

APPENDIX III

Table A.1 Potential Impacts and Mitigation Measures for Soils and Slopes - Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Clearing of forests & woodlands Blasting & stripping Cutting	Loss of productive soils (topsoil).	Long Term	Where possible, remove topsoil and store it where landowners may collect and spread it over existing adjacent areas or reuse it to restore affected areas. Limit all work activities within the Highway.
Movement of heavy machinery Blasting & stripping	Erosion of surface soils and modification of slope stability Increased risk of landslide and loss of productive soil.	Long Term	Avoid crossing known unstable slopes. If erosion is likely, build ditches to allow eroded soils to be captured and stored. Ensure installation of Gabion retention structures to limit slope stability. If the existing vegetation is removed, plant a new vegetation system of endemic or indigenous species growing species that are of dense and intricate root systems. During the land clearing phase, install a vegetation system in place to help stabilize slopes in steep areas.

Activity	Negative Impacts	Duration	Mitigation Measures
Movement of heavy machinery Clearing of land	Compaction of soils. Modification of surface drainage and of water infiltration. Reduces growth rate of cultivated plants.	Medium Term	Limit all work activities with the Highway. Where soils have low bearing capacity use vehicles with caterpillar bar pressure on soils. At the end of construction steps taken to restore surrounding state using a scarifier or similar.
Cut and fill.	Modifications of topography	Long Term	Avoid or minimise cut and fill to preserve recognised aesthetic value.
Cut and fill.	Increase erosion potential and landslide sensitivity.	Long Term	Minimise the use of dynamite for cutting into the rock strata. Include slope netting or other erosion control. Reforest slopes where possible.
Illegal dumping of material excavated on the hillsides.	Strong natural habitat modification	Long Term	Ensure construction activities are within right-of-way. Prevent side-tipping of spoils.
Opening new vistas or filling small valleys	Perturbation of landscape	Long Term	Plan the landscaping of the project to improve the quality of the view.
Side tipping of spoils and fills.	Compaction of soils. Loose and uncontained soils can wash away Generation of dust	Medium Term	Under no circumstance should excavated material be allowed to spill onto right of way. Financial penalties imposed on contractors for non-compliance. All excavated material must be covered or stored in approved sites.

Cutting & Clearing	Drainage modification Local flooding and long term water accumulation.	Long Term	Ensure surface water flow temporary ditches to redirect flows. Depressions created by movement must be filled.
Use of chemicals Use of paints Use of herbicides/ pesticides Accidental spills Use of combustion equipment	Contamination of soils. Contamination of surface and groundwater.	Medium Term	Use only vehicles that in good condition, and proceed carefully as needed to avoid leakage of fuel. All contaminants must be stored in adequately designed site: spill containment intervention kits. The site must be located outside of known landslide areas. When filling vehicles with fuel, install an absorbent spill kit on the vehicle. Keep a spill intervention kit on site.

Table A.2 Hydrology and Water Resources – Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Deforestation/ removal of soil cover, especially on slopes important to watershed management.	<ul style="list-style-type: none"> Increased soil erosion – sheet wash, gullying and headward erosion. -Increased suspended sediment in streams -Increased flood peaks -Increased incidences of flash flooding. -Ecological effects – sedimentation of riparian and aquatic habitats. 	Short term, but could become long term if slopes are not reforested	<ul style="list-style-type: none"> Avoid activity during wet seas Reforest or encourage soil cover possible after clearing Install check dams, gabions or control measures. Ensure maintenance of riparian
Exposure of bedrock	<ul style="list-style-type: none"> Sediment loading and resulting effects 	Short term	Avoid activity during wet seas
Construction activities – cutting, blasting, earth moving, filling, bridge building.	<ul style="list-style-type: none"> Sediment loading. Vast increases in sediment load to rivers -Increases in water treatment costs -Aggravation of stream bed -Increased scour during floods -Ecological effects – sedimentation of riparian and aquatic habitats 	Short term	<ul style="list-style-type: none"> Avoid activity during wet seas Terracing of slopes Slope stabilization Install check dams, gabions or control measures. Storage of excessive rainfall/runoff Settling ponds/dams to trap sediment Prohibit use of gully/stream/river Establish vegetation to stabilize as buffer to riparian zone.
Gravel mining (source of building material)	<ul style="list-style-type: none"> Multiple impacts in streams - increased bank erosion -channel deepening -increases in suspended sediment 	Short term	<ul style="list-style-type: none"> Identify specific reaches of river to be mined Regulate and monitor mining operations

Excavation of slope	Lowering of local water table deterioration of vegetation loss of agricultural land limestone cavern/sink hole collapse reduced supply to wells; loss of ground water for drinking	Long term	Replacement of existing veget that requires less water. Compensation to farmers affe Direct road runoff to groundw
	Positive Impact can reduce susceptibility to flooding	Duration Long term	

Activity Creation of embankments and structures	Negative Impacts Raising of local water table/creation of perched water table - deterioration of vegetation - increased flood risk	Duration Long term	Mitigation Measures Replacement of existing veget Drainage diversion measures
	Positive Impact increased availability of drinking water	Duration Long term	

Activity	Negative Impacts	Duration	Mitigation Measures
Diversion of drainage-overland	Lowering of local water table and resulting effects. Flow concentration and resulting increase in speed of flow can contribute to flooding, soil erosion, channel modification and siltation.	Long term	Flow velocity reduction measure riprap in channels. Avoid flow cutoff drains and diversion of c Diverted water can be used fo

Activity	Negative Impacts	Duration	Mitigation Measures
Diversion of drainage - to underground	Raising of local water table or creation of perched water table. Can lead to -vegetation changes -overloading of slopes and slope failure -waterlogging of soils or flooding -Increase in ground water gradient where drainage is diverted down a sink hole – may lead to increased solution and eventual subsidence. Groundwater recharge (+ve)	Long term	Replacement of existing veget Careful hydrological and slope Careful drainage routing Careful hydrological investigat Monitoring

Activity	Negative Impacts	Duration	Mitigation Measures
Restriction of drainage through culverts	Risk of flooding and/or damage to road if culverts are too small to handle seasonal and flood flow	Long term	Use empirical data to design c accommodate flood flows Maintenance and clearing of c
Straightening of channels	Increases in efficiency and therefore flow velocity – could result in flooding downstream during high flows and channel modification. Channel steepening and base level lowering, resulting in channel incision upstream which can in turn increase sediment load.	Long term	Flow velocity reduction measu riprap in channels Small check dams or gabions erosion.
Heightening and strengthening of existing levees or building of artificial levees and embankments	Increased efficiency of river, - downstream erosion	Long term	Flow velocity reduction measu riprap in channels
Emplacement of embankments.	Increased stream power if too close together	Long term	Design criteria - Set bank emt channel migration and to acco

Table A.3 Hydrology and Water Resources – Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Impoundment of flood waters by road	Inundation of areas upstream of road	Long term	Design placement of structures based on c: study and use of empirical data. Design culverts under road to handle storm
Road may act as channel during high flows Drainage ditches may act as flood channels or chutes	Scouring of road surface Erosion/undermining of road bed	Long term	Design placement of structures based on c: study and use of empirical data Provision for diversion of stormwater runoff.
Flow of polluted runoff into sink holes Flow of polluted runoff into streams	Pollution of aquifers and ground water supply. Pollution of domestic water supply.	Long term Long term	Use of infiltration ditches Use of settling basins/ponds to remove pollutant runoff is allowed to percolate into aquifer. Oxidizing macrophytes can be used to help Use of settling basins/ponds to remove pollutant runoff is drained into adjacent streams. Leave a buffer zone of undisturbed riparian banks

Table A.4 Sources, Health and Environmental Effects of Air Pollutants

Pollutant	Source(s)	Health Effects	Environmental Effects
Ozone (ground level ozone is the principal component of smog)	Chemical reaction of pollutants; VOCs and NOx	Breathing problems, reduced lung function, asthma, irritates eyes, stuffy nose, reduced resistance to colds and other infections, may speed up aging of lung tissue	Ozone can damage smog can cause Property damage - damage etc.
VOCs (smog formers)	They are released from burning fuel (gasoline, oil, wood, coal, natural gas, etc.), solvents, paints, glues and other products used at home and work. Cars are an important source of VOCs. VOCs include chemicals such as Benzene, Toluene, Methylene Chlorides and Methyl Chloroform.	In addition to ozone (smog) effects, many VOCs can cause serious health problems such as cancer and other effects.	Ozone smog effects, soil Formaldehyde and Ethy
Nitrogen Dioxide (One of the NOx; smog forming chemical)	Burning of gasoline, natural gas, coal, oil etc. Cars are an important source of NO ₂ .	Lung damage, illnesses of breathing passages and lungs (respiratory system).	Nitrogen Dioxide is an irritant (acid aerosols), which can damage lakes. Acid aerosols can cause Property damage – acid rain used on buildings, monuments, etc.

Pollutant	Source(s)	Health Effects	Environmental Effects
Carbon Monoxide	Burning of gasoline, natural gas, coal, oil etc.	Reduces ability of blood to bring Oxygen to body cells and tissues; cells and tissues need Oxygen to work. Carbon Monoxide may be particularly hazardous to people who have heart or circulatory (blood vessel) problems and people who have damaged lungs or breathing passages.	
Particulate Matter (PM 10; dust, smoke, soot)	Burning of wood, diesel and other fuels; industrial plants, agriculture (plowing, burning of fields), unpaved roads.	Nose and throat irritation, lung damage, Bronchitis, early death.	Particulates are the main cause of reduced visibility. Property damage – ash and dusts can dirty and discolor other property, including buildings.
Sulphur Dioxide	Burning of coal and oil, especially high-sulphur coal from the Eastern United States; industrial processes (paper, metals)	Breathing problems, may cause permanent damage to lungs.	SO ₂ is an ingredient in acid rain (acid aerosols), which can damage property. Property damage – acid rain can eat away stone used on buildings and monuments, etc.
Lead	Leaded gasoline (phased out in Jamaica), paint (houses, cars), smelters (metal refineries); manufacture of lead storage batteries.	Brain and other nervous system damage; children are at special risk. Some lead-containing chemicals cause cancer in animals. Lead causes digestive and other health problems.	Lead can harm wildlife.

Source: Adapted from EPA- Office of Air Quality Planning and Standards

Table A.5 Air Quality – Site Preparation/ Construction Phase

Activities	Negative Impacts	Duration	Mitigation Measures
Movement of construction equipment	Tail pipe and evaporative emissions include CO, NO _x , particulate matter, CO ₂ , Pb, CH ₄ , N ₂ O, Benzene etc. These emissions have the potential to cause chronic respiratory illness, cancer, headaches and premature deaths.	Short Term	Haulage vehicles should be in proper working condition and should be made to pass emissions tests. Use vehicles with low emissions. Also ensure all engines are properly tuned.
Site clearance	Particulates (PM 10) - Has the potential to cause chronic respiratory illness, asthma attacks and premature deaths.	Medium term	Taking into account wind direction & speed, limit the area near the site. Access roads should be consolidated by materials. Wetting of roads approximately every 2 hours. In addition public information and community consultation should be employed.

Activities	Negative Impacts	Duration	Mitigation Measures
Transportation of construction materials and waste	Transportation load losses	Medium term	Vehicles should be properly loaded and
Transportation of construction materials and waste	HAZMAT accidents & spills	Medium term	Emergency response plans should be in
Maintenance of construction equipment	Improper disposal of vehicular used parts and fluids such as tyres, batteries, oils, etc.	Medium term	Provide proper disposal sites and mech:
Blasting	Generation of particulates leading to respiratory problems and reduced visibility. In addition it may impair plant metabolism.	Medium term	Put heavy mats over the area that is beir prevent large chunks of debris from becc addition public relations and community be employed. Taking into account prevailing wind direc type, clearing only the area necessary & In addition public relations and communi should be employed.

Activities	Negative Impacts	Duration	Mitigation Measures
Ground excavation	Generation of particulates leading to respiratory problems and reduced visibility. In addition it may impair plant metabolism.	Medium term	Taking into account prevailing wind direction clearing only the area necessary & population addition public relations and community cooperation employed. Access roads can be wetted or of binding materials. Wetting should be done every three (3) hours.
Cut & Fill	Generation of particulates leading to respiratory problems and reduced visibility. In addition it may impair plant metabolism.	Medium term	Taking into account prevailing wind direction clearing only the area necessary & population addition public relations and community cooperation employed. Access roads can be wetted or of binding materials. Wetting should be done every three (3) hours.

Table A.6 Air Quality – Operation/Maintenance Phase

Activities	Negative Impacts	Duration	Mitigation Measures
Routine vehicular traffic	Tail pipe and evaporative emissions include CO, NOx, particulate matter, CO2, Pb, CH4, N2O, Benzene etc. These emissions have the potential to cause chronic respiratory illness, cancer, headaches and premature deaths.	Long term	Require vehicular emissions testing, enforcement. Roads should remain paved. gradients and sharp turns be at a minimum. Ensure that vehicles are properly tuned. should be between 80 - 100 km/hr.
Routine vehicular traffic	Particulates (PM 10) - Has the potential to cause chronic respiratory illness, asthma attacks and premature deaths.	Long term	Require vehicular emissions testing, legis: enforcement. Require that steep gradients at a minimum. (Design criteria)
Routine vehicular traffic	Fugitive Dust	Long term	Require that the road remains paved. In ad maybe planted along the verges so as to ac
Routine vehicular traffic	Emissions of refrigerant agents from vehicle air conditioners CFCs and HFCs are potential greenhouse gases.	Long term	Require vehicular a/c testing to minimize le: and enforcement.
Movement of industrial vehicles	Transportation load losses (eg. Bauxite and quarry vehicles).	Long term	Requires vehicles to be properly loaded anc Legislation and enforcement.
Movement of industrial vehicles	HAZMAT accidents & spills (eg. Oil trucks).	Long term	Legislation & emergency response plans.
Movement of routine vehicular traffic	Improper disposal of vehicular used parts and fluids such as tyres, batteries, oil, etc.	Long term	Provide proper disposal sites and mechanis there is need for public education and awar

Maintaining landscape	Herbicides/pesticides	Long term	Ensure proper usage
Maintenance of bridges and structures	Lead based paints for bridges	Long term	Use lead free paints. Zinc based paints ma
Maintenance of road surface	Increase in particulate and HAZMAT	Medium term	Require that the road surface remain paved

Table A.7 Noise – Site Preparation/Construction Phase

Activities	Negative Impacts	Duration	Mitigation Measures
Land clearing	Generation of noise above nuisance levels for long periods	Short term	Where activities occur outside of normal w relations and community consultations shc
Blasting	Increase noise levels	Short term	Where activities occur outside of normal w relations and community consultations shc
Ground excavation	Generation of noise above nuisance levels for long periods	Short term	Where activities occur outside of normal w relations and community consultations shc
Cut & Fill	Generation of noise above nuisance levels for long periods	Short term	Where activities occur outside of normal w relations and community consultations shc
Movement of construction machinery	Improper driver behavior	Short term	Supervision, education and sensitizing

Table A.8: Noise – Operation/Maintenance Phase

Activities	Negative Impacts	Duration	Mitigation Measures
Blasting	Generation of noise above nuisance levels for long periods	Long term	Where activities occur outside of n public relations and community cor employed.
Maintenance of road surface	Increased noise levels due to road surface	Long term	Use open graded asphalt, bituminc avoidance of surface dressings & ç maintained surfaces without cracks
Movement of routine vehicular traffic	Vehicular noise, increased vehicular speed increases noise levels, improper driver behaviour and disruption of community activities	Long term	Legislation, education and enforcer grade and sharp corners, installatic and maximize distance (where pos settlements. Vegetation may also highway verges to act as noise bar
Operating and movement of maintenance equipment	Increase in noise levels	Long term	Where activities occur outside of n public relations and community cor employed.

Table A.9 Flora - Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measure
Clearing of forests, woodlands, cultivated areas Cut & fill	Loss of habitat	Long Term	Where rare, threatened, endang species are affected, limit constr within the Right-of-Way. Prevent side-tipping of spoils on Prevent illegal dumping of solid Select proper storage sites of c
Clearing of forests, woodland etc	Fragmentation of habitat from splitting habitat during	Long Term	Ensure that portions of habitat re Land compensation to replace l Reduce construction impacts su and fill onto vegetated areas.
Movement of heavy equipment Clearing of forests & woodlands Cut & Fill	Loss of specimens (individual trees plants)	Long Term	Construction activities should be the right-of-way in order to reduc specimens lost. Establish a Tree Preservation O specimens, including large, old t
Movement of heavy equipment Clearing of forests & woodlands Cut & Fill	Loss of species (For plants of limited range loss of specimen could also mean loss of the species)	Long Term	Identify rare or endemic species preservation. Harvest rare or endemic species other sites or for arboreta. Select proper storage sites for c Prevent side-tipping of spoils on!
Landscaping Increase in human activity due to construction workers on site	Introduction of exotic invasive species Increase risk of fires	Long Term Medium Term	Use endemic or indigenous spe Secure relevant permits for intrc Construct adequate barriers. Restrict construction activities to Way Levy penalties and fines fo mitigation measures

Clearing of forests Preparation of right-of-way	Increased access to areas for orchid poachers.	Short Term	Construct adequate barriers to p habitats from the highway.
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Table A.10: Flora – Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Use of highway Maintenance of toll booths Maintenance of structures Use of highway	Increased access to areas for orchid poachers. Increase risk of fires due to increase in human activity	Long Term Long Term	Construct adequate barriers to pre habitats from the highway. Construct adequate barriers. Restrict construction activities to v Levy penalties and fines for breac

Table A.11: Positive Impacts – Flora

Potential Positive Impacts

It is anticipated that there will be some positive impacts. These include:

- Information gathering based on required research for 'red flag' areas.
- Build scientific data base for conservation and environmental management.
- Increase knowledge of biodiversity through interpretive signs.
- Preservation of specimens.

Table A.12 Fauna – Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Clearing of forests, woodland and cultivated areas	Loss of habitat	Long term	Limit construction activities to wif Prevent side-tipping of spoils onto Prevent illegal dumping of solid w.
Clearing of forests, woodland and cultivated areas	Fragmentation of habitat (birds, reptiles, amphibians, butterflies, mammals)	Long term	Ensure that portions of habitat ren through land compensation to rep
Clearing of forests, woodland, and cultivated areas and movement of heavy equipment	Loss of specimens (reptiles, amphibians) invertebrates	Long term	Limit construction activities to wif Prevent side-tipping of spoils onto Prevent illegal dumping of solid w.
Blasting			
Preparation of right of way	Obstruction of wildlife routes (coney, birds)	Medium Term	Maintain wildlife corridors. Design Criteria
Clearing of forests, woodland, and cultivated areas and movement of heavy equipment	Disruption of feeding, breeding and roosting areas (bats, birds, butterflies)	Short Term	Construction activities should be c main breeding seasons. Identify and avoid main breeding/r Identify, flag and maintain main fe
Blasting			
Stripping			
Preparation of right of way	Increased access to areas for wildlife poachers.	Medium Term	Construct adequate barriers to lim habitats from the highway.
Activity	Negative Impacts	Duration	Mitigation Measures

Land fill Construction of bridges for river crossing Exposure of top soil through land clearing	Aquatic habitat damage	Long Term	Ensure proper storage of construc prevent downstream siltation. Minimise rechanneling of waterwa Where rechanneling is essential t obstacles such as boulders Sedimentation traps.
Clearing of forests, woodland, and cultivated Cut & fill Blasting Stripping	Interruption of biogeochemical cycles	Medium Term	Minimise removal of biomass. Minimise relocation of topsoil. Prevent alteration of flows of surfa
Blasting Cut & fill Laying road surface	Interruption of life cycle through loss of juveniles (caterpillars)	Medium Term	Applications of water on exposed materials to reduce dust levels.
Blasting Stripping Drilling	Increase in noise levels and vibration	Short Term	Adhere to consideration schedule

Table A.13 Fauna - Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Maintain toll booths Maintenance of structures Use of highway Routine maintenance activities	Increased access for poachers (parrots)	Long Term	Construct adequate barriers to prevent access from the highway
24 hour traffic	Increase in noise levels	Long Term	Construct adequate sound barriers to mitigate
Routine traffic	Road Kills	Long Term	Design criteria, Establish animal crossings underneath road, Construct adequate barriers/fences to prevent

Table A.14 Positive Impacts – Flora

Potential Positive Impacts

It is anticipated that there will be some positive impacts. These include:

- Information gathering based on required research for 'red flag' areas.
- Build scientific data base for conservation and environmental management.
- Increase knowledge of biodiversity through interpretive signs.
- Preservation of specimens.

Table A.13 Parks and Protected Areas – Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Clearing forest and woodlands	Increase unauthorized access to protected areas	Medium Term	No interchanges that wi access to parks and prc Ensure adequate bounc Enforcement of regulati
Clearing forests, woodlands Land fill	Loss of ecologically sensitive areas	Long Term	Provide options for lanc Rehabilitation of adjace Design criteria
Clearing forests & woodlands Demolition of woodlands	Loss of acreage	Long Term	Compensation by exten maintain acreage.
Construction camp activities Clearing forests and woodland	Increased risk of fire	Medium Term	Limit construction activi right-of-way Construct adequate bar encroachment

Table A.14 Parks and Protected Areas – Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Routine use of highway Maintenance of toll booths Maintenance of structures	Increased unauthorised access to protected areas	Long Term	No interchanges that will allow unauthorised access to parks and protected areas. Ensure adequate boundaries to limit access. Enforcement of regulations
Increased access to parks & protected areas	Exceed carrying capacity of park	Long Term	Conduct carrying capacity studies. Enforce user limits.
Routine maintenance activity	Obstruction of proper park management strategies	Long Term	Proper storage of construction material outside protected area boundary. Removal of solid waste and sewage from site preparation and construction outside the protected area. Limit construction activities to within the park or protected area. Establishment and enforcement of rules. Penalties for breaches in mitigation

Table A.15 Positive Impacts – Parks and Protected Areas

<p>Potential Positive Impacts</p> <p>Some positive impacts are anticipated from the presence of the highway during the operation/maintenance phase. These include:</p> <p>Provision of adequate routes and access to parks and protected areas.</p> <p>Increase in public awareness of parks and protected areas through interpretive signs.</p> <p>Information gathering where required increasing the scientific database.</p>
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Activities	Negative Impacts	Duration	Mitigation Measures
Clearing during construction phase	Loss of primary forest and individual specimens	Short term activity with long term effect	Clear minimum required; reforest native species;
	Loss of secondary forest	Short term activity with long term effect	Identify areas where forest: species can take place; plant before clearing if possible
	Loss of forest resource and unknown species	Short term activity with long term effect	Conduct inventory and reforest
	Loss of forest related economic activity, such as logging and harvesting of minor forest products	Short term	Harvest timber before clearing; Reforest existing degraded resource
	Deforestation and related secondary impacts (watershed degradation) such as changes in: Groundwater, springs, wells Streamflow quantity Timing and distribution of streamflow On-site erosion Sediment in streams Nutrient outflow in stream water	Short term if slopes are reforested	During construction phase: place to reduce sediments Construct check dam structures in gullies. Introduce reforestation as soon as possible after construction
	Destabilization of slopes, causing or aggravating existing slope instability	Short term of slopes are reforested	Reforest slopes as soon as possible after construction.

	Increased gully and stream bank erosion	Short term if slopes are reforested	Establish undisturbed ripar
Compaction by heavy machinery	Disturbance to soil; Compaction of soil; affects natural regeneration of forest	Long term	Tilling of soil to reverse cor

Activities	Negative Impacts	Duration	Mitigation Measures
Dust creation	Pollutant – stress to trees along corridor from excessive dust	Short term	Wetting of soil and trees dust
Creation of open spaces in otherwise closed forest for actual corridor or for access roads	Fragmentation Decreases actual forest size Alienation of forest Reduces interaction with other communities Produces decline in number of species and abundance Loss of native species due to invasion/replacement by light or stress tolerant species Opening up of forest canopy can lead to changes in soil development.	Long term	Design criteria Minimise number of cross forested area Avoid creating small non forest Reduce access to the forest by installation of barrier.

Table A.17 Forestry Resources - Operation/Maintenance Phase

Activity	Negative Impact	Duration	Mitigation Measures
Fragmentation Creation of open spaces in otherwise closed forest for actual corridor or for access roads	Increases access; opening up of corridors to loggers, yam stick/charcoal traders and farmers	Long term	Creation of physical barriers along Increase number of forest rangers/ Create stiffer fines for encroachmer
Fragmentation Creation of open spaces in otherwise closed forest for actual corridor or for access roads	Remaining forest land may come under pressure for "development", especially if economic value of land increases with presence of highway	Long term	Strict monitoring and enforcement c
	Fragment of forest more difficult to protect than large tract; yields easily to developmental pressure	Long term	Increase budgets allocated to enforcement of existing legislation. Increase number of forest rangers/v
	The forest becomes more accessible to poachers.	Long term	Increase number of forest rangers/v Create stiffer fines for encroachmer

Activities	Negative Impacts	Duration	Mitigation Measures
Air pollution from vehicle exhaust	Gaseous and particulate pollutants from vehicular traffic. Gaseous emissions can be toxic to trees; particulates can smother leaves.	Long term	Monitor emissions from vehicles. E vehicles entering highway. Creation of buffer zone of vegetation primary forest
Polluted runoff	Contamination of soil; stress on trees along corridor	Long term	Ditches and drains along pollutants away from forest Creation of buffer zone between road
Hazardous spills	Pollution of forest environment	Long term	Design ditches bordering highway Rapid emergency response
Relocation of residents displaced by highway	Relocated persons may make new clearings in forest for small farms	Long term	Strict enforcement of legislation and Increased monitoring of clearing/buffer
Presence of Highway; all activities	Waldsterben or Waldschaden – Forest death or forest decline. The response of the forest to cumulative effect of many different stresses.	Long term	

Table A.18 Landscape Aesthetics and Scenic Vistas - Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Me
Blasting & stripping Movement of heavy machinery Clearing forests, woodlands and cultivated areas.	Interruption of views	Long Term	Reduce Right minimum req Landscape ve compatible to Views can be or reinforced design. Speed must t Construction interpretive si views. Design criteri
Blasting & stripping Movement of heavy machinery Clearing forests, woodlands and cultivated areas.	Physical scarring of landscape		Minimise dan appeal by cor design. Ensure prope of road and a Re-forest anc areas adjace Design criteri

Activity	Negative Impacts	Duration	Mitigation Me
Movement of heavy machinery Establishment of bridges and crossings	Interruption of physical and visual continuity	Long Term	Bridges, viaducts should be used on steep high cut embankments to maintain continuity. Design criteria
Clearing of forests & woodland	Destruction of vegetation	Long Term	Reforestation of lost acreage. Rehabilitation
Clearing of forests & woodland	Fragmentation of cultural areas	Long Term	Re-establishment of cultural areas. Design criteria

Table A.19 Landscape Attributes and Scenic Vista - Operation/Maintenance Phase

Activity Establishment of right of way	Negative Impacts Crossing or cutting off views of architectural or cultural heritage	Duration Long Term	Mitigation Mea: Ensure proper : of highway to fa Indicate upcom views with inter Construct Lay-f appreciation of
Establishment of right of way	Visual scarring of landscape	Long Term	Prevent 'uglifica Harmonise des surrounding lar Regulate billbo: Penalties and e littering.
Establishment of right of way	Interruption of topographical orientation	Long Term	Slopes can be v natural topogra
Lighting at night Illuminated billboards	Light Pollution	Long Term	Harmonise ligh Select and plac
Routine traffic Operation of toll booths Routine maintenance procedures	Littering	Long Term	glare and nega Establish solid systems. Penalties and e litter laws.

Table A.20 Positive Impacts - Landscape Attributes and Scenic Vistas

Potential Positive Impacts

Increased public access to and appreciation of vistas.

Increased public awareness through interpretive signs and displays.

Table A.21 Natural Hazards – Site Preparation/Construction Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Cutting	Undermining of slopes and resulting slope failure from cutting Spoil heaps could fail and become landslide hazards Changes in local groundwater levels could induce subsidence of sink holes and caverns	Long term	Slope stability measures put in place Spoil heaps carefully located, stored
Blasting	Seismic effects – slope failure, collapse of caverns or sink holes	Short term	Dampening of blasting where possible
Filling	Overloading of slopes and resulting slope failure from filling Overloading of dolines and resulting collapse or subsidence. Can impact on many different types of land use.	Long term	Geotechnical investigation of slope measures Careful geophysical exploration at sinkholes and other potential subsidence and grouting of sinkholes and caverns
Overloading, undercutting and/or steepening of slopes	Changes in type, speed of failure, e.g. slow creep to progressive creep	Long term	Geophysical investigation and slope place
Construction of bridges	Interference with permeability/mobility of banks – erosion and sedimentation during floods.	Long term	Careful hydrological investigations accommodate floods and mobility

Table A.22 Natural Hazards – Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures
Impoundment of floodwaters upstream of highway	Inundation upstream	Long term	Adequate drainage under the road are large enough to accommodate
Routing/channelisation /concentration of runoff	Flooding, gullyng, debris flows in areas not normally flood prone. Drainage of runoff into sinks (whether intentional or not) can accelerate solution processes and induce subsidence	Long term	Careful drainage design Monitoring of drainage during operation Monitoring of sink holes
Floods and flash floods	Inundation, scouring of road surface, structural damage to road, bridges and other structures.	Long term	Design criteria Heightening and strengthening of Construction of artificial levees Canalization/straightening of stream Drainage diversion Channel regulation Bank revetment Dams across gullies Maintenance of flood control structures

Activity	Negative Impact	Duration	Mitigation
Debris flows	Slope failures and landslides can cover road and cause temporary effects only, Can damage surface and/or undermine entire road structure	Long term	Rapid response to clear debris and reop Adequate drainage to quickly remove w Partial slope removal, slope reduction, t benching, depending on type of potentia Construction of retaining walls, gabions.
Rock Fall	Bridge undermining/collapse Can be hazardous to drivers	Long term	Design criteria to allow debris flows to p Install rock traps at base of slope, Use mesh nets

<p>Activity</p> <p>Natural subsidence due to solution or cavern collapse of existing dolines or sink holes induced by lowering of local ground water levels</p> <p>Cavern or sink hole collapse due to overloading of surface by fill.</p>	<p>Negative Impacts</p> <p>Subsidence of road bed</p> <p>Tilting, cracking of surface</p> <p>Creation of collapse feature in road bed</p> <p>Structural failure of road</p>	<p>Duration</p> <p>Long term</p>	<p>Mitigation Measures</p> <p>Geophysical exploration of karst terrain runs.</p> <p>Compilation of sinkhole density maps</p> <p>Drilling to locate caverns</p> <p>Study of location and hydrology of all en (dolines, sinkholes) and caves.</p> <p>Avoid other land uses that may cause lc other hydrological changes.</p> <p>Grouting /Infilling of caverns and sink hc</p>
<p>Earthquake</p>	<p>Resulting small surface cracks to major structural damage.</p>	<p>Long term</p>	<p>Design criteria</p> <p>Maintenance of structures</p>
<p>Storm surge</p>	<p>Possible scour of bridge supports</p>	<p>Long term</p>	<p>Design criteria</p>

Table A.23 Positive Impacts – Natural Hazards

<p>Potential Positive Impacts Reduced flood effects from drainage modification. Use of diverted run-off for irrigation. Installation of preventative slope-failure mechanisms.</p>

Table A.24 Health and Safety – Site Preparation/Construction Phase

Activity	Negative Impacts	Timeframe	Mitigation Measures	Comment: NEED TO FIND A BETTER TITLE
Cutting	Improper road geometry	Long Term	Refer to road design criteria	
Cutting	Increase in levels of particulates	Short Term	Use masks and other respiratory equipment	
	Hazardous materials (HAZMAT) accidents	Medium Term	Establish and enforce safety procedures and all plans	
Landscaping	Herbicides/pesticides	Long Term	Proper usage, education & storage	
Drilling	Noise levels	Medium Term	Where activities occur outside of normal working hours and community consultations should be employed. In addition ear plugs and ear muffs should be used for extended periods.	
Blasting				
Transportation	Accidents	Medium Term	Use flagmen, safety signs, lights, reflectors and safety procedures example the wearing of hard hats	
Blasting	Digestive tract illnesses and reduction in hygiene standards		Adequate and clean storage facilities and water washing, proper utensils. Ensure application of proper hygiene standards.	
Drilling				
Cleaning				
Construction Companies	Improper disposal of sewage, solid waste and reduction in hygiene standards	Medium Term	Supply portable toilets and adequate water supply for washing.	

Table A.24 Health and Safety – Operation/Maintenance Phase

Activity	Negative Impacts	Duration	Mitigation Measures	Comment: NEED TO FIND A BETTER TITLE
Traffic use	Accidents caused by slippery or faulty road surface	Long Term	Use materials that reduce accidents, for example, asphalt (porous).	
Traffic use	Improper road geometry	Long Term	Design criteria. Avoid steep grades and sharp corner	
Traffic use	Use of improper vehicles (old vehicles with harmful emissions, faulty vehicles, vehicles driving below the recommended speed limit)	Long Term	Legislation, education and enforcement	
Traffic use	Increased traffic speed	Medium Term	Legislation, education and enforcement	
Traffic use	Increased level of particulates	Long Term	Legislation, emissions testing and enforcement	
Traffic use	Increase in levels of tail pipe and evaporative emissions	Long Term	Legislation, emissions testing and enforcement	
Transportation	Hazardous materials (HAZMAT) accidents	Long Term	Legislation and emergency response plans. Establish procedures for transportation of HAZMAT.	
Landscaping	Use of herbicides/pesticides in landscaping	Long Term	Proper storage and usage of materials and education existing legislation	
Painting of Structures	Increase in levels of toxic materials for use of lead based paints for bridges	Long Term	Use lead free paint e.g. Zinc based paints	
Traffic Use	Increased noise levels from motorized vehicles	Long Term	Legislation, noise barriers and enforcement where applicable	

Traffic Use	Increase in accident	Long Term	Erection of adequate barriers to prevent unauthorized highway. Public education programme on proper use (ramps, exits, entrances, speed limits, toll booths, etc.
Traffic Use	Increase levels of sanitary and solid waste	Long Term	Establish adequate sanitary and solid waste disposal locations. These should be properly sited and of regu

Table A.25 Potential Negative and Positive Impacts - Economics Activities

Negative Impacts	Mitigation Measures
Agriculture	
- Loss of productive lands, primarily sugar cane at Bushy Park, Innswood, and Worthy Park Estates; bananas on Clarendon Plains; coffee plantations in Manchester, citrus in St. James, and mixed farming in St. Ann, St. Elizabeth and St. James.	Stakeholder consultations with estate managers and farmers who will be scale of impact, and corrective measures to be taken. Adequate compensation to be worked out with the project-affected persons.
- Destruction and modification of irrigation channels on the St. Catherine and Clarendon plains	Irrigation channels should be re-built, and an alternative source of water provided during the construction of these channels. Erection of structures to cross
- Increased incidence of praedial larceny	Existing legislation on this practice should be revised and stiffer penalties
- Livestock wandering onto right-of-way	Erection of barriers and culverts for cattle crossing
- Opening up of hinterland to "opportunistic squatters" and landless farmers	Restricted access by erection of barriers along corridor's ROW, and enforce legislation
Potential Positive Impacts	
- Improved transport of goods resulting in greater access to internal and external markets	
- Potential development of market gardening, reducing handling and storage of produce	

Negative Impacts	Mitigation Measures
Small Business	
<ul style="list-style-type: none"> - Loss of roadside business especially for stall vendors in Sandy Bay, Freetown, Clarendon Park and Whitney Turn -Encroachment of informal activities on highway ROW, especially in vicinity of Interchanges where traffic slows 	<p>Formalise and re-establish vendors in designated areas (lay-bys) to ensure continuity of business operations. These lay-bys should be constructed along the highway at strategic locations to accommodate those businesses (itinerant vendors) which depend solely on passers-by. Alternatively, the Faith's Pen and Melrose Hill model could be adopted, and if this not feasible, alternative space should be provided within close proximity to te original vending sites.</p> <p>A detailed inventory and socio –economic survey should be carried out to determine the vendor population at risk. Appropriate landscaping and barriers to discourage encroachment. Development control and legislative measures should also be considered</p>
Positive Impacts <ul style="list-style-type: none"> - Formal integration of small business operators into planned commercial activities, for example rest and food stops, craft and souvenir booths - Opportunity for food vendors standard to be established - Possible linkage between small business development and heritage tourism 	
Trade and Commerce	

- Downturn in sales and patronage as towns are by-passed e.g. Old Harbour, Porus and Williamsfield

While the Interchanges will facilitate access to these towns, the level of business generated may not be guaranteed. However, if existing roads are upgraded and the level of services improved, these areas should continue to attract enough through traffic to maintain buoyancy in business operations. Local businesses should also be encouraged to take advantage of new business opportunities provided.

Positive Impacts

- Generation of new businesses at Interchange points
- Injection of private-sector skill/technology
- Revitalization of dormant economies of some small towns and former growth centres such as Balaclava, Maggoty and Montpellier through increased access, greater visibility and increased traffic volumes

Negative Impacts	Mitigation Measures
Urban expansion	
- Limitations to outward expansion and economic growth of towns such as Old Harbour as highway will occupy lands that could accommodate future growth of town	Buffer zone should be left between urban fence of towns and highway corridor to accommodate urban growth and expansion.
Positive Impacts The project can spur the planned development of towns to curtail uncontrolled urban sprawl, particularly into right-of-way of highway, and areas prone to disasters.	
Mining	
- Sterilisation of bauxite deposits in the Manchester area and Hope Flats and the Schwallenburgh/Gibraltar area in St. Ann. -Existing mining and haulage roads may be altered or disrupted	Consultations with mining companies to ascertain future mining areas, and sites where high-grade ore exists. The sites that are likely to be impacted by the highway should be mined out prior to construction of the highway. Access to these private interior roads should be maintained by the erection of appropriate structures that will accommodate heavy duty trucks and trailers.
Tourism	
- Opening up of interior areas to	Carrying capacity studies should be conducted to

<p>tourism could increase demand pressure on attractions such as YS Falls and Appleton Valley Tour, resulting in loss of amenity value and aesthetic appeal of these areas.</p> <p>- Uncontrolled growth of services and related industries can cause increased stress on community resources and infrastructure</p> <p>- Anti-tourism sentiments and visitor harassment</p>	<p>determine acceptable limits change due to increased access and human interference. This is especially important for the potential opening up of pristine areas. These studies will inform the decision-making process with respect to linkages and connections, as well as appropriate legislation for regulating visitor use.</p> <p>Adequate infrastructure and services support to meet physical, social and economic needs of region should be provided to reduce stress on industry. The pace and scale of development of tourism -related activities should be controlled by appropriate integrated planning and legislation.</p> <p>Public awareness of industry sensitivity and benefits is required. The local community should also be involved in the decision-making process regarding tourism - development.</p>
<p>Potential Positive Impacts</p>	
<p>Improved transportation network, and reduced commuting time for visitors moving along the east-west and north-south corridors, especially cruise ship passengers who are constrained by time. Enable access to wider range of attractions. Reduce pressure on existing attractions.</p> <p>Linkages with GOJ Strategic Master Plan for Sustainable Tourism Development and South Coast Development Plan through the development of cultural, heritage and community tourism</p> <p>Possible opening up of new areas in the interior of the island to tourism -related activities. Pristine areas in Manchester, St. Elizabeth, St. James and St. Ann offer potential sites for</p>	

nature trails, picnics and other forms of recreational activities

Potential stimulation of indigenous industries- for example art and craft work in areas like Maggoty and Balaclava, resulting in greater potential for income generation
Support overall growth and development of industry.

Table A.26 Community Structure – Site Preparation/construction and Operation/Maintenance Phases

Negative Impacts	Mitigation Measures
Community Structure	
<p>Fragmentation of communities, resulting in their alienation from vital economic social services. These include Sandy Bay and Freetown in St. Catherine, Porus in Manchester and Gibraltar, and Guanaboa Vale in St. Catherine.</p>	<p>The alignment should be repositioned to a fragmentation of communities. Where repositioning the highway is not technically feasible, efforts should be made to re-connect such communities by construction of pedestrian bridges, underpasses, overpasses. Vital services such as health facilities, schools should be centrally relocated within community where easy accessibility is maintained.</p>
Transportation	
<p>Access to livelihood - Alienation from life-line activities (economic space). Highway could alienate communities from earning a livelihood by cutting them off from income-generating activities</p>	<p>Minimum changes should be made to cut off access to life-line industries. Where existing roadways have to be appropriated to facilitate the highway, alternative routes should be provided</p>

Potential Positive Impacts

Reduction in commuting time, and lower vehicle-operating costs for motorists
Overall infrastructural improvement in several communities across the island, especially those with an adequate road system
An improved road system and installation of telecommunications conduits should also result in spinoff for other sectors including health, education, commerce, industry and telecommunications

Culture shock	
Superimposition of a highway on the rural landscape, and changes to community life could result in cultural shock, especially among the elderly	Community consultations will be necessary to sensitize citizens of the effects of building a highway through the community, to get their perception of the project and to garner support for its development.
Loss of roadside community/social activities	Provision of alternative venue for social activities, and facilitate the development of new town square.
Disruption to social and economic interaction which adds to community vitality	Community consultations to determine best options
Gentrification effect	
Depressed land values due to pollution (noise, air), resulting in lack of high value investments of properties in close proximity to highway	Reduce air and noise pollution to minimum by application of appropriate air pollution mitigation strategies, and creation of sound barriers Maintain the aesthetic appeal of highway corridor and ROW

Potential Positive Impacts

Gentrification effect-property values in particular areas may increase due to infrastructural improvements resulting in higher lease and rental values.
Improved road infrastructure is likely to induce new business ventures within the corridors, thus placing a premium on lands in close proximity to the highway.

Table A.27 Land Acquisition and Settlement – Site Preparation/construction and Operation/Maintenance P

Negative Impacts	Mitigation Measures
<p>Loss of housing and lands</p> <p>Individual houses will be expropriated in a number of communities in all three segments of the corridor resulting in forced displacement of persons</p>	<p>Resettlement and rehabilitation following detailed socio-economic inventory and survey to determine numbers of houses and properties that will be expropriated. Appropriate compensation to be applied according to GOJ standards.</p>
<p>Displacement of households</p> <p>Involuntary displacement represents a break in social continuity, and may diminish people's sense of control over their lives. It can also result in stress-related health problems, and the possible death of elderly folk unable to cope with the psychological trauma of resettling.</p>	<p>Resettlement sites are to meet the needs of the persons to be resettled. Host population and community should be consulted to ensure adequate preparation for receiving new entrants. Attempts should be made to settle persons in a social environment similar to the one they are leaving. Counselling will help to alleviate stress and assist in adjustment.</p>
<p>Land acquisition</p>	
<p>This may result in the sub-division of family lands, and complex issues relating to land ownership and titles</p>	<p>Adequate compensation package should be worked out for land acquisition based on value of properties. Affected persons without</p>

<p>Severing of family ties to land</p> <p>Temporary loss of income and separation from "economic space" Separation from lifeline activities which may induce impoverishment at the onset.</p> <p>Loss of customary rights to land and resources Squatters may face eviction although they have informal customary rights to the land they occupy (i.e. they have been living on the property undisturbed for at least 7 years)</p>	<p>land titles should be assisted in acquiring them.</p> <p>Comprehensive compensation for loss of income and economic support during the relocation exercise</p> <p>Provision should be made for the resettlement of squatters, and the absence of titles to land should not be a barrier to compensation</p>
<p>Potential Positive Impacts</p>	
<p>Improved living standards for many persons, especially those in impoverished areas who will benefit from higher standards of living and improved social services.</p>	

Table A.28 Culturally Sensitive Groups – Site Preparation/Construction and Operation/Maintenance Phase:

<p>Negative Impacts</p> <p>Loss of traditional sense of identity. Breakdown of culturally distinct communities.</p> <p>Loss of livelihood.</p> <p>Loss of income. Increase in poverty and dependence on government. Breakdown of culturally distinct communities.</p> <p>Vanishing of traditional and distinct cultures.</p> <p>Cultural Disruption</p> <p>Loss of unique cultural aspects for Jamaica.</p>	<p>Mitigation Measures</p> <p>Communities as a whole in the project. Meet with representatives and take into consideration their concerns.</p> <p>Avoid creating links that are between culturally distinct communities and general population.</p> <p>Allow for sites along the highway where culturally distinct populations can sell their craft and homegrown food.</p>
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Table A.29 Cultural & Archaeological Heritage – Site Preparation/Construction Phase

Negative Impacts	Mitigation Measures
<p>Increased access to existing sites & new sites.</p> <p>Increased risk of damage to artefacts.</p> <p>Increased risk of modifying the integrity of the site.</p>	<p>Upon discovery of a new site, work should be stopped and the en supervisor should be contacted immediately.</p> <p>When a new site is discovered, access should be restricted until a archaeologist has been able to inspect the site and secure all val components.</p> <p>Design accessible display that limit risk of damage to artefacts.</p>
<p>Destruction of known sites</p> <p>Damages to components of the site. Loss of the context, when moving components of heritage site.</p> <p>Reduction of value of the heritage components.</p> <p>Destruction of heritage site and components</p> <p>Loss of unknown archaeological sites.</p> <p>Loss of clues to the understanding of past cultures and historical events.</p> <p>Loss of unique cultural insight for Jamaica's past.</p>	<p>Any heritage site before specialists have evaluated it.</p> <p>Evaluate the possibility of moving the alignment to save the site.</p> <p>Avoid all unknown archaeological sites.</p> <p>Upon discovery of a new site, work should be stopped and the en supervisor should be contacted immediately.</p> <p>When a new site is discovered, access should be restricted until a archaeologist has been able to inspect the site and secure all val components.</p>

Table A.30 Positive Impacts - Cultural & Archaeological Heritage

Potential Positive Impacts

Discovery of new archaeological sites
Opportunities for interpretive sign-posting of sites
Increased access to heritage tours