Ministry of Finance and Economic Planning – Gvt of SVG (MoFEP)

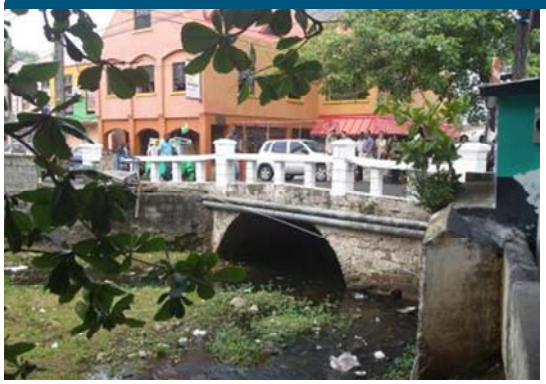
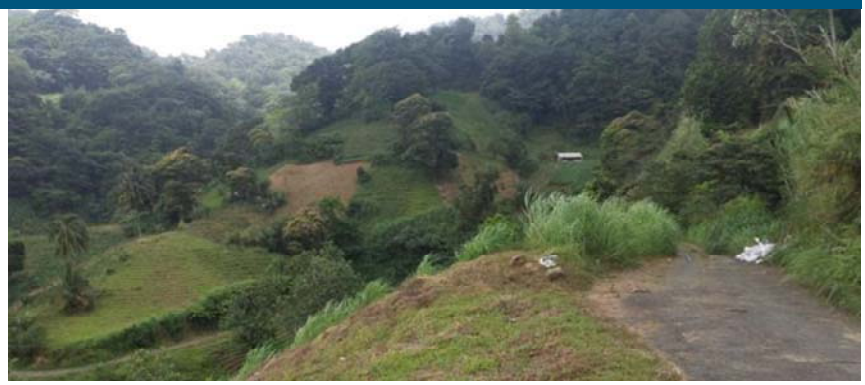
Saint Vincent and the Grenadines

Regional Disaster Vulnerability Reduction

Consultancy Services of Design and Construction Supervision for (i) South River Bridge; (ii) North River Bridge (iii) Green Hill Bridge; (iv) Dauphine Bridge; (v) Fenton River Fords; and (vi) Flood Mitigation works in Arnos Vale Watershed Area (vii) River embankment protection along North and South rivers.

Preliminary Design Report – Environmental Management Plan Reviewed Fenton Greenhill Road and Bridges

V1. Final Version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Acronyms and abbreviations

BOQ	Bill of Quantities
DBO	Design, Build and Operate
CPD	Central Planning Division
CPD/MoFEP	Central Planning Division, Ministry of Finance and Economic Planning
EIA	Environmental Impact Assessment
EMF	Environmental Management Farmework
EMP	Environmental Management Plan
GoSVG	Government of Saint Vincent and the Grenadines
HFL	Hight Flood Level
HHFL	Highest Flood Level
H/H	Hydrology and Hydraulic analysis
LWL	Low Water Level
MoFEP	Ministry of Finance and Economic Planning
PMIS	Project Management Information System
SVG	Saint Vincent and the Grenadines
ToR	Terms of Reference
WB	World Bank

1. Introduction

1.1 Background

St. Vincent and the Grenadines is an archipelagic State in the Eastern Caribbean. The country is comprised of a main island, St. Vincent, and a chain of 32 islands and cays, the Grenadines, of which only seven are inhabited - Bequia, Mustique, Canouan, Mayreau, Union Island, Palm Island and Petit St. Vincent. The total area of the country is 389 km² (150 mi²) of which the main island is 344 km² (133 mi²).

St. Vincent and the Grenadines due to its geographical location and particular conditions regularly suffers from natural disasters events such as hurricanes, tropical storms, sea surges, landslides, earthquakes and others. Also worth mentioning that a large amount of its population is in a vulnerable position because of its location near the sea and rivers, presence of Administrative Buildings on reclaimed land and the topography of the island.

This is the case of the damage left by Hurricane Tomas in October 2010 which due to its heavy rains and gusty winds damaged bridges, fords and other vital infrastructure.

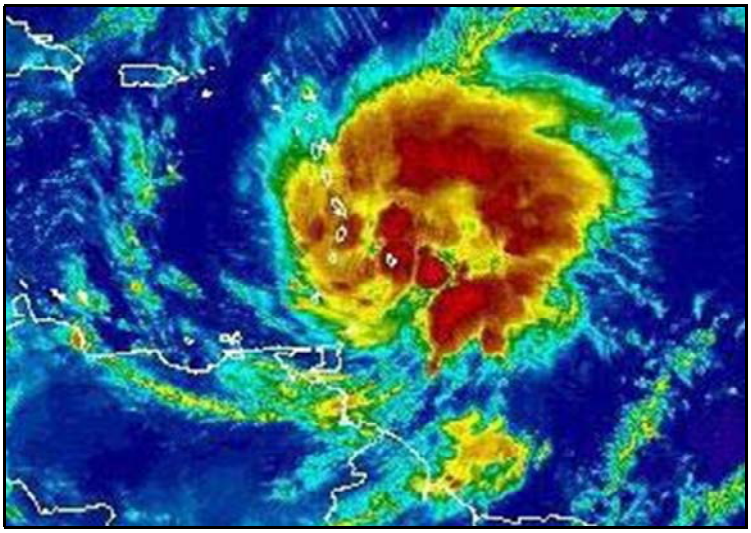


Figure 1: NOAA – Hurricane Tomas - National Oceanic and Atmospheric Administration

1.2 Disaster Vulnerability Reduction Project (DVRP)

St. Vincent and the Grenadines has received financing from the International Bank for Reconstruction and Development toward the cost of the Regional Disaster Vulnerability Reduction Project, Credit No: 4986-VC, Grant Number TF010206, Loan Number TF010207.

The overall objective of the Disaster Vulnerability Reduction Project (DVRP) is to measurably reduce vulnerability to natural hazards and climate change impacts in Saint Vincent and the Grenadines and includes various activities related to institutional strengthening and training as well as the execution of various civil works to retrofit or protect national assets. To achieve this goal, several sub-projects have been identified, one of them being the South River Bridge project which is the subject of this report.

The Central Planning Division (CPD) within the Ministry of Finance and Economic Planning (MoFEP) was designated the Project's main coordinating body. The Central Planning Division selected the Joint Venture Euroconsult/INHA/Vigiconsult for the realization of the basic design of the Regional Disaster Vulnerability Reduction Project (Contract No. 783/2014, March 2014). This study contained an Environmental Management Plan (EMP) for the (i) South River road bridge, (ii) Green Hill Bridge,

Dauphine Bridge and Fenton River Bridge and culvert and (iii) the Warrawarrow River, south of the Windward Highway.
In the present Contract with Egis Eau (Contract n° 729/2015 (previously named SVGRDVRP – C – QCBS – 23 (a)) signed the 13th of July 2015), these EMP are reviewed according to the facilities new design.

To point out Egis Eau contributions in this EMP, the news parts are written with a different letter type : in Green and Bold letters.

1.3 Environmental assessment framework

There are three main environmental assessment regulations and framework applicable to this project:

- The **St. Vincent and the Grenadines legislation**. The article 29 of the Town and Country Planning Act (No.45, 1992) indicates that an EIA for environmentally sensitive projects or activities is required. The Physical Planning Unit (PPU) has the legal authority for the evaluation of the need of an EIA.
- The **Environmental Management Framework (EMF)** for Regional Disaster Vulnerability Reduction Project (RDVRP), St. Vincent and the Grenadines Component (April 2014). This Environmental Management Framework (EMF) updates and expands the previously prepared Environmental Assessment (EA) by providing screening methods and procedures for the application of World Bank safeguards, including guidance on the scope of studies necessary to complete for each subproject, criteria for triggering additional studies in the case of complex or significant activities, and a generic Environmental Management Plan (EMP) for use in simple situations where activities need no additional assessment. It is likely that the majority of works will be relatively minor in nature and involve simple civil works where the environmental impacts are limited to the construction phase, requiring only the application of a standardized generic EMP. However, any exceptions will be identified during screening in the EMF, and subject to additional assessment work.

  This EMF describes the environmental impacts of the project on a program wide level. The EMF is the appropriate environmental management tool to be used for future subprojects as detailed information on particular specific sub-projects under the RDVRP have yet to be fully defined. General guidelines have been provided to assist in identifying potential impacts, mitigate potential negative impacts, statutory administration, and responsibilities as best as possible. An EMP with standard mitigation management measures has also been prepared and should be incorporated into the civil works contract as clauses to guide the contractor and to also form a basis for monitoring during implementation. Any additional detailed mitigation measures developed by specific studies (EIAs) for complex or sensitive subproject activities, or any additional environmental requirements imposed by St. Vincentian law and regulations, would also be translated into performance requirements for the contractors through civil works contracting clauses and verified by monitoring during implementation.
- The **World Bank's Environmental Assessment Policy** (Operational Policy OP 4.01). Various project types, depending on their potential environmental impact, are established:
  - ***Category A:*** *A proposed project is classified as Category A if it is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works. EA for a Category A project examines the project's potential negative and positive environmental impacts, compares them with those of feasible alternatives (including the "without project" situation), and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance. For a Category A project, the borrower is responsible for preparing a report, normally an EIA that includes, as necessary, elements of the other instruments.*

- ***Category B:*** *A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas -including wetlands, forests, grasslands, and other natural habitats- are less adverse than those of Category A projects. These impacts are site-specific; few if any of them are irreversible; and in most cases mitigatory measures can be designed more readily than for Category A projects. The scope of EA for a Category B project may vary from project to project, but it is narrower than that of Category A EA. Like Category A EA, it examines the project's potential negative and positive environmental impacts and recommends any measures needed to prevent, minimize, mitigate, or compensate for adverse impacts and improve environmental performance.*
- ***Category C:*** *A proposed project is classified as Category C if it is likely to have minimal or no adverse environmental impacts. Beyond screening, no further EA action is required for a Category C project.*
- ***Category FI:*** *A proposed project is classified as Category FI if it involves investment of Bank funds through a financial intermediary, in subprojects that may result in adverse environmental impacts.*

There are other World Bank's operational policies that should be taken into account in the environmental assessment, especially:

- OP 4.04 - Natural Habitats
- OP 4.11 - Physical Cultural Resources
- OP 4.36 - Forests

According with the EMF the overall Regional Disaster Vulnerability Reduction Project (RDVRP) has not been deemed to have any major negative environmental impacts but because of the presence of the civil works with minor to moderate impacts, the project has been classified as a Category B project.

The implementation of appropriate mitigation and management measures will assist in reducing any potential negative impacts from the various project components. This means that while there will be some negative impacts, they can be identified and managed through fairly standard means.
These simple projects would include an Environmental Management Plan (EMP), according with Annex C of the World's Bank OP 4.01. The EMP is an instrument that details the measures to be taken during the implementation and operation of a project to eliminate or offset adverse environmental impacts, or to reduce them to acceptable levels, and the actions needed to implement these measures.
However, it will be found as details emerge that the possible environmental effects could be significant or that sensitive areas or natural habitats could be affected. In those cases it is necessary an Environmental Impact Statement (EIS), to perform an Environmental Impact Assessment (EIA).
The way to decide if the EMP is enough or if it is necessary an EIS is a screening process, described in the EMF. The main tools are checklist, included as appendices in the EMF:

- Project Environmental Screening Checklist Form Part 1. Project and sponsor information. The applicant or project sponsor is responsible for the completion of this part.
- Project Environmental Screening Checklist Form Part 2. Preliminary screening of environmental impact.

The Lead/Approving Agency is responsible for the completion of this part.
The EMF included a sample table for "Identification of Complex/Sensitive Projects", useful as an advance of the screening process. In the following page the tables for the Middle Bridge over South River project is included.

Identification of Complex/Sensitive Projects **MIDDLE BRIDGE OVER SOUTH RIVER**		
Characteristic of Sub-project or Activity	***Yes/No***	***Observations***
1. Does the project involve construction of new roads, or major rehabilitation of existing roads?	No	It is not a major rehabilitation. Only three bridges and the road drainage will be reconstructed.
2. Does the project involve dam construction, reconstruction, rehabilitation, or strengthening?	No	
3. Does the project involve hazardous materials management and disposal (e.g. asbestos, medical or infectious waste, solvents or gasoline) except small amounts normally used during construction?	No	
4. Will the project significantly modify any coastal zone features, reef or marine features?	No	
5. Could the project activities significantly affect any natural or protected areas or Forest Reserves located within 1 km (0.62 miles) of the Project?	No	The northernmost part of the road runs alongside the proposed (not approved) Kingstown Forest Reserve, without crossing but just in the limit in one point. Anyway, the project activities are highly localized, and do not affect significantly the area.
6. Could the project impact or affect the habitat of endangered species of plants or animals?	No	There is not prevision of endangered plants or animals species affectation.
7. Would the project activities disrupt, trade and commerce or major economic activities of the country?	No	
8. Is the project within proximity of noise sensitive receptors like hospitals or schools?	No	
9. Could the project adversely affect critical resources such as drinking water diversions?	No	There are possible negative effects on rivers during the bridge construction, but the impacts are temporary and no significant.
10. Could the project adversely affect natural waterways (streams, rivers, or wetlands) by sedimentation, pollution, flooding, draining, or filling)?	No significantly	There are possible negative effects on rivers during the bridge construction, but the impacts are temporary and no significant.
11. Would the works adversely affect cultural property, including archeological and historical sites?	No	There is not notice of archeological and historical sites in the area
12. Would the works require leveling and clearing of lands with natural habitat (those water or land areas where most of the original plant and animal species are still present)?	No	There are only highly localized works in the bridge abutments, and in the road sides to reconstruct the drainage.
13. Does the project involve the use of introduced, nonnative species?	No	In the land reclamation works only native species will be used.
14. Does the project involve the use of pesticides, herbicides, or other agents to destroy pests?	No	
15. Does the project pose a high risk of causing landslides, slips, slumps, rock-falls, debris-flows, or excessive erosion?	No	The road had frequent landslides in the exiting slopes. New works do not increase the landslides risk.
16. Will the project result in the violation of St. Vincent and the Grenadines law, international treaty, or Bank policy?	No	

According to the above table, the project does not appear as complex or sensitive in the light of its possible adverse effects on the environment.

In this case, an Environmental Assessment can result in an Environmental Management Plan (EMP) only. Therefore, it is important that the EMP is specific and describes the mitigation measures which are adapted and relevant to the project.

This EMP includes in the Appendix No. 1 the "Project Environmental Screening Checklist Form" of the EMF. It also includes a prediction of the environmental impacts, included in the chapter 4, which is necessary to design the mitigation measures, and the monitoring plan.

2. Project description

2.1 Fenton Greenhill Road Project objectives

Fenton Greenhill Road is identified by the Government as an essential route between Gomea in the West St. George constituency and Green Hill in the Central Kingstown constituency, and as a bypass route to Kingstown due to that this design has a vital importance in order to reduce Fenton Road's vulnerability and increase it resiliency against adverse meteorological phenomenon that recurrently hit the country.

The road has three bridges, one box culvert and a few fords, which had been damaged by excessive stream and river heights and flows following the passage of Hurricane Tomas.

Figure 2: Photo of Fenton-Green Hill Road

The objective of the project is to rehabilitate existing structures (bridges, box culvert, fords, road within the 100 m before and after each bridge) damaged by natural hazards and to reduce their vulnerability to natural disasters in the future.

The following table summarizes the project interest and objectives.

AREA		INTEREST	POTENTIAL HAZARDS
Fenton Road	Bridge 1 (Dauphine), Bridge 2 (Fenton), Bridge 3 (Green Hill)	Fenton Road is identified by the Government as an essential route between Gomea in the West St.	Bridges and fords damaged by excessive stream and river heights and flows following the passage

	Box Culvert (1) and Fords Road drainage	George constituency and Green Hill and as a bypass route to Kingstown	of Hurricane Tomas

2.2 Project description

The project consists in rehabilitation of the three existing bridges, one box culvert, three fords and 100 m of the Fenton Road (including alignment, drainage, new pavement, etc.) before and after each bridge.

The location of different project sites is shown on the figure below:

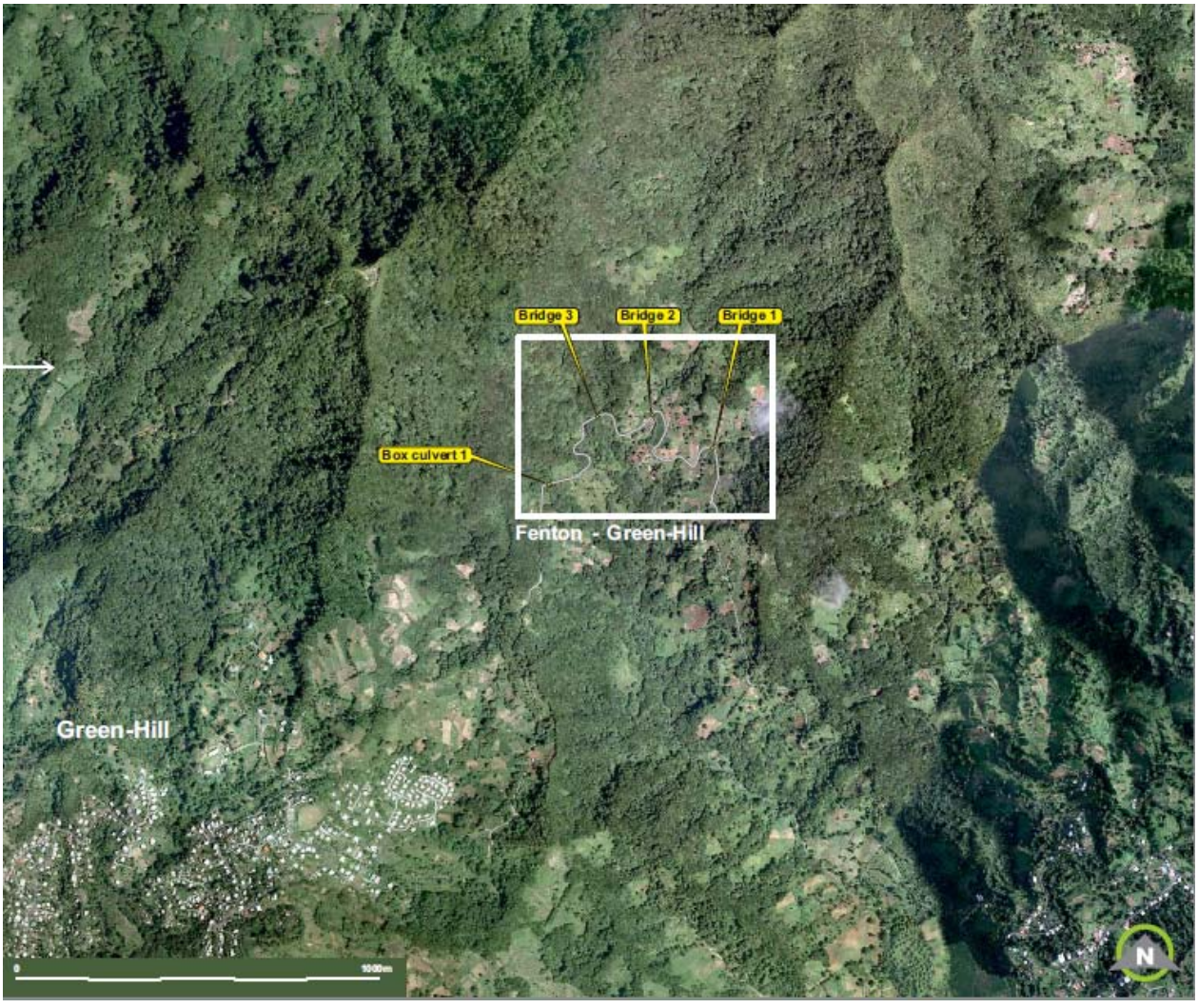


Figure 3: Location of the bridges and culvert

2.2.1 Bridge 1 « Dauphine Bridge »

Starting at Fenton, the first bridge is about 1.5 km from the beginning of the road. The bridge is on a low radius bend that passes through a valley. The valley is at the upper course of intermittent water current. The bridge allows the pass of water underneath when raining.

2.2.1.1 Current situation

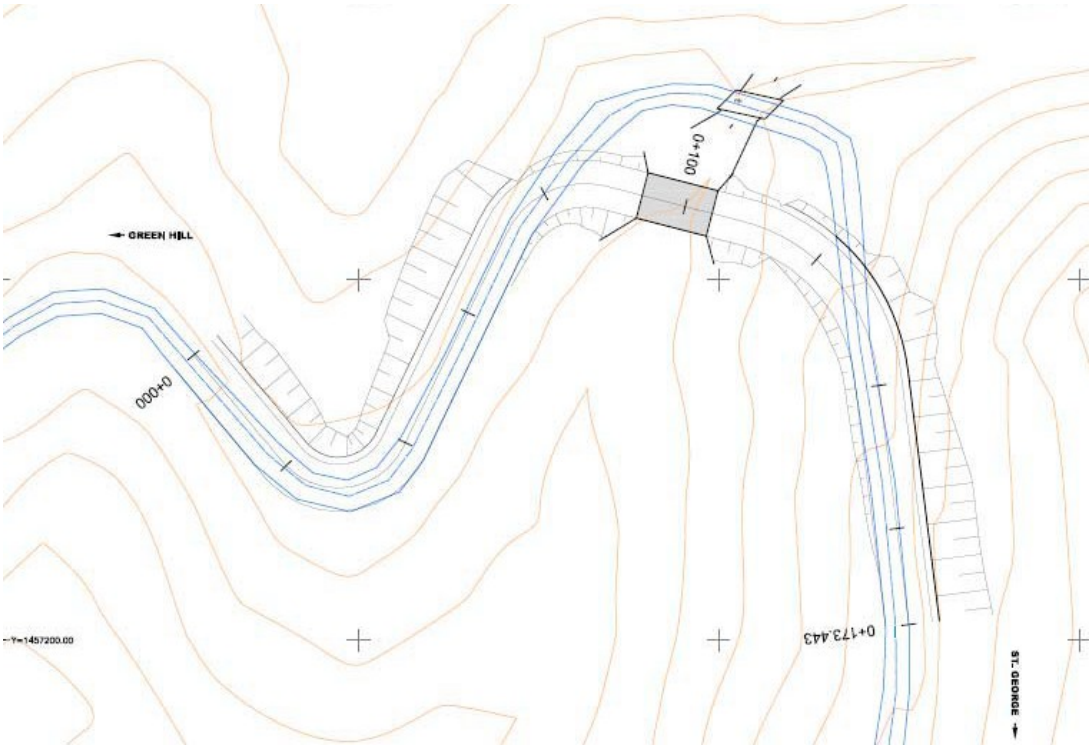
The bridge is about 6.0m long and 3.0m wide. It is made of a reinforced concrete slab that rests on two abutments make of masonry.

Figure 4 : Dauphine Bridge

2.2.1.2 Initial conceptual design (Euroconsult, 2014)

Initial conceptual design was prepared by Euroconsult in 2014. Two alternatives have been analysed for the bridge reconstruction, each one resulting in different foundation systems.

The alternative 1 was to build a new bridge downstream. During its construction the old bridge would remain in service. Then embankments that bind the new bridge with the road would be built. This operation would improve the current bend radius.



The new bridge would have a similar typology to the current one. Its foundation would be built up below the bed of the stream, to a minimum depth of 1.5 m. The foundation would be direct. For the construction of the embankments, the soil of the area would be used, preferably clayey sand. The material would be placed in 30 cm layers, adequately compacted.

The alternative 2 was to use the current bridge as formwork to build the new deck. A formwork that flies over the current slab should be used to widen the bridge, but this would be supported by the current bridge. This new slab would be supported by micropiles that would have been built previously.

It has been decided to adopt the alternative 1, a traditional construction with new abutments and bridge deck as it will allow more local participation. The micropile approach appeared technically feasible, but would pose procurement problems which could delay implementation.

The location of the proposed alternative 1, downstream of the existing bridge, has the advantage that the roadside material excavates should be used for the embankments, and also allows vehicular access during construction which can allow for construction of bridge 2 parallel with bridge 1.

2.2.1.3 Preliminary design (Egis, 2015)

Location and geometrical data

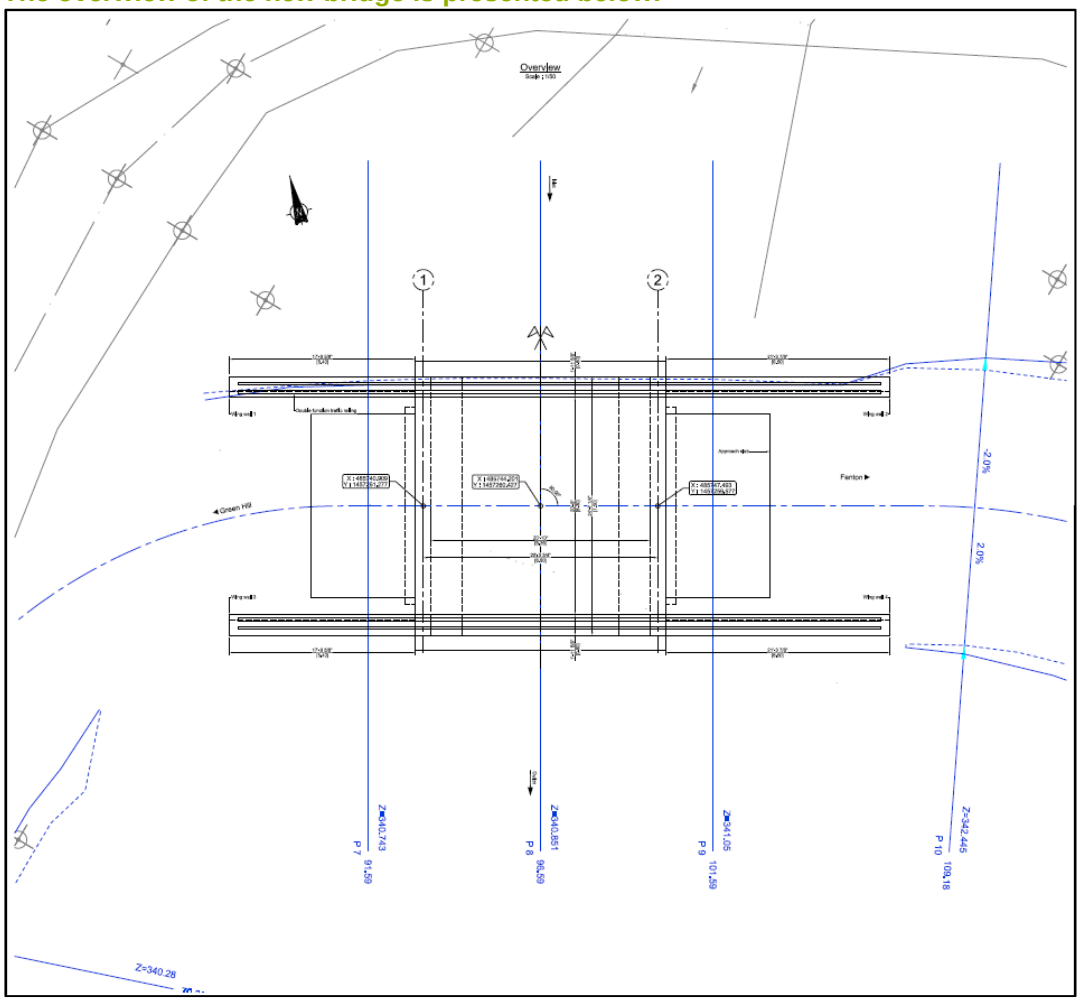
The preliminary design prepared by EGIS is similar to the Alternative 1 proposed by Euroconsult in terms of the bridge location (downstream the existing bridge).
The geometrical data will be following:

- **Sustained lane :**
  - **Identification : Fenton-Green Hill Road**

- **Plan axis : straight line**
- **Vertical section : 2% slope on the bridge, steep 25% slope on Fenton side,**
- **Bridge cross section :**
- **Stub, width 0.50m for traffic railings support,**
- **Traffic lane, width : 6.50m,**
- **Stub, width 0.50m for traffic railings support.**
- **Crossfall : unique 2% slope.**

- **Crossed lane stream: due to a leak of suitable topographic data, the terrain profile under the bridge has been taken from the Euroconsult office drawings. These elements must be updated on the coming complementary topographic campaign.**
- **Altimetry : Z project : 341.13 m ASL at the center traffic lane level, on the bridge.**

The overwiew of the new bridge is presented below.



Bridge structure

The type of structure has been modified since the conceptual design of 2014, and the retained structure is a box culvert (closed frame morphology).
Geometrical slanting : 100 grads,
Slant width (cross section) : 7.50m (measured on axis),
Straight/slant spans : 6.35/6.35m (between interior abutments facings),
Abutment heights : 4.42m (north), 4.57m (south),
All elements thickness is 45cm.
The bridge is designed on a rectangular frame basis:
An upper slab for the deck,
A bottom buried slab,
Two abutments.
The bridge is equipped with approach slabs, bearing on each abutment owing to corbels 30*60cm. The approach slabs dimensions are 5.30m*3.00m*0.35m. The approach slabs are cast in place on the compacted fills.
The wings walls are 60cm thick, regarding to their height varying from 4.85m to 5.80m. They are supported by 60cm thick slabs.

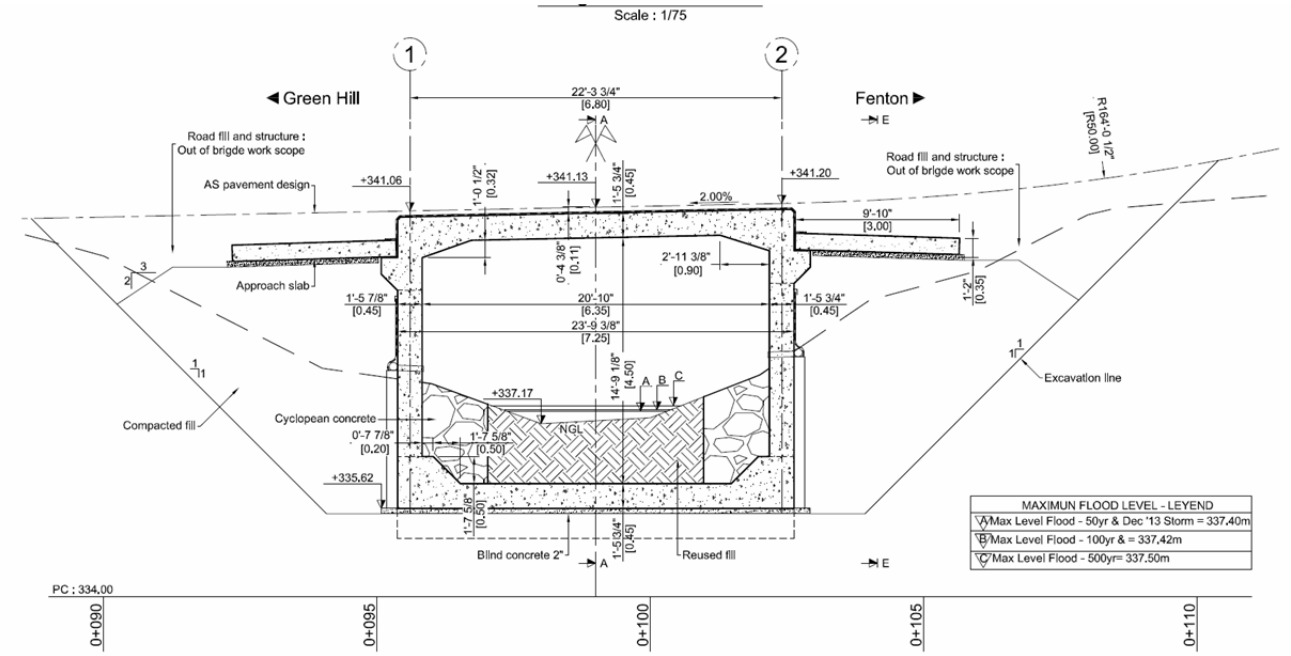


Figure 5 : Longitudinal section

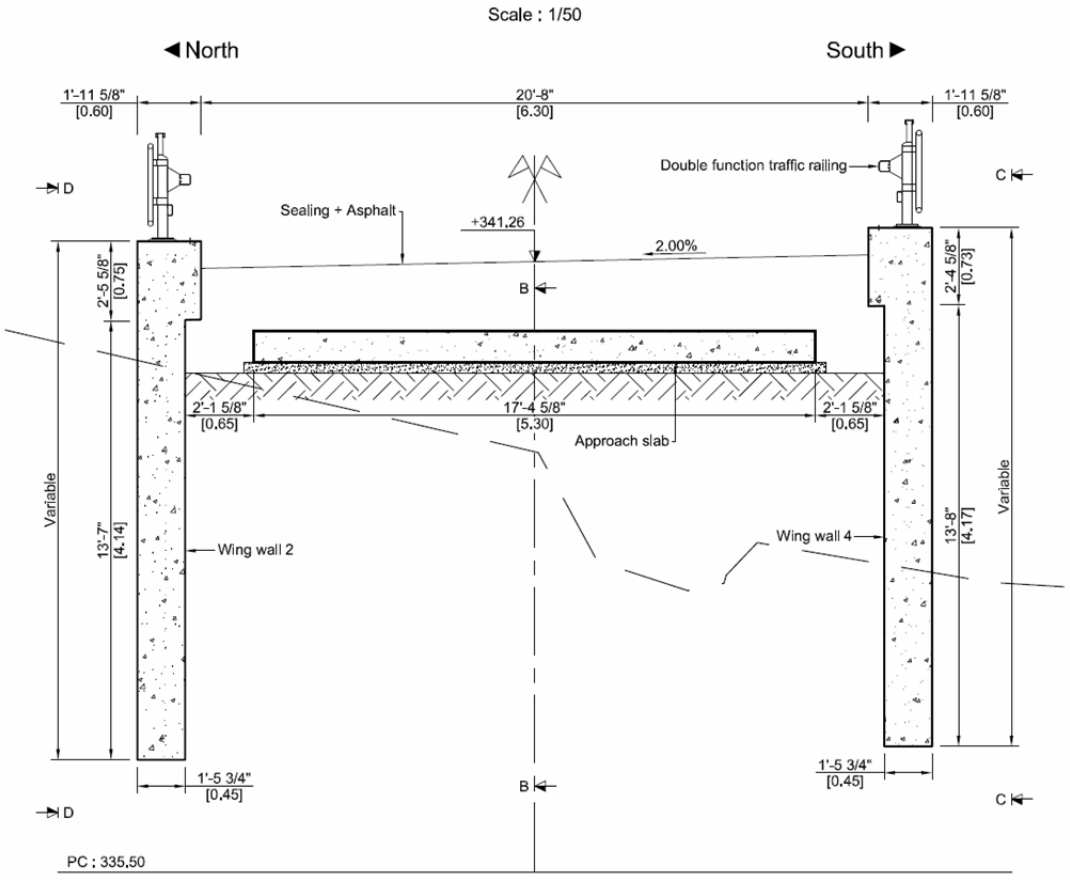


Figure 6 : Cross section

Equipments

Traffic railings

Contraringly to the conceptual design prepared in 2014, railings on bridge and wings walls will be made of stainless steel. The barriers will be chosen regarding to the local market availability.

As for an example, the french double function railing could be used. The figure below shows what this device looks like:

Figure 7: Double function railing example

Sealing expansion joints

Those joints are not necessary for such a bridge and its particular design.

Deck slab sealing – surface pavement
We suggest a fully-bonded elastomeric bitumen single-layer system for direct application of the overlaid wearing course as shown for the south river bridge.
In case of a sealing system requiring a protection layer, we have envisaged on our drawings a total 11cm thick complex, composed of:

- **3cm of sealing and its protection,**
- **8cm of tar macadam as a road cladding,**

Buried surfacing
Buried surfaces are painted with a bitumen emulsion so as to protect faces of concrete exposed to long term humid environment.
Draining
Buried surfaces of walls are drained with geocomposites mats and barbacans located at their lower part so as to evacuate water and prevent hydrostatic pressures.
Topographic benchmarks
We consider:

- **Benchmarks on horizontal surfaces, type "rivet", 2 units per wall, on top (see picture hereunder).**

Figure 8: Picture sample of benchmark type "rivet"

- **Benchmarks on vertical surfaces, type "medaillon", 2 per abutment and wall (see picture hereunder).**

Figure 9: Picture sample of benchmark type "medaillon"

Borders
None here (borders are considered only on the south river bridge).
Riprap blankets
The riprap blankets which had been considered by Euroconsult office have been kept. The material used to build them is cyclopean concrete: stones wrapped with concrete.

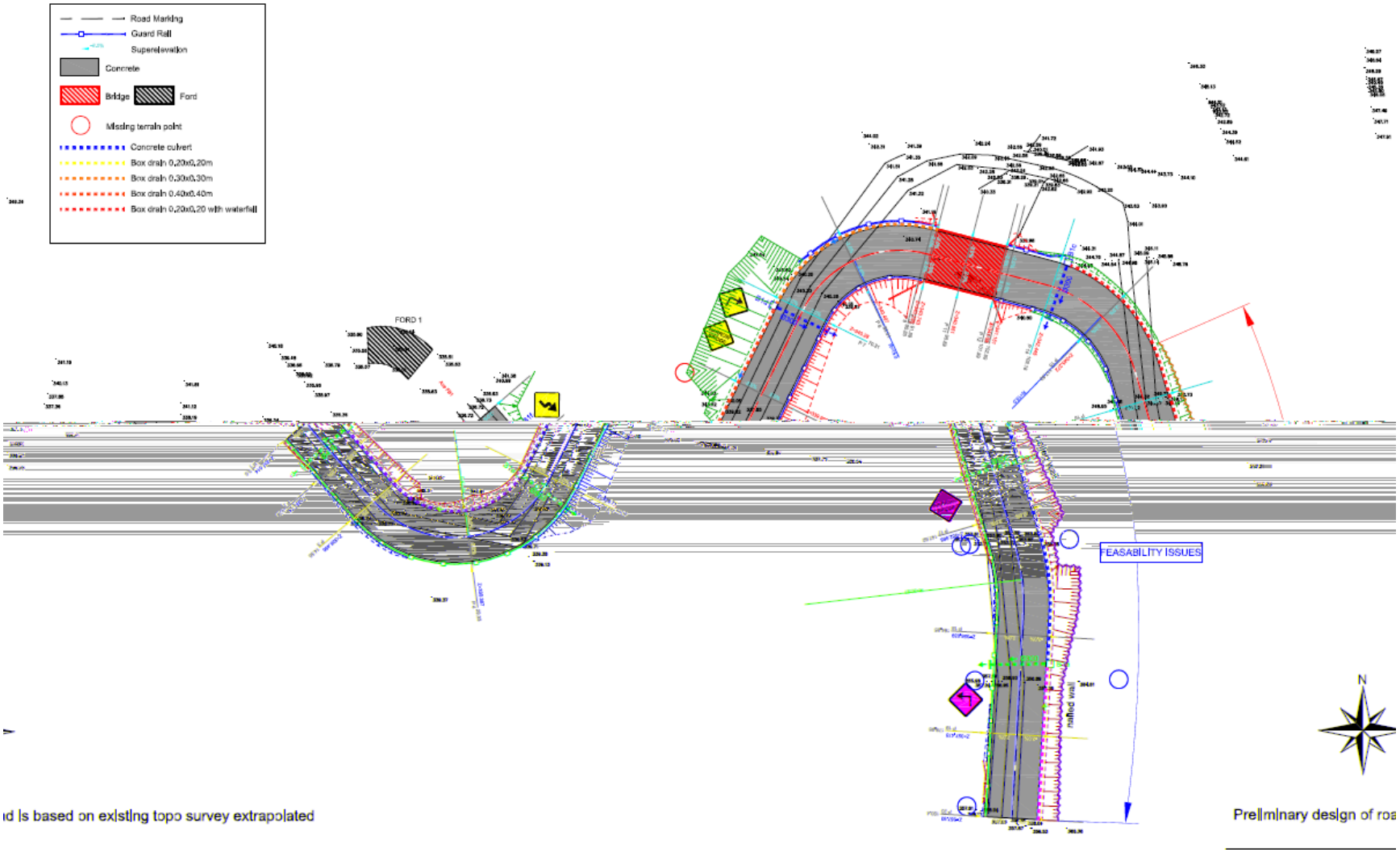


Figure 10 : Preliminary design of the Fenton Bridge (Egis, 2015)

Design assumptions

The bridge was desingned according to the following assumptions:

- **Maximum flood level**

The deck slab intrados level is widely above the maximum flood level (max flood level -500 yr = 337.50 mASL) : nearly 340.57 mASL.

- **Loads taken into account**

  - **Dead Loads: DC (Dead Load of structural components and nonstructural attachments), DW (Dead Load of Wearing surfaces and utilities),**
  - **Earth Loads: EH, ES, and DD, Earth pressure, earth surchase, and downdrag loads,**
  - **Live Loads: according to AASHTO 2012 :**

    Design truck : Vehicular Live Load on the roadway of bridges or incidental structures, designated HL-93 :

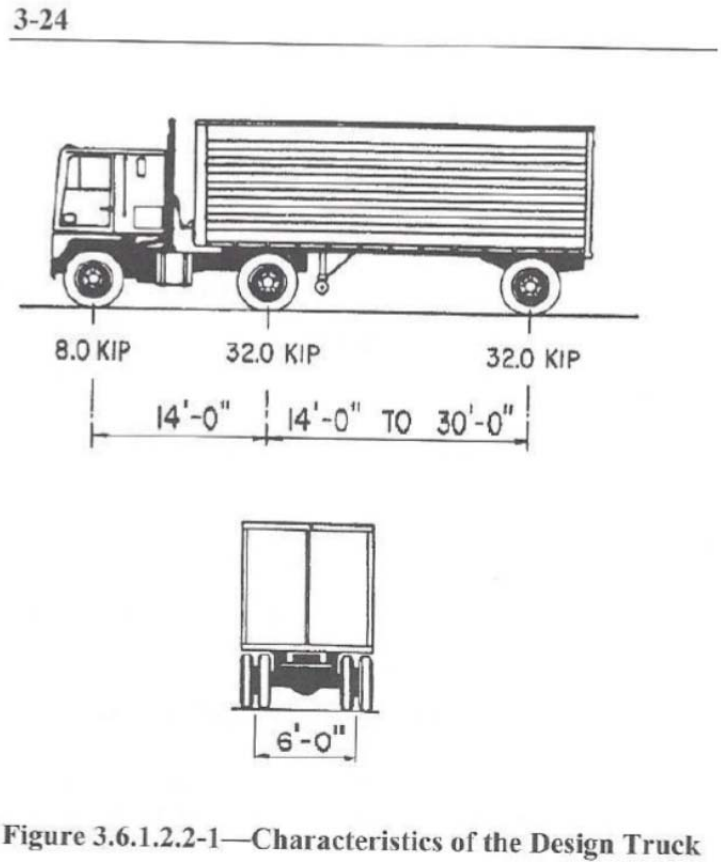


Figure 11: Design truck from AASHTO LFRD Bridge design (2012)

- **Design tandem : as defined in AASHTO § 3.6.1.2.3,**
- **Design lane load : as defined in AASHTO § 3.6.1.2.4,**

The application of the above design vehicular live loads is done as required by item § 3.6.1.3 of AASHTO.

- **Pedestrians load : there aren't any (no sidewalks available),**
- **Dynamic load allowance : as required by 3.6.2 of AASHTO IM value is taken at 33%.**

- **Seismic loads**

Studied structures are located in a seismic area. The seismic design in AASHTO is done with :

- **7% in 75 years event for development of a design spectrum,**
- **ASCE/NEHRP site Classification system and include site factors in determining response spectrum ordinates,**
- **sufficient conservatism (1.5 safety factor) for minimum support length requirement,**
- **establishing the Seismic Design Categories.**

Dynamic earth pressure is evaluated with the Mononobe-Okabe method.
For the design bridge criteria, the method used is based on the allowable stress on the foundation soil. Final settlement and liquefaction risk will be assessed on further more accurate geotechnical data.

2.2.1.4 Construction methodology

The construction should be scheduled during dry season so as to ease the work in the river bed (the flow is given to be strongly variable [2]).
During the construction of the new bridge, the existing bridge will be used to maintain the traffic until the new one is achieved. The traffic is supposed to be occasional and light during construction period.

The new bridge location will be excavated until satisfactory ground and soil substitution will be placed.
The structures will be built with common construction methodology: formwork, reinforced concrete, waterproofing works.

When the new bridge can be used by the traffic, the old bridge will be totally demolished, including its abutments and foundations.

The demolition is not necessary for the present works. However, demolishing the existing bridge during the construction works is a good economical alternative: all construction machines are on site and a new consultancy is not needed.

In addition, this option is safer for the road users as they will not try to take the elder bridge.

In the event of strong stream, manifolds, cofferdam and a light motor pump will be used to deviate water flow (apparently no ground water table found).

The bottom slab will be protected against scouring risk with toes on both edges. The riprap mentioned above is also protection measure for the walls and slab.

After the demolition of the existing bridge, the banks will be reshaped at the abutments places and protected from erosion with rip raps.

All precautions will be taken for environment preservation against accidental pollutions, hazardous and other various building site waste.

2.2.2 Bridge 2 “Fenton Bridge”

The second bridge is located about 300 meters ahead.
The bridge passes over a river, with a permanent water flow. Basalt rounded cobble can be seen at the bottom of the runway. The course is embedded in a rock outcrops, visible on its margins.

2.2.2.1 Curent situation

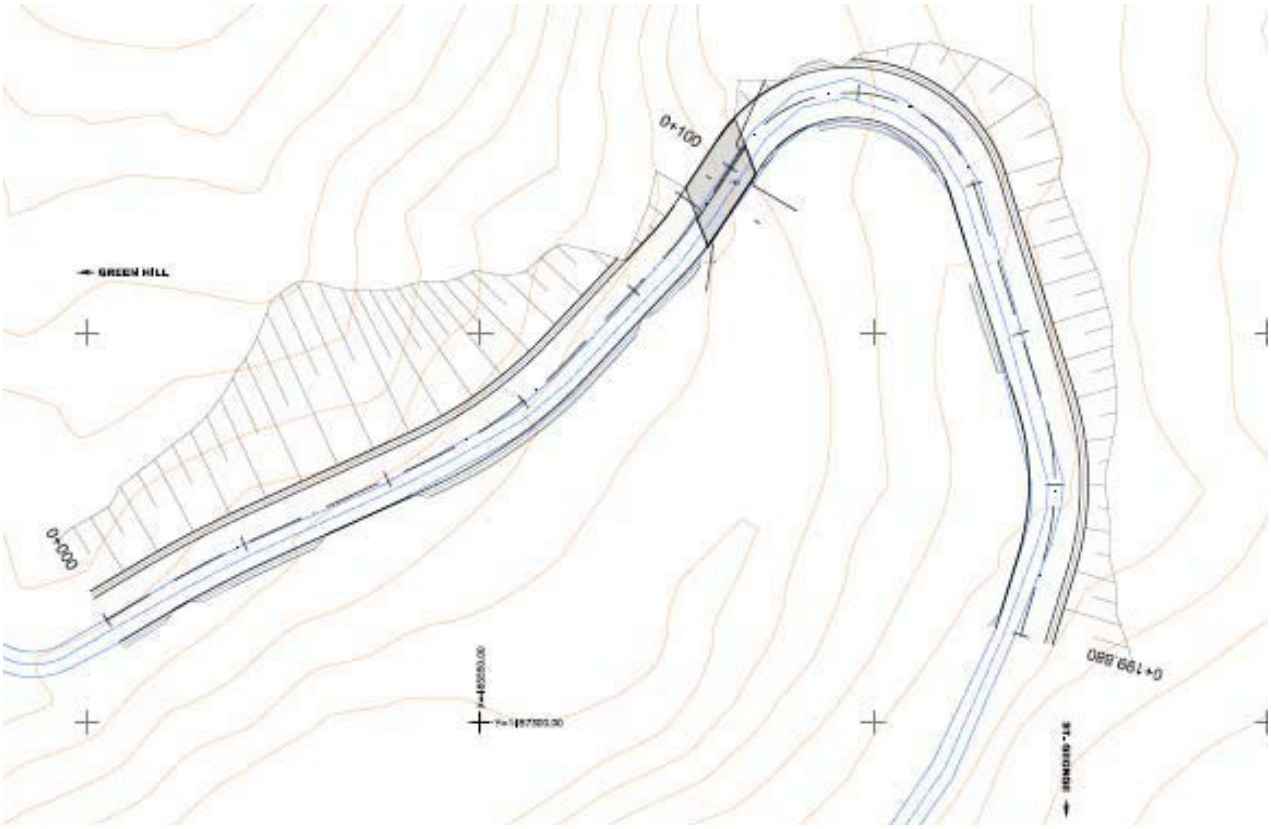
Similar to the bridge before, this one is about 8.0m long and 3.0m wide. It is made of a reinforced concrete slab that rests on two masonry abutments.

Figure 12 : Dauphine Bridge

2.2.2.2 Initial conceptual design (Euroconsult, 2014)

Two alternatives have been analysed for the bridge reconstruction, each one resulting in different foundation systems.

The first alternative (Alt. 1) is to build a new bridge upstream, very close to the old one. This solution requires that a part of the abutments should be demolished, keeping the old slab. This way, the traffic on the road is allowed during construction of the new bridge. The new bridge would have a similar typology to the current one. Its foundation would be built up below the bed of the river, to a minimum depth of 1.5 m. The Foundation would be direct. A diversion system of the water flow should be foreseen. It could be done using alternatively each river bank.



The second alternative (Alt. 2) is to reconstruct the bridge in the same location of the current one. In this option the old bridge abutments should be repaired.

Maintaining continuous vehicular traffic is not an issue, as this is practically non existent. Therefore, this parameter should not be considered a constraint in choosing the final design. Continuous pedestrian access however is required, but this can be achieved with a simple wooden footbridge.

As a result, Alternative 2 has been chosen.

2.2.2.3 Preliminary design (Egis, 2015)

Location and geometrical data

The new bridge is planned to be built at the same place as the existing one.
The geometrical data will be following:
Sustained lane :

- **Identification : Fenton-Green Hill Road**
- **Plan axis : straight line**
- **Vertical section : 1% slope on the bridge,**
- **Bridge cross section :**

  Stub, width 0.50m for traffic railings support,

  Traffic lane, width : 6.50m,

  Stub, width 0.50m for traffic railings support.

- **Crossfall : unique 2% slope.**

Crossed lane: river : due to a leak of suitable topographic data, the terrain profile under the bridge has been taken from the Euroconsult office drawings. These elements must be updated on the coming complementary topographic campaign.
Altimetry: Z project : 320.56 m ASL at the center traffic lane level, on the bridge.
The overwiew of the new bridge is presented below.

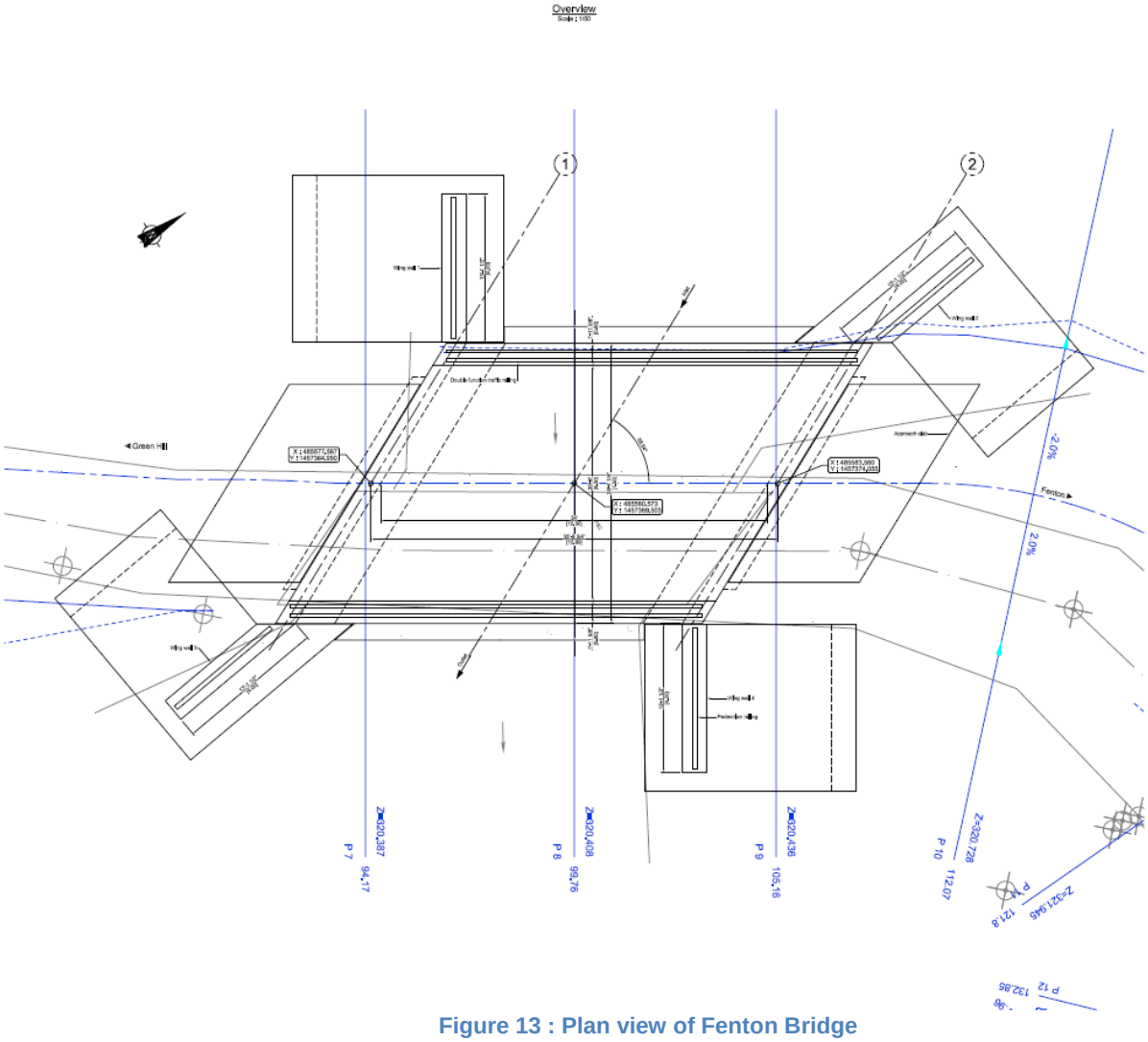


Figure 13 : Plan view of Fenton Bridge

Bridge structure

The type of structure has been modified since the conceptual design of 2014, and the retained structure is a box culvert (closed frame morphology).
Geometrical slanting : 65.2 grads,
Slant width (cross section) : 8.78m (measured on axis),
Straight/slant spans : 8.85/10.36m (between interior abutments facings),
Abutment heights : 5.62m (north), 5.77m (south),
All elements thickness is 45cm
The bridge is designed on a rectangular frame basis:
An upper slab for the deck,
A bottom buried slab,
Two abutments.

The bridge is equipped with approach slabs, bearing on each abutment owing to corbels 30*60cm. The approach slabs dimensions are 6.20m*3.00m*0.30m. The approach slabs are cast in place on the compacted fills.
The wings walls are 65cm thick, regarding to their height varying from 6.26m to 6.50m. They are supported by 60cm thick shallow footings. The wall calculations are given in annex 4.2. It appears that keels are necessary for non-slipping conditions under seismic forces.

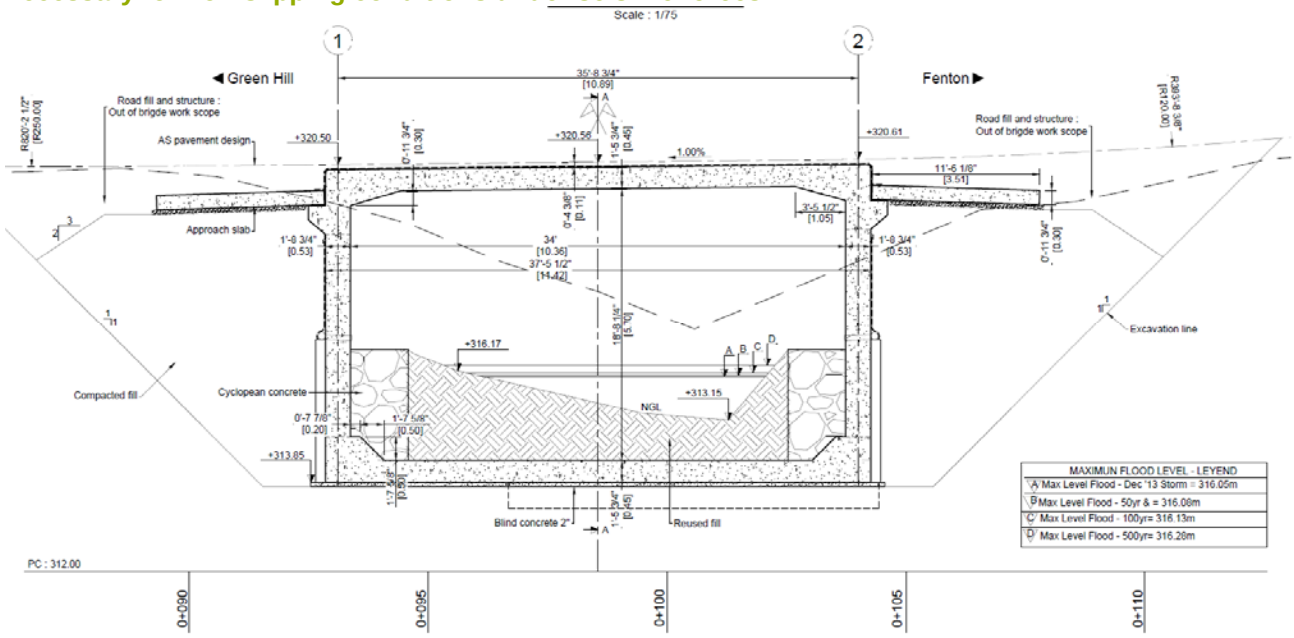


Figure 14 : Longitudinal section of Fenton Bridge

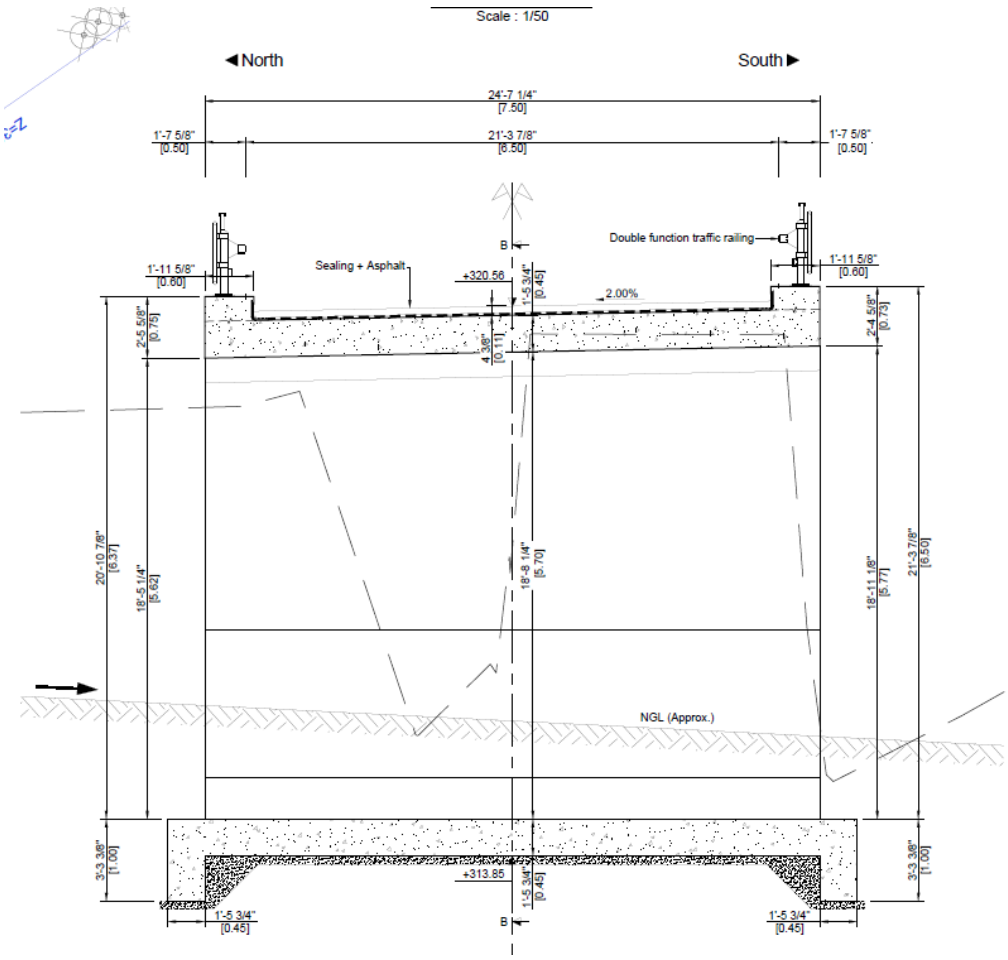


Figure 15 : Cross section of Fenton Bridge

Equipments

- **Traffic railings**

Railings on bridge and wings walls are made of stainless steel. The barriers will be chosen regarding to the local market availability.

As for bridge 1, the french double function railing could be used.

- **Sealing expansion joints**

Those joints are not necessary for such a bridge and its particular design.

- **Deck slab sealing – surface pavement**

As for bridge 1, we suggest a fully-bonded elastomeric bitumen single-layer system for direct application of the overlaid wearing course, like Parafor Ponts from Seaplast Inc.

In case of a sealing system requiring a protection layer, we have envisaged on our drawings a total 11cm thick complex, composed of:

- **3cm of sealing and its protection,**
- **8cm of tar macadam as a road cladding,**

- **Buried surfacings**

Buried surfaces are painted with a bitumen emulsion so as to protect faces of concrete exposed to long term humid environment.

- **Draining**

Buried surfaces of walls are drained with geocomposites mats and barbacans located at their lower part so as to evacuate water and prevent hydrostatic pressures.

- **Topographic benchmarks**

We consider :

- **2 benchmark, type "rivet" per wall, on top,**
- **2 benchmarks, type "medaillon", per abutment and wall,**

- **Borders**

None here (borders are considered only on the south river bridge).

- **Riprap blankets**

The riprap blankets which had been considered by Euroconsult office have been kept. The material used to build them is cyclopean concrete : stones wrapped with concrete.

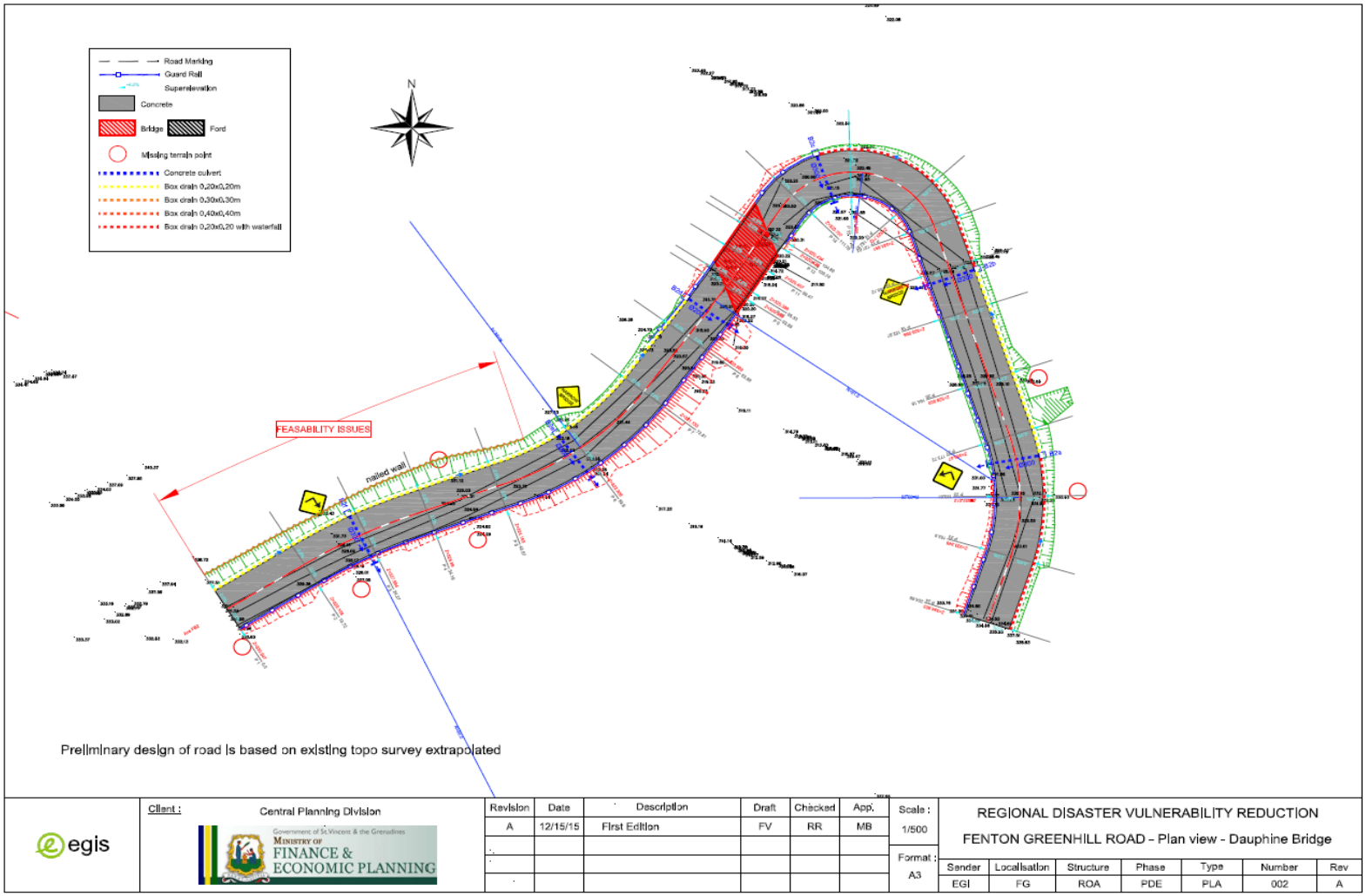


Figure 16 : Preliminary design of the Fenton Bridge (Egis, 2015)

Design assumptions

- **Maximum flood level**

The deck slab intrados level is widely above the maximum flood level (Max level flood – 500 yr =316.28 mASL) : 320.11 mASL.

- **Loads taken into account**

  - **Dead Loads: DC (Dead Load of structural components and nonstructural attachments), DW (Dead Load of Wearing surfaces and utilities),**
  - **Earth Loads: EH, ES, and DD, Earth pressure, earth surchase, and downdrag loads,**
  - **Live Loads: according to AASHTO 2012 :**

    Design truck : Vehicular Live Load on the roadway of bridges or incidental structures, designated HL-93 (as described for bridge 1),

    Design tandem : as defined in AASHTO § 3.6.1.2.3,

    Design lane load : as defined in AASHTO § 3.6.1.2.4,

The application of the above design vehicular live loads is done as required by item § 3.6.1.3 of AASHTO.

Pedestrians load : there aren't any (no sidewalks available),

Dynamic load allowance : as required by 3.6.2 of AASHTO IM value is taken at 33%.

- **Seismic loads**

As described for bridge 1. For the design bridge criteria, the method used is based on the allowable stress on the foundation soil. Final settlement and liquefaction risk will be assessed on further more accurate geotechnical data.

2.2.2.4 Building methodology

The construction should be scheduled during dry season so as to ease the work in the river bed (the flow is given to be strongly variable [2]).
During the construction, a temporary access road will be used for the traffic which is supposed to be occasional and light. The temporary road deviation will be built with a backfilling of the River including pipes for the water (if needed).

The old bridge will be totally broken, including its abutments and foundations, during the preliminary activities, after the site clearing of trees and various vegetation around the site.

After the demolition, soil should be cleared of all debris, stones, in order to obtain a homogenous platform for the bottom slab foundation. If needed, soil substitution will be placed.
The structures will be built with common construction methodology: formwork, reinforced concrete, waterproofing works.

In the event of strong stream, manifolds, cofferdam and a light motor pump will be used to deviate water flow (apparently no ground water table found).

The bottom slab will be protected against scouring risk with toes on both edges. The riprap mentioned above is also protection measure for the walls and slab.

All precautions will be taken for environment preservation against accidental pollutions, hazardous and other various building site waste.

2.2.3 Bridge 3: "Green Hill bridge"

The third bridge is another 200 meters ahead. It is in a dense forest area, with steeper slopes than the previous sites. Rock outcrop are close to the surface. Similar to the two previous bridges, this one is about 8.0m long and 3.0m wide. It is made of a reinforced concrete slab that rests on two masonry abutments.

2.2.3.1 Current situation

The bridge is clearly damaged. Cracks are visible on the abutments. Even a part of one of them has fallen down. The concrete slab is still resting safe, but it is unprotected. The river is undermining the foundation, so that the safety of the structure is compromised.

Figure 17 : Photo of Greenhill Bridge

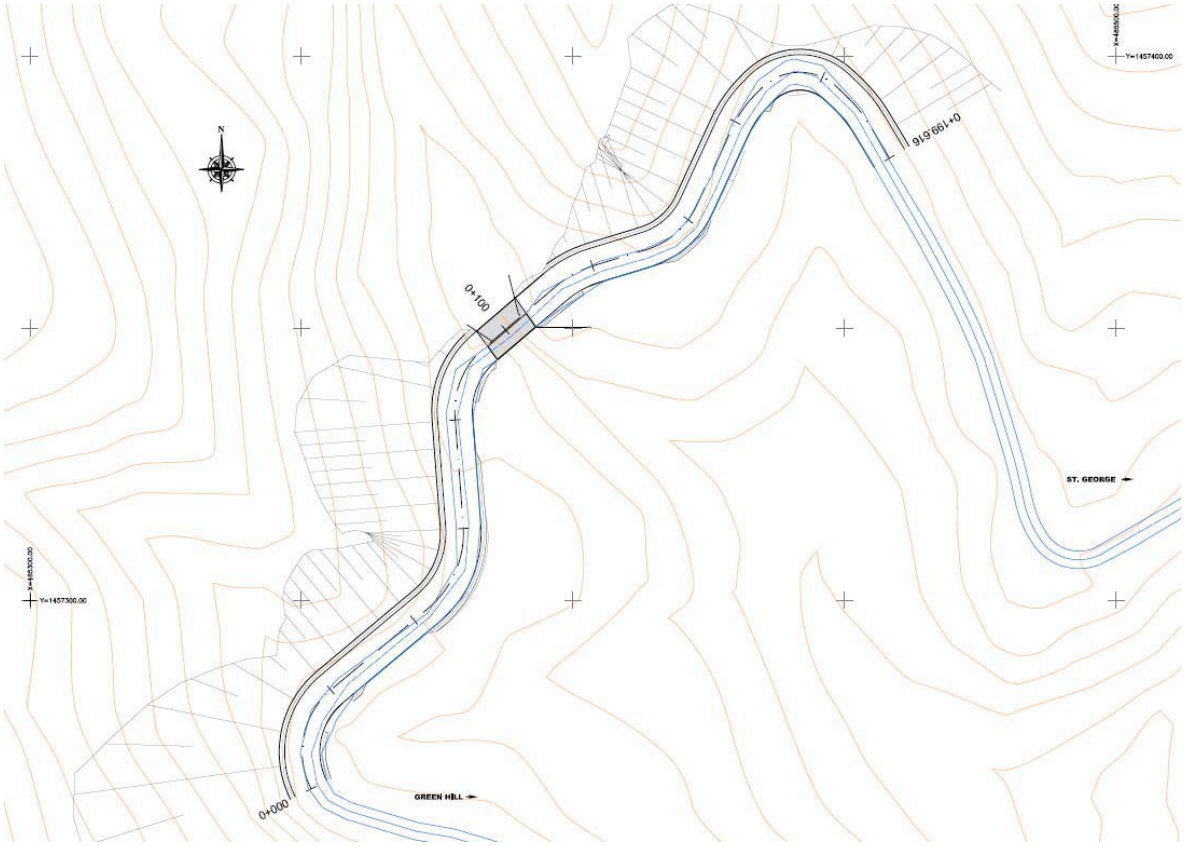
Bridge 3

Against what happened in the previous two locations, this bridge is severely damage.
The right hand abutment, the one place on the rock outcrop is specially damage, and indeed a part of it collapsed.

The more likely cause of this collapse is the rain water infiltration that reaches the walls. This water accumulates at the backface wall and pushes it down. Moreover, the hardness of the rock foundation did not allow a deep enough excavation to place the footing. So undermining processes are also observed.

2.2.3.2 Initial conceptual design (Euroconsult, 2014)

The proposed alternative was to reconstruct the bridge in the same location of the current one, because it is not necessary maintaining continuous vehicular traffic. The old bridge abutments should be repaired.



2.2.3.3 Preliminary design (Egis, 2015)

Location and geometrical data

The geometrical data are as provided in the preliminary design study.
Sustained lane :

- **Identification : Fenton-Green Hill Road**
- **Plan axis : straight line**
- **Vertical section : a 5 meters long slope of 0.66% between two circular curves, 30m radius on Geen Hill side and 70m radius on Fenton side. The bridge profile is so on a low point.**
- **Bridge cross section :**

  Stub, width 0.50m for traffic railings support,

Traffic lane, width : 6.50m,

Stub, width 0.50m for traffic railings support.

- **Crossfall : unique 2% slope.**

Crossed lane : river : due to a leak of suitable topographic data, the terrain profile under the bridge has been taken from the Euroconsult office drawings. It will be updated on the coming complementary topographic campaign.
Altimetry : Z project : 332.52 m NGF at the center traffic lane level, on the bridge.

The overwiew of the new bridge is presented below.

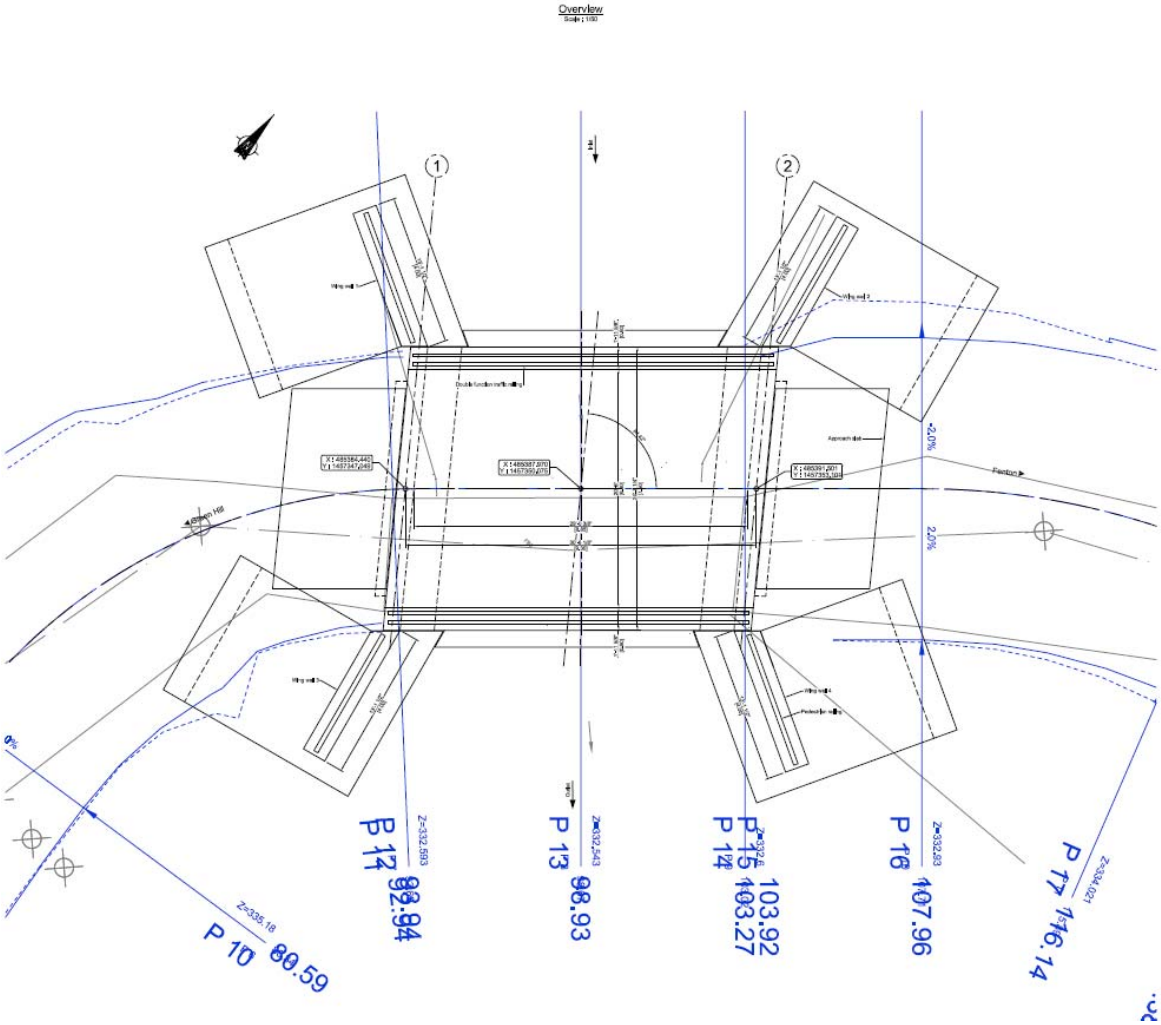


Figure 18 : Plan view of Greenhill Bridge

Bridge structure

The type of structure has been modified since the conceptual design of 2014, and the retained structure is a box culvert (closed frame morphology).

General characteristics :

Geometrical slanting : 93.8 grads,
Slant width (cross section) : 7.54m (measured on axis),
Straight/slant spans : 8.81/8.85m (between interior abutments facings),
Abutment heights : 5.84m (north), 5.99m (south),
All elements thickness is 45cm

The bridge is designed on a rectangular frame basis:
An upper slab for the deck,
A bottom buried slab,
Two abutments.

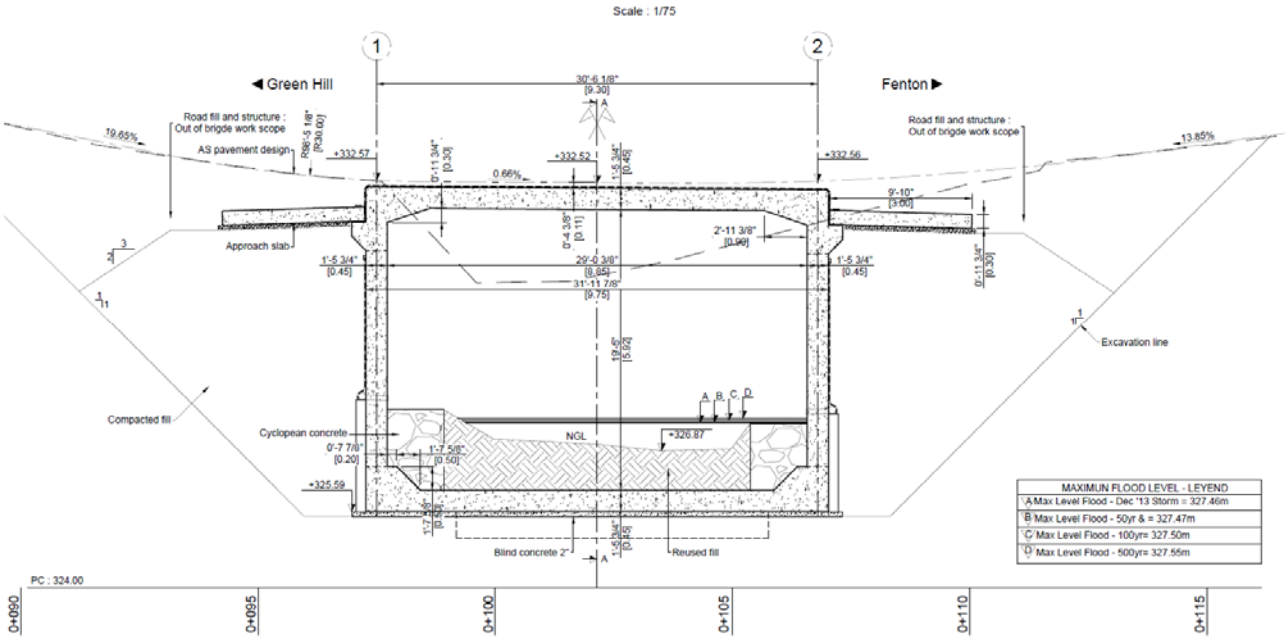


Figure 19 : Longitudinal section of Greenhill Bridge

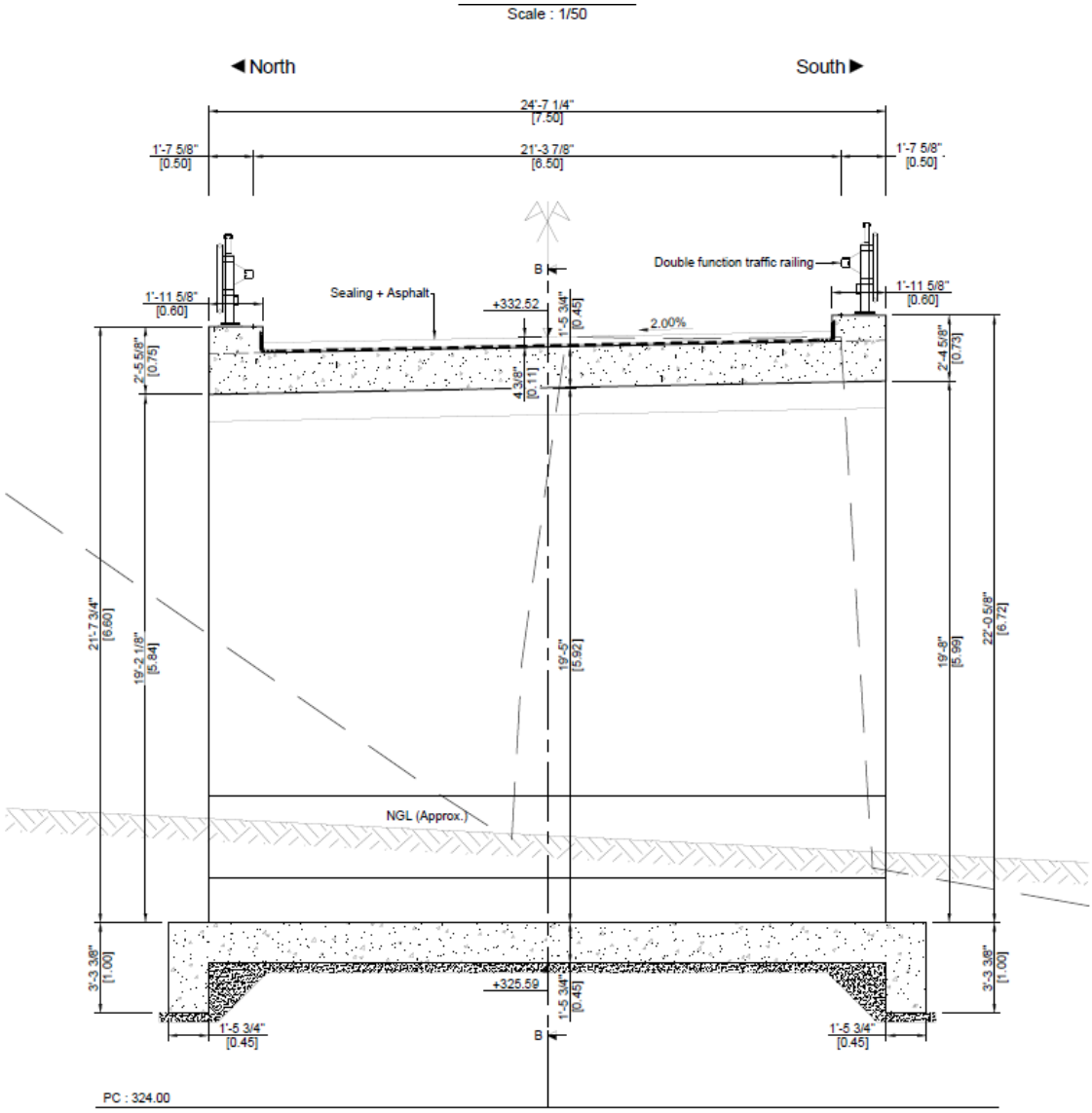


Figure 20 : Cross section of Greenhill Bridge

The bridge is equiped with approach slabs, bearing on each abutment owing to corbels 30*60cm. The approach slabs dimensions are 5.30m*3.00m*0.30m. The approach slabs are cast in place on the compacted fills.
The wings walls are 65cm thick, regarding to their height varying from 6.60m to 6.72m. They are supported by 60cm thick shallow footings. It appears that keels are necessary for non-slipping conditions under seismic forces.

Equipments

- **Traffic railings**

Railings on bridge and wings walls are made of stainless steel. The barriers will be chosen regarding to the local market availability.
As for bridge 1, the french double function railing could be used.

As the bridge profile is on a low point, the down stub will be interrupted so as to prevent rain water accumulation.

- **Sealing expansion joints**

Those joints are not necessary for such a bridge and its particular design.

- **Deck slab sealing – surface pavement**

As for bridge 1, we suggest a fully-bonded elastomeric bitumen single-layer system for direct application of the overlaid wearing course, like Parafor Ponts from Seaplast Inc.
In case of a sealing system requiring a protection layer, we have envisaged on our drawings a total 11cm thick complex, composed of:

- **3cm of sealing and its protection,**
- **8cm of tar macadam as a road cladding,**
-

- **Buried surfacings**

Buried surfaces are painted with a bitumen emulsion so as to protect faces of concrete exposed to long term humid environment.

- **Draining**

Buried surfaces of walls are drained with geocomposites mats and barbacans located at their lower part so as to evacuate water and prevent hydrostatic pressures.
Topographic benchmarks
We consider :

- **2 benchmark, type "rivet" per wall, on top,**
- **2 benchmarks, type "medaillon", per abutment and wall,**

- **Borders**

None here (borders are considered only on the south river bridge).

- **Riprap blankets**

The riprap blankets which had been considered by Euroconsult office have been kept. The material used to build them is cyclopean concrete : stones wrapped with concrete.

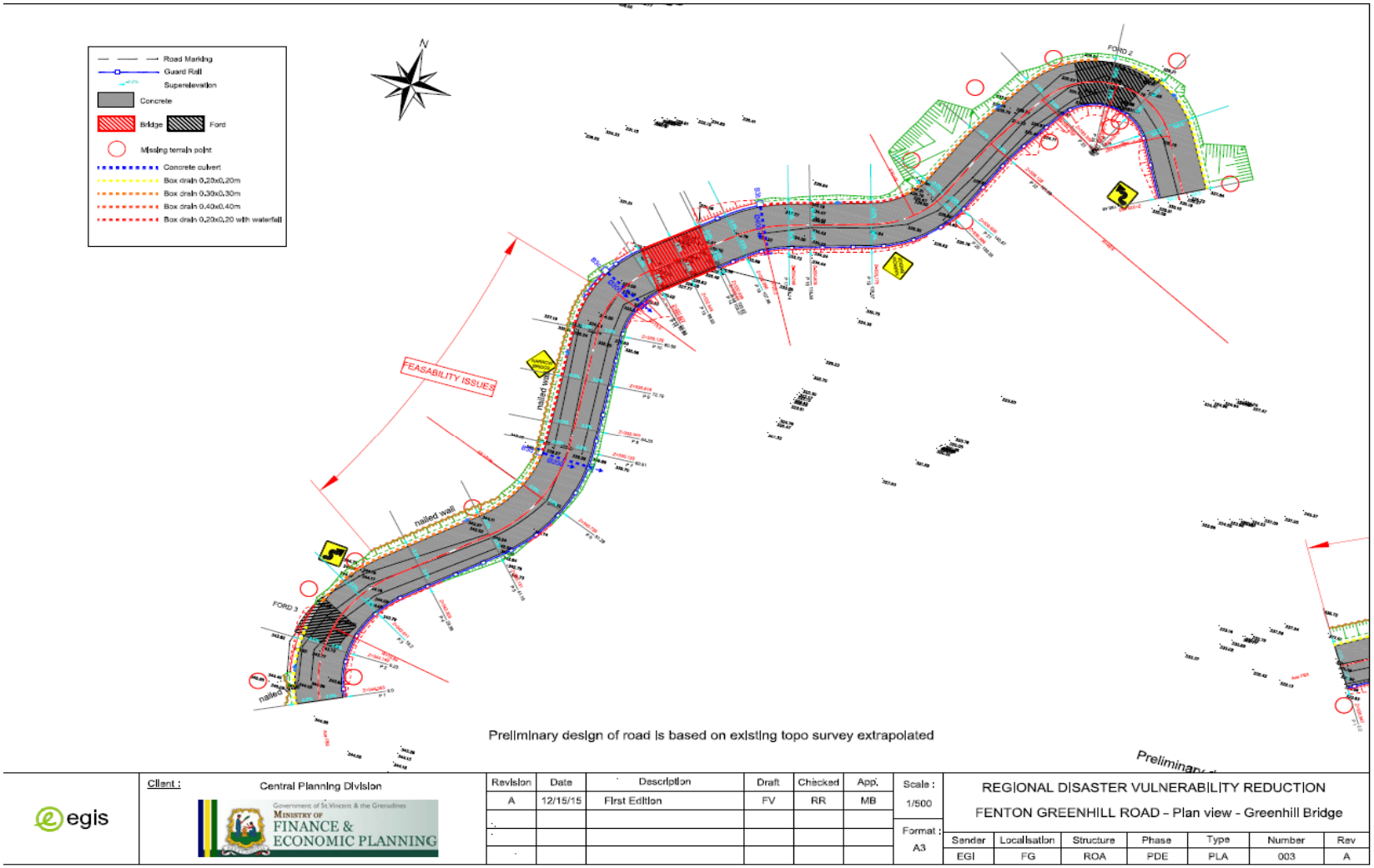


Figure 21 : Preliminary design of the Greenhill Bridge (Egis, 2015)

Design assumptions

Maximum flood level :

The deck slab intrados level is widely above the maximum flood level (Max level flood – 500 yr = 327.55 mASL): nearly 332.07mASL.

- **Loads taken into account**

  - **Dead Loads: DC (Dead Load of structural components and nonstructural attachments), DW (Dead Load of Wearing surfaces and utilities),**

  - **Earth Loads: EH, ES, and DD, Earth pressure, earth surchase, and downdrag loads,**

  - **Live Loads: according to AASHTO 2012 :**

    Design truck : Vehicular Live Load on the roadway of bridges or incidental structures, designated HL-93 (as described for bridge 1),

    Design tandem : as defined in AASHTO § 3.6.1.2.3,

    Design lane load : as defined in AASHTO § 3.6.1.2.4,

The application of the above design vehicular live loads is done as required by item § 3.6.1.3 of AASHTO.

- **Pedestrians load : there aren't any (no sidewalks available),**
- **Dynamic load allowance : as required by 3.6.2 of AASHTO IM value is taken at 33%.**

- **Seismic loads**

  As described for bridge 1.
  For the design bridge criteria, the method used is based on the allowable stress on the foundation soil. Final settlement and liquefaction risk will be assessed on further more accurate geotechnical data.

2.2.3.4 Building methodology

The construction should be scheduled during dry season so as to ease the work in the river bed (the flow is given to be strongly variable [2]).
During the construction, a temporary access road will be used for the traffic which is supposed to be occasional and light. The temporary road deviation will be built with a backfilling of the River including pipes for the water (if needed).

The old bridge will be totally broken, including its abutments and foundations, during the preliminary activities, after the site clearing of trees and various vegetation around the site.
After the demolition, soil should be cleared of all debris, stones, in order to obtain a homogenous platform for the bottom slab foundation. If needed, soil substitution will be placed.
The structures will be built with common construction methodology: formwork, reinforced concrete, waterproofing works.

In the event of strong stream, manifolds, cofferdam and a light motor pump will be used to deviate water flow (apparently no ground water table found).

The bottom slab will be protected against scouring risk with toes on both edges. The riprap mentioned above is also protection measure for the walls and slab.

All precautions will be taken for environment preservation against accidental pollutions, hazardous and other various building site waste

2.2.4 Box culvert

Sixty meter ahead of this last bridge, there is a culvert box, also in a dense forest area, with steeper slopes than the previous sites.

The box culvert is the drainage way of one small stream. It has a clearance of 2.0 m. It is about 3.0 m wide and 3.0 m long. The box culvert undergoes similar undermining phenomena than the bridge, but only on the spillway, downstream.

Figure 22 : Photo of Box culvert

The geotechnical profile at the place is like the bridge N°3. Rock outcrops are expected at the foundation.

The culvert box does not present structural damage, however it is experimenting an undermining process at its downstream spillway.

Reinforcement and protecting this spillway should be considered in order to avoid futures damage on the road.

2.2.5 Fords

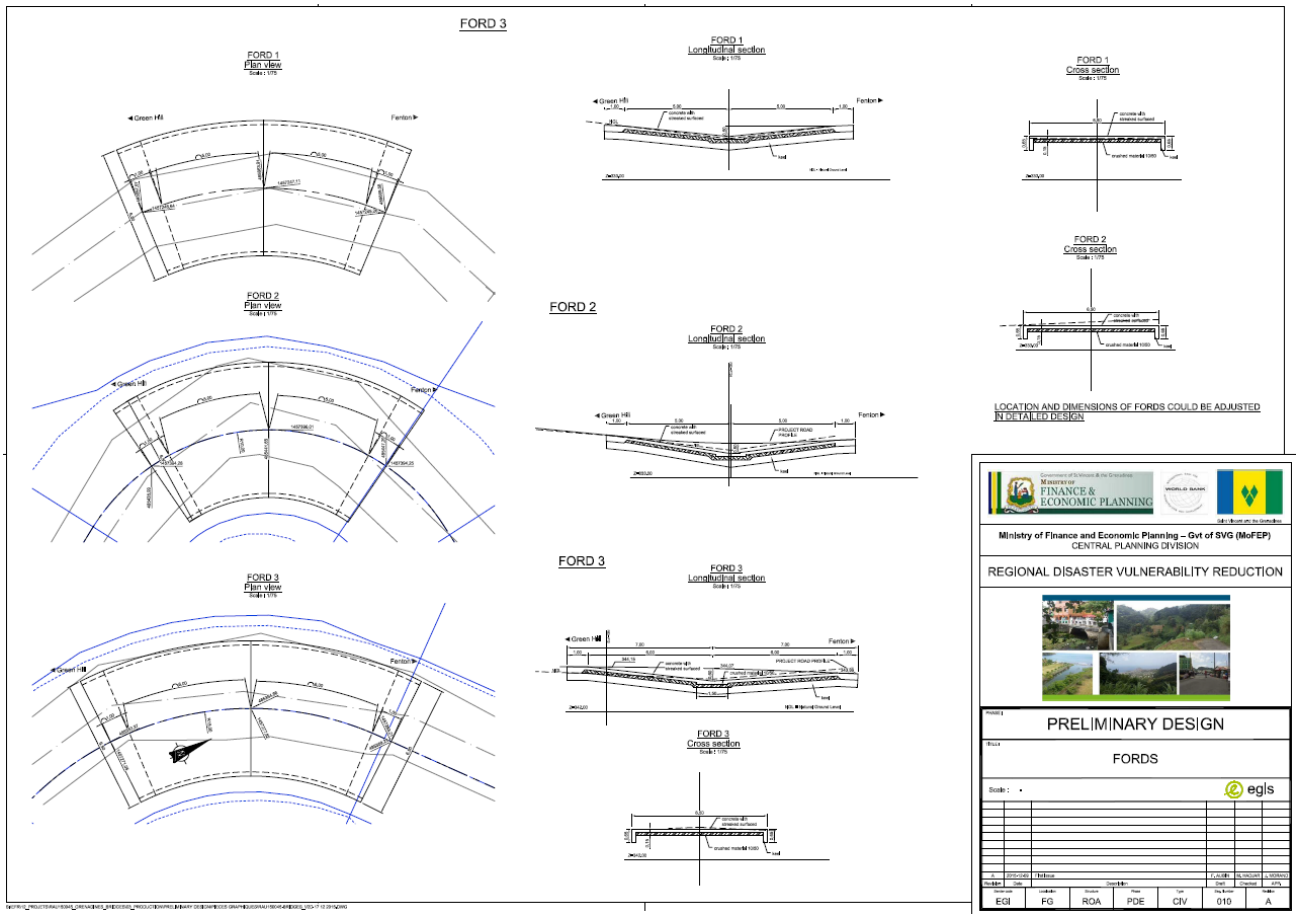


Figure 23 : Plan Views of the fords (Egis, 2015)

2.2.6 Road drainage

As noted during the field visits, the road is currently without roadside drainage capacity which has contributed to the serious deterioration that today reflects the way. Many earth slides were observed along the road and the remaining ditches and culverts that could be identified during the visit showed clogging problems

1. Runoff over the Road
2. Pavement Structure Deterioration
3. Earth slide observed along the road
4. Clogged Ditch

Initially (Euroconsult, 2014), the project consisted of the rehabilitation of the roadside drainage along 4km of the Fenton to Green Hill Road.

In current preliminary design, the roadrainage will be reconstructed along approximately 600m corresponding to 100m road line on each site of three bridges (200m per bridge).

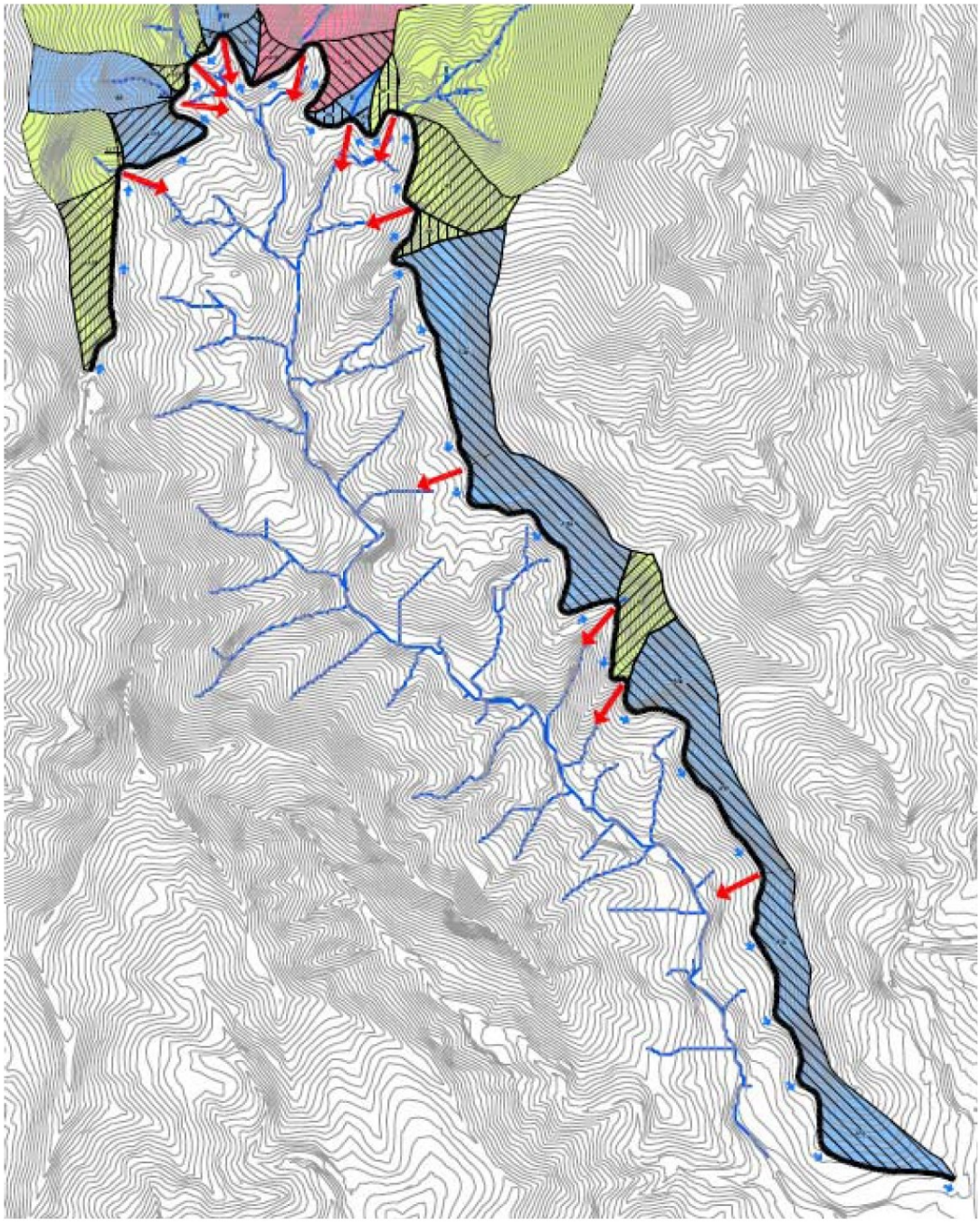


Figure 24 : Drainage : Catchment areas

Road drainage road-crossing pipe hydraulic calculation

The hydraulic calculation results are detailed in the following table.

Road drainage road-crossing pipe N°	Extrapolated Q 25yrs (m3/s)	Slope (%)	Concrete Pipe DN (mm)	Max velocity (m/s)	Max water level (m)
1a	0.037	2	300	1.54	0.15
1b	0.026	2	300	1.39	0.12
1c	0.026	2	300	1.39	0.12
1d	0.047	2	300	1.64	0.17
1e	0.169	2	500	2.25	0.28
1f	0.113	2	400	2.04	0.24
2a	0.050	2	300	1.66	0.17
2b	0.021	2	200	1.34	0.12
2c	0.061	2	300	1.75	0.19
2d	0.048	2	300	1.65	0.17
2e	0.018	2	200	1.29	0.11
2f	0.032	2	300	1.47	0.14
3a	0.034	2	300	1.5	0.14
3aa	0.033	2	300	1.49	0.14
3b	0.102	2	400	1.99	0.23
3c	0.031	2	300	1.46	0.13
3d	0.014	2	200	1.21	0.1

Road drainage ditches hydraulic calculation

The hydraulic calculation results are detailed in the following table.

Road drainage ditch N°	Extrapolated Q 25yrs (m3/s)	Slope (%)	U Concrete ditch dimension	Max velocity (m/s)	Max water level (m)
B1T3f	0.113	6.12%	0.3*0.3m	2.96	0.13
B1T3e	0.169	2.18%	0.4*0.4m	2.02	0.19
B1T3d	0.047	2.16%	0.3*0.3m	1.65	0.11
B1T2c	0.026	13.79%	0.2*0.2m	3.82	0.05
B1T2b	0.026	12.55%	0.2*0.2m	2.89	0.06
B1T2a	0.037	7.31%	0.2*0.2m	2.51	0.09
B2T2a	0.050	9.40%	0.2*0.2m	2.85	0.09
B2T2b	0.021	16.42%	0.2*0.2m	2.95	0.05
B2T2c	0.061	9.28%	0.2*0.2m	3	0.11
B2Dd	0.048	5.53%	0.2*0.2m	2.33	0.12
B2De	0.018	14.95%	0.2*0.2m	2.81	0.05
B2Df	0.032	13.84%	0.2*0.2m	3.02	0.07
B3T3a	0.034	1.89%	0.2*0.2m	1.43	0.13
B3Daa	0.033	3.22%	0.2*0.2m	1.71	0.11
B3Db	0.102	7.00%	0.3*0.3m	3.02	0.12

Road drainage ditch N°	Extrapolated Q 25yrs (m3/s)	Slope (%)	U Concrete ditch dimension	Max velocity (m/s)	Max water level (m)
B3Dc	0.031	13.50%	0.2*0.2m	2.98	0.07
B3Dd	0.014	10.87%	0.2*0.2m	2.2	0.04
B3T3e	0.022	0.73%	0.3*0.3m	0.93	0.1

The ditch slope has been reduced compared to the road slope due to hydraulic constraint.

As highlighted in the table above, the slope of six (6) ditches were reduced due to hydraulic constraint. In order to ensure a proper functioning of the hydraulic structure the slope was modified. Indeed in these cases, the maximum velocity of the flow calculated was higher that the established 3m/s tolerable limit (see Fenton Greenhill Road - plan views – Bridge 1 – 2 – 3).

2.2.7 Geometrical design

The following figure shows the geometrical design of the drainage system.

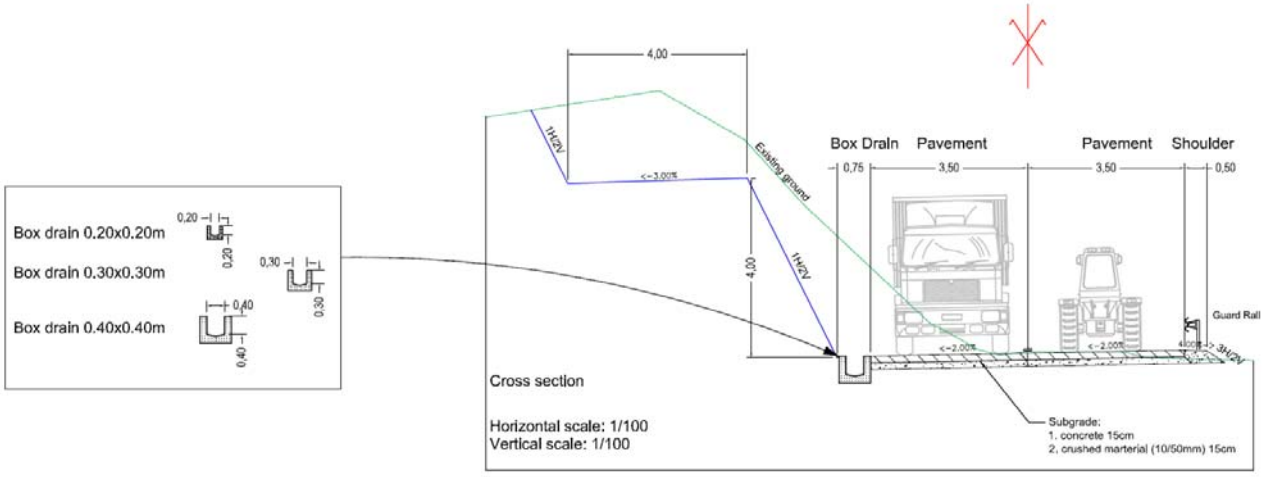


Figure 25 : Typical Cross section of Fenton Greenhill Road

Characteristics	Section 1 length	Section 2 length	Section 3 length	Total length
Length	190.40 m	204.69 m	196.46 m	591.55 m
Minimum radius of curvature	R = 15 m	R = 13 m	R = 11.48 m	R = 11.48 m
Maximum slope	22.77 %	16.48 %	20.07 %	22.77 %

Project actions which can cause some kind of environmental effect are:

- **Occupation of land for the new bridges, road diversions to connect new bridges and riverbed access.**
- **Occupation of land for the ditches, if necessary.**
- **Occupation of land for placement of staff and workers facilities, storage of materials and recycling zone.**
- **Placement of temporary fencing and signposting.**
- **Operation of machinery, often noisy, used in earthwork, demolition, loading, transport and unloading of materials and waste.**
- **Access tracks to the riverbeds, for abutments demolition or reinforcement.**
- **Diversion of the water flow to allow working in the river.**
- **Excavation in the riverbed for abutments foundation or protection.**
- **Excavation in the roadsides for ditch formation, and crosses in the road for ditches drains.**
- **Concreting of foundation, if this option is adopted.**
- **Concreting of ditches and drains.**
- **Demolition of existing ditches where damaged.**
- **Construction of new reinforced concrete slabs.**
- **Gabion walls for abutment protection, if necessary. In this case:**
  - **Placement of gabion baskets**
  - **Laying of geotextile fabric.**
  - **Gabion baskets filling with cobble sized stones.**
- **Demolition of existing bridges (decks and abutments), if necessary.**
- **Load and transport of surplus soils and debris (stone and concrete) to authorized landfill or dumping site.**
- **Load and transport of different waste types and rubbish to authorized landfill.**
- **Removal of auxiliary facilities, temporary fencing and signposting and cleaning of the work area.**

3. Environmental description

3.1 Physical conditions

3.1.1 Climate

St. Vincent and the Grenadines has a tropical marine climate characterized by a marked dry season, from mid December to mid May, and a rainy season from mid May to mid December. In the drier months higher than normal atmospheric pressure ensures dryness and drought conditions in coastal areas. The wet season is characterized by tropical waves, depressions and hurricanes. Hurricanes are perennial hazards related to the atmospherics of the region in the wet season.

The climate may be classified as humid tropical to sub-tropical in the Koppen climatic classification system.

- **Temperature**

Temperatures range from 18°C to 33°C, but in Kingstown are typically between 23 and 26°C with an annually average of 25.3°C. These stable temperatures are due to the moderating influences of the trade winds. There is little seasonal or diurnal variation, about 3 - 5°C and widest in the dry seasons, but temperatures in the interior of the island tend to be cooler at higher elevations.

- **Precipitation**

Annual precipitation varies from about 1,500 mm (60 inches) in the extreme south of St. Vincent to 3,800 mm (150 inches) or more in the north central portion of the island. In Kingstown, the average annual rainfall is 1,929 mm (76 inches). The leeward side of the island is in a “rain shadow” and shows marked variation in rainfall compared with the windward side.

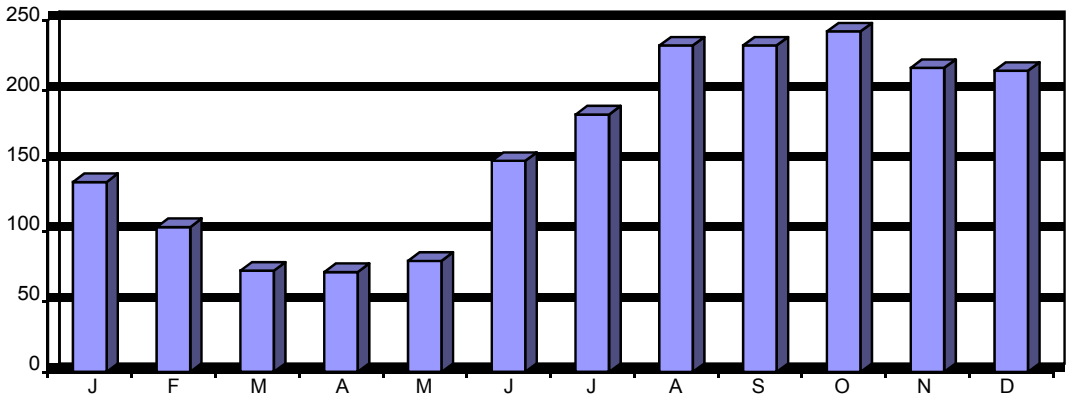


Figure 26: Monthly average rainfall

About 80% of the annual rainfall occurs during the wet season, which runs from June to December, being January a month of transition to the February to May dry season. The rainy season is associated with the

movement of the intertropical convergence zone, which is at its most northerly position over the Caribbean in this period. It also coincides with the hurricane season, which officially lasts from May to November.

Evapotranspiration

Evapotranspiration (ET) is the sum of evaporation and plant transpiration. Potential evapotranspiration (PET) is a representation of the environmental demand for evapotranspiration. Actual evapotranspiration is said to equal potential evapotranspiration when there is ample water. Potential evapotranspiration is high, due to high temperatures, but there is water surplus between June and February, and only deficit between March and May. Considering the soil water reserve, there is no physiological drought any month.

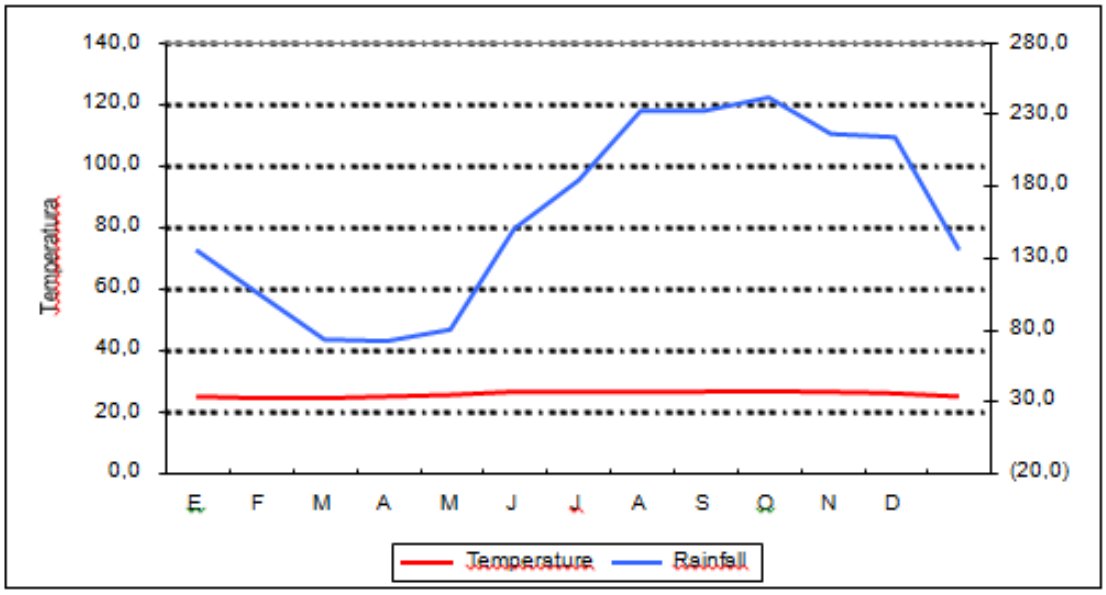


Figure 27: Ombrothermic diagram

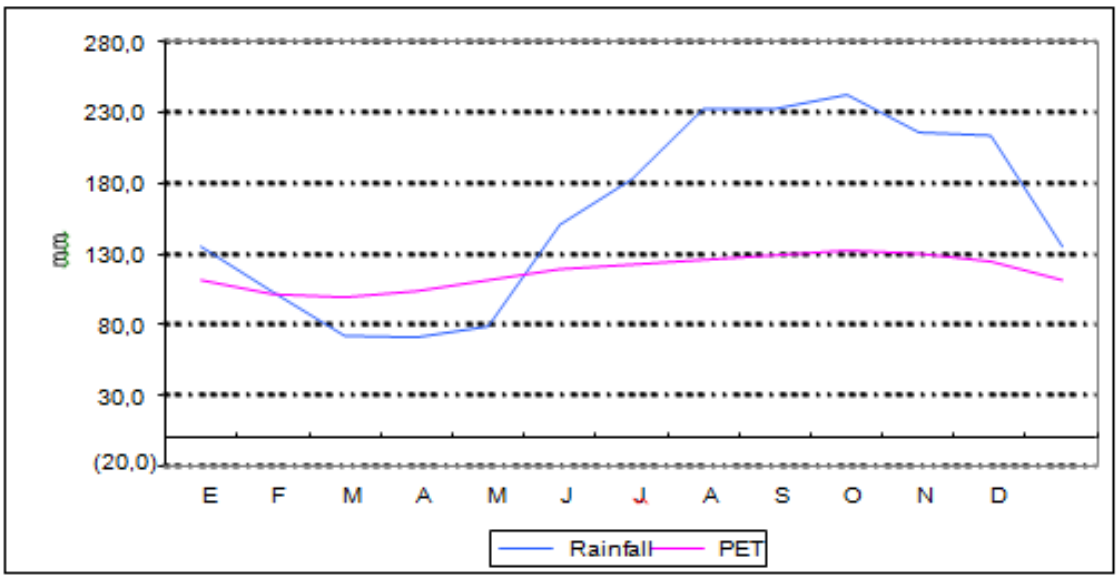


Figure 28: Water balance diagram

3.1.2 Topography

St. Vincent is roughly oval in shape with a central spine of mountains running from north to south with steep ridges radiating towards the east and west. The islands topography is due to the volcanic origin of the island, resulting in a central north&south mountain chain with La Soufriere volcano (1,234 m; 4048 feet) dominating the northern end of the island. This volcano last erupted in 1979.

St. Vincent has a very mountainous and deeply divided interior. The Soufriere Mountains are the most northerly, the Morne Garou mountains lie to their south and farther south Grand Bonhomme, Petit Bonhomme and Mt. St. Andrew. A large number of very steep lateral ridges emanate from the central massif culminating in high, almost vertical cliffs on the Leeward coast while the Windward coast has wider, flatter valleys and truncated spurs which are lower and more rounded than those of the leeward coast.

The main island of St. Vincent is very rugged with 50% of the slopes 30 degrees or more and 20% less than 20 degrees.

The specific project area, situated in Warrawarrow watershed headwaters, has an average slope greater tan 30 degrees.

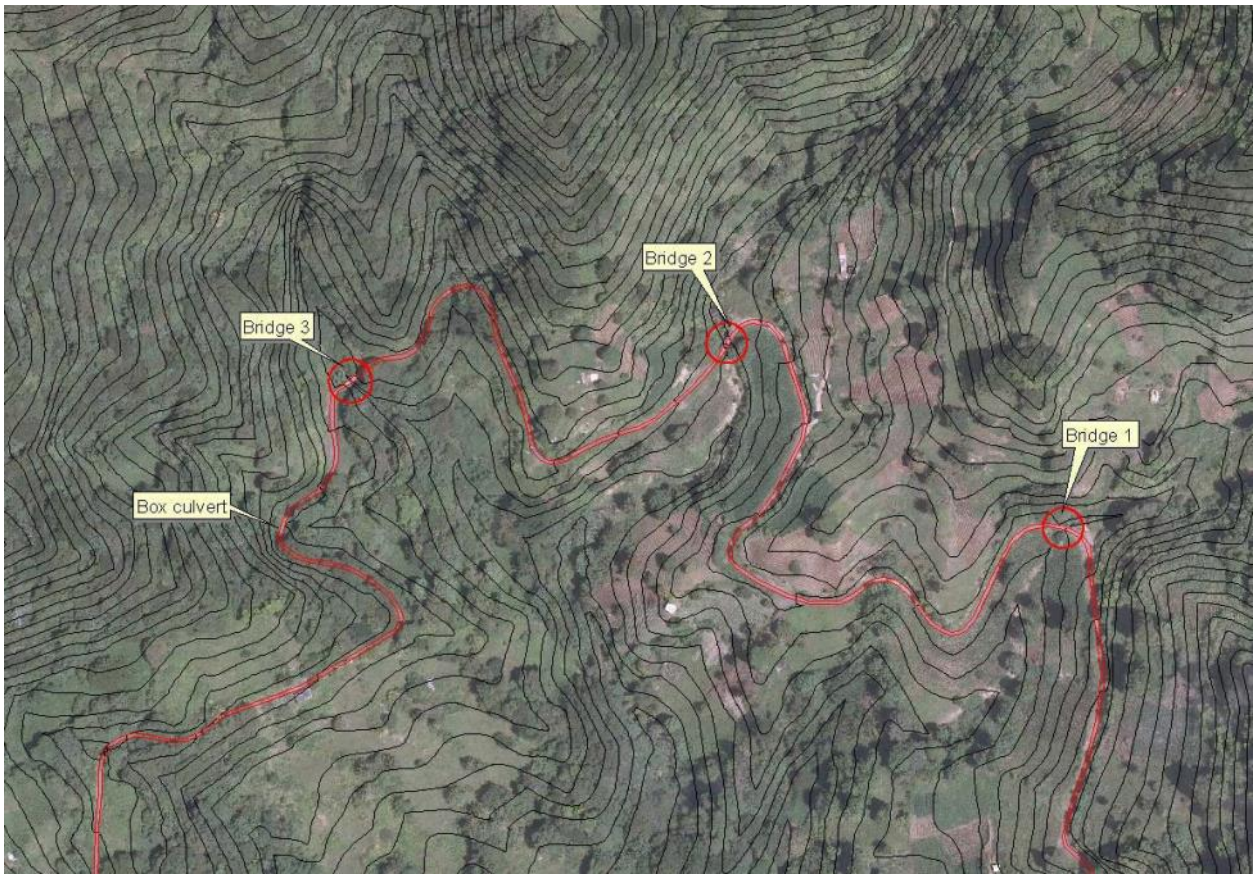


Figure 29 : Topography of the site

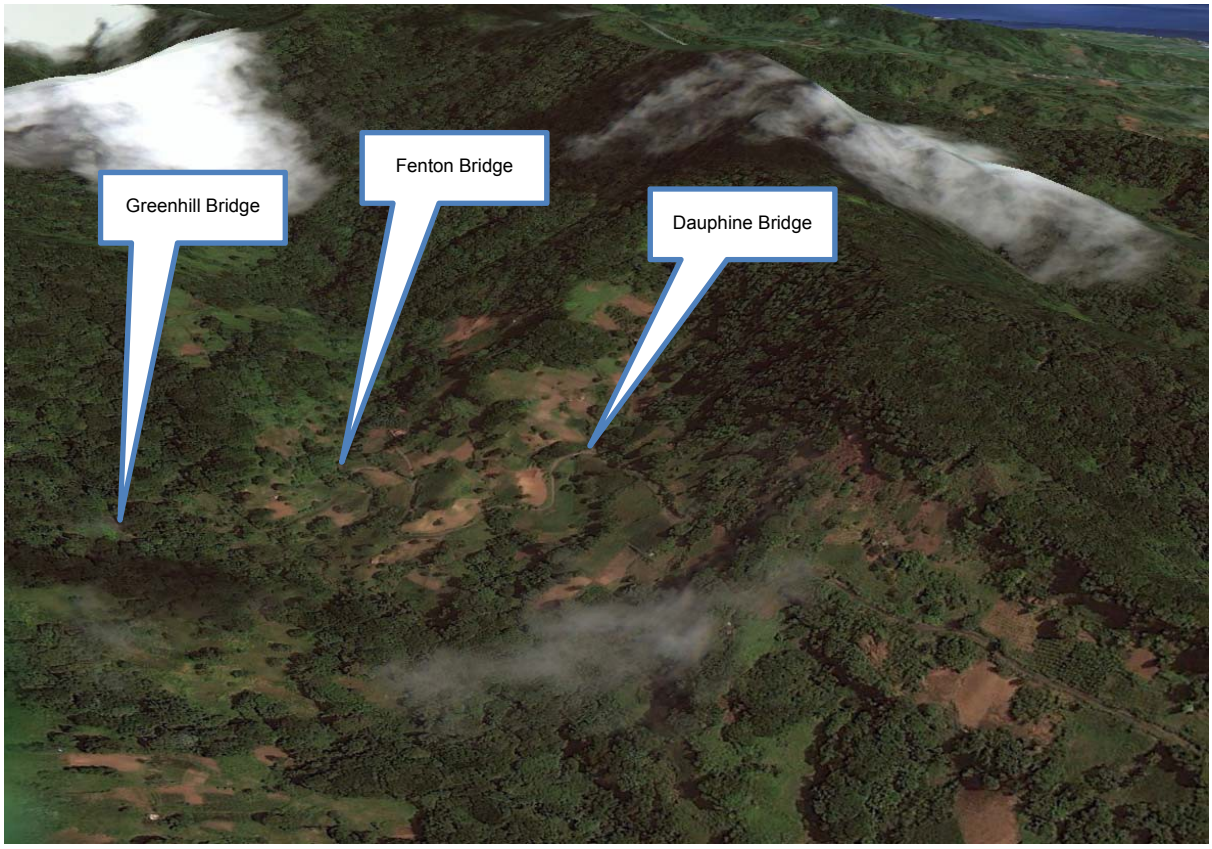
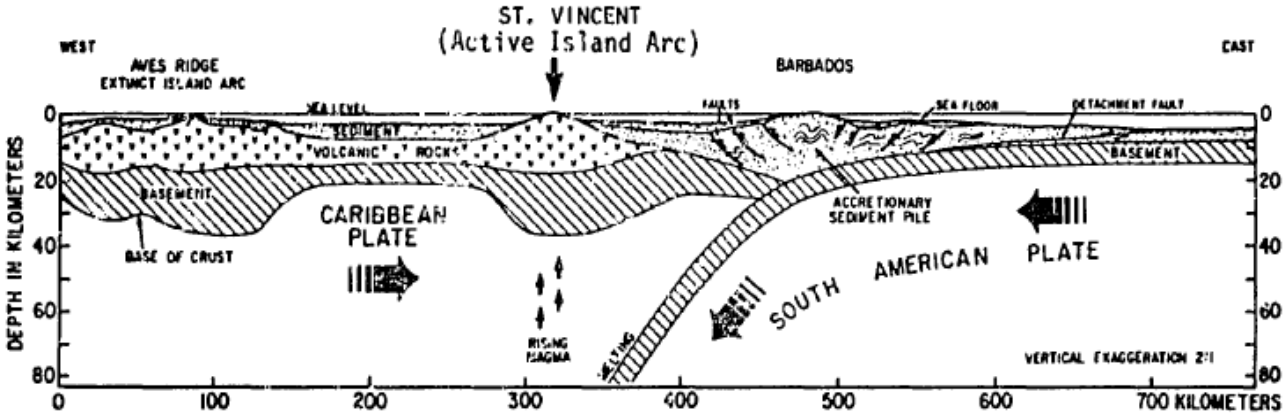


Figure 30 : Aerial View of the site

3.1.3 Geology

3.1.3.1 General context

The Antillean arc of islands in the Caribbean is geologically young, probably not exceeding 50 million years, and is predominantly volcanic in origin. St. Vincent is one of the youngest of the major islands. The island and the associated undersea ridge upon which it is perched are located near the edge of what is known as the Caribbean Tectonic Plate.



The Caribbean Plate is bounded by the North American Plate to the North, the South American Plate to the South and East, and the Cocos Plate to the west and southwest. The eastern boundary of the Caribbean Plate is a "subduction zone" in which the South American Plate passes under the Caribbean Plate and into the mantle where melting occurs. The melted plate material forms magmas which, when extruded as lavas by volcanoes, have resulted in the formation of the islands of the Antillean Arc.

The structure of St. Vincent is made up of a central north-south chain of mountains and a coastal plain of varying width. The rugged central mountain chain seems to be the eroded remnants of a series of volcanoes, with the oldest extinct remnants found in the south.

All of these extinct volcanoes are from two to five million years in age. Soufriere is much more recent, probably being built up within the last half-million years, with major activity occurring only a few thousand years ago when massive eruptions showered the entire island with andesitic ash and rock. Soufriere volcano has erupted frequently during its present period of activity which has been going on for about 700 years; historically recorded eruptions have occurred in 1718, 1812, 1902, 1971 and 1979.

The compositions of volcanic rocks vary along the 750 km long Lesser Antilles intra-oceanic arc, allowing the islands to be grouped according to three magma series: tholeiitic in the islands north of Montserrat, calc-alkaline in the central islands (Montserrat to St Lucia), and alkaline in the southernmost islands (Grenada and southern Grenadines). The volcanic rocks of St Vincent are transitional, in terms of magmatic affinity, between the southern and central island suites, consistent with the geographical position of the island. Although recognizing the transitional nature of the suite, the Soufriere rocks are usually referred as calc-alkaline.

3.1.3.2 Specific features in the project location

The road from Fenton to Green Hill is a very narrow and winding route that runs roughly maintaining height into the Warrawarrow valley. The valley is North-South oriented. It outline is a broad well defined semicircular circus. The slopes are very steep. The river course and the drainage network cut deeply into the ground surface.

The materials that make up the river basin are volcanic. The contrast between the valley upper relief and the middle and lower is due to the overlapping pyroclastic cones. The cones are partially dismantled by the action of erosion phenomena. Occasionally, strata of lava flows are interbedded. All of them correspond to volcanic materials whose centre is the Bonhomme volcano.

The outcrops are described as yellowish tephra and volcanoclastic materials (YTV unit) over interbedded basalt flows and dikes. Tephra is fragmental material produced by a volcanic eruption regardless of composition, fragment size or emplacement mechanism. Volcanologists also refer to airborne fragments as pyroclasts. Once clasts have fallen to the ground they remain as tephra unless hot enough to fuse together into pyroclastic rock.

The yellowish tephra is fine grained rock. By weathering, becomes reddish to yellowish sandy clay which can reach considerable thickness. The lava flows and dykes of basalt, tend to form large rounded cobbles or more or less regular prisms.

Figure 31 : Aerial Outcrop of yellowish tephra rock and its weathered layers

The following figures present the geotechnical profile in the location of three bridges:

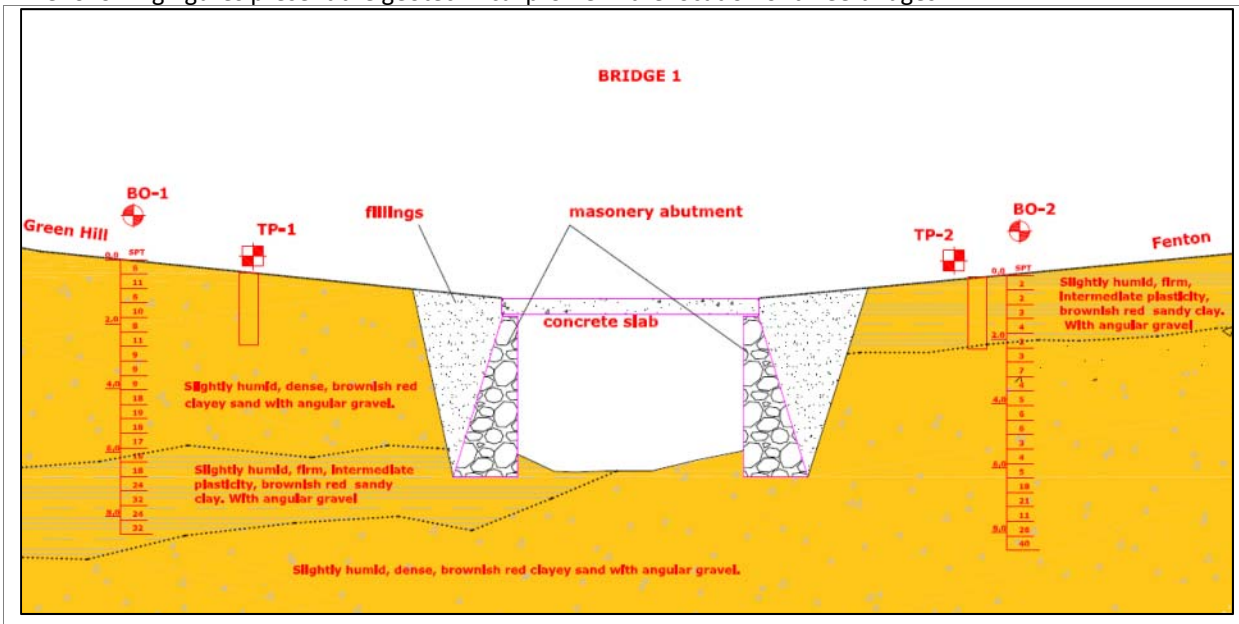


Figure 32 : Geotechnical profile of Dauphine Bridge

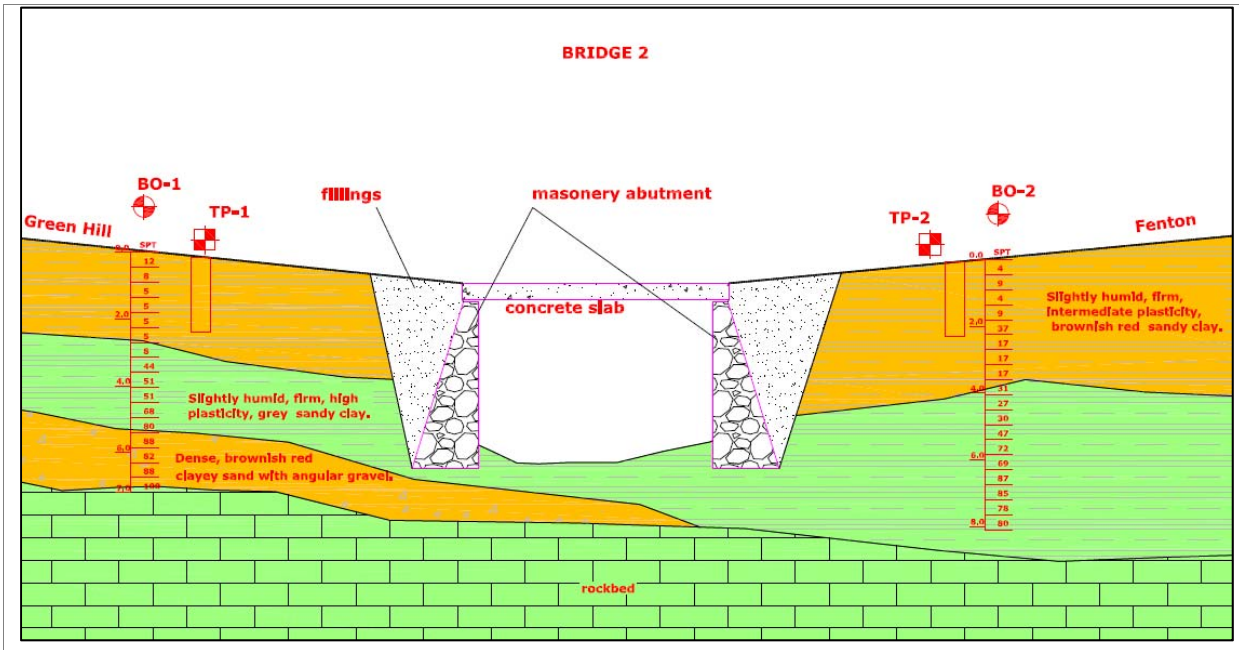


Figure 33 : Geotechnical profile of Fenton Bridge

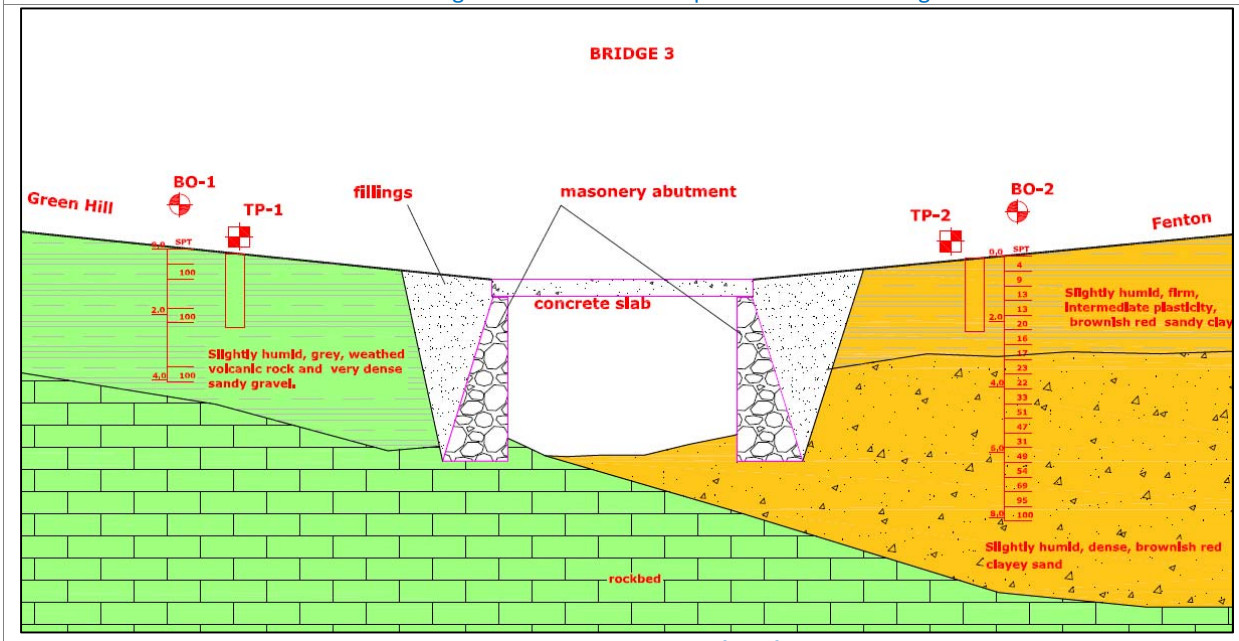


Figure 34 : Geotechnical profile of Greenhill Bridge

3.1.4 Soils

St. Vincent is made up of volcano ash soils in the north of the island. These are young, coarse textured sandy soils which are free draining and have the propensity to release their mineral nutrients when cultivated.
Above the 200 m (656 feet) level are so called zonal or high level yellow earth soils which are deeply weathered, poorly drained, leached and acidic due to their location in high rainfall areas. Below the 200 m (656 feet) level are the low-level yellow earth/brown earth soils. These are less leached and drain more freely. These are usually more fertile and occur on gentler slopes. The main soils types are:

- Alluvial soils: These soils occupy valley floors, mostly in the south west. These are the island's most fertile soils.
- Shoal clay soils: These occur in the southern and western coastal belt. They are sticky when wet and hard and cracked when dry. These soils are of medium fertility and are difficult to cultivate.
- Central mountain soils: Shallow soils occurring in high rainfall areas, most of them are under forest; they have high organic matter near the surface, are acidic and leached. They have the highest potential for serious erosion and should not be disturbed.

The only soil type in the project area is Greggs Loam and Clay Loam. This soil type has none to few boulders and slight to moderate erosion. Their main limitation is erosion hazard.

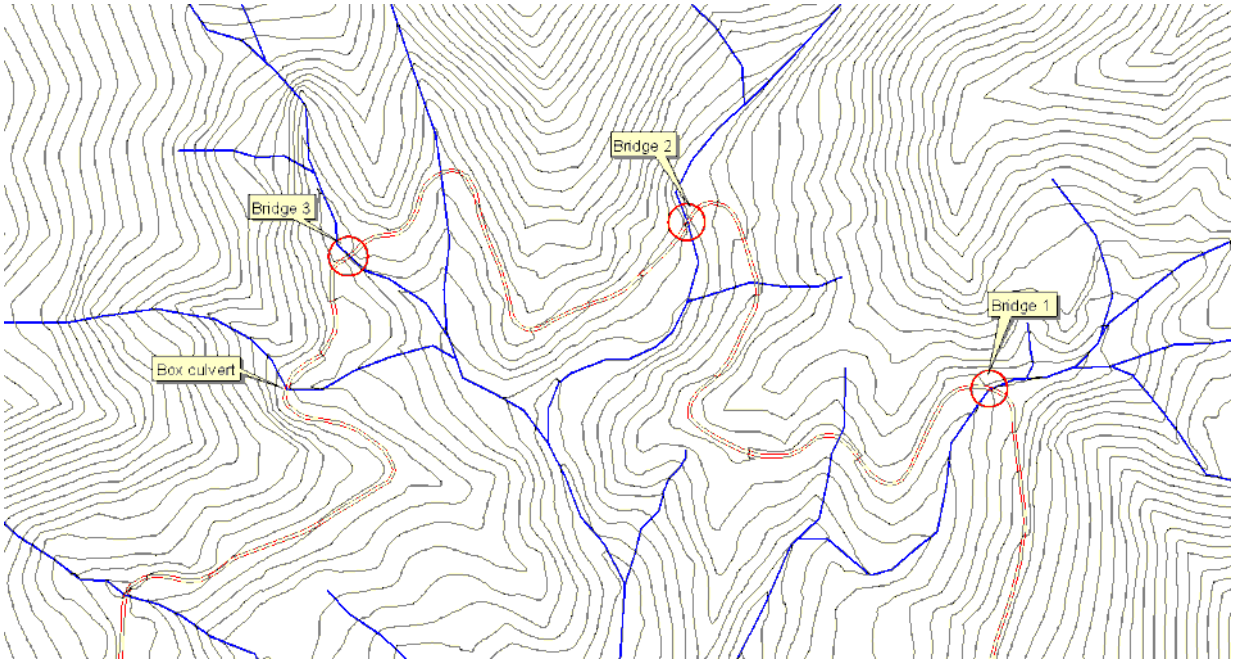
3.1.5 Hydrology

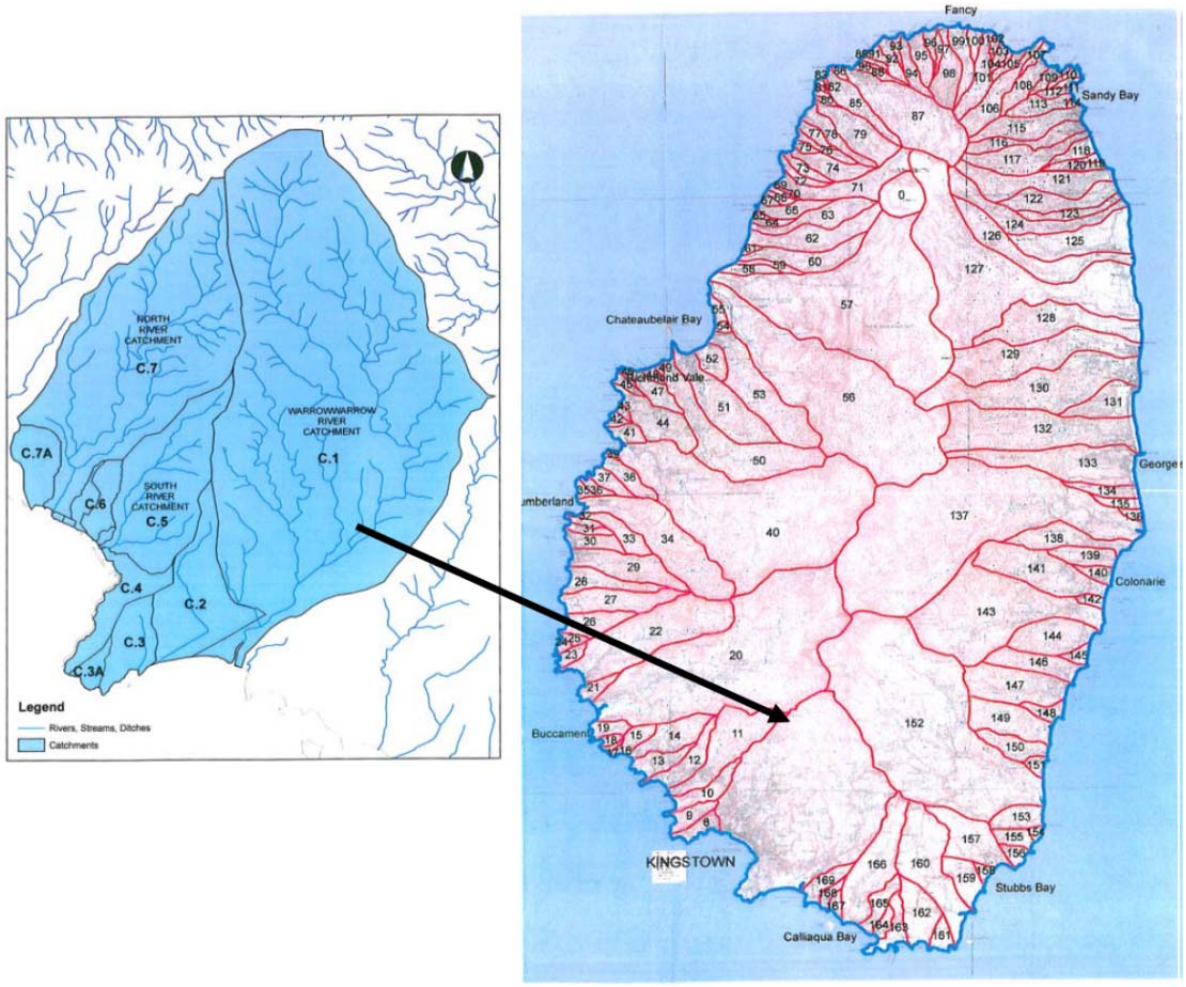
There are more than 170 catchments in St. Vincent island, between 0.004 km² (0.0015 mi²) and 21.66 km² (8.36 mi²). Most of then are lower than 1 km² (0.39 mi²), and only 8 are relevant. Usually rivers and folds have West to East or East to West direction, running from the central spine of mountains to the East or West coast.

In the south area (Kingstown and Arnos Vale catchments) there are three main catchments, North River, South River and Warrawarrow River, and other smaller.

The Fenton to Green Hill Road crosses two catchments, Warrawarrow River, from Fenton to Green Hill pass, the first 3.7 km (2.3 miles), and North River, from Green Hill pass to Green Hill village the last 1.5 km (0.93 miles). The specific project area (the three bridges and the box culvert) is located all in Warrawarrow catchment.

The Warrawarrow catchment is medium to big (relative to other country watersheds), with 1,288 hectares (3,182 ac) or 12.88 km² (4.97 mi²). The shape is elongated, 6.5 km (4.04 miles) long and 2.6 km (1.62 miles) wide. The Warrawarrow River runs approximately with North-South direction, flowing into the sea in Arnos Vale, close to the E.T. Joshua Airport and the Arnos Vale Stadium.




NORTH RIVER CATCHMENT
C.7
C.7A
C.6
SOUTH RIVER CATCHMENT
C.5
C.4
C.3
C.3A
C.2
WARROWWARROW RIVER CATCHMENT
C.1
Legend
Rivers, Streams, Ditches
Catchments
Fancy
Sandy Bay
Chateaubelair Bay
Buccament
KINGSTOWN
Stubbs Bay
Calliaqua Bay
Colonarie

3.1.6 Natural hazards

3.1.6.1 Volcanic hazards

The volcanic hazard of St. Vincent has been studied by many researchers.
Zones near the active La Soufriere volcano in the north part of the island have the highest risk level of a new eruption. The project area, in the southernmost part of St. Vincent, has a low hazard, as shown in the right image, from Robertson (2005).

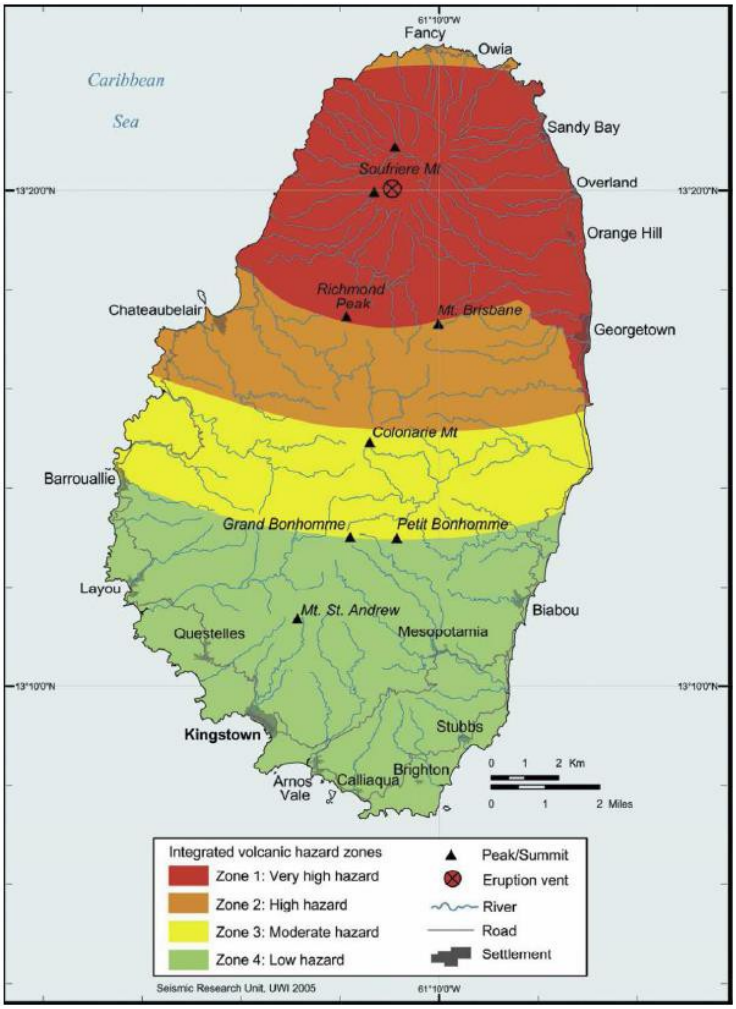


Figure 35 : Volcanic hazards (Robertson, 2005).

3.1.6.2 Storm surge

Costal zones are vulnerable to storm surge during hurricanes, and erosion from wave energy. Storm surge from hurricanes is pronounced on the southwest coast, where up to 5 meters of sea level rise during hurricanes could occur. The project area is far from the coast, so there are no storm surge risks.

3.1.6.3 Landslides

Throughout the entire road landslides have occurred in roadside cuttings. Although generally not very important in size, these landslides have obstructed the roadside drainage, which has led to the erosion of the platform.

In some sections, the crops on steep slopes have resulted in landslides that threaten the continuity of the road.

Figure 36 : **Landslide on a cutting in the side of the road, covering the roadside drainage**

Figure 37 : **Landslide due to crops on a steep slope**

3.2 Biological conditions

3.2.1 Vegetation

In the Warrawarrow and North River watersheds 13 categories of vegetation and land uses types have been identified:

Cloud forest and forest cloud transitional. Montane forests, mainly secondary rainforests disturbed either by natural occurrences such as volcanic eruptions and hurricanes, or by human activities, the most important reason in this area. This community appears in the northernmost part of the watershed, above 300 m altitude. The forest cloud transitional is a transitional community between evergreen forests and cloud forests, and it has been included with the cloud forests.

Forest evergreen and seasonal. Also termed moist forest, is found at slightly higher (150-350 m) or more sheltered locations, and with an annual rainfall higher than 1800-2000 mm and a shorter 3 month□long dry season. It comprises mainly broad-leaved evergreen trees with some foliage reduction in the dry season. Is like the semideciduous forest but with scattered, emergent trees. Some species in this community are also found in cloud forest and rainforest.

Forest semideciduous. Also termed moist forest, is found slightly higher than deciduous forests (50-200 m), in areas with an annual rainfall between 1500 and 1800-2000 mm but still a 5 month□long dry season. Is a two storied forest with an upper closed canopy at 20 m high and a lower tree layer at about half that height. The upper trees are mainly evergreens but a minority may shed their leaves in the dry season. A shrub layer is present but there are few herbs and epiphytes. The canopy has many woody vines or lianas.

Mixed forests and woody crops. Woodlands with spontaneous species of the precedent forests mixed with cultivated trees, such as breadfruit tree, mango or coconut.

Shrubland. Degraded forests, where tree canopy has disappeared, and only a shrub story remains, usually with some young trees, spontaneous or cultivated.

Scrub and grassland. A higher degradation level of forests, greater than shrublands. The grassland dominates the community, with some scrub and shrubs, but usually covering less than a half of the soil. Some artificial prairies are also included.

Cultivated. Arable crops. Herbaceous crops, mainly eddoe, in higher parts of the watershed. The land is cultivated in rows following the contour lines.

Cultivated. Woody crops. In all the area tree crops are very common, especially species like breadfruit tree, mangrove, wax apple or coconut. These crops usually are not pure, but mixed with surrounding forests, and also with gardens in urban areas.

Gardens and woody crops. In urban areas with medium or low density, gardens usually contact with woody crops and forest patches, resulting in a mixed continuous community.
Urban. High density. That unity includes only the city centre of Kingstown, where more than 80% of the soil is covered by houses and streets.

Urban. Medium density. The land use layer is very detailed so, when possible, urban areas have been separate form crops, grasslands or other uses in the surroundings. As a result, there are not low density urban areas, but only medium density, where houses and streets occupy between 40 and 60% of the soil.

Beach. Small and narrow sections of beach in the Warrawarrow river mouth.

Water. Lower section of Warrawarrow River, in the river mouth.

The specific project area is located in the Warrawarrow catchment headwaters. The main land uses are **cloud forest and cloud forest transitional**, but the Fenton to Green Hill road allows access to this forest area, and thus the development of crops. In the margins of the road are frequent fruit trees, woody crops or ornamental species plantations, especially breadfruit *(Artocarpus altilis)*, mango *(Mangifera indica),* coconut *(Cocos nuccifera)*, banana and plantain *(Musa spp.)* and wax apple *(Syzygium samarangense).*

In the slopes bordering the road are frequent, especially in the surroundings of bridges 1 and 2, arable crops of eddoe *(Colocasia esculenta)*, which in some cases give rise to stability problems and landslides.

In the mature forest grow up species like *Dacryodes excelsa*, *Sloanea spp., Amanoa caribaea, Licania ternatensis* and *Tapura antilliana*. Secondary forests, in areas previously occupied by mature forest that have experienced disturbance, are characterized by *Miconia mirabilis, Cecropia schreberiana, Chimarrhis cymossa, Sapium caribeum, Inga ignoides, Cecropia peltata, Freziera hirsuta, Ochroma pyramidale, Cordia sulcata* and *Smaruba amara*.

- **Bridge 1.** The surroundings are covered with shrubs, and eddoe crops on the river slopes.
- **Bridge 2.** The north area is covered with grassland and scrubland. The river, downstream the bridge, has shrubs, an eddoe crops in the slopes.
- **Bridge 3 a box culvert**. Is in a forest area. From the road up the hillside, the forest is spontaneous, a cloud forest transitional. From the road down the hillside, the forest is similar, but with more frequent exotic trees, especially breadfruit and coconut.

Figure 38 : Eddoe crops in the surroundings of bridges 1and 2

Figure 39 : Breadfruit *(Artocarpus altilis)* is common among crops and road margins.

Figure 40 : Mixture of secondary forests and crops between bridges 2 and 3

Figure 41 : Forest (with some exotic species) in the surroundings of bridges 3 and box culvert

3.2.2 Fauna

St. Vincent has a diversity of fauna species, some of which were introduced to the island by humans. Local island and regional endemics occur within the island; however there are enormous gaps in existing information that need to be filled.

There are four species of amphibians which include the introduced Marine Toad *(Rhinella marina)*, two tree frogs *(Eleutherodactylus johnstonei* and *E. urichi)* and the Pond Frog *(Leptodactylus wagneri).* There are also 12 species of reptiles on St. Vincent, including three gecko lizards, two anole lizards, two ground lizards, an iguana, a skink and three snakes.

The list of birds included 124 species on St. Vincent, with two endemic species, the St. Vincent Parrot *(Amazona guildingii)* and the Whistling Warbler *(Catharopezea bishopi)*. There are also seven regional endemic bird species.

The mammals are dominated by bats, with only six non-flying species, five introduced to the island, and the only endemic species is the Rice Rat *(Oryzomys victu)*, which is extinct. The other five include: Agouti *(Dasyprocta agouti)*, Mongoose *(Herpestes auropunctatus)*, Rats *(Rattus rattus* and *Rattus norvegicus)*, Mice *(Mus musculus)*, Opossum or Manicou *(Didelphis marsupialis)* and the Armadillo or Tatto *(Dasypus novemcinctus)*.

The project is located in an transitional area, between a natural and a semi-natural environment. The main habitat is the forest, but the surroundings of the road, especially in bridges 1 and 2, are an anthropic environment, dominated by with crops.

The rivers have a seasonal flow, so are not a good habitat for fishes, and no amphibians have been detected in the river crossings. However, a Saint Vincent's bush anole *(Anolis trinitatis)*, a medium-sized anole (lizard type) endemic of St Vincent has been seen in the roadside. It is widespread in its native island, where it is ubiquitous in all terrestrial habitats, including coastal cays. It has been introduced in Trinidad, where it is considered an invasive species.

The most important animal group in the area are birds. Some birds have been observed in the area, like the Common Ground-Dove *(Columbina passerina)*, Gray Kingbird *(Tyrannus dominicensis)* or Caribbean Elaenia *(Elaenia martinica)*. Among the raptors, the Broad-winged Hawk *(Buteo platypterus)* has been seen in the area, and the Common Black-Hawk *(Buteogallus anthracinus)* is widely cited.
Two endemic species are likely to be present in the project area: St Vincent Amazon *(Amazona guildingii)*, vulnerable, and the Whistling Warbler *(Catharopeza bishopi)*, endangered. The presence of these species in the vicinity of the road has not been detected during field visits, but is likely bearing in mind the proximity of the Forest reserve and an Important Bird Area (IBA VC007) according with Birdlife located North to the Road (see 3.2.3)**Erreur ! Source du renvoi introuvable.**.

3.2.3 Natural protected areas

There is a proposed protected area close to the project area - the Kingstown Forest Reserve and one existing protection area - an Important Bird Area (IBA nº VC007) of Birdlife International. The limits of two areas in their southern part are the same.

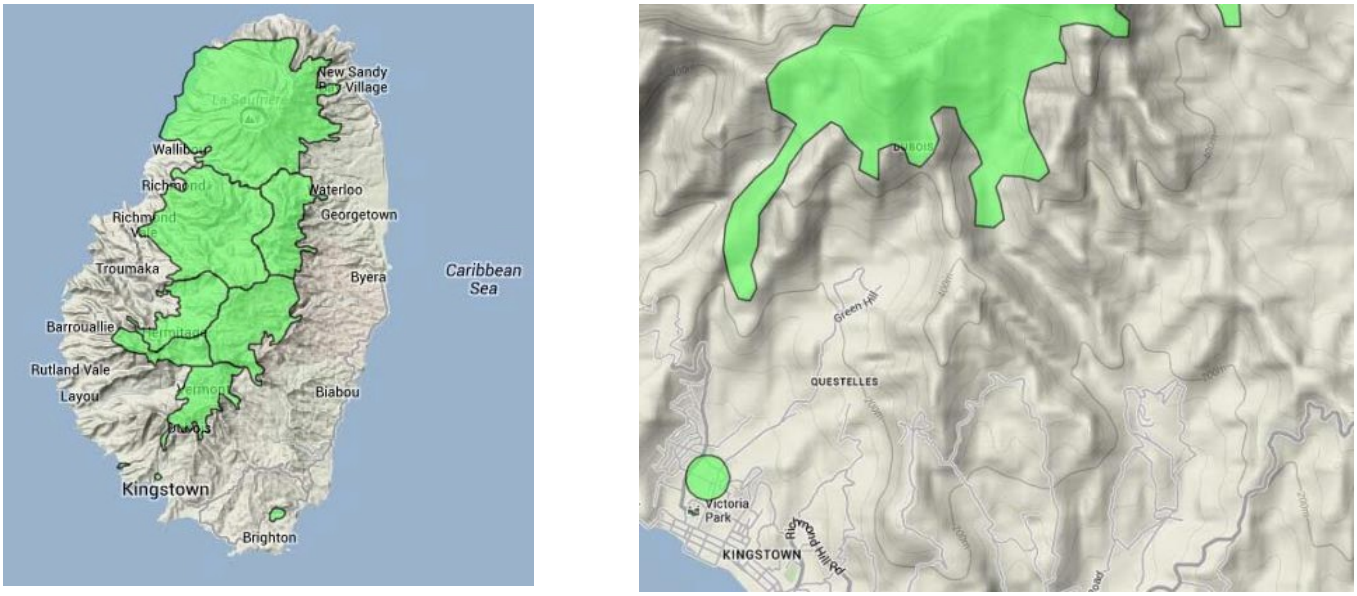


Figure 42 : **Left: St. Vincent Important Bird Areas (IBA). Right: IBA VC007 (Source: Birdlife International)**

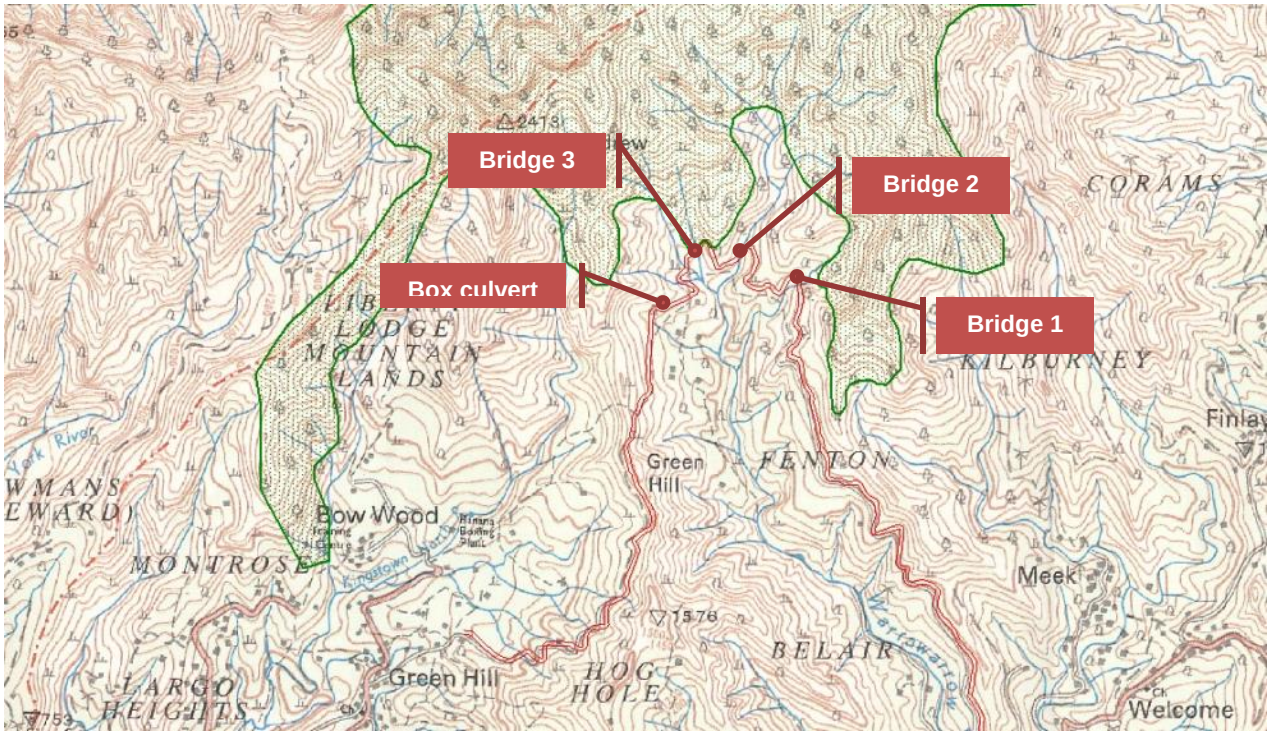


Figure 43 : **Location of the project sites and the proposed Forest Reserve**

The proposed reserve and the IBA encompass four watersheds (together producing over 25% of the country's potable water) and includes the island's highest southerly peak—Mount St Andrew—which overlooks the capital. The area, which maintains primary and secondary rainforest and dry scrub woodland, contains portions of **St Vincent Amazon** *(Amazona guildingii)* habitat and range that were omitted during the establishment of the St Vincent Parrot Reserve in 1987.

Overall, the area supports populations of all 14 Lesser Antilles restricted-range birds, including :

St Vincent Amazon *(Amazona guildingii)*
Lesser Antillean Swift *(Chaetura martinica)*
Purple□throated Carib *(Eulampis jugularis)*
- Green-throated Carib *(Eulampis holosericeus)*
- Antillean Crested Hummingbird *(Orthorhyncus cristatus)*
- Caribbean Elaenia *(Elaenia martinica)*
- Grenada Flycatcher *(Myiarchus nugator)*
- Scaly□breasted Thrasher *(Margarops fuscus)*
- Brown Trembler *(Cinclocerthia ruficauda)*
- Rufous□throated Solitaire *(Myadestes genibarbis)*
- Whistling Warbler *(Catharopeza bishopi)*
- Lesser Antillean Bullfinch *(Loxigilla noctis)*
- Lesser Antillean Tanager *(Tangara cucullata)*
- Antillean Euphonia *(Euphonia musica)*

Two among these species are of particular interest due to their protection status: the Endangered Whistling Warbler (Catharopeza bishopi) and Vulnerable Saint Vincent Amazon (Amazona guildingii).

The Whistling Warbler is endemic to St Vincent (St Vincent and the Grenadines) in the Lesser Antilles, where it primarily occurs at Colonaire and Perserence valleys, and Richmond Peak. The population is estimated to number 3,000-5,000 individuals, roughly equating to 2,000-3,300 mature individuals. The species qualifies as Endangered because it has a very small range, within which its habitat is declining in extent, area and quality. The extent of suitable habitat has diminished from 140 km^2 in the 1900s to c.80 km^2 in 1986.

The species inhabits dense undergrowth and vine-tangles in primary rainforest, palm brake, elfin forest, secondary growth and borders. Rainforest and palm brake are the most important, holding c.80% of the population. The nest is built low in a sapling, and eggs are laid between April and July.

The Saint Vincent Amazon occurs on the upper west and east ridges of St Vincent (**St Vincent and the Grenadines**), where it declined seriously through the 20th century until the early 1980s. Numbers increased from 370-470 individuals in 1982 to approximately 519 in 2002, and then to c.734 in 2004.

It inhabits moist forest, mainly at 125-1,000 m, preferring mature growth at lower altitude. It feeds in the canopy, on a wide variety of fruits, seeds and flowers (Raffaele *et al.* 1998), but sometimes forages in partially cultivated areas.

Breeding takes place between January and June, peaking in February-May

The Critically Endangered St Vincent blacksnake *(Chironius vincenti)* occurs. Other endemic reptiles include the lizards *Anolis griseus* and *A. trinitatus*, and the regionally endemic congo snake *(Mastigodryas bruesi)*. Several endemic plants are found including *Begonia rotundifolia*, the epiphytic *Peperomia cuneata* and *P. vincentiana*, forest orchid *Epidendrum vincentinum* and giant fern *Cyathea tenera*.

Kingstown Forest Reserve is a state-owned, proposed forest reserve under the System of Protected Areas and Heritage Sites. It is the most southerly part of the proposed Central Forest Reserve. Due to its close proximity to the capital (and thus of 25% of country population) human activities (including illegal squatting, hunting, farming and marijuana cultivation) have encroached across the forest reserve's boundaries.

The proposed reserve and IBA includes the areas of cloud forest, excluding agricultural and deforested areas around the Fenton to Green Hill road. Is very close to the bridge 3, where the forest reaches the road, being further away from the bridges 1 and 2 and the box culvert.

3.3 Socioeconomic conditions

3.3.1 Population

The population of St. Vincent and the Grenadines in 2012 is 109,400 inhabitants. The population has grown since the beginnings of XX century, except in 1991 to 2001 period, with a small decrease. In the last 20 years population growth has been slight.

Population of St. Vincent and the Grenadines 1991-2012				
1911	**1921**	**1931**	**1946**	**1960**
41,877	44,447	47,961	61,647	79,948
1970	**1980**	**1991**	**2001**	**2012**
86,944	97,845	106,499	106,253	109,400

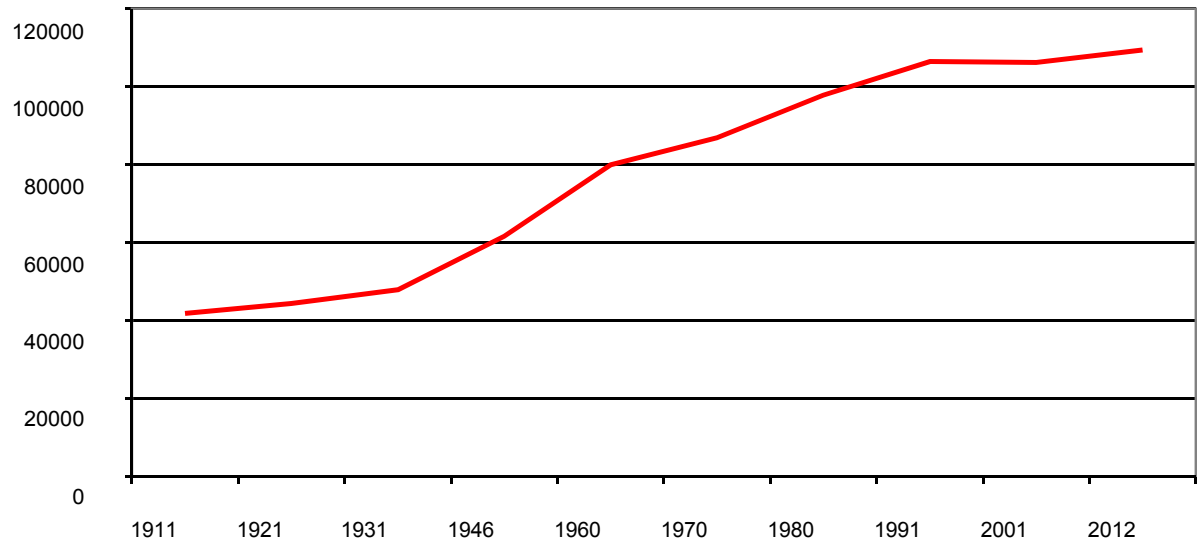


Figure 44: Population of St-Vincent and the Grenadines 1991-2012. Source: Population and Housing Census 2001; World Bank Data; and authors.

The country total area is 389 km² (150 mi²). According to the 2012 data, the current average population density in the country is 281.2 inhabitants/km².
Regarding the age distribution, the country population is young, with a maximum in the 15-19 age group.

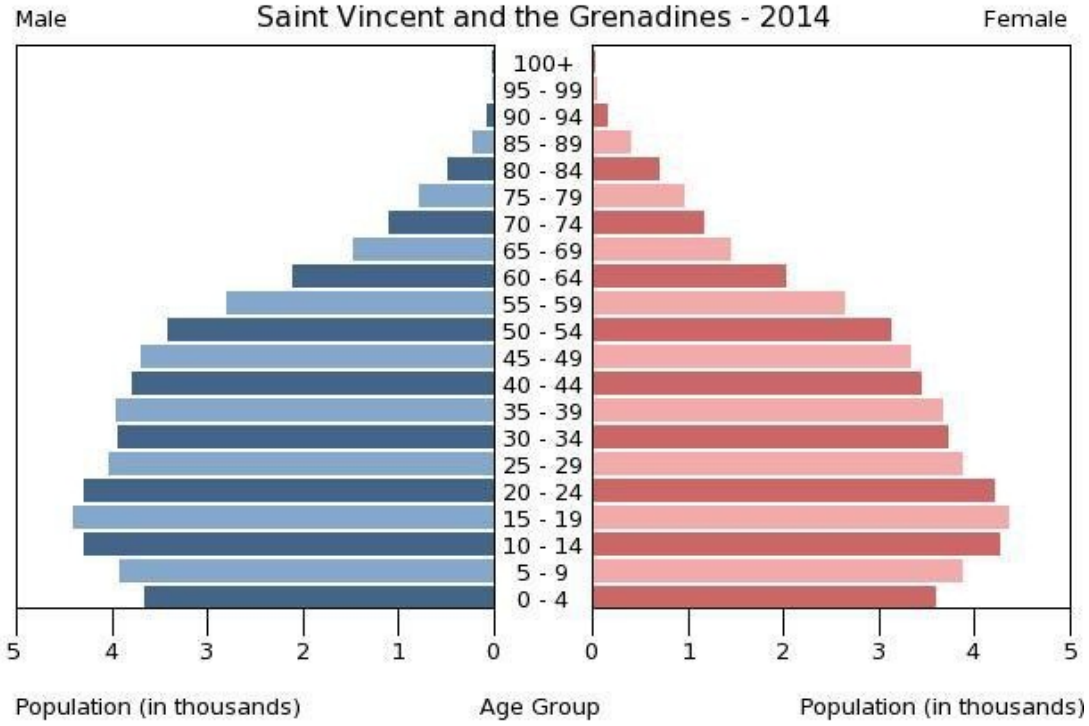
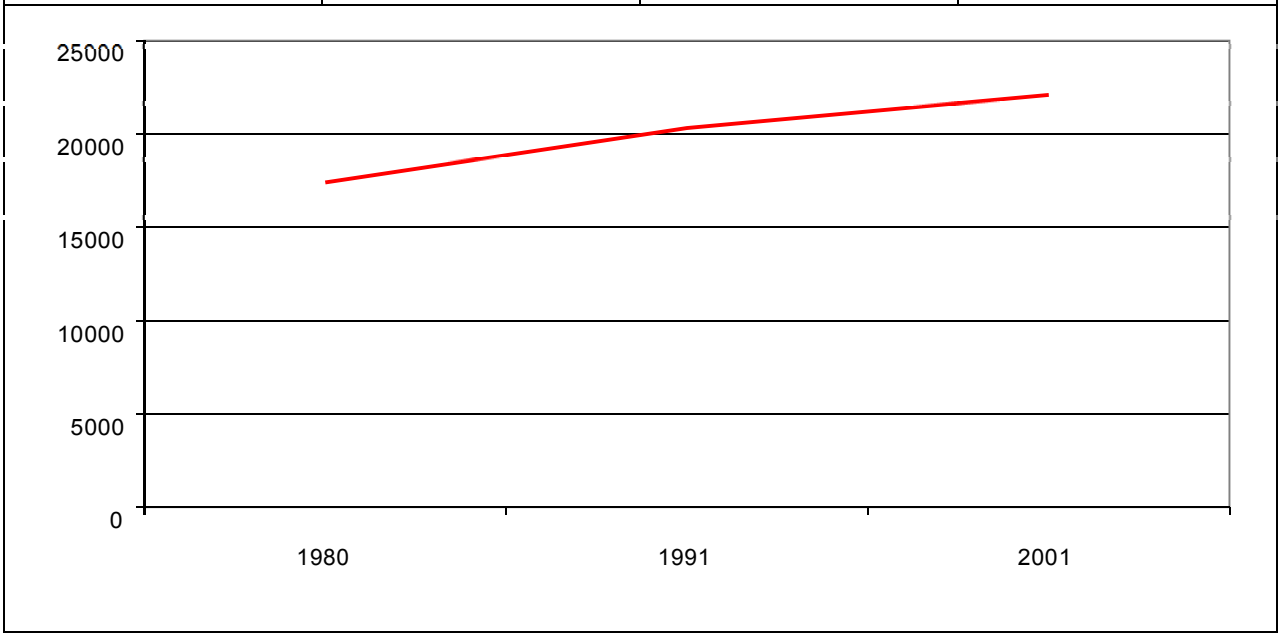


Figure 45: Population pyramid in St-Vincent and the Grenadines. Source : World Bank Group

The 2001 census revealed that 91.9 percent of the total population of St. Vincent and the Grenadines resided on mainland St. Vincent. Of this total, 85 percent lives in the coastal zone. The major concentration of the population is in the more developed areas in the southern part of the main Island, with 44% of the population.
The project area is located in Kingstown city centre. Kingstown is located in St. George parish, situated in the most southerly portion of the island of St. Vincent. With an area of 52 km² (20 mi²) it is the country's third largest parish by total area.
According to the 2000 census, St. George's population was approximately 52,400 people making it the most populous parish in St. Vincent and the Grenadines and by extent, the most densely populated as well. Its population accounts for 44% of that of the country and its area, only 13%.
The parish includes Kingstown, the largest settlement and the capital of St. George, and also the capital of St. Vincent and the Grenadines, and other major towns such as Arnos Vale, Calliaqua and Villa.

The Population and Housing Census of 2001 made a territorial division for the population study. According with this division, the project area is located in the Census Division 3 "Calliaqua", close to Division 1 "Kingstown" and Division 2 "Suburbs of Kingstown"

Population of Division 3 "Calliaqua" 1980 - 2001			
Zone	**1980**	**1991**	**2001**
Div. 3. Calliaqua	17,440	20,290	22,095



The population of Calliaqua Division has grown during the last 30 years, with a 26% growth rate. The population density of this division is 723 inhab./km², lower than the nearest divisions of Kingstown (2,634 inhabitants/km²) and Kingstown suburbs (832 inhabitants/km²).

Population density of Kingstown 2001			
Zone	**Area**	**Population**	**Population density**
Div. 3. Calliaqua	11.8 mi²	22,095 inhab.	1,872 inhab./mi²
	30.56 km²		723 inhab./km²

Figure 46: Population of Div.3. Calliaqua 1980-2010. Source: Population and Housing Census 2001; World Bank Data; and authors.

3.3.2 Land uses

The land uses in the Warrawarrow and North River watersheds, described in the vegetation chapter (3.2.1), are:

- Forests
- Treeless forest areas (shrubs, scrubs and grassland)
- Cultivated

- Arable crops. Herbaceous crops, mainly eddoe, in higher parts of the watershed.
- Woody crops. Especially breadfruit tree, mangrove, wax apple or coconut.

ƒ Urban.

- High density. Some areas in Arnos Vale, close to the airport.
- Medium density. Most of the built-up areas.
- Gardens and woody crops, in urban areas.

Other uses (unproductive)

- Beach. Small and narrow sections of beach in the Warrawarrow river mouth.
- Water. Lower section of Warrawarrow River, in the river mouth.

In the specific project area, there are three main land uses:

ƒ **Forests.** Most of the high Warrawarrow and North River watersheds are covered with forests. They are protected forests without timber exploitation. Although not produce economically quantifiable goods, produce very important services, such as water, oxygen, wildlife or landscape.

ƒ **Arable crops.** Herbaceous crops, mainly eddoe, abundant in the slopes. These crops produce stability problems, due to the steep gradient of the slopes.

Figure 47 : Left: Forest. Right: Arable crops

ƒ **Woody crops.** In roads and paths, near houses or in crops margins are frequent species like breadfruit, mango or coconut. In general, these crops are small groups of trees or rows, no large plantations, often mixed with spontaneous woods and shrubs.

ƒ **Livestock use.** In some areas the disappearance of the forest, or the abandonment of arable crops, resulting in meadows with livestock use.

Figure 48 : Left: Wax apple. Right: Cattle. Both in margins of Fenton to Green Hill road

3.3.3 Communications

The northern half of Warrawarrow and North River watersheds, where the project is located, has very poor communications. In fact, the main communication way is precisely the Fenton to Green Hill road and this is the reason why it is important repairing and improvement.

In the southern part of these watersheds, communications are very good, due to the presence of the E.T. Joshua Airport in Arnos Vale and Kingstown and its suburbs, the most populated area in the country.

Streets and roads

The main road in the area is the Windward Highway, in the southernmost extreme of the Warrawarrow and South River watersheds, close to the sea. The highway has its origin in Kingstown, running to the East, and bordering the E.T. Joshua Airport. Next to the crossing of this highway over Warrawarrow River is born the Vigie Highway, which juts into the island, connecting Belmont and Mesopotamia, and finishing again in the Windward Road close to the sea, in Peruvian Vale. A branch starting in Vigie Highway leads to Belair, where Fenton Road connects.

Starting in Kingstown, running first to the North and after to the West is the Leeward Highway. Before reaching this highway, leaving Kingstown by the north, a street reaches Green Hill, where the Fenton to Green Hill road ends.

Port

The port is in Kingstown, approximately 3.4 miles (5.5 km) from the project area (the bridges) by road.

Airport

The ET Joshua International Airport is in Arnos Vale, 4.13 miles (6.6 km) south of the project area (bridges). Currently is under construction the new Argyle International Airport, in the East coast of St. Vincent, 7.2 miles (12.1 km) from E.T. Joshua Airport to the East.

Bus

There is not public transport along Fenton to Green Hill road, but there is in the extremes, where the road is born.

Figure 49 : Map of main Communications ways in Kingstown area

3.3.4 Cultural resources

No known cultural resources exist in the project area, nor probability of appearance is detected.

4. Environmental impacts

4.1 Introduction

After analyzing the project and known the physical, biological and social conditions in which it will take place, it is possible to make a prediction of its environmental effects.

4.2 Effects on the physical conditions

4.2.1 Climate and atmosphere

The project will not have significant effects on climate. However, there is a risk of affecting the atmospheric conditions due to several actions:

Construction phase

- **Alteration of noise levels due to the noise of machinery and road traffic,** especially during demolition and earthworks.
  - Wildlife: **the proposed Kingston Forest Reserve and IBA, a sensitivity noise area for wildlife, is located close to the works area, in particular the Bridge 2 "Dauphine Bridge" site. Noise generated by works will impact wildlife, especially birds during breeding periods, including one endangered and one vulnerable species. It should be noted that the road currently has no traffic, so that the noise level is very low. In order to reduce negative effects of works on avifauna, preventive measures such as limitations in working hours will have to be adopted.**
  - Population: **there are no residential areas close to the project location. However, several settlements are located along the existing Road in the Green Hill and Fenton areas. Consequently, the possible adverse effects on the population will be related to the increased road traffic (trucks, engines) on the sections of the existing road used as access to the work sites. Preventive measures will have to be adopted to reduce noise emissions in this area.**

Figure 50 : Left: **Demolition of a bridge slab. Right: Debris truckload**

Emission of dust generated by drilling and earthworks. **As said before, there are not residential areas close to the project location, so the dust will principally affect wildlife and will consist in covering surrounding vegetation with fine particles. Bearing in mind that the most dust generating works will be limited to the bridges location, the extent of this impact will not be significant. However, due to the possible presence of endangered species of fauna of the Forest Reserve (in particular in the Bridge 2 location) it is recommended to implement preventive measures, especially surface watering covering any storage areas of fines such as sands or even cement to avoid dispersing by the wind.**


Figure 51 : Photos :**Left: Dust generated in a truckload. Right: Dust in drilling works.**

Emissions from machinery. The vehicles and machinery used on works can both produce noxious fumes such as carbon monoxide, diesel fumes, as well as burnt oil fumes. **These emissions will temporarily affect the air quality in the project sites and along the roads providing access to work sites. As the pollution increases proportionally to the age of equipments, prevention measures will have to be adopted such as use of equipments fulfilling noise emission standards.**

Other emissions. The mishandling of particularly noxious chemicals such as solvents or chemical washes, greases, as well as the burning of solid wastes on the construction site, especially chemical containers, can lead to air pollution resulting in negative health impacts **on workers but also population if such emissions occur close to settlements. This impact can be easily avoided by adopting preventive measures related to handling of tixic or noxious chemicals.**

Operational phase

- **Alteration of noise levels and emissions due to the traffic.** At present the road has no traffic, due to its poor condition, which makes impossible the movement of vehicles. The improvement of bridges, roadside drainage and in general of the road in the future (although not expressly contemplated in this project), will generate road traffic, which will be a source of noise and emissions along the road. **Eventhough the traffic intensity is expected to be low, the local noise levels will increase causing disturbance to wildlife.**

Figure 52 : Aerial view of cars on the road, in 2008

4.2.2 Topography

The topography of the road surroundings is very steep. The slope gradient is high, which combined with the high rainfall and forest clearance in some areas, especially for crops, results in landslides.

The project includes the construction of three new bridges, which implies adjustments of the existing road alignment to connect with new structures. These adjustmentswill consist of creation of new embankments at the bridge 1 location and cuttings due to the widening of the road platform at the bridge 1, 2 and 3.

At the Bridge 1, the embankments will be located on cultivated lands, without particular ecological values.
The cuttings on all three bridges will be located in natural areas.
The figure below gives an indicative idea of the project impact on local topography.

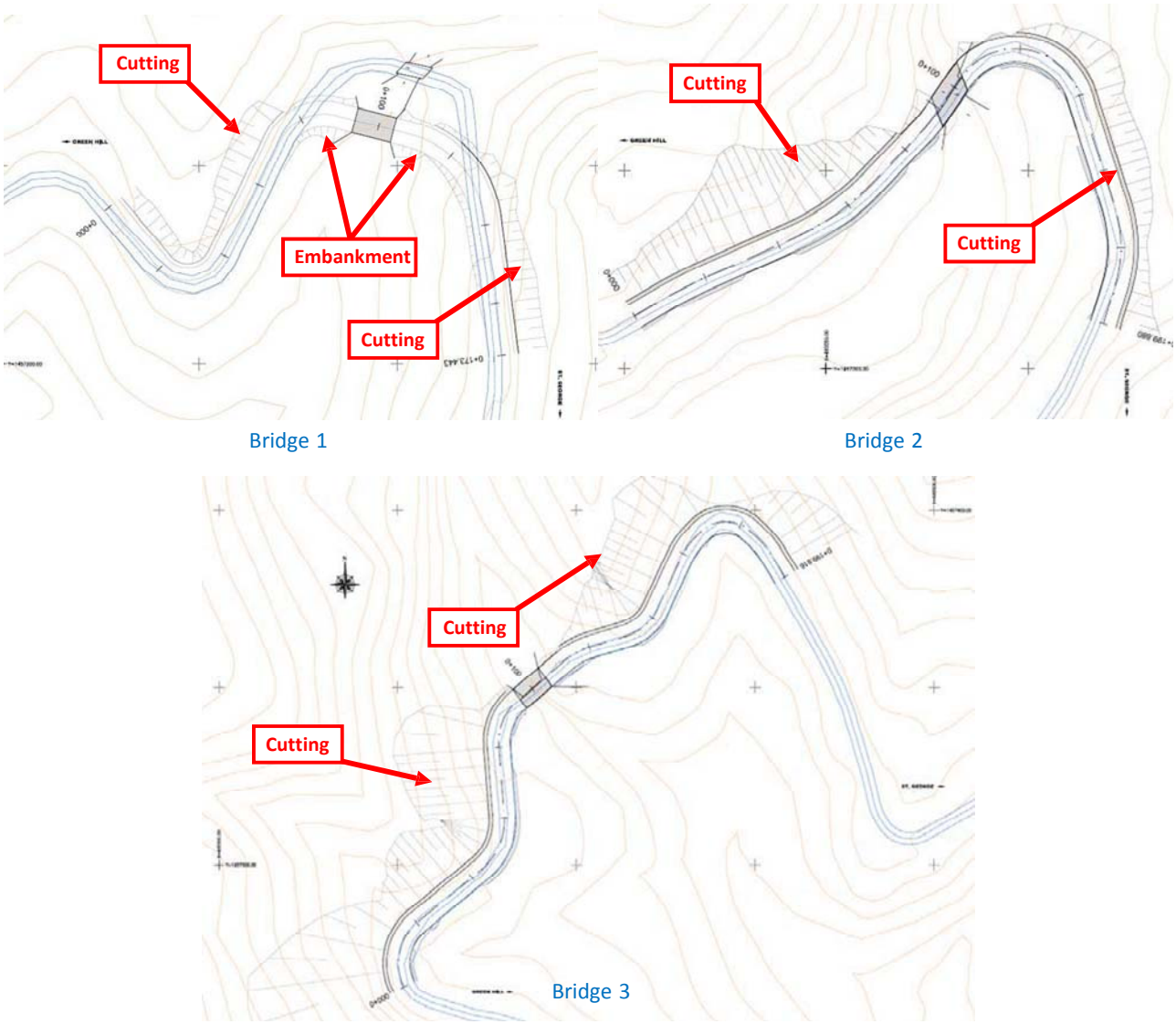


Figure 53 : Main Project impact on topography

Creation of embankments and cuttings will have direct impact on the local topography. Eventhough the visible alteration of the relief will be limited to bridges location, it will involve consulption of cultivated lands (Bridge 1) and natural areas (all three bridges).

Modification of the local topography can also lead to alteration of the slopes stability and, indirectly, increase the risk of natural hazards such as landslides. Mitigation measures will have to be incorporated into the project in order to ensure stability of the new slopes.

Another potential source of impacts on relief is the construction of tracks for the access of machinery to the rivers. This tracks must save a steep slope from the road to the riverbeds in the three bridges, with a gradient that allows the passage of machinery. This will involve the need for earthworks, forming cuttings and embankments, although very localized. Whenever possible, this access should be built in areas where after it will be constructed the bridge or road diversions.

4.2.3 Geology

Geology in the project can be analysed under two dimensions:

- **Geology as a natural resource**: a natural value and ressoruce, similar to the rest of physical conditions, which has to be preserved. **The geological value can be related to the presence of geologically unique areas that can be affected by the project and to the consumption of the geological resources (materials). This is the perspective regarded in the environmental assessment.**
- **Geology as a technical constraint for the project**. This perspective is discussed in the geotechnical study, and is a constructive aspect, and not environmental.

In the project location there are not singular geological areas that could be affected by the project. The impact on the alteration of quality of geological ressourses will not be significant.

In terms of resource consumption, the construction will require the use of materials such as sands or gravels to reinforce local grounds. Depending on the availability, these materials will be imported from outside the island, provided by local quarries or extracted from newly opened pits). The volumes of materials necessary for the project will be estimated at the design stage.

In order to reduce the impact on the geolpogical resource, the project design measures should be adopted such as promoting the reuse of excavation materials as much as possible and preferring the local operating guerries as source of additional materials.

4.2.4 Soils

The soil type in the project area is Greggs Loam and Clay Loam. This type is the most common in the area and bearing in mind the local character of works, the project will not lead to its rarefaction. This impact in this context will not be significant.

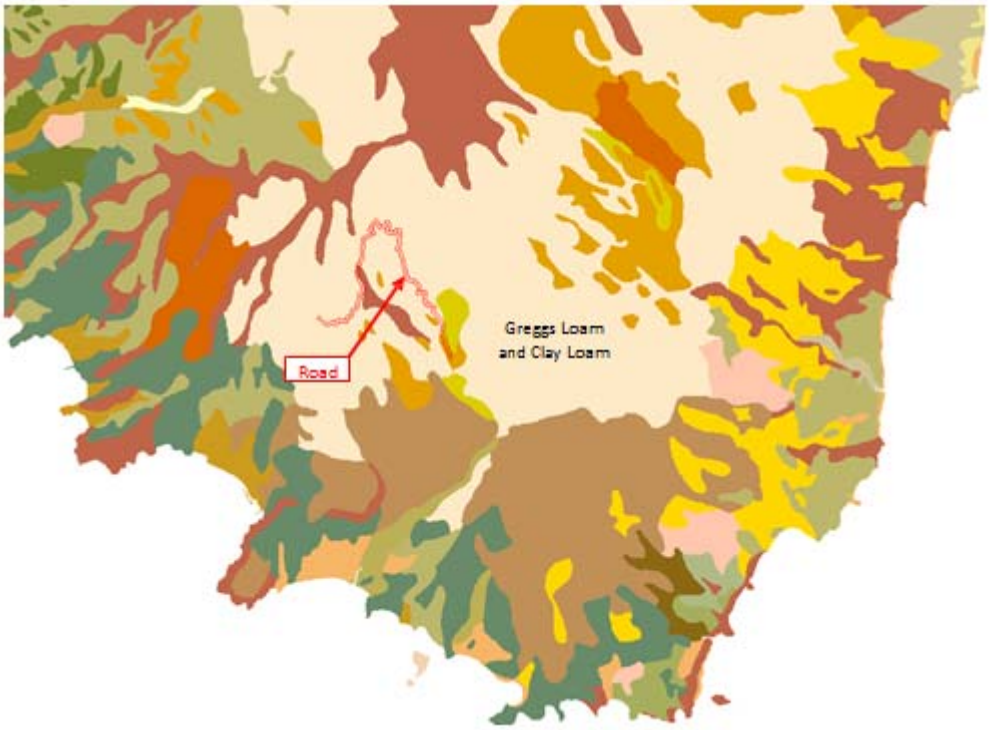


Figure 54 : Geological map of the project area

In some places (areas covered with natural vegetation or crops), works will require removal of top soil layer which is a valuable resource for vegetation and for agriculture as it concentrates most of the nutritive elements necessary for plants growth.

The top soil will be removed during the preliminary activities and earthworks and its volume will have to be estimated at the design stage. The impact on top soil will be difficult to avoid, but it can be reduced by adopting mitigation measures such as separate storage of the top soillayers and their reuse for land reclamation once the works are complete.

4.2.5 Hydrology

The main environmental effects of the project on physical conditions focus on hydrology, and in particular on Warrawarrow River and its tributaries, where bridges will be constructed. **The impacts will not be negligeable, but will be localized, limited to the duration of construction works and possible to mitigate using prevention or reduction measures.**

The identified effects and their sources include:

- **Effects on the riverbed and the river section due to bridge foundation and construction**. The use of machinery in this works will cause disturbance on the riverbed. However, the riverbed is formed by stone and boulders, with a low fragility, and easy to recover after the works. Although the expected impacts will not have a remarkable importance, it is necessary to apply mitigation measures and to restore the riverbed to its initial state once works are finished.
- **Effects on water quality.** There are several potential sources of water pollution:
  - Increase in water turbidity due to bridges construction and machinery movement in the river. To minimize this effect it is necessary to apply some prevention measures, such as carrying out works at the time of minimum flow (or better when the watercourses are dry) or make temporary diversions of the stream to avoid working in flooded areas.

- Risk of water pollution due to accidental spills of machinery oils or fuels. **Accidental spills will affect the project location, but will also be transported with the river flow contaminating the downstream section of the river. The risk will concern in particular all activities involving machinery working within the river bed or crossing it directly over water. It should be noted however that this impact will occur mainly in an abnormal situation (ex. spill) and should be sporadic. A number of preventive measures exist to avoid such situations and to reduce the risk of pollution if they happen.**
- Risk of water pollution due to accidental spills during concreting of foundations and abutments construction. The accidental discharge of concrete in the runway could generate pollution of water downstream the work site by dissolution.
- Increased siltation of waterways from works, due to soils washed away by runoff water. It is possible to reduce this effect with some preventive measures, such as sediment barriers.

- **Pollution of riverbanks.** **Temporary storage or uncontrolled dumping of waste from construction activities can generate pollution of riverbanks and in the riverbed. In particular, this risk will be related to concrete waste generated from cleaning concrete mixers. This waste will have to be collected and stored in an appropriate way. As mitigation measures, it will be necessary to provide special places to collect waste and works residues and to clean concrete mixers safely.**

4.3 Effects on the biological conditions

4.3.1 Vegetation

4.3.2 Vegetation

The impacts on vegetation have been identified and evaluated separately for each project location:

- ***Bridge 1.*** The new bridge and corresponding road diversion will be located in the area currently occupied by eddge crops without any particular botanic interest. The river in this location has no riparian vegetation. The effects on natural vegetation are minimal, but the crops will be affected.

- ***Bridge 2.*** The new bridge is in the same location as the current, but wider. The widening will take place in the upstream roadside. No diversion is necessary, but widen de road platform, which implies the formation of some cuttings. The land use in the area is mainly eddoe crops, without botanic interest. The river has some riparian vegetation, especially downstream the current bridge (the new one will be constructed upstream). The access track to the river should be done upstream, where it is easier and vegetation less dense. The effects on natural vegetation are reduced.

- ***Bridge 3.*** The new bridge is in the same location as the current, but wider. The widening will take place in the upstream roadside. No diversion is necessary, but widen de road platform, which implies the formation of some cuttings. Land use is mainly mountain forests. The river has not specific riparian vegetation because the forest reaches the banks. Downstream the current bridge the forest is dense. It must be avoided works in this margin. Upstream, where ne new bridge is projected, the area is treeless, so the construction has no important effects. Track access must be place at this margin.

4.3.3 Fauna

In the surroundings of the road several wildlife species are present, although none of them are endangered. The most interesting area is the surroundings of bridge 3 and the box culvert, a forest area close to de boundary of the proposed Kingstown Forest Reserve. The surrounding areas of bridges 1 and 2 are mainly eddoe crops, with a lower wildlife interest, although species as Gray Kingbird or St Vincent's bush anole have been detected here.

There will be effects on wildlife on construction and operation phases. These effects are:

Construction phase

- **Wildlife discomfort due to dust and noise**. These effects, especially the noise, will make that wildlife, especially birds, avoid the vicinity of the works zone during the construction phase, but again occupy it upon completion. As no sensitive o endangered species are detected, the effect is no significant.
- **Fish disturbance derived from river diversions and increase of water turbidity.** The only watercourse with a semi□permanent flow is Warrawarrow River, in bridge 2. The presence of fishes has not been detected at this point, but is sure in lower sections of the river. Any excavation in the river or its surroundings, or the passage of machinery will mean an increase in water turbidity, and a risk of oil pollution. This can directly affect aquatic life, at this point or downstream.

Operational phase

- **Wildlife discomfort due to traffic noise.** At present the road has no traffic, due to its poor condition, which makes impossible the movement of vehicles. The improvement of bridges, roadside drainage and in general of the road in the future (although not expressly contemplated in this project), will allow vehicles pass again, which will be a source of noise along the road. Anyway, the expected traffic will be reduced, so the problems of noise will be limited. The most sensible area is the surroundings of bridge 3, in the boundary of the proposed Kingstown Forest Reserve, but the expect impact is not important.
- **Barrier for wildlife.** Rectangular ditches are a potential barrier to small terrestrial animals such as mammals, certain amphibians and reptiles, which can not cross them and, if fall into them, can not leave. Therefore, the project drainage will create a potential risk for local wildlife.
- **Increased mortality risk.** Opening of the road for car traffic will also increase the risk of road mortality. In fact, some animal species, can be attracted by the road surface (ex. raptiles attracted by the warm asphalt of the road). Bearing in mid the weak intensity of the road traffic expected on the Fenton road, the impact should not be significant.

4.4 Effects on socioeconomic conditions

4.4.1 Population

The project has both negative and positive effects.

The **negative effects** on population are concentrated in the construction phase, and are no significant, due to the distance between populated areas and works zone. No impacts are identified on population due to dust and noise, because there are no inhabited areas close to the bridges, and the human presence in the area is very scarce.

During working period, and disappearing when the construction is complete, there are **accident risks**. The execution of works has always risks, for both workers and the population.

- ***Workers***. To avoid workers accidents some measures must be taken to prevent occupational risks and ensure safety at work: training, safety equipment such as helmets, hearing protectors or harnesses, safety protocols, protective measures against electrical hazards,...
- ***Population***. The risks for population are really low. In any case, it should be taken protective measures, especially to protect people who can walk along this road.

It is necessary to implement measures to ensure the safety in the works:

- Apply a policy of Occupational Health and Safety for all construction workers and staff.
- Placement of provisional fences and signposting to avoid access to the works of people who do not work in them.

The **positive effects** on population are concentrated in the operational phase. All of them are permanent (during the useful life of the bridges). The main effects are:

- **Greater guarantee of maintenance of communications,** as later explained in section 4.4.3 “Communications”.
- Creation of **temporary employment** opportunities during works.

The positive effects on population are just the reason to decide the bridges reconstruction, the project objective and justification.

4.4.2 Land uses

The works are developed mainly in the roadsides, close to the current bridges. They are only land occupation in the new bridges and the road diversions to connect them, especially in Bridge 1.

The bridges are located over watercourses, without a productive uses. Only the abutments and road diversions should affect productive land uses.

In Bridge 1, the road diversion will occupy a small area of eddoe crops. The occupied area is very low, so the impact is minimal. In Bridges 2 and 3, the diversions occupy roadsides, grasslands and scrublands, without any productive use.

As discussed below in section 5.3.9, there are two possibilities for surplus soils disposal, existing waste landfills or new dumping sites. If existing landfills are used, there will be not land use affections. If new dumping sites are designed, it could be negative effects, depending on the affected land uses. It is necessary, as noted below, avoid the most important, interesting and productive areas.

About machinery maintenance area, also section 5.3.9 indicates that the better option is perform maintenance on existing garages, avoiding the construction of specific maintenance areas.

4.4.3 Communications

The project has positive effects on communications. The Road is an essential route between Gomea in the West St. George constituency and Green Hill in the Central Kingstown constituency, and a bypass route to Kingstown. The road and bridges improvement has a vital importance in order to reduce Fenton Road's vulnerability and increase it resiliency against adverse meteorological phenomenon. These effects are the main reason to decide the bridges reconstruction.

4.5 Natural protected areas

As indicated in the previous chapter, the Kingstown Forest Reserve, a proposed Reserve and also an Important

Bird Area (IBA nº VC007) is located close to Bridge 3, and north of Fenton to Green Hill Road.

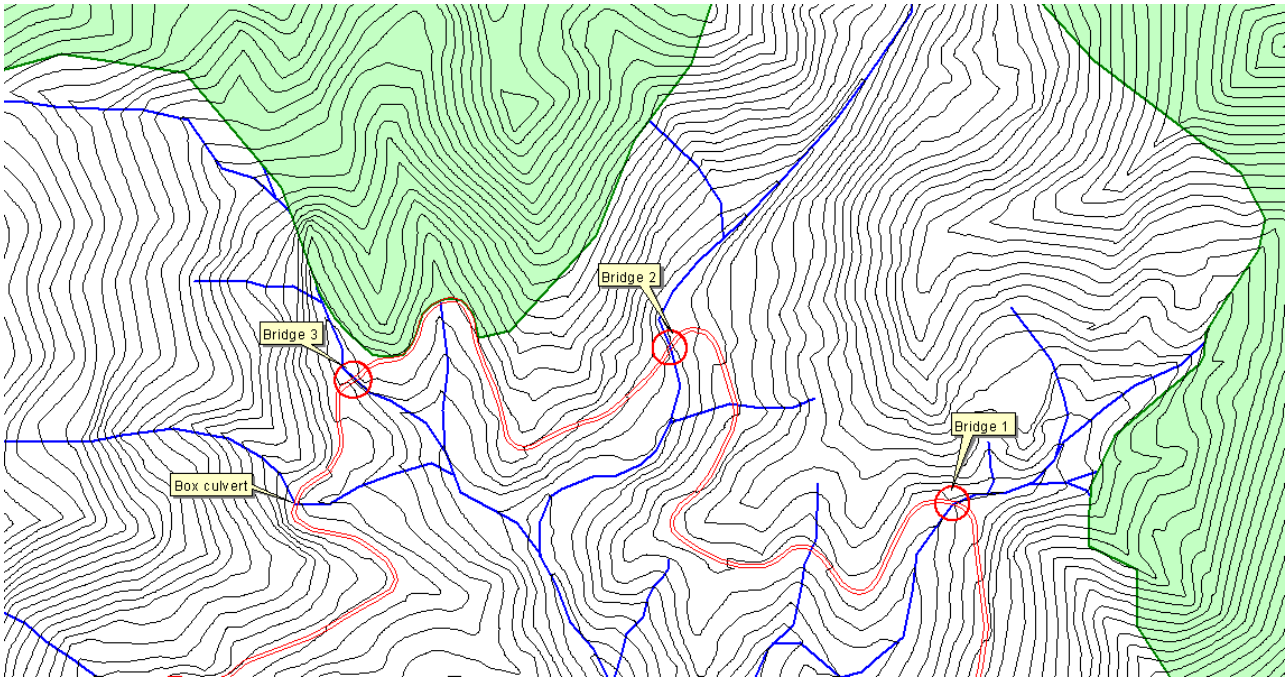


Figure 55 : Natural protected areas
(proposed)

The project has not direct effects in this area, but indirect effects are possible, during works and during the operational phase, especially on wildlife due to noise. At present the road has no traffic, due to its poor condition, which makes impossible the movement of vehicles, so that the noise level is very low.

During the works, the main effect is the noise of the machinery, especially in demolition and earthworks. Noise may affect wildlife, particularly birds during breeding periods, so it will be necessary to adopt preventive measures, as limitations in working hours.

In the **operational phase**, a possible effect is the increase of sound levels due to traffic. The improvement of bridges, roadside drainage and in general of the road in the future (although not expressly contemplated in this project), will allow vehicles pass again, which will be a source of noise along the road. Anyway, the expected traffic will be reduced, so the problems of noise will be limited, and no significant.

In case of decide to make new dumping sites for demolition debris, it must be avoided all the natural protected and interest areas, and particularly the proposed Kingstown Forest Reserve.

4.6. Cultural resources

As indicated in the previous chapter, no known cultural resources exist in the project area, nor probability of appearance is detected. Consequently, no impacts are identified.

4.7. Natural hazards

There are no significant volcanic hazards in the project area. The project area is far from the coast, so there are no storm surge risks.

There are significant risks of landslides in two areas close to the road:

- The whole roadside uphill, especially the sections with cutting slopes, that suffers frequent landslides. Due to these landslides, the whole roadside drainage is damaged.
- Some slopes downhill the road, with landslides associated with crops.

The landslides associated with crops may affect the stability and continuity of the road. To avoid them, should be avoided arable crops on steep slopes, at least along the roadside. This recommendation is part of the management measures in the watershed, exceeding the scope of this project.

The landslides in cutting slopes are quite frequent. Therefore, it is necessary that their design will be done in accordance with geotechnical recommendations to ensure stability. It is also necessary to restore vegetation cover on slopes, to minimize the risk of sliding.

Arable crops in a slope close to the road

The project has only small cuttings in the road diversion associated to Bridge 1. Although no significant landslide risk are anticipated, shall apply the above measures, adequate design and restoration of vegetation cover on slopes.

5. Mitigation plan

5.1 Introduction

5.1.1 Background

According with Annex C "Environmental Management Plan" of World Bank's Operational Policy 4.01, the mitigation section of the EMP has to include:

- Description of different mitigation measures
- Estimation of potential environmental impacts of these measures
- Linkage with any other mitigation plans required for the project.

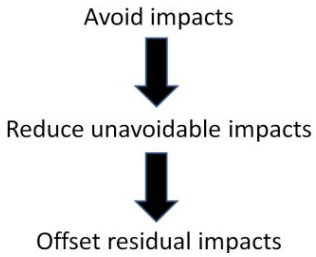
5.1.2 Objectives

The environmental assessment, when carried out properly, is an iterative activity that helps to avoid, reduce of compensate the adverse environmental effects of the project through mitigation measures.

There are four groups of mitigation measures applicable to projects:

- **Environmental design criteria. These measures consist in adopting an environmental friendly design, avoiding the impacts since the very early stage of the project.**
- **Prevention and protection measures (avoidance). Measures designed to avoid the occurrence of negative impact. Always prevention and protection measures are preferable to mitigation measures.**
- **Remediation and corrective measures (minimization and restoration). Measures to reduce or minimize the unavoidable negative impacts.**
- **Compensatory measures. Measures to compensate unavoidable impacts, that can't be mitigated, applied in a different area, preferably close to the affectation area (in situ) and aimed to restore similar environmental resources to those affected (in kind).**

The design of mitigation measures should follow the "mitigation hierarchy":



(Compensation)

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5.1.3 Implementation responsabilities

The Contractor will be the main responsible for the implementation of the mitigation measures and for the motoring of their efficiency (monitoring plan).

The construction company must have a responsible for environmental management and protection, which will take care to ensure that the proposed measures, both preventive and corrective, and spatial and temporary constraints are met effectively.

This responsible will depend hierarchically of the construction manager and must periodically inform him about the progress of works in relation to the environment.

5.2 Environmental design criteria

5.2.1 Concept

The best way to avoid environmental impacts is often adopting an "environmental friendly" design of the project. This includes a set of design measures which will minimize negative environmental impact while maintaining the functionality of the project.

5.2.2 Bridge type, parameters and abutments location

The general conception and typology of the bridges has great influence on its environmental effects. In this case the three are small bridges, crossing narrow watercourses. The bridges have small boards with single span, without intermediate supports, saving the rivers without appreciably affecting their riverbeds.

The bridge typologies will be similar to current, changing some parameter such abutments location and foundation or slab width or elevation. The abutments will be located out of the riverbed.

These works, although highly localized, can affect the river, water quality and wildlife, so it will be precise preventive and corrective measures.

5.2.3 Road diversions

In the road diversions, to connect the new bridges will seek to minimize the occupied area, and the earthworks.

Regarding earthworks, also will seek to offset the volume excavated and provided, so that there will be not deficit or surplus of soils, or if any, resulting minimized.

These works, like the bridges, can affect water quality and wildlife, so it will be precise preventive and corrective measures.

5.2.4 Drainage typology

The general typology of the ditches has influence on its environmental effects. Wide ditches with slightly inclined are better for wildlife, but need a greater occupation of land, which also involves earthworks and cuttings.

The project foresees construction of relatively narrow (0,2-0,4m wide) and shallow (0,2-0,4m wide) ditches with rectangular profile along the uphill side of the road. In order to reduce the risk for small mammals, reptiles and amphibians, the detailed design of the ditches should, as far as possible and without significant increase of the land occupation, adopt measures to reduce the barrier effect of the ditches.

5.3 Prevention and protection measures

5.3.1 Concept

During the construction phase of the works a number of preventive measures must be taken to avoid unnecessary changes in environmental conditions.

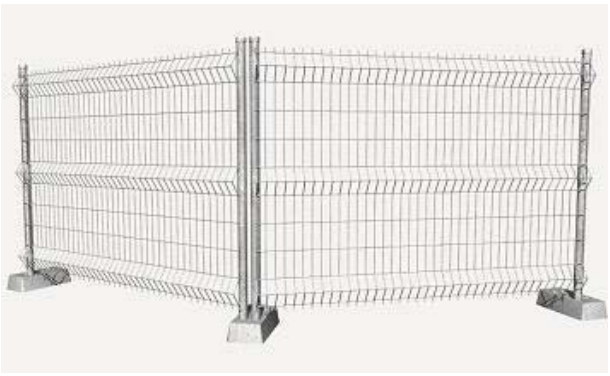
5.3.2 Measures related to the organization of worksites

5.3.2.1 Delimitation of work areas

During the construction phase the perimeter of the working area must be delimited and fenced in order to prevent two types of hazards:

- **Risk of accident for population**

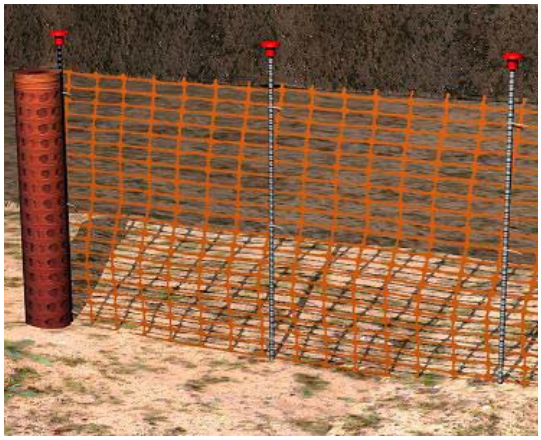
During the construction period, people using the Fenton road may enter, deliberately or not, the work zone and be exposed to a potential risk of accident. To avoid any risk for population, it is necessary to fence the entire work area.



It is also recommended to place signs warning of the works, and the potential hazards to the population. Signposting, warning signs, barriers and traffic diversions must be clearly visible and the public warned of all potential hazards.

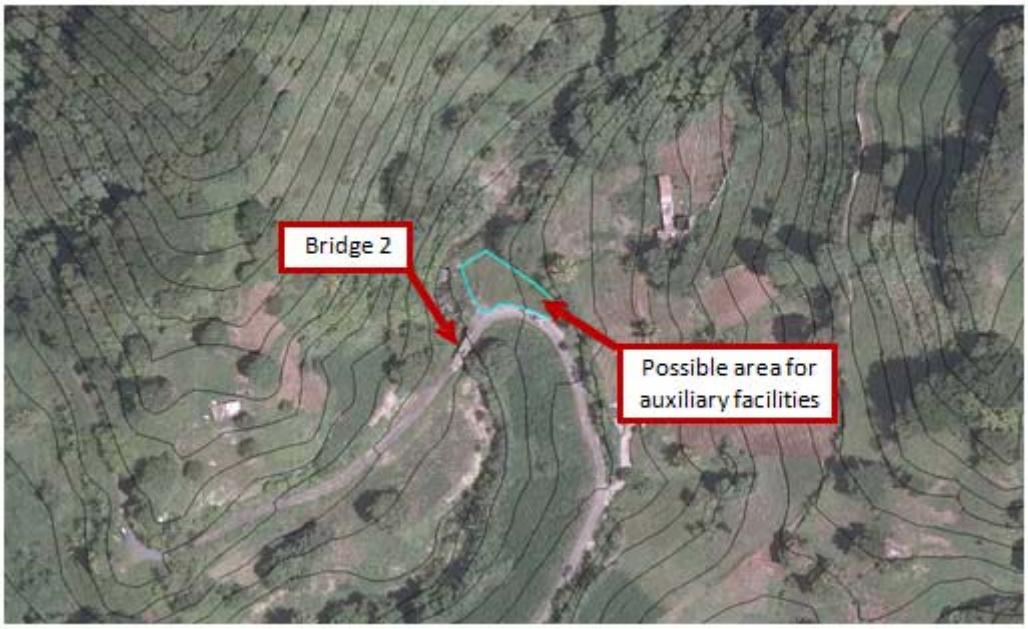
- **Risks of environmental damages**

Uncontrolled movements of machinery may affect the natural ecosystems nearby the worksite. To avoid any negative impact, it is recommended to place a temporary fence, typically a plastic mesh or band defining the work zone in the proximity of natural areas.



5.3.2.2 Organisation of work sites

- ***Auxiliary facilities for staff and workers*** (worksite huts, bathrooms, changing rooms...). These facilities must be placed necessarily close to the works. There is not much space for these facilities along the road. It is possible to place the close to bridge 2, in a small plot just in the roadside.



In order to prevent any impact of these facilities on the environment:

- The bathrooms should be chemical, being forbidden the discharge of waste water into the river.
- Facilities should be equipped with waste bins allowing waste segregation and collection

- ***Machinery maintenance area (yard and workshop).*** It must be strictly prohibited the maintenance of the machinery in the project area, due to the risk of water and soil pollution. The maintenance must be done on existing garages or workshops.

- ***Recycling point.*** It should be placed a recycling point in the work area, to allow the differentiated waste collection, and encourage recycling and proper treatment. At least containers for debris, concrete, organic waste, wood, metals, paper, glass, vegetable waste and harmful or hazardous waste will be placed. The recycling point must be placed along the platform of the road, avoiding land occupations.

- ***Storage areas for materials***. **It shall be provided specific areas for the storage of building materials. Harmful, hazardous or polluting materials should be stored indoors. If necessary stockpile lands or other materials that can be carried away by runoff water, it should be placed devices to prevent dragging.**

- ***Concrete mixers washing areas.*** To avoid uncontrolled concrete mixers cleaning, it must be built specific washing areas for this purpose. All the debris generated in these areas must be removed to licensed landfills or dumping sites.

If auxiliary areas outside the proposed zone are necessary for these purposes, their placement should avoid any protected, important, rare or fragile areas, like:

- Natural interest areas, especially the proposed Kingstown Forest Reserve.
- Indigenous forests or areas with interesting vegetation
- Residential areas
- Rivers, streams or creeks
- Crop areas

In all the cases, it should be taken special care to avoid river pollution and public nuisances.

5.3.3 Identification of auxiliary sites (borrow pits, landfills)

Before starting the works, the Contractor will identify the location for auxiliary sites and installations such as:

- ***Borrow pits***. In the construction of the road diversions or bridge foundations there may be a need for provision of external materials to create fills or to improve the ground structure.
  These materials can be obtained from:
  - existing quarries, which is the best solution in this case, because, if they were accurate, the volume would be very low.
  - soils accumulated in the roadside and platform, from landslides.
  - a specific borrow pit to obtain necessary soils, which is the least desirable alternative. In this case, the location of borrow pits should avoid areas of natural interest, forests, rivers, inhabited areas or productive crops. In addition, it must be considered the environmental restoration of the exploited areas once the extraction is complete.

Before the beginning of works, the Contractor will identify all sources of materials to be used during construction works.

- ***Landfills for solid waste generated on works***. The waste generated in the works, not abundant, must be treated like other urban waste. It is also possible, as said, transport the debris also to the same landfill, depending on SWMU criteria.

- ***Dumping sites used to collect demolition debris and surplus soils***. The demolition of the existing bridges will generate concrete rubble, stone and scrap metal. Moreover, the construction of the road diversions can generate surplus soils and stones. **T**here are two possibilities for debris and surplus materials disposal:
  - Send them to an existing waste landfill.
  - Create a specific dumping site for the debris, soils and stones.

The final solution, use of a landfill or construction of a new dumping sites will have to be approved by the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA). If possible, concrete debris will be reused to produce recycled aggregates.

5.3.4 Measures related to deforestation

Road rehabilitation works will be generally carried out within the existing road limit, but due to the proximity of the natural areas, it is likely that some vegetation will have to be removed, in particular in the vicinity of the bridges, and especially in bridge 3. Trees located close to the work areas, may be damaged by accidental bumps and scrapes.

To reduce deforestation and to prevent tree damages, following measures should be implemented:

- **Avoid any unnecessary clearing of natural vegetation (ex. by adapting the design of river diversions, location of abutment base etc.)**
- **Working area will be fenced, as cited on the item above, to avoid uncontrolled machinery movements within natural areas.**
- **The Contractor will avoid the use of herbicides or other chemicals.**
- **Any works to be undertaken in a protected forest area**
  - **must be done under the supervision of a representative of the Forestry Department.**
  - **must be done by manual means.**
  - **must generate as minimal impact as possible to flora and fauna**
- **All recognized natural habitats, wetlands and protected areas in the immediate vicinity of the activity must be protected from damage or exploitation.**
- **All large trees or rare medicinal plants in the vicinity of the construction site should be inventoried prior to the beginning of works.**
- **The contractor must ensure that all staff be strictly prohibited from hunting, foraging, logging or other damaging activities.**
- **There will be no unlicensed borrow pits, quarries or waste dumps in protected areas.**
- **Upon completion, all wastes must be immediately removed from the forested area.**
- **the trees located close to the work areas, tree trunks should be protected during field works, to avoid damages due to bumping of machinery. Protection can be accomplished by wooden planks tied around the trunk of the tree, as it proves effective to protect from accidental bumps and scrapes.**

Figure 56: Example of tree protection

5.3.5 Noise prevention

During the construction phase some actions that could be noisy or annoying should be controlled.

- To prevent disturbance to the surrounding population, it is necessary to avoid the execution of works with noisy machinery or other actions giving rise to a high level of noise during normal hours of rest, considering them at least between 10:00 pm and 8:00 am. If possible, construction activities will occur within daylight hours, from 8:00 am to 4:00pm.
- Community and public must be informed in advance of any work activities to occur outside of normal working hours or on weekends.
- Sites should be hoarded wherever possible.

- During operations, the engine covers of generators, air compressors and other powered mechanical equipment shall be closed, and equipment placed as far away from residential areas as possible.
- There will be no excessive idling of construction vehicles at sites.
- Noise suppression equipment or systems supplied by manufacture will be utilized.
- Ensure all vehicles and equipment are properly serviced.
- The contractor must develop and implement a public notification and noise management plan.
- The use of blasting should be avoided in the demolition of the bridge.

5.3.6 Protection of top soil layers

Topsoil will be stripped off along the existing road (road will be widened from 3,5m up to 6m, in cuttings, embankments and associated structures to depths defined for each particular location.

In order to reduce the negative impact related to the topsoil stripping, following measures will be implemented:

- **Top soil should be protected from destruction and mixing with other materials**
- **The topsoil will be stockpiled in large mounds, outwith working areas, until such time as it is re-used on the exposed side slopes of embankments and cuttings (if feasibile). Otherwise, adjacent grassland areas are to be protected. Measures such as cut off ditches may be required around stockpiles to transfer any contaminated run-off to temporary settlement ponds.**
- **Bearing in mind the works will be klocated close to the environnementaly sensitive area (Forest Reserve) topsoil stripping should be done by small excavators would be used to load dump truck transporters.**
- **The point of deposition of the topsoil will be located close to the zone of excavation to control invasive plant species and ensure that topsoil is reused close to the location it was stripped.**

5.3.7 Surface water protection

Rehabilitation works of the Fenton – Green Hill Road may affect water quality. To avoid or minimize their effects, it is necessary to design prevention measures aimed to protect and prevent spillage of contaminating substances into the natural drainage system, generated from the execution or operation of the project.

5.3.7.1 River diversions and Temporary crossings

Activities requiring interventions of machinery within the river bed (construction works, crossing etc.) should be reduce to a strict minimum to prevent the turbidity of the water.

If it is unavoidable that machinery cross the rivers, it must be build a suitable temporary crossing, using precast concrete tubes. When construction is completed, it shall proceed to dismantle this crossing, and restore the affected area.

The foundation and construction of the abutments will required the presence of machinery in the riverbanks. To minimize their impacts, it is necessary to apply some prevention measures, such as carry out the works at the time of minimum flow or make temporary diversions of the river to avoid working in flooded areas.

5.3.7.2 Sediment control measures

Sediment retention barriers should be disposed in the points or sections where there will be a high probability of water circulation (runoff water), that previously has discoursed over bare soils. This runoff water could drag to the river lands or sediments. There are several sediment retention barrier

types, depending on protection requirements, available space and type of materials usable or easy to collect:

- **Straw barriers, made with remains of cereal straw or other crops. They are frequently used in areas with large cereal crop areas.**
- **Branches barriers, useful for retaining coarse matter, though ineffective for thin materials.**
- **Geotextile barriers, made only with geotextile membranes or a combination of geotextile and other material such as vegetal branches. Is the best solution in narrow o very located areas, like these works.**

The Contractor will choose the most effective type barrier, depending on the nature of grounds present in construction site. The final location of the barriers will be decided during the works, depending on the real risks of water circulation.

5.3.7.3 Washing and maintenance of machinery and tools

Machinery and construction vehicles will be cleaned and washed inly in designated areas where runoff will be properly managed to avoid its discharge to natural surface bodies.

During construction washing of vehicles, machinery or tools in the river or any other natural areas shall be strictly forbidden. Particular attention will be paid to concrete mixers washing, in order to prevent contamination of the river and its riverbanks.

The maintenance of machinery on site will be avoided as much as possible. In case it will not be possible, maintenance will be done in designated areas where temporary ponds to collect polluted runoff will be installed. Similar equipment will also be installed at the machinery park area.

The Contractor will identify all areas where such pollution can be generated prior to beginning of works and will propose pollution control and elimination measures. Polluted effluents will have to be collected and evacuated according to the national standards.

5.3.7.4 Water intake form natural sources

During the construction phase it shall be forbidden taking water from Warrawarrow River or its tributaries watercourses for the works, both for the production of materials such as mortars or concrete and for cleaning or surface spraying purposes, without specific authorization from Central Water and Sewerage Authority (CWSA).

In this authorization, CWSA should indicate the points where it is possible to take water and set conditions or limitations in the dates, duration and volumes of water that can be taken.

5.3.8 Protection of air quality

During the works can be identified three main sources of particulate emissions and air pollutants:

- ***Increase of dust suspension in the atmosphere due to earthwork operations***. The significance of dust generation and nuisance can be effectively mitigated through the application of some preventive measures:
  - Regular water spraying of the work area.
  - The sand and fines should be kept moistened also with sprays of water.
  - Covering the trucks used in the haulage of material, especially that which can generate dust during transportation.
  - Timely and regular cleaning of streets.
  - Construction materials such as sand, cement, or other fines should be kept properly covered.
  - Cement should be kept stored within a shed or container.
  - Unpaved, dusty construction roads should be compacted and then wet periodically.

- Demolition debris shall be kept in controlled area and sprayed with water mist to reduce debris dust.
- During pneumatic drilling demolition dust shall be suppressed by ongoing water spraying and/or installing dust screen enclosures at site
- The surrounding environment (sidewalks, roads) shall be kept free of debris to minimize dust.

- ***Gaseous emissions from the movement of machinery.*** To minimize gaseous emissions:
  - engines and machinery should respect the emission norms.
  - engines should be maintained in perfect technical condition, which involved regular revisions and immediate repair of any breakdowns.
  - vehicle idling should be prohibited
  - vehicle drivers should be informed about the impact of the "eco-driving" on the emission levels
- ***Smoke from burning waste.***
  - To avoid this effect, burning any kind of waste will be strictly prohibited.

5.3.9 Transport routes and timetable for material and debris

The Contractor will identify access routes for construction vehicles and machinery including alternative roads in case of road blockages. The choice of transport routes will seek to minimize the impact on the population and traffic and will have to be validated by the local authorities.

A traffic management plan to be developed and implemented by contractor in consultation with the Traffic Department of the Royal St. Vincent and the Grenadines Police force.

The Contractor will install warning signs, barriers and traffic diversions in a clear and safe way and provide active traffic management if necessary.
The Contractor will also be responsible for informing population about possible traffic disturbances and will provide safe crossings for pedestrians and vehicles if works interfere with their normal route.

Transport timetable will also be defined, avoiding normal rest hours (at least from 22 pm to 8 am) and traffic rush hours.

5.3.10 Occupational Health and Safety

Worker safety is critical to any operation, therefore, mishandling of equipment, the improper storage and usage of various chemicals and construction materials on site, poor and unsafe working conditions, high levels of continuous noise and fumes, as well as inadequate safety equipment can cause serious injury and down time to the workers and project and should therefore be avoided.

Best management practices should always be implemented as labour laws hold the employer responsible for the workers safety. Proper facilities will need to be provided for workers.

Following measures will have to be implemented in order to avoid or reduce adverse effects on the health and safety:

- The contractor must ensure that an Occupational Health and Safety Plan are in place to guide work activities, and provide a safe environment for workers.
- The contractor must ensure that all workers operate within a safe environment.
- All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety.
- Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc.

- Sanitary facilities must be provided for all workers on site.
- The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid.
- Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow.
- All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety.
- Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc.
- Sanitary facilities must be provided for all workers on site.
- The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid.
- Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow.
- **The Contractor will identify muster points** (also known as 'Assembly Point') where everyone meets in the event of an emergency (land slide, hurricane, accident etc.) for each work site and in particular for the sites located in the remote areas. The muster point will have to be:
  - Easily accessible location close to the building
  - Located close but in a safe distance away from a worksite or a construction zone.
  - Located in an area which is not impeded by other hazards (ex. streams, hazardous trees, fences, or other obstacles)
  - Large enough to accommodate the number of people assigned to that point, so as not to overcrowd or constrict movement should a blowout or secondary emergency occur (ex. a large open parking lot
  - Be located upwind to the work sites
  - known to all employees and visitors

Locate outside the areas presenting natural risks (land slide, flooding) or technological risks (vicinity of dangerous or toxic materials and installations)

In its Emergency response plan, the Contractor will define evacuation a procedures for each site, including identification of the muster areas where all personnel and visitors will reassembly after evacuation of the work site. Evacuation roads leading to a muster point will have to be clearly identified and communicated to all employees and visitors.

Muster point sign will be placed within optimal viewing range.

The contractor will review existing muster points to ensure that new hazards have not developed, such as electrical interference possibilities, roadways and other dwellings at the occasion of the safety reviews and at least every six months.

5.4 Remediation and corrective measures

5.4.1 Concept

Despite the application of preventive measures there are some negative effects that will not be possible to avoid. In these cases it is necessary to implement measures to correct or at least minimize the negative impacts that will be generated.

Following the mitigation hierarchy, corrective measures should be adopted after preventive measures, to mitigate the unavoidable negative effects.

In this project, remediation and corrective measures will be related to the waste management, cleaning of the work site, restoration of the river bed and replacement of the affected utilities.

5.4.2 Waste management

Waste types

During the construction phase, different types of waste will be generated. The waste types generated will be:

- Stone from the demolition of the existing abutments
- Surplus soils from excavations
- Concrete from foundations, decks, or remains of the new concreting works
- Mixed debris o rubble (stone, brick, mortar, concrete ...)
- Steel remains produced in the manufacture of reinforced concrete
- Lumber used in shuttering or packaging material (pallets)
- Plastics form packaging materials
- Drums and cans made of plastic or metal
- Hazardous waste such as paint cans and packages of additives or chemical contaminants
- Urban solid waste (rubbish), such as paper, plastic or organic waste

General solid and liquid waste management prescriptions

- **Contractor must develop and implement a waste management plan in consultation with the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA).**
- **The destination of all types of waste must be approved by the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA).**
- Contractor must abide all pertinent waste management and public health laws.
- All the waste, debris and remains from the works must be selectively collected and stockpiled in the recycling area.
- Construction and demolition wastes will be stored in appropriate bins.
- Waste collection and disposal pathways and sites will be identified for all major waste types expected from demolition and construction activities.
- Each type of waste must be removed to a disposal or treatment area according to their type and hazard.
- Wherever possible the waste will be sent to recycling plants for reuse. If possible, concrete debris will be reused to produce recycled aggregates.
- Liquid and chemical wastes will be stored in appropriate containers separated from the general refuse.
- All waste will be collected and disposed of properly in approved landfills by licensed collectors.

- The remains of stone, rubble and concrete debris will go to landfills or dumping sites, as indicated in section "5.3.10 Location of dumping sites, auxiliary facilities and machinery maintenance area".
- The records of waste disposal will be maintained as proof for proper management as designed.
- Whenever feasible the contractor will reuse and recycle appropriate and viable materials (except asbestos or other hazardous material).
- Construction related liquid wastes must not be allowed to accumulate on or off the site, or to flow over or from the site in an uncontrolled manner or to cause a nuisance or health risk due to its contents.

Specific prescriptions for hazardous substance

- Contractor must provide temporary storage on site for all hazardous or toxic substances in safe containers labeled with details of composition, properties and handling information.
- The containers of hazardous substances shall be placed in a leak-proof container to prevent spillage and leaching.
- The wastes shall be transported by specially licensed carriers and disposed in a licensed facility or landfills that meet the security conditions required for removal or storage.
- Paints with toxic ingredients or solvents or lead-based paints will not be used.
- Banned chemicals will not be used on any project.
- If termite treatment is to be utilized, appropriate chemical management measures will be implemented to prevent contamination of surrounding areas and use only licensed and registered pest control professionals with training and knowledge of proper application methods and techniques.

5.4.3 Cleaning of construction area

After completing the works, the entire construction area will have to be cleaned. This will include:

- Removing any kind of waste, like debris, packaging material, rubble, scrap metal, concrete or rubbish.
- Dismantling of auxiliary facilities such as huts, bathrooms or storage areas.
- Removal of temporary fencing and signposting.
- Final cleaning of streets.

The cleaning of the construction area is an obligation of the Contractor, who must leave the area at least equal to conditions existing prior to the works.

Figure 57: View of a worksite before cleaning

5.4.4 River section reclamation

During the abutments foundation and construction the river morphology could be affected, despite having taken preventive measures, due to several actions:

- Machinery access tracks.
- Machinery movement in the riverbeds and banks.
- Diversion of the rivers to allow the abutments foundation and construction.
- Debris falling during demolition.

After completion of rehabilitation works The Contractor will reestablish the original land topography and river morphology.
Earthworks required to recover the shape of the riverbeds must be achieved when the flow is minimal. To prevent water pollution during earthmoving, it should be done a temporary river diversion. The final section of the rivers should be similar to that existing before the works.

5.4.5 Old road and bridge demolition

Once the new bridges are built, the Constructor will proceed to the demolition of the current one, as well as the stretch of road that runs out of service.

The demolition of the bridge should minimize the impact on the river. All debris (stone, concrete, metal) or demolition residues shall be handled as indicated for the waste management, and retreat to areas authorized by the CWSA.

In the road section out of service should be done a deep tillage with a subsoiler, to break the compactness and allow revegetation.

5.4.6 Vegetation reclamation

The riparian vegetation of the riverbanks and the surrounding forests in bridge 3 should be affected by the works. If any vegetation is affected, The Contractor will restore natural vegetation upon completion of the works.

The plantations should be done with close coordination and under supervision of the Forest reserve authorities using native species only.

5.4.7 Replacement of affected utilities

Is not expected the affection of utilities during the works.

If any utility is detected, cutting of, even temporarily, involves a direct effect on the users of the interrupted supply. It is therefore necessary to ensure the immediate replacement of any services affected by the works, without entailing supply disruptions beyond the essential.

In the detailed design of the project it should be included a specific chapter of “Affected utilities”, where its presence and, if necessary, replacement is analyzed.

When the replacement is carried out by the owner company, it is not necessary include in the detailed design detailed information about its replacement. Also, the costs may be included in the project budget or run through a specific agreement between the Government and the company.

Must be included a letter from the owner company, accepting carrying out the replacement or authorizing the execution by a third party

5.5 Compensatory measures

5.5.1 Concept

It is common that some of the adverse impacts will remain despite the application of the mitigation measures. These unavoidable effects are called residual impacts. When residual impacts are significant, it is necessary to apply compensatory measures.
A compensatory measure is an action applied at a different location to the specific area of operation or an improvement on the initial situation of some environmental factor, to compensate for an unavoidable impact.

5.5.2 Crops compensation

In the Bridge 1 location, the new bridge and the road will be built over a cultivated parcel. According to the World Bank Operational Policy OP 4.12 on Involuntary resettlement, the persons which are affected by loss of assets such as agriculture lands, should be provided with agricultural sites for which a combination of productive potential, locational advantages, and other factors is at least equivalent to the advantages of the old site.
Compensation measures can include land-based solutions (preferably) or financial compensation for lost assets.
In any case, before the project start following steps should be completed:

- **Identification of land owners and their property rights clarified (formal legal rights to land, no formal legal rights to land but have a claim to such land or assets, no recognizable legal right or claim to the land they are occupying.**
- **Evaluation of value of affected assets (land and crops)**
- **Identification of compensation measures and their discussion with the owner**
- **Signature of the agreement with affected owners**
- **Notification of the date on which the land should be made available**

The compensation process will have to be implemented in compliance with the World Bank OP 4.12 and national legislation. In case of discrepancy between the two standards, it is recommended to adopt the more favorable one.

5.5.3 Waste cleaning and removal of abandoned vehicles

During fieldwork, residues have been detected at several points.

- Many rivers and watercourses have waste. Part of this waste are rubbish such plastics, cans or bottles, but it is particularly conspicuous the presence of tyres, which due to their weight have not been swept away by the water flow down.
- Abandoned vehicles. At least it has been observed an abandoned bus on the road, and a crashed car off the road, close to bridge 3.

The mitigation plan includes as a corrective measure the cleaning of the construction area. But this cleaning can be extended to the road platform and the surrounding area, and the watercourses crossed by the road, at least in the areas closest to it.

The waste must be removed to an approved landfill.

When possible, tires should be carried to a recycling centre; they can be used in the production of road agglomerates, as an asphalt additive.

Abandoned vehicles should be transported to an approved scrapping place, where hazardous substances will be removed and, if still usable, metals will be recycled.

Abandoned bus in Fenton to Green Hill road

Tyres dumped in rivers. Left: Downstream box culvert. Right: Downstream bridge 2

Left: Remains of concrete tubes downstream box culvert. Right: Waste in Warrawarrow River

5.6 Summary of the proposed mitigation measures

Impact Area	Mitigation measure	Implementation responsibility
Air Quality	• Regular water spraying of the work area. • The sand and fines should be kept moistened also with sprays of water. • Covering the trucks used in the haulage of material, especially that which can generate dust during transportation. • Timely and regular cleaning of streets. • Construction materials such as sand, cement, or other fines should be kept properly covered. • Cement should be kept stored within a shed or container. • Unpaved, dusty construction roads should be compacted and then wet periodically. • Demolition debris shall be kept in controlled area and sprayed with water mist to reduce debris dust. • During pneumatic drilling demolition dust shall be suppressed by ongoing water spraying and/or installing dust screen enclosures at site • The surrounding environment (sidewalks, roads) shall be kept free of debris to minimize dust. • engines and machinery should respect the emission norms. • engines should be maintained in perfect technical condition, which involved regular revisions and immediate repair of any breakdowns. • vehicle idling should be prohibited • vehicule drivers should be informed about the impact of the “eco-driving” on the emission levels • open burning of construction or any other kind of waste material at the site will be strictly prohibited	Contractor
Noise	• To prevent disturbance to the surrounding population, it is necessary to avoid the execution of works with noisy machinery or other actions giving rise to a high level of noise during normal hours of rest, considering them at least between 10:00 pm and 8:00 am. If possible, construction activities will occur within daylight hours, from 8:00 am to 4:00pm. • Community and public must be informed in advance of any work activities to occur outside of normal working hours or on weekends. • Sites should be hoarded wherever possible. • During operations, the engine covers of generators, air compressors and other powered mechanical equipment shall be closed, and equipment placed as far away from residential areas as possible.	Contractor

Impact Area	Mitigation measure	Implementation responsibility
	• There will be no excessive idling of construction vehicles at sites. • Noise suppression equipment or systems supplied by manufacture will be utilized. • Ensure all vehicles and equipment are properly serviced. • The contractor must develop and implement a public notification and noise management plan. • The use of blasting should be avoided in the demolition of the bridge.	
Terrestrial and water pollution	• During the construction phase it shall be forbidden taking water from Warrawarrow River or its tributaries without specific authorization from Central Water and Sewerage Authority (CWSA). • Avoid uncontrolled river crossing of machinery • Build a suitable temporary crossing, using precast concrete tubes. • Dismantle this crossing, and restore the affected area when construction is completed • carry out works at the time of minimum flow or make temporary diversions of the river to avoid working in flooded areas • establish appropriate erosion and sediment control measures (sediment retention barriers, sedimentation basins, and / or silt fences and traps to prevent sediment from moving off site and causing excessive turbidity in nearby streams • Construction vehicles and machinery will be washed only in designated areas where runoff will not pollute natural surface water bodies. • Temporary ponds will be installed in the machinery maintenance and park areas to collect polluted runoff. • The contractor will remove any kind of waste, like debris, packaging material, rubble, scrap metal, concrete or rubbish. • All auxiliary facilities such as huts, bathrooms or storage areas as well as temporary fencing and signposting will be removed after work completion	Contractor
Deforestation	• placing temporary fencing to protect natural vegetation • reduce deforestation to a strict minimum by adapting project design • Avoid any unnecessary clearing of natural vegetation (ex. by adapting the design of river diversions, location of abutment base etc.) • Working area will be fenced, as cited on the item above, to avoid uncontrolled machinery movements within natural areas. • The Contractor will avoid the use of herbicides or other chemicals. • Any works to be undertaken in a protected forest area must be done under the supervision of a representative of the	Contractor

Impact Area	Mitigation measure	Implementation responsibility
	Forestry Department, must be done by manual means, must generate as minimal impact as possible to flora and fauna • All recognized natural habitats, wetlands and protected areas in the immediate vicinity of the activity must be protected from damage or exploitation. • All large trees or rare medicinal plants in the vicinity of the construction site should be inventoried prior to the beginning of works. • The contractor must ensure that all staff be strictly prohibited from hunting, foraging, logging or other damaging activities. • There will be no unlicensed borrow pits, quarries or waste dumps in protected areas. • Upon completion, all wastes must be immediately removed from the forested area. • the trees located close to the work areas, tree trunks should be protected during field works, to avoid damages due to bumping of machinery • The Contractor will restore natural vegetation unpon completion of works with close coordination and under supervision of competent national authorities	
Soil and Erosion Slippage	• Identify volumes and sources of materials before beginning of works • Top soil should be protected from destruction and mixing with other materials • The topsoil will be stockpiled in large mounds, outwith working areas, until such time as it is re-used on the exposed side slopes of embankments and cuttings (if feasible). • Measures such as cut off ditches may be required around stockpiles to transfer any contaminated run-off to temporary settlement ponds. • The point of deposition of the topsoil will be located close to the zone of excavation to control invasive plant species and ensure that topsoil is reused close to the location it was stripped. • The contractor must ensure that appropriate erosion control measures such as silt fences are installed. • Proper site drainage must be implemented, including drainage at the tops of slopes, around slopes, and beneath roadways. • Any drain clogged by construction material or sediment must be unclogged as soon as possible to prevent overflow and flooding. • The use of retaining structures and planting with deep rooted grasses to retain soil during and after works must be considered.	Contractor

Impact Area	Mitigation measure	Implementation responsibility
	• The use of bio-engineering methods must be considered as a measure to reduce erosion and land slippage. • Keep angle of slopes within limits of soil type. • Balance cut and fill to limit steepness of slopes. • All slopes and excavated areas must be monitored for movement. • Reestablish initial site topography and shape of riverbeds	
Occupational Health and Safety Issues	• The contractor must ensure that an Occupational Health and Safety and Emergency Preparedness Plan / procedures are in place to guide work activities, and provide a safe environment for workers. • The Contractor will establish muster points for each worksite • The contractor must ensure that all workers operate within a safe environment. • All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety. • Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc. • Sanitary facilities must be provided for all workers on site. • The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid. • Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow. • All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety. • Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc. • Sanitary facilities must be provided for all workers on site. • The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid. • Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow.	Contractor
Solid and Liquid Waste Management (general)	• Contractor must develop and implement a waste management plan in consultation with the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA). • The destination of all types of waste must be approved by the Solid Waste Management Unit (SWMU), of the Central	Contractor

Impact Area	Mitigation measure	Implementation responsibility
	Water and Sewerage Authority (CWSA). • Contractor must abide all pertinent waste management and public health laws. • All the waste, debris and remains from the works must be selectively collected and stockpiled in the recycling area. • Construction and demolition wastes will be stored in appropriate bins. • Waste collection and disposal pathways and sites will be identified for all major waste types expected from demolition and construction activities. • Each type of waste must be removed to a disposal or treatment area according to their type and hazard. • Wherever possible the waste will be sent to recycling plants for reuse. If possible, concrete debris will be reused to produce recycled aggregates. • Liquid and chemical wastes will be stored in appropriate containers separated from the general refuse. • All waste will be collected and disposed of properly in approved landfills by licensed collectors. • The remains of stone, rubble and concrete debris will go to landfills or dumping sites, as indicated in section "5.3.10 Location of dumping sites, auxiliary facilities and machinery maintenance area". • The records of waste disposal will be maintained as proof for proper management as designed. • Whenever feasible the contractor will reuse and recycle appropriate and viable materials (except asbestos or other hazardous material). • Construction related liquid wastes must not be allowed to accumulate on or off the site, or to flow over or from the site in an uncontrolled manner or to cause a nuisance or health risk due to its contents.	
Solid and Liquid Waste Management (hazardous	• Contractor must provide temporary storage on site for all hazardous or toxic substances in safe containers labeled with details of composition, properties and handling information. • The containers of hazardous substances shall be placed in a leak-proof container to prevent spillage and leaching. • The wastes shall be transported by specially licensed carriers and disposed in a licensed facility or landfills that meet the security conditions required for removal or storage. • Paints with toxic ingredients or solvents or lead-based paints will not be used. • Banned chemicals will not be used on any project. • If termite treatment is to be utilized, appropriate chemical management measures will be implemented to prevent contamination of surrounding areas and use only licensed and registered pest control professionals with training and knowledge of proper application methods and techniques.	Contractor

Impact Area	Mitigation measure	Implementation responsibility
Traffic impacts	• A traffic management plan to be developed and implemented by contractor in consultation with the Traffic Department of the Royal St. Vincent and the Grenadines Police force. • Alternative routes to be identified in the instance of extended road works or road blockages. • The public to be notified of all disturbances to their normal routes. • Signposting, warning signs, barriers and traffic diversions must be clearly visible and the public warned of all potential hazards. • Provision must be made for the safe passages and crossings for all pedestrians where construction traffic interferes with their normal route. • There must be active traffic management by trained and visible staff at the site or along roadways as required to ensure safe and convenient passage for the vehicular and pedestrian public. • Adjustment of working hours to facilitate local traffic patterns, e.g. avoiding major work activities during rush hours and do temporary road closures at night.	Contractor
Private property (crops)	Prior to the work commencement, the SVG national authorities will : • identify land owners and their property rights before beginning of works • Evaluate the value of affected assets (land and crops) • Identify compensation measures and discuss them with the owner • Sign the agreements between the affected owner • Notify the date on which the land should be made available	Contractor

6. Monitoring plan

6.1 Introduction

6.1.1 Background

According with Annex C "Environmental Management Plan" of World Bank's Operational Policy 4.01, the EMP has to provide:

- **Description of monitoring measures, including the parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits, and definition of thresholds that will signal the need for corrective actions**
- **Monitoring and reporting procedures to**
  - **Ensure early detection of conditions that necessitate particular mitigation measures.**
  - **Furnish information on the progress and results of mitigation.**

6.1.2 Objectives

The overall purpose of the Environmental Monitoring Plan is to define monitoring arrangements and methods allowing to check the efficiency of the preventive, corrective and compensatory measures contained in the EMP by monitoring key environmental parameters.
Objectives of the environmental monitoring are to:

- Monitor negative impacts and verify the adequacy of forecast included in the EMP.
- Detect unforeseen impacts and articulate the necessary preventive and corrective measures.
- Verify compliance of limitations or restrictions set in the EMP.
- Monitor the implementation of mitigation measures and verify their effectiveness and efficiency.
- Monitor in the medium term to determine the effects of the works exploitation on environmental resources.

6.2 Monitoring Plan during construction phase

6.2.1 Objective

The main objectives of the Monitoring Plan during the construction phase are:

- Monitoring of negative impacts, to determinate their adequacy to the forecast included in the EMP.
- Detect unforeseen impacts and articulate the necessary preventive and corrective measures.
- Verify compliance of limitations or restrictions set in the EMP.
- Monitoring the implementation of protective and corrective measures.

6.2.2 Monitoring measures and procedures

Control of dust emissions
Objectives
Check the minimum incidence of dust emissions due to earthworks and machinery traffic as well as the correct execution of irrigation (spraying).

Measures
Periodic visual inspections at the work area to detect dust clouds. Periodic visual inspections to verify the spraying execution. Control of the source of water used for irrigation.
Inspection location
All work zone including auxiliary areas, especially in the vicinity of residential areas.
Control parameters and thresholds
Is not accepted the presence of dust clouds, especially in urban areas or near inhabited area.
Frequency of inspection
Inspections shall be at least weekly.
Prevention and correction measures
Intensification of irrigation. Cleaning in areas that might have been affected.
Responsibility : Contractor's HSE Officer

Control of machinery emissions and noise
Objectives
Check the condition of the machinery employed in the works regarding emissions and noise.
Measures
Inspections of documentation and maintenance of all the machinery used at works. Noise measurements of each machine during operation.
Inspection location
Works zone or machinery maintenance area.
Control parameters and thresholds
Each machine must have its documentation in order and be in good operating and maintenance condition.
Frequency of inspection
Each new machine incorporated to the works must be checked.
Prevention and correction measures
Stoppage of machines that do not meet the requirements.
Responsibility : Contractor's HSE Officer

Control of noise levels at works
Objectives
Check that the noise levels at works do not exceed the maximum allowed.
Measures
Noise measurements using a sound level meter, during 15 minutes.
Inspection location

Works zone, and the nearest residential buildings.
Control parameters and thresholds
The parameters used are the equivalent sound level (Leq) and the maximum sound level (Lmax), during day and night periods. The thresholds are: ƒ Leq 65 dB(A) during day and 55 dB(A) during night. ƒ Lmax 85 dB(A) during day and 60 dB(A) during night.
Frequency of inspection
Weekly, and when it is expected to perform especially noisy operations.
Prevention and correction measures
Limitation of the machinery used simultaneously. Limitation throughout the day of the execution times of noisy operations.
Responsibility : Contractor's HSE Officer

Monitoring of water quality
Objectives
Ensuring the maintenance of water quality during construction.
Measures
Water analysis in South River during the works.
Inspection location
South River, upstream and downstream the bridge.
Control parameters and thresholds
The parameters used must be at least suspended solids, pH, hydrocarbons and oils, potassium and sulphates. The thresholds must be fixed under national regulations or otherwise in international standards. In each analysis it is necessary to take a sample upstream and other downstream for comparison.
Frequency of inspection
At least twice, during demolition and during concreting of abutments.
Prevention and correction measures
Stoppage of works. Temporary detour of the stream or piping to prevent water pollution.
Responsibility : Contractor's HSE Officer

Monitoring of sediment barriers and pollutants ponds
Contractor's HSE Officer
Objectives
Verify that sediment retention barriers have been placed in point with potentially risk of dragging. If a machinery maintenance area is built, verify that it has a pollutants retention pond.
Measures
Periodic visual inspections of these elements.
Inspection location
Work area, and machinery maintenance area if done.
Control parameters and thresholds
It shall not be acceptable the absence of sediment barriers in areas with potentially risk of land dragging. It shall not be acceptable a new machinery maintenance area without a pollutants retention pond.
Frequency of inspection
Weekly.
Prevention and correction measures
Immediate placement of sediment barriers or pollutants ponds construction. Until the pollutants pond is built, maintenance of machinery must be prohibited.
Responsibility : Contractor's HSE Officer

Control of work delimitation and signalling
Responsibility
Contractor's HSE Officer
Objectives
Verify the placement of temporary fencing and signposting, to ensure population safety and prevent unnecessary damage to the river and surrounding forest areas.
Measures
Visual inspections during the works.
Inspection location
Work area, especially in rivers and forests.
Control parameters and thresholds
It will not be acceptable the absence of any stretch of fencing or the presence of any opening that allows access to the construction area.
Frequency of inspection
Weekly.
Prevention and correction measures
Immediate placing of fences or closing of openings.
Responsibility : Contractor's HSE Officer

Control of forest protection
Objectives
Verify that the surrounding forests will not be affected during the works.
Measures
Mapping forest areas bordering the road. Signaling sensitive areas. Visual inspections during the works.
Inspection location
Forest areas close to the bridges, especially the proposed Kingstown Forest Reserve.
Control parameters and thresholds
They should only be affected the forest areas that have been specifically identified in the final design. Is not acceptable the affection to any forest area outside of those.
Frequency of inspection
Weekly.
Prevention and correction measures
Stop works immediately. Restore the affected forest areas.
Responsibility : Contractor's HSE Officer

Monitoring of endangered species
Objectives
Verify that not endangered species are present in the area, and if so, that they will not be affected.
Measures
Bird census before the start of construction, and at least every six months.
Inspection location
Forest areas, especially the surrounding area of bridge 3, where the boundary of the proposed Kingstown Forest Reserve is located. The main species to control will be St Vincent Amazon *(Amazona guildingii)*, vulnerable, and the Whistling Warbler *(Catharopeza bishopi)*, endangered.
Control parameters and thresholds
It presence of St Vincent Amazon or Whistling Warbler is detected, it will be done a specific report, to decide if complementary protection measures are necessary. Also, if this presence is detected, it should be necessary more frequent census, to ensure that these birds will not be affected.
Frequency of inspection
First census previous to the works, and after during the works.
Prevention and correction measures
Avoid working during nesting dates. More strict noise limitations. Changes in machinery, to use less noisy equipment.
Responsibility : Contractor's HSE Officer

Monitoring of landscaped areas
Objectives
Verify that compensatory plantations are done.
Measures
Visual inspections during the works. Control at completion of the works.
Inspection location
Landscaped areas, in the junction of South River and its tributary.
Control parameters and thresholds
It shall be checked the presence of the planted trees, quality of the used plants, plantation method and tree stability.
Frequency of inspection
During plantation works, and at the end of construction phase.
Prevention and correction measures
Making plantations if not executed. Replacing plants if their quality is poor. Improved the way to make plantations if inadequate
Responsibility : Contractor's HSE Officer

Monitoring of waste management
Objectives
Verify that all the waste, debris and remains from the works is selectively collected and stockpiled in the recycling area, and removed to disposal or treatment areas according to their type and hazard.
Measures
Visual inspections during the works. Collecting CWSA authorizations and receiving part from landfills.
Inspection location
Work area, with special attention to recycling zone.
Control parameters and thresholds
It will not be acceptable the storage of unsorted waste. It will not be acceptable the removal of waste to landfills or dumping sites that have not been previously authorized by the CWSA
Frequency of inspection
Weekly.
Prevention and correction measures
Classification of all waste stockpiled. Stoppage of transportation of waste to landfills or dumping sites unauthorized.
Responsibility : Contractor's HSE Officer

6.2.3 Monitoring plan during construction phase

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
Air Quality	• Regular water spraying of the work area. • The sand and fines should be kept moistened also with sprays of water. • Covering the trucks used in the haulage of material, especially that which can generate dust during transportation. • Construction materials such as sand, cement, or other fines should be kept properly covered. • Cement should be kept stored within a shed or container. • Unpaved, dusty construction roads should be compacted and then wet periodically. • Demolition debris shall be kept in controlled area and sprayed with water mist to reduce debris dust. • During pneumatic drilling demolition dust shall be suppressed by ongoing water spraying and/or installing dust screen enclosures at site • The surrounding environment (sidewalks, roads) shall be kept free of debris to minimize dust. • Engines and machinery should respect the emission norms. • Engines should be maintained in perfect technical condition, which involved regular revisions and immediate repair of any breakdowns. • vehicle idling should be prohibited • vehicle drivers should be informed about the impact of the “eco-driving” on the emission levels • open burning of construction or any other kind of waste material at the site will be strictly prohibited	The Contractor	• Amount of dust generated during construction activities • Water resource use for spraying • Spill of materials along the transport routes	• Site inspection • Contractor records • Vehicle and machinery maintenance records • Incident reporting	Contractor Supervision Engineer Local population	Weekly
Noise	• To prevent disturbance to the surrounding population, it is necessary to avoid the execution of works with noisy machinery or other actions giving rise to a high level of noise during	Contractor	• Amount of noise being created during construction	• Civil society complaints	Contractor Supervision Engineer	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	normal hours of rest, considering them at least between 10:00 pm and 8:00 am. If possible, construction activities will occur within daylight hours, from 8:00 am to 4:00pm. • Community and public must be informed in advance of any work activities to occur outside of normal working hours or on weekends. • Sites should be hoarded wherever possible. • During operations, the engine covers of generators, air compressors and other powered mechanical equipment shall be closed, and equipment placed as far away from residential areas as possible. • There will be no excessive idling of construction vehicles at sites. • Noise suppression equipment or systems supplied by manufacture will be utilized. • Ensure all vehicles and equipment are properly serviced. • The contractor must develop and implement a public notification and noise management plan. • The use of blasting should be avoided in the demolition of the bridge.		hours and days • Frequency of disturbance to local villagers	• interviews	Local population	
Water pollution	• During the construction phase it shall be forbidden taking water from Warrawarrow River or its tributaries without specific authorization from Central Water and Sewerage Authority (CWSA). • Avoid uncontrolled river crossing of machinery • Build a suitable temporary crossing, using precast concrete tubes. • Dismantle this crossing, and restore the affected area when construction is completed • carry out works at the time of minimum flow or make temporary diversions of the river to avoid working in flooded areas • establish appropriate erosion and sediment control measures	Contractor	• Vehicles/equipment operating at standard levels • Excess oil, fuel, lubricant leaks and gas emissions • Disorderly conduct or misuse of equipment / vehicles • Amount of erosion and sediments being released,	• Site visit /inspection • Incident reporting • Water sampling • Laboratory testing	Contractor Supervision Engineer Local population	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	(sediment retention barriers, sedimentation basins, and / or silt fences and traps to prevent sediment from moving off site and causing excessive turbidity in nearby streams • Construction vehicles and machinery will be washed only in designated areas where runoff will not pollute natural surface water bodies. • Temporary ponds will be installed in the machinery maintenance and park areas to collect polluted runoff. • The contractor will remove any kind of waste, like debris, packaging material, rubble, scrap metal, concrete or rubbish. • All auxiliary facilities such as huts, bathrooms or storage areas as well as temporary fencing and signposting will be removed after work completion		particularly into water resources			
Deforestation	• placing temporary fencing to protect natural vegetation • reduce deforestation to a strict minimum by adapting project design • Avoid any unnecessary clearing of natural vegetation (ex. by adapting the design of river diversions, location of abutment base etc.) • Working area will be fenced, as cited on the item above, to avoid uncontrolled machinery movements within natural areas. • The Contractor will avoid the use of herbicides or other chemicals. • Any works to be undertaken in a protected forest area must be done under the supervision of a representative of the Forestry Department, must be done by manual means, must generate as minimal impact as possible to flora and fauna • All recognized natural habitats, wetlands and protected areas in the immediate vicinity of the activity must be protected from damage or exploitation. • All large trees or rare medicinal plants in the vicinity of the construction site should be inventoried prior to the beginning of	Contractor	• Natural areas delimitation • Harvesting techniques • Debris storage and disposal sites • Involvement of local community in clearing • Ability of soils, vegetation, water resources, fauna and biodiversity to replenish after construction	Site inspection	Contractor, Supervision Engineer, Forest Reserve Authorities	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	works. • The contractor must ensure that all staff be strictly prohibited from hunting, foraging, logging or other damaging activities. • There will be no unlicensed borrow pits, quarries or waste dumps in protected areas. • Upon completion, all wastes must be immediately removed from the forested area. • the trees located close to the work areas, tree trunks should be protected during field works, to avoid damages due to bumping of machinery • The Contractor will restore natural vegetation unpon completion of works with close coordination and under supervision of competent national authorities					
Soil and Erosion Slippage	• Identify volumes and sources of materials before beginning of works • Top soil should be protected from destruction and mixing with other materials • The topsoil will be stockpiled in large mounds, outwith working areas, until such time as it is re-used on the exposed side slopes of embankments and cuttings (if feasible). • Measures such as cut off ditches may be required around stockpiles to transfer any contaminated run-off to temporary settlement ponds. • Bearing in mind the works will be located close to the environmentally sensitive area (Forest Reserve) topsoil stripping should be done by small excavators. • The point of deposition of the topsoil will be located close to the zone of excavation to control invasive plant species and ensure that topsoil is reused close to the location it was stripped. • The contractor must ensure that appropriate erosion control measures such as silt fences are installed.	Contractor	• Volumes of top soil excavated and reused •	• Site visit • /inspection	• Contractor • Supervision Engineer • Local population	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	• Proper site drainage must be implemented, including drainage at the tops of slopes, around slopes, and beneath roadways. • Any drain clogged by construction material or sediment must be unclogged as soon as possible to prevent overflow and flooding. • The use of retaining structures and planting with deep rooted grasses to retain soil during and after works must be considered. • The use of bio-engineering methods must be considered as a measure to reduce erosion and land slippage. • Keep angle of slopes within limits of soil type. • Balance cut and fill to limit steepness of slopes. • All slopes and excavated areas must be monitored for movement. • Reestablish initial site topography and shape of riverbeds					
Occupational Health and Safety Issues	• The contractor must ensure that an Occupational Health and Safety and Emergency Preparedness Plan / procedures are in place to guide work activities, and provide a safe environment for workers. • The Contractor will establish muster points for each worksite • The contractor must ensure that all workers operate within a safe environment. • All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety. • Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc. • Sanitary facilities must be provided for all workers on site. • The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid. • Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow. • All relevant Labour and Occupational Health and Safety regulations must be adhered to ensure worker safety.	Contractor	• Safety, security and orderly • conduct of construction • workers • Accidents and unplanned • events • Conflict with local villagers	• Medical reports, workers interview	• Contractor • Supervision Engineer • Local population	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	• Workers must be provided with necessary equipment as well as protective gear as per their specific tasks such as hard hats, overalls, gloves, goggles, boots, etc. • Sanitary facilities must be provided for all workers on site. • The contractor must ensure that there are basic medical facilities on site and that there are staff trained in basic first aid. • Appropriate posting of information within the site must be done to inform workers of key rules and regulations to follow.					
Solid and Liquid Waste Management (general)	• Contractor must develop and implement a waste management plan in consultation with the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA). • The destination of all types of waste must be approved by the Solid Waste Management Unit (SWMU), of the Central Water and Sewerage Authority (CWSA). • Contractor must abide all pertinent waste management and public health laws. • All the waste, debris and remains from the works must be selectively collected and stockpiled in the recycling area. • Construction and demolition wastes will be stored in appropriate bins. • Waste collection and disposal pathways and sites will be identified for all major waste types expected from demolition and construction activities. • Each type of waste must be removed to a disposal or treatment area according to their type and hazard. • Wherever possible the waste will be sent to recycling plants for reuse. If possible, concrete debris will be reused to produce recycled aggregates. • Liquid and chemical wastes will be stored in appropriate containers separated from the general refuse. • All waste will be collected and disposed of properly in approved	contractor	• Amount of waste generated • at construction and camp • sites • Amount of waste disposed • at the landfill • Recycling of material • Littering and contamination • of environment	• Waste tracking • sheets or register • Incident reports • site visits	• Contractor • Supervision Engineer • Local population	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	landfills by licensed collectors. • The remains of stone, rubble and concrete debris will go to landfills or dumping sites, as indicated in section "5.3.10 Location of dumping sites, auxiliary facilities and machinery maintenance area". • The records of waste disposal will be maintained as proof for proper management as designed. • Whenever feasible the contractor will reuse and recycle appropriate and viable materials (except asbestos or other hazardous material). • Construction related liquid wastes must not be allowed to accumulate on or off the site, or to flow over or from the site in an uncontrolled manner or to cause a nuisance or health risk due to its contents.					
Solid and Liquid Waste Management (hazardous)	• Contractor must provide temporary storage on site for all hazardous or toxic substances in safe containers labeled with details of composition, properties and handling information. • The containers of hazardous substances shall be placed in a leak-proof container to prevent spillage and leaching. • The wastes shall be transported by specially licensed carriers and disposed in a licensed facility or landfills that meet the security conditions required for removal or storage. • Paints with toxic ingredients or solvents or lead-based paints will not be used. • Banned chemicals will not be used on any project. • If termite treatment is to be utilized, appropriate chemical management measures will be implemented to prevent contamination of surrounding areas and use only licensed and registered pest control professionals with training and knowledge of proper application methods and techniques.	contractor	• Storage facility location, • security and maintenance • Volumes of hazardous waste generated and disposed	• Disposal records, site visits • Inventory checklists • Reporting incidents • or accidents	• Contractor • Supervision Engineer • Local population	Weekly
Traffic impacts	• A traffic management plan to be developed and implemented by	Contractor	• Presence of road	• Traffic	• Contractor	Weekly

Impact Area	Mitigation measure	Mitigation Responsibility	Monitoring parameter	Monitoring method	Monitoring responsibility	Frequency
	contractor in consultation with the Traffic Department of the Royal St. Vincent and the Grenadines Police force. • Alternative routes to be identified in the instance of extended road works or road blockages. • The public to be notified of all disturbances to their normal routes. • Signposting, warning signs, barriers and traffic diversions must be clearly visible and the public warned of all potential hazards. • Provision must be made for the safe passages and crossings for all pedestrians where construction traffic interferes with their normal route. • There must be active traffic management by trained and visible staff at the site or along roadways as required to ensure safe and convenient passage for the vehicular and pedestrian public. • Adjustment of working hours to facilitate local traffic patterns, e.g. avoiding major work activities during rush hours and do temporary road closures at night.		signage • Traffic deviations	police report • Complaints from local population • Contractor reports	• Royal SVG Police force	
Private property (crops)	Prior to the work commencement, the SVG national authorities will : • identify land owners and their property rights before beginning of works • Evaluate the value of affected assets (land and crops) • Identify compensation measures and discuss them with the owner • Sign the agreements between the affected owner • Notify the date on which the land should be made available	Government of SVG	• Compensation of the affected owners	• Project progress reports	• World Bank	Once, after work commencement

6.3 Monitoring plan during operational phase

6.3.1 Objective

The main objectives of the Monitoring Plan during the construction phase are:

- Detect unforeseen impacts and articulate the necessary preventive and corrective measures.
- Determining the effectiveness of protective and corrective measures.
- Monitoring in the medium term to determine the effects of the works exploitation on environmental resources.

6.3.2 Monitoring measures and procedures

The environmental effects associated to the project are focused on the construction phase. Once construction is completed, the situation will be similar to the existing before works, with no new negative impacts detected. The main change is the protection of the slope (defence wall), that stops the erosion in this margin.
Anyway, it is possible to establish two track points on the effectiveness of the actions taken.

Monitoring of endangered species
Objectives
Verify that not endangered species are present in the area, and if so, that they will not be affected.
Measures
Bird census during operational phase, at least every year.
Inspection location
Forest areas, especially the surrounding area of bridge 3, where the boundary of the proposed Kingstown Forest Reserve is located. The main species to control will be St Vincent Amazon *(Amazona guildingii)*, vulnerable, and the Whistling Warbler *(Catharopeza bishopi)*, endangered.
Control parameters and thresholds
It presence of St Vincent Amazon or Whistling Warbler is detected, it will be done a specific report, to decide if complementary measures are necessary. Also, if this presence is detected, it should be necessary more frequent census, to ensure that these birds will not be affected.
Frequency of inspection
Every year, preferably during the nesting season of these birds.
Prevention and correction measures
Noise barriers, but only if a regression in endangered bird populations due to traffic is detected, which is highly unlikely.

Monitoring of landscaped areas
Objectives
Monitoring of planted trees to check their establishment and development.
Measures
Visual inspections.

Inspection location
Landscaped areas, in the riverbanks, slopes and roadsides.
Control parameters and thresholds
Death or poor tree growth.
Frequency of inspection
Annually.
Prevention and correction measures
Replanting of trees.

Monitoring of waste cleaning and removal of abandoned vehicles
Objectives
Check that the abandoned vehicles are retired, and the watercourses and roadsides are cleaned, paying special attention to tyres removal.
Measures
Visual inspections.
Inspection location
All the road (platform and margins) and watercourses.
Control parameters and thresholds
Presence of abandoned vehicles. Presence of waste (especially tyres).
Frequency of inspection
At the end of the cleaning works.
Prevention and correction measures
Retire the detected waste.

7. Capacity development and training plan

7.1 Introduction

According with Annex C "Environmental Management Plan" of World Bank's Operational Policy 4.01, the EMP should include:

- Technical assistance programmes
- Procurement of equipment and supplies
- Organizational changes

It has been included a fourth section devoted to environmental training.

7.2 Technical assistance programmes

There are no necessary specific technical assistance programmes to implement the mitigation measures included in the present environmental management plan.

All the measure are defined and budgeted, and should be developed in parallel with the construction works.

7.3 Procurement of equipment and supplies

The equipment, supplies and materials required to develop the mitigation measures should be included in the main project, as a part of it, so it is no necessary special requirements in this regard.

7.4 Environmental training

All personnel participating in the works, both technical staff and workers, should receive a breakout session on environmental protection, where the environmental risks associated to works will be detailed, as well as the proposed mitigation measures, its objectives, timing and effectiveness.

8. Implementation responsibilities

This section describes the organizational structure and responsibilities for implementation of the EMP as shown in the table below:

Organisation	Responsibility
Project promoter	• Overall responsibility for the environmental performance of the project
	• Decision-making on the applicable environmental rules and standards
	• Oversight supervisory role during construction phase
	• Review of environmental management and monitoring reports
	• Approval of changes to the EMP
	• Responsible for the public and stakeholder consultation
	• Representing the project during the community meetings
	• Ensure effective communication and dissemination of the EMP content to the contractors and subcontractors
	• Review of EMP performance and implementation of corrective actions or stop procedures in the event of breaches of the EMP
	• Reporting of the environmental performance to the SVG Government and the Financing Institutions (World Bank)
Supervision Engineer	• Supervision of the implementation of the Environmental mitigation and monitoring plan by the Construction Contractor
	• Supervision reporting any incidents or non-compliance with the EMP to the Project promoter
	• Making recommendation regarding the performance of the EMP
Construction contractor	• Implementation of mitigation measures identified in the EMP
	• Monitoring of the efficiency of the implemented measures as defined in the Monitoring plan
	• Reporting on the environmental mitigation and monitoring issues
	• Keeping records related to the environmental performance of works
	• Ensuring that all environmental mitigation and monitoring requirements are known and implemented by its personnel and sub-contractors
Local authorities, civil society	• Supervision of the environmental mitigation and monitoring actions

9. Reporting

9.1 Construction phase

During construction phase, reporting related to the environmental mitigation and monitoring will be the responsibility of the Contractor.

The following reports:

- ***Inception report.*** **This report will:**
  - **List all requirements (studies, surveys or analyzes) that might be required and that must be fulfilled prior to start of construction.**
  - **Include the location of the auxiliary areas: machinery maintenance area (if necessary), staff and workers facilities, recycling zone, landfills, dumping sites (if necessary) or temporary stockpiles, collecting its official authorization in cases where it is needed.**
  - **Provide brief description (photo report) of the site before the start of works.**
- ***Periodic (monthly) reports.*** **These reports will present progress in implementation of the mitigation measures and monitoring actions implemented during the reference period, as well as measurement data or analyzes that had been carried out and any parts of nonconformity.**
- ***Special reports.*** **They will be made only when exceptional reasons require a specific report.**
- ***Final report.*** **This report will be made at the completion of the works, and will be a summary of all the above, detailing the initial situation, the impacts produced, the measures adopted and the nonconformity parts and its solution.**

These reports must be submitted to Central Planning Division, Ministry of Finance and Economic Planning, who will decide whether to send them to other Agencies.

9.2 Operation phase

The responsibility of reporting during the operation phase should be defined by the Client.

The inception report for the operational phase is the final report of the construction phase, where is detailed the initial situation, the impacts produced during works, the measures adopted and the nonconformity parts and its solution.

During the two first years of the operational phase following Environmental should be prepared:

- ***Annual reports.*** These reports analyze the environmental situation of the works, and the evolution and effectiveness of mitigation measures adopted during the works. These reports will have an annual frequency. The second report can be directly included in the final report.
- ***Special reports.*** If unforeseen impacts are detected during the operational phase, a specific report analyzing their causes and mitigation measures necessary to prevent its occurrence must be made.

- ***Final report.*** This report will be made at the end of the second year after the works completion, and will be a summary of all the monitoring works done during these two years of operational phase. The report may include recommendations for future monitoring or any further improvement action.

10. Implementation schedule and cost estimates

10.1 Introduction

According with Annex C "Environmental Management Plan" of World Bank's Operational Policy 4.01, the content of the Implementation Schedule and Cost Estimates chapter of the EMP is, for all three aspects (mitigation, monitoring, and capacity development):

- Implementation schedule for measures that must be carried out as part of the project
- Capital and recurrent cost estimates and sources of funds for implementing the EMP.

10.2 Implementation schedule

10.2.1 Mitigation measures

Preventive, corrective and compensatory measures contained in the EMP will be implemented in three stages of work:

- Before start of works
- During the works
- Final stage of the works, before completion

The measures implemented in each stage are:

- **Before start of works**
  - Delimitation of working area
  - Location of dumping sites, auxiliary facilities, borrow pits and machinery maintenance area
  - **Top soil removal and storage**
  - **Crops compensation**
- **During the works**
  - Tree protection
  - River diversions and temporary crossings
  - Restrictions to noisy work
  - Date limitations of works
  - Protection of water quality
  - Protection of water quantity
  - Protection of air quality
  - Transport routes and timetable for material and debris
  - Occupational Health and Safety

- Waste management

- **Final stage of the works, before completion**
  - Cleaning of construction area
  - Waste management
  - River section reclamation
  - Vegetation reclamation on slopes (depending on the slope stabilization method)
  - Forest and riparian vegetation restoration
  - Waste cleaning and removal of abandoned vehicles

The following table shows the temporal distribution of the mitigation measures during the works.

Measures	Before works	During works	Final stage
Delimitation of working area			
Location of auxiliary areas			
Top soil removal			
Crops compensation			
Tree protection			
River diversions and temporary crossings			
Restrictions to noisy work			
Date limitations of works			
Protection of water quality			
Protection of water quantity			
Protection of air quality			
Transport routes and timetable			
Removal of obstacles in the river			
Occupational Health and Safety			
Waste management			
Cleaning of construction area			
River section reclamation			
Old road and bridge demolition			
Vegetation reclamation			
Waste cleaning and removal of abandoned vehicles			

10.2.2 Monitoring Plan

As indicated in the chapter “6 Monitoring plan”, the Monitoring Plan is divided into two phases:

- First **phase**, stretching to the construction phase of the works.
- Second phase, extending from the end of the works for a period of time in this case of two years, which coincides with the early years of the **operational** phase.

10.3 Cost estimation of environmental measures

10.3.1 Mitigation measures

The cost of mitigation measures has been estimated based on the conceptual and preliminary design assumptions which include still several uncertainties regarding the final project design, constructive method, access to work sites, location of auxiliary facilities etc.

Therefore, the final EMP budget will have to be revised at the detailed design stage. The estimate below gives however a first picture of the costs related to the environmental measures that should be implemented.

Measures	Estimated cost
Prevention and protection measures	**EC$ 12.200,00**
Delimitation of working area	EC$ 1.800,00
Temporary crossings	Included in work overheads
Restrictions to noisy work	No execution cost
Date limitations of works	No execution cost
Protection of water quality	EC$ 2.000,00
Protection of water quantity	No execution cost
Protection of air quality	EC$ 8.400,00
Location of auxiliary areas	Included in work overheads
Transport routes and timetable	No execution cost
Occupational Health and Safety	Specific chapter of the budget
Remediation a corrective measures	**EC$ 88.000,00**
Waste management	EC$ 56.000,00
Cleaning of construction area	Included in work overheads
River section reclamation	EC$ 12.000,00
Old road and bridge demolition	Specific chapter of the budget
Revegetation*	EC$ 20.000,00
Compensatory measures	**EC$ 7.000,00**
Waste cleaning and removal of abandoned vehicles	EC$ 7.000,00
Crops compensation **	To be estimated at the design stage
Total estimated cost of Mitigation Plan	**EC$ 107.200,00**

*** Revegetation cost will depend on the technique adopted for the slope stabilization. If the slopes surface is not artificially reinforced, revegetalisation will be necessary to ensure slopes stability and prevent from land slides. In this case, revegetalisation costs will be important. If slopes are stabilized using one of the engineering methods, slope revegetalisation will not be necessary and the corresponding cost will be reduced.**

**** Cost of compensation for lost of agriculture land will have to be estimated at the design stage based on the affected surface and the nature of the land.**

10.3.2 Monitoring Plan

In a similar way, the cost of the monitoring plan presented below is indicative. The cost will be revised and adjusted at the detailed design stage.

Phase	Estimated cost
MP during Construction Phase	EC$ 30.000,00
MP during Operational Phase	EC$ 3.500,00
Total estimated cost of Monitoring Plan	**EC$ 33.500,00**

10.3.3 Funding sources

The costs of implementing preventive, corrective and compensatory measures should be included within the overall project budget.

The implementation of environmental monitoring plan must be contracted separately to works, to ensure the independence of the team, and because its duration is longer than works, stretching during the first two years of the operational phase. The bidding and award of the environmental monitoring plan shall be concurrent with that of the bridge project.

Funding for the bridge project and the environmental monitoring plan will come from the same source, both considered essential and dependent actions to achieve the objectives.

Appendices

Appendix Nº1 : Screening checklists

SCREENING CHECKLIST FORM. PART 1			
PROJECT AND SPONSOR INFORMATION			
Name of Project:	Hydrology/Hydraulic Modeling and Geotechnical Site Investigation of Bridges, Fords and Rivers. Fenton Green Hill Road Bridges.		
Project Location:	Fenton to Green Hill road crosses Warrawarrow and North River watersheds. The specific project area, the bridges and culvert box, is located in the upper part of Warrawarrow watershed, crossing the main river, on the slopes of Mt St Andrew, at an elevation between 330 and 350 m (1,082.7 1,148.3 feet).		
			
Name of Applicant:	Central Planning Division Ministry of Finance and Economic Planning	**Telephone:**	(784) 457 1343
E Mail	office.finance@mail.gov.vc		
Address	Ministry of Finance and Economic Planning P.O.Box 608 Kingstown. St. Vincent and the Grenadines		
Brief description of proposed project	Fenton Road is an essential route between Gomea and Green Hill and as a bypass route to Kingstown. It has a vital importance reduce road's vulnerability and increase it resiliency against adverse meteorological phenomenon. The road has three bridges, one box culvert and a few fords, which had been damaged by excessive stream and river heights and flows. The object of the project is the design of the three existing bridges and the box culvert, including the road design of 100 m before and after each of them.		

SCREENING CHECKLIST FORM. PART 1		
SITE INFORMATION		
Total acreage of the site of the proposed action?	< 0,75	acres
Total acreage to be physically disturbed?	< 0,75	acres
Total acreage (project site and any contiguous properties) owned or controlled by the applicant or project sponsor?	< 0,75	acres

LAND USE AND PLANs			
Check all land uses that occur on, adjoining and near the proposed action.			
Urban			
Rural			
Industrial			
Residential			
Commercial			
Forest	30%		
Agriculture	30%		
Parkland			
Other Specify: Scrubland and grassland	40%		
Aspect	**Yes**	**No**	**N/A**
Is the proposed action consistent with adjacent uses? *New bridges to replace existing*	X		
Is the proposed action consistent with the predominant character of the existing built or natural landscape? *Road, with bridges, which require improvement*	X		
Is the proposed project compatible with the National Development Plan and other development plans?	X		
Is the site of the proposed action located in or adjoin an environmentally sensitive or valuable area?	***YES***		
If Yes, specify: *Bridge 3 is close to the proposed Kingstown Forest Reserve and IBA VC007, but out of it. Crossed rivers have some interest, in a forest landscape or crops with forest patches.*			

TRAFFIC MANAGEMENT			
Aspect	**Yes**	**No**	**N/A**
Will the proposed action result in a substantial increase in traffic above present levels? *The road is currently impassable, so it has no traffic. The final aim of the project is to be passable again.*	X		
Are public transportation service(s) available at or near the site of the proposed action? *At the origin and end points of the road, but not along it.*		X	

SCREENING CHECKLIST FORM. PART 1			
UTILITES			
Aspect	**Yes**	**No**	**N/A**
Will the proposed action connect to an existing public water supply?		X	
Will improvements be necessary to allow for connection?		X	
Will the proposed project be able to connect to an existing roadway?	X		
Will improvements be necessary?		X	
Will project require the re-location of existing roadways, drainage and other utilities?	X		
Will the proposed project require connection to the electrical grid after construction?		X	
Will the proposed action connect to an existing wastewater utility?		X	
What method is proposed to handle sanitary wastewater? Please specify *No wastewater is produced with the operation of the project. In the construction phase will seek to employ autonomous chemical toilets for workers.*			
WATER			
Aspect	**Yes**	**No**	**N/A**
Will the proposed project require connection to water mains?		X	
Will the project include any water conservation devices/techniques?	X		
Will the project include any rainwater capturing devices?		X	
AESTHETICS AND CULTURAL RESOURCES			
Aspect	**Yes**	**No**	**N/A**
Is the project site known to contain any scenic vistas or recreation area that are important to the community?	X		
Is the proposed action located in an archaeological sensitive area?		X	
ENVIRONMENTALLY SENSITIVE AREAS			
Aspect	**Yes**	**No**	**N/A**
Does any portion of the site of the proposed action, or lands adjoining contain wetlands or other water bodies?	X		
Would the proposed action physically alter, or encroach into, any existing wetland or water body?	X		
If Yes, identify the wetland or water body and extent of alterations? *Temporary affectation to South River in the Middle Bridge crossing, in an urban section*	<0,05		acres

SCREENING CHECKLIST FORM. PART 1			
VEGETATION			
Identify the typical habitat types that occur on, or are likely to be found on the project site. Check all that apply:			
Shoreline/Beach			
Forest		30%	
Farmland		30 %	
Pasture		35%	
Wetland		5%	
Urban			
Rural			
SENSITIVE OR THREATENED SPECIES			
Aspect	**Yes**	**No**	**N/A**
Does the site of the proposed action or surrounding sites contain any species of animal or plant that are known to be threatened or endangered? *Not in the project area, but in the proposed Kingstown Forest Reserve, close to bridge 3, they are two interesting birds, St Vincent Amazon (Amazona guildingii), vulnerable, and the Whistling Warbler (Catharopeza bishopi), endangered.*		X *see beside*	
STORMWATER/DRAINAGE			
Aspect	**Yes**	**No**	**N/A**
Will the proposed action create storm water discharge, either from point or nonpoint sources * *No changes respect current situation*		X	
Will the storm water discharges flow to adjacent properties? * *To South River*		X	
Will the storm water discharges flow to offsite drainage? * *To South River*		X	
Will storm water flow to onsite conveyance or drainage features/devices?		X	
Does the proposed action include construction or other activities that result in the impoundment of water or other liquids (e.g. retention pond, waste lagoon, dam)?		X	
Please describe: *If a specific machinery maintenance area is necessary (not recommended) , it will have a temporary pollutants retention pond.*			

SCREENING CHECKLIST FORM. PART 1			
NATURAL HAZARDS			
Aspect	**Yes**	**No**	**N/A**
Is the project site located in an area that is prone to flooding?	X		
Is the project site located in an area that is prone to landslides?	X		
Is the project located in an area that can be inundated by storm surge?		X	
In what volcanic hazard zone is the project located?	Zone 4. Low hazard		
Is the project site located in a coastal area that can be impacted by coastal erosion due to sea level rise and/or strong wave action?		X	

I AFFIRM THAT THE INFORMATION PROVIDED ABOVE IS TRUE AND ACCURATE TO THE BEST OF MY KNOWLEDGE

Applicant/sponsor name: Central Planning Division. Ministry of Finance and Economic Planning

Date: September, 2014

Signature: _____

_____

SCREENING CHECKLIST FORM. PART 2			
LAND USE AND PLANS	No to minimal Impact	Moderate Impact	Large Impact
Will the proposed action create a material conflict with an adopted land use plan or surrounding uses?	X		
Will the proposed action result in a change in the use or intensity of use of land?	X		
Will the proposed action impair the character or quality of the existing community?	X		
Will the project conflict with any existing or planned adjacent uses?	X		
TRAFFIC MANAGEMENT	No to minimal Impact	Moderate Impact	Large Impact
Will the proposed action result in an adverse change in the existing level of traffic or affect existing infrastructure?	X *Traffic level*		
UTILITIES	No to minimal Impact	Moderate Impact	Large Impact
Will major works be required to allow the project to connect to utilities?	X		
STORMWATER MANAGEMENT	No to minimal Impact	Moderate Impact	Large Impact
Will the proposed action result in an increase in the potential for erosion, flooding or drainage problems?	X *Flooding problems*		
Will storm water quality and quantity control devices/techniques be incorporated into project?	X		
SUSTAINABILITY	No to minimal Impact	Moderate Impact	Large Impact
Will the project incorporate any green/sustainable building practices/techniques?	X *Mitigation measures*		
Will the project incorporate reasonably available energy conservation or renewable energy opportunities?	X		
Will the project incorporate energy conservation practices?	X		
Will the proposed action have an impact on existing water supplies?	X		
Will the project incorporate reasonably available water conservation fixtures/devices?	X		
Will the project incorporate water conservation practices?		X *Mitigation measures*	

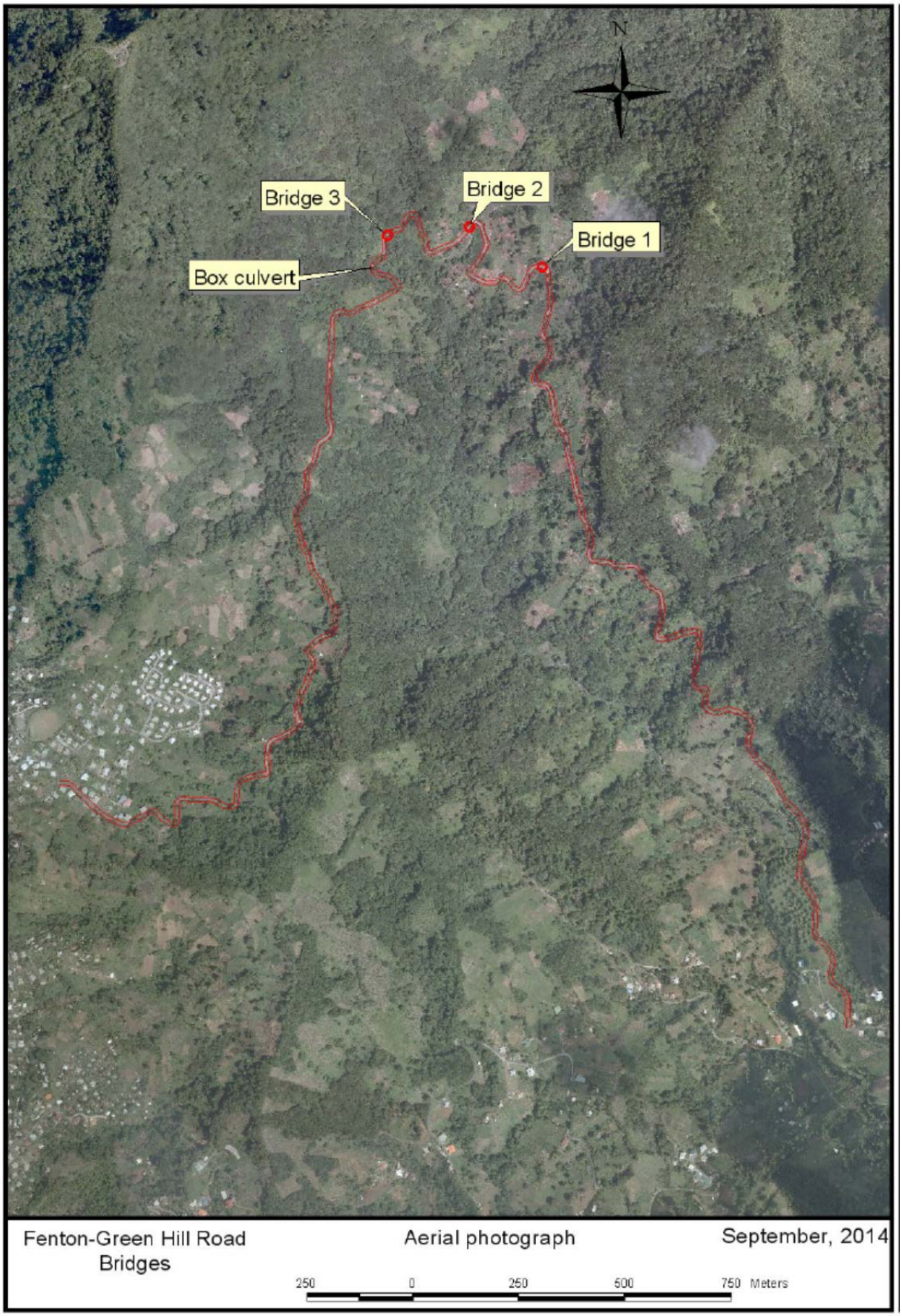
SCREENING CHECKLIST FORM. PART 2			
NATURAL RESOURCES	No to minimal Impact	Moderate Impact	Large Impact
Will the proposed action have an impact on environmentally sensitive areas (steep slopes, rivers, flood plains, unique habitats, etc)?		X *During works*	
Will the proposed action result in an adverse change to natural resources (e.g., forests, wetlands, waterbodies, groundwater, air quality, flora and fauna)?		X *During works and due to*	
Will the project result in a decrease in farmland?	X		
Will the project affect any endangered or threatened plant or animal species (on project or adjacent site)?	X *No expected off*		
AESTHETIC, CULTURAL AND HISTORICAL RESOURCES	No to minimal Impact	Moderate Impact	Large Impact
Will the proposed action impair the character or quality of important historic, archaeological, architectural or aesthetic resources?	X		
Will the project result in the disturbance/removal of significant historical/cultural resources?	X		
PEST MANAGEMENT	No to minimal Impact	Moderate Impact	Large Impact
Will the project result in the increased use of chemicals used for the control/treatment of pests?	X		
Will the project employ the use of Integrated Pest Control?	X		

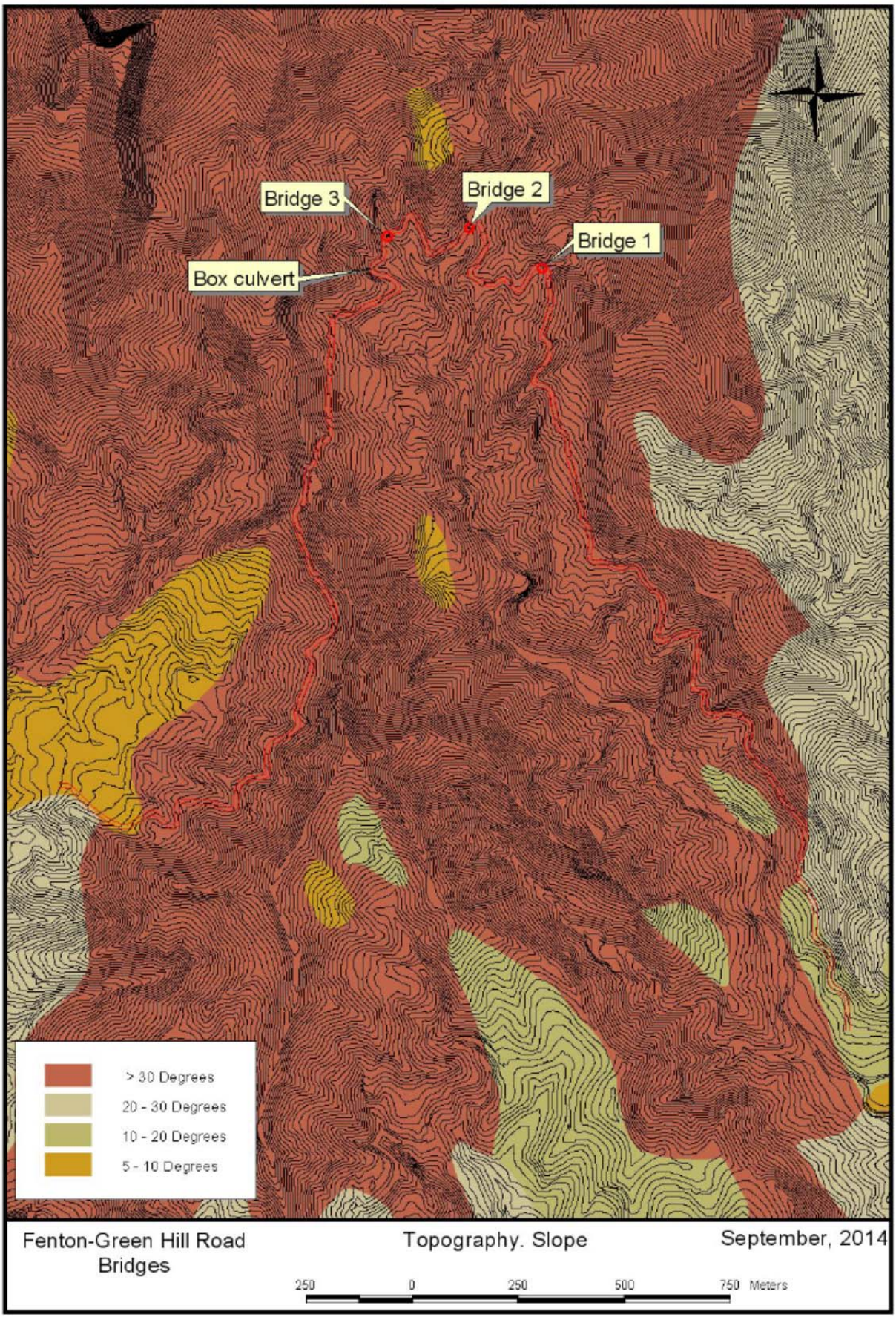
NO IMPACT TO MINIMAL IMPACT
For all selections in this column, little impact is anticipated; some explanation for why the impact is minimal or mitigation to be used will be required.

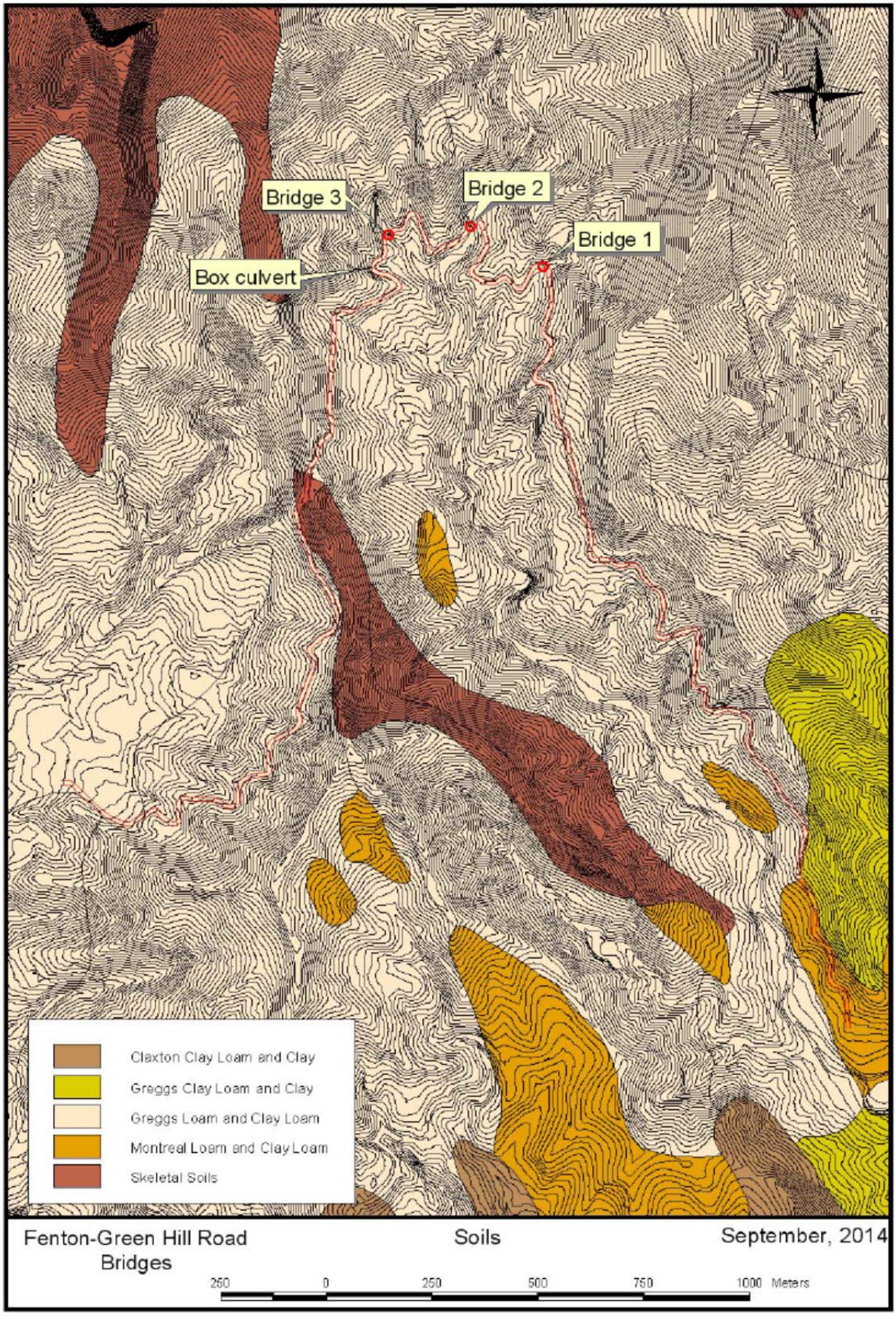
MODERATE IMPACT
For selections in this column, moderate impact is anticipated. Documentation will be required that analyses the impacts expected. Mitigation measures that are planned to be implemented to reduce these impacts will need to be presented.

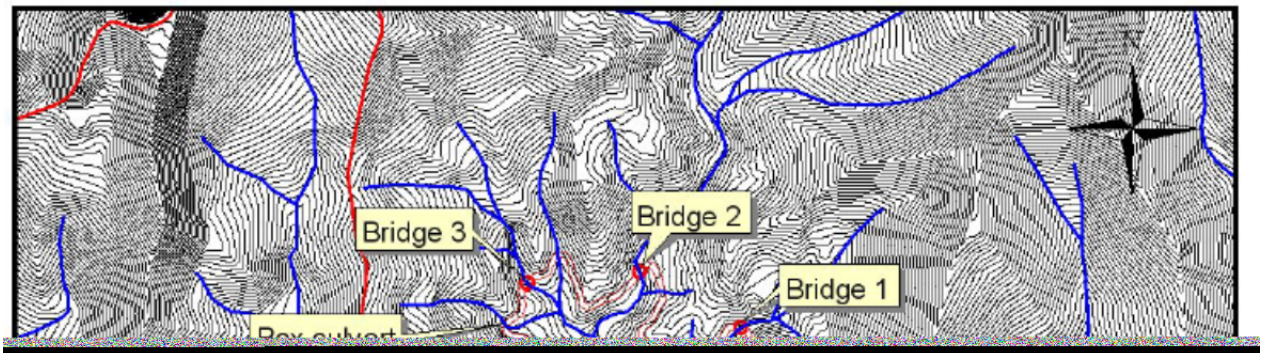
LARGE IMPACT
Large impacts are anticipated by the proposed project.

Appendix Nº2 : Theme Maps

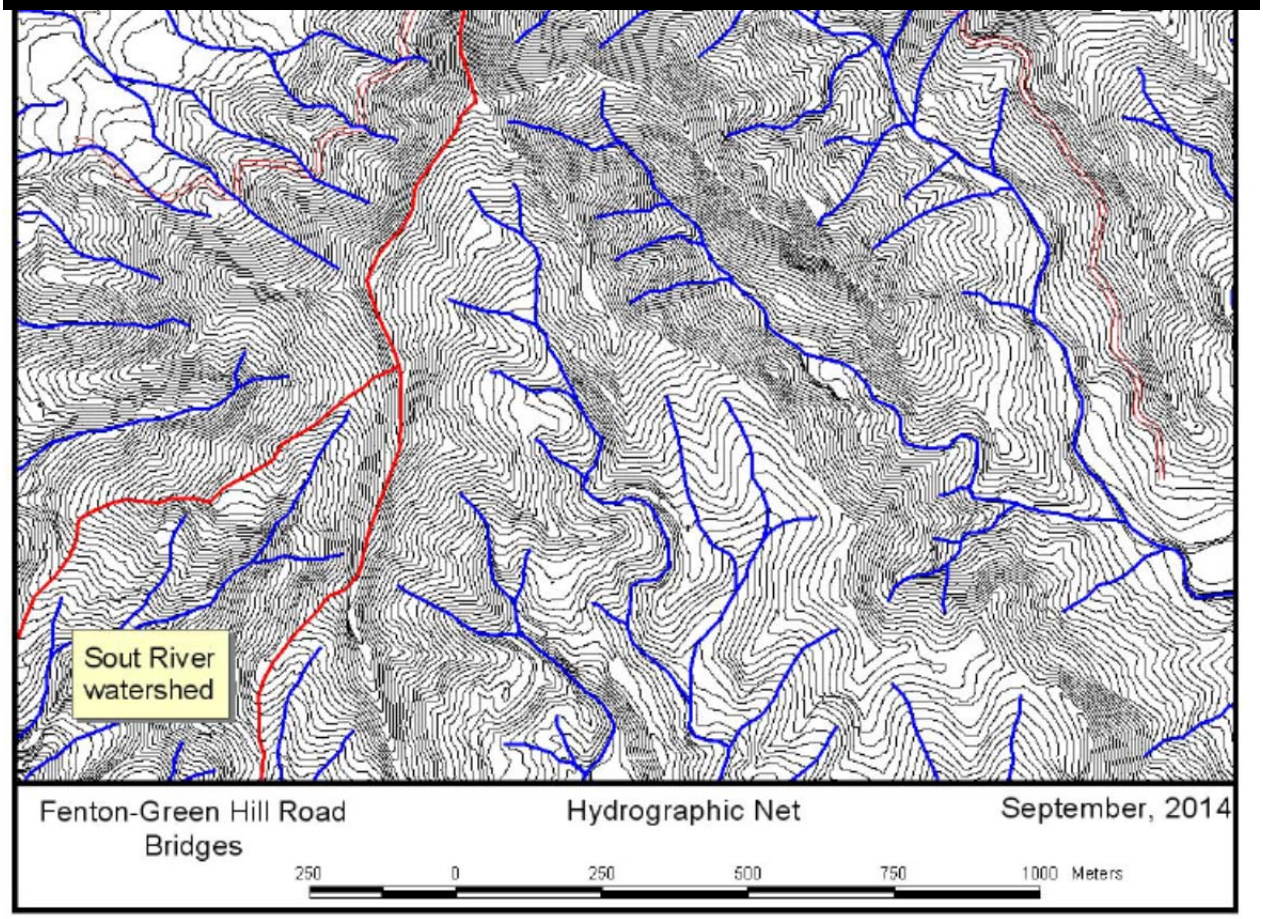

N
Bridge 3
Bridge 2
Bridge 1
Box culvert
Fenton-Green Hill Road Bridges
Aerial photograph
September, 2014
250
0
250
500
750 Meters

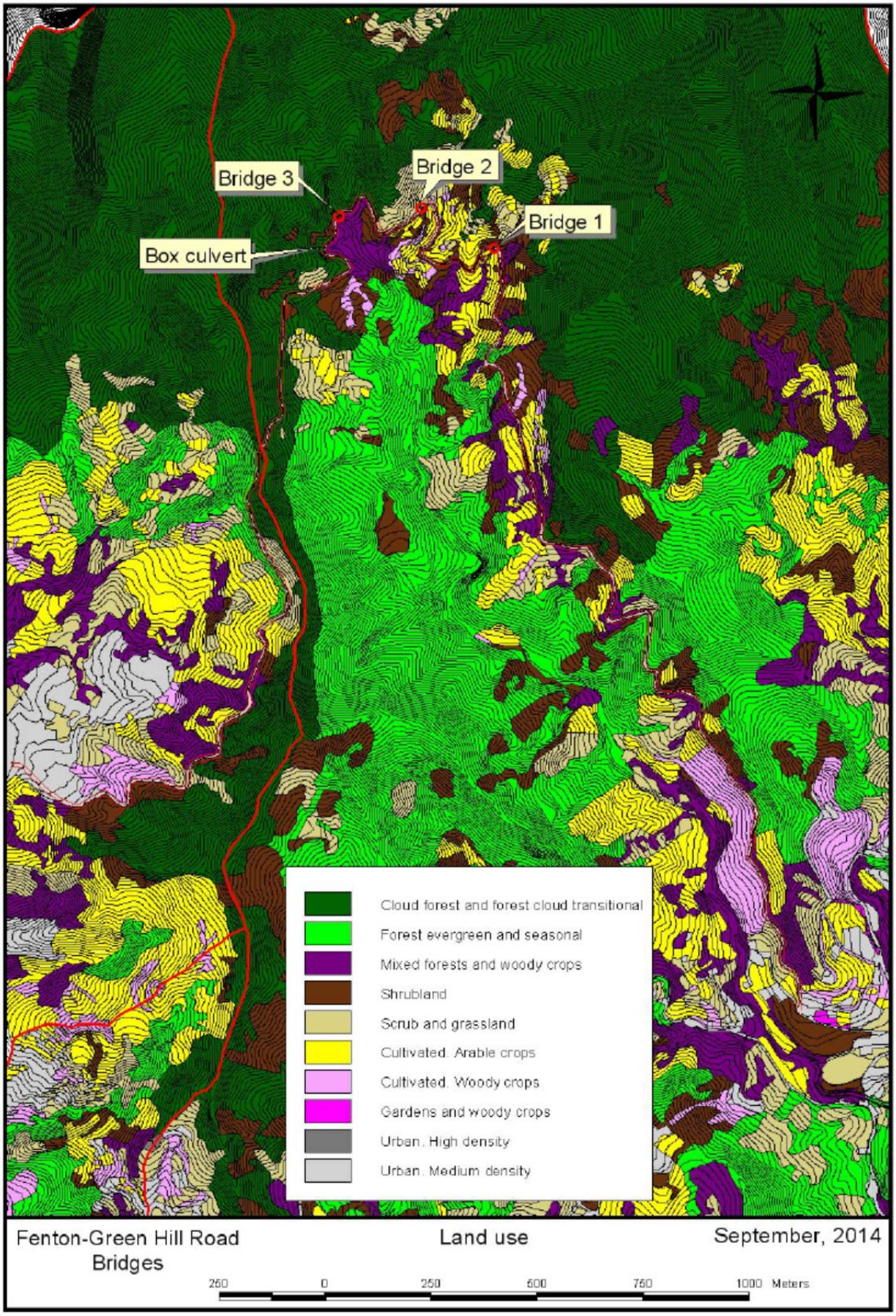

Bridge 3
Bridge 2
Bridge 1
Box culvert
> 30 Degrees
20 - 30 Degrees
10 - 20 Degrees
5 - 10 Degrees
Fenton-Green Hill Road Bridges
Topography. Slope
September, 2014
250
0
250
500
750 Meters


Bridge 3
Bridge 2
Bridge 1
Box culvert
Claxton Clay Loam and Clay
Greggs Clay Loam and Clay
Greggs Loam and Clay Loam
Montreal Loam and Clay Loam
Skeletal Soils
Fenton-Green Hill Road Bridges
Soils
September, 2014
250 0 250 500 750 1000 Meters

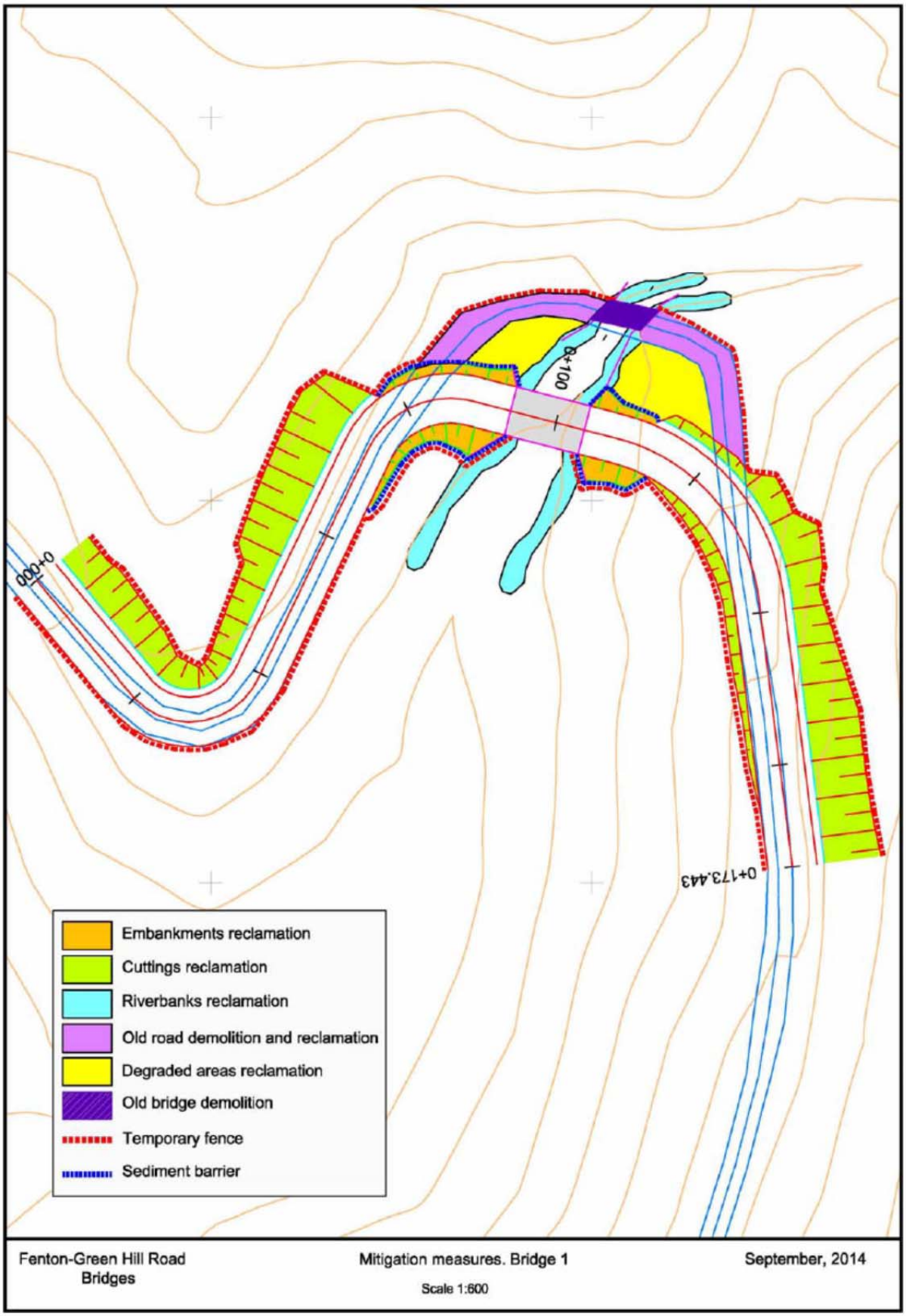

Bridge 3
Bridge 2
Bridge 1

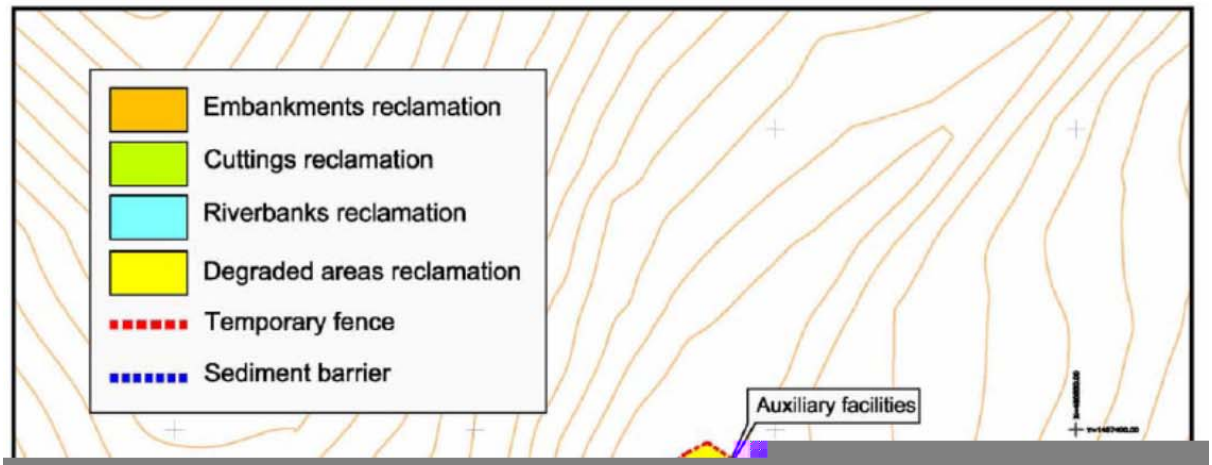
[redacted]

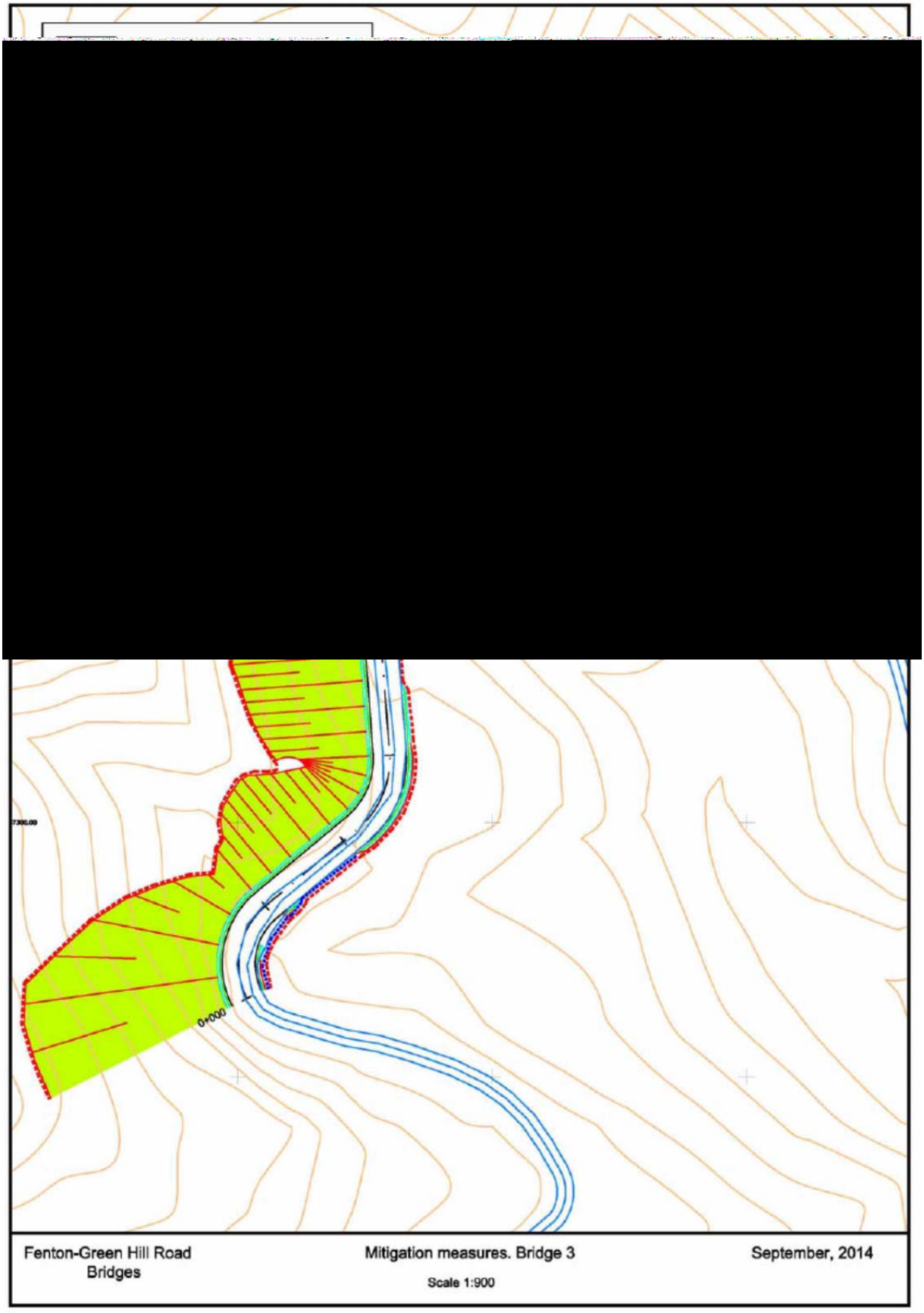

Sout River watershed
Fenton-Green Hill Road Bridges
Hydrographic Net
September, 2014
250 0 250 500 750 1000 Meters


Bridge 3
Bridge 2
Bridge 1
Box culvert
Cloud forest and forest cloud transitional
Forest evergreen and seasonal
Mixed forests and woody crops
Shrubland
Scrub and grassland
Cultivated. Arable crops
Cultivated. Woody crops
Gardens and woody crops
Urban. High density
Urban. Medium density
Fenton-Green Hill Road Bridges
Land use
September, 2014
250 0 250 500 750 1000 Meters

Appendix Nº3 : Mitigation measures map


0+000
0+100
0+173.443
Embankments reclamation
Cuttings reclamation
Riverbanks reclamation
Old road demolition and reclamation
Degraded areas reclamation
Old bridge demolition
Temporary fence
Sediment barrier
Fenton-Green Hill Road Bridges
Mitigation measures. Bridge 1
Scale 1:600
September, 2014


Embankments reclamation
Cuttings reclamation
Riverbanks reclamation
Degraded areas reclamation
Temporary fence
Sediment barrier
Auxiliary facilities


0+000
Fenton-Green Hill Road Bridges
Mitigation measures. Bridge 3
Scale 1:900
September, 2014

Appendix 4 to Environment Management Plan

Measures for Protection of Avian Species

Rehabilitation of the Green Hill to Fenton road is expected to create disturbance to bird species that inhabit and/or utilize the vicinity. It will also affect other wildlife in the area. This disturbance will include cutting and removal of vegetation, damage to feeding trees/plants, human presence, exposure, increased heat from the tarmac, and noise and smoke pollution from machinery. The effects of the disturbance will also continue after the works are completed. There are, however, a number of mitigation measures that can minimize/reduce these impacts during and after rehabilitation works are complete. These include to:

1. Maintain large trees that existed in the area prior to the damage to roads and bridges.

2. Where possible, maintain areas along the road where crowns of trees from both sides of the road overhang and touch each other. These will form private and secure corridors and feeding areas for birds and other wildlife.

3. Conduct site visit(s), using qualified persons, prior to commencement of rehabilitation works to identify and mark key areas and trees/vegetation that should be maintained.

4. Prune, instead of cut, large trees and other overhead vegetation that may become an issue for construction, except where absolutely necessary.

5. Conduct briefing session(s) with works staff, on wildlife to watch out for and/or relocate. Workers should also be instructed to desist from harming or hunting wildlife such as snakes, lizards, and frogs which are protected by law.

6. Prior to and during works, and before clearing leaf litter or vegetation, conduct flushing exercises for fauna to allow them to move away from work sites.