gazette* and two local newspapers.

(2) Rules and by-laws made pursuant to subsection (1) may be made for the following purposes:-

(a) securing regular and efficient supplies of electricity;

(b) protecting the general public from danger related to electrical works and installations;

(c) eliminating or reducing the risk of personal injury or property damage arising from the generation, supply or use of electricity;

(d) requiring licencees to take all prescribed steps to secure compliance with quality standards;

(e) ensuring that the electricity fittings installed and used by persons to whom electricity is to be supplied are safe;

(f) promoting the efficient use of electricity;

(g) establishing technical standards applicable to electricity equipment and to customer premises equipment in order to safeguard against harm to the electricity networks or services, to public health and safety and to the environment;

(h) specifying the types to electricity equipment and which may be used for providing an electricity service, for operating electricity equipment or for connecting to the electricity grid or to an electricity generation, transmission or distribution system;

(i) approving electricity equipment by reference to a type approval used in another country;

(j) enquiring into any accident which is or may be attributed to an escape of electricity or to the state or conduce of any part of the operations of a licencee; and

(k) regulating tariffs for electricity and electrical services.

(3) Rules and by-laws made for purposes specified in subsection (2) may -

(a) prohibit transmission or supply in specified circumstances;

(b) require notification of accidents, and of failures of supply, transmission or distribution facilities;

(c) require plans, maps and related documents to be kept and made available for inspection and copying;

(d) require compliance with directives served by the Commission which -

(i) are intended to prevent or end a breach of regulations made under this Act; or

(ii) eliminate or reduce risk of personal injury or property damage or interference with property;

(e) restrict or require the use of certain products, substances or processes or forbid unapproved substances, products and processes;

(f) require substances, products and processes to comply with standards or other requirements established by the regulations;

(g) require the provision of information to prescribed persons;

(h) forbid the use or installation of fittings which have not been approved;

(i) impose requirements as to installation, arrangement, connection, testing disconnection, alteration and repair of electrical equipment;

(j) improve requirements regarding earthing of electrical installations, electrical voltage and frequency; or

(k) provide for the installation and certification of meters.

PART IX
POWERS AND EXEMPTIONS OF LICENCEE

44. (1) Where in the exercise of its powers under this Act a licencee finds it necessary to enter upon any land or property in accordance with the provisions of this section, the Licencee shall so locate all its poles, lines, apparatus or equipment as not in any way to obstruct or hinder the use or development of the land or property. Powers of licence.

(2) Subject to subsection (3), a licencee may -

(a) erect or fix in, on, under or over any land, any pipe, electrical line or other work or apparatus used or to be used in the installation or operation of the undertaking; and

(b) alter, substitute, repair or remove any pipe, electrical line, work or other apparatus when so erected or fixed at any time when, in the opinion of the Licencee such undertakings are necessary or desirable.

(3) In the exercise of its power under subsection (2) (a), a licencee shall serve written notice of its intention on the owner or occupier of any private land or property if the name and address of the owner or occupier can reasonably be ascertained and if the name and address of the owner or occupier cannot reasonably be ascertained the Licencee shall post the notice in a conspicuous place on the land or property in question, and if the owner or occupier, within fifteen days of the notice, gives written notice to the Licencee of his objection thereto, the matter shall be referred by the Licencee to the Commission.

(4) Within fifteen days of the referral of the matter to the Commission, the Commission shall afford the owner or occupier of the land an opportunity to be heard on the objection and shall have the power to overrule the objection and direct the Licencee to enter upon the private land or property in question for the purpose set out in subsection (2).

(5) A licencee may, for the purpose of erecting, fixing, altering, substituting, repairing or removing any pipe, electrical line or other apparatus, enter upon any land and may -

(a) clear the land;

(b) dig the soil and remove the surface of the land;

(c) temporarily close or obstruct the land; and

(d) generally do all acts and things necessary for its purposes.

(6) An owner or occupier of land to which subsection (2) applies may request a licensee, through the Planning Authority to relocate on another part of his property or move completely from his property of the Licencee's poles or lines, and the Licencee shall accede to any such request if the Authority confirms that any pole or line occupy the only available area of the property where any structure may be built or erected.

(7) Where the cost of relocation or removal exceeds seven hundred and fifty dollars, the owner shall pay a proportion of the excess as may be determined by the Licencee as fair and reasonable.

(8) A licencee shall do as little damage as possible in carrying out any of the works permitted by this section.

(9) A licencee may on application grant to an electrical contractor approved by the Licencee and the Commission permission to construct lines for the transmission of electricity anywhere in the State.

(10) Any contractor referred to in subsection (9) shall comply with the requirements of any Regulation made under this Act and any other condition which may be specified by the Licencee.

(11) For the purposes of this section, "Planning Authority" means the Physical Planning and Development Authority established by section 4 of the Physical Planning Act 2002

Act No. 5 of 2002.

Duty free importation of goods.

45. (1) During the continuance of the licence, all plant, and equipment, machinery, meters, instruments, protective clothing and gear and materials imported by a licencee for the purpose of the Licencee's business of generating, transmitting, distributing or supplying electricity or for the purposes of any capital project are exempt from all duties and taxes on importation or any sales tax or value added tax.

(2) Notwithstanding subsection (1) a licencee is liable for all duties and taxes in respect of plant and equipment imported by the Licencee for hire, resale or the private use of any of its employees.

Acquisition of land.

46. The Government shall, whenever requested by a licencee and approved by the Commission, acquire in accordance with the Land Acquisition Act any land reasonably required by the Licencee for the purpose of its business of generating, transmitting, distributing or supplying electricity and shall transfer the land to the Licencee at the actual cost of acquisition.

Transfer of state land.
Chap. 53:01.

47. Subject to the State Lands Act Government shall, whenever requested and approved by the Commission transfer to a licencee the freehold title of any State land reasonably required by the Licencee for the purpose of the Licencee's business at a price equal to the value of such land on the open market or at such lesser price as the Government may in its sole discretion determine.

Licencee may enter lands.

48. (1) In the course of construction and for the more effective working of the undertaking, a licenceemay enter upon and remove from any public or private land, any tree, branch, or part of a tree growing on such land which is within one hundred feet of any electric line and which may interfere with, endanger or otherwise prejudicially affect the working of its operations.

(2) Notwithstanding subsection (1), a licencee may not, except with the consent of the owner or occupier of any land, enter upon the land before the expiration of fifteen days' notice in writing given to the owner or occupier thereof or posted thereon in a conspicuous position.

(3) Where the owner or occupier, within seven days from the service or posting up of a notice, gives written notice of his objection to the proposed entry, the matter shall be referred by the Licencee to the Commission.

(4) Within fifteen days of the referral of the matter to the Commission, the Commission shall afford the owner or occupier of the land and opportunity to be heard on the objection and shall have the power to overrule the objection and direct the Licencee to enter upon the private land or property in question for the purpose set out in subsection (1).

(5) Where any condition exists which is dangerous or is interrupting or threatens to interrupt, the supply of electricity in Dominica or any part thereof, a licencee may immediately enter upon any private land without the consent of the owner or occupier and take whatever action is necessary to establish safe conditions or to ensure the continuity of the supply of electricity.

(6) Where the Licencee takes action under subsection (4) the Licencee shall within three days, inform the owner or occupier of the land in question (either by service of a written notice on him or by posting up conspicuously a notice on such land) of the action taken.

(7) Any person wishing to erect any building or structure in such a position or manner as may interfere with the supply of electricity conducted through any overhead electric line, which belongs to a licencee, shall apply to the Commission for permission to erect such building or structure.

(8) Whenever any overhead line has been constructed and any person erects any building or structure which interferes with or which may interfere with the proper working of such line, a licencee may request the owner or occupier of the building or structure in question to remove or adjust the same as may be necessary.

(9) Where the owner or occupier fails to comply with the request, the Licencee may apply to the Commission for the determination and the removal or adjustment of the building or structure in question and, after making any enquiry as the Commission deems necessary, the Commission may make such order as it deems fit.

(10) Every such order may, by leave of the High Court, be enforced in the same manner as an injunction granted by a Judge of the High Court.

Power of entry for ascertaining electricity consumed.

49. (1) A licencee may at all reasonable times enter upon any land or premises to which electricity is or has been supplied by the Licencee for the purpose of inspecting, testing or maintaining the electric lines, meters, accumulators, fittings and other works and apparatus thereon belonging to the Licencee, or of ascertaining the quantity of electricity consumed or supplied in or to such premises or, where a supply of electricity is no longer required or where the Licencee is entitled to take away and cut off the supply of electricity from any such land or premises, for the purpose of removing any electric lines, meters, accumulators, fittings, or other works or apparatus belonging to the Licencee and the Licencee shall repair all damages caused by an entry, inspection, maintenance or removal.

(2) Notwithstanding subsection (1), anyone who willfully or maliciously places or erects anything which impedes or hinders the easy entry, inspection, maintenance or removal by a licencee of its property the licencee may remove the impediment or hindrance in question at the cost of the occupier of the land or premises in question and the Licencee is not liable for any damage caused thereby.

Licencee may run lines etc. on roads without charge.

50. (1) Subject to a licencee making good to the reasonable satisfaction of the Chief Technical Officer (Works), all damage occasioned thereby, the Licencee may erect, place or replace pipes and electric lines along or under or over any road in Dominica without payment of any way-leave, rent, fee or other charge, to remove or repair any such pipe or electric line and for the purpose of erecting, placing, replacing, removing or repairing the same, break, excavate and temporarily obstruct any road.

(2) Whenever a licencee breaks up or excavates any road, it shall with all convenient speedcommence the works for the purpose for which the road was broken up or excavated within fourteen days of completion of the breakup and excavation and the repairs to the road to be completed within three months or a period to be determined by the Commission.

(3) Subject to subsection (4), where a road has been broken up or excavated, the Licencee shall commence repairs within fourteen days of completion of works and shall ensure that such works are completed within three months or otherwise determined by the Commission and shall carry away the rubbish occasioned thereby.

(4) Until the road has been made good, the Licencee shall fence the road where it has been broken up or excavated and shall maintain during the hours of darkness a light sufficient to warn persons using the road of the danger constituted by the breaking up or excavation.

(5) Where a road has been broken up or excavated by the Licencee , the Licencee shall keep the same in good repair for three months after it is made good and for such further period not exceeding twelve months as the sub-soil of the road at that place continues to subside.

Property for supplying etc. of electricity.

51. Where any electric line, meter, accumulator, fitting, or other work or apparatus belonging to a lcencee is placed for the purpose of supplying or measuring electricity in or upon any land or premises not being in the possession of the Licencee, the electrical line, meter, accumulator, fitting or other work or apparatus shall not be subject to distress or to the landlord's remedy for rent of the land or premises where the same may be, nor can the same be liable to be taken in execution under any process of a Court of Justice, or under any proceeding in bankruptcy or insolvency.

Damage to lines, etc. and payment of compensation.

52. (1) Any person who on any private land fells, lops or trims any tree thereby causing damage to any electric line or other works or apparatus which forms part of the Licencee's electricity operation commits an offence and in addition to any penalty that may be imposed on him, is liable to pay the expenses of remedying the damage so caused.

(2) Notwithstanding subsection (1), whenever a licencee is requested by any owner of land to cut, lop or trim any tree on the owner's land, which is threatening to damage any electric line, or other works or apparatus the Licencee shall do so.

Payment of compensation.

53. (1) In the exercise of any powers conferred by this Act, a licencee shall cause as little inconvenience and damage to other persons as is reasonably practicable and a licencee is liable to pay compensation to any person who suffers damage to his property in consequence of the exercise of the Licencee's powers.

(2) No compensation shall be payable in respect of any tree planted on or near the right of way after the location of the electrical lines over the property, in such a manner that the tree does or is likely to endanger, interfere with or prejudicially affect the electric lines.

(3) The amount of compensation shall, failing agreement, be determined by arbitration.

(4) All losses or damages caused to any property through the negligence of a licencee its agents, contractors or officers shall be paid by the Licencee.

(5) A licencee shall be answerable for all damages or injuries sustained by any person through the negligence of the Licencee or of any person in its employment, by reason of or in consequence of the Licencee works.

(6) A licencee shall save harmless and keep indemnified all persons by whom any road or street is repairable in respect of any damages or injury referred to in subsection (5).

Licencee may harness water.

54. (1) Subject to Government's approval a licencee may without making payment therefore, harness waterpower throughout Dominica at such sites as the Government may from time to time reserve for public electricity supply purposes and the Government shall reserve for the generation of electricity energy by hydroelectric works for public electricity supply purposes the water power rights of the Roseau and Mural rivers and their respective tributaries from their sources to a point one mile down stream from the confluence of the two rivers below the waterfalls, and no development for any other purpose of those stretches of the above rivers or their tributaries shall be allowed.

(2) Notwithstanding subsection (1) any person may use the waterpower of that part of any river within the confines of his property where this has not been previously reserved for public electricity supply purposes.

PART X
GENERATION AND SUPPLY OF ELECTRICITY AND CHARGES THEREFORE

55. (1) The voltage of electricity supplied for domestic or lighting purposes shall be 230 volts and this shall be maintained by a licencee within plus 4% and minus 8% (measured at the consumers' terminals) of such voltage. Voltage of electricity supply.

(2) The frequency of electricity supplied for any purpose shall be 50 cycles per second and this shall be maintained within plus and minus 3% of such frequency.

(3) Subject to subsection (4), the system of distribution of electricity shall be 3 phase 4 wire for 400 volts between lines and 230 volts between line and neutral, single phase 3 wire for 460 volts between lines and 230 volts between lines and neutral, the neutral in each case being earthed, or single phase 2 wire for 230 volts between lines with one line earthed and designated "the neutral" all or any of such systems to be used, the choice in any particular case being by the Licencee according to load conditions and the most economical method of supply.

(4) A consumer may by agreement with the Licencee be supplied with electricity at a voltage in excess of 460 volts and step this down in his own transformers to any voltage for the time being approved by the Government Electrical Inspector.

(5) A consumer may by agreement with the Licencee be supplied with electricity at a single phase 2 wire for 115 volts between lines with one line earthed and designated "the neutral."

56. (1) A licencee shall use reasonable efforts to ensure that sufficient firm generating capacity is maintained in order that peak demand may be met, assuming that the largest single thermal generating unit is unavailable for generating electricity and all other systems are restricted to firm power criterion. This constraint may be varied by agreement between the Licencee and the Commission in the event that a higher level of reliable supply is determined than the estimation of firm generating capacity dictates. Maintenance of adequate generating capacity.

(2) For the purposes of this section, "peak demand" means the highest demand for electrical energy in any continuous half hour period in any given year.

Electricity supply to Government.

57. Whenever required, a licencee shall enter into a contract for the supply of electricity to the Government for the Government's own use and consumption at any place in Dominica which is within 100 feet of any distributing main of the Licencee.

Rural electricfication.

58. The Government may require a licencee to implement rural electrification programmes from time to time and the Licencee shall accede to any such requirement, on terms and conditions agreeable to both Government and the Licencee which shall include the provision of funds by the Government for this purpose if it is confirmed by the Commission that the said rural electrification programmes are not financially viable for the Licencee to invest in.

Charges to Government.

59. (1) A licencee may charge the Government for all electricity supplied to the Government at the ratesas determined by the Commission after deducting from the basic energy rate a discount at the rate of up to 10 percent conditional upon payment for such charges being made within forty-five days of the date upon which an invoice for those charges is issued.

(2) This section does not apply to electricity supplied or to be supplied for the purposes of street lighting and domestic consumption. Electricity supplied to the Government for the purposes of street lighting shall be charged at such rate as the Licencee and Commission shall agree in consultation with Government.

Street lighting.

60. (1) Subject to subsection (2), whenever required to do so, a licencee shall enter into a contract to supply street lighting in any area in Dominica which is supplied with electricity by the Licencee.

(2) The Licencee shall be entitled to charge for electricity supplied for street lighting and for the hire of street lamps (and associated fittings and equipment) on the basis that, subject to the payment by the consumer of such minimum annual amount as may be agreed in writing between the consumer and the Licencee, the consumer will pay such monthly sum as may be agreed per street lamp of a specified type and output rating for the time being comprised in the street lighting system in question.

Licencee's liability for failure to supply electricity.

61. Where a certificate of electrical fitness is issued by the Commission to an intended consumer and theconsumer pays to a licencee not later than one month before the date of the expiry of the certificate any deposit or contribution as may be required by the Licencee and the Licencee fails, within one month from the date of payment, to supply electricity to such consumer and does not give to the Commission a satisfactory explanation for its failure to do so, the Licencee is liable to pay the fee in respect of a valid certificate approving the supply of electricity.

Deposits and contributions.

62. (1) A licencee may require any consumer to deposit with the Licencee by way of security for sums from time to time due by the consumer to the Licencee for electricity supplied such sums of money as may from time to time be fixed by the Licencee.

(2) Any sums of money fixed under subsection (1) may not exceed the charge for an estimated two months supply of electricity and shall be placed to the credit of a deposit account in the consumer's name in the books of the Licencee and the deposit shall bear interest at a rate to be determined from time to time by agreement between the Licencee and the Government; however the rate shall not be less than the rate the consumer would have earned over the period aforesaid if the deposit had been placed on a savings account in a commercial bank.

(3) A licencee shall not require any monies to be paid in the form of a contribution or by way of a bond or security by an intended domestic consumer towards the cost of construction and erection of service lines to any property where the service lines do not exceed one hundred feet in length from the nearest point of connection.

(4) A licencee may require a consumer or intended consumer to pay a contribution determined by the Licencee in accordance with this section towards the cost of the erection and construction of service lines in excess of one hundred feet in length from the nearest point of connection to his property excluding distance traversed across any road.

(5) Notwithstanding any payments made in accordance with subsection (4) and anything contained in this Act whereby a consumer lawfully erects and constructs transmission and supply lines on his property and pays a contribution in accordance with this section for the erection and construction thereof, such transmission and supply lines shall be the property of the Licencee which shall be responsible for their proper maintenance, repair and safe condition.

(6) Where a consumer, hereinafter referred to as the first consumer, requests transmission and supply lines to be erected and constructed, whether or not on his own property, and makes a contribution in accordance with this section towards the erection or construction thereof, the lines may be used by the Licencee for the purpose of supplying other consumers or intended consumers on condition that the use shall not prejudicially affect the supply of electricity to the first consumer.

(7) Every such other consumer or intended consumer so connected shall pay to the Licencee on demand, such sum as may be determined by the Licencee to be a fair and just proportion of the contribution paid by the first consumer, and the Licencee shall promptly pay to the first consumer the part thereof as may be determined by the Licencee to be a fair and just proportion of his contribution.

Meters.

63. (l) Whenever requested by any consumer, and after payment of the meter testing fee for such service, a licencee shall test the meter registering the electricity supplied to that consumer against a standard meter, and supply the consumer with a certificate showing the result of the test.

(2) Where the result of the test shows that the meter is registering more than three per cent above or below the registration of the standard meter, the Licencee shall replace the meter in question and refund to the consumer the fee that he was required to pay by the Licencee.

(3) The Commission shall be entitled to require and supervise any test carried out pursuant to subsection (1) and to be supplied with a copy of the report.

(4) Where a meter through no fault of the consumer fails to record within the margin of error allowed by subsection (2), the consumption of electricity by a consumer, the Licencee shall, upon the written request of the consumer, examine the accounts of the consumer and from the examination compute the average monthly sum charged to that consumer over the six months immediately preceding the meter failure, or from the date of connection, whichever period is the shorter, and the Licencee shall charge or credit as the case may be, the account of the consumer at a rate not exceeding the average monthly charge.

Non-payment of electricity charges.

64. (1) Subject to this section, where a consumer defaults with respect to payment due to the Licencee for electricity supplied, a licencee may disconnect the supply of electricity to that consumer until the payment and the reconnection fee prescribed in the tariff structure determined by the Commission are paid.

(2) The Licencee shall not discontinue the supply of electricity to any consumer unless -

(a) the consumer is given not less than twenty-one days previous written notice by the Licencee of its intention to do so; and

(b) the consumer has not during the period of notice required under paragraph (a) paid all sums due by him to the Licencee.

(3) Where the Licencee in accordance with subsection (1) discontinues the supply of electricity to a consumer the Licencee shall reconnect the supply of electricity to the consumer within twenty-four hours after the arrears reconnection fee and any required deposit have been paid to the Licencee.

(4) Where the consumer remains disconnected for a period of three months before reconnecting, the consumer shall be required to present a new certificate of electrical fitness to the Licencee before such reconnection.

(5) Notwithstanding subsection (3) where the day for reconnection falls on a Sunday or a public holiday, the reconnection shall be effected on the next working day thereafter.

(6) Where over a period of five successive years a consumer has not suffered disconnection of his supply of electricity for failure to pay his proper charges and there has been no significant delay in payment of those charges, a licencee shall, upon written application, accompanied by his deposit receipt, by the consumer, pay to the consumer the interest which the deposit paid to the Licencee by the consumer would have earned over the period aforesaid if the deposit had been placed on a savings account in a commercial bank in Dominica.

(7) Any previous subsection does not affect the right of the deposit to continue to bear interest in accordance with this Act and the consumer to payment thereof in accordance with subsection (6).

Obligation to provide electrical services.

65. A licencee shall not withhold electrical services once a consumer has complied with all the requirements necessary for the provision of electrical service.

PART XI
ARBITRATION

Disputes to be detemined by arbitration.

66. (1) When any disagreement relating to any matter touching or concerning anything under this Act arises between a licencee on the one hand and the Government or any local authority on the other hand, the disagreement shall be determined by arbitration.

(2) Where there are disputes between Licencees, the dispute may be determined by arbitration.

Appointment of arbitrator.

67. (1) When any disagreement is required to be determined by arbitration then, unless both parties to the disagreement concur in the appointment of a single arbitrator, each party on the request of the other party shall nominate and appoint an arbitrator to whom the disagreement shall be referred.

(2) The appointment of an arbitrator

(a) by the Government, shall be made under the hand of the Attorney General;

(b) by a local authority, shall be made under the hand of the Clerk of the local authority; and

(c) by a licencee or debt holder shall be made under the hand of a director or other officer of the Licencee.

(3) Every such appointment shall be delivered to the arbitrator so appointed and shall be deemed a submission to arbitration by the party delivering the same.

(4) After any of the appointments specified in subsection (2) is made neither party to the disagreement may revoke the appointment without the consent of the other.

(5) Where after a period of fourteen days after a request in writing (in which must be stated the matter so required to be referred to arbitration) is served by one party on the other party to appoint an arbitrator and the last mentioned party fails to appoint the arbitrator, then upon such failure the party making the request and having himself appointed an arbitrator may appoint an arbitrator to act on behalf of both parties, and the arbitrator may proceed to hear and determine the matter to which the disagreement relates and in such a case the award or determination of the single arbitrator is final.

Vacancy of arbitrator.

68. (1) Where before the matter so referred is determined any arbitrator appointed by either party dies or becomes incapable of acting, the party by whom the arbitrator was appointed may nominate and appoint in writing some other person to act in his place.

(2) Where after a period of seven days after notice in writing from the other party for that purpose the party fails to do so, the remaining or other arbitrator shall act as sole arbitrator and his award is binding on both parties as if he had been appointed sole arbitrator by consent.

(3) Every substituted arbitrator has the same power and authorities as were vested in the former arbitrator at tile time of his death or disability.

Appointment of umpire.

69. (1) Where two arbitrators are appointed, the arbitrators shall before they enter upon any matter referred to them nominate and appoint, by writing under their hands, an umpire to decide any matter on which they differ, or which is referred to him under this Act.

(2) Where an umpire dies or becomes incapable of acting or refuses to act, the arbitrators shall forthwith after the death, or incapacity or refusal appoint another umpire in his place, and the decision of any umpire on the matters so referred to him is final.

(3) Whenever the arbitrators cannot agree upon the umpire to be appointed or substituted by them for the purpose of subsection (1) the umpire shall be appointed or substituted in writing, in the case of any disagreement to which the Government is a party, under the hand of the President of the Dominica Association of Professional Engineers and, in the case of any disagreement to which the Government is not a party under the hand of the Registrar General and Provost Marshal.

Circumstances of single arbitrator.

70. Where a single appointed arbitrator dies or becomes incapable of acting or refuses to act before he makes his award, any disagreement referred to him shall be determined by arbitration in the same manner as if such arbitrator had not been appointed.

71. Where two arbitrators are appointed under section 69 and either of them, in writing, refuses or for seven days neglects to act, the other of them shall act as sole arbitrator and his award is binding on both parties as if he had been appointed sole arbitrator by consent.

Refusal of arbitrator to act.

72. Where two arbitrators are appointed, and either of them refuses or neglects to act, or fails to make their award within twenty one days after the day on which the last of such arbitrators is appointed, or within any extended time as appointed for that purpose by both arbitrators under their hands, the matters referred to them shall be determined by the umpire to be appointed.

Refusal to make award.

73. The arbitrators, or their umpire, may call for the production of any documents in the possession or power of either party which they or he may think necessary for determining the question in dispute and may examine the parties or their witnesses on oath, and administer any oath necessary for that purpose.

Power to call for books.

74. (1) Before any arbitrator or umpire enters into the consideration of any matters referred to him, he shall in the presence of a person legally authorised to administer oaths, take and subscribe the oath as set out in the schedule.

Arbitrator and umpire to take oath.

(2) The affidavit shall be annexed to the award when made and if any arbitrator or umpire, having made such oath, willfully acts contrary thereto, he commits an offence.

75. All the costs of and incidental to any arbitration (which costs shall be settled by the arbitrators or the umpire to whom the disagreement in question has been referred) shall be borne by the parties in such proportions as the arbitrators or umpire determine and in arriving at their decision on costs the arbitrators or umpire shall apply the same principles as are applicable to suits heard and determined by the High Court.

Costs of arbitration.

Correction of slips in awards etc.

76. (1) Every arbitrator and umpire shall have power to correct in any award made by him any clerical mistake or error arising from any accidental slip or omission.

(2) A copy of every award made in the course of any arbitration shall be certified as a true copy by the arbitrator or umpire making the award and shall be delivered by him to each of the parties to the arbitration.

Awards to be final

77. Every award made in the course of any arbitration shall be final and binding on the parties to the arbitration and the persons claiming under them respectively.

Enforcement of awards.

78. Every award made in the course of any arbitration may, by leave of the High Court, be enforced in the same manner as a judgment or order to the same effect, and where leave is so given, judgment may be entered in terms of the award.

PART XII
GENERAL

Powers of Technical Inspector.

79. (1) The Technical Inspector shall enforce any Regulations under this Act and he may at all reasonable times enter, for the purpose of inspecting or testing any electrical line or any electrical apparatus or works, upon any land or premises to which electricity is supplied or upon which electricity is generated, transmitted or distributed.

(2) The Commission shall direct a licencee not to supply electricity to any installation, apparatus or works that it deems unsafe or which, in its opinion, fails to comply in any respect with any Regulations.

(3) The Licencee shall require the Technical Inspector to inspect and test any installation, apparatus or works which the Licencee has reason to believe is unsafe or fails to comply with any Regulations.

Offence of obstructing the licencee.

80. Any person who without due cause obstructs or attempts to obstruct a licencee in the performance of any of the powers conferred on it by this Act commits an offence and is liable on summary conviction to a fine of five thousand dollars and six months imprisonment.

Stealing electricity.

81. If any person without legal right, the proof of which shall be upon him, abstracts or causes to be abstracted, or diverts or causes to be diverted, any electricity, or consumes or uses any such electricity, knowing the same to have been wrongfully or unlawfully abstracted or diverted, the person commits an offence and is liable on summary conviction to a fine of five thousand dollars and twelve months imprisonment.

Criminal liability for damage and prima facie evidence thereof.

82. (1) If any person without legal right, the proof of which shall be upon him, willfully disconnects, damages or removes or suffers to be disconnected, damaged or removed any electric line, meter, switch, fuse or other works or apparatus belonging to a licencee, or alters the index of any meter belonging to the Licencee or otherwise prevents such meter from correctly registering any quantity of electricity supplied by the Licencee, that person commits an offence and for every offence he is liable on summary conviction to a fine of one thousand dollars for the first offence and a fine of five thousand dollars for any subsequent offence, and without prejudice to the foregoing, the Licencee may recover from that person the amount of any damage sustained by it and may also (notwithstanding any agreement or contract previously existing) discontinue any supply of electricity to that person.

(2) If upon any premises or land in the occupation of a consumer there is connected to any electric line or meter any wire or device capable of wrongfully abstracting, diverting, consuming or using electricity or of preventing any meter from correctly registering any quantity of electricity supplied by a licencee, the existence of the wire or device shall be accepted by a Court as *prima facie* evidence that the consumer has without legal right abstracted or diverted electricity, or (as the case may be) has without legal right prevented a meter from duly registering any quantity of electricity supplied by the Licencee .

Regulations.

83. (1) The Minister may, after consultation with a licencee or licencees and a body representing consumers, make Regulations for -

(a) the protection of consumers and of the public generally against personal injury or damage to property arising from the generation, supply or use of electricity;

(b) enquiries to be held in connection with any accident which is or may be attributed to an escape of electricity or to the state or conduct of any part of the undertaking;

(c) conferring or imposing upon any sub-licensee, powers, privileges, obligations and restrictions similar to those imposed or conferred upon the Licencee by this Act;

(d) the purpose of preventing or minimizing radio interference or electrical interference arising from the generation, transmission, distribution or use of electricity;

(e) prescribing the qualifications of electrical engineers, chargemen, wiremen and contractors;

(f) the examination, licensing and registration of electrical engineers, chargemen, wiremen, and contractors and for the grant of certificates of competency and of registration;

(g) prescribing the forms of certificates of competency and registration for electrical engineers, chargemen, wiremen and contractors;

(h) prescribing the fees to be charged in respect of the examination of electrical engineers, chargemen, wiremen, and contractors; and

(i) prescribing the forms of certification of inspection to be issued by electrical inspectors, the fees to be charged for inspections to be made by those

inspectors and the persons by whom the fees shall be paid.

(2) In accordance with the procedure of subsection (1) Regulations may be made for carrying into effect the purposes of this Act.

Penalty for breach of regulations.

84. Any Regulations made under section 83 may impose penalties for any failure or omission to observe or comply with the Regulations, not exceeding five thousand dollars for each offence and a further penalty not exceeding five hundred dollars for each day or part thereof on which the offence continues after a conviction.

General Penalty.

85. Any person who commits an offence under this Act for which no special penalty is provided is liable on summary conviction to a fine of ten thousand dollars and one year imprisonment.

Repeal and savings.

86. (1) The Electricity Supply Act 1996 is hereby repealed.

(2) Notwithstanding subsection (1) and any other law -

(a) the Company shall be licensed to generate, transmit, distribute and supply electricity up to December 31, 2015 subject to the regulations imposed by the Independent Regulatory Commission.

(b) if the Company fails to conform to the regulations imposed by the Commission, the Company's licence shall be revoked by the Commission if in the opinion of the Commission the revocation of such Licence will serve the public interest.

(c) within six months of the establishment of the Commission, the Company shall comply with the provisions of this Act and in particular section 23 and section 24 as if it has not been licenced under this Act and seek to get the tariff approved by

following the procedures prescribed in the aforesaid sections.

Non-application of Aliens Land Holding Regulatrions Act.

87. The Aliens Land Holding Regulation Act shall not apply to a licencee.

SCHEDULE

(section 74 (1).

OATH

I, ... do solemnly swear that l will faithfully and honestly and to the best of my skill and ability hear and determine the matters referred to me under the provisions of the Electricity Supply Act, 2006.

A.B.

Taken and subscribed in the presence of

C.D.

Passed in the House of Assembly this 9th day of November, 2006.

HELEN E. AMBO
Clerk of the House of Assembly (Ag.)

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COMMONWEALTH OF DOMINICA

ARRANGEMENT OF SECTIONS

SECTION

SECTION

PART IV

MANAGEMENT OF DEVELOPMENT OF LAND

PART V

COMPLIANCE

SECTION

PART VI

ENVIRONMENTAL PROTECTION

SECTION

COMMONWEALTH OF DOMINICA

ACT NO. 5 OF 2002

I assent

LS

VERNON L. SHAW
President

9th May, 2002

AN ACT TO MAKE PROVISION FOR THE ORDERLY AND PROGRESSIVE DEVELOPMENT OF LAND IN BOTH URBAN AND RURAL AREAS AND TO PRESERVE AND IMPROVE THE AMENITIES THEREOF; FOR THE GRANT OF PERMISSION TO DEVELOP LAND AND FOR OTHER POWERS OF CONTROL OVER THE USE OF LAND; FOR THE REGULATION OF THE CONSTRUCTION OF BUILDINGS AND RELATED MATTERS; TO CONFER ADDITIONAL POWERS IN RESPECT OF THE ACQUISITION AND DEVELOPMENT OF LAND FOR PLANNING PURPOSES AND FOR OTHER MATTERS CONNECTED THEREWITH.

(Gazetted 16th May, 2002).

BE IT ENACTED by the Parliament of the Commonwealth of Dominica as follows:

PART 1
PRELIMINARY

Short title.

1. This Act may be cited as the -

PHYSICAL PLANNING ACT, 2002.

Interpretation.

2. (1) In this Act, unless the context otherwise requires -

"adjoining land" means that portion of land extending a distance of one hundred feet landward from the spring high water mark, or where the land to that distance includes a cliff, to a distance of fifty feet landward from the seaward edge of the cliff top; and wherever land is extended into the sea by or as a result of filling, dredging or other man-made alteration the landward boundary of the adjoining land shall remain at the line established;

"advertisement" means any word, letter, model, sign, placard, board, notice, awning, blind, balloon, device or representation, whether illuminated or not, in the nature of, and employed wholly or partly for the purpose of, advertisement, announcement or direction, or calling attention to any person, matter, object or event, and (without prejudice to the preceding provisions of this definition) includes any hoarding, billboard, wall, fence, or similar structure used, adapted, designed, or intended for use, for display of advertisement;

"agriculture" includes horticulture, fruit growing, seed growing, dairy farming, the breeding and keeping of livestock for the production of food, wool, skins or fur for the purpose of its use in farming the land, the use of land as grazing land, market gardens and nursery grounds but does not include the use of land for fish-farming and "agricultural" shall have a corresponding meaning;

"amenity order" means an order made under section 50;

"Appeals Committee" means the Appeals Committee established under section 75;

"Authority" means the Physical Planning and Development Authority established under section 4;

"beach" means that area of the coastal zone from the seaward line of the foreshore running inland to the vegetation line or other natural barrier whichever is closer to the foreshore; and a beach may consist of sand, stones, gravel, coral fragments or boulders;

"builder" means a person engaged as a contractor or otherwise in the erection, construction, alteration, improvement, maintenance or repair of buildings or works incidental to any of the foregoing;

"building" includes any erection or structure, including chattels or movable structures in, on, over or under any land and any part of a building so defined (but does not include plant or machinery comprised in a building), any erection or structure permanently attached to the sea bed, or temporarily so attached for the purpose only of the exploitation of minerals in, on or under the sea bed;

"building inspectors" means persons appointed as building inspectors under the provisions of section 64;

"building operations" includes the demolition of buildings or parts thereof, rebuilding operations, structural alterations of or additions to buildings and other operations normally undertaken by a person carrying on business as a builder;

"building or works" includes waste materials, refuse and other matter deposited on land, and references to the construction of building or works shall be construed accordingly;

"building permit" means a written notice that building plans have been passed in accordance with section 65;

"building preservation order" means an order made under section 47;

"building regulations" means regulations made under section 63 and a reference to Building Regulations, in a particular case in relation to which a requirement of Building Regulations is for the time being dispensed with, waived, relaxed or modified, is a reference to building regulations as they apply in that case unless the context otherwise requires;

"Chief Physical Planner" means the person appointed under section 6;

"clearing", in relation to land, means the demolition of buildings or parts thereof, the removal of materials from land, the levelling or grading of the surface of the land, the removal of vegetation and the carrying out of such other operations in relation thereto as may be prescribed;

"coastal waters" means the sea, and those waters adjacent to the landward limit of the adjoining land or connected permanently or intermittently with the sea which contain a measurable quantity of sea water, including sounds, bays, lagoons, ponds and estuaries, and the land below and along the banks of the waters;

"coastal zone" means all lands and waters of Dominica contained within the area bounded by the outer limit of the territorial sea and by the landward limit of the adjoining land, and includes coastal waters;

"compliance notice" means a notice issued under section 36;

"State land" means any land which belongs to and is vested in the State;

"development" means the carrying out of building, engineering, mining or other operations in, on, over or under any land, the making of any material change in the use of any building or land or the sub-division of land, provided that the following shall not be deemed to constitute development -

(a) work for the maintenance or other alteration of any building, if the work affects only the interior thereof and does not materially affect the external appearance of the building;

(b) work carried out by the Government or a local Government Authority for the maintenance or improvement of a road;

(c) work carried out with the approval of the Government or by statutory agency for the purpose of inspecting, repairing or renewing any sewers, water mains, electric mains, cables or other apparatus, including the excavation of any road or other land for that purpose;

(d) the use of any building or other land within the curtilage of a dwelling house for purposes incidental to the enjoyment of that dwelling house as such;

(e) the use of land for the purposes of agriculture or forestry, but not including any building or engineering activity thereon or the operations of a saw-mill;

(f) the erection of gates, fences, walls or other means of enclosure, not being adjacent to a highway or the sea, not exceeding three feet six inches in height and not constructed of asbestos, plastic, fibre glass or sheet metal;

(g) the enlargement, improvement or other alteration of a dwelling house, provided that-

(i) the square footage of the enlargement does not exceed one tenth of the square footage of the

ground floor of the house at the date of the development or of the house at the commencement of this Act, whichever is the larger;

(ii) the enlargement is single story;

(iii) the enlargement is an integral part of the existing house;

(iv) the enlargement complies with the requirements of any planning and building regulations for the time being in force; and

(v) written notice of intention to carry out such work is given to the Authority through the Chief Physical Planner;

"development permission" means permission for development given under the provisions of Part IV;

"development plan" means any development plan prepared under Part III and includes any modification or amendment thereof, and "plan" shall mean a development plan where the context so admits;

"discontinuance notice" means a notice issued under section 45;

"dwelling house" means a set of premises constructed for use for the purpose of a dwelling but does not include a building containing one or more flats, apartments, condominiums or townhouses, or a flat, apartment, condominium or townhouse contained in such a building;

"engineering operations" include the laying out, building and maintenance of roads, drains, runways and bridges, the preparation of land for carrying out of any development, the clearing of land, the dredging of watercourses or channels, the filling in of any cavity or excavation and the reclamation of land;

"environment" means all or any of -

(a) the media of land, water and air, including all layers of the atmosphere;

(*b*) organic and inorganic matter and living organisms;

(*c*) the interacting systems that include components referred to in paragraphs (*a*) and (*b*);

within the territorial jurisdiction and control of Dominica;

"environmental impact assessment" means:

(*a*) the process of collection, analysis, evaluation and review of information on the likely effects of a proposed development on the environment and the means to overcome adverse effects; or

(*b*) the document or series of documents which contain the information on the likely effects of the proposed development on the environment and the means to overcome adverse effects required by section 23;

"environmental protection area" means any area declared to be an environmental protection area under section 57;

"fish farming" means the breeding, rearing or keeping of fish or shellfish which involves the placing or assembly of any pen, cage, tank, pond or any other structure in any part of inland or coastal waters or in, on or over any land for the purpose of fish farming;

"foreshore" means the portion of the land of Dominica which lies between the mean low watermark and the mean high watermark of the sea;

"industrial development" means the development of land for the manufacture or partial manufacture of goods, articles or substances of any kind, or the assembly of manufactured goods or the turning into manufactured goods of articles which are partially manufactured or of substances in their natural state, of the repairing, finishing, cleaning, washing, packing or canning, adapting for sale or breaking up of any article;

"land" means any corporeal hereditament including a building as defined in this section and other things permanently affixed to land and includes the foreshore, sea bed and land covered by water within the boundaries of the territorial sea of Dominica;

"lawful use" does not include use of any building or other land which was commenced in contravention of the provisions of this Act or of earlier planning control;

"means of access" includes any means of access whether private or public for vehicles or for pedestrians and includes a street or road;

"mineral" means any substance in liquid, solid or gaseous form occurring naturally in or on the earth or on, in or under the sea bed and formed by or subject to a geological process, but does not include water;

"mining operation" means -

(a) to carry out in relation to any mineral, any activity with a view to working, carrying away, treating or converting that mineral;

(b) to search or explore for any mineral with a view to carrying out any activity mentioned in paragraph *(a)* of this definition and to carry out any work necessary for such search or exploration; or

(c) the deposit of waste or refuse materials in consequence of or incidental to any activity mentioned in paragraph *(a)* or *(b)* of this definition;

"Minister" means the Minister responsible for physical planning;

"mortgage" includes any charge or lien on any property for securing money or money's worth;

"owner" in relation to any land, means a person who is for the time being -

(a) the estate owner in respect of the fee simple in the land; or

(b) entitled to a tenancy of the land granted for a term of years certain of which not less than 10 years remain unexpired;

"permitted development" means development which is authorised under section 17 (2);

"plant" includes any flower, shrub, tree and any herb,grass, lichen, moss or other vegetation;

"plant preservation order" means a plant preservation order made under section 49;

"prescribed" except in relation to matters expressly required or authorised by this Act to be prescribed in some other way, means prescribed by Regulations made under this Act;

"purchase notice" means -

(a) in section 48 a purchase notice with respect to building subject to a building preservation order;

(b) in section 73 a purchase notice with respect to adverse decisions namely -

(i) refusal of development permission in circumstances where no development permission is available with respect to that land;

(ii) a revocation or modification notice;

(iii) a discontinuance notice;

(iv) a public access notice;

(vi) an environmental protection area order;

"Regulations" means Regulations made under this Act;

"resources" means any social, cultural, historical, technological, biological, physical or chemical elements and processes, renewable or non-renewable, tangible or intangible, of economic or aesthetic importance which compose the surroundings of mankind;

"road" means any road whether public or private and includes any street, square, court, alley, lane, bridge, footpath, trace, passage or highway, whether thoroughfare or not;

"sea" means the Caribbean Sea, the Atlantic Ocean, and all areas subject to tidal action through any connection with the Caribbean Sea or the Atlantic Ocean;

"sea bed" means the floor and subsoil of the sea between mean low watermark and the seaward limits of the territorial waters of Dominica;

"sub-division" means the division of a parcel of land other than buildings held under one ownership into two or more parts whether such division is by conveyance, transfer, assignment, vesting order, plan of survey, plan of sub-division, or any other instrument for the purpose of sale, gift, partition, succession, lease, mortgage or for any other purpose and such sub-division constitutes development whether or not the use for which the sub-divided land is intended constitutes development and "sub-divide" shall be construed accordingly;

"unauthorised development" means any development for which a grant of development permission has not been obtained and which is not permitted development authorised under section 17 (2) or development which is not in accordance with the conditions or limitations subject to which development permission was granted;

"use" in relation to land, does not include the use of land by the carrying out of any building or other operations thereon;

"waste material" includes garbage, refuse, spoil, mineral tailings, sludge, effluent and anything of whatever kind which has the appearance of being material abandoned, discarded or intended to be abandoned or discarded by the owner or former owner thereof, or the only value of which appears to be as scrap or for the utilization of parts thereof or the extraction of the residue of the substance of which it formerly formed part.

(2) For the avoidance of doubt it is hereby declared that -

(a) the use for the display of an advertisement, of any land or of the external part of a building, which is

not ordinarily used for that purpose, shall be deemed to involve a material change in the use of that land or part of the building;

(b) the use as two or more separate premises for the purpose of dwelling of any building previously used as one dwelling house involves a material change in the use of that building and of each part thereof so used; and

(c) the deposit of any waste material on land involves a material change in the use of the land, notwithstanding that the deposit is on a site which has been previously so used, if either the superficial area thereof or the height of the deposit is thereby extended or exceeds the level of any similar deposit on adjacent land

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3. (1) The objects and purposes of this Act are - Objects and purposes of Act.

(a) to foster the awareness that all persons and organisations owning, occupying and developing land have a duty to use that land with due regard for the wider interests both present and future of society as a whole;

(b) to maintain and improve the quality of the physical environment within which patterns of human settlement are situated in Dominica;

(c) to achieve orderly, economical and beneficial development and use of land and patterns of human settlement;

(d) to assist in the orderly, efficient and equitable planning, allocation and development of the resources of Dominica taking account of all relevant social, economic and environmental factors so as to ensure that the most efficient, equitable and environmentally sustainable use is made of land in the interests of all the people of Dominica;

(*e*) to provide for the orderly sub-division of land and the provision of services in relation thereto;

(*f*) to protect and conserve the cultural heritage of Dominica as it finds expression in the natural and the built environment;

(*g*) to secure the health, safety, welfare and convenience of persons in or about buildings and of others who may be affected by buildings or matters connected with buildings; and

(*h*) to facilitate a continuous improvement in the quality of life of all the people in Dominica.

(2) In implementing, applying and interpreting this Act, all persons shall have regard to, use their best efforts to further and give a broad and purposive interpretation to the matters set out in subsection (1).

PART II

ADMINISTRATION

Physical Planning and Development Authority.

4. (1) For the purposes of this Act there shall be a Physical Planning and Development Authority for Dominica.

Ch. 84:01.

(2) The Development and Planning Corporation incorporated by the Development and Planning Corporation Act, 1972, is hereby established as the Physical Planning and Development Authority and hereinafter in this Act are referred to as “the Authority”.

(3) The Authority shall from time to time consult local authorities either generally on development applications or in relation to specific cases which show a major departure from a development plan or where such consultation is desirable in the interests of good planning.

(4) The Authority shall -

(a) advance the purposes of this Act as set out in section 3;

(b) institute, complete, maintain and keep under review a study of matters pertinent to planning the use and development of the land of Dominica;

(c) prepare or cause to be prepared development plans in accordance with part III of this Act;

(d) regulate development by the means provided by this Act having regard to the need to secure consistency and conformity with the development plan;

(e) regulate the design and construction of buildings and the provision of services, fittings and equipment in or in connection with buildings;

(f) prepare, and submit to the Minister subject reports on matters which the Authority or the Minister may from time to time consider necessary or desirable having regard to the provisions of section 3;

(g) do all other things necessary for carrying out the purposes and provisions of this Act as may be authorised by this Act; and

(h) receive and consider applications for permission to carry out development of land in accordance with the provisions of this Act.

(5) The Authority shall remain at all times responsible for the proper performance of its functions under this section, but subject to subsection (1) may, for the purpose of such performance, as it thinks fit -

(a) consult with or obtain advice from other authorities, persons or bodies of persons;

(b) engage other persons to carry out work on its behalf; or

(c) delegate any of its functions under section 9 to any of the persons referred to at paragraph *(a)* or *(b)*, but shall at all times remain responsible for the proper discharge of those functions.

(6) Without restricting the generality of subsection (4), the Authority may delegate any of its duties to the Chief Physical Planner.

(7) The Authority shall be responsible for the implementation of the policies framed by the Minister and the Authority shall act in accordance with directions of a general character which may be given by the Minister as to the policy to be followed in the exercise of its functions.

Chief Physical Planner.

5. (1) A Chief Physical Planner who shall be a public officer shall be appointed to exercise and perform the duties specified in subsections (2), (3), (4) and (5).

(2) The Chief Physical Planner shall be responsible to the Authority for the administration and operation of the system of planning for which this Act provides.

(3) The Chief Physical Planner shall be the Secretary to the Authority and the Chief Executive Officer.

(4) The Chief Physical Planner shall sign and issue all development permissions, refusals of development permission, compliance notices and other documents authorised by the Authority to be issued under the provisions of this Act.

(5) The Chief Physical Planner has the powers conferred upon him by this Act and the duties that he is required by this Act or by the direction of the Authority to perform.

Exercise of functions of Chief Physical Planner.

6. (1) Functions assigned to the Chief Physical Planner by or under this Act, other than those mentioned in section 5 (4), may be exercised by any planning officer authorised by the Chief

Physical Planner in writing, either generally or specially, in that behalf.

(2) Any person exercising a function assigned to a planning officer by or under this Act shall be deemed, for the purpose of the exercise of that function, to be the proper officer for the exercise of that function, if authorised for the purpose by the Chief Physical Planner in writing, and shall be deemed to have the powers of a planning officer for the purpose of that function.

Limitation of personal liability.

7. The Minister, members of the Authority, the Chief Physical Planner or other public officer shall not be personally liable in any court for or in respect of any act or matter done, or omitted to be done, in good faith, in the exercise or purported exercise of any function under or power conferred by this Act.

PART III

DEVELOPMENT PLANS

Proposal for development plan.

8. (1) The Authority may, and if so required by the Minister shall, submit to the Minister proposals for the preparation of a development plan.

(2) A proposal for the preparation of a development plan shall include -

(a) a reasoned statement of the need for the plan;

(b) the main headings of the proposed contents of the plan;

(c) a suggested timetable for the preparation of the plan;

(d) proposals for obtaining representations from persons likely to be affected by or likely to wish to submit representations and views on the proposed plan during the course of its preparation;

(e) proposals for the review of the plan by sectoral agencies and private sector representatives; and

(f) such other matters as are required by the Minister or are considered by the Authority to be necessary for a decision to be made on the proposal.

(3) Where the Minister rejects a proposal submitted under this section, he may require the Authority to submit a fresh or modified proposal for the same plan or a new proposal for a different plan.

Scope and preparation of development plan.

9. (1) The Authority may prepare or cause to be prepared and thereafter keep under review a development plan -

(a) for Dominica as a whole, which shall be called a National Physical Development Plan; or

(b) for any specified part of Dominica, which shall be called by the name of the part of Dominica to which it relates.

(2) A development plan shall set out -

(a) a statement of the principal aims and objectives with respect to the development and other use of land in the area;

(b) a report on the existing conditions of the area including -

(i) the principal physical, social, economic and environmental characteristics of the area including the principal purposes for which land is used;

(ii) the size, composition and distribution of population of the area;

(iii) the communications, transport systems and traffic in the area;

(iv) the public services and the physical and social infrastructure provided in the area;

(v) any other matter which may affect the development and other use of land in the area; and

(vi) such other matters such as the Minister may, in a particular case, direct;

(c) a statement of the policies, proposals, and programmes for the future development and use of land in the area including principles for regulating the use and development of land and measures for the maintenance and improvement of the environment;

(d) a reasoned justification of the policies and proposals for the future development and use of land in the area having regard to -

(i) the report of the existing conditions of the area under paragraph *(b)*;

(ii) an examination of the likely environmental effects of the proposals;

(iii) any specific policies of the Government which may affect the pattern of development in the area;

(iv) the relationship between the proposals in the plan and other previously approved development plans which may affect the area;

(v) the financial and other resources which are likely to be available for carrying out the proposals of the plan; and

(e) a schedule setting out the stages by which the proposals of the plan may be implemented.

(3) The development plan shall include such maps, plans, drawings, diagrams and other graphic representations as the Authority considers necessary to illustrate and explain the plan with such a degree of particularity as may be appropriate to different parts of Dominica and to the nature of the development plan.

(4) A development plan may -

(a) define the sites of proposed roads, public and other buildings and works, or the allocation of land for agricultural, residential, industrial or other purposes of any class, and the conditions under which such development should be carried out;

(b) designate any area as an area which should not be developed due to its susceptibility to aircraft hazard or to flooding, erosion, subsidence, instability or other condition of the physical environment;

(c) make proposals for the preservation of buildings, sites and other features of special architectural, cultural, historical or archaeological interest;

First Schedule.

(d) provide for any of the matters set out in the First Schedule as the Authority considers appropriate to the nature and scope of the proposed plan;

(e) designate as a comprehensive planning area any area which in the opinion of the Authority needs to be planned as a whole for one or more of the purposes of development, redevelopment, improvement or conservation.

(5) Where any land is designated in a development plan made under this Part as a comprehensive planning area, the land may be purchased compulsorily by the Minister in accordance with the Land Acquisition Act as being land required for public purposes within the meaning of that Act.

Chap. 53:02.

(6) As soon as practicable after the designation of land as a comprehensive planning area, the Authority shall prepare a detailed plan for the relevant area showing the manner in which it is to be developed.

(7) A development plan shall not designate any land as a comprehensive planning area if it appears to the Authority that the

acquisition is not likely to take place within seven years from the date on which the plan is approved.

(8) Where any land is designated by a development plan as a comprehensive planning area, then if at the expiration of seven years from the date on which the plan, or the amendment of the plan, by virtue of which the land was first so designated came into operation, any of that land has not been acquired by the Minister, any owner of an interest in the land may serve on the Minister a notice requiring the interest of the owner in the land to be acquired and if, within six months after the service of that notice the interest of the owner in the land has not been so acquired, the development plan shall have effect, after the expiration of the six months, as if the land in which the said interest subsists was not subject to compulsory purchase.

Public participation.

10. (1) During the preparation of a development plan and before finally determining its content for submission to the Minister, the Authority shall take such steps as in its opinion will ensure -

(a) that adequate publicity is given in the area to which the plan relates to the matters which it proposes to include in the proposals;

(b) that persons who may be expected to desire an opportunity of making representations to the Authority with respect to those matters are made aware that they are entitled to an opportunity of doing so; and

(c) that such persons are given an adequate opportunity of making such representations.

(2) The Authority shall consider any representations made to it within the prescribed period.

Consideration of draft development plan.

11. (1) When the Authority has prepared a draft development plan it shall send a copy to the Minister and shall deposit a copy at the offices of the Authority and at such other place or places as the Authority considers to be most effective for bringing it to the notice of persons residing, working or owning property in the area to which the draft development plan proposals relate, or who are likely to be affected by the proposals in the draft development plan.

(2) The Authority shall give notice in the *Gazette* and at least one newspaper circulating in Dominica of the depositing of a draft development plan, and of the places where it may be examined, and shall give such other publicity to and written or oral explanation of the draft development plan as, in its opinion, is best calculated to inform all persons affected or likely to be affected by the proposals in the draft development plan, and all persons of the right to make representations with regard to the proposals in the draft development plan.

(3) Any person may, within eight weeks of the publication in the *Gazette* of the notice referred to in subsection (2), make either oral or written representations on the draft development plan to the Authority.

(4) When the Authority submits a draft development plan for the approval of the Minister, it shall be accompanied by a statement of the steps taken by the Authority to comply with the provisions of this section and section 10 and the particulars of the consultations held with other persons with respect to the proposals in the draft development plan.

(5) After the expiration of the period prescribed for making representations on a draft development plan, the Authority shall meet and consider the draft development plan and the representations and comments made, and shall forward the same together with its own recommendations and comments to the Minister.

Approval of development plan.

12. (1) The Minister, after considering a draft development plan which has been submitted to him under section 11 and all comments, representations and recommendations made thereon, shall -

(a) adopt the draft plan and submit it for the approval of Cabinet;

(b) require further work on or revision of the draft plan; or

(c) require further consultations on the draft plan in whole or in part.

(2) Where the Minister determines that before a draft plan is adopted, further work on or revision of or consultations on, the draft plan is required, he may require the Authority to undertake such further work, revision or consultation as may be necessary and to give such publicity to the matter as will enable persons likely to be affected or interested to make representations or comments on the draft plan.

(3) Unless the Minister otherwise directs, the provisions of section 11 shall apply to any modifications, work or revision undertaken by the Authority under this section and to the re-submission of the draft plan or any modification thereof.

(4) Where a draft development plan is submitted to the Minister under section 11, and is accepted by the Minister with or without modifications, the Minister shall submit the draft development plan for approval of the Cabinet.

(5) Where a draft National Physical Development Plan is submitted to the Minister under section 11, and is accepted by the Minister and Cabinet with or without modifications, the Minister shall submit the draft National Physical Development Plan for the approval of Parliament.

(6) Parliament may approve a development plan with or without modifications or may reject the plan.

Rejection of development plan.

13. Where a development plan is rejected by the Parliament under section 12(6) the Authority shall prepare a fresh plan in accordance with section 9.

Deposit of approved plan.

14. (1) When a development plan for a specified part of Dominica has been approved by Cabinet or a National Physical Development Plan for Dominica has been approved by Parliament, as the case may be, a copy of the plan shall be deposited at the Registry of titles, the offices of the Authority, the Department of Lands and Surveys, the public library and post offices in Dominica, and the substance of the plan shall be publicized in the area or areas to which it applies, in such manner as the Authority may direct.

(2) Notice of the approval of a development plan shall be published in the *Gazette* and the plan shall come into effect on the date of such publication.

(3) Copies of a plan shall be available for inspection and purchase, at all reasonable times at the offices of the Authority, at such price as may be prescribed.

Modification or revocation of plan.

15. (1) The Minister may at any time require the Authority to review or prepare proposals for modification or revocation of any plan, or any part thereof.

(2) Without prejudice to subsection (1), it shall be the duty of the Authority to keep under review the operation of any plan in the light of changing circumstances in Dominica and in the area to which it applies, and the Authority may prepare proposals for the modification or revocation of any plan as it sees fit and shall submit the same to the Minister.

(3) The provisions of this Act with respect to the participation in, preparation, consideration and approval of a development plan shall apply *mutatis mutandis* to the participation in, preparation, consideration and approval of the modification or revocation of a plan.

(4) The modification or revocation of an approved development plan for a specified part of Dominica shall be submitted by the Minister for the approval of Cabinet.

(5) The modification or revocation of an approved National Physical Development Plan shall be subject to an affirmative resolution of Parliament.

(6) Notice of the modification or revocation of an approved plan shall be published in the *Gazette* and at least one newspaper circulating in Dominica.

Legal status of development plans.

16. (1) Where two or more development plans have been approved which apply in whole or in part to the same area and there is any conflict or discrepancy between them, then -

(a) the plan drawn to the larger scale shall have precedence; or

(b) if the plans are drawn to the same scale the later plan shall be deemed to have modified the earlier plan unless there is an express provision to the contrary.

(2) When a development plan has been approved -

(a) it may be the reason for the compulsory acquisition of land designated in that approved development plan as a comprehensive planning area;

(b) it shall be the duty of all public officers to have due regard to, and so far as is practicable, be guided by the plan in formulating and preparing any project of public investment and development in Dominica; and

(c) the Authority shall, in considering any application for development permission, give principal consideration to and be guided by the plan.

(3) When a plan has been prepared but is not yet approved, subsection (2)*(b)* and *(c)* shall apply as if the plan had been approved.

(4) An approved development plan remains in effect until it is revoked by the Minister by notice published in the *Gazette*.

PART IV

MANAGEMENT OF DEVELOPMENT OF LAND

Permission required to develop land.

17. (1) No person shall carry out any development of land except under and in accordance with the terms of a development permission granted in that behalf prior to the commencement of such development, on an application made in accordance with the regulations made under section 88, unless the development is permitted development authorised under subsection (2).

(2) The Minister may by Order published in the *Gazette*, grant permission to any class of development specified in the Order either unconditionally or subject to such conditions or limitations as may be specified in the Order, without the requirement for the making of an application for grant of development permission.

(3) Every Order made under subsection (2) shall be subject to a negative resolution of Parliament.

Types of development permission.

18. (1) The Authority may grant development permission expressed to be an outline development permission subject to the conditions and limitations therein, the effect of which shall be to grant approval in principle to erect buildings but not to permit the commencement of building operations until detailed development permission has been granted in respect of the details of the development or part thereof, for which outline development permission was granted, and those details shall not form part of the grant of outline development permission.

(2) Where the Authority is of the opinion that an application for outline development permission ought not to be considered separately from the detailed information required under section 19, it shall within thirty days of the receipt of the application notify

the applicant that it is unable to entertain the application and shall invite the applicant to submit the required further information under that section.

(3) Notwithstanding subsection (1) and without restricting the generality of subsection (2) the Authority shall not entertain applications for outline development permission for the classes of development set out in the Second Schedule, or for the development which is subject to the provisions of Part VI. .Second Schedule.

(4) The Authority may grant development permission expressed to be a detailed development permission the effect of which is to permit the carrying out of operations in, on, over or under any land, the making of a material change in the use of any building or land or the sub-division of land, subject to the terms and conditions of the grant of detailed development permission.

Application for development permission.

19. (1) An application for a grant of development permission shall -

(a) be submitted to the Authority through the Chief Physical Planner;

(b) be made in such manner as may be prescribed by regulations made under section 88;

(c) include such information as may be required by the regulations or by directions given by the Authority or the Chief Physical Planner; and

(d) be accompanied by the prescribed fee.

Requirement for further information.

20. (1) Within such time as may be prescribed by the Chief Physical Planner by notice in writing, an applicant for development permission shall -

(a) furnish the Chief Physical Planner, with such further information as may be specified in the notice; and

(b) at his own expense, cause an environmental impact statement or economic feasibility study to be prepared of the proposed development and submitted to the Chief Physical Planner.

(2) Where such further information required under subsection (1) *(a)* and *(b)* is furnished, the application shall be treated as having been made on the date when the information was received and the 120 day period provided for the determination of applications in section 26 shall not commence until the date of receipt of the further information.

(3) Where an applicant does not furnish the Chief Physical Planner with the further information required under subsection (1) *(a)* and *(b)* within the period prescribed in the notice or such longer period as may be agreed upon between the applicant and the Chief Physical Planner, the Authority may decline to determine the application and may return the application to the applicant with a notice to that effect, or the Authority may refuse to grant development permission, as it thinks fit.

Proof of ownership.

21. (1) Every application for permission to develop land, made by the owner of the land, shall be accompanied by a certified copy of the applicant's certificate of title or other relevant title document in respect of the land to which the application relates.

(2) Where the applicant for permission to develop land is not the owner of the land, the application shall be accompanied by a statutory declaration sworn to by the applicant stating that he has notified the owner of the land to which the application relates, or the owner's duly authorised representative, of the application and that the owner or his duly authorised representative does not object to the application.

Publicity of applications.

22. (1) In respect of certain classes of development which the Minister may by Order designate as likely to derogate from the amenities of the public or of adjacent or nearby properties, the Chief Physical Planner, by written notice served on an applicant for a grant of development permission, may require the applicant to do either or both of the following:

(a) publish details of his application at such times, in such places and in such manner as may be specified in the notice;

(b) give details of his application to such persons or authorities as may be specified in the notice.

(2) Without restricting the generality of subsection (1) the notices referred to in paragraphs *(a)* and *(b)* of that subsection shall be served in respect of any application -

(a) for permission to develop, alter, add to, demolish in whole or in part a listed building or a building which is subject to a building preservation order;

(b) for permission to develop land in an environmental protection area;

(c) for which environmental impact assessment is required;

(d) for permission to deposit, store or otherwise deal with toxic or hazardous waste;

(e) for permission to develop any manufacturing process which will involve either directly or as waste, the production of toxic or other hazardous substances;

(f) for permission to construct buildings or for the use of land for the purposes of a slaughterhouse, plucking or poultry, or processing of fish;

(g) for permission to construct buildings or for the use of land for the purpose of a casino, gambling hall, recreation club, liquor shop, bingo hall, music hall, dance hall, theatre, cinema or sports hall;

(h) for permission to carry out mining operations or mineral processing; or

(i) for permission to carry out development for an auto-repair shop, garage or gas station.

(3) the Authority may and in respect of an application referred to in subsection (2) shall -

(a) publish a notice in at least one daily newspaper and affix a notice on the land to which the application relates that an application to develop land has been received and will be determined on a date specified in the notice; and

(b) invite comments and representations either in writing or orally on such application.

(4) The Authority shall take into account any report, representation or comment submitted or made to it under this section.

Environmental impact assessment.

Second Schedule.

23. (1) Unless the Authority otherwise determines, environmental impact assessment shall be required in respect of any application for development permission to which the Second Schedule applies.

(2) Notwithstanding the provisions of subsection (1) the Authority may require environmental impact assessment of any development where it is of the opinion that significant environmental harm could result.

(3) On receipt of an application for development permission, the Authority shall determine whether environmental impact assessment of the proposal is required having regard to -

(a) the nature of the development activity proposed;

(b) the geographical extent, scale and location of the proposed development;

(c) the extent and significance of the changes to the environment likely to be caused by the proposed development;

(d) the extent of general knowledge about the nature of the proposed development and its likely impact on the environment;

(e) any development plan for the area; and

(f) any other matter as may be prescribed in the regulations.

(4) Where it determines that environmental impact assessment is required, the Authority shall, within 30 days of receipt of an application for development permission, issue a written notice notifying the applicant or the person responsible of the determination that environmental impact assessment of the development proposal is required and setting out the terms of reference for the preparation of an environmental impact statement on the development proposal and the period within which the environmental impact statement shall be submitted to the Authority.

(5) Where the Authority issues a notice under subsection (4) that environmental impact assessment is required, the applicant or as the case may be the person responsible shall submit to the Authority an environmental impact statement on the development proposal in such form and containing such information as may be prescribed and the applicant or, as the case may be the person responsible, shall comply with this requirement.

(6) In this section "person responsible" includes any person at whose order or on whose behalf the development will be or is being undertaken.

(7) Where the Authority issues a notice under subsection (4) notifying the applicant or person responsible that environmental impact assessment is required, it shall inform any agency or department of Government having responsibility for the issue of any licence, permit, approval consent or other document of authorization in connection with any matter affecting the development.

(8) The Minister may make Regulations prescribing the qualifications, skills, knowledge and experience which shall be

possessed by persons preparing environmental impact statements and may cause a register of persons so qualified to be compiled and a person who is on such register shall be deemed to be approved by the Minister to prepare environmental impact statements for Dominica.

Consultation on application.

24. (1) The Chief Physical Planner may consult in writing any public officer or other person who appears to him to be able to provide information relevant to an application for development permission to enable the Chief Physical Planner to advise the Minister or the Authority , as appropriate, with regard to the application and shall consult any authority as may be prescribed in regulations made under section 88.

(2) An authority which receives a request in writing from the Chief Physical Planner for its comments on an application for development permission shall reply to that request within 28 days or such other period as may be agreed between the Chief Physical Planner and the Authority.

(3) Where the Chief Physical Planner has not received a reply to a written request for comments on an application from an authority within the time specified or agreed, he may proceed to determine the application notwithstanding the absence of a reply from the Authority.

(4) Any public officer or other person referred to in subsection (1), or his representative, may be invited by the Authority to attend and speak at any meeting called to consider the relevant application.

Material considerations.

25. (1) In considering an application for development permission, the Authority shall give principal consideration to -

(a) an approved National Physical Development Plan for Dominica if any; and

(b) an approved development plan applicable to the land to which the application relates, if any.

(2) In addition to the consideration referred to in subsection (1) the Authority shall take into account such of the following matters as appear to it to be relevant, or as the Chief Physical Planner may advise, in order to make a proper decision on the application -

(a) any representations made by any person with regard to the application or the probable effect of the proposed development;

(b) any view expressed by any authority consulted under section 24;

(c) any statement of policy issued by the Minister;

(d) any information, study or report provided by the applicant in response to a notice served under section 20;

(e) the likely impact of the proposed development on the natural or built environment;

(f) the likely impact of the proposed development on public health and safety;

(g) the social and economic costs and benefits likely to accrue to the community as a result of the proposed development;

(h) where the application is for commercial or industrial development, or for sub-division of land -

(i) any policies on the use of land for agricultural purposes which have been issued by the Minister responsible for agriculture;

(ii) the suitability of the land for the purpose intended;

(iii) the quality and economy of the proposed development and of its design;

(iv) the proposals made in the application for the means of access to, from and within the development, and for the provision of utility services to the development;

(v) the availability of water, electricity and waste disposal services; and

(vi) traffic considerations;

(i) the financial and other resources which are, or which will be, available to the applicant for the development permission;

(j) the area of land required for the proposed development; and

(k) such other matters as the Chief Physical Planner considers to be relevant to the determination of the particular application.

(3) Advice given to the Authority by the Chief Physical Planner, under this section shall be in the form of a report on each application, summarizing any relevant factors recommended to be taken into account in respect of that application and the suggested appropriate decision to be given on the application.

(4) The Authority may, in addition to the matters set out in subsection (2) take into account any other material planning considerations notwithstanding that the Chief Physical Planner has not advised the Authority on such planning considerations.

(5) The Authority shall not, by virtue of anything said in or following discussions or negotiations which may have taken place between any proposed developer and the Chief Physical Planner or any person acting on his behalf as to any proposed or contemplated development be bound to grant development permission in relation to any such development nor, if development permission is granted in respect of any such development, shall anything so said in any way preclude the Authority from granting it subject to any conditions that the Authority may consider proper.

(6) No claim to compensation or damages shall lie against the Government, the Minister, the Authority, the Chief Physical

Planner or other public officer in respect of, or arising out of, or in connection with, any refusal of permission for development in relation to which subsection (5) applies, nor shall any such claim lie in respect of, or arising out of or in connection with, the grant of any such permission subject to such conditions as the Minister or the Authority considers proper.

26. (1) The Authority may - Determination of applications.

(a) grant development permission unconditionally;

(b) grant development permission subject to such conditions as it thinks fit; or

(c) refuse development permission.

(2) Within 120 days of receipt of the application for development the Chief Physical Planner shall notify the applicant in writing, of the determination of the application, providing in the case of subsection (1) *(b)* or *(c)* -

(a) a full and clear statement of all reasons for the determination; and

(b) information on the opportunities available to the applicant for appeal against the determination.

(3) Where no decision has been made within 120 days of receipt of the application, the Chief Physical Planner shall notify the applicant of the progress made on the application and the extended date by which the decision is likely to be made, being no later than 60 days from the date of notification.

(4) Where no decision is made within 120 days of receipt of the application and no notification of an extended date has been issued to the applicant that application shall be deemed to have been refused for the purposes of section 75 (2) *(a)*.

(5) For the avoidance of doubt, it is hereby declared that a development permission granted after expiration of the 120 day

period referred to in subsection (4) is effective as a development permission for all purposes except those of section 75 (2)*(a)*.

Applications inconsistent with development plan.

27. (1) If it appears to the Authority that an application is inconsistent in some material respect with an approved development plan applicable to the area in which the development is proposed, but nethertheless it considers that permission should be granted, the Authority shall -

(a) publish a notice in the *Gazette* and at least one newspaper circulating in Dominica notifying the public -

(i) that an application which departs from an approved development plan has been received;

(ii) of the places where the application may be inspected by persons interested; and

(iii) that a public inquiry to examine the application will be held at a place specified in the notice, and at a time not being less than 28 days from the date of the notice; and

(b) invite comments and representations on any such application to be submitted to the Authority either orally at the public inquiry or in writing within a notice; and

(c) take into account any report, representation or comment submitted to it under this section, including the findings of the public inquiry held under this section.

(2) When the Authority has concluded its consideration of the comments received and the findings of the public inquiry held in respect of an application, it shall advise the Minister of its findings and recommendations thereon, giving its reasons therefor in writing, and shall determine the application in accordance with the views of the Minister, which shall be given to the Authority in

writing together with the reasons therefor.

Conditions of development permission.

28. (1) Without prejudice to the generality of section 26 (1)*(b)* the Authority may impose conditions on a grant of development permission which relate to any matter referred to in section 25 (2) or which arrange for -

(a) regulating the manner in which the development authorised by the permission is to be carried out including -

(i) the timing and phasing of the implementation of the development;

(ii) the dimensions, design, structure, or external appearance of any buildings or the number or disposition of any buildings on the land which is the subject of the development permission;

(iii) the location, design or materials of construction of any means of access from the development to a public road;

(iv) the disposal of sewage, effluent or trade waste from the development;

(v) the supply of water to the development;

(vi) the landscaping of the development;

(vii) the preservation of trees, vegetation or other natural features of the land where the development is to take place;

(viii) the preservation of any buildings or sites of importance to the cultural heritage of Dominica;

(ix) the reservation of any part of the land on which the development is to take place for roads, open space or other public or communal purposes reasonably incidental to the development;

(x) the nature of the materials to be used in any building or engineering operations in the development;

(xi) the routing of any vehicles or vessels to be used for the purpose of or in connection with the development;

(xii) the removal of materials or waste from such land or adjacent land used for the purpose and the carrying out of any works required for the reinstatement, restoration, or preservation of the land and the environment when the development is completed;

(b) regulating the development or use of any land adjacent to the land which is the subject of the development permission under the ownership or control of the applicant including the discontinuance of any existing uses of the land requiring the carrying out of works including the demolition of any buildings on such land or the removal of plant and machinery from the land so far as appears to the Authority expedient for the purposes of or in connection with the development authorised by the permission;

(c) requiring the removal of any buildings or works authorised by the permission, or the discontinuance of any use of land so authorised at the expiration of a specified period, and the carrying out of any works required for the reinstatement of the land at the expiration of that period;

(d) regulating the use which may be made of any building or use of land authorised by the development permission notwithstanding an order made under section 17(2);

(e) controlling or prohibiting the display on the land comprising the development of any advertisement including the size, shape, colour or location of any such advertisement;

(f) requiring continuous environmental monitoring of the development authorised by the development permission;

(g) regulating the hours of work during which the authorised by the permission may operate;

(h) the retention of any existing development or use of land to which the application relates, for a specified period;

(i) the payment of money or money's worth or the conveyance of land to the Authority in lieu of works required under the development permission;

(j) the entering into a performance bond with the Authority to guarantee the implementation of any of the conditions subject to which the grant of development permission is made.

(2) A condition may be imposed under this section requiring the developer to carry out any works or other development on land or public roads in the ownership or under the control of the State, even if the effect of the imposition of such a condition would be to require the developer to carry out works or development at his own cost for the public benefit.

(3) A development permission granted subject to any such condition as is referred to in subsection (1)*(c)* is in this Act referred to as "permission granted for a limited period only".

(4) No claim to compensation shall lie against the Government, the Minister, the Authority, the Chief Physical Planner or any other public officer in connection with or arising out of the grant by the Authority of development permission subject to conditions.

Development agreements.

29. (1) The Authority may, on the advice of the Chief Physical Planner, and with the consent of the Minister, and the consent of any other government authority who may be a party to the agreement, enter into an agreement containing such terms and conditions as it thinks fit with the applicant for development permission or with any other person interested in that land for the purpose of regulating the development of the land proposed by the application.

(2) Without restricting the generality of subsection (1), terms and conditions may be included in an agreement -

(a) covering any matter in respect of which conditions may be imposed on a grant of development permission;

(b) providing for contribution whether of works, money or land by the applicant towards the provision of services, facilities and amenities in the area in which the proposed development is to be carried out;

(c) for the provision of security by the applicant for ensuring due compliance with the agreement.

(3) An agreement made under this section with any person interested in land may be enforced by the Authority against persons deriving title under that person in respect of that land as if the Authority were possessed of adjacent land and as if the agreement had been expressed to be made for the benefit of such land.

(4) An agreement made under this section shall not be entered into except by an Instrument executed as a deed.

Performance bonds.

30. (1) Where the Authority requires, in a condition imposed on a grant of development permission to develop land under section 28 or as a term of an agreement made under section 29 that an applicant or, as the case may be, a person with whom it makes an agreement, provide a bond as a security for the performance of any condition subject to which permission to develop land was granted or for the performance of the agreement, the Authority shall require a charge on the land to which the permission or agreement relates as appears to it to be expedient and proper to ensure that the bond may be enforced.

(2) The Authority may enforce a bond entered into by an applicant for permission to develop land under section 28, or by a person with whom it has made an agreement under section 29, by all appropriate legal and equitable remedies.

lapse of development permission.

31. (1) An outline development permission shall be granted subject to a condition that if no detailed development permission covering the same development has been applied for within one year of the grant of outline development permission or such longer period as may be authorised by the Authority in any particular case, that outline development permission shall lapse and cease to have any force or effect.

(2) Where in accordance with the provisions of this section an outline development permission has expired, an application for detailed development permission in respect of that expired outline development permission may be refused without any liability to pay compensation under section 69.

(3) A detailed development permission shall be granted subject to a condition that it shall lapse and cease to have effect if the development to which it relates has not been completed within three years of the grant of detailed development permission, or such longer period as may be authorised by the Authority in any particular case.

(4) Where detailed development permission provides for different parts of the development to commence at different times, the provisions of this section shall apply to those separate parts of the development as if a grant of detailed development permission was made for each separate part or stage of development.

(5) The Authority may serve written notice on a person who has commenced, but has not completed, within the time prescribed therefor, the development for which he has obtained permission, requiring that person to complete the development within the time specified in such notice, and stating that if the development is not completed within that period the development permission will cease to have effect after the expiration of a further period specified in the notice.

(6) Upon expiration of the further period specified in a notice served under subsection (5) the grant of development permission shall cease to be valid or to have any effect and any further development or work carried out with respect to that development permission shall be a breach of planning control.

Supplementary provisions as to grant of development permission.

32. (1) Without prejudice to the provisions of this Part as to the lapse, modification or revocation of any grant of development permission such grant shall, except in so far as the grant otherwise provides, ensure for the benefit of the land concerned and of all persons for the time being entitled to an interest in the land.

(2) Where a grant of development permission is made for a limited period only in accordance with section 28 (1)*(c)* at the expiration of that period the use of the land for the purpose for which it was used before the grant of such permission for a limited period, may be resumed without express grant of development permission only if that use was a lawful use.

(3) Where a grant of development permission is made for the erection of a building, the grant shall specify the purposes for which the building may be used.

(4) Grant of development permission may include permission, with or without conditions, to retain on land buildings or works constructed or carried out thereon before the date of the application or for the continuance of any use of land instituted before that date (whether without permission granted under this Part or in accordance with permission so granted for a limited period only).

(5) A condition in a permission granted under subsection (4) may require the applicant to pay a sum of money as provided for in the Regulations under this Act to the Authority in respect of the buildings or works constructed or carried out before the date of the application or in respect of land instituted before that date.

Minor variation of development permission.

33. (1) The Chief Physical Planner, acting on behalf of the Authority, may approve a minor variation to a grant of development permission which in his opinion does not alter or affect the terms and conditions of the grant of development permission in any material respect and in such event the Chief Physical Planner shall inform the Authority of the action which he has taken in that particular case.

(2) A request for approval of variations to a grant of development permission shall be submitted to the Chief Physical Planner in writing and any approval shall be recorded in the register of planning decision.

(3) Where the Chief Physical Planner is requested to approve a variation under subsection (1) but is of the opinion that the variation proposed is not a minor one, he shall, refer the request to the Authority for determination and shall inform the applicant of that fact in writing.

Modification or revocation of development permission.

34. (1) Subject to the provisions of this section, if it appears to the Authority, after consideration of such advice as may be given by the Chief Physical Planner that it is desirable that any grant of development permission ought to be modified or revoked the Authority may, with the consent of the Minister, by written notice to the person entitled to the benefit of the permission, revoke or modify the development permission to such extent as it considers desirable.

(2) The power conferred on the Authority by this section may be exercised -

(a) where the grant of permission relates to the carrying out of building or other operations, at any time before those operations have been completed; or

(b) where the grant relates only to the making of a material change in the use of building or other land, at any time before the change has taken place.

(3) The modification or revocation of a grant of development permission for the carrying out of building or other operations shall not affect so much of the operations as has been previously carried out.

(4) A notice of the modification or revocation of a grant of development permission under this section shall include -

(a) a statement of the reasons for the modification or revocation;

(b) such directions as the Authority considers necessary for the bringing to an end any development to which the notice relates;

(c) information as to any claim for compensation that may arise in consequence of the modification or revocation, and the procedure for making any claim for compensation;

(d) information as to the right of appeal under Part IX of this Act; and

(e) such other matters as may be prescribed.

(5) Upon the service of a notice under subsection (1), to the extent to which the modification or revocation so requires, the grant of development permission concerned shall cease to be valid or to have effect, and any further development or work carried out contrary to such notice shall be a breach of planning control.

(6) Notwithstanding subsection (5), the Authority, after considering any representations made in respect of such a notice, may at any time cancel or withdraw that notice.

(7) An appeal shall lie, under Part IX against the issue of a notice by the Authority under subsection (1), or against the refusal of the Authority to cancel or withdraw such notice under subsection (6).

(8) Pending the determination of an appeal referred to in subsection (7), the notice concerned shall be deemed to be suspended in its operation, save that any further development or work carried out shall be a breach of planning control.

Reference of application.

35. (1) The Minister may by notice in the *Gazette* and at least one newspaper circulating in Dominica direct the Authority to refer to him -

(a) any application for development permission;

(b) all such applications of any specified class.

(2) The Authority shall refer to the Minister for his decision any application for development permission to which a direction made under subsection (1) relates.

(3) Where an application is referred to the Minister under this section, the provisions of this Part shall apply with necessary modifications as they apply to an application for development permission which fails to be determined by the Authority.

(4) In determining an application referred to him under this section, the Minister may consult any body or person he thinks fit.

(5) A determination of the Minister under this section shall be accompanied by a full and clear statement of the reasons for the determination of the application.

(6) The decision of the Minister or any application referred to him under this section shall be final.

PART V

COMPLIANCE

Compliance notice.

36. (1) Where it appears to the Authority that a breach of planning control has taken place, that is to say -

(a) that any development of land has been carried out without the grant of development permission required under Part IV; or

(b) that any conditions or limitations subject to which development permission was granted have not been complied with;

the Authority may if it considers it expedient to do so having regard to any development plan applicable to the land where the breach of planning control is alleged to have taken place and to other material considerations such as are set out in sections 25 and 37, serve a compliance notice in accordance with subsection (4) requiring the breach to be remedied.

(2) Where the compliance notice alleges a breach of planning control relating to development other than the making of a material change in the use of building or other land or the sub-division of land, the period within which a compliance notice may be served shall be -

(a) in the case of development of land alleged to have taken place without grant of development permission, six years from the carrying out of the development;

(b) in the case of non-compliance with a condition or limitation, six years from the date of the alleged failure to comply with it.

(3) Where the compliance notice alleges a breach of planning control relating to the making of a material change in the use of building or other land or the sub-division of land there shall be no time limit restricting the service of a compliance notice under subsection (1) and in all other respects the provisions of subsection (1) shall apply.

(4) A copy of the compliance notice shall be served on the owner and on the occupier of the land to which it relates, and may be served on -

(a) any other person having a material interest in the land, that is to say, an interest which in the opinion of the Authority is materially affected by the notice;

(b) the authorised representatives of the persons referred to in paragraph *(a)*; or

(c) any other person carrying on , or who is in control of a person carrying on, activities on the land which are alleged to constitute the breach of planning control.

(5) The fact that the Authority fails to serve a notice on anyone or other of the persons referred to in subsection (4) shall not invalidate any action or proceedings against any other of such persons.

(6) A compliance notice shall take effect on the date specified in it (in this Part referred to as the "specified date").

(7) A compliance notice shall be served not later than 21 days from the date of issue and not later than 28 days before the specified date.

(8) A compliance notice shall state clearly -

(a) which breaches of planning control referred to in subsection (1) *(a)* and *(b)* are alleged to have taken place;

(b) the particulars of development which appear to constitute the breach;

(c) the person or persons on whom it is served in accordance with subsection (4);

(d) the steps which the Authority requires to be taken to remedy the breach and the time within which they must be taken;

(e) the powers of the Authority, in case of default in compliance with the notice, to enter upon the land and take the steps specified in paragraph *(d)*;

(f) the penalties which may be incurred if the steps specified in paragraph *(d)* are not taken; and

(g) the opportunities which are available to the person or persons on whom the copy of the compliance notice was served to appeal the notice.

(9) The steps which the Authority may require to be taken by a person on whom a compliance notice has been served, to remedy the breach to which the compliance notice relates, may be one or more of the following namely -

(a) to restore the land as near as may be to the appearance and state that it had before the breach took place including replacement of soil, planting or replanting of trees and other vegetation;

(b) to comply with any limitation or condition in a grant of development permission;

(c) to demolish or remove a building in whole or in part;

(d) to carry out any building or other operations on the land to which the notice relates;

(e) to discontinue any use of land or buildings;

(f) to remove anything which constitutes development and was placed on the land without development permission;

(g) to remove any advertisement or to display it in the place permitted by a grant of development permission;

(h) to remove any authorised marks of identification in, on, or over land which have as their purpose the identification of a boundary of a sub-division alleged to constitute a breach of planning control;

(i) to remove or prevent any damage to the land or amenities of the area which has been or is likely

to be caused by the development which constitutes the breach of planning control;

(j) to do or to refrain from doing or to take or to refrain from taking any actions similar to those listed in paragraphs *(a)* to *(i)* which would assist in the ending of the unauthorised development;

(k) to cease any specified operations on the land which are alleged to be a breach of planning control.

(10) The Authority may at any time -

(a) withdraw a compliance notice without prejudice to its power to issue another one in respect of the same breach of planning control and shall if it does so serve a notice of withdrawal on every person who was served with a copy of the compliance notice; or

(b) modify a compliance notice and if it does so the provisions of this section shall apply to any modification of a compliance notice made under this section as they apply to the compliance notice.

(11) The powers conferred by subsection (10) may be exercised whether or not the compliance notice has taken effect.

Material planning considerations with respect to compliance notices.

37. (1) In considering whether or not a compliance notice shall be served the Authority shall take into account such of the following matters as may be relevant in the circumstances of the particular case namely-

(a) any development plan applicable to the land where the breach of planning control is alleged to have taken place;

(b) the nature and extent of the development which constitutes the alleged breach;

(c) the extent or likely extent of damage to the natural or built environment;

(d) the extent to which the development constitutes a nuisance or a threat to public health and safety;

(e) any objections and representations made by aggrieved persons in the neighbourhood;

(f) the length of time the breach of control has continued;

(g) the benefits to the community (if any) resulting from the development;

(h) any possible alternative measures which could be taken to remedy the unauthorised development;

(i) the effect of the development of any public works;

(j) whether it is necessary, desirable and convenient having regard to the public interest to serve or confirm a compliance notice;

(k) any other material considerations.

Notice to apply for development permission.

38. (1) The Chief Physical Planner may, in any case in which he considers that a breach of planning control has taken place, by written notice served on the person or persons referred to in section 36 (4) require that an application shall be submitted for development permission and in such case the Chief Physical Planner shall refrain from issuing a compliance notice if such application for development permission is submitted within 28 days of the service of such notice or such extended period as may be agreed.

(2) Where the Authority approves a grant of development permission in respect of an application made in conformity with a notice served under subsection (1), the Authority may authorize the grant of permission with retrospective effect to the date when the development commenced, or such other date as the

Authority considers to be appropriate in the particular case.

(3) Where the Authority grants development permission under this section, the provisions of section 32 (5) shall apply.

(4) Where the Authority refuses to grant development permission under this section, the provisions of section 37 may apply.

Suspension of effect of compliance notice.

39. (1) If, within 28 days of the service of the compliance notice -

(a) an application is made to the Authority for permission for the retention on the land of any buildings or works to which the compliance notice relates, or for the continuance of any use of the land to which the compliance notice relates; or

(b) notice of an appeal is given under section 75 by a person on whom the compliance notice was served;

the compliance notice shall be suspended and shall not take effect pending the determination of the application or appeal.

Stop Order.

40. (1) Where the Board considers it expedient in the interests of public health , public safety or the integrity of the environment that a breach of planning control should cease before the expiry of the period for compliance with a compliance notice, the Board may, at the same time serve a copy of the compliance notice or afterwards, being at any time before the specified date in the compliance notice, serve an order (in this Act referred to as a 'stop order") to stop the breach.

(2) A stop order shall refer to, and have annexed to it, a copy of the compliance notice to which it relates and shall prohibit any person on whom the stop order is served from carrying out or continuing any specified activities on the land, being activities either alleged in the compliance notice to constitute a breach of planning control or so closely associated therewith as to constitute

substantially the same activities, and shall direct that person to immediately cease and desist from the activities prohibited.

(3) The activities which may be the subject of a stop order shall include the deposit of refuse or waste materials on land or causing environmental damage or actions affecting the health or safety of persons where such action is a breach of planning control alleged in the compliance notice.

(4) A stop order may be served by the Authority on any person who appears to it to have an interest in the land or to be concerned with the carrying out or the continuance of any operations thereon.

(5) A stop order shall -

(a) take effect from the date of its service;

(b) without prejudice to subsection (8) cease to have effect when -

(i) the compliance notice to which it relates is withdrawn or quashed;

(ii) the compliance period expires;

(iii) notice of the withdrawal of the stop notice is served under subsection (8).

(6) If a person on whom a stop order is served carries out, or causes or permits to be carried out, any operations prohibited by the order, he commits an offence and is liable on summary conviction to a fine of forty thousand dollars and if the offence is continued after conviction he shall be liable to a further fine of one thousand dollars for each day on which the offence continues.

(7) A stop order shall not be invalid by reason that the compliance notice to which it relates was not served as required by section 36 of this Act if it is shown that the Authority took all such steps as were reasonably practicable to effect proper service.

(8) The Authority may at any time withdraw a stop order (without prejudice to their power to serve another) by serving notice to that effect on the person on whom the stop order was served and the stop order shall cease to have effect as from the date of withdrawal.

(9) It is declared that -

(a) the Authority need not provide any person with an opportunity to make representation prior to the making of a stop order;

(b) there shall be no right of appeal to the Appeals Tribunal against the making of a stop order;

(c) an appeal against the compliance notice to which it relates shall not suspend the operation of a stop order;

(d) a person on whom a stop order is served may appeal to the Court against the making of the stop order within 28 days of the service of the stop order and the Court may confirm the stop order with or without modification, or quash it in whole or in part;

(e) the making of an appeal referred to in paragraph *(d)* shall not suspend the operation of a stop order, and the stop order shall remain in full force and effect pending the determination of the appeal;

(f) no compensation shall be payable in respect of the prohibition in a stop order of any activity which at any time when the order is in force, constitutes, or contributes to, a breach of planning control.

41. In addition to any other remedy provided by this Act, the Authority may in any case that it thinks fit, institute a civil action for an injunction to prevent any person from violating the provisions of this Act, or to enforce any compliance notice or stop Injunctions.

order, whether or not it has exercised or is proposing to exercise any of its other powers under this Act.

Action by Authority for for non-compliance with compliance notice.

42. (1) If a person on whom the notice was served fails or refuses to take the steps required by the compliance notice to remedy the breach of planning control within the period specified in the compliance notice, the Authority may authorize the Chief Physical Planner to enter the land with such assistance as may be necessary and take those steps in respect of the unauthorised development to enforce the notice as it may see fit.

(2) When the Authority has exercised any power under subsection (1), it may recover as a civil debt, from the person on whom the notice has been served, those expenses reasonably incurred by it in the exercise of such power.

(3) If the person referred to in subsection (2), having been entitled to appeal under section 43 has failed to make such an appeal he shall not be entitled in any proceedings to dispute the validity of the action taken by the Authority or the Chief Physical Planner upon any ground that could have been entertained on such an appeal.

(4) Nothing in this Part shall be construed as requiring development permission to be obtained for the use of land for the purpose for which it could lawfully have been used if the development in respect of which a compliance notice was served under section 36 had not been carried out.

Appeal against compliance notice.

43. (1) If any person on whom a compliance notice is served is aggrieved by the compliance notice, he may at any time within 28 days of the service of the notice appeal against the compliance notice under section 75 and on any such appeal the Appeals Committee -

(a) if satisfied that permission was granted under Part IV for the development to which the compliance notice relates, or that no such permission

was required in respect thereof, or, as the case may be, that the conditions subject to which such permission was granted have been complied with, shall quash the compliance notice to which the appeal relates;

(b) if satisfied that a variation of the compliance notice would be appropriate, may vary the compliance notice accordingly; or

(c) in any other case shall dismiss the appeal.

(2) Where the compliance notice is varied or the appeal is dismissed the Authority may, if it thinks fit, direct that the compliance notice shall not come into force until a date, not being later than 28 days from the determination of the appeal.

Continuing operation of compliance notice.

44. (1) Compliance with the requirements of a compliance notice shall not discharge the compliance notice.

(2) Without restricting the generality of subsection (1), where any development is carried out by way of reinstating or restoring buildings or works that have been demolished or altered in accordance with a compliance notice, the compliance notice shall, notwithstanding that its terms are no longer wholly apt for the purpose, be deemed to apply in relation to any building or works so reinstated or restored as it applied in relation to such building or works before they were demolished or altered, and section 42 (1) and (2) shall apply accordingly.

(3) Without affecting the operation of section 42, a person who carries out any development on land by way of reinstating or restoring buildings or works that have been demolished or altered in accordance with a compliance notice commits an offence and is liable on summary conviction to a fine of five thousand dollars.

Notice requiring discontinuance of use, alteration or removal of building or works.

45. (1) If it appears to the Authority that it is expedient in the interests of the proper planning of Dominica (including the interests of amenity), regard being had to a development plan and to any other material considerations -

(a) that any use of land should be discontinued, or that any conditions should be imposed on the continuance of a use of land; or

(b) that any buildings or works should be altered or removed;

the Authority may with the consent of the Minister, by notice (in this Act referred to as a "discontinuance notice") rquire the discontinuance of that use, or impose such conditions as may be specified in the notice on the continuance thereof, or require such steps as may be so specified to be taken for the alteration or removal of the buildings or works, as the case may be.

(2) The provisions of section 36 (4) to (10) inclusive, and the provisions of sections 37, 39, 42, 43 and 44, shall apply to a notice served under subsection (1) in like manner to a compliance notice served under section 36, save that -

(a) references to a compliance notice in those provisions shall have effect as if they were references to a notice served under subsection (1);

(b) references to a breach of planning control shall have effect as if they were references to the use of land or the buildings or works specified in the notice served under subsection (1);

(c) where a claim for compensation has been submitted under section 69 the provisions of section 42 shall be exercisable only by way of counter-claim, to offset against the said claim for compensation;

(d) section 43 (1) *(a)* shall not apply; and

(e) references to "remedy" the breach of planning control shall have effect as if they were references to the carrying out of the acts and works

required under the notice served under subsection (1), and, notwithstanding the adoption of the said provisions for the purposes of this section, it shall not be inputed that work previously carried out under a valid development permission shall be retrospectively deemed unauthorised.

PART VI

ENVIRONMENTAL PROTECTION

Compliance of a list of buildings.

46. (1) The Authority may, and if so directed by the Minister shall cause a survey of the buildings in the whole or any part of Dominica to be made with a view to determining if, having regard to the importance of preserving the architectural, cultural and historical heritage of Dominca, any such building or part thereof or group of buildings of special architectural or historic interest ought to be preserved or protected, as hereinafter provided.

(2) The Authority shall compile or cause to be compiled or adopt the compilation of a list of the buildings of special architectural or historic interest in any area, and may amend, add to or delete from any such list of buildings so compiled and submit that list to the Minister for his approval.

(3) Before compiling, adopting or amending any list thereunder, the Authority shall consult with the relevant Ministers and such other persons or bodies of persons as appear to it appropriate as having special knowledge of, or interest in buildings of architectural or historic interest.

(4) As soon as may be after the approval of the compilation of a list or the amendment of a list, a notice shall be published in the *Gazette* and at least one newspaper circulating in Dominica, of the compilation or amendment of the list and of the place or places where the list may be inspected.

(5) The Authority shall serve notice on every owner and occupier of a building which has been placed on a list of buildings informing them of that fact.

(6) Subject to this section so long as a building not being a building to which a building preservation order applies, is included in a list compiled or approved under this section, no person shall execute or cause or permit to be executed any works for the demolition of the building or for its alteration or extension in any manner which would seriously affect its character unless no less than 60 days prior to the execution to the works notification of the proposed works has been given in writing to the Authority.

(7) Nothing in subsection (6) shall render unlawful the execution of any works which are urgently required in the interests of safety or health or for the preservation of the building or of neighbouring property, provided that notice in writing thereof has been given to the Authority within a reasonable time after the necessity for the work arises.

(8) Where the Authority received notice of any proposed works under subsection (6) it shall send a copy of the notice to the relevant Ministers and to such other persons or bodies as may be specified by directions of the Minister either generally or in respect of the building in question.

Building preservation orders.

47. (1) Where it appears to the Authority on its own initiative or on the representation made to the Authority or to the Minister by a person or body of persons that it is desirable having regard to the importance of preserving the landscape, architectural, cultural or historical heritage of Dominica to make provision for the preservation of any building or group of buildings of special architectural or historic interest in Dominica, the Authority may for that purpose make an interim building preservation order restricting the demolition, alteration or extension of the building or group of buildings.

(2) For the purposes of this section a group of buildings may be made the subject of a building preservation order if by reason of their proximity and relationship to each other it is considered desirable that the whole group should be preserved.

(3) A copy of the interim building preservation order shall -

(a) be served on every owner and occupier of the building or group of buildings concerned;

(b) be affixed in a prominent place on each building to which the order applies;

(c) specify the building or group of buildings to which it relates;

(d) state the effect of the interim order and when it comes into effect;

(e) invite the owners and occupiers and any other person with an interest in the building or group of buildings to make representations within 28 days of the service or the affixing of the interim building preservation order.

(4) An interim building preservation order shall be in force for a period of 90 days and shall cease to have any effect at the termination of that period unless it is confirmed by the Minister before the termination of that period.

(5) Where an interim building preservation order has been made in respect of a building or group of buildings and while it is in force, any person who executes or causes or permits the execution of any works for the demolition of, alteration or addition to or any other building operations other than essential repairs or maintenance on that building or group of buildings without first obtaining permission from the Authority commits an offence.

(6) In considering whether to grant, with or without conditions, or to refuse permission for any demolition, alteration, addition or other building operations on, or in the curtilage of, a building or group of buildings which is the subject of an interim building preservation order, in addition to any other matters which under the provisions of this Act, it is required to take into account, the Authority shall have regard to -

(a) the matters mentioned in subsections (1) and (2);

(b) the desirability of allowing such economic activity within the building or group of buildings as will facilitate their continued preservation and use; and

(c) the quality of architectural design of any proposed additions to or new buildings within the curtilage of the building or group of buildings.

(7) Notice of the service of an interim building preservation order shall be published in at least one newspaper circulating in Dominica and of the opportunity for any member of the public to make written representations on or objections to the interim preservation order within 28 days of the date of the notice.

(8) The Minister may, after considering the representations of the owners and occupiers and any other representation made under subsection (7) and the comments of the Authority on any such representation, confirm with or without modifications or cancel the interim building preservation order.

(9) An interim building preservation order shall from the date of the confirmation with or without modifications thereto become a building preservation order.

(10) Notice of the making of a building preservation order shall be published in the *Gazette* and at least one newspaper circulating in Dominica.

(11) A building preservation order shall -

(a) be served on every owner and occupier of the building or group of buildings to which it applies;

(b) specify the building or group of buildings to which it applies;

(c) state the effect of the order and when it comes into effect; and

(d) inform the owner and occupier of the building or group of buildings of the opportunities for making an appeal against the order under section 75.

(12) Where an appeal is made against a building preservation order, the order shall remain in force notwithstanding the making of the appeal.

(13) The provisions of subsection (5) apply to a building preservation order as they apply to an interim building preservation order.

Purchase notice with respect to buildings subject to building preservation order.

48. (1) Where the owner of a building for which a building preservation order has been confirmed, claims that -

(a) the building has become incapable of reasonably beneficial use in its existing state; or

(b) the building cannot be rendered capable of reasonably beneficial use by the carrying out of the conditions imposed by the building preservation order;

he may within the prescribed time and in the prescribed manner serve on the Authority a purchase notice requiring the Minister to purchase his interest in the building.

(2) The provisions of section 73 (3) *(a)* and *(b)*, and (4) shall apply to a purchase notice served under subsection (1) as if for the word "land" there were substituted the word "building" and as if for the words "modification or revocation notice, the discontinuance notice, the public access notice or the environmental protection order," there were substituted the words "building preservation order".

Plant preservation order.

49. (1) Where the Minister after consultation with the Minister responsible for the environment, is of the opinion that it is desirable for amenity, environmental, landscape, scientific or similar reasons that any plant or group or species of plants, ought to be preserved, the Minister may make a plant preservation order with respect to such plant, group or species of plant.

(2) Any person who, without the permission with or without conditions of the Authority, cuts down, tops, lops, digs up or destroys the plant, group or species of plant, to which a plant preservation order applies, commits an offence.

(3) A plant preservation order shall-

(a) be served on the owner and occupier of the land on which the plant, group or species of plants, to which the order applies is situated;

(b) specify the plant, group or species of plant, to which it applies;

(c) define the position of the plant, group or species of plant, by reference to a map which shall be available for inspection at a place specified in the order;

(d) state the effect of the plant preservation order and when it comes into effect; and

(e) inform the owner and occupier and any other person with an interest in the land on which the plant, group or species of plant is situated of the opportunities for making an appeal against the plant preservation order.

(4) Where an appeal is made against a plant preservation order, the order shall remain in force notwithstanding the making of the appeal.

(5) No plant preservation order made under this section shall apply to the cutting down, topping or lopping of plants or trees that are dying or dead or have become dangerous or the cutting down, topping or lopping of any plants or trees in compliance with any obligation imposed by or under any Act or so far as may be necessary for the prevention or abatement of a nuisance.

(6) Notice of the making of a plant preservation order shall be published in the *Gazette* and in at least one newspaper circulating in Dominica.

Amenity orders.

50. (1) In any case in which the Authority considers that land is -

(a) unsightly and injurious to the amenity of the area, and visible to persons using a public highway or any other area to which the public has a right of access; or

(b) likely to be or is offensive to persons residing in the immediate neighbourhood of such land, by reason of any waste, rubbish, derelict or abandoned machinery, articles or materials of any kind, or the dilapidated state of any structure or building thereon;

it may prepare and submit to the Minister a draft amenity order.

(2) An amenity order shall state clearly -

(a) the land to which it applies, and the owner or occupier thereof;

(b) any matter that is required to be cleared;

(c) if screening is required to be carried out, the requirements to effect the screening;

(d) the time, not being less than 28 days from the date of service of the order upon the owner or occupier, for compliance with the order;

(e) in the case of an order requiring clearance, the matter which must be destroyed, or the place, being an authorised place for the disposal of rubbish, to which it must be removed, as appropriate;

(f) in the case of a building, the manner in which the building is required to be repaired, painted or demolished, in whole or in part;

(g) where the Authority is aware that the occupier of the land have access to such land on such terms and conditions as may be specified in such notice.

(3) A draft amenity order prepared by the Authority under subsection (1) shall be submitted to the Minister, together with a statement by the Authority in support of the proposed action.

(4) The Minister may approve or reject the draft order.

(5) Where the order is approved by the Minister, copies shall be served on the occupier or owner of the land concerned, or if no such person can be found, may be served by affixing a copy of the order in a conspicuous place on the land concerned.

(6) If any person upon whom an amenity order is served fails to comply with the requirements of the order within the time specified in that order or any extension thereof approved by the Authority, the Authority may arrange for the work to be carried out at the expense of the person who is in default, and may recover the cost of so doing as a civil debt from the person in default.

Appeal against amenity order.

51. (1) Any person upon whom an amenity order has been served under the provisions of section 50 may appeal to the Appeals Committee constituted under Part IX against the making or terms of such order.

(2) An appeal made under subsection (1) may be on any of the following grounds -

(a) the person upon whom an order has been served is not an owner or occupier of the land to which the order applies;

(b) the person upon whom the notice has been served has no control over and no authority to remove, destroy or demolish any matter or building referred to in the order;

(*c*) the time within the order must be complied with is not reasonably sufficient for the purpose;

(*d*) the work specified in the order is unreasonable in character or exent or is unnecessary;

(*e*) that having regard to the character and condition of land and buildings in the immediate neighbourhood, the order is unreasonable.

(3) The Appeals Committee, upon the hearing of an appeal under this section may confirm, with or without modification, or may quash, in whole or in part, the order against which the appeal is made.

(4) Where an appeal is made under this section, the operation of the order which is the subject of the appeal shall be suspended pending the determination of the appeal.

Public access for recreational purposes.

52. (1) Where it appears to the President acting in the advice of the Cabinet that it is desirable that members of the public should have access to any unoccupied State land for open air recreation and preambulation on such land, he may declare by notice in the *Gazette* that the public shall have access to such land on such terms and conditions as may be specified in such notice.

(2) In any other case, the Minister may negotiate an agreement for such access with the owner or tenant thereof, on such terms as may be agreed.

(3) In any case where the Minister is unable to obtain the agreement of the owner or tenant for such access, the Minister may acquire a right of way over such land in accordance with the provisions of the Land Acquisition Act, as being an interest in land required for public purposes within the meaning of that Act, and shall confer a public right of access by notice in the *Gazette* on such terms as may be specified in the notice, but in such case the owner or tenant of the land shall be entitled to receive compensation from the State for the depreciation, if any, in the value of

his interest in the land by reason of such right of access by members of the public.

(4) If agreement cannot be reached in such a case as is mentioned in subsection (3), as to whether or not any compensation is payable or as to the amount thereof, the matter shall be determined in accordance with the provisions of the Land Acquisition Act.

(5) The Minister may at any time alter or amend the terms on which members of the public have access to any land under the provisions of this section, except that where such access has been authorised with the agreement of the owner or tenant, alteration of such terms shall only be authorised with the agreement of the owner or tenant.

Public access and right of way to beaches.

53. (1) There shall be at least one public landward access to every beach in Dominica.

(2) Where there is no alternative public access, traditional public use of a private landward access through an existing private development shall be sufficient grounds for establishing a public right of way over that access for the purpose of access to the beach by the public.

(3) Where the only landward access to a beach is through an existing private development where traditional public use pursuant to subsection (2) of this section has not been established, the State may acquire the right to public use of that beach access by gift, negotiation, contract, purchase or lease, compulsory acquisition in exchange for other property, interest, or financial exemption, or by such other means as the Minister may recommend, as a condition of issuance of any permit or licence required under the provisions of any Act.

(4) Where land is acquired by way of compulsory acquisition for a beach access the provisions of the Land Acquisition Act shall apply in respect of such acquisition.

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(5) Where a proposed development is likely to adversely affect the public's ability to access a beach from the landward side, any development permission shall require as a condition a landward public access through the development at all times free of charge.

(6) In this section "traditional public use" means peaceable, open and uninterrupted enjoyment for a period of 20 years.

Control of advertisements.

54. (1) Subject to this section, provision shall be made by Regulations under this Act for restricting or regulating the display of advertisements so far as appears to the Minister to be expedient in the interest of amenity or public safety, and without restricting the generality of the foregoing, any such Regulations may provide-

(a) for regulating the dimensions, appearance and position of advertisements that may be displayed, the sites on which the advertisements may be displayed, and the manner in which they are to be affixed to land;

(b) for requiring the consent of the Authority to be obtained for the display of advertisements, or of advertisement of any class specified in the regulations;

(c) for applying, in relation to any such consent and to applications therefor, any of the provisions of Part IV relating to permission to develop land and to application for such permission, subject to such adaptations and modifications as may be specified in the regulations;

(d) for enabling the Authority to require the removal of any advertisement that is being displayed in contravention of the Regulations, or the discontinuance of the use for the display of advertisements of any site that is being used for that purpose in contravention of the Regulations, and for that purpose for applying any of the provisions

of this Part with respect to compliance notices, subject to such adaptations and modifications as may be specified in the regulations;

(e) for the constitution, for the purpose of the Regulations, of such advisory panels as may be prescribed by the Regulations, and for determining the manner in which the expenses of any such panels are to be defrayed.

(2) Subject to section 55, Regulations made under this section may be made so as to apply to advertisements that are being displayed on the date on which the regulations come into force, or to the use for the display of advertisements of any site that was being used for that purpose on that date.

(3) Regulations made under this section shall provide for exempting therefrom -

(a) the continued display of any advertisement referred to in subsection (2); and

(b) the continued use for the display of advertisements of any site referred to in subsection (2), during such period as may be prescribed by the Regulations, and different periods may be so prescribed for the purposes of different provisions of the Regulations.

(4) Regulations made under this section may direct that any Act, Regulations or By-laws, affecting the display of advertisements in force on the day when the Regulations made under this section come into operation, shall not apply to the display of advertisements in any area to which the Regulations made under this section apply.

(5) Regulations made for the purpose of this section may make different provisions with respect to different areas and in particular may make special provision -

(a) with respect to environmental protection areas; or

(b) with respect to areas defined for the purposes of the Regulations as areas of special control, being areas which appear to the Minister to require special protection on the grounds of amenity.

(6) In exercising the powers conferred by this section the Minister shall -

(a) in the interests of amenity, determine the suitability of sites for the display of advertisements having regard to any development plan applicable to the area and to the general characteristics of the locality including the presence of any feature of architectural, historic, cultural or similar interest and the natural beauty or scenic value of the locality; and

(b) in the interests of public safety have regard to the safety of persons who may use any road, dock, harbour or airfield and in particular shall consider whether any display of advertisements thereon is likely to hinder or obscure any road or traffic sign or any aid to navigation by air or water.

Supplementary provisions as to advertisements.

55. (1) Where the display of advertisements in accordance with Regulations made under section 54 involves the development of land within the meaning of this Act development permission for that development shall be deemed to be granted by virtue of this section, and no application shall be necessary in that behalf under the provisions of Part IV.

(2) Without affecting any provisions included in regulations made under section 88 (2) (i), a person who displays an advertisement in contravention of the provisions of the Regulations, commits an offence and is liable on summary conviction to a fine of such amount as may be prescribed by the Regulations,

not exceeding five thousand dollars and, in case of a continuing offence, to a further fine not exceeding three hundred dollars for every day after the first day during which the display is so continued.

(3) For the purposes of subsection (2) and without restricting the generality thereof, a person shall be deemed to display an advertisement if -

(a) the advertisement is displayed on the land of which he is the owner or occupier; or

(b) the advertisement gives publicity to his goods, trade, business or other concerns.

(4) A person shall not be guilty of an offence under subsection (2) by reason only that an advertisement is displayed on land of which he is the owner or occupier, or that his goods, trade, business or other concerns are given publicity by the advertisement, if he proves that it was displayed without his knowledge or consent.

Environmental protection area.

56. (1) The Authority may, and if so directed by the Minister shall, cause a survey to be made of the whole or any part of Dominica, either independently of or as part of a development plan made under Part III of this Act, with a view to determining whether any area of Dominica ought to be declared an environmental protection area.

(2) Before finally determining whether to recommend to the Minister that any area should be declared an environmental protection area, the Authority shall -

(a) take such steps as in its opinion will ensure that adequate publicity is given to its proposals in the area to which the proposals relate;

(b) provide persons living and working in the area and any other persons interested in the area with an opportunity of making representations and comments on the proposals;

(c) consult with the Minister responsible for the Environment and any other person, body or authority who appears appropriate as being interested in or having special knowledge on environmental matters; and

(d) receive and take account of the representations and comments received on the proposals.

(3) In determining whether it is desirable to declare any area an environmental protection area the Authority shall have regard to-

(a) the survey prepared under subsection (1);

(b) any representations or comments submitted by any person, body or authority on the proposals;

(c) such of the following matters as may be relevant to the area -

(i) the flora and fauna of the area;

(ii) the natural features and beauty of the area;

(iii) any outstanding geological, physiographical, ecological, or architectural, cultural or historical features of the area which it is desirable to preserve and enhance;

(iv) any special scientific interest in the area;

(v) any special natural hazards to which the area is or may be subject; and

(vi) the characteristics, circumstances and interests of the people living and working in the area.

(4) Where the Authority is of the opinion that any area ought to be declared an environmental protection area it shall submit to the Minister -

(a) its recommendations and proposals;

(*b*) a draft of the environmental protection area order;

(*c*) a report of the survey made under subsection (1); and

(*d*) the representations and comments received on the proposals.

Environmental protection area order.

57. (1) The Minister shall consider the report of the Authority and shall in determining whether to declare any area to be an environmental protection area have regard to the matters set out in section 56 (3).

(2) Where the Minister is of the opinion that it is desirable to afford special protection to an area on account of the matters set out in section 56 (3), he may by Order declare that area to be an environmental protection area.

(3) An Order made under subsection (1) may -

(*a*) designate any part of an environmental protection area as being an area in which, subject to the grant of development permission, only certain development or classes of development may be permitted;

(*b*) prohibit any development within the area or any part thereof;

(*c*) authorize the carrying out in the environmental protection area of such works and the doing on the land of such other things as may be expedient for the protection of the area as an environmental protection area;

(*d*) provide for control over use of land within an environmental protection area for purposes of agriculture or forestry;

(e) without prejudice to the provisions of Part IV, require that any person who proposes to undertake any activity or enterprise of a description or category as may be prescribed shall, no less than 60 days before commencing, notify the Authority of his proposals and furnish to the Authority such documents and information as it may require;

(f) require that environmental impact assessment be undertaken with respect to any proposal for an activity, enterprise or development referred to in paragraphs *(a)* to *(e)*; or

(g) restrict or prohibit the entry into the area of any person or the movement of, or any activity carried out by, any person in the area.

58. (1) In any case in which private land is included in an area which has been declared to be an environmental protection area, and in which the Minister does not acquire the land under the Land Acquisition Act, any person holding any interest in such land shall be entitled to receive compensation from the State for the depreciation if any, of the value of his interest in the land consequential upon any restriction imposed on his use or interest in the land by reason of such declaration, such compensation to be determined in the same manner as compensation payable under section 69.

Land in environmental protection areas.

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(2) If agreement cannot be reached between the Minister and the party concerned as to whether or not any compensation is payable, or as to the amount thereof, the matter shall be determined under the provisions of the Land Acquisition Act.

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59. (1) The Authority may prepare or cause to be prepared an environmental protection area management plan with respect to any area declared to be an environmental protection area under section 57.

Environmental protection area management plan.

(2) The purpose of a plan prepared under this section shall be to set out the operational policies and measures for the preservation, enhancement and management of the special features of the environmental protection area, including as may be relevant to the area to which the order applies, policies and measures for -

(a) the preservation of marine and terrestrial flora and fauna including the regulation of hunting and fishing;

(b) the protection of water supplies, water catchment areas and mineral resources;

(c) the prevention of erosion, landslips and flooding;

(d) the control of fires;

(e) the control of pollution;

(f) the designation of special resource and use areas in the coastal zone;

(g) the use and development of land so as to sustain the local economy of the environmental protection area;

(h) the prohibition, restriction or regulation of access to any area and the prevention of squatting;

(i) the development of facilities for residents and visitors for the enjoyment of the special features of the environmental protection area; and

(j) the development of facilities for educational visits, study and research of the special features of the environmental protection area.

Designation of special resource and use areas.

60. (1) The Minister may, in consultation with the Minister responsible for State lands, by Notice published in the *Gazette*, declare any area of the foreshore or the sea bed as special resource and use areas where public use of certain lands and waters of the foreshore or sea bed needs to be controlled or protected to ensure the safety and welfare of the public and for the preservation of the coastal environmental namely -

(a) protected swimming and surfing areas where other potentially conflicting uses are prohibited; and

(b) designated area for -

(i) anchoring;

(ii) mooring;

(iii) beaching;

of ships, yachts, motor boats, boats and other water craft, and restrictions on the numbers and kinds of ships, yachts, motor boats, boats, and other water craft that may be anchored, moored, or beached in any particular bay or other coastal area at one time;

(c) designated areas where the use of equipment for -

(i) wind surfing;

(ii) water skiing; or

(iii) any other water-related sport, including spear fishing;

is prohibited.

(2) Prohibited and permitted activities in special resource and use areas designated pursuant to this section shall be as specified in the notice, or prescribed by Regulations made under this Act.

Ministerial order to protect the Environment.

61. (1) Where the Minister is satisfied on information received from the Authority, that it is in the public interest for the purpose of preventing or mitigating a specified environmental threat or hazard so to do, he may by Order published in the *Gazette*, and at least one newspaper circulating in Dominica, direct the Authority to take such steps as are necessary to remove, mitigate or prevent any condition that poses or is likely to pose a threat to the environment and the Authority shall act in accordance with such Order.

(2) An Order under subsection (1) may be made to extend to the whole of Dominica or to any part thereof, and may contain such ancillary and supplementary matters as the Minister thinks appropriate for removing, mitigating or preventing any condition that poses or is likely to pose a threat to the environment.

(3) An Order made under subsection (1) shall be subject to negative resolution of Parliament;

(4) The Authority shall cause a copy of every Order made under this section to be posted in a conspicuous place at every police station and post office in Dominica.

(5) Any person who -

(a) obstructs any person in carrying out any measures authorised by an Order under subsection (1); or

(b) contravenes any provision of such Order,

commits an offence, and is liable on summary conviction to a fine not exceeding twenty thousand dollars.

PART VII

BUILDING REGULATION

Application for building control.

62. Subject to the provisions of this Part no person shall commence the construction of a building without first obtaining a building permit issued by the Authority in respect of that building.

Building Regulations.

63. (1) The Minister may make Regulations hereinafter referred to as "Building Regulations" with respect to the design and construction of buildings and the provision of services, fittings and equipment in or in connection with buildings and particularly with respect to the following matters -

(a) as to new buildings -

(i) the preparation and foundation of the site appropriate to the prevailing soil conditions;

(ii) the method of construction, structural strength and stability;

(iii) the suitability and durability of the materials, including materials of short life and their preservation from decay and infestation;

(iv) the space about buildings;

(v) the insulation, lighting and ventilation of rooms;

(vi) the dimensions of rooms and spaces;

(vii) fire precautions and safety;

(viii) plumbing and water supply;

(ix) drainage;

(x) sanitation;

(xi) sewage disposal;

(xii) electrical installations and wiring, gas installations and piping, and telecommunications services;

(xiii) lifts and other mechanical means of conveyance for access;

(xiv) refuse disposal, storage, treatment and removal of waste, and emission of noxious or offensive substances;

(xv) hurricane and earthquake precautions and protection;

(xvi) means of access to and egress from buildings;

(xvii) low cost housing; and

(xviii) matters connected with, or ancillary to, any of the foregoing matters;

(b) as to existing buildings -

(i) structural alterations or extensions to buildings;

(ii) buildings so far as affected by alterations or extensions;

(iii) buildings or part of buildings in cases where the purposes for which or the manner or circumstances in which a building or part of a building is used change or changes in a way that constitutes a material change of use of the building or part as defined, within the meaning of this section;

(c) so far as they relate to the matters mentioned in this paragraph, Regulations made under paragraph *(a)*, may be made to apply to buildings erected before the date on which the Building Regulations came into force but except as aforesaid shall not apply to buildings erected before that date; and

(d) generally, for carrying the purposes or provisions of this Part of the Act into effect.

(2) For the purposes of this Part, there shall be deemed to be a material change in the purposes for which a building or part of a building is used where -

(a) a building, or a part of a building, being a building or part of a building which was not originally constructed for occupation as a house, or which

though so constructed, has been appropriated to other purposes, becomes used as a house;

(b) a building or part of a building being a building or part of a building which was originally constructed for occupation as a house by one family only, becomes occupied as separate establishments by two or more families; or

(c) Building Regulations contain special provisions with respect to buildings used for any particular purpose, a building not previously used for that purpose, becomes so used.

(3) Building Regulations may -

(a) exempt any building, part of a building or class of building from any of the requirements of the Regulations;

(b) provide for different Regulations to apply to different buildings, parts of buildings or classes of buildings; or

(c) provide for the imposition of or impose conditions on any permit to construct a building.

(4) Regulations made under this section may include provisions as to -

(a) the depositing of plans, sections, specifications and written particulars;

(b) the giving of notices and certificates, the inspection and testing or work, (including the power to require the uncovering of work which has been covered prior to inspection), the testing of drains and sewers, and the taking by the Authority or a building inspector of samples of materials to be used in the construction of buildings or in the execution of other works; and

(*c*) the prescribing and payment of fees.

Appointment of building inspectors.

64. It shall be a function of the Authority to enforce Building Regulations and the Authority shall appoint such persons as it shall deem appropriate, as building inspectors, to assist the Chief Physical Planner in the performance of such function.

Passing and rejection of plans.

65. (1) Where plans of any proposed work are, in accordance with Building Regulations, deposited with the Chief Physical Planner, the Chief Physical Planner shall pass the plans, unless -

(*a*) they are defective;

(*b*) they contravene any provision of Building Regulations; or

(*c*) there is a failure to comply with the provisions of this Part, in which case he shall refer those plans to the Authority together with his advice thereon.

(2) If the Chief Physical Planner on referring plans in accordance with subsection (1) considers that the operation of any requirement contained in Building Regulations would be unreasonable in relation to that particular case, he may recommend that the Authority relax or dispense with that requirement.

(3) Building Regulations may provide, as regards any requirement contained in the Regulations, that subsection (2) shall not apply.

(4) On receipt of any plans on a referral by the Chief Physical Planner under subsection (1), the Authority may -

(*a*) reject those plans; or

(*b*) pass them subject to either or both of the following conditions namely -

(i) that such modifications shall be made to the deposited plans as the Authority may specify; and

(ii) that such further plans shall be deposited within such time as the Authority may specify;

in order to bring the plans into conformity with Building Regulations; or

(c) if the Authority is advised by the Chief Physical Planner in the manner indicated by subsection (2), it may relax or, dispense with the requirements of Building Regulations mentioned in that recommendation and pass those plans.

(5) A person by whom, or on whose behalf, plans have been deposited shall, within 60 days or such extended time as may before the expiration of the period be agreed between him and the Authority, be notified in writing by the Chief Physica l Planner whether those plans are passed or rejected.

(6) A notice of rejection of plans shall state the defects on account of which, or the Building Regulation or section of this Act for non-conformity with which, or under the authority of which, the plans have been rejected.

(7) A notice that plans have been passed shall -

(a) specify any condition subject to which they have been passed;

(b) if the plans have been passed by the Authority in exercise of any power to relax or dispense with any requirement of Building Regulations, or this Part, state the requirements of the Building Regulations or this Part, relaxed or dispensed with;

(c) in any case state that the notice that plans have been passed operates as an approval thereof only for the purposes of the requirements of Building Regulations and this Part, and does not constitute development permission.

(8) Any question arising between the Authority or the Chief Physical Planner and the person by whom or on whose

behalf plans are deposited as to whether -

(a) the plans are defective; or

(b) the work would contravene the Building Regulations or this Part; or

(c) a relaxation of or dispensing with the requirements of the Building Regulations ought to have been granted under subsection (4);

may on the application of that person be determined by the Appeals Committee, but no such application may be made unless it is made before the proposed work has been substantially commenced if the question arising under the subsection is a failure on the part of the Chief Physical Planner or the Authority to pass or reject the plans within a time to be specified by the Minister.

Power to require removal or alteration of work.

66. (1) If any work to which Building Regulations apply, contravenes any provision of this Part or of the Regulations, the Authority, without prejudice to any prosecution under this Part, may by notice require the owner either to pull down or remove the work or, if he so elects, to effect such alteration therein as may be necessary to make it comply with Building Regulations or this Part.

(2) If a person to whom a notice has been given under the foregoing provisions of this section fails to comply with the notice before the expiration of the period specified in the notice, or such longer period as the Authority may on his application allow, the Authority or any department or officer of the Government or any contractor or officer of the Government of any contractor engaged by any of them may pull down the work, or effect such alteration therein and the Authority may recover from him the expenses reasonably incurred in so doing as a civil debt.

(3) Nothing in this section shall affect the right of the Authority or of the Attorney General or any other person to apply for an injunction for the removal or alteration of any work on the grounds that it contravenes the Building Regulations or any provision of this Part.

67. (1) A person aggrieved by the giving of a notice under section 66 may appeal to the High Court. Appeal against notices.

(2) On appeal under this section, the Court shall -

(a) if it determines that the Authority was entitled to give notice, confirm the notice; and

(b) in any other case, give the Authority a direction to withdraw the notice.

(3) An appeal under this section shall be brought within 28 days of the giving of notice under section 66 and the notice shall be of no effect pending the final determination or withdrawal of the appeal.

68. Where plans of any proposed work have been deposited in accordance with Building Regulations or this Part, and either the plans have been passed or notice of rejection of them has not been given in accordance with this Part, and the work to which the plans relate has not been substantially completed within 4 years of the deposit of those plans, the deposit of the plans shall be invalid and of no effect. Lapse of deposit of plans.

PART VIII

COMPENSATION AND ACQUISITION

69. (1) If on a claim for compensation made to the Minister in the manner prescribed it is shown that - Claim for compensation.

(a) Where a grant of development permission has been revoked or modified by notice under section 34 -

(i) the holder of that permission, or his successor in title, has incurred expenditure necessarily arising out of commencing to develop or developing in accordance with that permission or has otherwise suffered loss or damage directly attributable to such revocation or modification; or

(ii) any person with an interest in the land or who has lent money on the security of the land, has suffered loss or damage directly attributable to such revocation or modification; or that

(b) a person has suffered loss or damage by depreciation in the value of an interest in land by virtue of -

(i) the refusal of the Authority, where a building has been destroyed by fire, hurricane or other natural disaster, to allow a building of similar cubic content to be erected in the same position, as near as can be, to the destroyed building and for the same purposes for which the destroyed building had been used prior to the fire, hurricane or other natural disaster;

(ii) the making of a notice under section 45 requiring any use of land to be discontinued or imposing conditions on the continuance thereof or requiring that buildings or works on land be altered or removed;

(iii) the making of a public access notice under section 52; or

(iv) the making of an environmental protection area order under section 57;

then the Minister shall, subject to the provisions of this Part, pay to that person compensation assessed in accordance with this Part in respect of that expenditure, loss or damage.

(2) Compensation payable shall be assessed in respect of loss or damage consisting of the depreciation in value of any interest in land directly attributable to the revocation or modification of a development permission if -

(a) the development permitted by the development permission revoked or modified has not been carried out; or

(b) the person claiming compensation acquired an interest in the land or building to which the development permission relates for valuable consideration, after the grant of that development permission and such development permission, at the material time, had not lapsed under the provisions of section 31.

(3) For the purposes of this section, any expenditure incurred in the preparation of plans for the purposes of any work, or upon similar matters preparatory thereto, shall be taken to be included in the expenditure incurred in carrying out that work.

(4) No compensation shall be payable under this sec tion in respect of any work carried out before the grant of development permission which is revoked or modified, or in respect of any other loss or damage (not being loss or damage consisting of depreciation of the value of an interest in the land) arising out of anything done or omitted to be done before the grant of that permission.

(5) If a person has suffered loss or damage consisting of depreciation in value of an interest in land by virtue of a planning decision referred to in section 69 (1), compensation shall be payable in an amount equal to the difference between the value of the interest in the land and what the value would have been if the relevant decision had been a decision to the contrary effect, but no compensation shall be paid under this section in respect of loss or damage consisting of depreciation of the value of an interest in land where that value was attributed to use of the land or development thereon which was in breach of planning control.

(6) A claim for compensation alleged to be payable under this Part shall be made in writing to the Minister within 6 months of the date upon which notice of the decision which gives rise to the claim was served upon the claimant or within 6 months of the date on which the order was made.

(7) When a claim is made under subsection (1), the Minister by written notice served on the claimant, may require the claimant to provide such further information in support of the claim as may be specified in the notice, and a decision on the claim may be deferred until such further information has been supplied by the claimant.

(8) Where a claim for compensation has been made to the Minister -

(a) he shall consult the views of the Authority, who after making such enquiries as it thinks fit shall submit its own recommendation on the matter to the Minister;

(b) and it appears to the Minister that the decision which gave rise to the claim might properly be withdrawn or modified, he may refer the matter to the Appeals Committee for its determination as if the claim for compensation had included an appeal against the decision which gave rise to the claim;

(c) and such claim for compensation cannot be settled through negotiation between the claimant and the Minister, the Minister shall refer the question as to whether any compensation is payable to the claimant, or as to the amount thereof, for decision by the High Court, which for the purpose shall be constituted as provided by the Land Acquisition Act, and the provisions of that Act shall apply *mutatis mutandis* to the assessment of compensation payable under this Part as they apply in the case of compensation payable under the Land Acquisition Act.

Ch. 53:02.

Ch. 53:02.

Position where land is subject to mortgage.

70. Where any compensation is payable under this Part in respect of the depreciation of the value of an interest in land which is subject to a mortgage -

(a) the amount of the compensation payable shall be assessed as if the interest was not subject to the mortgage;

(b) a claim for any part of such compensation may be made by any mortgagee of that interest, but without prejudice to the making of a claim by the person entitled to the interest;

(c) no compensation to which this section applies shall be payable in respect of the interest of the mortgagee (as distinct from the interest which is subject to the mortgage); and

(d) any compensation to which this section applies which is payable in respect of the interest which is subject to the mortgage shall be paid to the mortgagee, or, if there is more than one mortgagee, to the first mortgagee, and shall in either case be applied by him as if it were proceeds of sale.

Registration of claim for compensation.

71. (1) Where a claim for compensation is made under section 69 notice of the fact shall -

(a) be recorded in the register of planning applications; and

(b) be deposited with the Registrar of Titles.

(2) Notices deposited under this section shall specify -

(a) the land to which the claim for compensation relates;

(b) the relevant planning decision, notice, or order to which the claim for compensation relates; and

(c) the amount of the compensation and any apportionment of it among claimants.

Acquisition of land in lieu of compensation.

72. Where a claim for compensation under this Part, in respect of any interest in land has been determined in accordance with section 69, the Minister may, within one month after the date of the determination of such compensation and instead of having the same paid, cause to be made an offer in writing to purchase the interest in the land to which the claim for compensation relates, and if the person entitled to that interest is unwilling to sell the same, the Minister may forthwith cause the interest to be acquired compulsorily under and in accordance with the provisions of the Land Acquisition Act.

Ch. 53:01.

Purchase notice with respect to adverse decisions.

73. (1) Where any person having an interest in land for which -

(a) a grant of development permission has been refused and there is available with respect to that land no development permission to which this Act applies;

(b) development permission has been revoked or modified by imposition of conditions;

(c) a discontinuance notice has been served under section 45;

(d) a public access notice has been made under section 52; or

(e) an environmental protection area order has been made under section 57;

claims that such land has become incapable of reasonably beneficial use in its existing state, or cannot be rendered capable of reasonably beneficial use by the carrying out of the conditions of the modification or revocation notice, the discontinuance notice, the public access notice or the environmental protection area order as the case may be; he may within the prescribed time and in the prescribed manner serve on the Authority a purchase notice, requiring the Minister to purchase his interest in the land.

(2) Where the purchase notice served under subsection (1) relates to the refusal of development permission, the making

of a modification or revocation notice of the making of a discontinuance notice, the Minister may if he considers it expedient so to do, refer it to the Appeals Committee for reconsideration of the refusal of grant of development permission, the making of the modification or revocation notice or the making of the discontinuance notice.

(3) The Minister may -

(a) refuse to confirm the purchase notice; or

(b) if satisfied that the land has become incapable of reasonably beneficial use in its existing state, or cannot be rendered capable of reasonably beneficial use by the carrying out of the conditions of the modification or revocation notice, the discontinuance notice, the public access notice, or the environmental protection area order as the case may be, shall confirm the purchase notice; or

(c) instead of confirming the notice -

(i) grant development permission to any development application in question;

(ii) cancel or amend the modification or revocation notice; or

(iii) revoke or amend the discontinuance notice.

(4) Where the Minister confirms a purchase notice, the Authority shall serve a notice on the owner to compulsorily acquire the interest of the owner in the land in accordance with the Land Acquisition Act. Ch. 53:02.

PART IX

APPEALS

Establishment of Appeals Committee.

74. (1) There is hereby established an Appeals Committee which, in addition to the jurisdiction, power and authority conferred upon it by this Part and by any Regulations made hereunder, shall advise the Minister on any matter which he may refer for its advice under the provisions of this Act.

(2) The Appeals Committee shall consist of not less than three nor more than five members appointed by the Minister of whom the Chairman shall be a legal practitioner of not less than 10 years standing, and the other members shall be appointed from among persons trained and experienced in -

(a) physical planning;

(b) architecture;

(c) engineering;

(d) environmental, coastal and marine matters.

(3) A member of the Appeals Committee shall hold office for a period not exceeding two years but such a member shall be eligible for reappointment.

(4) The names of all members of the Appeals Committee as first constituted and every change in the membership thereof shall be published in the *Gazette*.

(5) The Minister shall appoint a secretary to the Appeals Committee and such other officers as may be necessary to provide assistance to the Appeals Committee.

(6) The secretary shall keep a written record of all proceedings of the Appeals Committee which shall be confirmed by the Chairman.

(7) The decisions of the Appeals Committee shall be by a majority of votes of members present and voting and in addition to an original vote, the chairman shall have a second or casting vote in any case in which the voting is equal.

(8) It shall be the duty of a member of the Appeals Committee who is in any way directly or indirectly interested in a matter coming before the Appeals Committee to declare the nature of his interest in the matter as soon as it is practicable for him to do so, and he shall take no part directly or indirectly in any

deliberation, discussion, consideration or similar activity by the Appeals Committee on that matter.

(9) Subject to the provisions of this Part, the constitution and procedure of the Appeals Committee shall be such as may be prescribed by the Minister.

75. (1) An applicant, or person other than an applicant, whose interest in land may be affected by a decision of the Authority set out in subsection (2) if dissatisfied with such a decision of the Authority may appeal to the Appeals Committee against that decision in the manner prescribed hereunder. Right of appeal.

(2) An appeal shall lie to the Appeals Committee against any decision made by the Authority under this Act -

(a) refusing a grant of development permission;

(b) imposing conditions on a grant of developing permission;

(c) refusing consent to display an advertisement;

(d) any condition subject to which consent to display an advertisement has been granted;

(e) rejecting building plans as being defective or in contravention of Building Regulations;

(f) refusing to relax or dispense with the requirements of the Building Regulations;

(g) modifying or revoking a grant of development permission;

(h) requiring the completion of a development within a time limit;

(i) imposing a building preservation order or a plant preservation order, except that no appeal shall lie against an interim building preservation order;

(j) making an amenity order, on any of the grounds mentioned in section 50 (2);

(k) issuing a compliance notice or as to the terms thereof; or

(l) issuing a notice requiring discontinuance of use or alteration or removal of buildings or works.

(3) Subject to any provisions to the contrary in this Act an appellant wishing to appeal under subsection (2) shall -

(a) within 42 days of the determination of the decision which is to be appealed against under subsection (2) *(a)* to *(f)*;

(b) within 42 days of the date on which the notice or order which is to be appealed against under subsection (2) *(g)* to *(j)* was served;

(c) within the period specified in the notice as the period at the end of which the notice is to take effect in the case of a notice which is to be appealed against under subsection (2)*(k)* and *(l)*;

send a Notice of Appeal to the secretary of the Appeals Committee who shall forthwith on receipt thereof send a copy of such notice to the Minister and the Authority.

(4) A notice given under subsection (3) shall set out -

(a) concisely the decision appealed against;

(b) a description of the land affected thereby;

(c) the name of the appellant;

(d) the interest of the appellant in the land affected by the decision; and

(e) concisely the grounds on which the appellant wishes to appeal against the decision.

(5) A notice given under subsection (3) shall be accompanied by -

(a) a copy of all papers and documents submitted by the appellant or any person acting on his behalf to the Authority;

(b) a copy of the decision appealed against; and

(c) a plan sufficiently identifying the location and boundaries of the land affected by the decision.

(6) On receipt of a copy of the notice given under subsection (3) the Appeals Committee shall reject the notice of appeal if -

(a) it appears not to comply with subsection (4); or

(b) the appellant appears not to have any sufficient interest in the land to justify him appealing against the decision.

(7) Where a Notice of Appeal is not rejected under subsection (5), the Appeals Committee shall, in its discretion, direct whether the appeal shall be dealt with by public inquiry or by written representations and shall, within 28 days of receipt of the Notice of Appeal, notify the appellant and the Authority accordingly.

(8) The Appeals Committee shall take the following matters into consideration before deciding whether the appeal may be dealt with by written representations or by public enquiry -

(a) whether the public interest requires that all persons, including the appellant, who may have a view to express in relation to the matter to which the appeal relates should have an opportunity of having their views taken into account, of submitting evidence and of examining witnesses called by others;

(b) without prejudice to the generality of paragraph *(a),* whether it would be reasonably practicable to deal with the appeal by way of written representations; and

(c) the importance of the matter to which the appeal relates.

(9) Where the Appeals Committee decides that a public inquiry shall be held, it shall notify the appellant and the Authority of the fact and of the time and place at which the public inquiry shall be held and a notice thereto shall be published in the *Gazette* and in at least one newspaper circulating in Dominica.

(10) Unless the Appeals Committee directs that a public inquiry shall be held in relation to an appeal, the appeal shall be dealt with by written representations.

Procedure at public inquiries.

76. (1) It shall be the primary function of a public inquiry to examine the issues between the parties and to determine the merits of the appeal having regard to the purposes of this Act set out in section 3, the need to secure consistency in the execution of policy, any approved plan relevant to the issues and any other relevant considerations.

(2) Subject to the provisions of this Act and any Regulations, the Appeals Committee may determine the procedure to be followed at any public inquiry directed under section 75 as appears to it convenient to enable the functions referred in section 75 (2) to be fulfilled without being bound to adopt such procedure as might be appropriate in a court, provided that the Appeals Committee shall -

(a) at all times have regard to the rules of natural justice in the conduct of the proceedings for the determination of the appeal; and

(b) ensure, when hearing evidence of one party, that the other party has had an opportunity to consider that evidence and to make comment or representation on it.

(3) Without prejudice to the generality of subsection (1)-

(a) the Appeals Committee may hold a pre-inquiry review of the issues with the Authority and the

appellant and may issue directions in writing to both parties concerning-

(i) the form and procedure to be adopted at the inquiry;

(ii) the dates and likely duration of the inquiry;

(iii) the Appeals Tribunal's identification of the issues to be examined;

(iv) the evidence required;

(v) whether third party agencies and persons who made representations or were consulted on the application are required to give evidence;

(vi) the incident of the burden of proof; and the standard of proof required;

(vii) the exchange of proofs of evidence;

(viii) the dates of any proposed site visits, giving both parties an opportunity to be present at the site visits;

(ix) any other matters which the Appeals Committee considers necessary for the fair and expeditious examination of the appeal;

(b) there may be given and received in evidence at a public inquiry any material which the Appeals Committee may consider relevant to the subject matter of the inquiry whether or not it would be admissible in a court of law;

(c) evidence at a public inquiry may be given on oath or affirmation or as unsworn evidence or partly as sworn evidence and partly as unsworn evidence, as the Appeals Committee may think fit;

(d) any interested party may appear in person or may be represented by another person acting with his authority, whether or not the other person is a legal practitioner.

Record of proceedings of public inquiry.

77. (1) A record shall be kept of all public inquiries held by the Appeals Committee.

(2) The record under this section shall contain -

(a) the name and address of any person heard at the public inquiry and, where any such person was represented by another, the name and address of that representative;

(b) the name and address of any person giving evidence at the public inquiry;

(c) a summary of the evidence given by each person at the public inquiry;

(d) an inventory of all exhibits including models, maps, plans, drawings, sketches, diagrams, photographs, petitions, and written statements received in evidence at the inquiry;

(e) the Appeals Committee's findings of fact in relation to any relevant matter;

(f) a full and clear account of the reasoning of the Appeals Committee on which its decision is based; and

(g) the determination of the Appeals Committee as to the manner in which the appeal should be disposed of.

(3) Every record under this section shall be accompanied by all documents referred to in subsection (2) *(b)*.

Appeals by written representations.

78. (1) Whenever the Appeals Committee has directed that an appeal to which section 75 relates shall be dealt with by written representations, the secretary to the Appeals Committee shall send a copy of the direction to the appellant and to the Authority and each of them shall within 6 weeks thereafter send to the Appeals Committee and to the other of them such written representations as they wish to make in relation to the appeal (herein referred to as "written representation").

(2) Within 28 days of the receipt of the written representations of the other, or within the 6 weeks period specified in subsection (1), whichever is the later, the appellant and the Authority shall send to the Appeals Committee and to the other of them in writing such further representations as they may wish to make arising out of the written representations of the other.

(3) The Appeals Committee in deciding an appeal by written representations, shall not -

(a) receive any oral evidence; or

(b) consider any representations in writing other than those provided for by subsections (1) and (2) unless it has given the appellant or the Authority a full and sufficient opportunity of answering them in writing.

(4) The record to be kept of the proceedings under this section shall contain -

(a) a list of the names and addresses of the parties;

(b) a summary of the written representations submitted;

(c) a list of all models, maps, plans, drawings, sketches, diagrams, photographs, petitions, and written statements submitted with the written representations;

(d) the Appeals Committees findings of fact in relation to any relevant matter;

(e) a full and clear account of the reasoning of the Appeals Committee on which its decision is based; and

(f) the determination of the Appeals Committee as to the manner in which the appeal should be disposed of.

(5) The Appeals Committee acting in its discretion shall, following the expiration of the period specified in subsection (2), decide the appeal and in deciding shall have like powers to those under section 79 (1) *(a)*, *(b)*, *(c)*, and *(d)*.

Decision and notification of appeal.

79. (1) The Appeals Committee in deciding whether to allow or dismiss an appeal may-

(a) allow the appeal in whole or in part and quash the decision of the Authority;

(b) if it allows the appeal in part, do so by varying the decision of the Authority in any manner and subject to any conditions or limitations it thinks fit, but not so as to impose any condition or requirement the Authority had no power under this Act to impose when making the decision or taking the action appealed against;

(c) correct any procedural defect in the decision or error of law in the order of the Authority appealed against; or

(d) dismiss the appeal and confirm the decision of the Authority.

(2) As soon as reasonably possible after the decision of the Appeals Committee, the Secretary of the Appeals Committee shall send to the appellant, the Authority and the Minister, written notification of the determination of the appeal together with full and clear reasons for that determination.

80. (1) Save as provided in this Act no appeal shall lie against a decision of the Authority in a matter to which section 75 relates otherwise than as provided for by sections 75 to 79 inclusive nor shall any such decision or order be reviewable in any manner by any court. Appeals to the High Court.

(2) Save as otherwise provided in this section the decision of the Appeals Committee shall be final.

(3) An appeal shall lie to the High Court from a decision of the Appeals Committee on a point of law but not on any matter of fact and not in any manner upon the merits of the policies applied by the Authority or the Appeals Committee in reaching the relevant decision.

(4) An appeal to which subsection (3) relates shall be filed in the High Court within 28 days of the notification of the decision of the Appeals Committee.

PART X

MISCELLANEOUS AND SUPPLEMENTARY

81. (1) Subject to subsection (2), the Minister, any member of the Authority, the Chief Physical Planner, or any person authorised by him in writing, may during all reasonable working hours enter on any land or any building - Powers of entry.

(a) to inspect or survey the land, or any building for the purpose of the preparation of any development plan, or to decide on whether or not any development plan should be prepared under the provisions of Part III;

(b) to obtain information relevant to the determination of any application for development permission or for any consents, licences or permits;

(c) to determine whether any breach of planning control is being or has been undertaken on the land or in any building thereon;

(d) to determine whether any order or interim order should be made under Part VI or for the exercise of any powers conferred by any such order;

(e) to determine whether or not any compensation is payable under Part VIII, or as to the amount thereof; or

(f) to ensure compliance with the Act and Regulations.

(2) Any person who intends to enter on any land or building under the provisions of this section, without the consent of the owner or occupier thereof, shall give such owner or occupier not less than twenty-four hours written notice of his intention so to do and the intended purpose of such entry; and if the person entering requires to search and bore for the purpose of examining the nature of the sub-soil, that fact shall be stated in the notice.

(3) Before exercising any powers under this section, the Chief Physical Planner or any other person concerned shall provide evidence of his identity and authority to the occupier or other person who is or appears to be in control of the land or building concerned.

(4) The powers conferred by this section shall be deemed to extend to permit the Chief Physical Planner or other person concerned to make such examination and inquiries as are necessary to achieve the purposes for which the entry was authorised.

(5) If any damage is caused by reason of the exercise of any right of entry conferred by this section, or in the making of any survey for the purpose for which such right of entry was conferred, or by the wrongful or negligent use of powers conferred, or alleged to have been conferred, by this section, the Authority as soon as may be after such entry, shall pay compensation to the person injured thereby.

(6) If the amount of such compensation cannot be agreed, the amount payable shall be determined in the same manner as

compensation payable under section 69, and the Chief Physical Planner shall refer the matter accordingly.

(7) Nothing in subsection (2) or (5) applies in respect of any work or operation which the Minister, the Authority, or any public officer is authorised to do or carry out in relation to any building or land under Part VII or the Building Regulations and for the purposes of Part VII and those Regulations it is declared that the Minister, the Authority and any public officer has a right to enter on any land or in any building at all reasonable working hours -

(a) for the purpose of ascertaining whether there is, or has been, on or in connection with the premises, a contravention of Part VII of this Act, or of the Building Regulations;

(b) for the purpose of ascertaining whether or not circumstances exist that would authorize or require the Authority to take any action, or execute any work, under Part VII of this Act or under the Building Regulations;

(c) for the purpose of taking any action, or executing any work, authorised or required by Part VII of this Act or the Building Regulations or by notice made under Part VII of this Act or under the Building Regulations; or

(d) generally for the purpose of the performance by the Authority of its functions under Part VII of this Act of the Building Regulations.

(8) No compensation shall be payable in respect of the exercise of any power specified in this subsection.

(9) Any person who hinders or obstructs the Authority or any public officer in the exercise of any power of entry commits an offence and shall be liable on summary conviction to a fine of one thousand dollars or to imprisonment for six months.

Service of notices.

82. (1) Any notice or other document required or authorised to be given or served under this Act or under any regulation, order, direction or other instrument made under this Act may be served on or given to the person concerned -

(a) by delivering it to that person;

(b) by leaving it at the usual or last known place of abode of that person;

(c) by sending it in a prepaid registered letter addressed to that person at his usual or last known place of abode or, where an address for service has been given by that person, at that address;

(d) in the case of a body corporate, or other body, by delivering it to the secretary or other officer of that body at its registered or principal office in Dominica, or by sending it in a prepaid registered letter addressed to the secretary or other officer of that body at that office; or

(e) where a facsimile number or e-mail address has been provided by a person, by a facsimile or e-mail transmission which provides confirmation of receipt.

(2) In any case where a notice or other document has been served by a means other than personal delivery, it shall be deemed to have been served, given or delivered 4 days after it was left, nailed or affixed, as the case may be, or if it was sent by facsimile or e-mail, on the day after it was so sent.

Power to require information.

83. (1) For the purpose of enabling the Minister, the Authority or the Chief Physical Planner to make an order or serve a notice or other document under the provisions of this Act, the Chief Physical Planner may require the owner or the occupier of any premises, and any person who either directly or indirectly, receives rent in respect of any land or premises, to state in writing the nature of his interest therein, and the name and address of any other person known to him to have an interest therein, whether as a freeholder, mortgagee, lessee or otherwise.

(2) Any person who, having been required in pursuance of this section to give any such information, without reasonable cause fails to give the information within 28 days of being so required, or such longer period as the Chief Physical Planner may allow in any particular case, commits of an offence and is liable on summary conviction to a fine of five hundred dollars.

(3) Any person to whom information has been given under this section, or otherwise under this Act, or who has obtained any information in the course of his duties under this Act, who makes any unauthorised disclosure of that information to any person who is not required to receive that information commits an offence and is liable on summary conviction to a fine of ten thousand dollars or to imprisonment of six months, or to both such fine and imprisonment.

Register to planning decisions.

84. (1) The Chief Physical Planner shall maintain a register of all -

(a) applications for a grant of development permission;

(b) decisions on applications referred to in paragraph *(a)* and any conditions attached to development permissions;

(c) notices of modification or revocation of grant of development permission;

(d) compliance notices, stop notices, injunctions and discontinuance notices;

(e) public access agreements or notices under sections 52 and 53;

(f) any orders made or notices served under Part VI;

(g) applications for approval of plans under the Building Regulations;

(h) decisions on applications referred to in paragraph *(g)* and any conditions attached to approvals;

(i) development agreements under section 29;

(j) purchase notices under sections 48 and 73;

(k) applications for express consent to display advertisements under section 54;

(l) claims for compensation under section 69; and

(m) decisions on appeals against any decisions made or action taken under this Act.

(2) Any person who so requests shall be provided by the Chief Physical Planner with a copy of any entry in the register upon payment of the prescribed fee.

(3) The register required to be maintained by subsection (1) shall include an index which shall be in the form of a map and both the register and the index may be kept in an electronic data storage and retrieval system whether by use of a computer or otherwise.

Notification to Registrar of Titles.

85. (1) The Chief Physical Planner shall notify the Registrar of Titles giving full details with respect to the parcels of land affected, of every -

(a) modification or revocation of a grant of development permission;

(b) compliance notice;

(c) discontinuance notice;

(d) building preservation order or interim building preservation order;

(e) plant preservation order;

(f) amenity order;

(g) public access agreement or notice;

(h) development agreement;

(i) claim for compensation; or

(j) purchase notice.

(2) The Registrar of Titles shall duly record the matters referred to in subsection (1) on the Register of Titles.

Death of person having claim or right.

86. Any reference in this Act to any person having a claim for or a right to the payment of compensation, or to appeal against any decision given under this Act, upon the death of that person before the determination of the matter at issue, shall be construed as if such reference were a reference to that person's personal representative.

Offences.

87. (1) Any person who, without reasonable excuse -

(a) fails to comply with the requirements of -

(i) a compliance notice issued under section 36;

(ii) a notice to discontinue use or to alter or remove buildings or works issued under section 45;

(iii) a building preservation order or interim building preservation order made under section 47;

(iv) a plant preservation order made under section 49;

(v) an amenity order made under section 50;

(b) fails to comply with any requirement of Part VII or of the Building Regulations made thereunder;

(c) obstructs or hinders any person in the exercise of any right conferred under an access notice made under section 52;

(d) wilfully gives false information, relating to any matter in respect of which he is required to give information under this Act;

(e) obstructs any person in the exercise of any powers or the performance of any duties under this Act; or

(f) fails to comply with any Regulations made with respect to the control of any activities in, or the management of, any environmental protection area,

commits an offence and is liable -

(i) on summary conviction to a fine of five hundred dollars, and if, in the case of a continuing offence, the contravention is after such conviction, he commits a further offence and is liable to a fine of one hundred dollars for each day on which the contravention continues; or

(ii) on conviction on indictment, to a fine of ten thousand dollars, or to imprisonment for six months, or to both such fine and imprisonment.

(2) Where an offence under this Act is committed by a body corporate and is proved to have been committed with the consent or connivance of any director, manager, secretary or other similar officer of the body corporate, or of any person who was purporting to act in such capacity, he, as well as the body corporate, shall be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

(3) Proceedings in respect of an offence alleged to have been committed under this Act may be brought, with the approval of the Authority, by the Chief Physical Planner, provided that if it is considered that the gravity of the offence requires that it be tried on indictment, proceedings shall only be brought by or with the consent of the Director of Public Prosecutions.

88. (1) The Minister may make Regulations for carrying into effect the provisions of this Act. Regulations.

(2) Without derogation from the generality of the power conferred by subsection (1), such Regulations may provide for -

(a) the form and scope of development plans;

(b) the procedures for public representations during the preparation of a plan;

(c) the procedures to be followed and the forms to be used in connection with -

(i) applications for a grant of development permission;

(ii) consultation on applications for development permission;

(iii) compliance notices;

(iv) the modification or revocation of a grant of development permission;

(v) claims for compensation;

(vi) purchase notices;

(d) development which may be permitted under section 17 (2), without the requirement of a prior grant of development permission;

(e) the designation of classes of development which are likely to derogate from amenity under section 22;

(f) the management and protection of environmental protection areas and the preservation of any form of marine or other wildlife therein;

(g) the procedures for environmental impact assessment and the form of environmental impact statements;

(*h*) access to land for recreational purposes and to beaches;

(*i*) fees payable for the purposes of the Act;

(*j*) the procedures of the Authority;

(*k*) the qualifications required of person signing forms, plans and drawings on behalf of any applicant for development permission and the qualifications required of persons preparing environmental impact statements;

(*l*) the control of advertisements;

(*m*) the preservation of buildings or plants;

(*n*) the form of the register to be maintained under section 84;

(*o*) procedures of the Appeals Committee;

(*p*) Building Regulations.

Repeal.

89. The Town and Country Planning Act, 1975 is hereby repealed.

Act binds state.

90. This Act binds the State.

(Section 9 (4)(d).)

SCHEDULE I

MATTERS FOR WHICH PROVISION MAY BE MADE IN DEVELOPMENT PLANS

PART I

ROADS

1. Reservation of land for roads and establishment of public rights of way including public rights of way to and over beaches.

2. Closing or diversion of existing roads and public and private rights of way.

3. Construction of new roads and alteration of existing roads.

4. The line, width, level, construction, access to and egress from the general dimensions and character of roads, whether new or existing.

5. Providing for and generally regulating the construction or execution of works incidental to the making or improvement of any road, including the erection of bridges, culverts, gullies, fencing, barriers, shelters, the provision of artificial lighting, and seats and the planting or protecting of grass, trees and shrubs on or adjoining such road.

PART II

BUILDING AND OTHER STRUCTURES

1. Regulating and controlling, either generally or in particular areas, all or any of the following matters:

(a) the size and height of buildings and fences;

(b) building lines, coverage and the space about buildings;

(c) the objects which may be affixed to buildings;

(d) the purposes for the manner in which buildings may be used or occupied including in the case of dwelling houses, the letting thereof in separate tenements;

(e) the prohibition of building or other operations on any land, or regulating such operations.

2. Regulating and controlling the design, colour and materials of buildings and fences.

3. Allocating any particular land, or all land in any particular area, for buildings of a specified class or classes or prohibiting or restricting either permanently or temporarily, the making of any building or any particular class or classes of buildings on any specified land.

4. Limiting the number of buildings or the number of buildings of a specified class which may be constructed, erected or made, on, in or under any area.

PART III

COMMUNITY PLANNING

1. Providing for the control of land by zoning or designating specific uses.

2. Regulating the layout of housing areas including density, spacing, grouping and orientation of houses in relation to roads, open spaces and other buildings.

3. Determining the provision and siting of community facilities including shops, schools, churches, meetings halls, play centres and recreation grounds in relation to the number and siting of houses.

PART IV

AMENITIES

1. Allocation of lands as open spaces whether public or private.

2. Allocation of land for burial grounds and crematoria.

3. Allocation of lands-

(a) for communal parks;

(b) for game and bird sanctuaries;

(c) for the protection of marine life;

(d) for national parks and environmental protection areas.

4. Preservation of buildings, caves, sites and objects of artistic, architectural, archaeological, historical, or cultural interest.

5. Preservation or protection of forests, woods, trees, shrubs, plants and flowers.

6. Protection of the coastal zone, designation of marine parks, special resource and special use areas.

7. Prohibiting, restricting or controlling, either generally or in particular places, the exhibition, whether on the ground, or any building or any temporary erection, whether on land or in water, or in the air, of all or any particular forms of advertisement or other public notices.

8. Preventing, remedying or removing injury to amenities arising from the ruinous or neglected condition of any building or fence, or by the objectionable or neglected condition of any land attached to a building or fence or abutting on a road or situate in a residential area.

9. Prohibiting, regulating and controlling the deposit or deposal of waste materials and refuse, the disposal of sewage and the pollution of rivers, lakes, ponds, gullies beaches and the seashore.

PART V

PUBLIC SERVICES

Facilitating the establishment, extension or improvement of works by statutory or other undertakers in relation to power, lighting, water supply, sewage, drainage, sewage disposal, refuse disposal or other public services.

PART VI

1. Facilitating the establishment, extension or improvement of systems of transport whether by land, water or air.

2. Allocating sites for use in relation to transport, and the reservation of land for that purpose.

3. Providing for the establishment, extension or improvement of telegraphic, telephone, wireless or radar communication, the allocating of sites for use in relation to such communication, and the reservation of land for that purpose.

PART VII

MISCELLANEOUS

1. Providing for regulating the making of agreements for the purpose of a development plan by the Minister with a local authority or with owners and other persons, and by a local authority with such persons and by such persons with one another.

2. Sub-division of land and in particular, but without restricting the generality of the foregoing -

(a) regulating the type of development to be carried out and the size and form of plots;

(b) requiring the allocation of land for any of the public services referred to in Part V or for any other

purposes referred to in this Schedule for which land may be allocated;

(c) prescribing the character and type of public services or other works which shall be undertaken and completed by any applicant for permission to sub-divide as a condition of the grant of such permission;

(d) co-ordinating the sub-division of contiguous properties in order to give effect to any scheme of development appertaining to such properties.

3. Making any provisions necessary for -

(a) adjusting and altering the boundaries and areas of any towns;

(b) enabling the establishment of satellite towns and new towns;

(c) effecting such exchanges of land or cancellation of existing sub-division plans as may be necessary or convenient for the purposes aforesaid.

SCHEDULE II

(Section 18(3) and 23).

MATTERS FOR WHICH ENVIRONMENTAL IMPACT ASSESMENT SHALL BE REQUIRED

1. Hotels of more than twelve rooms;
2. Sub-divisions of more than six plots;
3. Residential development of more than six units;
4. Any industrial plant which in the opinion of the Authority is likely to cause significant adverse environmental impact;
5. Quarrying and other mining activities;

6. Marinas;
7. Land reclamation, dredging and filling of ponds;
8. Airports, ports and harbours;
9. Dams and reservoirs;
10. Hydro-electric projects and power plants;
11. Desalination plants;
12. Water purification plants;
13. Sanitary land fill operations, solid waste disposal sites and other similar sites;
14. Gas pipeline installations;
15. Any development projects generating or potentially generating emissions, aqueous effluent, solid waste, noise/vibration or radioactive discharges;
16. Any development involving the storage and use of hazardous materials;
17. Coastal zone developments;
18. Development in wet lands, marine parks, national parks, conservation areas, environmental protection areas or other sensitive environmental areas.

Passed in the house of Assembly this 16th day of April, 2002.

ALEX F. PHILLIP (Mrs.)
Clerk of the House of Assembly

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ENVIRONMENTAL AND PLANNING REGULATIONS FOR RENEWABLE ENERGY, 2010

ARRANGEMENT OF REGULATIONS

THE COMMONWEALTH OF DOMINICA
ENVIRONMENTAL AND PLANNING REGULATIONS FOR RENEWABLE ENERGY
Draft of February 26, 2010

STATUTORY RULES AND ORDERS No. ___ of 20___

REGULATIONS

MADE by the Minister under section 88 of the Physical Planning Act, 2002 (Act No.5 of 2002)

PART I
PRELIMINARY

1. Short title and commencement

These Regulations may be cited as the "Environmental and Planning Regulations for Renewable Energy" and shall come into force on the date of publication in the *Gazette*.

2. Interpretation

In these Regulations—

"**Authority**" means the Physical Planning and Development Authority established under section 4 of the Physical Planning Act, 2002;

"**blowout**" means the sudden release of solid, liquid, or gas;

"**contaminant or pollutant**" has the same meaning as in the Environmental Health Services Act, 1997;

"**certificate of approval**" has the same meaning as in the Environmental Health Services Act, 1997;

"**compliance notice**" has the same meaning as in the Physical Planning Act, 2002;

"**emission**" has the same meaning as in the Environmental Health Services Act, 1997;

"**environment**" has the same meaning as in the Physical Planning Act, 2002;

"**developer**" means (without prejudice to the meaning of "geothermal resource developer" as defined in the Geothermal Resources Development Bill, 2010) a person who undertakes, or intends to undertake, renewable energy developments in the Commonwealth of Dominica;

"**development**" has the same meaning as in the Physical Planning Act, 2002;

"**development permission**" has the same meaning as in the Physical Planning Act, 2002;

"**development plan**" has the same meaning as in the Physical Planning Act, 2002;

"**discharge**" has the same meaning as in the Environmental Health Services Act, 1997;

"**distributed renewable energy development**" means [(as defined by the United States Environmental Protection Agency)] small, modular, decentralized, grid-connected or off-grid renewable energy systems located in or near the place where energy is used;

"**ecological system**" means the organic and inorganic matter, living organisms and nonliving elements comprised in a particular area;

"**environmental impact assessment**" has the same meaning as in the Physical Planning Act, 2002;

"**environmental impact statement**" has the same meaning as in the Physical Planning Act, 2002;

"**geothermal energy**" means the energy contained in geothermal resources as defined in the Geothermal Resources Development Act, 20__;

"**Government**" means the Government of the Commonwealth of Dominica;

"**hydro energy**" is the energy derived from moving masses of water;

"**renewable energy**" means [(as defined by the United States Energy Information Administration)] energy sources that are naturally replenishing and virtually inexhaustible in duration, but limited in the amount of energy that is available per unit of time. They include geothermal, hydro, wind, solar, biomass, ocean thermal, wave action, and tidal action energy sources;

"**visual amenity**" means the elements and values that create the appeal of a particular place;

"**wind energy**" means the energy contained in the movement of atmospheric air masses that can be used for generating electricity.

PART II
OBJECTIVE

3. Objective of these Regulations

The objective of these Regulations is to allow the development of renewable energy resources while safeguarding the natural environment and the public welfare of the Commonwealth of Dominica.

PART III
PROCEDURE FOR DEVELOPMENT PERMISSION FOR RENEWABLE ENERGY DEVELOPMENTS

4. Single permission and single point of contact for renewable energy developments

(1) A renewable energy resource developer shall submit an application for a grant of development permission to the Authority through the Chief Physical Planner, in accordance

with section 19(1)(a) of the Physical Planning Act, 2002. No other permission shall be required other than the development permission.

(2) The Authority shall be the single point of contact for renewable energy resource developers. As such, the Authority shall coordinate all administrative tasks required in relation to the development permission and monitoring of a renewable energy development. Such tasks shall include—

(a) Prescribing in writing all information required and procedures to be followed for a grant of development permission for renewable energy developments at the time development permission is sought;

(b) Informing, when issuing a notice under subsection (4) of the Physical Planning Act, 2002 that an environmental impact assessment is required, any agency or department of Government having responsibility for the issue of any licence, permit, approval consent, or other document or authorization in connection with any matter affecting the development, in accordance with section 23(7) of the Physical Planning Act. This may include, but not be limited to, obtaining a certificate of approval by the Chief Environmental Health Officer in accordance with section 10 of the Environmental Health Services Act, 1997; and consulting the Environmental Coordinating Unit and the Environmental Heath Department;

(c) Making available to developers any forms or information held by agencies or departments of Government and necessary for applying for any licence, permit, approval consent, or other document or authorization, or completing any procedure at the time development permission is sought;

(d) Accepting forms and applications on behalf of other agencies and departments of Government, transmitting those forms and applications to the appropriate agencies, and communicating any response to the applicants;

(e) Addressing, in as far as it is appropriate and practical, the administrative requirements of other agencies and departments of Government in relation to any necessary permissions or approvals without referring back to the developer;

(f) Coordinating discussions with different agencies and departments of Government where their advice or response disagrees.

5. Consideration to beneficial impacts of renewable energy developments

(1) In addition to material considerations prescribed under section 25 of the Physical Planning Act, 2002, in considering an application for development permission of renewable energy developments, the Authority shall also give consideration to the ability of these developments to—

(a) avoid, reduce, or displace global emission of carbon dioxide (CO_2);

(b) avoid, reduce, or displace local emission of other contaminants or pollutants produced by conventional generation technologies that are based on the combustion of fossil fuels;

(c) maintain or increase security of electricity supply in the Commonwealth of Dominica by diversifying the technology type or location of electricity generation.

6. Conditions of development permission for renewable energy developments

(1) Without prejudice to the generality of section 26 of the Physical Planning Act, 2002, and in accordance with section 28 of such Act, the Authority may impose conditions on a grant of development permissions with the purpose of mitigating, avoiding, or remedying adverse environmental effects of renewable energy developments.

(2) Conditions imposed pursuant to section 6(1) may include arrangements to allow the Authority to monitor compliance of the renewable energy development with the development permission.

PART IV
ENVIRONMENTAL IMPACT ASSESSMENTS FOR RENEWABLE ENERGY DEVELOPMENTS

7. Qualifications, skills, knowledge, and experience of persons preparing environmental impact statements for renewable energy developments

(1) In accordance with section 23(8) of the Physical Planning Act, 2002, the Authority shall keep a register of persons qualified and approved by the Minister to prepare environmental impact statements for renewable energy developments in Dominica, and shall only accept environmental impact statements for renewable energy developments from persons included in such register.

(2) The Authority may prescribe, in writing, criteria for including persons in the register described in subsection (1). Criteria prescribed by the Authority may regard—

(a) Professional and academic qualifications;

(b) Years of experience;

(c) Knowledge of renewable energy technologies;

(d) Skills in preparing environmental impact statements for renewable energy developments;

(e) Previous experience in Dominica, in the Caribbean Region, or tropical small island countries;

(f) Any other qualification the Authority may require.

(3) The Authority shall include persons in the register described in subsection (1) when the persons demonstrate compliance with criteria prescribed by the Authority.

(4) The Authority may remove persons in the register described in subsection (1) when it finds that the persons do not, or no longer, comply with the criteria it prescribes.

(5) For avoidance of doubt, this section does not prevent the Authority from keeping a register for persons qualified and approved to prepare environmental impact statements for developments other than renewable energy ones, and prescribe other criteria for their inclusion.

8. Form of environmental impact statements for renewable energy developments

(1) When an environmental impact assessment is required for a renewable energy development in accordance with Schedule II of the Physical Planning Act, 2002, or as required by the Authority in accordance with section 23 of such Act, the applicant shall submit to the Authority an environmental impact statement in the form prescribed in this Part IV of the present regulations.

(2) For the avoidance of doubt, subsection (1) does not apply to any other development that is not a renewable energy development.

9. Parts that environmental impact statements for renewable energy developments shall include

(1) Without prejudice to the generality of section 23 of the Physical Planning Act, 2002, environmental impact statements required for renewable energy developments shall include the following four parts—

(a) a description of the method, extent, and duration of activities involved in the construction, operation, and maintenance of the renewable energy development;

(b) an assessment of the likelihood, severity, and extent of adverse [and beneficial] impacts that the above mentioned activities are expected to have on the environment;

(c) a description of actions that the developer commits to undertake or have undertaken to mitigate, avoid, or remedy adverse environmental impacts assessed under subsection (1)(b), and an estimate of the likelihood and extent to which such plans may be effective;

(d) a monitoring plan to examine, through a specialized independent third party, the veracity of activities described and impacts assessed in the environmental impact statement, the implementation and effectiveness of actions proposed, and the compliance with any conditions imposed by the Authority on the grant of a development condition.

10. Activities and environmental impacts that environmental impact statements for renewable energy developments shall address

(1) Environmental impact statements prepared for renewable energy developments shall address—

(a) Activities specific to geothermal, hydro, and wind energy developments as described in sections 11(1), 12(1), and 13(1), respectively;

(b) Impacts specific to geothermal, hydro, and wind energy developments as described in sections 11(2), 12(2), and 13(2), respectively;

(c) For types of renewable energy developments other than geothermal, hydro, and wind, any activities and impacts that the Authority may require in accordance with its powers described in section 23 of the Physical Planning Act, 2002;

(d) All activities and impacts that are relevant to any development plan for the area where the renewable energy development is located, or which the renewable energy development may have an effect on.

11. Specific activities and environmental impacts to be addressed for geothermal energy developments

(1) Environmental impact statements prepared for geothermal energy developments shall address the following activities—

(a) Building on or near geothermal resources;

(b) Building of infrastructure to access the geothermal resource;

(c) Drilling into or in proximity of geothermal resources;

(d) Extracting energy from the geothermal resources;

(e) Discharging contaminants or pollutants into the environment, or changing the rate at which a naturally occurring discharge occurs;

(f) Any other activity that may lead to environmental impacts described in subsection (2);

(g) Any other activity that the Authority may require.

(2) Environmental impact statements prepared for geothermal energy developments shall address the following impacts—

(a) Changes in the activity, temperature, or chemistry of geothermal resources;

(b) Changes in the physical structure of geothermal resources or surrounding environment, including land subsidence;

(c) Damage to any ecological system associated with a geothermal resource;

(d) Contamination of groundwater or local aquifers;

(e) Contamination of local waterways;

(f) Change in the temperature of local waterways;

(g) Contamination of air causing a health hazard or an unpleasant odour;

(h) Risks and consequences of possible blowouts;

(i) Production of noise;

(j) Impacts on visual amenity.

12. Specific activities and environmental impacts to be addressed for hydro energy developments

(1) Environmental impact statements prepared for hydro energy developments shall address the following activities—

(a) Building on or near a waterway;

(b) Building of infrastructure to access the hydro resource;

(c) Damming or diverting water;

(d) Clearing any vegetation adjacent to a waterway;

(e) Disturbance of a lake or river bed;

(f) Any discharge of contaminants or pollutants into a river or lake bed, or onto land adjacent to a river or lake;

(g) Any other activity that may lead to environmental impacts described in subsection (2);

(h) Any other activity that the Authority may require.

(2) Environmental impact statements prepared for hydro energy developments shall address the following impacts—

(a) Any change in the volume, rate of flow, or direction of water in a river or lake;

(b) Any impact on the likelihood or direction of flooding;

(c) Any effect on an agreed water allocations[, including allocations under the water control regime of the Water and Sewage Act, 1989];

(d) Any accelerated rate of erosion;

(e) Any change in amount of suspended solids in a waterway;

(f) Damage to any aquatic ecological system;

(g) Any effect on the recreational amenity of a waterway;

(h) Any obstruction to navigation on a waterway

(i) Production of noise;

(j) Impacts on visual amenity.

13. Specific activities and environmental impacts to be addressed for wind energy developments

(1) Environmental impact statements prepared for wind energy developments shall address the following activities—

(a) The building or operation of wind turbines;

(b) Building of infrastructure to access the wind resource;

(c) Any other activity that may lead to environmental impacts described in subsection (2);

(d) Any other activity that the Authority may require.

(2) Environmental impact statements prepared for wind energy developments shall address the following impacts—

(a) Production of noise;

(b) Impacts on visual amenity;

(c) Avian or bat mortality.

14. Activities and environmental impacts to be addressed for other renewable energy developments

The Authority may prescribe, in writing, activities and impacts that environmental impact statements prepared for renewable energy developments other than geothermal, hydro, and wind energy shall address.

15. Exemption from environmental impact statements for distributed renewable energy developments

(1) Without prejudice to the generality of Schedule II of the Physical Planning Act, and unless the Authority requires otherwise in accordance to section 23(2) of the Physical Planning Act, 2002, applications for the grant of a development permission for distributed renewable energy developments do not require an environmental impact statement when such developments are—

(a) Hydro energy developments with an installed capacity less than [1]kW;

(b) Wind energy developments with an installed capacity less than [5]kW;

(c) Solar photovoltaic energy developments with an installed capacity less than [10]kW;

(d) Solar thermal energy developments with an installed capacity lower than [20]kW;

(e) All renewable energy developments above above and other renewable energy developments other than geothermal, with size smaller than […] cubic meters or covering a surface area smaller than […] square meters.

(2) Distributed renewable energy developments that are exempt from the submission of an environmental impact statement shall comply with all other requirements prescribed by or under the Physical Planning Act, 2002.

(3) An environmental impact statement is always required for geothermal energy developments.

16. Fees for implementing the environmental impact assessment monitoring plan

(1) Without prejudice to the generality of section 19(d) of the Physical Planning Act, 2002 and the power of the Authority to impose other fees payable for the purposes of such Act, the Authority may impose fees payable for the reasonable cost of hiring a specialized independent third party who will implement the monitoring plan described in an environmental impact assessment. Fees may be imposed—

(a) For a once-only monitoring;

(b) For an ongoing or recurring monitoring, for those renewable energy developments that the Authority determines may have a particularly high or ongoing adverse environmental impact.

PART V
STANDARDS FOR ENVIRONMENTAL IMPACTS OF RENEWABLE ENERGY DEVELOPMENTS

17. Preparation of Standards for environmental impacts of renewable energy developments

(1) The Authority shall prepare, or cause to be prepared, Standards that prescribe detailed levels for determining the acceptability of the environmental impacts addressed in environmental impact statements for renewable energy developments.

(2) The Authority may prepare Standards in cooperation with the Chief Environmental Health Officer, the Environmental Coordinating Unit, the Environmental Health Department, or any other agency or department of Government as the

Authority sees fit. The Authority may also, at its discretion, conduct consultations with private persons for preparing the Standards.

18. Form and content of the Standards

(1) Each Standard shall be specific to each of the following renewable energy technology: geothermal, hydro, and wind energy. It the Authority prescribes under section 14 activities and environmental impacts to be addressed for other renewable energy technologies, it shall prepare a Standard for such technologies.

(2) A Standard for each renewable energy development type shall consist of a matrix which, for each impact that needs to be addressed in the environmental impact statement, prescribes—

(a) A level below which the impact is allowed—activities that cause an environmental impact not exceeding this level shall not be a cause for rejecting a development permission;

(b) A level above which the impact is prohibited—activities that cause an environmental impact exceeding such level shall be a cause for rejecting a development permission;

(c) A band between levels prescribed under (a) and (b)—activities that cause an environmental impact within such band shall be assessed on a case by case basis.

COMMONWEALTH OF DOMINICA

ARRANGEMENT OF SECTIONS

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SCHEDULE

COMMONWEALTH OF DOMINICA

ACT No. of 2013

BILL

FOR

AN ACT TO PROVIDE FOR THE DEVELOPMENT, EXPLORATION AND USE OF GEOTHERMAL RESOURCES AND FOR RELATED MATTERS.

(*Gazetted* ,2013)

BE IT ENACTED by the Parliament of the Commonwealth of Dominica as follows–

PART I
PRELIMINARY

Short title and commencement.

1. (1) This Act may be cited as the-

GEOTHERMAL RESOURCES DEVELOPMENT ACT, 2013

(2) This Act shall come into force on the such date as the Minister may appoint by Order published in the *Gazette*.

Interpretation.

2. In this Act, unless the context otherwise requires—

"Advisory Committee" means the Geothermal Resources Advisory Committee established under section 3;

Act No. 17 of 1995.

"alien" has the same meaning as in the Aliens Land Holding Regulation Act, 1995;

"application fee" means the application fee set by Order of the Minister under section 40;

"bid" means a proposal submitted for carrying out the terms of reference in the tender documents;

"concession area" is the land, described by parameters related to its surface area or areas that the geothermal resource developer is authorised to develop or to carry on geothermal resource development under the Geothermal Resources Concession;

Act No. 5 of 2002.

'development' has the same meaning as in the Physical Planning Act, 2002;

Act No. 10 of 2006.

"distribution" has the same meaning as in the Electricity Supply Act, 2006;

"electricity supply control" means the term or conditions required or authorised by the Electricity Supply Act, 2006 to be imposed on holders of a licence that is referred to in section 30 of that Act;

"exploration" means activity that demonstrates the dimensions, positions, characteristics and extent of geothermal resources by geological, geochemical and geophysical studies and surveys and includes drilling of shallow temperature-gradient wells or deep exploratory wells;

"generation' means production of electrical energy from other forms of energy;

"geothermal energy" means the heat of the earth;

"Geothermal Exploration Agreement" means a development agreement referred to in section 31;

"geothermal resource developer" means a person who is authorised to undertake geothermal resource development under a Geothermal Exploration Agreement or Geothermal Resources Concession, and includes an entity referred to in section 29 (3);

"geothermal resource development application" means an application referred to in sections 36 and 37;

"geothermal resource development" means exploration or use of geothermal resources;

"geothermal resource development agreement" means an agreement referred to in subsection 29(1);

"Geothermal Resources Concession" means a development agreement referred to in section 29(1);

"IRC" means the Independent Regulatory Commission established under the Electricity Supply Act, 2006; Act No. 10 of 2006.

"Minister" means the Minister responsible for energy;

"planning and environmental controls" means the conditions and limitations on developments in general, or geothermal resource developments in particular, required or authorised by the Physical Planning Act, 2002 or regulations made under it; Act No. 5 of 2002.

"reconnaissance" means activity which has minimal impact on the environment of the land that determines whether the land may be a source of geothermal resources, and does not include drilling;

"Register" means the register maintained by the Advisory Committee in accordance with section 41;

"special geothermal zone" means the land described in terms of its surface area and subsurface land, designated as such under sections 23 and 24;

"tender documents" means the documents containing the terms of reference for, and relevant details of, the tender process;

"tender process" means a competitive selection process, the rules, including selection criteria, of which are issued by the Advisory Committee for the purpose of allocating geothermal resource applications in special geothermal zones;

Act No. 10 of 2006.

"transmission" has the same meaning as in the Electricity Supply Act, 2006;

"use a geothermal resource" means accessing the geothermal resource for the purpose of enjoying it, and drawing from it any of the profit, utility and advantage which it may produce, including geothermal energy.

PART II
GEOTHERMAL RESOURCES ADVISORY COMMITTEE

Division 1— Establishment

3. (1) There is hereby established a statutory board to be known as the Geothermal Resources Advisory Committee comprising the following members— Constitution.

(a) the Permanent Secretary of the Ministry with responsibility for energy;

(b) the Executive Director of the IRC;

(c) the Chief Physical Planner of the Physical Planning and Development Authority;

(d) a senior State Attorney; and

(e) senior technical public officers, and other professionals not in the public service, with relevant knowledge or expertise, altogether not exceeding 6 in number, appointed by the Minister.

(2) The Minister shall appoint one member to be the Chairman and the Permanent Secretary of the Ministry with responsibility for energy shall act as the Deputy Chairman, unless the Permanent Secretary is appointed Chairman, in which case the Minister shall select another member to act as Deputy Chairman.

(3) The names of the initial members, their title, if any, and the names of subsequent members, shall be published in the *Official Gazette*.

(4) A member appointed under subsection (1)(d) shall hold office for a term of 3 years.

(5) The Chairman and Deputy Chairman shall appoint a secretary from among the members.

Alternate members.

4. (1) The Minister may appoint a person to be an alternate member for any member, other than the Chairman, so long as the alternate member possesses similar qualifications and background as the member for whom he or she is serving as an alternate.

(2) The alternate member may act temporarily in the place of that member if that member is absent, incapacitated or ineligible to perform the duties of a member.

Conflict of interest.

5. (1) A person is not qualified for appointment as a member if he or she is —

(a) of unsound mind; or

(b) an undischarged bankrupt.

(2) A member of the Advisory Committee shall inform the Advisory Committee of any matter in which he or she has, either directly or indirectly, personally or by his or her spouse, partner, business associate or company, any pecuniary or business interest, and the member shall take no part, directly or indirectly, in any consideration or decision of the Advisory Committee on that matter.

Vacancy.

6. If a vacancy occurs in the membership, the Minister shall appoint a person to fill the vacancy in a manner that respects the requirements in section 3 for the composition of the Advisory Committee.

Casting Vote.

7. The chairman has the right to vote at meetings of the Advisory Committee, and, in the case of an equal division, has also a casting vote.

8. (1) The Advisory Committee shall meet at the times that it considers necessary or expedient for the transaction of business and such meetings shall be held at the place that the Advisory Committee determines. Meetings and Quorum.

(2) A majority of all members constitute a quorum, provided that under no circumstance shall less than three members constitute a quorom.

9. All decisions made by the Advisory Commitee shall be signed by the chairman, vice-chairman or secretary. Signature.

10. The members of the Advisory Committee shall be paid remuneration set by Order by Cabinet. Remuneration.

11. (1) A budget for the operations of the Advisory Committee shall be a charge on the Consolidated Fund. Funds.

(2) The fees, royalties, bonds and administrative monetary penalties paid under this Act must be paid in to the Consolidated Fund of the Government of the Commonwealth of Dominica.

Division 2— Functions, Duties and Powers

12. (1) The functions of the Advisory Committee are to advise the Minister respecting— Functions and objectives.

(a) policy formulation for the promotion, sustainable development and use of geothermal resources including policy relating to regional and international co-operation in such matters;

(b) the determination of geothermal resource development applications in accordance with section 37;

(c) the negotiation of regional and international initiatives and agreements relating to geothermal resources;

(d) public education and training on geothermal resources and related matters;

(e) setting of fees, royalties and bonds to be charged under this Act; and

(f) other functions that the Minister may assign.

(2) In carrying out its functions the Advisory Committee shall seek to promote—

(a) sustainable development of Dominica's geothermal resources, for the benefit of the people of Dominica;

(b) provision of low cost, secure energy in Dominica, at stable prices;

(c) investment and competition in the development of geothermal resources, where applicable; and

(d) implementation of best practices in the operation of geothermal facilities.

Sub-Committees.

13. (1) The Advisory Committee may appoint sub-committees to examine and report to it on any matter relating to any of its functions under this Act.

(2) A sub-committee shall include not less than 2 members of the Advisory Committee, and may include persons who are not members.

(3) The Advisory Committee shall determine the composition and functions of a sub-committee.

Delegation by Advisory Commitee.

14. The Advisory Committee may delegate, in writing, to a sub-committee or to a member, the exercise of any power or the performance of any duty vested in it by this Act, except the power to delegate under this section.

15. No civil liability shall attach to any member of the Advisory Committee in respect of anything done, or omitted, in good faith under this Act. Civil liability.

16. (1) The Advisory Committee shall give to the Minister any information that Cabinet may require regarding its operations. Report.

(2) The Advisory Committee shall submit to the Minister at the end of each calendar year a report that includes—

(a) an assessment of the state of the development of geothermal resources, and its impact and significance for the development of the State;

(b) a description of the activities undertaken by the Advisory Committee; and

(c) any other matters that the Minister may require.

(3) The Minister shall cause a copy of the report to be laid before the Parliament within 90 days following the commencement of each calendar year.

PART III
GEOTHERMAL RESOURCES

17. (1) A geothermal resource is *sui generis* property and the rules relating to it, including the creation, acquisition, transfer, exercise, termination of rights respecting it, are set out in this Act. Nature.

(2) For the avoidance of doubt, it is not a mineral, nor a water resource, nor real property.

Content.

18. (1) Geothermal resource comprises geothermal energy, and includes the geothermal fluids, vapour, and gases in which the energy exists and the fluids, vapour, and gases that result from the extraction of the energy.

(2) In this section "fluids" means any liquid having a temperature of at least 75° Celsuis.

Ownership.

19. Despite anything contained in any law or title of land, geothermal resources in, or under any land of whatsoever ownership or tenure are deemed to be, and to always have been, vested in, and are subject to the control of, the State.

PART IV
MANAGEMENT OF GEOTHERMAL RESOURCE DEVELOPMENT

Division 1—General

Physical Planning Act applies.

20. For the avoidance of doubt, a geothermal resource development is a development within the meaning of the Physical Planning Act for which development permission must be obtained in accordance with the procedure of Part IV of that Act, except to the extent modified by this Act and any regulations made under this Act.

Electricity Supply Act applies.

Act No. 10 of 2006.

21. For the avoidance of doubt, when electricity is derived from a geothermal resource, the generation, transmission or distribution must be authorised in accordance with Part VI of the Electricity Supply Act, 2006, except to the extent modified by this Act and any regulations made under this Act.

Aliens Land Holding Regulation Act does not apply.
Act No. 17 of 1995.

22. (1) A geothermal resource is not land within the meaning of the Aliens Land Holding Regulation Act, 1995 and a geothermal resource developer who is an alien is consequently not subject to the provisions of the Aliens Land Holding Regulation Act in respect of his rights in respect of a geothermal resource.

(2) The Aliens Land Holding Regulation Act, 1995 does not apply to a geothermal resource developer in respect of any interest in land that the developer is authorised to hold under the developer's geothermal resources development agreement.

Division 2— Special geothermal zones

23. The Minister may, by notice in the *Gazette*, designate any place, whether surface area or subsurface land or both, to be a special geothermal zone if— Designation.

(a) the Advisory Committee advises that, on the basis of the information it possesses, the place is likely to be a source of geothermal resources;

(b) the Minister reasonably believes that it is in the public interest that the right to use geothermal resources in that place be allocated on a competitive basis.

24. Once a special geothermal zone is designated under section 23— Effect of designation.

(a) no right to explore or sue geothermal resources in any part of that zone shall be allocated except on application in the form of a bid for a geothermal resource development agreement under the tender process described in section 35 and 37, as applicable, unless determined otherwise by the Advisory Committee; and

(b) the Physical Planning and Development Authority shall not approve any development in that zone in consistent with uses described in this Act.

Division 3— Management of Reconnaissance, Exploration, Use and Export

Reconnaissance.

25. A person may conduct reconnaissance in any part of Dominica. However, the person—

(a) is subject to the law relating to trespass and any other law relating to rights of access to, or use of land;

(b) obtains no rights or interest in respect of any geothermal resources identified through the activities; and

(c) has no entitlement to any privilege or priority in respect of a geothermal resources development agreement.

Exploration.

26. A person shall not, in any part of Dominica, conduct exploration for geothermal resources unless the person is authorised under a Geothermal Exploration Agreement.

Use.

27. A person shall not use any geothermal resources except to the extent authorised under, and under the terms and conditions contained in, a Geothermal Resources Concession.

Export.

28. (1) A person shall not export electricity generated from geothermal resources except if the Minister, after consultation with the Advisory Committee and the IRC, authorises such export under—

(a) a geothermal resources development agreement; or

(b) a specific contract authorising export of electricity.

(2) The export shall be on the terms and subject to the conditions imposed by the Minister after consultation with the Advisory Committee and the IRC.

(3) The terms and conditions may include a requirement

to pay royalties based on the use of geothermal resources or on the export of electricity, or both, as the Minister, after consultation with the Advisory Committee and the IRC, determines.

PART V
GEOTHERMAL RESOURCE ALLOCATION

Power of Minister to allocate resources.

29. (1) Subject to sections 38 and 39 and to this section, the Minister may, on behalf of the State, enter into any of the following development agreements for geothermal resource development—

(a) a Geothermal Exploration Agreement authorising the exploration for geothermal resources; and

(b) a Geothermal Resource Concession authorising the use of geothermal resources.

(2) The Minister may enter into an agreement under subsection (1) only if the application for authorisation to carry on geothermal resources development is made in accordance with Part VI.

(3) This section applies even though the entity authorised to carry out the geothermal resource development—

(a) carries on the development as a contractor of the State using State funds; or

(b) is an entity that is partly owned or controlled by the State.

No additional permits necessary

30. A geothermal resources development agreement executed in accordance with section 39 constitutes—

(a) development permission required by section 17(1) of the Physical Planning Act, 2002 for the geothermal

Act No. 5 of 2002.

resource development, subject to the planning and environmental controls which are set out in, the geothermal resources development agreement except as modified by this Act or excluded by this Act or regulations under ths Act; and

Act No. 10 of 2006.

(b) authorisation required by section 29(1) of the Electricity Supply Act, 2006 for any one or more of the following activities, to the extent authorised in the geothermal resources development agreement, and subject to the electricity supply controls which are set out in the agreement except as modified or excluded by this Act or regulations under this Act—

(i) generation,

(ii) transmission,

(iii) distribution.

Rights accorded by Geothermal Exploration Agreement.

Act No. 5 of 2002.

31. (1) A Geothermal Exploration Agreement entitles the geothermal resource developer to carry on exploration activities for a term, not exceeding three years, stated in the Geothermal Exploration Agreement, subject to the planning and environmental controls which are set out in the Physical Planning Act, 2002 except as modified by regulations under this Act or authorised otherwise by the Minister, and subject further to the following—

(a) the exploration must be—

(i) limited to the area accorded under the Geothermal Exploration Agreement,

(ii) with the technology approved in the Geothermal Exploration Agreement, if any, and

(iii) in accordance with any other term or condition

not contrary to *(i)* and *(ii)* above, contained in the Geothermal Exploration Agreement;

(b) the geothermal resource developer must pay the fees and bonds set out in the Geothermal Exploration Agreement within the time required and must comply with the other terms and conditions contained in the Geothermal Exploration Agreement; and

(c) the Geothermal Exploration Agreement may be renewed on the application of the geothermal resource developer, for a term, not exceeding two years, set out in the Geothermal Exploration Agreement, if the Advisory Committee so recommends in accordance with section 37.

(2) A Geothermal Exploration Agreement also entitles the geothermal resource developer to obtain the land, including easements, acquired under section 33 for the purpose of the geothermal resource development on payment of the price and in accordance with the statutory rights set out in section 34.

(3) Subject to subection (4), in a special geothermal zone, the geothermal resource developer obtains no rights or interest in respect of any geothermal resources discovered.

(4) In a special geothermal zone a geothermal resource developer who is authorised to undertake geothermal resource development under a Geothermal Exploration Agreement has the right of refusal to a Geothermal Resource Concession.

(5) If a geothermal resource developer operating under a Geothermal Exploration Agreement desires to use any geothermal resource, the geothermal resource developer shall apply for and be granted a Geothermal Resource Concession under section 35.

(6) The State shall be represented in the negotiation of any Geothermal Exploration Agreement by the Advisory Committee or any other committee appointed by the Minister for that purpose.

(7)The rights set out in this section are deemed abandoned—

(a) in the circumstances set out in the Geothermal Exploration Agreement; or

(b) in the absence of contractual provisions under *(a)*, if there is no exploration for a period of 2 years or more from the execution of the Geothermal Exploration Agreement.

Rights accorded by Geothermal Resource Concession.

32. (1) A Geothermal Resource Concession entitles the geothermal resource developer to use geothermal resources in a concession area for the term, not exceeding forty years, set out in the Geothermal Resource Concession, subject to the electricity supply controls which are set out in the Electricity Supply Act, 2006, except as modified by regualtions under this Act or authorised otherwise by the the Minister and subject further to the following—

Act No. 10 of 2006.

(a) the use must be—

(i) limited to geothermal resources located in the concession area accorded under the Geothermal Resources Concession,

(ii) for the purposes authorised in the Geothermal Resources Concession,

(iii) with the technology approved in the Geothermal Resources Concession; and

(iv) in accordance with any other term or condition not contrary to subparagraphs *(i)* to *(iii)*, in the Geothermal Resource Concession.

(b) the geothermal resource developer must pay the fees, bonds and royalties set out in the Geothermal Resources Concession within the time required and must comply with the other terms and conditions contained in the Geothermal Resources Concession;

(c) the Geothermal Resource Concession may be renewed on the application of the geothermal resource developer, for a term, not exceeding ten years, set out in the Geothermal Resource Concession, if the Advisory Committee so recommends in accordance with section 37.

(2) A Geothermal Resource Concession also entitles the geothermal resource developer to—

(a) obtain the land, including easements, acquired under section 33 for the purpose of the geothermal resource development on payment of the price and the statutory rights set out in that section; and

(b) export electricity generated from geothermal resources if authorised by the Minister in accordance with section 28.

(3) The State shall be represented in the negotiation of any Geothermal Resource Concession by the Advisory Committee or any other committee appointed by the Minister for that purpose.

(4) The rights set out in this section are deemed abandoned—

(a) in the circumstances set out in the Geothermal Exploration Agreement; or

(*b*) in absence of contractual provisions under *(a)*, if the use is not started within 3 years or more of the execution of the Geothermal Resource Concession.

Compulsory acquisition rights.

Chap. 53:02.

33. (1) Land that the Advisory Committee advises the Minister is required for a geothermal resource development may be purchased compulsorily by the State in accordance with the Land Acquisition Act as being land required for public purposes within the meaning of that Act and in lieu of a compulsory purchase of the land, the State may acquire an easement over the land in a manner consistent with the Land Acquisition Act.

(2) Land, or any easement thereon, acquired under this section and transferred to a geothermal resource developer must be not less than the cost of acquisition.

Statutory rights relating to land.
Act No. 10 of 2006.

34. (1) Subject to subsection (2), section 44 of the Electricity Supply Act, 2006 applies to a geothermal resource developer in respect of all of the apparatus of the geothermal resource developer used in, or in the installation of, the developer's authorised geothermal resource development as if the word "licencee" were replaced with "geothermal resource developer", "Commission" were replaced with "Advisory Committee" and the words "this Act" were construed as references to this Act.

Act No. 10 of 2006.

(2) Subsections 44(9) and (10) of the Electricity Supply Act, 2006 apply only to a geothermal resource developer who is authorised to generate, transmit, distribute or supply electricity.

PART VI
PROCEDURE FOR OBTAINING DEVELOPMENT AGREEMENT

Geothermal Exploration Agreement application.

35. (1) An application for a geothermal resource developmet Agreement must be made—

(a) in writing if—

(i) the area to be developed i snot located in a special geothermal zone; or

(ii) the application is for renewal of the geothermal resource development agreement; or

(b) in the form of a bid as part of a tender process in accordance with tender deocuments issued by the Advisory Committee in the event the area to be developed is located within a special geothermal zone.

(2) An application must be accompanied by the application fee set by Order of the Minister under section 40, and contain the information required—

(a) in the case of an application under subsection (1) *(a)* by the tender documents prepared by the Advisory Committee;

(b) under section 23 of the Physical Planning Act, 2002 except to the extent excluded by subsection (2) *(a)*; and Act No. 5 of 2002.

(c) any other information ans particulars that may be prescribed by the Advisory Committee.

Submission of application.

36. An application under this Part must be submitted to the Advisory Committee.

Determination of application.

37. (1) In this section "application" means an application for the making or renewal of a geothermal resource development agreement.

(2) The Advisory Committee shall review an application in accordance with the procedure set out in Schedule 1 and recommend in respect of an application for—

(a) the making of a geothermal resource development agreement in respect of an area not located in a special geothermal zone, whether approval should be given by the Minister;

(b) the making of a geothermal resource development agreement in respect of an area located within a special geothermal zone—

(i) the list of bidders who qualify for approval in descending order starting with the highest evaluated bidder;

(ii) the parameters of the development area to be accorded under the geothermal resource development agreement; and

(c) renewal of a geothermal resource development agreement, whether approval should be given by the Minister and the term of the renewal.

(3) The Advisory Committee shall not recommend an application under subsection (2) unless the Advisory Committee is satisfied—

(a) on consultation with the Physical Planning and Development Authority, that the application qualifies for planning approval having regard to the considerations set out in section 25 of the Physical Planning Act, 2002 and any applicable planning and environmental standards;

Act No. 5 of 2002.

(b) the application does not pose an unacceptable threat to national security and establishes an acceptable balance among competing developers, if any, of the geothermal resources and competing users of land affected by the application;

(c) on consultation with the IRC, that the applicant meets the criteria, if any, established by the IRC under section 28 of the Electricity Supply Act, 2006; Act No. 10 of 2006.

(d) the applicant has the necessary legal capacity, financial standing, technical expertise and managerial competence to carry out efficiently, any electricity generation, transmission, or distribution as required by section 30(7) of the Electricity Supply Act, 2006 which the geothermal resources development agreement may authorise; and Act No. 10 of 2006.

(e) on consultation with the IRC, that the geothermal resource developer has, in the case of an application for renewal, during the preceding terms of the geothermal resource development agreement, continued to invest in the efficient and sustainable use of the resource, complied with requirements of applicable environmental and planning regulations, and met the specific terms set out in the geothermal resource development agreement.

(4) The objectives in deciding on the parameters of the concession area for the purpose of subsection (3)*(b)(ii)* include—

(a) allowing for efficient use of the geothermal resources;

(b) limiting conflict between geothermal resources users;

(c) fairly rewarding the investment, if any, that parties have made in exploration leading to the finding of useable geothermal resources.

(5) The Advisory Committee shall forward recommendations to the applicant promptly following communication of them to the Minister.

(6) For the purpose of this section, the Advisory Committee, or any person authorised by it in writing, has the powers of entry, examination and inquiries conferred by section 81 of the Physical Planning Act, 2002 for the purpose set out in section 81(1)*(b)* of that Act.

Act No. 5 of 2002.

Minister approval.

38. (1) The Advisory Committee shall submit its recommendation in respect of an application to the Minister for his approval in the time frame required under the Schedule.

(2) The Minister shall not give his approval in respect of an applicant recommended under section 37, unless the terms and conditions of a geothermal resources development agreement are successfully negotiated with the applicant.

(3) In the case of an application in respect of an area located within a special geothermal zone, the parties are bound by the terms in tender documents and the bid, where applicable, but may negotiate in respect of other terms and conditions which are not inconsistent.

Execution of Agreement.

39. If the Minister approves an applicant, a geothermal resources development agreement must, to be valid, be executed by—

(a) the Commonwealth of Dominica, represented by the Minister, as party to it;

(b) the applicant, as party to it.

PART VII
FEES, BONDS AND ROYALTIES

Minister to set fees and royalties.

40. (1) The Minister shall set application fees, annual fees and bonds to be payable by geothermal resource developers by Order published in the *Gazette* and the fees and bonds shall apply, unless otherwise agreed to in the geothermal resource development agreement.

(2) The Minister, after consultation with the IRC and the Minister for Finance, shall set royalties that geothermal resource developers are required to pay by Order published in the *Gazette* and the royalties shall apply, unless otherwise agreed to in a geothermal resource development agreement.

PART VIII
RECORD KEEPING AND PUBLICITY

41. (1) The Advisory Committee shall maintain a Register of all geothermal resource development plans, special geothermal zones, geothermal resource development applications, and geothermal resources development agreements. Register.

(2) The Register shall contain the particulars of applications under this Act and an indication of whether or not the Minister's approval was given and in entering information into the register, the Advisory Committee shall take full account of the need to protect confidential and commercially sensitive information and shall, where necessary, suitably restrict disclosure of such information to achieve such goal.

(3) Subject to subsection (2), the Register shall be a public register and shall be open for inspection by members of the public at such times and on such days as the Advisory Committee determines.

(4) A person may, on payment of a fee to be determined by the Advisory Committee, require the Advisory Committee to supply such person with a copy or an extract, certified by the Advisory Committee as a true copy or extract, from any part of the Register.

Publication in the *Gazette*.

42. The Advisory Committee shall cause to be published in the *Gazette*, within six weeks of the occurrence, the following—

(a) notice of geothermal resource development applications;

(b) recommendations made under section 37;

(c) notice of the execution, expiration, suspension, surrender, modification, revocation, or extension of geothermal resource development agreements.

PART IX
COMPLIANCE AND ENFORCEMENT

Division 1—General

Responsible Authorities.

43. (1) The Advisory Committee shall—

(a) assist the Physical Planning and Development Authority in the monitoring and enforcement of compliance with planning and environmental controls, subject to subsection (2);

(b) assist the IRC in the monitoring and enforcement of compliance with the electricity supply controls; and

(c) monitor and enforce any other term or condition in a geothermal resources agreement.

Act No. 5 of 2002.

(2) Despite the provisions of the Physical Planning Act, 2002, the Physical Planning and Development Authority shall exercise its monitoring and enforcement powers conferred under Part V of the Physical Planning Act, 2002 in respect of geothermal resource developments, only in accordance with the advice of the Advisory Committee.

(3) Despite the provisions of the Electricity Supply Act, 2006, the IRC shall exercise its monitoring and enforcement powers conferred under Parts III, VI, VII, and VIII of the Electricity Supply Act, 2006 in respect of geothermal resource developments, only in accordance with the advice of the Advisory Committee. Act No. 10 of 2006.

Self-monitoring.

44. For the purpose of Part IX, the Advisory Committee may direct, by notice in writing, the geothermal resource developer to submit information to it, with the frequency and in the manner indicated in the notice, or by a time stipulated in the notice, concerning its activities under the geothermal resource development agreement, and the geothermal resource developer shall comply with the notice.

Division 2—Inspections

Designation of inspectors.

45. (1) For the purpose of assisting in its monitoring and enforcement functions set out in section 43, the Advisory Committee may designate any qualified person, whether a member of the Advisory Committee or not, as an inspector to carry out inspections.

(2) An inspector shall be provided with a certificate of designation, which certificate the inspector shall present at the request of any person appearing to be in charge of any place entered by the inspector.

Powers of inspectors.

46. (1) An inspector may, for the purposes for which the inspector was designated an inspector under section 45—

(a) enter and inspect, subject to subsection (2), at any reasonable time, any place owned by, or under the control of, a geothermal resource developer, in which the inspector believes on reasonable grounds there is any document, information or thing relevant to the enforcement of this Act, or a geothermal resource development agreement,

and examine the document, information or thing, or remove it for examination or reproduction;

(b) make use of, or cause to be made use of, any data processing system at the place to examine any data contained in or available to the system;

(c) reproduce any record, or cause it to be reproduced, from the data, in the form of a print-out or other intelligible output, and take the print-out or other output for examination or copying;

(d) make use of any copying equipment or means of communication located at the place;

(e) take photographs of any thing in the place being inspected and remove the photographs from the place;

(f) take for analysis of any thing in the place being inspected and remove for analysis outside the place;

(g) search and bore for the purpose of examining the subsoil;

(h) interview any person in the place being inspected; and

(i) make any other investigation, examination and inquiries that are necessary to achieve those purposes for which the entry was authorised.

(2) An inspector must not enter a dwelling-place except with the consent of the occupant or under the authority of a warrant issued under subsection (3).

(3) Where on an *ex parte* application a magistrate is satisfied by information on oath—

(a) that a dwelling-place is a place described in paragraph (1)*(a)*;

(b) that entry to the dwelling-place is necessary for the monitoring and enforcement referred to in section 43; and

(c) that entry has been refused, or that there are reasonable grounds for believing that entry will be refused, or consent to entry cannot be obtained from the occupant,

the magistrate may issue a warrant authorizing an inspector named in the warrant to enter the dwelling-place, subject to any conditions specified in the warrant.

(4) An inspector executing a warrant issued under subsection (3) shall not use force unless the inspector is accompanied by a peace officer and the use of force has been specifically authorized in the warrant.

(5) If any damage is caused by reason of the exercise of any right of entry conferred by this section, or in the making of any survey for the purpose for which such right of entry was conferred, or by the wrongful or negligent use of powers conferred, or alleged to have been conferred, by this section, the Advisory Committee, as soon as may be after such entry, must pay compensation to the person injured.

(6) If the amount of such compensation cannot be agreed, the amount payable must be determined in the same manner as compensation payable under section 69 of the Physical Planning Act, and the Advisory Committee must refer the matter accordingly.

Division 3—Administrative Monetary Penalties and Other Sanctions

Commission of violation..

47. (1) A person commits a violation who—

(a) fails to comply with a notice for information under section 46;

(b) fails to comply with the planning and environmental control or electricity supply control to which their geothermal resource agreement is subject; or

(c) fails to pay in full when due, a fee or royalty imposed by Order of the Minister under section 40;

(d) fails to comply with or defaults under a Geothermal Resource Development Agreement; or

(e) commits any other act which the Minister by Order published in the *Gazette*, designates as a violation.

(2) A person who commits a violation referred to in subsection (1)(a) is liable—

(a) in the case of an individual, to an administrative monetary penalty of $1,000; or

(b) in the case of a corporation, to an administrative monetary penalty of $5,000.

(3) A person who commits a violation referred to in subsection (1)(b) is liable—

(a) in the case of an individual, to an administrative monetary penalty of $2,500; or

(b) in the case of a corporation, to an administrative monetary penalty of $10,000.

(4) A person who commits a violation referred to in subsection (1)*(c)* is liable to an administrative monetary penalty in the amount of 10% of the outstanding fee or royalty.

(5) A person who commits a violation referred to in subsection (1)*(e)* is liable to the administrative monetary penalty set out in the Order, which may not exceed $1,000 in the case of an individual and $5,000 in the case of a corporation.

(6) A violation that is continued on more than one day constitutes a separate violation in respect of each day during which it is continued.

Notice of intention to impose penalty.

48. (1) If the Advisory Committee believes on reasonable grounds that a person has committed a violation, the Chairman may issue, and shall cause to be served on that person, a notice of its intention to impose an administrative monetary penalty which—

(a) sets out the name of the person who is believed to have committed the violation;

(b) sets out the alleged violation and the relevant facts surrounding the violation;

(c) sets out the administrative monetary penalty prescribed in section 51 for the violation that it intends to impose; and

(d) advises the person of the right to make written respresentations to the Advisory Committee and of the period within which that right must be exercised in accordance with subsection (2);

(2) A person who receives a notice under subsection (1) may, within 28 days of the date on which he or she receives the notice, send written representations to the Advisory Committee

respecting the facts of the alleged violation or the administrative penalty imposed or both.

Penalty notice.

49. (1) After the expiration of 28 days from the date that it sent a notice of intention to impose a penalty under section 48, the Advisory Committee may impose an administrative monetary penalty in the amount prescribed in section 51 by sending him a penalty notice stating—

(a) the name of the person;

(b) the violation for which the penalty is imposed;

(c) the date on which the notice of intention to impose a penalty in respect of that violation was sent to the person;

(d) the amount of the penalty for the violation in accordance with section 47;

(e) a date, not less than 28 days after the date of the penalty notice, by which the person must pay the penalty to the Advisory Committee; and

(f) the fact that, if the person does not pay the penalty or appeal to the High Court under section 50, the person is considered to have committed the violation and that he or she is liable for the penalty set out in the notice.

(2) Before imposing an administrative monetary penalty under this section, the Advisory Committee shall consider any written representations that it has received from the person and, where it receives such representations, it must provide reasons for the action that it takes.

(3) A person who receives a penalty notice under this

section shall pay the penalty stated to the Advisory Committee on or before the date specified in the notice, or appeal to the High Court under section 50.

(4) If the person pays the administrative monetary penalty, the person is deemed to have committed the violation and proceedings in respect of it are ended.

(5) A person who neither pays the administrative monetary penalty nor appeals to the High Court under section 50 is considered to have committed the violation and is liable for the penalty.

Appeal to the High Court.

50. (1) A person served with a penalty notice under section 49 may, within 28 days after the notice is served, or within any longer period that the High Court allows, appeal in writing to the High Court.

(2) On an appeal, the High Court may confirm, set aside or vary the decision of the Advisory Committee.

Publication.

51. If the Advisory Committee imposes an administrative monetary penalty on a person, the Committee shall publish the imposition of the penalty in the *Gazette* as soon as practicable after—

(a) if the person pays the penalty, the date of payment;

(b) if the person neither pays the penalty nor appeals the penalty notice, the date stipulated in the penalty notice for payment;

(c) if the person appeals under section 50, the date the High Court confirms that the person is liable to pay the penalty.

Debts to the State.

52. (1) An administrative monetary penalty constitutes a debt due to the State and may be recovered as such in the High Court.

(2) The Advisory Committee may, on the later of the dates referred to in section 51*(b)* and *(c)*, issue a certificate certifying the unpaid amount of any debt referred to in subsection (1) and the registration of the certificate in the High Court has the same effect as a judgment of the High Court for a debt of the amount specified in the certificate, together with the costs of registration.

(3) No proceedings to recover a debt referred to in subsection (1) may be commenced later than five years after the date stipulated in the penalty notice in accordance section 50(1)*(e)* or, if the person appeals under section 51, the date the High Court confirms that the person pay the penalty.

(4) An administrative monetary penalty paid or recovered in relation to a violation is payable to and must be remitted to the Accountant General.

Common law principles.

53. Every rule and principle of the common law that renders any circumstance a justification or excuse in relation to a charge for an offence applies in respect of a violation to the extent that it is not inconsistent with this Act.

Time limit.

54. (1) No proceedings in respect of a violation may be commenced later than two years after the day on which the subject-matter of the proceedings became known to the Advisory Committee.

(2) A document appearing to have been issued by the chairperson, vice-chairperson or secretary of the Advisory Committee, certifying the day on which the subject-matter of any proceedings became known to the Advisory Committee, is admissible in evidence without proof of the signature or official character of the person appearing to have signed the document and is, in the absence of evidence to the contrary, proof of the matter asserted in it.

Invalidation of agreement.

55. (1) In this section "competent authority" means the authority empowered in accordance with section 57 to make a decision that is final and binding on the parties to a dispute arising under a geothermal resource development agreement.

(2) A geothermal development agreement is invalidated if a competent authority declares that the agreement is terminated owing to the breach by a party that the competent authority considers substantial, or that is stated in the geothermal resource development agreement to constitute a substantial breach.

Forfeiture.

56. (1) If the geothermal resource agreement is terminated within the meaning of subsection (4), the geothermal resource developer must, as soon as practicable, and in any event, by the date stated in a notice served under subsection (2), remove any equipment, assets or other property from any land owned or leased by the State on behalf of the developer for the purpose of the geothermal resource development activities.

(2) If the geothermal resource agreement is terminated within the meaning of subsection (4), the Advisory Committee may issue a notice to the geothermal resource developer to remove any equipment, assets or other property from the land by the date stated in the notice.

(3) If a geothermal resource developer fails to comply with this section, the equipment, assets or other property is forfeited to the State on the date stated in the notice in accordance with subsection (1).

(4) A geothermal resource agreement is terminated if—

(a) rights under a geothermal resource agreement are abandoned in accordance with sections 31(6) or 32(4);

(b) the agreement is invalidated under section 55 or any other law;

(c) the obligations under the agreement are executed; or

(d) it is terminated by operation of any law of Dominica.

Division 4—Alternative Dispute Resolution

Dispute settlement.

57. Unless, and to the extent that, the geothermal resource development agreement otherwise provides—

(a) disputes arising under the agreement shall be referred to three arbitrators, one to be appointed by the developer, one appointed by the Minister, and one appointed by the first two arbitrators; and

Chap. 4:50

(b) the Arbitration Act applies and references in that Act to an arbitration agreement are to be construed as a reference to this section to the extent, if any, modified by this Act or a geothermal resource development agreement.

PART X
MISCELLANEOUS

Statutory provision obligatory.

58. A provision of a geothermal resources development agreement or other document that derogates from the provisions of this Act is invalid, except to the extent the derogation is expressly authorised by this Act.

Schedules .

59. The Minister may, by Order published in the *Gazette*, amend the Schedule.

Regulations.

60. The Minister may make regulations respecting anything that the Minister considers expedient for the administration or enforcement of this Act.

Consequential and transitional provisions

61. (1) A person who at the commencement of this Act, is conducting exploration activities for, or is using, geothermal resources under any licence or other authority, does not commit a violation if he or she applies for the relevant geothermal resource development agreement in accordance with this Act within 3 months of the date that this Act comes into force.

(2) An application under subsection (1) must be made in accordance with Part VI.

(3) In respect of applications under this section—

(a) the parties must negotiate on reasonable grounds and in good faith, and must respect all rights granted under existing authorisations to the extent that they are not inconsistent with this Act; and

(b) the terms and conditions must be determined by reference to arbitration under section 65, if the parties fail to agree.

Amendment of Physical Planning Act. Act No. 5 of 2002

62. Schedule II of the Physical Planning Act, 2002 is amended by adding the following at the end of the list—

"19. Geothermal resource development within the meaning of the Geothermal Resources Development Act."

Repeal. Chap. 85:02.

63. The Geothermal Energy Act is repealed.

SCHEDULE (section37)

ADVISORYCOMMITTEEPROCEDUREFOR DETERMINGAPPLICATIONS

Part A

Applications subject to a competitive process

This process applies only to applications for the grant of a geothermal resource development agreemnet in a special geothermal zone

The Advisory Committee must determine the application in accordance with the procedure outlined in the tender documents which documents must include information in respect of—

(a) technical approach and methodology; and

(b) cost.

Part B

Applications subject to a negotiated process

This process applies to applications for—

- *the grant or renewal of a geothermal resource development agreement in any part of the State in not located in a special geothermal zone; and*

- *renewal of geothermal resource development agreement in an area that is designated as a special geothermal zone.*

1. Within 7 days of the receipt of an application, the Advisory Committee shall publish a notice containing particulars of the application in the Gazette inviting comments in writing from the public.

2. Within 60 days of the receipt of the application or, such extended time that the Minister authorises, the Advisory Committee shall submit a report to the Minister containing its recommendations.

3. In determining the application, the Advisory Committee shall consider any comments and any further information requested in clarification of the comments, received before the expiration of 30 days from the publication of the notice described in item 1.

Passed in the House of Assembly this day of 2013.

Clerk of the House of Assembly

OBJECT AND REASONS

This Bill seeks to provide for the regulation of geothermal resources with the objective of ensuring the sustainable development of the resource, and ensuring its allocation to the uses that are most economically beneficial to Dominica.

The general approach taken to achieve the above objective is to create a complete, integrated regulatory framework comprising institutions and rules specific to geothermal resource development, designed to complement—as opposed to supplant—the existing regulatory framework. This existing framework (contained primarily in the Physical Planning Act, 2002 and the Electricity Supply Act, 2006) was not designed with geothermal resource development in mind. As such, it fails to provide for key aspects of an effective geothermal resources regulatory regime. However, building on that structure makes sense because these Acts contain valuable rules that should be applied to geothermal resources.

The Bill defines what a geothermal resource is—a one of a kind property (not mineral, not water resource, not real property). It establishes the content of geothermal resources (fluids, vapour, and gases in which geothermal energy—defined as heat of the earth—exists, and which result from the extraction of the energy), and declares who owns geothermal resources—the State.

The Bill adopts a holistic approach to geothermal energy—while electricity generation is expected to be the most profitable of the uses of geothermal energy, the Bill's provisions allow regulating other uses too. Also the definition of 'use' of the resource is not necessarily for electricity generation.

The Bill allows following two procedures or 'tracks' for allocating geothermal resources in Dominica:

- **A competitive track**—this track maximizes revenue, and awards a concession to the best bidder presenting the best option. However, this track has a cost—it requires that there be the condition necessary for competition to work. Such condition is the availability of information on the resource—such information is uniquely expensive to obtain for geothermal resources through complex and costly exploration. Under this track, the Government provides funding for exploration (done by a 'developer' who is actually a contractor), and publish results of the exploration. Then, the Government would designate the zone where publicly-funded exploration revealed good geothermal potential as a 'special geothermal zone'—the effect of this designation is that use must be allocated competitively. Bidders would therefore be put in the condition to compete for the best sites in an auction

- **A negotiated track**—in zones other than the 'special geothermal zones', where there is no sufficient information for competition to work—of the Government is unwilling or generally unable to fund it—Dominica must still be able to attract investors. This can be done under a negotiated track. Under such track, developers fund exploration, and are given certainty that they can fully capture the benefits of their investment, instead of losing them to other developers. At the same time, developers' rights would be subject to conditions—exclusive rights, limited duration, use or lose provisions, and annual fees.

The Bill creates a new multi-sectoral statutory board—the Geothermal Resources Advisory Committee—to advise the Minister responsible for energy, who in turn advises Cabinet on geothermal resource development. Cabinet must ultimately act on the Committee's advice within an established procedure, and under provisions that ensure transparency and accountability—such as the publication of the Committee's recommendations. The Committee advises on the ability to use and access the resource, as well as on matters related to planning and selling electricity—however, the Bill does not give the Committee any of the powers currently conferred on other responsible authorities. In particular, powers and independence of the Independent Regulatory Commission (IRC) and the Physical Planning and Development Authority (PPDA) remain intact. The Committee seeks the approval of the PPDA and IRC, which must sign concession and exploration agreements—development permission and licence for sale of electricity are still required, but obtained through a streamlined procedure. The annual report of the Committee is sent to Cabinet and laid before Parliament—this ensures public reporting. Finally, the Committee can delegate powers to subcommittees to get more work done—and also so that it can use specialized technical assistance to exercise its functions (otherwise, its decisions might be in breach of Administrative Law).

The Bill provides for a coordinated approach for securing all relevant approvals: a potential developer applies for all such approvals by submitting one application to the Physical Planning Division. Further, all relevant approvals are contained in a single authorisation. The rules provide that such single authorisation be in the form of a contract. This is determined to be the optimum approach that best reflects the reality of awarding the right to develop a geothermal resource—particularly the fact that the terms and conditions of the award are consensual, arrived at through negotiation, and not subject to the unilateral changes on the part of the Government that a licence implies. The contract that authorises exploration is a 'Geothermal Exploration Agreement', and the contract that authorises use is a 'Geothermal Resource Concession'.

The Bill's rules control two of the internationally recognized geothermal resource development activities: exploration and use.

The Bill protects the geothermal resource from unregulated use, while ensuring that authorised use will be for the economic benefit of Dominica. This includes provisions for creating geothermal development plans and designating special geothermal zones; provisions to manage reconnaissance, exploration, use, and export of geothermal energy; provisions for geothermal resource allocation; procedures for obtaining a development agreement; and provisions for fees, bonds, and royalties. Reconnaissance remains unregulated.

Finally, the Bill makes provisions for what happens when persons do not fulfil their obligations or disobey the law.

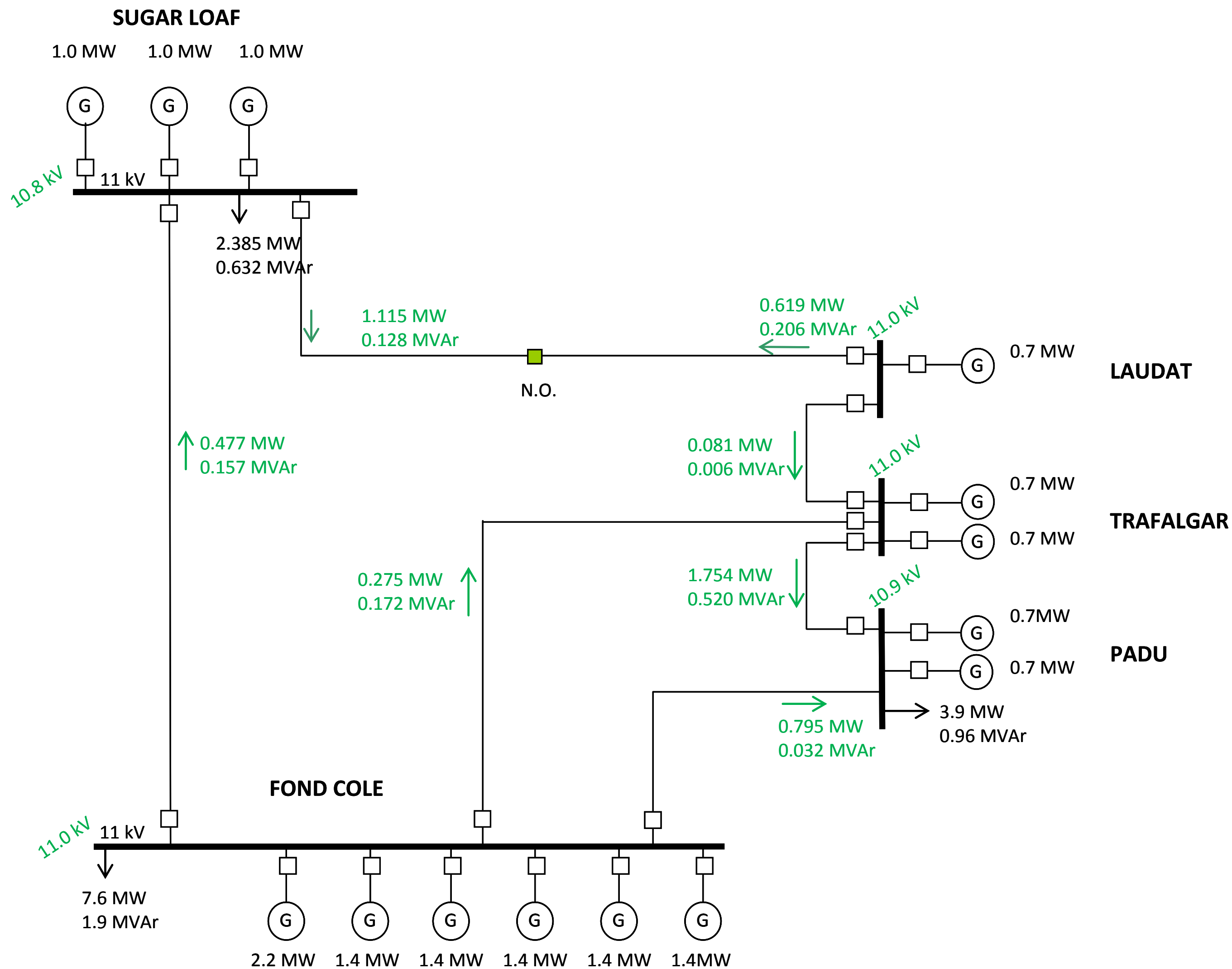
LEVI A. PETER
AttorneyGeneral

Attorney General's Chambers
Ministry of Tourism and Legal Affairs
Government Headquarterss
Roseau
COMMONWEALTH OF DOMINICA

ANNEX 2: Transmission Network Upgrade and Generation Dispatching Projection

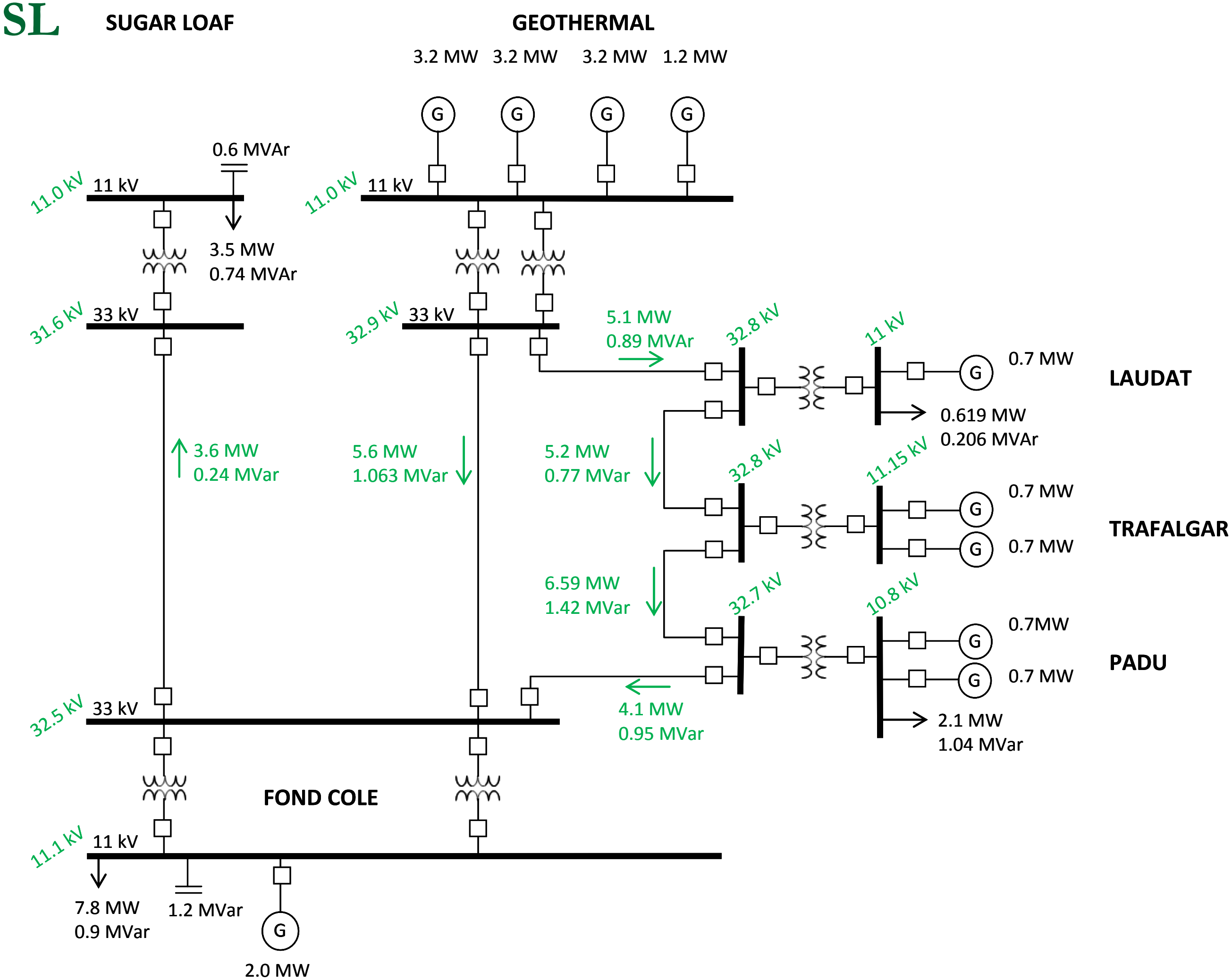
T&D PREPARATION Continued

DOMLEC'S PRESENT SYSTEM

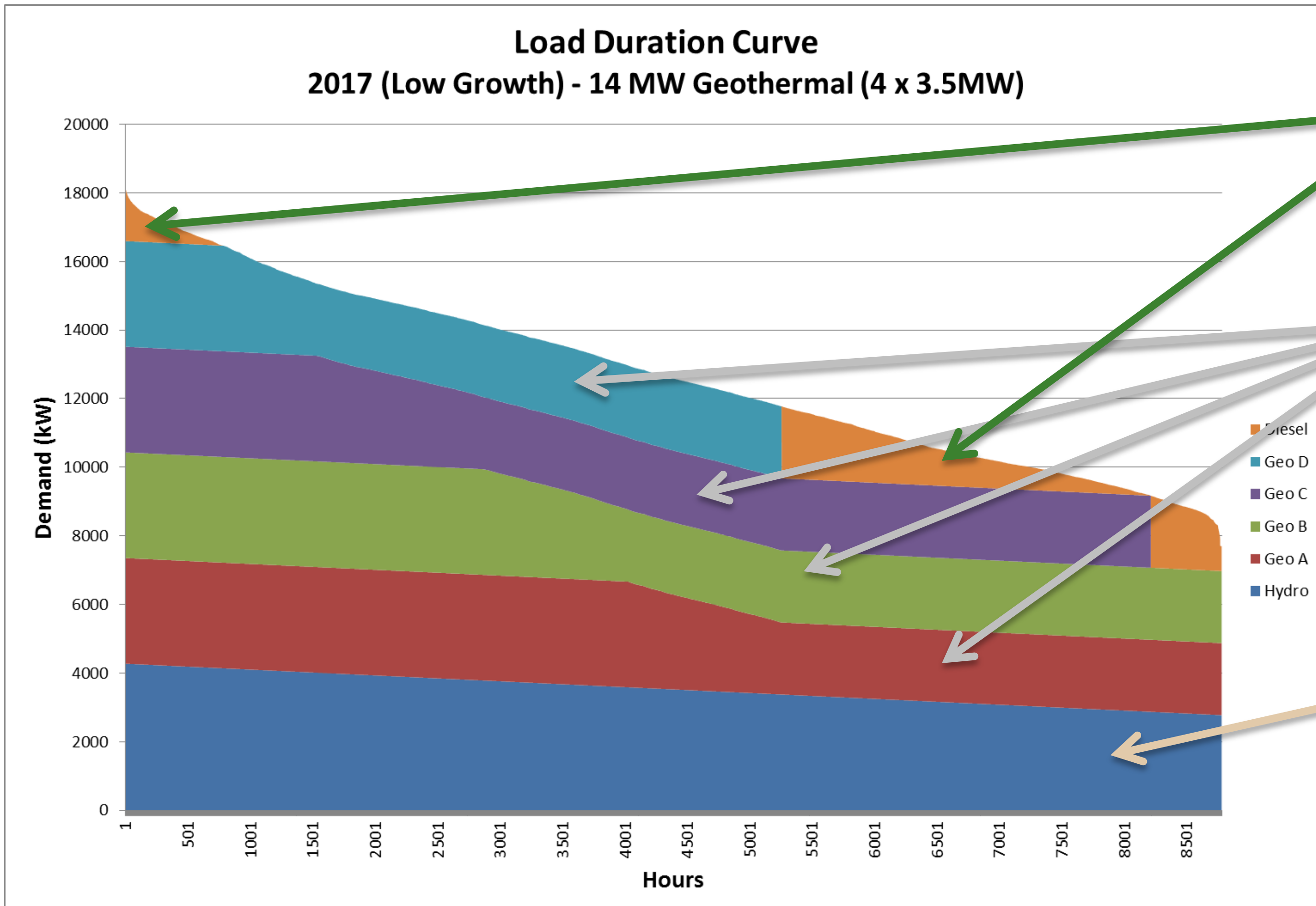


T&D PREPARATION Continued

Scenario 5 – How Much Geothermal with two 33kV lines to FC a 33kV line SL



Hydro & Diesel with 14 MW Geothermal

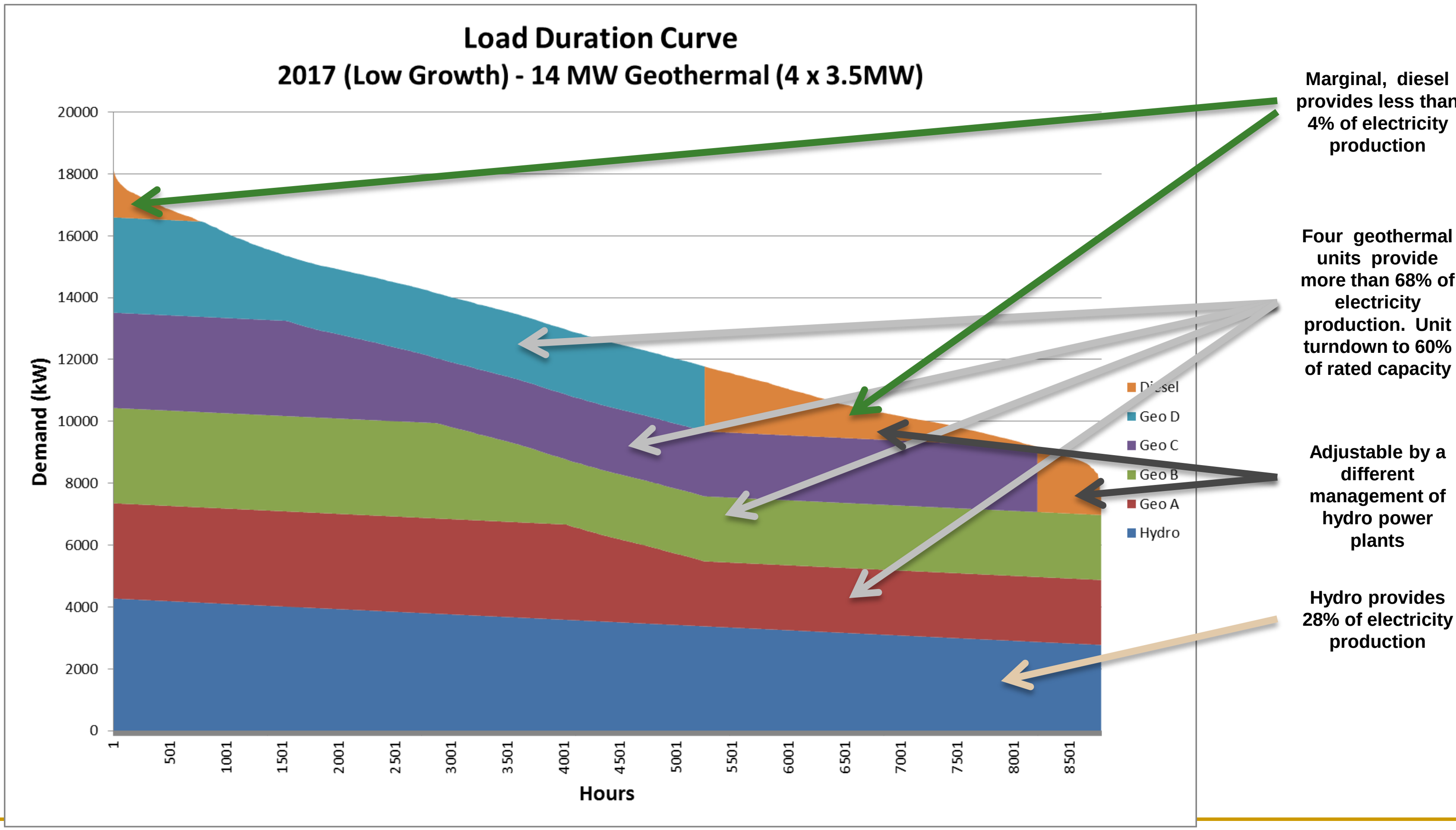


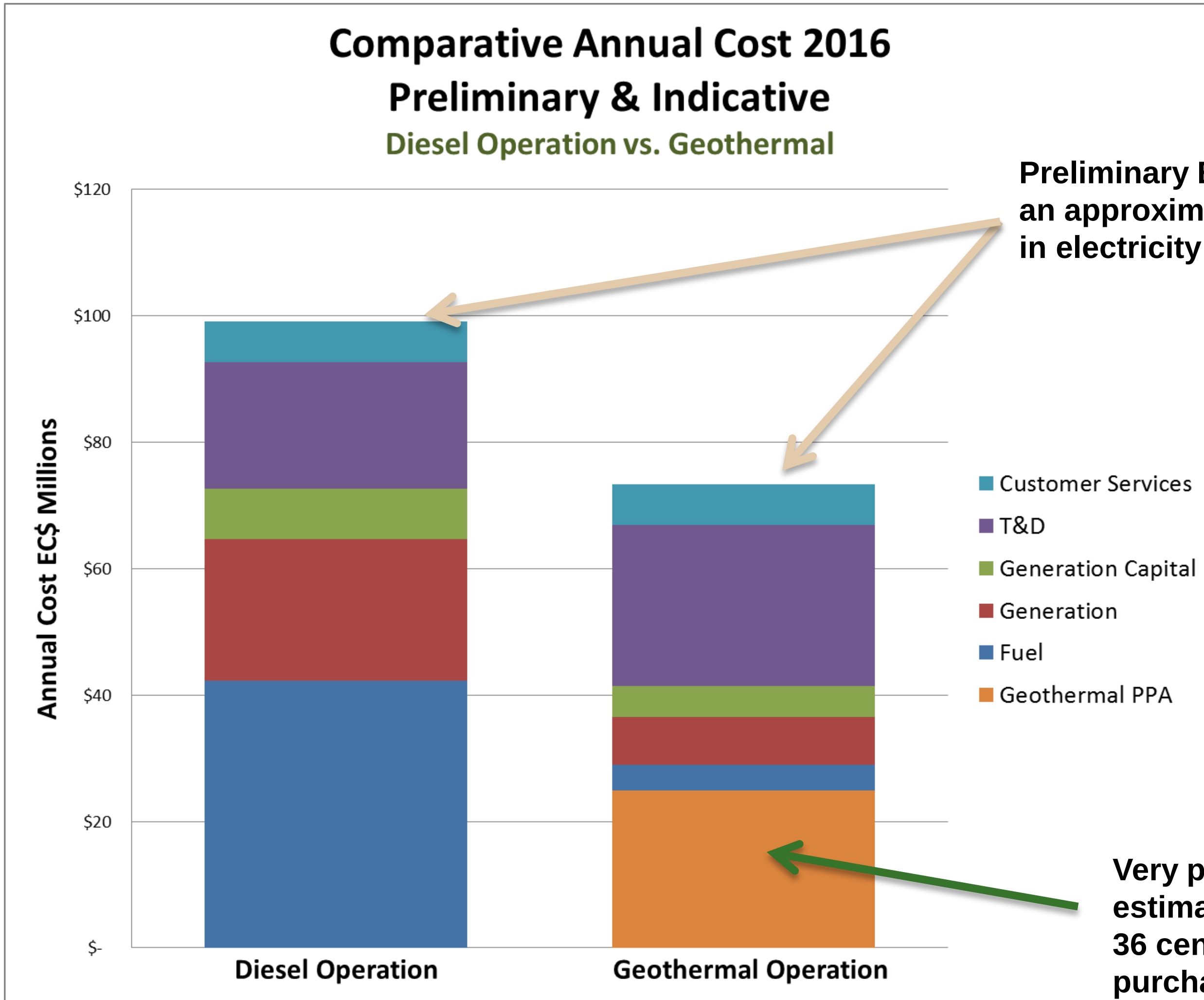
Diesel provides 4% of electricity production

Four geothermal units provide 68% of electricity production. Unit turndown to 60% of rated capacity

Hydro provides 28% of electricity production

Hydro & Diesel with 14 MW Geothermal





Preliminary Estimates suggest an approximate 25% reduction in electricity tariffs

Very preliminary estimates <u>suggest</u> EC 36 cents/kWh for purchased power from the geothermal plant.

ANNEX 3: Two Scenarios Financial Analysis

file: Dominica Financial Analysis.xls

Dominica Geothermal Project - Development Scenario 4 x 3.5 MW : Public - Mainly Concessionary Loan

TECHNICAL INPUT

Gross Installed Capacity (MW)	14.0
Plant Factor (1*(1-IC)*(1-SM-UM-LR)	0.82
(IC) Internal Consumption	5.0%
(SM) Scheduled Maintenance	6.0%
(UM) Unscheduled Maintenance	3.0%
(LR) Load Reduct. separated from SM and UM	5.0%

CAPEX OPEX INPUT

Field Explorat. Cost (M$)	0.0
Field Develop. Cost (M$)	19.2
Plant Cost (M$)	43.4
O&M Cost (%.inv.)	3.4%

ASSETS VALUES (M$)

Investment Cost	62.6	(Field E&D + Plant Costs)
Total Equities	13.2	
Term Loan	52.7	(Inv. Cost - Equities)
Cumulat. Loan	56.4	
Debt Completion	3.7	(Cumulative - Term Loan)
Assets	66.3	(Inv. Cost + Debt Compl.

FINANCIAL INPUT

US Inflation (yearly)	3.0%
Depreciation (yearly)	3.3%
Dividend (% Total Eq.)	5.0%
Expected Equity IRR	10.0%
Loan Interest	3.0%
Weighted Disc. Rate	4.6%
Loan Duration (years)	20
Income Taxes	30.0%
Cost Recov.Tariff(c$/kWh	5.61

MAIN RESULTS

Pre-Finance, Pre-Tax C.F. IRR (IRR[5])	5.9%
Pre-Finance, Post-Tax C.F. IRR (IRR[7])	4.9%
Average Debt Service Coverage Rate (AVG[13])	1.42
Equity IRR (IRR[12])	10.0%
Equity NPV (NPV[12])	0.0
Debt-Equity Ratio (8/9)	4.28
Levelized Cost (Costs / Output) c$/kWh	6.26

YEARLY INPUT BREAK-DOWN

			2013	2014	2015	2016	2017	2018																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Field Exploration Costs Distrib.																																								
Field Development Costs Distrib.			32.9%	67.1%																																				
Plant Development Costs Distrib.				16.7%	50.0%	33.3%																																		
Total Costs Distrib.			10.1%	32.1%	34.7%	23.1%																																		
Total Costs Distrib. Non Inflated			6.3	20.1	21.7	14.5																																		
O&M Costs Distribution						2.4%	10.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	10.4%	2.4%	3.4%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%	11.3%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%					
O&M Costs Non Inflated						1.5	6.5	1.5	1.5	2.1	1.5	1.5	1.5	1.5	2.1	1.5	1.5	6.5	1.5	2.1	1.5	1.5	1.5	2.1	1.5	1.5	1.5	7.1	1.5	1.5	1.5	2.1	1.5	1.5	1.5					
Price Deflator		0.970	1.000	1.030	1.061	1.093	1.126	1.159	1.194	1.230	1.267	1.305	1.344	1.384	1.426	1.469	1.513	1.558	1.605	1.653	1.702	1.754	1.806	1.860	1.916	1.974	2.033	2.094	2.157	2.221	2.288	2.357	2.427	2.500	2.575					
Output (GWh)						50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100					

WORKING TABLES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
OPERATING CASH FLOW																																								
Investment Cost	0.0	0.0	6.3	20.7	23.0	15.8	0.0	0.0	0.0	0.0	0.0																													
O&M Costs						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
Total Costs	0.0	0.0	6.3	20.7	23.0	17.5	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
Total Revenues						3.1	6.3	6.5	6.7	6.9	7.1	7.3	7.6	7.8	8.0	8.3	8.5	8.8	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.8	12.1	12.5	12.9	13.2	13.6	14.1	14.5					
Operat. Cash Flow	0.0	0.0	-6.3	-20.7	-23.0	-14.4	-1.0	4.8	4.9	4.3	5.2	5.4	5.5	5.7	5.0	6.1	6.2	-1.4	6.6	5.8	7.0	7.2	7.4	6.6	7.9	8.1	8.4	-3.1	8.9	9.2	9.4	8.3	10.0	10.3	10.6					
EQUITY EVALUATION																																								
Equity Funding	0.0	0.0	1.3	4.1	4.6	3.2																																		
Loan Drawings	0.0	0.0	5.1	16.6	18.4	12.7																																		
Interest in Constr.	0.0	0.0	0.2	0.7	1.2	1.6	1.7																																	
Cumulative Loan	0.0	0.0	5.2	22.4	42.1	56.4																																		
LOAN REPAYMENT																																								
Debt Service												3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8									
Interest Pmt												1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1									
Principal Pmt												2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7									
Loan Outstanding												54.3	52.1	49.9	47.6	45.3	42.8	40.3	37.7	35.1	32.3	29.5	26.6	23.6	20.5	17.4	14.1	10.7	7.3	3.7	0.0									
Total Inflow	0.0	0.0	6.5	21.4	24.3	20.5	8.0	6.5	6.7	6.9	7.1	7.3	7.6	7.8	8.0	8.3	8.5	8.8	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.8	12.1	12.5	12.9	13.2	13.6	14.1	14.5					
Total Outflow	0.0	0.0	6.5	21.4	24.3	19.1	9.0	1.7	1.8	2.6	1.9	5.7	5.8	5.9	6.8	6.0	6.1	13.9	6.2	7.3	6.3	6.4	6.5	7.7	6.7	6.8	6.8	18.7	7.0	7.1	7.2	4.9	3.6	3.8	3.9					

Income Statement Projections (Mill. US$)

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Total Revenues						3.1	6.3	6.5	6.7	6.9	7.1	7.3	7.6	7.8	8.0	8.3	8.5	8.8	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.8	12.1	12.5	12.9	13.2	13.6	14.1	14.5					
2. Total Operating Expenses						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
3. Operating Surplus or Losses (1-2)						1.4	-1.0	4.8	4.9	4.3	5.2	5.4	5.5	5.7	5.0	6.1	6.2	-1.4	6.6	5.8	7.0	7.2	7.4	6.6	7.9	8.1	8.4	-3.1	8.9	9.2	9.4	8.3	10.0	10.3	10.6					
4. Depreciation & Amortization						2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1					
5. Interest Expenses						0.0	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0					
6. Pre-Tax Income (3-4-5)						-0.6	-4.7	1.0	1.2	0.6	1.5	1.6	1.8	2.1	1.5	2.6	2.8	-4.7	3.3	2.6	3.9	4.2	4.5	3.7	5.1	5.4	5.8	-5.6	6.5	6.9	7.3	6.2	7.9	8.2	8.5					
7. Income Taxes						0.0	0.0	0.3	0.3	0.2	0.4	0.5	0.6	0.6	0.4	0.8	0.8	-1.4	1.0	0.8	1.2	1.3	1.3	1.1	1.5	1.6	1.7	-1.7	1.9	2.1	2.2	1.9	2.4	2.5	2.6					
8. Net Income (6-7)						-0.6	-4.7	0.7	0.8	0.4	1.0	1.1	1.3	1.5	1.0	1.8	2.0	-3.3	2.3	1.8	2.7	2.9	3.1	2.6	3.6	3.8	4.1	-3.9	4.5	4.8	5.1	4.4	5.6	5.8	6.0					

Cash Flow Projections (Mill. US$)

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Total Revenues						3.1	6.3	6.5	6.7	6.9	7.1	7.3	7.6	7.8	8.0	8.3	8.5	8.8	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.8	12.1	12.5	12.9	13.2	13.6	14.1	14.5					
2. Total Operating Expenses						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
3. Cash Flow from Operation (1-2)						1.4	-1.0	4.8	4.9	4.3	5.2	5.4	5.5	5.7	5.0	6.1	6.2	-1.4	6.6	5.8	7.0	7.2	7.4	6.6	7.9	8.1	8.4	-3.1	8.9	9.2	9.4	8.3	10.0	10.3	10.6					
4 Capital Cost	0.0	0.0	6.5	21.4	24.3	17.5																																		
5. Pre-Finance, Pre-Tax C.F. (3-4)	0.0	0.0	-6.5	-21.4	-24.3	-16.0	-1.0	4.8	4.9	4.3	5.2	5.4	5.5	5.7	5.0	6.1	6.2	-1.4	6.6	5.8	7.0	7.2	7.4	6.6	7.9	8.1	8.4	-3.1	8.9	9.2	9.4	8.3	10.0	10.3	10.6					
6. Income Tax						0.0	0.0	0.3	0.3	0.2	0.4	0.5	0.6	0.6	0.4	0.8	0.8	-1.4	1.0	0.8	1.2	1.3	1.3	1.1	1.5	1.6	1.7	-1.7	1.9	2.1	2.2	1.9	2.4	2.5	2.6					
7. Pre-Finance, Post-Tax C.F. (5-6)	0.0	0.0	-6.5	-21.4	-24.3	-16.0	-1.0	4.5	4.6	4.2	4.8	4.9	5.0	5.1	4.6	5.3	5.4	0.0	5.6	5.0	5.8	6.0	6.1	5.4	6.4	6.5	6.6	-1.4	6.9	7.1	7.3	6.4	7.6	7.8	8.0					
8. Loan Drawing *	0.0	0.0	5.2	17.2	19.7	14.3																																		
9. Equity Funding	0.0	0.0	1.3	4.1	4.6	3.2																																		
10. Debt Service							1.7	1.7	1.7	1.7	1.7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8							
11. Post-Fin., Post-Tax CF (7+8+9-10)	0.0	0.0	0.0	0.0	0.0	1.4	-2.7	2.8	2.9	2.5	3.1	1.1	1.2	1.3	0.8	1.5	1.6	-3.7	1.8	1.2	2.1	2.2	2.3	1.7	2.6	2.7	2.8	-5.2	3.1	3.3	3.5	2.6	3.8	7.8	8.0					
12. Equities Cash Flow (11-9)	0.0	0.0	-1.3	-4.1	-4.6	-1.7	-2.7	2.8	2.9	2.5	3.1	1.1	1.2	1.3	0.8	1.5	1.6	-3.7	1.8	1.2	2.1	2.2	2.3	1.7	2.6	2.7	2.8	-5.2	3.1	3.3	3.5	2.6	3.8	7.8	8.0					
13. Debt Service Coverage Rate (7/10)														1.3	1.2	1.4	1.4	0.0	1.5	1.3	1.5	1.6	1.6	1.4	1.7	1.7	1.8	-0.4	1.8	1.9	1.9	1.7	2.0							

BALANCE SHEET PROJECTIONS [M€]

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Fixed Assets						66.3	63.6	56.8	55.4	54.2	52.5	51.5	49.9	48.4	47.2	45.5	44.5	43.8	37.7	37.3	36.5	36.5	36.7	37.1	36.9	37.8	38.9	40.2	33.6	35.4	37.5	39.8	41.5	44.3	47.3					
2. Depreciation						2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1					
3. Net Fixed Assets						64.3	61.6	54.7	53.4	52.1	50.5	49.4	47.8	46.4	45.1	43.4	42.5	41.7	35.7	35.3	34.4	34.4	34.6	35.0	34.9	35.7	36.8	38.1	31.5	33.3	35.4	37.8	39.4	42.2	45.3					
4. Earnings Cash Flow						-0.6	-4.7	0.7	0.8	0.4	1.0	1.1	1.3	1.5	1.0	1.8	2.0	-3.3	2.3	1.8	2.7	2.9	3.1	2.6	3.6	3.8	4.1	-3.9	4.5	4.8	5.1	4.4	5.6	5.8	6.0					
6. Dividends												0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7					
7. Net Current Assets						63.6	56.8	55.4	54.2	52.5	51.5	49.9	48.4	47.2	45.5	44.5	43.8	37.7	37.3	36.5	36.5	36.7	37.1	36.9	37.8	38.9	40.2	33.6	35.4	37.5	39.8	41.5	44.3	47.3	50.6					
8. Total Debt						56.4	56.4	56.4	56.4	56.4	56.4	54.3	52.1	54.3	52.1	49.9	47.6	45.3	42.8	40.3	37.7	35.1	32.3	29.5	26.6	23.6	20.5	17.4	14.1	10.7	7.3	3.7	0.0	0.0	0.0					
9. Net Assets						7.2	0.4	-1.0	-2.2	-3.9	-4.9	-4.4	-3.7	-7.1	-6.7	-5.4	-3.9	-7.5	-5.5	-3.9	-1.3	1.6	4.7	7.4	11.2	15.3	19.7	16.2	21.3	26.7	32.6	37.8	44.3	47.3	50.6					

file: Dominica Financial Analysis.xls

Dominica Geothermal Project - Development Scenario 4 x 3.5 MW : Public - Mainly Concessionary Loan

TECHNICAL INPUT

Gross Installed Capacity (MW)	14.0
Plant Factor (1*(1-IC)*(1-SM-UM-LR)	0.82
(IC) Internal Consumption	5.0%
(SM) Scheduled Maintenance	6.0%
(UM) Unscheduled Maintenance	3.0%
(LR) Load Reduct. separated from SM and UM	5.0%

CAPEX OPEX INPUT

Field Explorat. Cost (M$)	0.0
Field Develop. Cost (M$)	19.2
Plant Cost (M$)	43.4
O&M Cost (%.inv.)	3.4%

ASSETS VALUES (M$)

Investment Cost	62.6	(Field E&D + Plant Costs)
Total Equities	13.2	
Term Loan	52.7	(Inv. Cost - Equities)
Cumulat. Loan	62.9	
Debt Completion	10.2	(Cumulative - Term Loan)
Assets	72.9	(Inv. Cost + Debt Compl.)

FINANCIAL INPUT

US Inflation (yearly)	3.0%
Depreciation (yearly)	3.3%
Dividend (% Total Eq.)	5.0%
Expected Equity IRR	20.0%
Loan Interest	8.0%
Weighted Disc. Rate	10.9%
Loan Duration (years)	15
Income Taxes	30.0%
Cost Recov.Tariff(c$/kWh	10.64

MAIN RESULTS

Pre-Finance, Pre-Tax C.F. IRR (IRR[5])	13.3%
Pre-Finance, Post-Tax C.F. IRR (IRR[7])	11.7%
Average Debt Service Coverage Rate (AVG[13])	1.46
Equity IRR (IRR[12])	20.0%
Equity NPV (NPV[12])	0.0
Debt-Equity Ratio (8/9)	4.77
Levelized Cost (Costs / Output) c$/kWh	7.81

YEARLY INPUT BREAK-DOWN

			2013	2014	2015	2016	2017	2018																															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Field Exploration Costs Distrib.																																								
Field Development Costs Distrib.			32.9%	67.1%																																				
Plant Development Costs Distrib.				16.7%	50.0%	33.3%																																		
Total Costs Distrib.			10.1%	32.1%	34.7%	23.1%																																		
Total Costs Distrib. Non Inflated			6.3	20.1	21.7	14.5																																		
O&M Costs Distribution						2.4%	10.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	10.4%	2.4%	3.4%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%	11.3%	2.4%	2.4%	2.4%	3.4%	2.4%	2.4%	2.4%					
O&M Costs Non Inflated						1.5	6.5	1.5	1.5	2.1	1.5	1.5	1.5	1.5	2.1	1.5	1.5	6.5	1.5	2.1	1.5	1.5	1.5	2.1	1.5	1.5	1.5	7.1	1.5	1.5	1.5	2.1	1.5	1.5	1.5					
Price Deflator		0.970	1.000	1.030	1.061	1.093	1.126	1.159	1.194	1.230	1.267	1.305	1.344	1.384	1.426	1.469	1.513	1.558	1.605	1.653	1.702	1.754	1.806	1.860	1.916	1.974	2.033	2.094	2.157	2.221	2.288	2.357	2.427	2.500	2.575					
Output (GWh)						50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100					

WORKING TABLES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
OPERATING CASH FLOW																																								
Investment Cost	0.0	0.0	6.3	20.7	23.0	15.8	0.0	0.0	0.0	0.0	0.0																													
O&M Costs						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
Total Costs	0.0	0.0	6.3	20.7	23.0	17.5	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
Total Revenues						5.8	12.0	12.4	12.7	13.1	13.5	13.9	14.3	14.8	15.2	15.7	16.1	16.6	17.1	17.6	18.1	18.7	19.2	19.8	20.4	21.0	21.7	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.4					
Operat. Cash Flow	0.0	0.0	-6.3	-20.7	-23.0	-11.6	4.7	10.6	10.9	10.5	11.6	11.9	12.3	12.7	12.2	13.4	13.9	6.5	14.7	14.1	15.6	16.1	16.5	15.9	17.5	18.1	18.6	7.4	19.7	20.3	21.0	20.2	22.2	22.9	23.6					
EQUITY EVALUATION																																								
Equity Funding	0.0	0.0	1.3	4.1	4.6	3.2																																		
Loan Drawings	0.0	0.0	5.1	16.6	18.4	12.7																																		
Interest in Constr.	0.0	0.0	0.4	1.8	3.4	4.7																																		
Cumulative Loan	0.0	0.0	5.5	23.8	45.6	62.9																																		
LOAN REPAYMENT																																								
Debt Service							7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4																			
Interest Pmt							5.0	4.8	4.6	4.4	4.2	3.9	3.7	3.4	3.1	2.7	2.3	1.9	1.5	1.0	0.5																			
Principal Pmt							2.3	2.5	2.7	2.9	3.2	3.4	3.7	4.0	4.3	4.6	5.0	5.4	5.8	6.3	6.8																			
Loan Outstanding							60.6	58.1	55.4	52.5	49.3	45.9	42.3	38.3	34.0	29.4	24.4	19.0	13.1	6.8	0.0																			
Total Inflow	0.0	0.0	6.7	22.5	26.4	26.3	12.0	12.4	12.7	13.1	13.5	13.9	14.3	14.8	15.2	15.7	16.1	16.6	17.1	17.6	18.1	18.7	19.2	19.8	20.4	21.0	21.7	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.4					
Total Outflow	0.0	0.0	6.7	22.5	26.4	22.1	14.7	9.1	9.1	9.9	9.3	9.3	9.4	9.4	10.3	9.6	9.6	17.5	9.8	10.8	9.9	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					

Income Statement Projections (Mill. US$)

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Total Revenues						5.8	12.0	12.4	12.7	13.1	13.5	13.9	14.3	14.8	15.2	15.7	16.1	16.6	17.1	17.6	18.1	18.7	19.2	19.8	20.4	21.0	21.7	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.4					
2. Total Operating Expenses						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
3. Operating Surplus or Losses (1-2)						4.2	4.7	10.6	10.9	10.5	11.6	11.9	12.3	12.7	12.2	13.4	13.9	6.5	14.7	14.1	15.6	16.1	16.5	15.9	17.5	18.1	18.6	7.4	19.7	20.3	21.0	20.2	22.2	22.9	23.6					
4. Depreciation & Amortization						2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1					
5. Interest Expenses						0.0	5.0	4.8	4.6	4.4	4.2	5.0	4.8	4.6	4.4	4.2	3.9	3.7	3.4	3.1	2.7	2.3	1.9	1.5	1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
6. Pre-Tax Income (3-4-5)						2.1	-2.4	3.7	4.2	4.0	5.3	4.8	5.4	6.0	5.7	7.2	7.8	0.7	9.2	9.0	10.8	11.6	12.5	12.3	14.4	15.5	16.5	5.4	17.7	18.3	18.9	18.1	20.2	20.8	21.5					
7. Income Taxes						0.0	-0.7	1.1	1.3	1.2	1.6	1.5	1.6	1.8	1.7	2.2	2.4	0.2	2.8	2.7	3.2	3.5	3.8	3.7	4.3	4.6	5.0	1.6	5.3	5.5	5.7	5.4	6.0	6.2	6.5					
8. Net Income (6-7)						2.1	-1.7	2.6	3.0	2.8	3.7	3.4	3.8	4.2	4.0	5.0	5.5	0.5	6.5	6.3	7.6	8.1	8.8	8.6	10.1	10.8	11.6	3.8	12.4	12.8	13.2	12.7	14.1	14.6	15.1					

Cash Flow Projections (Mill. US$)

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Total Revenues						5.8	12.0	12.4	12.7	13.1	13.5	13.9	14.3	14.8	15.2	15.7	16.1	16.6	17.1	17.6	18.1	18.7	19.2	19.8	20.4	21.0	21.7	22.3	23.0	23.7	24.4	25.1	25.9	26.6	27.4					
2. Total Operating Expenses						1.6	7.3	1.7	1.8	2.6	1.9	2.0	2.0	2.1	3.0	2.2	2.3	10.1	2.4	3.5	2.6	2.6	2.7	3.9	2.9	3.0	3.0	14.9	3.2	3.3	3.4	4.9	3.6	3.8	3.9					
3. Cash Flow from Operation (1-2)						4.2	4.7	10.6	10.9	10.5	11.6	11.9	12.3	12.7	12.2	13.4	13.9	6.5	14.7	14.1	15.6	16.1	16.5	15.9	17.5	18.1	18.6	7.4	19.7	20.3	21.0	20.2	22.2	22.9	23.6					
4 Capital Cost	0.0	0.0	6.7	22.5	26.4	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																										
5. Pre-Finance, Pre-Tax C.F. (3-4)	0.0	0.0	-6.7	-22.5	-26.4	-16.3	4.7	10.6	10.9	10.5	11.6	11.9	12.3	12.7	12.2	13.4	13.9	6.5	14.7	14.1	15.6	16.1	16.5	15.9	17.5	18.1	18.6	7.4	19.7	20.3	21.0	20.2	22.2	22.9	23.6					
6. Income Tax						0.0	-0.7	1.1	1.3	1.2	1.6	1.5	1.6	1.8	1.7	2.2	2.4	0.2	2.8	2.7	3.2	3.5	3.8	3.7	4.3	4.6	5.0	1.6	5.3	5.5	5.7	5.4	6.0	6.2	6.5					
7. Pre-Finance, Post-Tax C.F. (5-6)	0.0	0.0	-6.7	-22.5	-26.4	-16.3	5.4	9.5	9.7	9.3	10.0	10.5	10.7	10.9	10.5	11.3	11.5	6.3	11.9	11.4	12.3	12.6	12.8	12.2	13.2	13.4	13.7	5.8	14.4	14.9	15.3	14.7	16.2	16.6	17.1					
8. Loan Drawing *	0.0	0.0	5.5	18.3	21.8	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0																											
9. Equity Funding	0.0	0.0	1.3	4.1	4.6	3.2	0.0	0.0	0.0	0.0	0.0																													
10. Debt Service							7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4																			
11. Post-Fin., Post-Tax CF (7+8+9-10)	0.0	0.0	0.0	0.0	0.0	4.2	-1.9	2.2	2.3	2.0	2.6	3.1	3.3	3.5	3.1	3.9	4.1	-1.1	4.6	4.1	5.0	12.6	12.8	12.2	13.2	13.4	13.7	5.8	14.4	14.9	15.3	14.7	16.2	16.6	17.1					
12. Equities Cash Flow (11-9)	0.0	0.0	-1.3	-4.1	-4.6	1.0	-1.9	2.2	2.3	2.0	2.6	3.1	3.3	3.5	3.1	3.9	4.1	-1.1	4.6	4.1	5.0	12.6	12.8	12.2	13.2	13.4	13.7	5.8	14.4	14.9	15.3	14.7	16.2	16.6	17.1					
13. Debt Service Coverage Rate (7/10)							0.7	1.3	1.3	1.3	1.4	1.4	1.5	1.5	1.4	1.5	1.6	0.9	1.6	1.6	1.7																			

BALANCE SHEET PROJECTIONS [M€]

Operating Period	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
1. Fixed Assets						72.9	72.2	67.8	67.7	67.9	68.0	69.0	69.7	70.7	72.2	73.4	75.7	78.5	76.3	80.0	83.6	88.4	93.9	99.9	105.8	113.2	121.3	130.1	131.2	140.8	150.9	161.4	171.3	182.7	194.6					
2. Depreciation						2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1					
3. Net Fixed Assets						70.8	70.2	65.8	65.6	65.8	65.9	66.9	67.6	68.7	70.1	71.4	73.7	76.4	74.2	78.0	81.5	86.4	91.8	97.8	103.8	111.1	119.2	128.1	129.1	138.8	148.8	159.3	169.3	180.7	192.5					
4. Earnings Cash Flow						2.1	-1.7	2.6	3.0	2.8	3.7	3.4	3.8	4.2	4.0	5.0	5.5	0.5	6.5	6.3	7.6	8.1	8.8	8.6	10.1	10.8	11.6	3.8	12.4	12.8	13.2	12.7	14.1	14.6	15.1					
6. Dividends						0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7					
7. Net Current Assets						72.2	67.8	67.7	67.9	68.0	69.0	69.7	70.7	72.2	73.4	75.7	78.5	76.3	80.0	83.6	88.4	93.9	99.9	105.8	113.2	121.3	130.1	131.2	140.8	150.9	161.4	171.3	182.7	194.6	206.9					
8. Total Debt						0.0	60.6	58.1	55.4	52.5	49.3	60.6	58.1	60.6	58.1	55.4	52.5	49.3	45.9	42.3	38.3	34.0	29.4	24.4	19.0	13.1	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
9. Net Assets						72.2	7.2	9.6	12.5	15.5	19.7	9.1	12.6	11.5	15.3	20.3	26.0	26.9	34.1	41.4	50.2	59.9	70.6	81.5	94.2	108.2	123.3	131.2	140.8	150.9	161.4	171.3	182.7	194.6	206.9					