

12. ALTERNATIVES FOR DEVELOPMENT

12.1 Present all reasonable alternatives for development in comparative form, exploring each alternative. Include the no-action alternative, and the reason why certain alternatives were recommended or eliminated. These alternatives should look at the following components:

- I. Siting of the necessary support infrastructure and all facilities;
- II. Earth Movement Activities (evaluate the different extraction/dredging methodologies, extraction/dredging points (burrow sites), extraction/dredging volumes, material fill sites etc.);
- III. Liquid and Solid waste treatment and disposal options (evaluate the different treatment technologies and methodologies); and
- IV. Boat storage mooring/docking facilities (siting, design, etc.).

EXAMINATION OF ALTERNATIVES TO DEVELOPMENT

The alternatives for development are itemized in **Table 31** and described in further detail as follows.

Siting Options are limited to the proposed development site owing it being private land. The design layout for the proposed development satisfies both the economic and density objectives of the development, changes in which would only serve to either reduce economic feasibility, and hence economic benefit of the project. The unavoidable negative impacts of the proposed option primarily concern:

Reduction Of 9 Forest Types

Reduction Of Bird Nesting Sites

Reduction of shoreline-stabilizing mangrove cover

Alteration of Wagner Creek and Mullins River bank

Extirpation of wildlife from development sites

The non-development option will likely entail loss of more than US \$ 10 M in investment and foreign exchange revenue over the next 10 years (alone). Of the previously described habitats that will be impacted, only one remains under-protection in Belize, *Rhizophora mangle Forest*; however, Mahogany is also currently listed on the National List of Critical Species for Belize and is listed on the IUCN Red List as a vulnerable species. Consequently, and given that public benefit strongly favors the project's implementation, it is reasonable to accept the proposed siting option as the preferred option for development.

Land-Based Transportation Options concern proposed development of 15.7 km of feeder roads & streets with which to access residential units within the community and development of a 1.4 km center road loop to access the interior of the sport fishing retreat. No other design options for land based transportation are available to the development, save for the non-development option (see **Page 93**). Hence the proposed option is reasonable to accept as the preferred option for development.

TABLE 31
SUMMARY OF DEVELOPMENT ALTERNATIVES AND IMPACTS¹

IMPACT CATEGORY	OPTION 1	OPTION 2	OPTION 3
Siting Options	<u>Proposed Siting Scheme</u>	<u>Non-Development</u>
	Private landholding is most financially feasible location for proponent, but imposes reduction of 9 forest types, reduction of bird nesting sites, alteration of creek and river bank, and extirpation of wildlife from development sites	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Land-Based Transportation	<u>Proposed Road Scheme</u>	<u>Non-Development</u>
	Nominal impact following landfill operations	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Sea-Based Transportation and Boat Storage	<u>Proposed Mooring slips & boating related facilities</u>	<u>Non-Development</u>
	Loss of shoreline-stabilizing mangrove cover	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Material Supply (Excavation)	<u>Cut and fill actions as planned</u>	<u>Non-Development</u>
	Land cover loss, increased rainfall runoff velocity, and bank destabilization along the Mullins River Channel	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Freshwater Supply	<u>Water abstraction from Mullins River coupled with rainwater catchment in cisterns</u>	<u>Non-Development</u>
	Best water resource strategy for developer and environment	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Liquid Waste Management	<u>Batch Plant Treatment</u>	<u>Non-Development</u>
	Highest level of treatment effectiveness.	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	
Solid Waste Management	<u>Partial Source-Separation with storage at designated MSW site at mile 25</u>	<u>Complete Off-Site Storage</u>	<u>Non-Development</u>
	Lowers storage requirement at designated Msw Site and cost to Development	Nominal Environmental Risks, But Significant Elevation In Development Cost	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years
Energy Use Option	<u>Supply from Belize Electricity Limited and Emergency back-up energy by self-generation reciprocating / turbine diesel-electric plant(s)</u>	<u>Non-Development</u>
	Only available option	Loss Of > US \$ 10 M In Foreign Exchange Over Next 10 Years	

¹Note: Green shading indicates the preferred option for implementation by the proposed development

Sea-Based Transportation Options chiefly concerns the presence of the sport fishing retreat's 600 Ft water frontage on Mullins River and/or scaling of the mooring slips and other boating-related facilities proposed for placement on Mullins River, given that the sea-based transportation plans are not anticipated to create any significant negative impact risks related to material supply. The unavoidable negative impact risk includes loss of shoreline-stabilizing mangrove cover. Consequently, and given that no alternative sea-based transportation design options are available which can both reduce pollution risks without jeopardizing the economic viability of the proposed development, the proposed sea-based transportation design and scale options represent the preferred options for development.

Material Supply Options concern material excavations for road construction and boat basin development. Unavoidable negative impacts that will result from these actions concern land cover loss, increased rainfall runoff velocity, and bank destabilization along the Mullins River Channel.

Alteration of the design plan by way of eliminating the proposed boat basin would only serve to render the project infeasible to develop. In as much as the potential impacts of the proposed development are reversible through ground stabilization, the use of silt screens, placement of rip-rap along the perimeter of the newly excavated boat basin and bank beneath the riverside boardwalk, followed by replanting with mangroves to improve soil retention and prevent river-born erosion, the proposed option has been elected as the preferred option for material supply to the proposed development.

Freshwater Supply Options available to the gated community includes mixture of rainwater catchment in cisterns and recycling, combined with water abstraction from Mullins River as abstraction from Wagner Creek or ground water reserves is unlikely to be sufficient to meet the developments demands on any level. Given these considerations, along with the fact that Mullins River is more than capable of supplying the proposed development with the bulk quantity of water required by the proposed development, it is reasonable to reject the non-development option in favor of the proposed abstraction option as the preferred option for development.

Freshwater Supply Options available to the sport fishing retreat includes rainfall catchment, groundwater abstraction, or abstraction from Mullins River itself. The nominal balance of freshwater supply requirements (i.e. 2 gpm) can be readily met from groundwater resources, since the site's proximity to Mullins River will be likely to result in continuous recharge of groundwater's in the immediate vicinity of the proposed development. As such, the above strategy for potable water supply to the sport fishing retreat embodies the proposed alternative for development.

Liquid Waste Treatment Options available to the proposed development involve a distributed batchplant system which improves treatment effectiveness and provides surety that if one component in the network fails for any reason; it will not disrupt the operation of the remaining treatment capacity. Consequently, the distributed approach reduces failure risk and therefore might best reflect the preferred option for development.

Solid Waste Treatment Options for management of solid waste produced by the proposed development are essentially limited to source separation and transportation to National Solid Waste Storage Site servicing Dangriga Town for solid waste storage. Source separation is expected to be an important consideration due to the level of waste production anticipated. Non-biodegradable waste includes slow degrading materials such as plastic, glass, metal and rubber, which, because their storage requires continuing allocation of space, will of necessity need to be stored at the National Solid Waste Storage Site servicing Dangriga Town. On the other hand, paper waste may be eliminated through on-site incineration, which would reduce the annual requirement for transportation and off-site storage of waste by 15%. Organic food waste can be efficiently on-site in compost sites, and therefore can further reduce transportation and off-site storage requirements by an additional 47%.

Collectively, source separation and treatment of paper and organic waste offers the reduction of municipal solid waste transportation and storage requirements by as much as 62%, and therefore should be elected as the preferred treatment plan for solid waste.

Energy Use Options to the proposed development are limited to the proposed option of supply from Belize Electricity Limited, in compliance with the company's licensing, which prohibits private distribution of electricity by third parties. Emergency back-up energy requirements of 15% will be supplied by self-generation with one or more reciprocating / turbine diesel-electric plant(s) in support of security lighting, water supply, communications and other essential services. Fuel and other petroleum products used in support of the back-up power facility will be stored in either a concrete or buried earthen bund or the manufacturers' containers as the case may apply. Spilled petroleum, spent oils and related materials will be stored in 55 gal drums also located within the above-described fuel bunds. Consequently, purchase of power from BEL, with self-generation petroleum-based backup energy represents the preferred option for development.

13. MITIGATION MEASURES AND MONITORING PLANS

- 13.1 Based on the investigations, develop a mitigation matrix outlining mitigation measures for all potential negative environmental impacts including, but not limited to, construction activities, waste treatment and disposal, habitat alteration and erosion control, and management of pests and vectors (rodents, mosquitoes, flies, etc.).
- 13.2 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).
- 13.3 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.
- 13.4 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:
 - I. Public health;
 - II. Forest, wetland and adjacent aquatic habitats; and
 - III. Endangered or threatened species in the project area and zone of influence.

MITIGATION MEASURES FOR THE PROPOSED DEVELOPMENT

A summary of the potential impacts of the proposed development, and the measures proposed for their mitigation is shown in **Table 32**.

Construction and Habitat Impacts concern the direct reduction of nine types of terrestrial forest habitat as well as alteration of the existing shoreline of Mullins River. The reduction of such vegetation cover is unavoidable, but is partially reversible through replanting of native vegetation following construction. The indirect and residual impacts of such forest disturbance include lowered storm resistance and increased susceptibility to erosion of Wagner Creek and Mullins River and temporary disturbance and emigration of mobile wildlife which can be mitigated by replanting new vegetation.

Land-Based Transportation Impacts concern habitat loss, reduction of vegetation cover; increased soil erosion and creek channel scouring, increased traffic and degradation of the Coastal / Manatee Highway. While there are no mitigating measures for the direct impact of reduction of vegetation cover except for non-development; the indirect and residual impacts can be mitigated by: replanting native or specialized grasses along drainage swales to reduce or prevent soil erosion and creation of soil traps along drainage routes to slow drainage flows and capture of runoff-borne sediments before discharge into Wagner Creek and Mullins River.

TABLE 32
SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Construction	<ul style="list-style-type: none"> I. Construction will reduce 9 forest types; II. Alteration of existing shoreline of Mullins River; III. Lowered storm resistance and increased susceptibility to erosion of Wagner Creek and Mullins River; IV. Temporary disturbance and emigration of mobile wildlife. 	<ul style="list-style-type: none"> I. None, non-development; II. Replant the development site with native vegetation following construction activities.
Land-Based Transportation	<ul style="list-style-type: none"> I. Habitat loss and reduction in vegetation cover; II. Increased soil erosion and creek channel scouring; and III. Increased traffic and degradation of the Coastal/manatee highway. 	<ul style="list-style-type: none"> I. None, non-development; II. Replant native or specialized grasses along drainage swales to reduce or prevent soil erosion; and III. Create soil traps along drainage routes to slow drainage flows and capture of runoff-borne sediments before discharge into Wagner Creek and Mullins River.
Sea-Based Transportation	<ul style="list-style-type: none"> I. Loss of shoreline-stabilizing mangrove cover; II. Increased potential for severe bank erosion during high-velocity flooding of Mullins River; and III. Collision risk associated with night time navigation within the Mullins River channel. 	<ul style="list-style-type: none"> I. Minimize the boat basin opening onto Mullins River, so as to maintain the upstream side of the boat basin entrance in a superior position relative to the downstream side of the boat basin entrance, therein promoting overpassage, rather than scouring of the downstream side of the boat basin; II. Place rip-rap along the perimeter of the newly excavated boat basin and bank beneath the riverside boardwalk; III. Replant with mangroves to improve soil retention and prevent river-born erosion; and IV. Utilize all weather lighting of the slips and boardwalk structure to prevent night time collisions.
Material Supply (Excavation)	<ul style="list-style-type: none"> I. Land cover loss; II. Increased rainfall runoff velocity; III. Bank destabilization along the Mullins River Channel; and IV. Increased erosion along Wagner Creek and Mullins River channels during periods of heavy rainfall 	<ul style="list-style-type: none"> I. None, non-development; II. Minimize the boat basin opening onto Mullins River to maintain the upstream side of the boat basin entrance in a superior position relative to the downstream side of the boat basin entrance; III. Place rip-rap along the perimeter of the newly excavated boat basin and bank beneath the riverside boardwalk; IV. Replant with mangroves to improve soil retention and prevent river-born erosion; and V. Create sediment traps along drainage water courses that can assist in the retention of erosion products and otherwise act to slow rainfall runoff velocity prior to discharge into Wagner Creek.

Continued...

TABLE 32

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
<p>Freshwater Supply</p>	<ul style="list-style-type: none"> I. Public safety risk imposed on area land owners and drivers while laying the pipe work from pump station to development site; II. Potential for saline intrusion of groundwater in either the retreat or Mullins River communities; III. Noise pollution and attractive nuisance associated with heavy duty equipment operation; IV. Land clearing and habitat loss associated with pump station and supply line placement; and the potential for entrainment of aquatic organisms, particularly aquatic larvae, at the point of water intake; V. Increase in vegetation growth and wildlife occupancy along Wagner Creek which may eutrophy the creek bed and promote excessive vegetation growth in dry weather; VI. Potential loss of salt intolerant vegetation species from saline intrusion at the ground water abstraction point; VII. Discharge of potable water through septic leach fields as landscaping runoffs may increase nutrient concentration in Wagner Creek; and VIII. Potential toxification of Wagner Creek water from nutrient loading. 	<ul style="list-style-type: none"> I. Provide for a water take-off point, which can be tapped to connect a water main to the Mullins River village and sport fishing retreat in the event of well contamination with saline from Mullins River; II. Place adequate signage and traffic controls along the Mullins River Road during construction activities; III. Operate of the pump station during regular (daylight) working hours to minimize noise impacts on area residents; IV. Place protective security fencing, lighting and alarms around the perimeter of the pump station to prevent vagrant occupation and vandalism to the site; V. Ensure the intake pipe is adequately screened, and set within a depressurizing chamber to reduce suction force at the point of water entry; VI. Post caution signs near to the intake pipe; VII. Routine daily inspection of the pump intake to insure screens are intact and that the intake pipe has not been compromised by wildlife; VIII. Routine weekly inspections of groundwater quality for saline intrusion, particularly in dry weather, and monthly inspection of vegetation between the well site and River for dryness and potential for saline impacts; IX. Employ sediment traps as photo-oxidation ponds for chemical runoffs, while ensuring, through monitoring, the discharged water is devoid of these constituents as well as any noxious microbial blooms; and X. Routinely examine water quality in the settlement ponds and Wagner Creek to ensure that chemical conditions are not favorable to microbial population blooms.
<p>Liquid Waste Treatment</p>	<ul style="list-style-type: none"> I. Nominal reduction in land cover associated with plant placement; II. Gradual reduction of percolation capacity and/or alteration of water distribution characteristics as may result from subsoil loading with particulate organic matter during landscape irrigation applications; III. Subsoil erosion from leakages and/or ground settlement after construction; IV. Excessive irrigation leach-field damage from root growth and subsequent reduction in effectiveness; V. Increased risk to aquatic life in Wagner Creek from leakage of toxic nutrients such as nitrogen, pH, etc 	<ul style="list-style-type: none"> I. None, non-development; II. Construction of septic tank and drain field according to specifications, insuring that leaching rate does not exceed background percolation rate; III. As above (II); IV. Use shallow root system vegetation such as grasses and/or annual flowers to cover irrigation leach fields; regularly inspect, repair and thin excessive vegetation growth over irrigation leach fields; V. Regularly lime leach field in support of bacterial denitrification processes; VII. Adhere to manufacturer's specifications for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates;

Continued...

TABLE 32
SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

IMPACT	NEGATIVE IMPACT RISKS	MITIGATION MEASURES
Liquid Waste Treatment (continued)	<ul style="list-style-type: none"> VI. Risk of contamination of ground water and Wagner Creek with nutrients and human pathogens; and VII. Potential for low level eutrophication of the proposed development's water features and Wagner Creek. 	<ul style="list-style-type: none"> VIII. Ensure plant operation at design specification; and IX. Ensure nearby Wagner Creek water quality is regularly monitored for Coliform bacteria, Vibrio bacteria and nitrogen levels.
Solid Waste Treatment	<ul style="list-style-type: none"> I. Nominal land conversion requirement for their composting; II. Reduction of savanna habitat that will be utilized for composting and increased wildfire risk from incineration; III. Increasing the local population of nuisance and disease-bearing species (raccoons, vultures, etc.); and IV. Seepage of nitrogen and other nutrients from composting pits into ground water and/or Wagner Creek. 	<ul style="list-style-type: none"> I. None, non-development; II. Regular management and recycling of compost sites to limit land conversion requirements; III. Use incineration chamber fitted with ash collector to prevent airborne drift of cinders; IV. Properly train incineration operators; V. Adequately cover composting pits with soils to reduce fugitive odors that may attract nuisance species to the composting site; VI. Cover composting pits to reduce rainfall leaching; and VII. Regular management and recycling of compost sites to limit land conversion requirements.
Energy Supply/Usage	<ul style="list-style-type: none"> I. Increased road use for fuel supply; II. Spill risk; III. Increased risk of chemical contamination, and explosion; IV. Remote location of development site may increase potential for serious injury; V. Increased risk of electrocution wherever poor electrical engineering standards are employed or storms may cause failure of utility poles; VI. Short-term exposure to petrochemicals and/or noise from generating facilities effects on staff health and hearing loss; VII. Production of noise pollution and thermal waste up to 3.4×10^9 BTUs per a at capacity development; VIII. Noise-induced hearing loss in staff; and IX. Noise induced wildlife desertion of the area. 	<ul style="list-style-type: none"> I. None, non-development; II. Construction of either concrete or earthen bunds and maintenance of all fuel containers and generating equipment within these structures; III. Train staff in safe fuel handling procedures, and of fuel usage sites regular inspections; IV. Ensure qualified electrical engineers are employed during the design and construction phase of the development; V. Develop safety protocol for training fuel handlers; VI. Maintain fuel storage facilities at safe distance from generating equipment and provide warnings about inflammable device use near fuel storage areas; VII. Have at least two full-time staff receive emergency medical training at Belize City BERT Center; VIII. Provide staff with proper clothing, gloves and noise pollution protection equipment; IX. Place generating equipment in specially designed noise-retarding shelters; and discharge exhaust waste into baffled exhaust pipes buried underground; and X. Develop a regular monitoring protocol to determine presence/ absence of noise-related impacts.

TABLE 32

SUMMARY MITIGATION MATRIX OF DEVELOPMENT IMPACTS

(Continued)

<p>Wildlife Disturbance</p>	<ul style="list-style-type: none"> I. Development will reduce local and national inventory of 9 habitat types and various fruit bearing plant species; II. Increased erosion and lowered storm resistance of the development site as a result of vegetation removal for the proposed residential communities; III. Emigration and/or decrease in density of many resident species of wildlife that are presently dependent on the existing land cover for survival; IV. Increased surface runoff into Wagner Creek; V. Reduction in water quality of Wagner creek and eventual loss of aquatic flora and fauna; VI. Poor water exchange combined with pesticide and petroleum loading of the Wagner Creek watershed may toxify area waters; VII. Petroleum loading of the Mullins River from proposed boating activities; VIII. Permanent displacement of any remaining bird and/or terrestrial animals from the development site during construction activities; IX. Potential decline in vegetation dependent bird species that utilize the plants for food and nesting; and X. Alteration of terrestrial habitats which subsequently affects herbivore abundance and may possibly cause a decline in the abundance of large mammals and top predators. 	<ul style="list-style-type: none"> I. None, non-development; II. Preservation of existing vegetation wherever possible, and otherwise encourage the establishment of native vegetation species following land filling and housing development; III. Creation and use of settlement ponds to retain surface run off and otherwise permit their return to Wagner Creek by gradual percolation and migration through undisturbed, <i>in situ</i> profiles; IV. Use a bio-filter to capture pesticide contamination in effluent surface waters; V. No aerial spraying of pesticides and prevent application in wet weather; VI. Maintain petroleum stores in bonds having 110% volume of storage products, train all fuel handlers in safe practices; VII. Promote use of 4-cycle outboard motor engines by all staff and residents; VIII. Re-landscaping activities such as the creation of green space and vegetation corridors between the various residential communities that provide an opportunity for wildlife to relocate and to stabilize habitat within the proposed development; and IX. Educate staff and area residents of the importance of observing wildlife conservation guidelines, consequence in the event of injury or death of any wildlife from neglect of the guidelines, and surveillance of the development site for infarction against the guidelines.
<p>Archaeology and Social Factors</p>	<ul style="list-style-type: none"> I. Artifacts of historical and/or cultural significance may be uncovered, damaged or destroyed during construction of the proposed development; II. Proposed development will create jobs and increase foreign exchange earnings through property development and property tax revenue; III. X+ mile distance of proposed development from hospital resources increases risk of complications from accidental or serious injury to workers; and IV. Long-term support for traditional cultural practice. 	<ul style="list-style-type: none"> I. An archaeological observer must be present on site during all excavation activities to evaluate the significance of any finds and to make recommendations as to an appropriate course of action regarding their preservation; II. None, positive impact; and III. Have a minimum of two full-time staff on-site trained in emergency medical practices at the BERT facility in Belize City.

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Sea-Based Transportation Impacts concern the establishment of the boat basin, mangrove boardwalk and boat slips which may lead to loss of shoreline-stabilizing mangrove cover, increased potential for severe bank erosion during high-velocity flooding of Mullins River, and collision risk associated with night time navigation within the Mullins River channel. Mitigation measures for these impacts include: minimizing the boat basin opening onto Mullins River, so as to maintain the upstream side of the boat basin entrance in a superior position relative to the downstream side of the boat basin entrance, therein promoting overpassage, rather than scouring of the downstream side of the boat basin; placement of rip-rap along the perimeter of the newly excavated boat basin and bank beneath the riverside boardwalk, followed by replanting with mangroves to improve soil retention and prevent river-born erosion.

Material Supply Impacts involving excavations for road construction and boat basin development primarily concern land cover loss; increased rainfall runoff velocity, and bank destabilization along the Mullins River Channel and increased erosion along Wagner Creek and Mullins River channels during periods of heavy rainfall. Mitigation measures for these impacts include: minimizing the boat basin opening onto Mullins River, so as to maintain the upstream side of the boat basin entrance in a superior position relative to the downstream side of the boat basin entrance, therein promoting overpassage, rather than scouring of the downstream side of the boat basin; placement of rip-rap along the perimeter of the newly excavated boat basin and bank beneath the riverside boardwalk, followed by replanting with mangroves to improve soil retention and prevent river-born erosion and creation of sediment traps along drainage water courses that can assist in the retention of erosion products and otherwise act to slow rainfall runoff velocity prior to discharge into Wagner Creek.

Freshwater Supply Impacts from the elected supply option concern the short term nuisance and public safety risk imposed on area land owners and drivers while laying the pipe work from pump station to development site, and the potential for saline intrusion of groundwater in either the retreat or Mullins River communities in addition the noise pollution and attractive nuisance associated with heavy duty equipment operation. Mitigation measures for these impacts include: providing a water take-off point, which can be tapped to connect a water main to the Mullins River village and sport fishing retreat in the event of well contamination with saline from Mullins River; placement of adequate signage and traffic controls along the Mullins River Road during construction activities, including 24-hr supervision of traffic during placement of water main along public carriageway easements; operation of the pump station during regular (daylight) working hours to minimize noise impacts on area residents; and placement of protective security fencing, lighting and alarms around the perimeter of the pump station to prevent vagrant occupation and vandalism to the site.

Biological impacts include land clearing and habitat loss associated with pump station and supply line placement; and the potential for entrainment of aquatic organisms, particularly aquatic larvae, at the point of water intake; increase in vegetation growth and wildlife occupancy along Wagner Creek which may eutrophy the creek bed and promote excessive vegetation growth in dry weather; and the potential loss of salt intolerant vegetation species from saline intrusion at the ground water abstraction point.

Mitigation measures available for these impacts include: ensuring that the intake pipe is adequately screened, and set within a depressurizing chamber to reduce suction force at the point of water entry; providing posting of caution signs near to the intake pipe, and conducting routine daily inspection of the pump intake to insure screens are intact and that the intake pipe has not been compromised by wildlife.

Water resource impacts include discharge of potable water through septic leach fields as landscaping runoffs may increase nutrient concentration in Wagner Creek, and potential toxification of Wagner Creek water from nutrient loading. Mitigation measures available for these impacts include: employing sediment traps as photo-oxidation ponds for chemical runoffs, while ensuring, through monitoring, the discharged water is devoid of these constituents as well as any noxious microbial blooms, and routinely examining water quality in the settlement ponds and Wagner Creek to ensure that chemical conditions are not favorable to microbial population blooms.

Liquid Waste Discharge Impacts concern land cover removal for plant placement; subsoil erosion from leakages and/or ground settlement after construction; and gradual reduction of percolation capacity and/or alteration of water distribution characteristics as may result from subsoil loading with particulate organic matter during landscape irrigation applications. Mitigation measures available for these impacts include construction of pipe works and irrigation fields to specifications, and ensuring that leaching rates at all irrigation endpoints are less than background percolation capacity.

Biological impacts concern increased risk to aquatic life in Wagner Creek from leakage of toxic nutrients such as nitrogen, pH, etc; and excessive irrigation leach-field damage from root growth and subsequent reduction in effectiveness. Mitigation measures include use of shallow root system species such as grasses and/or perennial flowers as groundcover for irrigation leach fields; regular inspection and thinning of excessive vegetation growth over leach fields, regular repairs to and liming of leach fields in support of bacterial denitrification processes; and adherence to manufacturer's specification for tank sludge removal rates, which can be as frequent as every 4-6 months for large scale systems supporting heavy loading rates.

Water resource impacts concerns risk of contamination of groundwater and/or Wagner Creek with nutrient and/or human pathogens and the potential for low level eutrophication of the proposed development's water features and Wagner Creek. Mitigation measures include ensuring plant operation at design specification; and ensuring nearby Wagner Creek water quality is regularly monitored for Coliform bacteria, Vibrio bacteria and nitrogen levels in defense of effluent discharge standards and as a check to ensure proper batchplant function.

Solid Waste Storage Impacts concern the additional land conversion requirement for composting sites. Biological impacts concern reduction of savanna habitat that will be utilized for composting and increased wildfire risk from incineration. Additional biological impacts include increasing the local population of nuisance and disease-bearing species (raccoons, vultures, etc.). Measures available for mitigating these impacts include use of an incineration chamber fitted with an ash collector to prevent airborne drift of cinders, and proper training of incineration operators; and adequately covering composting pits with soils to reduce fugitive odors that may attract nuisance species to the composting site.

Water resource impacts concern the possibility of seepage of nitrogen and other nutrients from composting pits into ground water and/or Wagner Creek. Mitigation measures involve covering of composting pits to reduce rainfall leaching; and regular management and recycling of composting sites, in order to prevent anaerobic digestion of organic wastes which reduces composting speed and promotes toxification of the compost site.

Energy Use Impacts from fuel supply concern increased road use for fuel supply and spill risk. Measures available for mitigating these impacts include construction of either concrete or earthen bunds and maintenance of all fuel containers and generating equipment within these structures and training of staff in safe fuel handling procedures, and regular inspections of fuel usage sites.

Health and safety impacts from public energy use concern increased risk of electrocution wherever poor electrical engineering standards are employed or storms may cause failure of utility poles, while health and safety impacts from petroleum-based, backup-energy generation concern increased risk of chemical contamination and explosion, concern increased risk of serious personal injury due to the proposed development's remote location, and short-term exposure to petrochemicals and/or noise from generating facilities effects on staff health and hearing loss. Mitigation measures include ensuring accredited electrical engineers during the design and construction phase of the development; developing a safety protocol for training fuel handlers; maintaining fuel storage facilities at safe distance from generating equipment and providing warnings about inflammable device use near fuel storage areas; having at least two full-time staff receive emergency medical training at Belize City BERT Center; and providing staff with proper clothing, gloves and noise pollution protection equipment to reduce potential for health effects.

Pollution impacts concern the risk of noise pollution and the production of 3.4×10^9 BTUs of thermal waste per year; long-term exposure to petrochemicals and/or noise from generating facilities that may cause hearing loss to staff; and cause noise induced wildlife desertion of the area. Heat production is largely unavoidable and can only be mitigated by non-development. Long-term exposure to petrochemicals and/or noise from generating facilities can be mitigated by providing staff with proper safety clothing, gloves and noise pollution equipment.

Wildlife Impacts concern aquatic habitat impacts from implementation of the proposed development concern increased surface runoff into Wagner Creek. Indirect aquatic habitat impacts from the proposed development concern reduction in water quality of Wagner creek and eventual loss of aquatic flora and fauna. Measures available for mitigation of the avoidable, aquatic sedimentation impacts entail creation and use of settlement ponds to retain surface run off and otherwise permit their return to Wagner Creek by gradual percolation and migration through undisturbed, *in situ* profiles. Residual aquatic habitat impacts from the proposed development include increased risk of pesticide-induced impacts on vegetation of the tropical broadleaf forest near the creek bank from utilization of the Wagner Creek watershed for drainage of the project site, and petroleum-based pollution of Mullins River from the proposed boating operations.

With respect to petroleum-based contamination of the Mullins River, fewer such de-toxification options are available, yet promotion of 4-cycle outboard engine use and maintenance of all petroleum-based materials in safety bonds will significantly reduce petroleum accumulation in the surface waters of Mullins River. Consequently, the recommended measures available for mitigation of avoidable, aquatic toxification impacts include the creation of an adequate filtration mechanism that will remove pesticides from effluent waters prior to their discharge into Wagner Creek.

Terrestrial habitat impacts from implementation of the proposed development concern partial reduction of the 9 habitat types within the proposed development site. Indirect and terrestrial habitat impacts concern increased erosion and lowered storm resistance of the development site as a result of vegetation removal for the proposed residential communities. Measures available for mitigation these indirect and direct impacts include preservation of existing vegetation wherever possible; and otherwise encourage the establishment of native vegetation species following land filling and community development. Residual terrestrial habitat impacts concern the likely emigration and/or decrease in density of many resident species of wildlife that are presently dependent on the existing land cover for survival.

Specie-specific impacts from implementation of the proposed development concern the potential for permanent displacement of any remaining bird and/or terrestrial animals from the development site during construction activities, and potential decline in vegetation dependent bird species that utilize the plants for food and nesting. Residual species-specific impacts concern alteration of terrestrial habitats which subsequently affects herbivore abundance and may possibly cause a decline in the abundance of large mammals and top predators. Measures available for mitigation of these potential impacts include: re-landscaping activities such as the creation of green space and vegetation corridors between the various residential communities that provide an opportunity for wildlife to relocate and to stabilize habitat within the proposed development, and education of staff and area residents of the importance of observing wildlife conservation guidelines, the consequence in the event of injury or death of any wildlife from neglect of the guidelines, and surveillance of the development site for infarction against the guidelines.

Culture, Customs and Social Impacts concern the negative impacts of the possible damage and/or destruction of artifacts of historical and/or cultural significance that may be uncovered; damaged or destroyed during construction of the proposed development and the potential for any serious injury to be exacerbated due to the remote location of the development, loss of bird nesting habitat, and risk of storm erosion from alteration of mangrove cover but also the positive impacts of job creation, increased foreign exchange earnings through property development and income revenue for accommodation rentals, and support for the cultural practices. Negative impact risks are avoidable and may be mitigated by the presence of an archaeological observer during all excavation activities to evaluate the significance of any findings and to make recommendations as to an appropriate course of action regarding their preservation; improving navigational regulations in the area, including new bird nesting habitat, and stabilizing with rooted vegetation following landfill activities; and by having a minimum of 3-5 full-time staff trained in emergency medical practices at BERT facility in Belize City.

CUMULATIVE IMPACTS

Cumulative impacts presented on the proposed development are essentially nil, as it is the first residential subdivision development of its kind in the area. However, the proposed development does present a cumulative impact in the form of alteration of the Mullins River bank for the 22.5 acre development, vegetation reduction of development sites, and reduction of large scale agricultural developments of the Coastal/Manatee highway, which primarily include citrus farming. The mitigating or redeeming value of the development in this regard is its comparatively minute land use in trade for employment and accrued economic benefit to the residents of the desolate Mullins River Village and surrounding area.

14. MONITORING PLANS

- 14.1 Provide a detailed monitoring plan to be implemented for the entire operation, identifying any agency/body responsible for its implementation and any training that may be necessary for the implementation of the plan. The plan should include monitoring of wastewater discharge characteristics (if any), changes in ecological species (including endangered species), contingency measures to emergency response to accidental events (fire, flood, hurricane, leakages, spillages, etc.).
- 14.2 Provide a detailed plan for the decommissioning and rehabilitation of the site to other uses in the event that the project is discontinued.
- 14.3 Identify and develop a water quality monitoring program able to detect any change (s) in ground water or surface water quality, that will impact:
 - I. Public health;
 - II. Forest, wetland and adjacent aquatic habitats; and
 - III. Endangered or threatened species in the project area and zone of influence.

MONITORING PLANS FOR THE PROPOSED DEVELOPMENT

The parameters and scheduling of monitoring activities recommended for the development are shown in **Table 33**; and recommended monitoring points are shown in **Illustrations 59 - 60**.

Land-Based Transportation Monitoring Requirements consist of the need for weekly inspections in the wet season and monthly inspections in the dry season of Wagner Creek water quality for sediment deposition and scouring from site-based runoffs from the gated community development.

Sea-Based Transportation Monitoring Requirements concern the need for the development to conduct weekly inspections to insure secure attachment of any removable slip sections, and that slip lighting is in good working order at all times.

Material Supply Monitoring Requirements primarily concern the need to conduct weekly inspections along the Mullins River bank and entryway into the boat basin for rip-rap integrity and need for repair; and concurrent inspection of the Wagner Creek channel for snags and/or new point sources of erosion that may be linked to channelization of rainfall runoffs from the gated community.

Water Resource Monitoring Requirements will involve daily checks of the pump station intake for fouling and security integrity; monthly checks of well water quality and area vegetation for saline intrusion; and quarterly checks of Wagner Creek for erosion and fouling with snags, tree falls or grasses. Water quality in Wagner Creek should also be inspected on a quarterly basis for nutrient loading (i.e. chlorine and/or nitrogen), and all potable water supplies (i.e. cisterns and water abstracted from Mullins River) should be inspected quarterly for infestation of Coliform bacteria and protozoan infestations.

TABLE 33

RECOMMENDED MITIGATION-MONITORING PROGRAM FOR THE PROPOSED DEVELOPMENT

DEVELOPMENT CATEGORY	PROGRAM OR ACTION TO BE UNDERTAKEN	CRITICAL LEVELS, PARAMETERS OR CHARACTERISTICS	COMPLETION DATE OR FREQUENCY	MAP SYMBOL REFERENCE ¹
TRANSPORTATION	<p><i>Land Based:</i> Inspections in the wet season and dry season of Wagner Creek water quality for sediment deposition and scouring from site-based runoffs</p> <p><i>Sea Based:</i> Inspections to insure secure attachment of any removable slip sections, and that slip lighting is in good working order</p>	None	<p>Land Based: Weekly and Monthly</p> <p>Sea Based: Weekly</p>	<p>E</p> <p>SL</p>
MATERIAL SUPPLY	Inspections along the Mullins River bank and entryway into the boat basin for rip-rap integrity and need for repair; and concurrent inspection of the Wagner Creek channel for snags and/or new point sources of erosion	None	Weekly	E
FRESHWATER SUPPLY	Checks of pump station intake; checks for well water quality for saline intrusion; inspection of cisterns for Coliform bacteria and protozoan infestations	Record Changes To Total Nitrogen, Pesticides, Chlorine, Coloform- And Vibrio Bacteria Levels	Monthly	WQ
LIQUID WASTE MANAGEMENT	Assessment of Wagner Creek water quality conditions for Coliform and Vibrio bacteria population levels and nitrogen levels.	Nearshore Water Nitrate Levels (< 1ppm):	Quarterly	WQ
SOLID WASTE MANAGEMENT	Regularly Check For Operation of incinerator to Specifications	None	Annually	SW
ENERGY USE	<p>Establish Fuel Bonds, Develop Handlers Protocol, Train Staff, Supply Clothing, EMT Training For ≥ 2 Staff</p> <p>Fuel Storage & Power Generation Equipment Inspections</p> <p>Public Power Supply Related Inspections</p>	None	<p>Before Operation</p> <p>Weekly / Monthly</p>	F

¹Monitoring sites are shown in **Illustrations 59 - 60.**

TABLE 33

RECOMMENDED MITIGATION-MONITORING PROGRAM FOR THE PROPOSED DEVELOPMENT

DEVELOPMENT CATEGORY	PROGRAM OR ACTION TO BE UNDERTAKEN	CRITICAL LEVELS, PARAMETERS OR CHARACTERISTICS	COMPLETION DATE OR FREQUENCY	MAP SYMBOL REFERENCE ¹
WILDLIFE	Inspection of Wagner Creek water quality (turbidity in particular) for sediment travel into waters during construction activities Inspection of effluent water concentration and any petroleum stores or dispensing facilities	None	Weekly Quarterly	WQ
CULTURE, CUSTOMS & SOCIAL FACTORS	Arrange For Archaeological Monitoring With IOA EMT Training For ≥ 2 Staff	None	Prior To Construction By Onset Of Operations	A

¹Monitoring sites are shown in **Illustrations 59 - 60**.

ILLUSTRATION 59: MONITORING PLAN FOR THE 403-ACRE DEVELOPMENT SITE

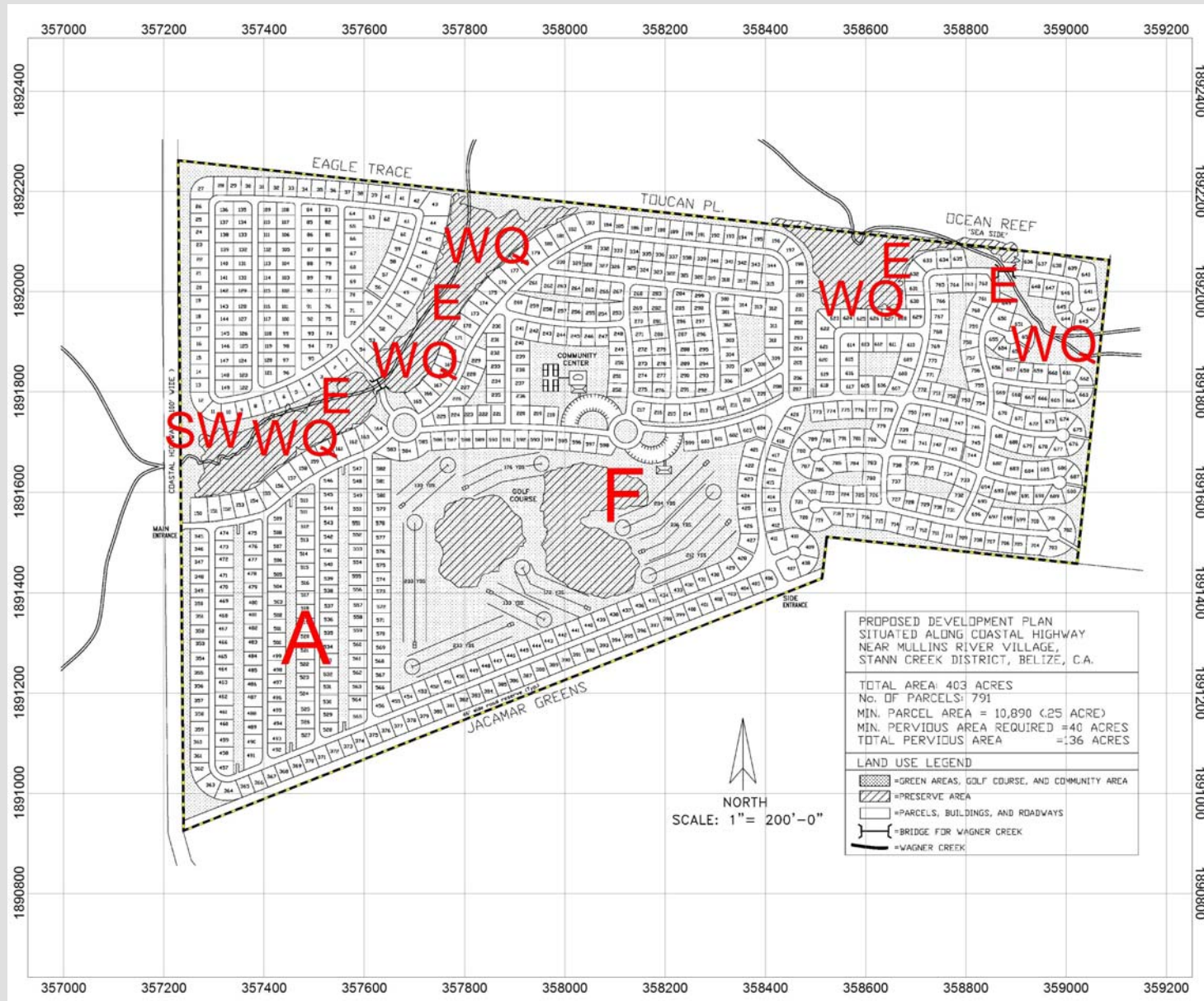
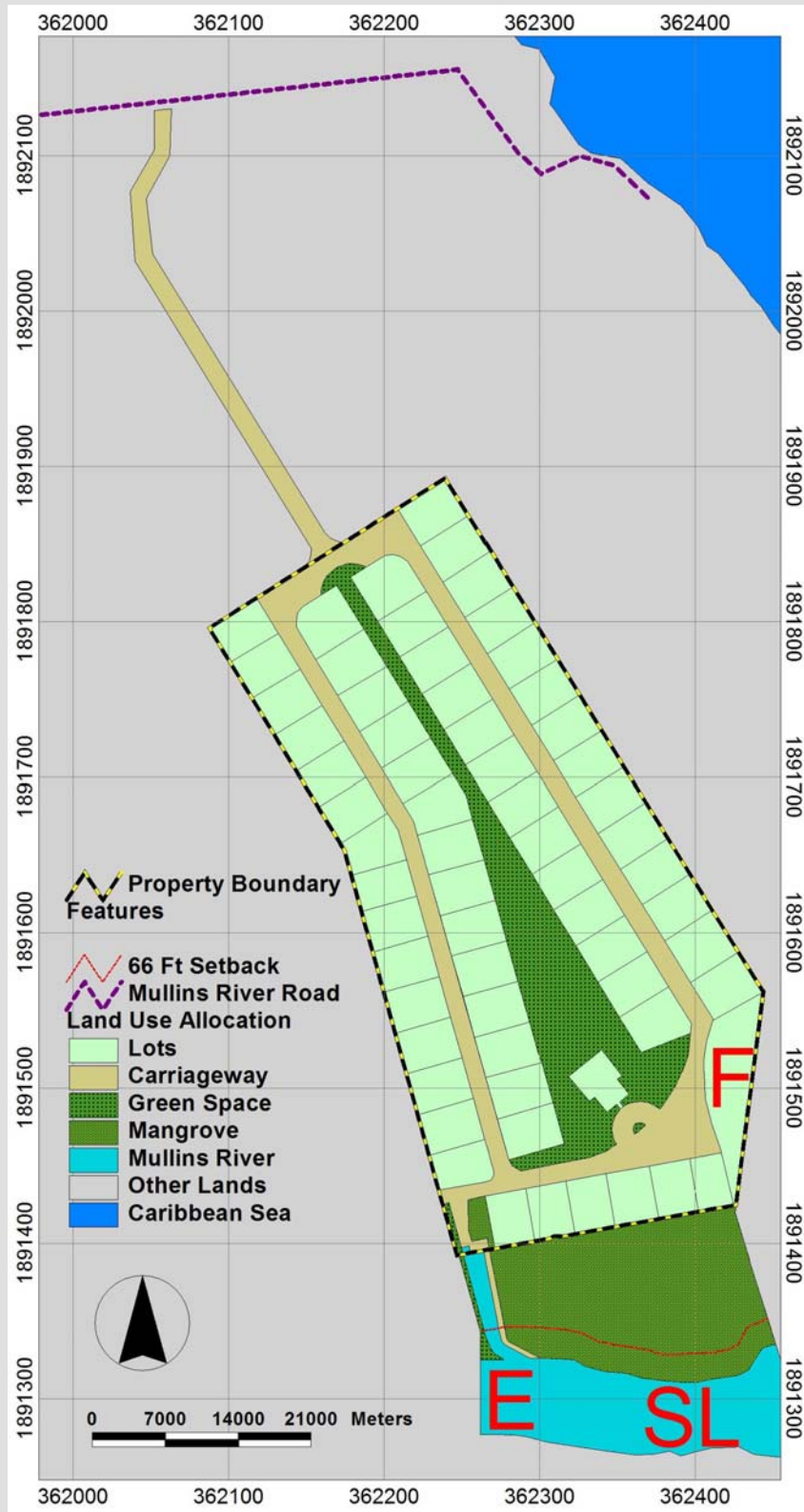


ILLUSTRATION 60: MONITORING PLAN FOR THE 22.5-ACRE DEVELOPMENT SITE



Liquid Waste Monitoring Requirements include quarterly assessment of prevailing Wagner Creek water quality conditions for Coliform and Vibrio bacteria population levels and nitrogen levels.

Solid Waste Monitoring Requirements consist of the need to ensure that staff designated to manage any and all incineration and composting areas are adequately trained in procedures and that the necessary arrangements have been made to cover composting pits in wet weather; and monthly inspection of incineration composting sites for appropriate management.

Energy Monitoring Requirements consist of monthly signed inspection of all primary electrical connection points to development structures, voltage levels, and utility infrastructure for damage and/or potential failure of function; weekly signed inspections of all fuel storage and power generating equipment for repair and/or maintenance requirements before and during operation; and monthly wildlife monitoring to determine the presence/absence of noise related impacts.

Wildlife Monitoring Requirements include weekly inspection of Wagner Creek water quality (turbidity in particular) for sediment travel into waters during construction activities; weekly inspection of effluent water concentration for dissolved solids and where possible, one or more indicator pesticide residues as indication of filtration effectiveness; quarterly inspection of any petroleum stores or dispensing facilities to insure the safety bond remains uncompromised; and standard monthly post-development inspection of the various development components for return of native wildlife, particularly bird species; if species abundance fails to return to pre-existing levels, the proponent will need to increase plantings of native fruit bearing trees having various sized fruits and flowering shrubs in order to promote the return of native birds and wildlife to the area.

Culture, Customs and Social Monitoring Requirements consist of the need for the proponent to make provision for an archaeological monitor, approved by the Belize Institute of Archaeology, to observe all material excavations on the proposed development property, for the purpose of advising preservation requirements in the event of an archaeological find during construction of the interior waterway or marina basin and also the need for DOE to establish that at least two staff have been trained in emergency medical support.