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ENVIRONMENTAL ASSESSMENT REPORT

ON THE
PROPOSED SOUTHEAST PENINSULA ACCESS ROAD
ST. KITTS, WEST INDIES

(February 1986)

Prepared For
The Government of St. Christopher-Nevis

Prepared By
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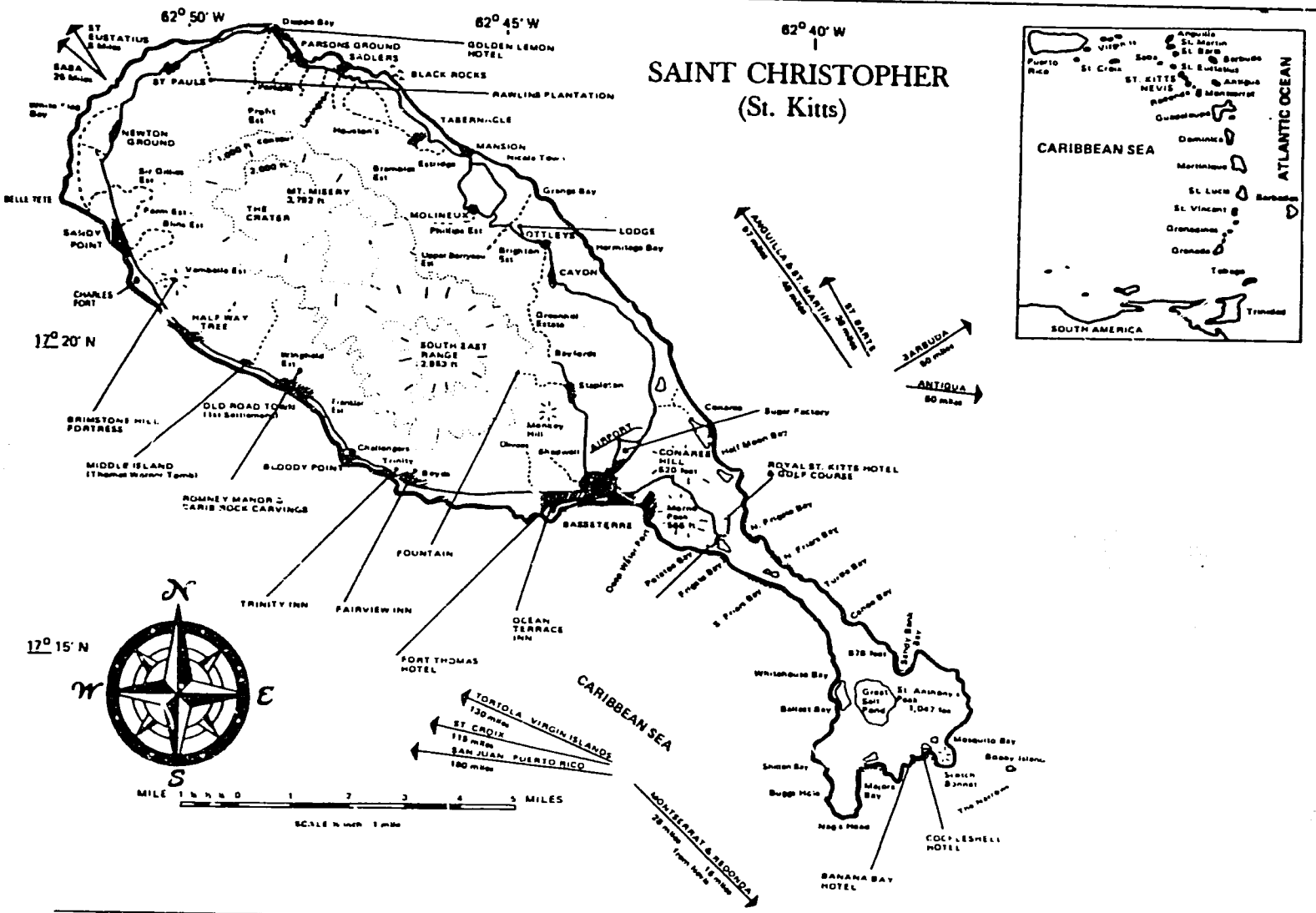

Island of St. Kitts, West Indies, including Southeast Peninsula (source: St. Kitts-Nevis Tourist Board, Tourist Guide, November 1984).

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ACRONYMS

A&E	Architectural and Engineering (contract or firm)
AID	Agency for International Development (U.S.)
CCA	Caribbean Conservation Association
CEP	Country Environmental Profile
CIDA	Canadian International Development Agency
CITES	Convention on International Trade in Endangered Species
EA	Environmental Assessment
EAR	Environmental Assessment Report
ECNAMP	Eastern Caribbean Natural Area Management Programme
EEU	Environmental Engineering Unit
EIA	Environmental Impact Assessment
EMU	Environmental Management Unit
ERP	Environmental Research Projects
FBDC	Frigate Bay Development Corporation
GIS	Geographic Information System
GOSK	Government of St. Kitts-Nevis
IRF	Island Resources Foundation
IUCN	International Union for the Conservation of Nature and Natural Resources
LUMP	Land Use Management Plan
NGO	Non Government Organization
PMPP	Public Management and Policy Planning Project (U.S. AID)
RBF	Rockefeller Brothers Fund
RO-RO	Roll On - Roll Off (truck/ferry terminal)
SEP	Southeast Peninsula
USAID	United States Agency for International Development
USAID/RDO/C	U.S. Agency for International Development/Caribbean Development Office/Caribbean
WATS	Western Atlantic Turtle Symposium
WWF	World Wildlife Fund

ABBREVIATIONS

cfs	cubic feet per second
cm	centimeter
cm/sec	centimeters per second
gpd	gallons per day
kg	kilogram
km	kilometer
kn	knot
m	meter
mgd	million gallons per day
mm	millimeter

1. SUMMARY AND KEY RECOMMENDATIONS

1.1 Background

The Government of St. Christopher-Nevis and the United States Government (through its Agency for International Development [AID]) are considering a project to build a 10 km penetration road into the Southeast Peninsula of St. Kitts for the purpose of providing access to and stimulating economic development in the area. U.S. regulations require that prior to project approval an Environmental Assessment (EA) be prepared as recommended in the Initial Environmental Examination (IEE) approved in June 1985 (Talbot, 1985).

On August 16, 1985, the Government of St. Kitts-Nevis issued a formal "Tender for an Environmental Assessment," and the Island Resources Foundation (IRF), a non-profit environmental planning institution based in the Eastern Caribbean, submitted its proposal on September 3. Subsequently, a contract was entered into at Basseterre on September 25, 1985, between the Government of St. Kitts-Nevis (the contracting agency) and the Island Resources Foundation (the contractor). IRF was to assemble a professional team of specialists and prepare an Environmental Assessment Report (EAR) which would, as required by 22CFR Par. 216 AID Environmental Procedures, examine foreseeable impacts of activities undertaken by the proposed project on the human and natural environment and propose measures to mitigate or reduce negative effects to the best practicable extent.

1.2 Issues and Scope of Work

The EAR was to establish whether the project would involve unreasonable degradation, defined as follows:

(1) significant changes in biological diversity within the affected area;
(2) loss of endangered species or their habitat (refuge area, nesting sites, feeding grounds and the like); and
(3) loss of aesthetic, recreational, archaeological, scientific, or economic value which is unreasonable in direct relationship to the proposed activity, as well as "irreparable harm," i.e., significant undesirable effects occurring once the project is implemented.

Additionally, the contractor was to address the following issues and concerns:

(1) All items listed in the IEE prepared for the project (Talbot, 1985).

8'

(2) Land and facility development causing indirect impacts once access is gained to the Peninsula, i.e., once the road and other basic infrastructure such as water, electricity, and telephones as well as other facilities such as hotels, marinas, and the like, are operational.

(3) Possible data gaps which would preclude making prediction about impacts.

(4) Potential public vs. private sector conflicts, especially arising from the lack of a coordinated development programme for the Peninsula, which would result in direct or indirect negative impacts on the environment.

(5) Ecological and sociocultural impacts of increased sail or powerboat activities on water bodies on or adjacent to the Peninsula, including the marine shelf, seagrass beds, coral reefs.

(6) Impacts of road construction, mentioned in previous studies, especially areas indicated on pages 41-43 of the Jackson (1981) study.

(7) Unresolved issues which may impede an effective environmental protection plan.

Lastly, the contractor was to include necessary measures to reduce or eliminate negative impacts on the human and natural environment, including any guidelines to be included in road construction activities to reduce soil erosion and other negative impacts. A listing of these mitigating measures was also required as part of the final report summary (see below).

1.3 Findings

1.3.1 Ownership

Excluding the beaches and the northerly half of Sir Timothy Hill (which are both owned by Government), the 4,000 acre Peninsula currently is privately owned by approximately 30 individuals, companies, trusts or partnerships. Land ownership, parcel size, key resource features, known development plans and site-specific impacts and constraints are summarized in Table 1.1, which is keyed to the accompanying ownership map of the Southeast Peninsula (Figure 1.1).

From discussions with various owners (October 1985), it appears there are differences of opinion over certain boundaries and some question about the "ownership" of several of the salt ponds. All owners interviewed (see List of Contacts) were cooperative and genuinely interested in being helpful by providing information, but there is no master ownership list or map as yet nor an accurate accounting of

Table 1.1. Land ownership and major impact concerns arising from development plans for present land holdings on the Southeast Peninsula, St. Kitts. See also Figure 1.1.

MAP REF. # (Figure 1.1)	APPROXIMATE SIZE	LAND OWNER (S)	RESOURCE FEATURES	DEVELOPMENT STATUS and PLANS	DEVELOPMENT IMPACT CONCERNS
1	850 acres	Frigate Bay Development Corp. (Govt. of St. Kitts-Nevis)	8 ponds; open, low hills; 500 m Caribbean beach; 1500 m Atlantic beach	Golf Course; 356 hotel/condo rooms; residential housing; infrastructure; 24 rooms partially completed Proposed: 100 rooms and central sewage treatment	Drainage; nutrient impact on marine systems; beach erosion; Timothy Hill scenic value loss; mangrove damage; dune vegetation removal; unregulated sand mining; road impacts
2	312 acres	George Michelle Archi Zuliani Kutayba Alghamin	North Friar's Bay beach and dunes; South Friar's Bay beach; Friar's Bay Pond Red/White/Black Mangroves; wading and shore birds; nesting sea turtles High resort tourism potential	Status: recently acquired by purchase from the Wigley family Plans: 2 large hotels (one each on Atlantic/Caribbean sides), condos, marina at Friar's Bay salt pond	Modification of dune system would limit natural defence against storms, hurricanes; loss of mangrove wetland and bird species it supports; pond as sediment trap; reduction in sea turtle nesting or hatchling survival
2A	1.7783 acres	R. Andrews	Friar's Bay	2 housing lots on hill	soil erosion
2B	2.7502 acres	C.G. Wigley	Friar's Bay	2 housing lots on hill	soil erosion
3	250+ acres	Reginald Kawaja	Canoe Bay Beach; Turtle and Pyms Bay; Salt Pond Hill (NE portion); Canoe Bay historic sites; Atlantic exposure Scrub woodland; back beach forest; sea turtle nesting Moderate residential/tourism potential	Unknown	Accelerated erosion from building on steep slopes; reduction in turtle nesting
4	200+ acres	Dr. W. Herbert	Grape Tree Bottom; Salt Pond Hill (NW portion) Caribbean exposure Scrub/grasslands Steep, rocky shoreline, cliffs Moderate residential/tourism potential	Unknown	Accelerated erosion from building on steep slopes Sediment impact on near-shore marine habitats

MAP REF. # (Figure 1.1)	APPROXIMATE SIZE	LAND OWNER (S)	RESOURCE FEATURES	DEVELOPMENT STATUS and PLANS	DEVELOPMENT IMPACT CONCERNS
5	850 acres	Jack Wigley Ian Reid Reginald Kawaja	Little Salt Pond (?) Great Salt Pond Sand Bank Beach Salt Pond Hill (so. portion); Sugar Loaf Hill; Atlantic and Caribbean exposures; White House Beach Nesting sea turtles; flat grasslands; dry woodland and mangroves; wading and shore birds (nesting/foraging areas); archaeological sites High tourism potential	250 room hotel at Sand Bank Bay and marina at Great Salt Pond being discussed with investor; sale of entire holding also being pursued	A degraded Sand Bay dune would limit natural defence against storms, hurricanes; loss of Great Salt Pond as a sediment trap; effects on coastal resources by exposure to sediments via marina channel; problems in disposing dredged materials
6	c. 23 acres	Jacques Cramer	Guana Point Reef; access to Little Salt Pond	Water sports facility Residence	Accelerated erosion from building construction
7	483 acres	Charles Wilkin Jacques Cramer Colin Periera	Mosquito Beach; St. Anthony's Peak; salt pond; steep hillsides; shore birds; scrub/woodland vegetation; dunes High tourism potential	50-60 room hotel at Mosquito Bay 1-2 acre residential lots on slopes	Accelerated erosion from building on steep slopes Modified drainage
8	20? acres	Mrs. E. Walker		Unknown	Modified drainage
9	20 acres	Mrs. M. Sabastian	Archaeological site	Unknown	Modified drainage
10A 10B 10C 10D 10E 10F 10G 10H 10I 10J	21 acres 30 acres 21 acres 6 acres 1 acre 1 acre 1 acre 2 acres 2 acres unknown	Sue-Carib Industries Tropi-Canada Properties Betts Realty Leeward Island Trust David J. Onglen David Hayden Steven Cagangh Jane Elliott Simon Withers Carib (Realtors) Canada	Major's Bay Beach and Pond Scrub woodland; grassland; Least Tern nesting; spiny lobster nursery (nearshore); archaeological sites; sea turtle nesting	Unknown (originally owned by M. Goldgar)	Development could further increase erosion
11	100 acres	F. Kelsick	St. Anthony's Peak Steep terrain; scrub vegetation Residential/tourism potential	Unknown	Accelerated erosion from development

MAP REF. # (Figure 1.1)	APPROXIMATE SIZE	LAND OWNER (S)	RESOURCE FEATURES	DEVELOPMENT STATUS and PLANS	DEVELOPMENT IMPACT CONCERNS
12	900 acres (possibly less parcels 10/13 acreage sold in 1960)	Michael Goldgar	Dry grassland; scrub woodland; nesting colony of Frigate Bird and Brown Pelican	Unknown	Loss of key wildlife habitat; development could increase soil erosion and sedimentation impacts on marine communities
13	6.57 acres	F. Kelsick	Small salt pond; mangroves	Unknown (originally owned by M. Goldgar)	
14A	6.50 acres	Carl Fuchs (Banana Bay Hotel)	Banana Beach	Hotel is open and up for sale	
14B	10 acres	Cockleshell Beach	Cockleshell Beach Sea turtle nesting	Closed; reportedly, recently sold to LORMAD	
15	?	?	Mosquito Bay (part) Salt pond; turtle nesting	Unknown	
16	5 acres	John Napier	Whale Back Hill	Unknown	
17	22.30 acres	Mrs. E. Walker	Mosquito Beach (part) Cockleshell Beach (part) Sea turtle nesting	Possible small tourism resort complex	Beach erosion; reductio in sea turtle nesting
18A	?	Bruce Wiggins	Scotch Bonnet Little Monkey Hill	Unknown	
18B	?	June Mestier	Scotch Bonnet	House Lot	
19	6? acres	Chris Walwyn	Scotch Bonnet Cockleshell Bay	Unknown	
20	4.78 acres	Campbell Evelyn	Mosquito Beach (part) Sea turtle nesting	Land willed to young children; no development planned	Beach erosion
21	?	Michael Goldgar	Narrow strip between beach and pond from parcel 6 to 13; controls access to Little Salt Pond from Ballast Bay	Marina Entrance Channel Dredge-Cut?	Archaeological site
22	10? acres	Mrs. R. Bradshaw	Chaney Ruins "Old Cotton Grounds" Great Salt Pond access		

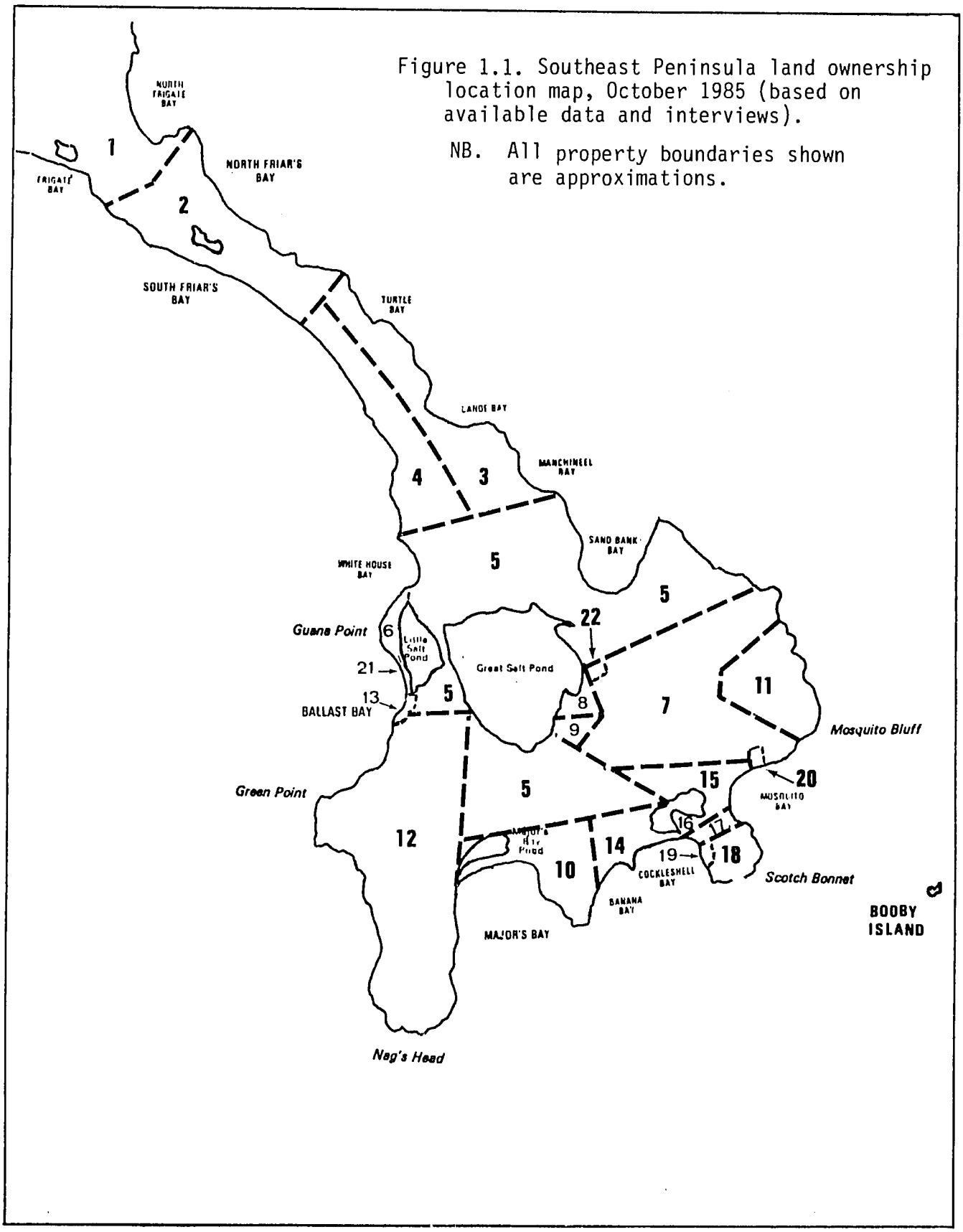


Figure 1.1. Southeast Peninsula land ownership location map, October 1985 (based on available data and interviews).

NB. All property boundaries shown are approximations.

parcel acreage, boundaries and in-holdings. The EA team began investigation of SEP land ownership with a list of 12 owners provided by Government and has now identified over 30. This list is undoubtedly not yet complete. A boundary survey needs to be undertaken and an accurate ownership list and map prepared, prior to starting the road if possible but certainly before its completion.

The current situation, with several large land holdings and many smaller ones, will present problems over time in establishing a consensus on various environmental issues, wildlife protection strategies, and the acquisition of land for public use and management as parks, protected habitats, and recreational areas. Initially, the Government and landowners should each develop a planning committee with a spokesperson to begin and maintain an ongoing dialogue with the other. Perhaps, at a later date, the committees should be combined as a single "steering committee" for Peninsula development.

1.3.2 Resource Assessment and Mapping

Important Peninsula terrestrial wildlife habitat locations, largely as determined by Arendt (1985), are displayed in Figure 1.2, and prospective parks, protected areas and special resource management zones are presented in Figure 1.3.

Critical wildlife species requiring fairly prompt management attention in a programmatic sense include all three endangered turtle species (green, hawksbill, and leatherback), the endangered brown pelican, the least tern and the frigate bird. All three bird species maintain nesting colonies on the Southeast Peninsula. Legislative modifications and government-sponsored monitoring and habitat protection strategies should be in place and functional before the road construction starts. Detailed recommendations for all six species are presented in Section 5, with additional commentary on pertinent environmental legislation and needed changes provided in Appendix E.

Critical marine areas warranting further evaluation and long-term monitoring as prospective candidates for marine park or preserve status include Major's Bay, Guana Reef and South Friar's Bay (see Section 2.4). Their optimal size, shape and external boundaries can not be determined at this time. Nevertheless, a preliminary management plan for each area should be prepared, with the Fisheries Unit of the St. Kitts-Nevis Government taking the lead under the new Fisheries Regulations to be promulgated shortly (see also Salm, 1984).

Eight sandy beaches where turtle nesting has been reported and observed (see Table 2.5) should be included in a sea turtle monitoring, protection, and management programme, as outlined in Section 5. However, all 21 Peninsula beaches (see Table 2.3 and Figure 2.4) should be targeted for systematic observation as an element within the larger framework of a yet-to-be-developed Peninsula-wide environmental monitoring programme to precede and coincide with the road construction.

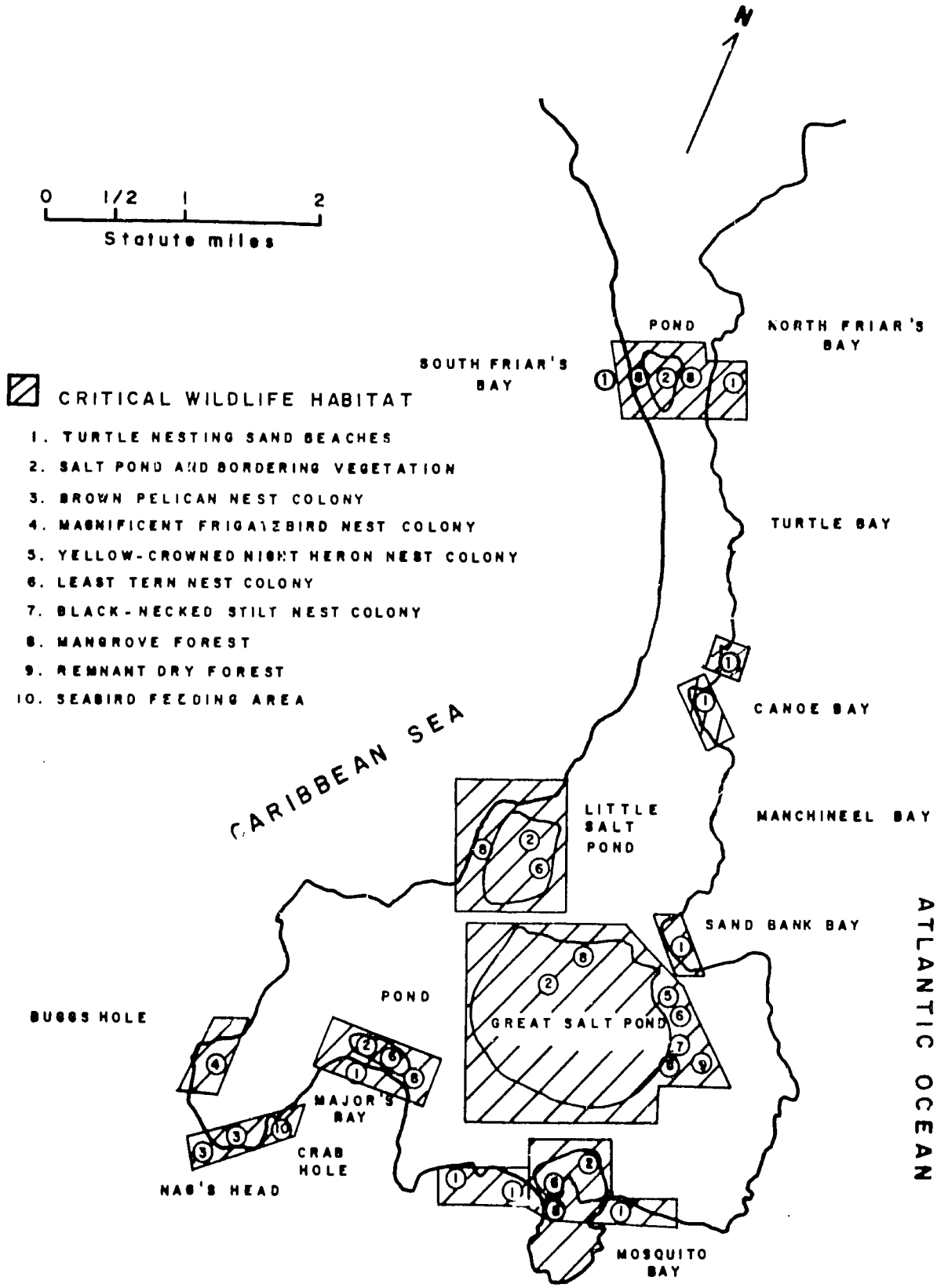


Figure 1.2. Critical habitat for Southeast Peninsula wildlife (source: Arendt, 1985).

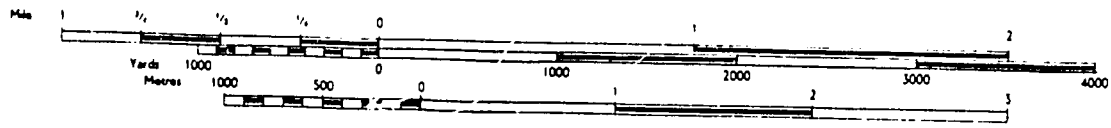


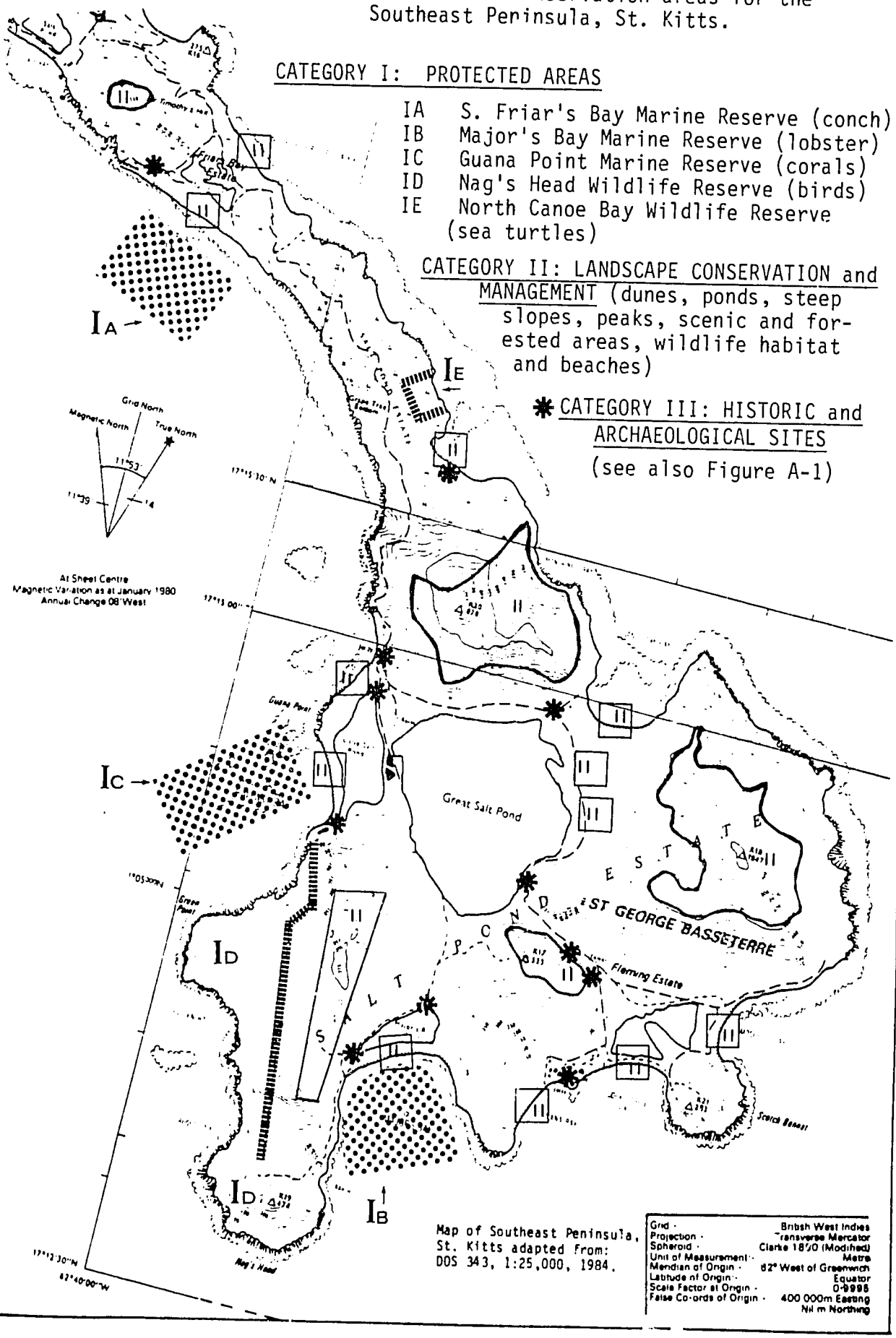
Figure 1.3. Recommended conservation areas for the Southeast Peninsula, St. Kitts.

CATEGORY I: PROTECTED AREAS

IA S. Friar's Bay Marine Reserve (conch)
IB Major's Bay Marine Reserve (lobster)
IC Guana Point Marine Reserve (corals)
ID Nag's Head Wildlife Reserve (birds)
IE North Canoe Bay Wildlife Reserve (sea turtles)

CATEGORY II: LANDSCAPE CONSERVATION and MANAGEMENT (dunes, ponds, steep slopes, peaks, scenic and forested areas, wildlife habitat and beaches)

✱ CATEGORY III: HISTORIC and ARCHAEOLOGICAL SITES (see also Figure A-1)



Map of Southeast Peninsula, St. Kitts adapted from: DOS 343, 1:25,000, 1984.

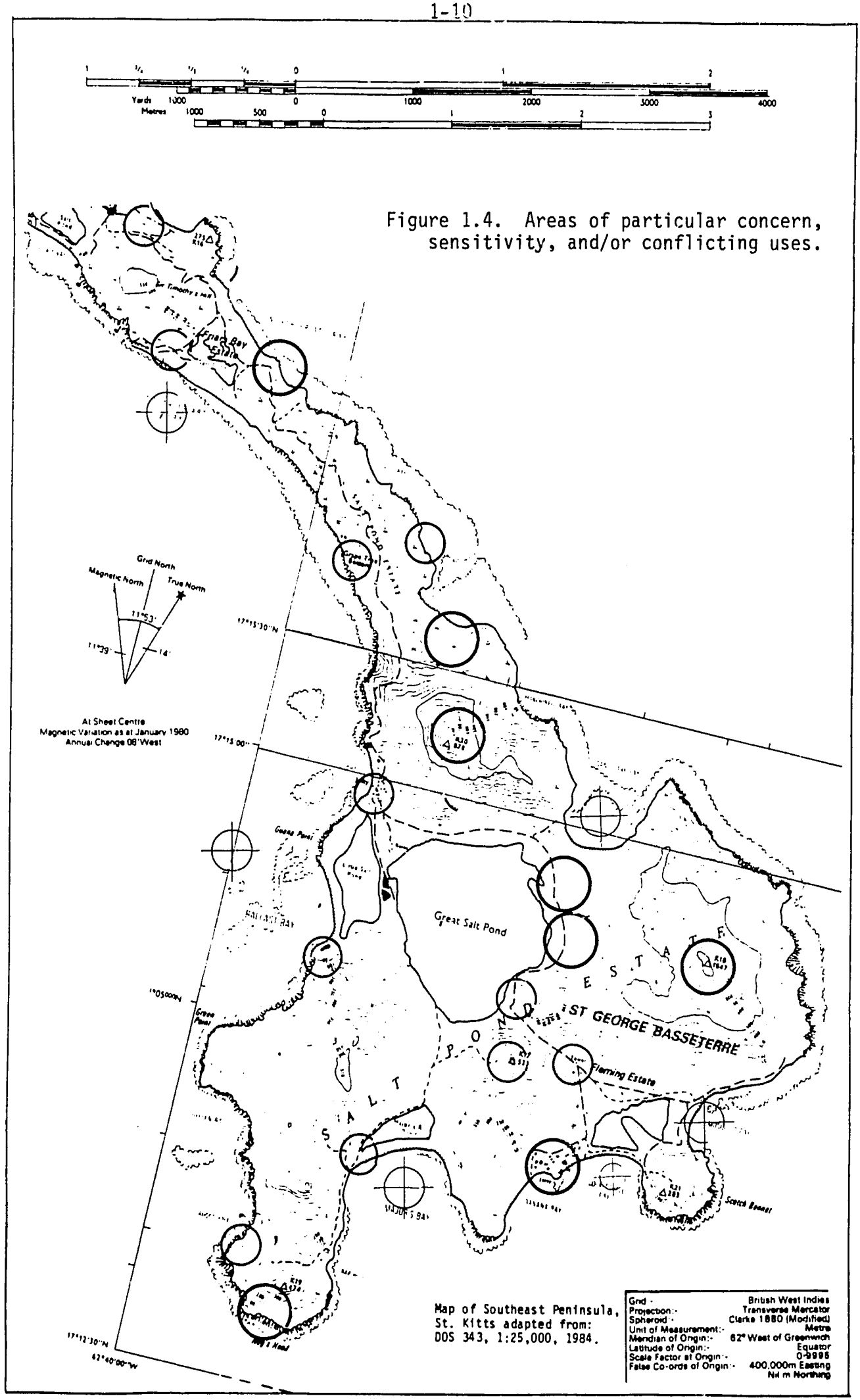


Figure 1.4. Areas of particular concern, sensitivity, and/or conflicting uses.

Figure 1.4 identifies those areas and resources on the Peninsula that have some unique or valuable features likely to be ecologically disrupted or stressed by primary and secondary impacts of constructing the proposed road and by the associated development activity presumed to follow in train. They represent the preliminary universe of landscape features, wildlife habitats and sites requiring special environmental management strategies and, in some cases, long-term monitoring and protection, if not acquisition by Government.

Detailed discussions and mapping of Peninsula shelf bathymetry, marine resource features, shoreline characteristics, beaches, wildlife, archaeological sites and historical land use patterns are provided in Section 2. Section 3 describes the proposed action, the purpose of this study and local perspectives on the Southeast Peninsula road and tourism development project presently being investigated. Section 4 provides a more specific inventory of impacts and their significance and suggests mitigation strategies. Detailed recommendations for improved environmental planning, protection strategies, and action programmes are presented in Section 5.

1.3.3 Road Impacts and Mitigation

The purpose of the proposed 10 km road from Frigate Bay to Major's Bay is to provide access to the 4,000 acre undeveloped Southeast Peninsula in order to stimulate external investment in tourism facilities, encourage economic development and expand local employment opportunities. However, the 1981 Roughton engineering plan and original routing of the road is somewhat out-of-date as it was designed to serve a slightly different purpose and, therefore, poses certain problems, which can be summarized as follows.

(1) Its southerly terminal point at Major's Bay was selected to accommodate linkage with a Ro-Ro (Roll-on/Roll-off) freight terminal and dock to serve Nevis, a scheme now abandoned. This permits and requires reselection of a terminal point based on new criteria which should be set out in the Land Use Management Plan (Major's Bay? Cockleshell Bay? Banana Bay? White House Bay?).

(2) Presently the proposed road passes east of Great Salt Pond, but a routing on the westerly side might be preferable for three reasons: (i) it would avoid the cluster of avian wildlife nesting habitats on the west; (ii) it also would put the road closer to the proposed marina/safe harbour/dock area at Little Salt Pond; and (iii) it is shorter and probably would reduce costs.

(3) In the absence of heavy Ro-Ro trucking traffic (as originally planned in 1981) a slightly steeper road grade might be permissible and allow an improved routing to avoid certain projected adverse impacts identified in this study (as discussed below in Section 4). A lower peak elevation would also reduce water supply pumping demand and costs for energy.

Direct impacts of the Peninsula road, if built as designed, and projected road construction activities are summarized in Table 1.2. Indirect impacts, resulting from the road (access, recreational use, and development activity), are presented in Table 1.3. Recommended mitigation strategies are included for both direct and indirect impacts. More detailed environmental management action strategies are outlined, however, in Section 5. At the very least, serious consider tion needs to be given to:

(1) minimizing erosion impacts, both during and post-construction;

(2) minimizing "cut" size and cut surplus as well as "scar" effects and scenic degradation;

(3) including overlook turn-outs at key scenic areas;

(4) avoiding dunes, archaeological sites, and critical wildlife habitats;

(5) extensive replanting of damaged landscape and beautification of roadsides and roundabouts.

All of the above should be written into both the construction and the independent supervisory contracts for building the road.

1.4 Unresolved Issues

1.4.1 Government/SEP Landowners Relationship

The absence of any organized and regular dialogue between Peninsula landowners (especially those with major holdings) and Government presents a serious environmental risk. Coordinated, cooperative action and advance concurrence by Government planners and private sector developers in the pursuit of impact mitigation and resource management strategies are very important if such efforts are to succeed in a non-adversarial, cost-effective manner.

For example, the sooner the Government can obtain a relatively clear picture of the full spectrum of landowner development objectives, intentions and plans, the better it will be able to design practical and reasonable facilities design and site loading guidelines for quality control in both early and later site-specific private sector development schemes. The sooner landowners become familiar with the policy and regulatory framework likely to be employed by Government to guide SEP development activity, the quicker they can proceed with project design and financing plans that will not later have to "go back to the drawing board" for costly re-thinking and redesign because they fail to meet certain criteria.

Table 1.2. Southeast Peninsula access road (design and construction): summary of direct impacts and mitigation options (see sections 4 and 5 for details).

Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
Southeast Peninsula Landscape	Road Design/ Final Siting & Routing	Damage to: - wildlife habitats - dunes and dune vegetation (Friar's Bay) - archaeological/historic sites - skyline aesthetics	1. Avoid wherever possible 2. Archaeologist to check final route, examine excavations and conduct salvage archaeology if required; contractor's terms to include provision for brief stop-work period to permit salvage
Southeast Peninsula Landscape	Road Design/ Grade/Peak Elevations (currently not optimum)	Water Pumping Costs Fuel Costs	1. Strive for lowest possible peak elevation of road to reduce capital and recurring energy costs for pumping potable water (would also reduce user vehicle energy costs)
Southeast Peninsula Landscape	Road Design/ Emergency Turn-outs, Overlooks (not now planned)	Failure to provide would present safety risks and diminish aesthetic effect	1. Make provisions for in final road design; Land Use Management Plan to recommend locations for turn-out stations, overlooks
Southeast Peninsula Landscape	Road Construction/ Drainage and soil disruption and exposure to erosion, sediment loss and downslope movement to the sea	- loss of thin soils and sediment cover - accelerated downslope sediment movement resulting in negative impact on coastal waters, beaches and benthic organisms, due to turbidity and other effects	1. Develop erosion control/sediment reduction plan 2. Protect exposed soil (cut & fill slopes): - grass seed, planting - mulching (fixed to slope where required) 3. Prevent channel and roadbed erosion by: - paved and grouted ditches - back sloping road surface toward hill - oversized catch basins & culvert pipe (at least to 25 yr. storm size) - grouted rock flow checks (dikes) in drainageways 4. Reduce downslope sediment movement by installing temporary sediment traps/ filters below all major fill slopes in guts and clear as required until road is finished and slope is stabilized by vegetation [Lashley's (1985) proposed modification to the Roughton (1981) design re larger cuts to reduce gabion use is not satisfactory and not recommended as it will result in accelerated erosion downslope into coastal waters] 5. Government to establish and deploy erosion/sediment management monitoring team to oversee construction phase

Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
Southeast Peninsula Landscape and Coastal Waters	Road Construction/Wastes 1. Oil and Tar	Casual disposal of waste hydrocarbon-based fuels, oils, greases from heavy earth-moving machinery and vehicles and waste asphalt/ tar could damage vegetation in drainage cuts and injure coastal environments	1. Establish waste oil disposal routine (containers, pick-up, etc.)
	2. Plastic Film	Thin plastic waste material (lunch bags, cement bag liners, etc.) is deadly to sea turtles when ingested	1. Establish a waste clean-up and disposal plan for road construction site(s) 2. Conduct environmental education instruction for construction crews
	3. Construction material, machinery, cement bags	Aesthetically unacceptable; fire hazard	1. Design/establish a solid waste clean-up and disposal strategy; Land Use Management Plan to select possible SEP dump site (or use of Conaree)
	4. Excess Fill	Lashley's (1985) cut plan generates surplus, normally tipped on downslope side of road, exacerbating erosion/ sedimentation effects on coastal waters	1. Balance cut and fill volume 2. Use excess fill for overlooks and turn-outs 3. Mulch and re-vegetate all surplus/ waste fill slopes 4. Use Roughton cut design and gabions
	5. Scrub/Brush Removal	Fire hazard	1. Deploy brush chopper and use as mulch for erosion control and soil stabilization
Southeast Peninsula Landscape	Road Construction/ Beach use as a barge/staging area (White House? Friar's?)	Risk of damage to beach berm, dune, nesting sea turtles, vegetation	1. Select staging area carefully, monitor wastes, restore to original state upon completion
Southeast Peninsula Landscape	Road Construction/ Crew access prior to resource protection mechanisms being in place	Sea turtle exploitation, hunting, disturbance of bird nesting colonies, trash, "joy-riding," brush fires	1. Monitor off-hours crew use of Peninsula resources 2. Conduct environment education sessions for crew 3. Establish police/enforcement presence on Peninsula during construction (including night visits to apprehend turtle poachers)

Table 1.3. Southeast Peninsula access road: summary of indirect impacts of development (see Sections 4 and 5 for details).

Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
SEP (all areas made accessible by new Peninsula road)	Opening of Road (providing easy public access) [NB. assumes no tourism development activity]	-expanded recreational use (local and tourist) -expanded hunting -expanded turtle poaching -expanded beach use -indiscriminate vehicular parking damaging to vegetation -increased trash/garbage -increased fishing -trespassing on private property -need for public toilet facilities -need for marked public access to beaches	1. Recreation Management Plan 2. Waste Management Plan 3. Beach Management Plan 4. Wildlife Management Plan 5. Resolve/confirm beach access routes with landowners 6. Installation of toilets, car parks, signs 7. Establishment/promulgation of rules and regulations 8. Monitoring Programme 9. Police patrol schedule 10. Acquisition of land by Government for public purposes (parks, recreational facilities) 11. Implementation of public environmental education programme
Beaches (all)	-expanded use -tourism facilities -sand mining for construction -vegetation damage and removal -structures in foreshore and nearshore -litter	-beach erosion -beach destabilization (increased variability) -net sand loss (narrowing and steepening of foreshore -interruption of sand replenishment process -reduced beach quality -increased wind erosion and sand loss -reduced aesthetic value -compaction	1. Develop and implement a beach management/monitoring plan 2. Develop guidelines for beach use 3. Prohibit all beach and berm sand extraction/mining (see also dunes) 4. Establishment of clear lines of responsibility for each beach 5. Require licences or permits for all large beach parties, fetes, etc., with clear clean-up provisions and an enforcement mechanism 6. Develop a litter control/trash and garbage system (containers, pick-ups, beach clean ups, etc.); however, see sea turtles, Section 5 re compaction
Sand Dunes (Friar's Bay, Sand Bank Bay, Mosquito Bay)	-vehicle traffic -sand mining -beach access (road and trail construction) -tourist facility construction	-vegetation damage and removal acceleration -wind-driven movement of sand and dune translation -sand mining eliminates coastal barrier effect of dune system against storm waves	1. Primary dune systems and their associated strand vegetation should not be removed, mined, modified or "used" except as natural storm barriers and sand sinks for the beach; foot traffic should be restricted 2. Passage to a beach where a dune system exists should be effected via a raised wooden walkway or boardwalk, set above the vegetation wherever possible 3. If cuts through the dune system are made to provide access to the beach, they should be a) narrow, b) not at right angles to the beach, c) preferably "Z" shaped with a "dog leg"

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Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
Sand Dunes (continued...)			4. Larger dune systems, well away from the beach, may be considered a possible source of construction sand; careful site selection, a permitting system and monitoring of such sand mining are essential; a yardage fee should be charged
Salt Ponds (Friar's Bay, Little Salt Pond, Great Salt Pond, Major's Bay)	-proposed marina and water sports center (requiring dredging and opening to sea)	-difficulty of sea discharge of dredge spoil (anoxic fine sediments) without severe damage to marine environment due to induced turbidity, etc. -difficulty of maintaining an opening to the sea without destabilizing beach sand budgets -loss of sediment trap function of salt pond -impact on wildlife -destruction of mangroves (where present) -toxic materials discharge to coastal waters	1. Conduct careful site specific environmental impact assessment to achieve optimum design/minimum damage 2. Barge spoil offshore for deep-sea dumping 3. Conduct careful geophysical/engineering study of coastal dynamics re siting and design of opening cut 4. Disturb as few mangroves as possible (using elevated walkways, etc.) 5. For Little Salt Pond only, consider using spoil to create an "island" for wildlife in center of Great Salt Pond 6. Land Use Management Plan to include salt pond use guidelines and rank marina constraints and potential
SEP Receiving Environment (various sites)	Sewage Discharge/ -tourism facilities waste water and sanitary systems	-high nutrient discharge into receiving water (ground, pond or sea) -pollution effects -environmental health risks -cost of treatment	1. Develop standards appropriate to development sites 2. Develop "package treatment plant" requirements 3. Evaluate central plant possibility for the long-term 4. Evaluate ocean outfall strategy 5. Evaluate sewage lagoon (facultative) options as low capital and maintenance costs may override large land use requirement
SEP Receiving Environment (various sites)	Sewage Discharge/ -residential and small facility waste water and sewage disposal	-nutrient discharge to ground water -environmental health risks -impractical to connect to central sewerage system	1. Enforce existing code re septic tanks (soak-pits) and soak-aways 2. Use percolation test for each site to establish system size and drain field dimensions and multi-site spacing/loading
Water (potable)	Tourist and residential demand (proposed 10" main under road supplied from Frigate Bay resevoir at Morne Hill)	-high pumping costs -dependency on distant supply and single water main -risk of interruption due to electrical or pipe failure	1. Require cisterns (and gutters and downspouts on all buildings; suggest minimum 5 gallons of cistern capacity/sq ft of roof area) 2. Require full metered hook-ups 3. Require installation of dual systems (cistern and main)

Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
water (potable) continued...		-no "encouragement" to conserve water use	4. Charge full delivered cost for water to encourage use of cistern water and maintenance of catchment systems 5. Encourage water conservation strategies in tourist facilities and residential design 6. Possibly establish SEP "water district" for management and billing/installation amortization purposes 7. Recycle package plant secondary effluent via polishing ponds and use for landscaping, etc.
Pelican Nesting Colony/Nag's Head	Disturbance by: -visitor intrusion -hunters -development -noise -pesticides	-reduced nesting -loss of nesting colony -population loss NB. Brown pelican is on Endangered Species List and is the national bird of St. Kitts-Nevis	1. No development at/near site 2. Prepare Species Management/Protection Plan 3. Establish required rookery boundaries, negotiate with landowners 4. Protect rookery as park/reserve area 5. Post signs, monitor 6. Amend wildlife regulations to include pelican and provide enforcement of protected status 7. Provide environmental education regarding wildlife conservation
Frigate Bird Nesting Colony/Nag's Head	Same as Above	-loss of rookery (not an endangered species but important to St. Kitts fishermen)	Same as Above
Least Turn Nesting Colonies/Great Salt Pond (Figure 1.2)	Same as Above	-reduced nesting -population loss -predation by dogs, mongoose -flooding	1. Minimal development near sites 2. Prepare management plan and institute monitoring regime 3. Temporary fencing and sign posting 4. Provide environmental education regarding wildlife conservation
Migratory and Local Terrestrial Birds (Figure 1.2)	-road routing -facilities siting -pesticides	-habitat loss	1. Select critical, high priority habitats for inclusion in SEP park/preserve system 2. Post signs and monitor areas so designated 3. For other sites, negotiate with landowners for no development/green space private sanctuary status (i.e., conservation easement)

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Resource Category Affected/Location	Development Action/ Cause/Problem	Adverse Impact(s)	Mitigation/ Recommendations
Sea Turtle Nesting (Beaches indicated in Table 2.5)	-beach use & traffic -tourism facilities siting -improved access -beach and shore lighting -more dogs	-beach nest compaction -egg predation (animals) -egg collecting (humans) -nesting female capture -nestirg deterrence by lights -reduced hatch levels and hatchling survival	1. Develop and implement SEP Sea Turtle Protection/Management Plan 2. Monitor beaches, nesting, nests, hatchlings 3. Obtain Peace Corps volunteer with sea turtle expertise to assist Fisheries Unit 4. Finalize 5-year moratorium under fisheries regulations 5. Carry out sea turtle element of environmental education programme

Since both Government and the landowners have a common interest in the development of the Southeast Peninsula, it is important to establish the scope and dimensions of those shared and mutual interests -- and this includes marketing objectives and strategies. Once this common ground (in effect, a partnership) is defined and understood by all parties, emerging points of disagreement can be kept in proper perspective and also are less likely to be addressed in an adversarial, polarized context.

It is better to experiment with techniques for defining, refining, and formalizing a constructive working relationship between the Government and the owners group than to not communicate at all awaiting some "grand design" or format to be carefully put forth.

1.4.2 Fisheries Regulations

Although the St. Kitts-Nevis Government has recently enacted new fisheries legislation, the parallel administrative regulations have not yet been approved (Appendix E). Without these in place, it is difficult to predict what the role of the Fisheries Unit of Government could or should be in monitoring and protecting Peninsular coastal and marine resources. Many of the recommendations made in Section 5 are likely to require input from, if not operational management by, the Fisheries Unit, even if a new, broader natural resources or environmental management agency of Government is established (as recommended in Section 5).

1.4.3 Peninsula Road Routing and Terminal Point Selection

As noted above (Section 1.3.3), final route selection remains a future task which should be done by an engineering firm after the Land Use Management Plan is completed. But the nature and location of the southerly road terminal point remains unresolved at this time. Should the Ro-Ro terminal idea be revived, all steep grades would require a third or passing lane for the road to carry the anticipated trailer truck use without unnecessarily impeding normal vehicular traffic. The issue of feeder roads also remains unresolved and should be addressed, at least preliminarily in the Land Use Management Plan.

1.4.4 Keystone International's "Mandate" and SEP Development Rights

A clarification of the scope, viability and current validity and tenure of this prior (August 1981) arrangement is needed. Land use planning will be difficult until this matter is so clarified.

1.4.5 SEP Nevis Public Pier or Jetty Location

This issue should also be resolved, assuming a public jetty is still desired. Its design and siting could have significant environmental impact. It was originally (1981) sited on the eastern end of

Major's Bay. It obviously is related to and will be affected by (a) the road routing; (b) whether or not and where a marina is sited for construction; (c) development planning for Cockleshell, Banana, and Major's Bays; and (d) whether Major's Bay becomes a "protected" marine area or park, as herein recommended.

1.5 Conclusions

1.5.1 The Peninsula Road

We conclude that the proposed road construction will not involve unreasonable degradation of the living and non-living resources of the Southeast Peninsula and its environs, assuming that the following conditions are met:

(1) an erosion control/sediment reduction plan and pollution control impact mitigation strategy is incorporated into the final engineering design for the road and is made part of the contractor's "specifications;"

(2) the impact concerns and mitigation recommendations outlined in Tables 1.2 and 1.3, and described in detail in Section 5 of this report, are carefully evaluated and incorporated into the final road design and/or the erosion control/sediment reduction plan, as appropriate;

(3) a separate Architectual and Engineering (A&E) contract is let for the supervision of both the engineering performance of the road contractor and the contractor's adherence to environmental impact mitigation requirements as specified in the primary contract terms of reference;

(4) the Government of St. Kitts-Nevis assigns at least one engineer to work with the A&E supervisory team and to inspect regularly the road construction site and ensure that the contractors perform according to the protection plan (this will be an excellent opportunity for the Government's engineer to become more familiar with a broad spectrum of erosion control measures, practices, and procedures);

(5) the proposed Government Environmental Management Unit (EMU) designs and mounts a coastal environmental monitoring strategy regarding beaches, sediment input, turbidity, waste disposal, and wildlife, as specified in Section 5.5.

1.5.2 Peninsula Development (made possible by road construction)

We conclude that the nature, level and pace of development likely to follow completion of the Southeast Peninsula road will be manageable if the conditions listed below relating to improved Government capacity to manage environmental resources are met and the rate of Peninsula tourism growth does not exceed the maximum limit set in the Land Use Management Plan, now scheduled to follow the Environmental Assessment study. In this event, we do not foresee any unreasonable degradation of the living and non-living resources of the Southeast Peninsula. In fact, we view the SEP project as a vehicle by which the Government of St. Kitts-Nevis could substantially improve its capacity to address both Peninsula and country-wide environmental and resource management issues.

The Government has the will and commitment to carry forward a co-ordinated and well-planned development strategy for the SEP with careful attention to environmental sensitivity and the unique resource features of the Peninsula. The landowners interviewed for the EA have unanimously expressed interest in the same general objectives. However, both the Government and the landowners at this time lack some of the expertise, tools and procedures that will be required. Assuming at least ten months will pass before commencement of road construction and allowing for the fifteen months scheduled to complete it, this will provide the Government with the necessary time -- over two years -- to acquire and put in place the required personnel, administrative structure, procedures, legislation, and facilities to routinely carry out the following tasks related to monitoring and managing the natural resource base and environmental quality of the Southeast Peninsula:

(1) Watershed management, erosion control and sediment reduction, sand mining regulations and beach management.

(2) Wildlife management (both species and habitat).

(3) National park, reserve and protected areas planning and management (marine and terrestrial).

(4) Improved environmental planning and development control, including monitoring procedures, incorporation of environmental factors in development planning, and establishing and promulgating prescribed standards and guidelines for development practices.

(5) A system for requiring environmental impact assessment reports for all major development projects, at least on the Peninsula, and establishing a review and approval process for the same.

To accomplish these tasks, the Government of St. Kitts-Nevis will need to move expeditiously to:

(1) Establish a properly staffed and supported Environmental Unit or Office (probably under the aegis of the Ministry of Development) to design, implement, co-ordinate, manage, and monitor a comprehensive environmental protection programme for the state;

(2) Draft, gazette, and enact supporting environmental legislation;

(3) Create, fund and fill a new professional level position within the existing Planning Unit of "Environmental Planner" or "Environmental Control Officer," whose responsibilities should include, pari passu, development application review, environmental impact assessment review, and on-site conformance inspections of all major government and private sector development projects.

2. DESCRIPTION OF THE AFFECTED ENVIRONMENT: THE SOUTHEAST PENINSULA OF ST. KITTS

2.1 The National Context and Significance of the Southeast Peninsula

St. Kitts-Nevis, which achieved independent statehood on September 19, 1983, is by Eastern Caribbean standards a small country with (in 1980) a total population of 44,404 (35,104 on St. Kitts), 269 sq kms (or 104 sq mi) of land (68 sq mi on St. Kitts) and a gross domestic product (1982) of US$43 million.

The total labor force is approximately 20,000 persons. A small but growing light manufacturing sector of approximately 30 firms employed 3,000 persons generating approximately eight percent of GDP (1980). Sugar production (approximately 30,000 tons annually) occurs entirely on St. Kitts and occupies 12,000 acres out of 19,000 regarded as agricultural land. Sugar, therefore, dominates the economy and, with its molasses by-product, accounts for 17.5 percent of GDP and 70 percent of total exports (Williams, 1983). Food crops occupy 3,000 acres, yielding in excess of 200,000 lbs. annually, while 11,000 acres (23 percent of St. Kitts' total land area) are forested.

Given the secular decline in world sugar prices, the Government's continuing search for increased invisible export earnings, tax revenues, and expanded employment opportunities by enlargement and enhancement of the tourism sector is quite understandable and defensible. A recent Government document sums it up:

> The careful development of Tourism in the State is of vital importance. It is necessary in order to provide a wide variety of services and attraction to the visitor. It is also important in that it provides employment and income to our Nationals while retaining as much as possible of our socio-cultural fabric intact (St. Kitts-Nevis Government, Ministry of Tourism, 1982).

The tourist industry, which is gaining in economic significance, recorded substantial increases in visitor arrivals in 1984. Numbers of visitors to St. Kitts-Nevis rose by 16 percent in 1984 to nearly 40,000 arrivals (see Table 2.1). The increase followed three years of essentially no growth (1981-1983) when arrivals were at levels of 34-35,000 annually. This pattern reflects trends in the Caribbean region as a whole. For the final quarter, visitor arrivals by air increased by 38.6 percent over the corresponding quarter of 1983, to 10,312 (Eastern Caribbean Central Bank, 1984). Cruise ship passenger arrivals increased for the year by approximately 49 percent to 34,000. This performance, among the best in the Caribbean, reflects the strong market interest in "new" destinations, especially those which can be reached on a seven-day cruise from southern Florida, Puerto Rico, or

the Virgin Islands, which has started to "home port" smaller cruise ships.

Table 2.1 Visitors* to St. Kitts and Nevis by country of usual residence (source: St. Kitts/Nevis Tourist Board and Beekhuis, 1985).

Country of Usual Residence	1983	%	1984	%	Percent Change 1983/1984
U.S.A.	9,858	28.77	14,572	36.55	47.82
U.K.	2,838	8.28	3,081	7.73	8.56
Other/Europe	453	1.32	437	1.10	(3.53)
Canada	2,056	6.00	2,488	6.24	21.01
Subtotal	15,205	44.37	20,578	51.60	
OECS	3,518	10.27	4,099	10.28	16.52
Other CARICOM	2,231	6.51	2,107	5.29	(5.56)
Other	13,315	38.85	13,082	32.81	(1.75)
Subtotal	19,064	55.63	19,288	48.40	
TOTAL	34,269	100.0	39,866	100.0	16.33

*does not include 34,000 cruise ship passenger arrivals in 1984

St. Kitts-Nevis has approximately 718 hotel rooms and another 80 guest rooms, with approximately 528 hotel rooms located on St. Kitts and 190 on Nevis. Occupancy rates are consistently low (under 30%) as is the average length of stay of five days. In 1984, approximately US$13 million in foreign exchange and 14 percent of the country's employment came from tourism. In that same year, the proportion of arrivals from North America and Europe (especially the U.S.) increased significantly. This trend bodes well for hotel occupancy as most visitors from North America and Europe stay in tourist hotels, while many Caribbean visitors stay with friends and relatives. The United States continues to provide over one-third of the total visitor arrivals and over one-half if cruise ship passenger arrivals are counted (Beekhuis, 1985).

The St. Kitts-Nevis Government has concluded that expansion of the tourism sector must play an increasingly important role in its economic diversification strategy. In order for this to occur, however, enough hotel rooms must be constructed to justify increased regular, direct jet airline scheduling. At present only two international airlines, Pan American and BWIA, serve St. Kitts (no daily service).

The major tourism sector development focus of the Government of St. Kitts-Nevis has, until recently, been on Frigate Bay, a government owned 850 acre complex with 67 percent of the hotel rooms on St. Kitts. However, the adjacent, essentially inaccessible, undeveloped, and unoccupied Southeast Peninsula area, five times larger than Frigate Bay -- with its superior beaches, diverse landscape and vistas -- has long offered an attractive development option for the state. For this to occur, however, the need for a full-length penetration road to provide access has generally been acknowledged as essential. Beginning in 1966 (see the Tripartite Economic Survey Report), the Government has periodically explored various engineering design and external funding possibilities for an all-weather, hard surface road that would "open up" the remainder of the Peninsula and its resources to development.

The remainder of this section constitutes a fairly detailed resource inventory of the Southeast Peninsula based on over 30 personal interviews, 120 person days of field work by the study team and the scattered, marginal literature. With the exception of Jackson's 1981 study and Arendt's recent (1985) wildlife survey report commissioned by USAID, there are no other resource assessment documents that focus solely on the Peninsula area, making it somewhat of a terra incognita. For this reason, this report presents a somewhat more detailed description of the SEP's environment that would be affected by the proposed peninsular road than is customary in Environmental Assessments as required under 22 CFR, Part 216, U.S. AID "Environmental Procedures."

2.2 Land Resources: The Terrestrial Environment

2.2.1 Land Forms and Drainage

The Southeast Peninsula is actually a cluster of seven older small rocky islands linked by more recent beach and saline marsh deposits (originally tombolos but now broadened flat sedimentary plains) tying the seven islets together and, at Frigate Bay, linking them to the main island at the base of the Conaree Hills. The Frigate Bay area is, therefore, technically part of the peninsular ecosystem, which is much older than and differs substantially from the rest of St. Kitts. All the residual hills on the Peninsula are smoothly rounded with slightly convex peaks, once forested but now covered, for the most part, with dry scrub woodland vegetation -- principally acacia, agave, and columnar and Turks Head cacti, with manchineel, mangrove, seagrape and beach strand vegetation occuring intermittently on the saline sedimentary plain areas at the base of the hills. Guinea grass is common in burned-over, lower slope areas.

Excluding the Frigate Bay area (850 acres), the Peninsula proper embraces slightly over six square miles (4,000 acres), including eight saline ponds which vary in size from over 400 to about four acres.

The topography of the Southeast Peninsula consists of two distinct features: 1) a narrow, isthmus-like, rocky spine slightly more than 0.5 km in width and about 4.5 km in length, extending in a southeasterly direction from the Frigate Bay area to Salt Pond Hill, and 2) a larger, roughly triangular area shaped like an amphitheater with a group of hills surrounding the Great Salt Pond and its associated low-lying, almost flat basin (see Figure 2.1).

The peak elevations on the isthmus are 550 feet above sea level at Sir Timothy's Hill and 878 feet at Salt Pond Hill. Just south of Timothy Hill, the sharp relief is interrupted by a low lying flat area between North and South Friar's Bay, with significant beaches on both the Atlantic and Caribbean sides. The largest water shed on the isthmus drains north from Salt Pond Hill toward Canoe Bay, encompassing 47 hectares (about 116 acres). The remainder of the smaller watersheds descend down the steep Atlantic and Caribbean slopes, discharging directly into the sea except in the case of Friar's Bay where two salt ponds serve as drainage sinks and sediment traps.

The Great Salt Pond watershed drains from the surrounding hills into the salt pond, having a catchment area of about 380 hectares (940 acres) (see Figure 2.2). The highest of the surrounding hills is St. Anthony's Peak with an elevation of 1,047 feet and an average slope in excess of 30 percent; however, many of the slopes are substantially steeper. The Great Salt Pond has an area of about 450 acres, which varies in size however as a function of the seasonal rainfall and evaporation rates. Lang, et al. (1966) indicate that it may be the site of a former volcanic crater.

Precipitation on the Peninsula varies from about 1,000 mm per year (39 inches/year) on the peaks to 870 mm (34 inches/year) at Cockleshell Bay (Lang, et al., 1966 and Jackson, 1981), considerably less than the rest of St. Kitts which, in the central mountains, exceeds 3,810 mm (150 inches) (Lang, 1966). The remnant dry forest and scrub vegetation of the Peninsula reflect this relatively dry climate. Despite the comparatively low yearly rainfall, individual rainstorms can be very intense. Roughton (1981) projects a ten year frequency storm (a storm which on a statistical basis occurs once in ten years) to have an intensity of 130 mm/hour (5 inches/hour). Such storms would produce a peak discharge at Canoe Bay of about 8.5 cubic meters/sec. (300 cfs.). By comparison, the total of the various water sheds draining into the Great Salt Pond would have a combined peak discharge of 35.7 cubic meters/sec. (1,260 cfs.).

2.2.2 Soils and Sediments

The soils found on the Peninsula are mainly the weathered products of the intrusive andesites and tuffs, although other types such as modern beach sands, older dunes, and saline beach deposits are present (Figure 2.3).

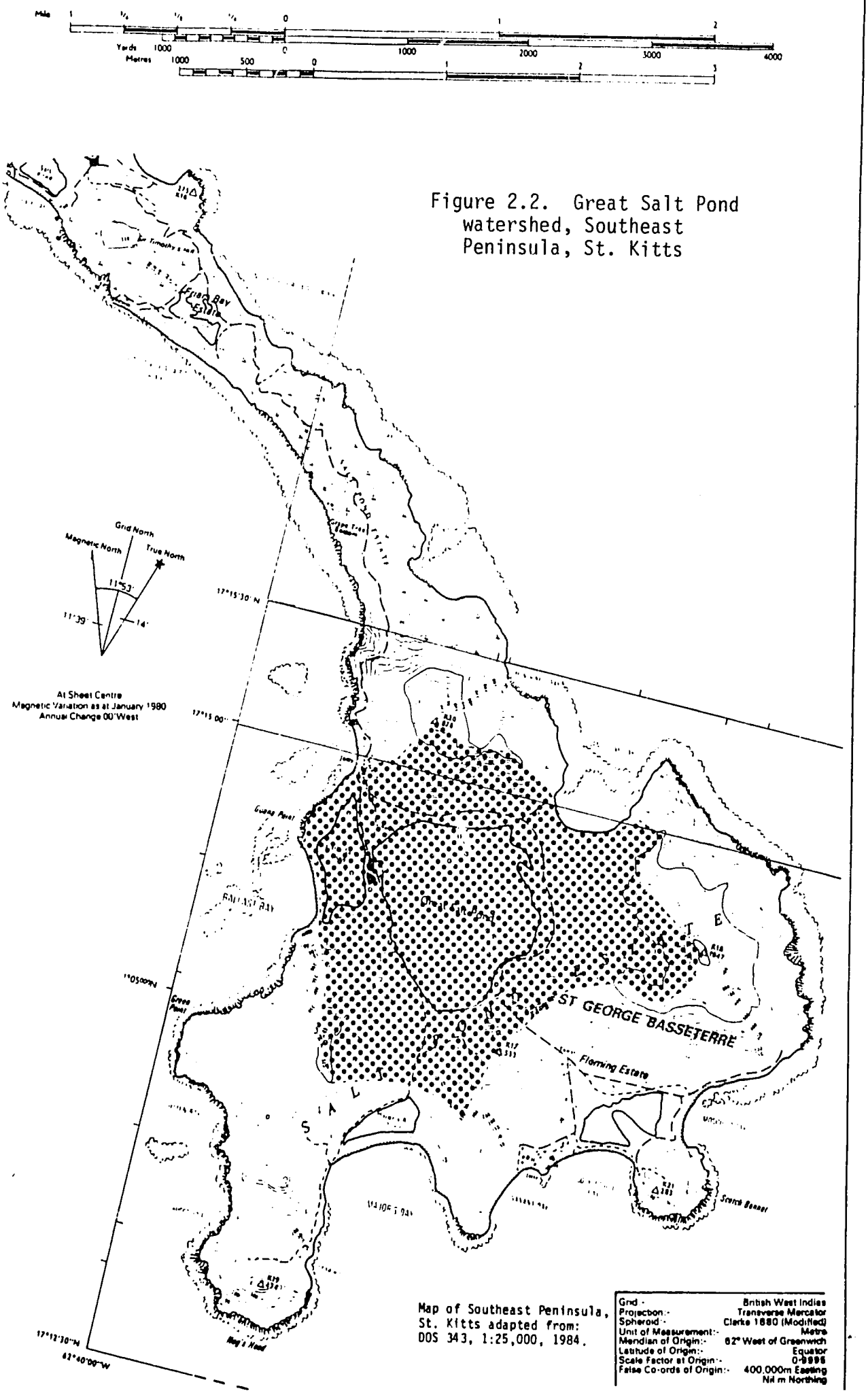

Figure 2.2. Great Salt Pond watershed, Southeast Peninsula, St. Kitts

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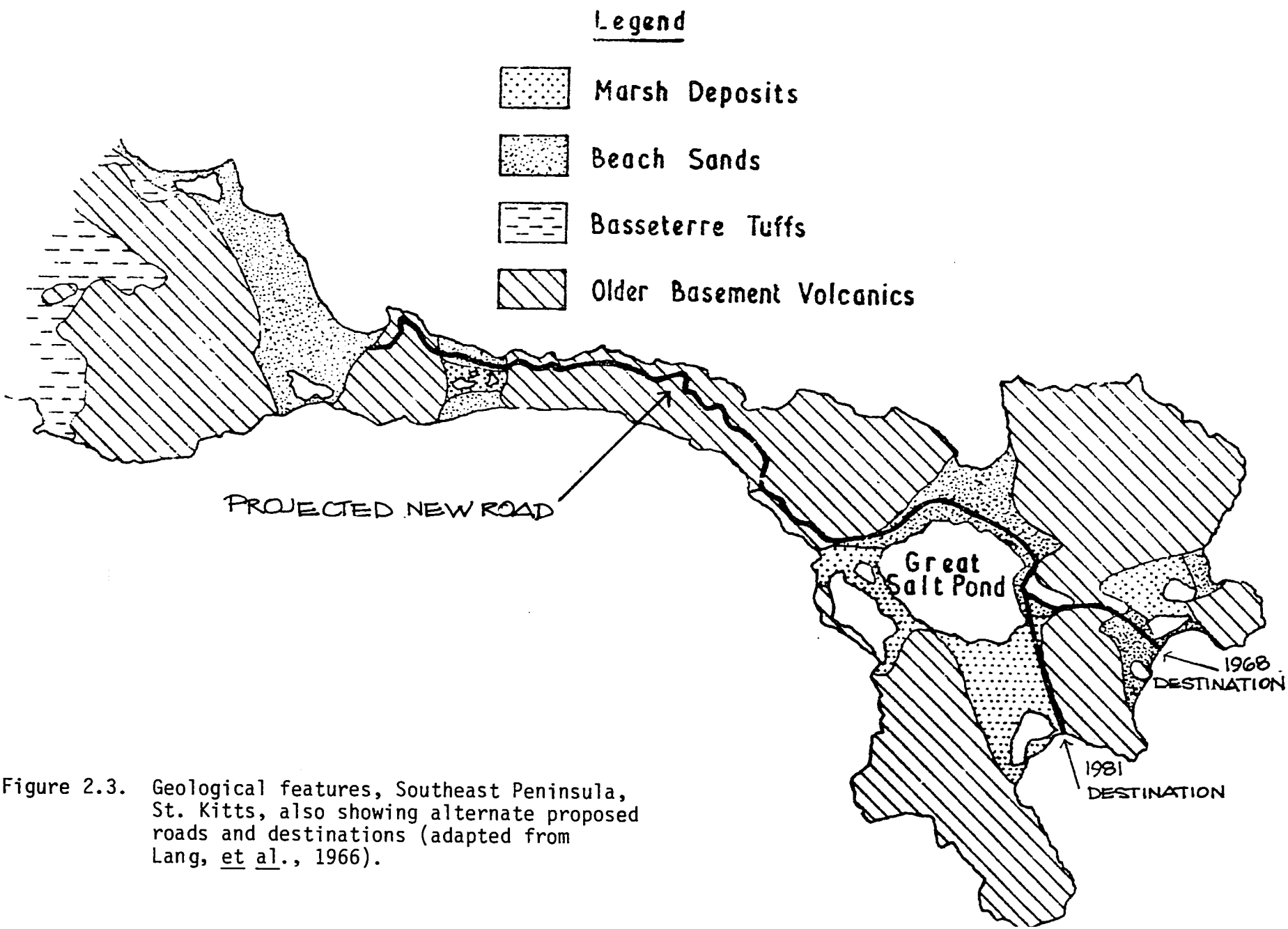

Figure 2.3. Geological features, Southeast Peninsula, St. Kitts, also showing alternate proposed roads and destinations (adapted from Lang, et al., 1966).

The intrusive andesites and tuffs found on the Peninsula are part of the older basement rock which is obscured over much of the rest St. Kitts by the relatively younger volcanics. The residual soils are thin over the parent rock, consisting of well-drained, weakly developed sectoral (montmorillonitic) clay soils (Roughton, 1981a, vol. 3). The generally steep slopes, scant rainfall and reduced vegetative cover result in rapid erosion of the soil material during peak rainfall pulses.

Modern beach sands are found in the Friar's Bay area and the various beaches situated in the coves of the Peninsula, particularly on its southern end. These sands are a mixture of carbonate marine and terrestrial inorganic sands. Older sand dunes are found at several locations, with 10 m deep, substantial deposits behind the beach berm at Friar's Bay facing the Atlantic Ocean. Other significant deposits are found at Mosquito Bay and at Sand Bank Bay, where massive dunes are located well inland off the beach and situated perpendicular rather than parallel to the beach, stretching west to the edge of the Great Salt Pond. Dunes result from the lifting and transport of beach sand by wind.

The lower slopes of the hills surrounding the salt ponds are generally sandy, outwash fans or alluvial and colluvial deposits (Lang, et al, 1966). The eroded soil material has covered the base rock forming the smooth slopes, terminating in the salt ponds where the saline sediment deposits have accumulated over time. The areal extent of all the shallow salt ponds, however, vary seasonally as is evident from an inspection of sequential aerial photographs.

2.2.3 Erosion

Soil erosion by water and wind are evident on the Peninsula; it is a natural and ongoing process. The weathered rock is transported by wind and water to other locations, usually lower elevations.

Accelerated erosion generally results when the protective vegetation cover is removed from the soil and with the physical disruption of the top soil layer, causing numerous adverse impacts both to the natural ecosystems and to human use of the environment. For example, the destruction of reefs by sedimentation resulting from excessive land erosion will manifest itself in reduced fishery products, the loss of sand beaches and shorelines, and direct loss of coastal property subsequently damaged by high energy waves which are not minimized by the destroyed reefs. Sediment build-up diminishes the effectiveness of drainage facilities and such clogging generally results in the flooding of surrounding areas. Removing the sediments and debris from drainage works becomes a recurring task and burden on the public treasury. Furthermore, soil erosion results in loss of valuable top soil critical to agriculture, horticulture and slope stabilizing natural vegetation.

Although the Peninsula is not heavily used at present, previous, extensive agricultural use and recurring brush fires have resulted in some accelerated erosion of the lower slopes of the hills. At one time, the area was used for sugar cane, cotton, coconut and livestock production. The 1753 map by Lt. Samuel Baker, RN (see Figure 2.18) identifies several plantation sites, and early accounts of settlers also tell of heavily wooded areas (Merrill, 1958). During the field investigations in October 1985 (the end of the peak rainfall period), the lower slopes of the hills around the salt ponds were lush with vegetation, mainly Guinea Grass. However, evidence of brush fires was found on larger trees as well as on the ground. The repeated burning of the hillside vegetation has prevented the formation of a permanent protective vegetative cover. The spacing of the grasses on the steeper slopes was sparce, with substantial soil erosion evident. Such fires destroy all vegetative matter, laying the soil completely bare.

While detailed soil sampling, mapping, analysis and erosion susceptibility studies were not included within the terms of reference for this report, studies from Dominica have shown erosion rates of 1.5 tons per acre per year in rain forest to 22.2 tons per acre per year in pure banana stands (Cracknell, 1981). It is not asserted that the erosion rates at the Peninsula approach such levels, but rather that the impact of clearing or removing the vegetation can result in significant increases in soil erosion.

Most of the transported sediment and organic detritus from the watersheds around the salt ponds are washed into the salt ponds where they settle out. The ponds, therefore, provide an extremely useful function in that they act as natural sediment traps, thereby protecting the surrounding marine waters, reefs, seagrasses and the benefits accrued therefrom, i.e., fishery products, marine recreational activities and coastline protection against storm waves, to name a few.

2.3 Coastal Resources: The Littoral Environment

2.3.1 The Coastline

Because of its irregular shape and several deeply indented bays, the Southeast Peninsula (starting at Sir Timothy's Hill) has over 16 miles (26.2 km) of coastline, representing fully one-fourth of the total for St. Kitts (102.5 km), even though the Peninsula has only approximately one-tenth of the total land area of St. Kitts. Figure 2.4 and Table 2.2 present the Peninsular coastline demarcated into three categories. There are five km of rocky shoreline, 12.8 km of cliffs, plus 21 beaches (only 12 have sand) with a linear measurement of 8.4 km.

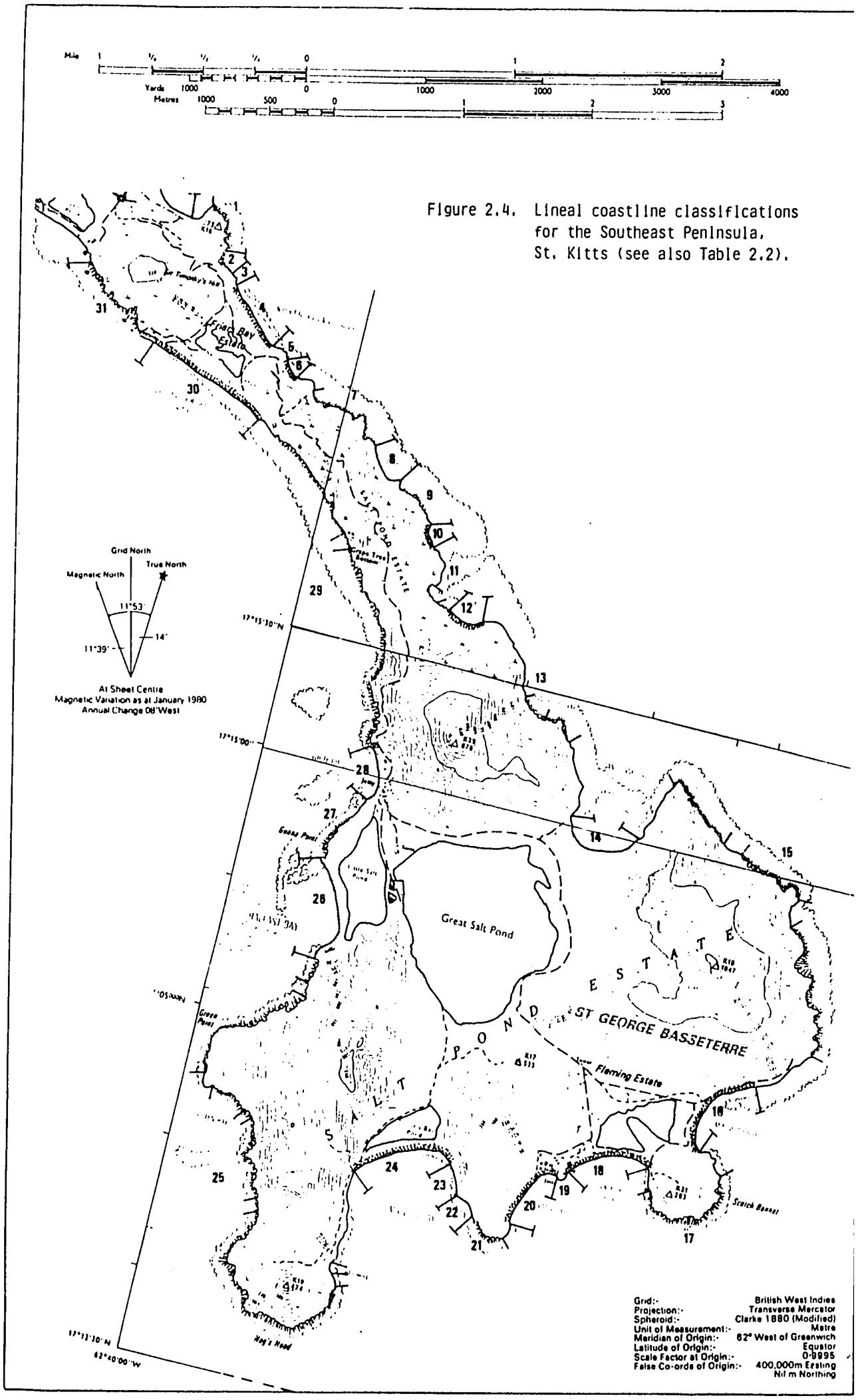

Figure 2.4. Lineal coastline classifications for the Southeast Peninsula, St. Kitts (see also Table 2.2).

Table 2.2. Southeast Peninsula shoreline classifications (see Figure 2.4). Coastal segments around Southeast Peninsula clockwise from North Frigate Bay, subdivided into three categories (beach, cliff, rocky shore) and listed in 100 m units estimated to the nearest 50 m.

Sector # (Fig. 2.4)	SEGMENT NAME	Beach	Rocky Shore	Cliff
1			1.5	4.0
2	Pocket Beach (unnamed)	2.0		
3			1.0	
4	North Friar's Bay	4.0		
5			2.0	
6	Unnamed Beach	1.5		
7			2.0	7.0
8	Turtle Bay		3.5	
9				3.5
10	Unnamed Beach	1.5		
11	Unnamed Beach	1.0	3.5	1.0
12	Canoe Bay	2.5		
13	Manchineel Bay & Environs	2.0	13.0	3.0
14	Sand Bank Bay	7.5		
15	Unnamed Beach	3.5	5.5	22.5
16	Mosquito Bay	7.5		
17	Scotch Bonnet		4.0	9.5
18	Cockleshell Bay	7.5		
19			1.0	
20	Banana Bay	5.5		
21			1.0	3.0
22	Unnamed Beach	2.0		
23	Unnamed Beach	.5	1.5	
24	Major's Bay	8.0		
25	Buggs Hole	3.0	9.5	38.0
26	Ballast Bay	8.5		
27				5.5
28	White House Bay	5.0		
29	Grape Tree Bottom	1.0	1.5	24.0
30	South Friar's Bay	10.0		
31				7.0
	100 m Unit Totals	84.0	50.5	128.0

Total Peninsula Shoreline: 26.2 km (25% of St. Kitts total, 102.5 km)
Total Peninsula Beaches: 8.4 km (32% of total Peninsula shoreline)

2.3.2 Beaches and Coastal Erosion

Peninsula beaches are classified in Table 2.3 according to location, material and tourism potential (derived as a function of length, width, stability, access, sand quality and sea wrack problem).

All Peninsula beaches derive their material, in some combination, from coral reefs, seagrass beds, marine erosion of rocky cliffs and shorelines or stream-borne terrestrial sediments from upland areas; and they all undergo natural cycles of erosion and redeposition. The cycles can be disturbed by headland erosion which changes the equilibrium of wave energy at the beach or by extreme storms carrying sand offshore out of the littoral cell at any given beach. Headlands typically define the littoral cell, but reefs and other bottom features may also play an important role. Marked, short-term beach retreat is more likely on leeward beaches of the Peninsula because of the greater range of variation in wave regime between the normal quiet conditions and the rare storm with winds, waves and swells out of the southwest.

Serious coastal erosion, the progressive loss of sand and sand beaches due to wave action, has been reported on St. Kitts as well as elsewhere in the Caribbean since the late 1960's (Deane, et al., 1973; Cambers, 1985). Severe erosion on St. Kitts' shoreline occurred during the hurricanes David (1979), Frederick (1979) and Klaus (1984) and continues at the present time in some areas. The most severely impacted coastal areas are on the northwest coast, although the Southeast Peninsula has also been affected (Cambers, 1983). Many beaches there showed evidence of severe storm change, but have begun to recover. For example, at Banana Bay and Cockleshell Bay, large trees and shrubs were slumped onto the beach, and beachrock was found exposed at several locations, including Frigate Bay, during the field investigations in October, 1985.

The specific causes for the widespread, accelerated coastal erosion in St. Kitts are not clear. Camber's (1983) has suggested possible agents as: the increase of winter swells, the increase in wave energy, as well as the secular, worldwide rise in sea level due to melting of the polar ice caps. However, none of those agents have been identified with certainty. At specific locations (like Frigate Bay), sand mining in proximity to the water line has also been suggested as an exacerbating agent (Cambers, 1983, 1985). The important point to remember is that erosion is an ongoing natural process that can be accelerated by inadvertent human intervention, thereby raising the risk of even more serious short- and long-term damage.

The sand beaches on the Southeast Peninsula are a mixture of terrestrially-derived (quartz and several dark minerals) and fragments of the carbonate skeletons of marine organisms (corals, algae, mollusc shells). The proportions of terrestrial and various marine components differ among beaches around the Peninsula. Those on the north shore behind substantial fringing reefs (e.g., Friar's Bay North or Sand

Table 2.3. Location key and classification of Southeast Peninsula beaches, St. Kitts.

Shore Sector (Fig. 2.4)	Parcel Number (Fig. 1.1)	Beach Name	Beach Material (central portion)	Tourism Potential
4	2	North Friar's Bay	sand	high
6	2	Unnamed, east of North Friar's Bay	sand	low
8	3	Turtle Bay	boulders	medium
10	3	Unnamed, west of Canoe Bay	sand	medium
11	3	Western Cove of Canoe Bay	cobbles/sand	low
12	3	Eastern Cove of Canoe Bay	sand	low
13	3	Manchineel Bay	boulders	nil
14	5	Sand Bank Bay	sand	high
15	5	Unnamed, north of St. Anthony's Peak	boulders	nil
15	7	Unnamed, northeast of St. Anthony's Peak	boulders	nil
16	15	Mosquito Bay	sand	medium
18	14	Cockleshell Bay	sand	high
20	14	Banana Bay	sand	high
22/23	10	Unnamed, eastern shore of Major's Bay	boulders	nil
24	10	Major's Bay	sand	high
25	12	Buggs Hole	boulders	nil
25	12	Shitten Bay	boulders	nil
26	13/21	Ballast Bay Beach	boulders/cobble	nil
28	5	White House Bay	sand/shingle	medium
29	4	Grape Tree Bottom	cobble/sand	low
30	2	South Friar's Bay	sand	high

NB. Several boulder, shingle and/or cobble beaches were sandy in decades past and may experience sand deposition over time. Some suffered severe net sand losses as a consequence of hurricane Klaus in 1984.

Bank Bay) contain much reef-derived coral material. In quieter waters, such as Mosquito Bay, terrestrial material and non-reef marine-derived algal sands predominate. Most beaches are slowly replenished by a sand supply from adjacent marine communities. While, as noted above, beaches change shape cyclically in response to shifts in wind and wave regimes, natural or human-induced damage to these biolgical systems producing sand can cause progressive losses and decline of beach quality (see also Figure 2.5).

Offshore reefs also protect the sand beaches from the direct attack of high energy waves by dissipating much of the wave energy before it reaches the shoreline. Major physical damage to such reefs (and pollution induced slower growth rates) can have a marked effect on the beaches by permitting larger waves to reach the shore with a resultant shifting or permanent loss of sand. Such damage to the reefs may be both man-made or due to natural causes such as unusually severe storms. The high erosion rate at the sand spit at Dieppe Bay is attributed to reef damage due to Hurricanes David and Frederick in 1979 (Cambers, 1983, 1985).

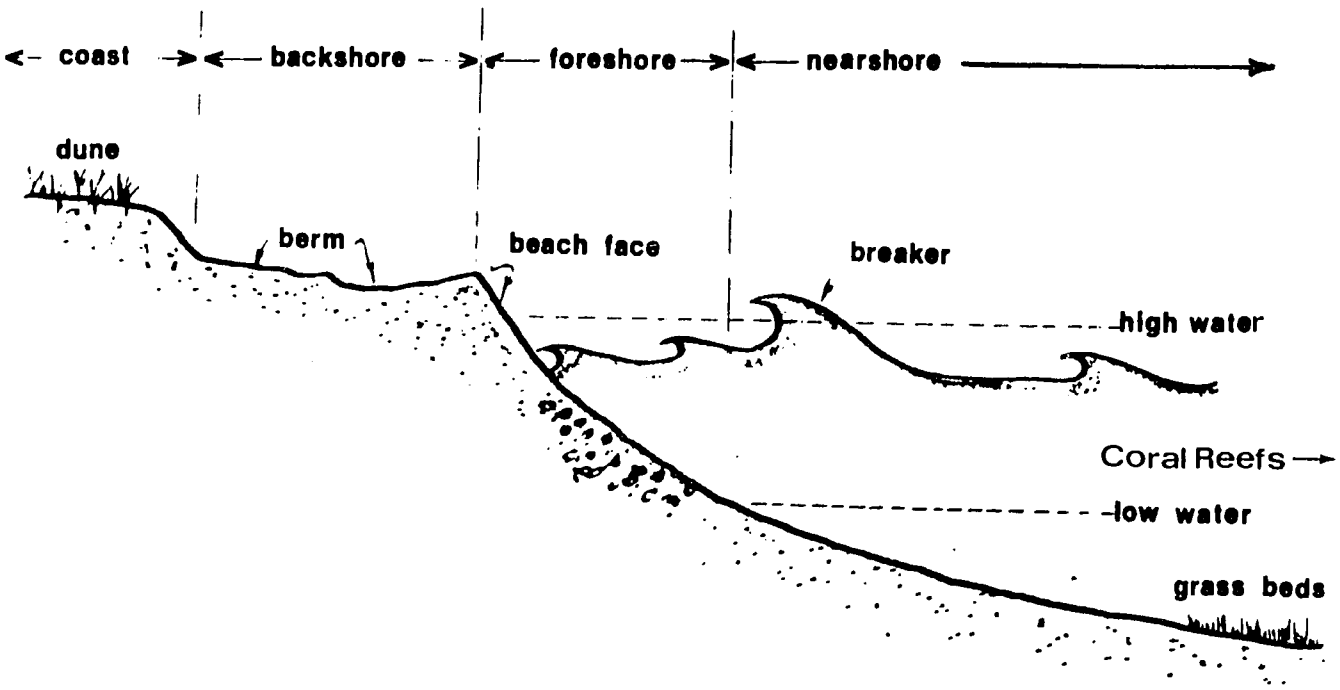

Figure 2.5. Beach profile showing beach terminology and component parts in relation to high and low water (source: Towle, et al., 1976).

Additionally, long term reef damage is likely due to high soil erosion rates during periods of extensive development or heavy agricultural land use. The resulting sediment and turbidity in the coastal waters, from accelerated soil erosion is very likely to have major adverse effects on the nearshore reefs. Damage to the reef organisms eventually results in a decrease in coral sand production (Hayden, et al., 1978).

Seaward of the reefs and often between the reefs and the beach are extensive submarine meadows of seagrass (see also Section 2.4 for description of seagrass distribution along Peninsula coastlines). These are highly productive communities biologically and act as nursery and feeding areas for several commercially important fisheries as well as contributing to sand production which nourishes the beaches (Figure 2.6). Seagrasses flourish in the clear, relatively nutrient poor waters of Caribbean island coasts. Though some species tolerate storm-generated pulses of sediment in terrestrial runoff, they can be degraded by persistent turbidity, such as results from poorly executed dredging operations, severe soil erosion, or by increased nutrient levels from sewage outfalls. The seagrass meadows have a similar role

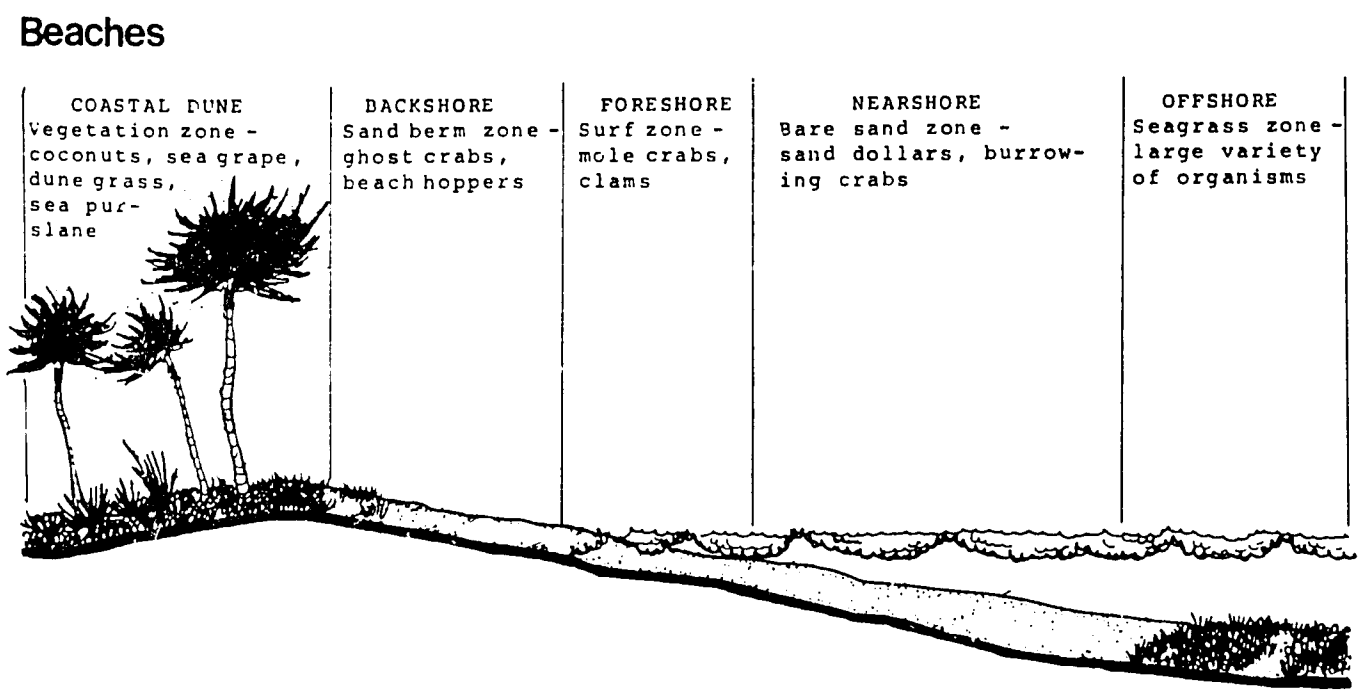

Figure 2.6. Profile of a beach indicating physical zonation and characteristic organisms (source: Towle, et al., 1976).

to the above-water beach strand vegetation in that they both stabilize the sands. If seagrasses are lost through natural processes or human intervention, it can trigger severe shoreline erosion. (For example, see Towle, et al., 1976.)

2.3.3 Rocky Shores and Cliffs

Most of the Peninsula's shoreline consists of steep rocky cliffs or boulder slopes (18.3 km or 68 percent), formed over geologic time by weathering and severe storms and wave action. These are distinguished from rocky beaches which have a gentle seaward slope and are covered with semi-sorted, smaller rocks and/or coral rubble. The rocky shore areas are rigorous environments, some with near vertical cliffs over 30 m high (at Scotch Bonnet, Mosquito Bluff and south of Grape Tree Bottom, for example). But they are far from sterile, often supporting salt tolerant vegetation such as century plants (Agave), Turks Head (Melocactus intortus) and pipe organ cacti, some grasses and related fauna. The Nag's Head westerly cliffs, some nearly 45 m in height, provide precisely the proper remote environment for St. Kitts' frigate bird (Frigata magnificens) nesting colony. At the southern tip, the brown pelican (Pelicanus occidentalis) also uses the cliffs as a nesting site. On the lower seaward faces of most Peninsula rocky cliffs and shorelines, where some sea spray occasionally reaches, a few hardy marine animals can be found; and closer to and in the wet/dry splash zone, one finds chitons, sea urchins, and various molluscs, including the edible whelk (Cittarium pica). The hard underwater rocky substrate on the Peninsula is ideal for coral attachment (see Figure 2.7), and various gorgonians or soft corals (e.g., sea fans, sea whips) and sponges abound. Water at the base of most rocky shoreline areas is both turbulent (due to high wave energy) and clear (due to the absence of concentrated terrestrial sediment discharges).

2.3.4 Coastal Linkages Between Land and Sea

The Peninsula is so small that all of its terrestrial habitats are marine-influenced -- from the wind-trimmed vegetation on the mountain peaks to the saline ponds in the lowlands.

Conversely, each terrestrial habitat on the Peninsula is part of one or another coastal watershed which, with varying degrees of buffering by salt ponds, feed into the adjacent shallow marine waters. The movement of water and the substances it carries is one of the most basic links which development of the Peninsula will influence. Flows through drainageways, surface runoff and subsurface flows eventually reach the coastal land/sea interface where a complex and dynamic association exists between pond, beach, seagrass and reef ecosystems (see Figure 2.8). Some level of terrestrial sediments and nutrient inputs are not only acceptable but needed. However, increased, irregular flows and pulses of nutrients and sediments (such as would occur if all major salt ponds on the Peninsula were filled in or

Rocky Shores and Cliffs

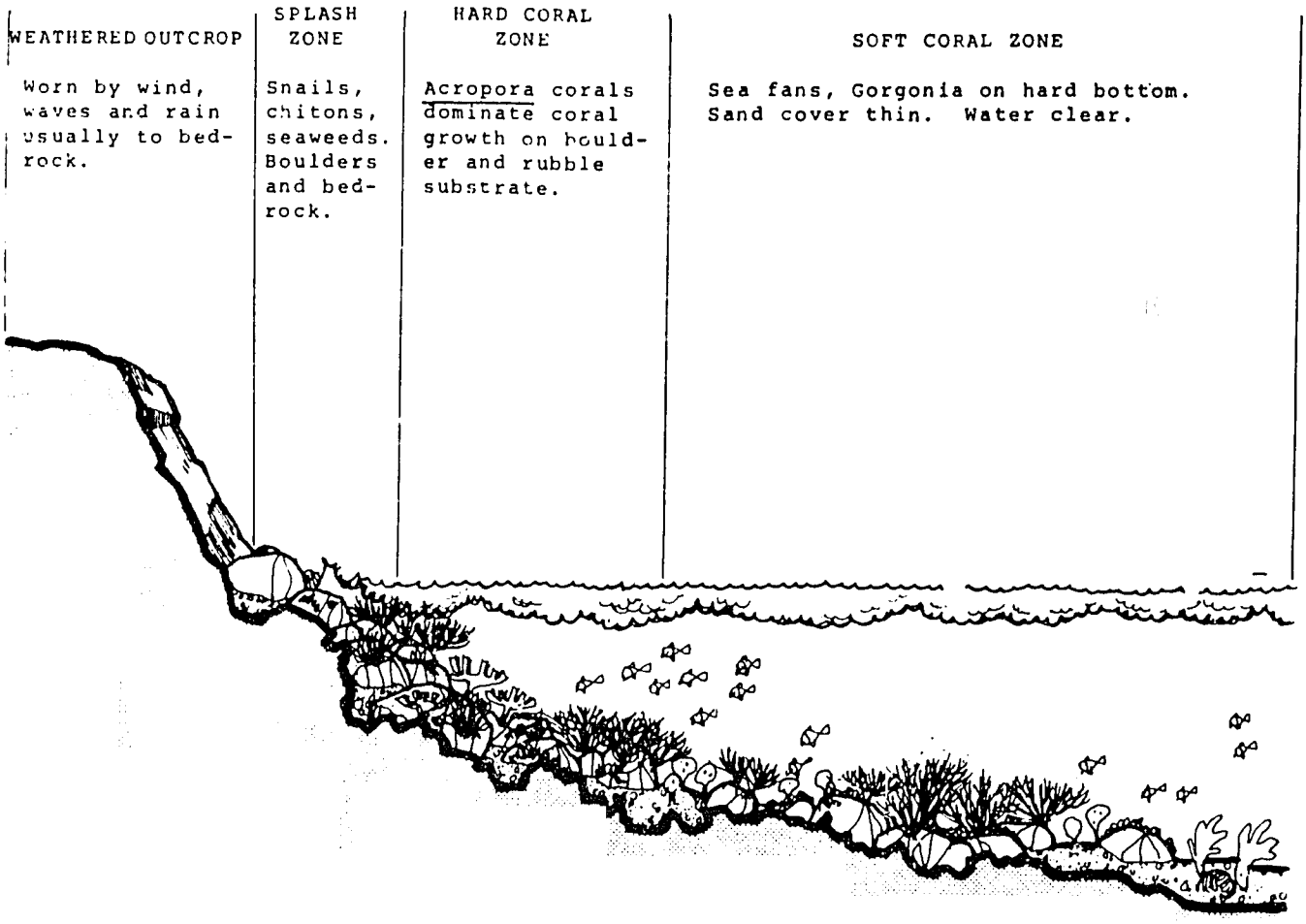

Figure 2.7. Typical rocky shoreline of eroded volcanic rock with boulder and rubble bottom (source: Towle, et al., 1976).

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dredged and opened up directly to the sea) would have a catastrophic effect as the "systems" are closely coupled -- the land, the coast, and the sea are, in effect, one.

2.4 Sea Resources: The Marine Environment

2.4.1 Scope of Survey

The marine resource component of the EAR considered 37 sq km of marine area between a submarine contour of approximately 30 m and the shoreline of the Southeast Peninsula, bounded by a northeast-southwest line extending through Timothy Hill perpendicular to shore and the approximate midpoint of the St. Kitts-Nevis Channel determined by a line connecting Booby and Cow Rocks (Table 2.4). General bathymetry of the Peninsula shelf is shown in Figure 2.9, with more detailed fathometer and diver transect data displayed in Figure 2.10. Loca-

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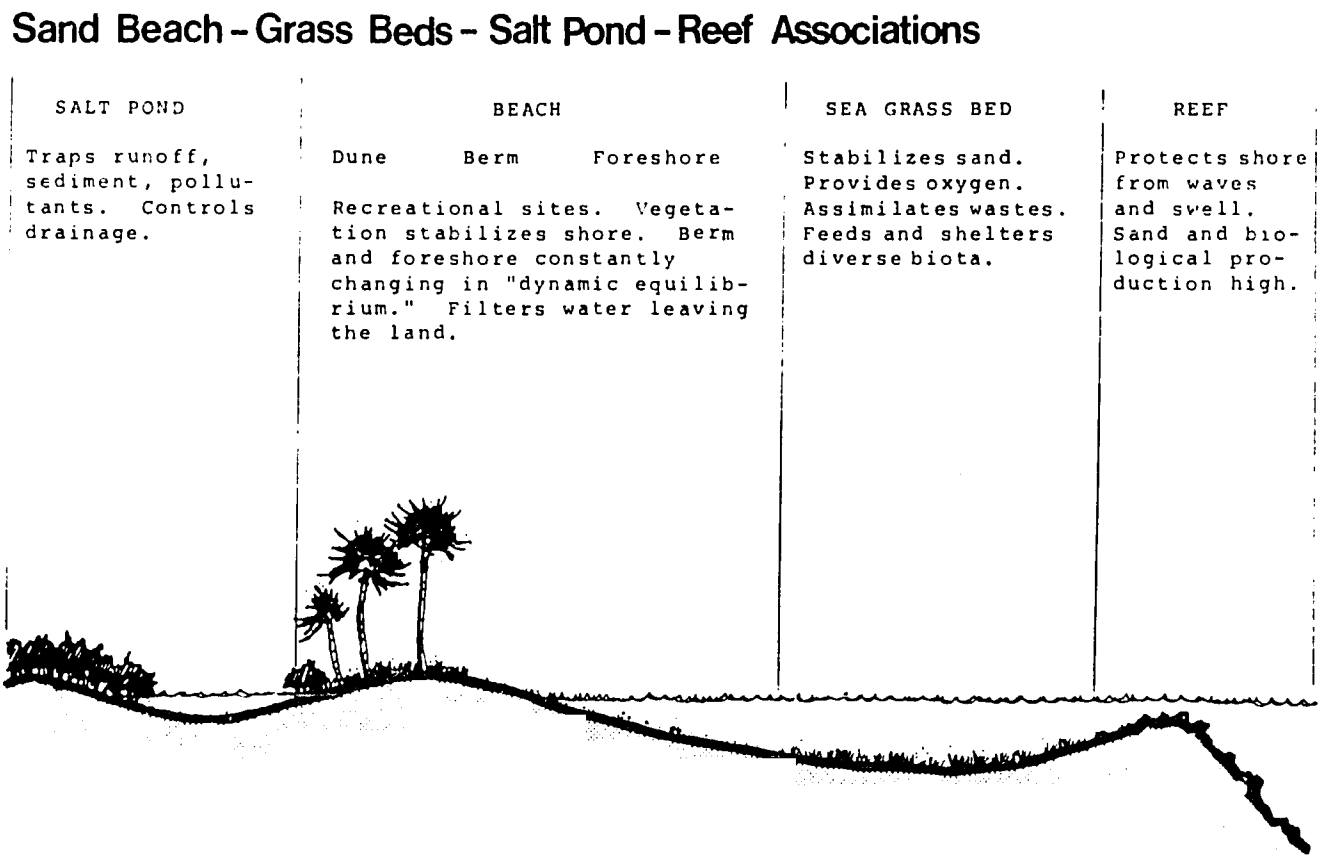

Figure 2.8. Typical sand beach ecosystem showing relationship of component habitats (source: Towle, et al., 1976).

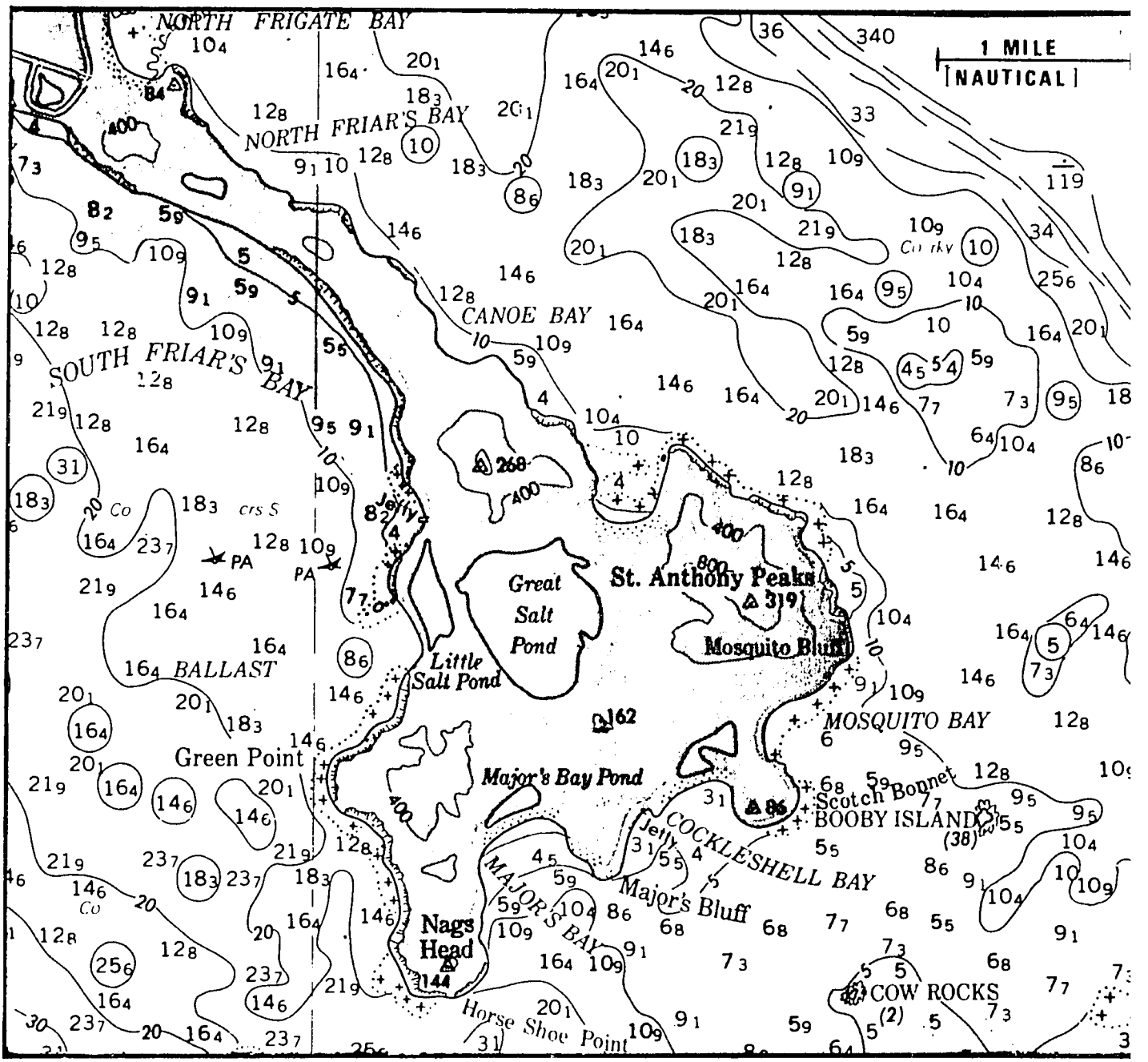

Figure 2.9. Southeast Peninsula shelf bathymetry (depths in meters and decimeters) as displayed on U.S. Defense Mapping Agency Hydrographic/Topographic Center Map #25601, dated August 1984. NB. Enlarged from original by twenty-five percent.

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tions of major physical features and marine habitats derived from aerial photo interpretation and field observations are diagrammed in Figures 2.11, 2.12, 2.13, and 2.14. Methods, instrumentation and sources used during field investigations are described in Appendix B.

Table 2.4. Southeast Peninsula submarine shelf area.

SEP Area	Area Surveyed (sq km)	Total Shelf Area (sq km)
Friar's Bay North to Mosquito Bluff	8.46	32.37
Mosquito Bluff to Nag's Head	17.39	19.83
Nag's Head to Friar's Bay South	11.14	38.96
Total	36.99	91.16

2.4.2 Physical Components: Friar's Bay North to Mosquito Bluff (see Figures 2.11 and 2.12)

The area to the northeast of the Southeast Peninsula (Friar's Bay North to Mosquito Bluff) is subjected to almost constant wave action resulting from trade winds characteristic of this region. These waves are normally 0.8 to 1.0 m in height, but waves of 3.7 m are expected, on the average, at least once per year, and waves of 9.1 m are expected once every ten years. During hurricanes, wave heights could exceed 17 m (Cambers, 1983). Strong currents have not been reported in this area (a single measurement in the area during this study indicated a velocity of 41 cm/sec or 0.8 kn). This regime of water movement probably has been the primary factor controlling development of submerged coral reefs parallel to and abutting the shoreline. Sand covers the majority of the bottom from shore to the 60-foot contour (the designated seaward limit of this study). All of the bays on this Atlantic facing coast (Friar's Bay North, Canoe Bay, Manchineel Bay, Sand Bank Bay) are seasonally subjected to heavy wave action which limits the development of living bottom communities.

2.4.3 Physical Components: Mosquito Bluff to Nag's Head (see Figures 2.12 and 2.13)

The southerly coast of the Southeast Peninsula (Mosquito Bluff to Nag's Head) faces the St. Kitts-Nevis Channel, known as "The Narrows." This Channel is generally shallow, and depths exceed 14 m only in the

area adjacent to Nag's Head. As water driven by trade winds enters the Channel from the southeast, gradual shoaling and the close proximity of the Southeast Peninsula to Nevis cause a funnelling effect which can produce currents exceeding 100 cm/sec (2 kn). Maximum current velocity recorded during this study was 74.2 cm/sec (1.46 kn). Mosquito Bay is subjected to oblique wave action from the east and northeast, and receives protection from direct impact by a shallow fringing reef in the northeast sector of the Bay. Indentations of Cockleshell Bay, Banana Bay, and Major's Bay are sufficient to avoid direct impact of normally prevalent waves, and circulation in these bays results primarily from diffraction around projecting headlands as water moves through the Channel. Even when the wind direction is directly into the Bays (i.e., from the southeast) the shallow depth and short fetch afforded by the Channel limits the size of incoming waves. Reef structures are not well-developed in this area; rock, open sand and seagrass habitats predominate nearshore, and rubble pavements are common on the current-swept floor of the channel.

2.4.4 Physical Components: Nag's Head to Friar's Bay South (see Figures 2.13 and 2.14)

Because they are normally in the lee of St. Kitts, marine areas to the southwest and west of the Southeast Peninsula (Nag's Head to Friar's Bay South) are generally characterized by low wave heights (less than 0.5 m) and moderate currents; the maximum velocity recorded during this study was 34.8 cm/sec (0.69 kn). During storms, however, wind direction often shifts to the south so that the southeast coast may be subjected to much more intense water movement. The bottom slopes gradually at an average angle of about 2.2 degrees. These conditions favor the development of submerged patch reefs, and at least two distinct series of such reefs are found parallel to the shoreline. The first series rises from a depth of about 12 m to roughly 9 m, while the second is approximately 15 m on top and 21 - 24 m at the base. Reports from local fishermen suggest that at least one additional series of reefs is located in deeper water to the southwest of the area included in this study. It is likely that these structures initially developed closer to the water surface and ancient shorelines of St. Kitts when sea levels were substantially lower than at present. Inshore of the shallowest reef series, sand and seagrass beds characterize South Friar's Bay, White House Bay, Ballast Bay, Shitten Bay, and Bugg's Hole.

2.4.5 Living Components: Coral Reef Habitats

Coral reef and seagrass habitats typify much of the marine area adjacent to the Southeast Peninsula. Prominent species characteristic of these habitats are listed in Appendix C. Individual coral habitats to the southeast and southwest of the Southeast Peninsula generally are small, and species diversity (in terms of numbers of species) is not as great as that of similar habitats elsewhere in the Eastern Caribbean. A notable exception exists in the deeper reef series off Guana Point, where coral variety is particularly high (22 coral

species recorded), and living cover is extensive (estimated to be greater than 75 percent of total surface). A large variety of fishes and other organisms typical of coral reefs is present, and this area is the best example of deep coral reef habitat seen during the study.

Reefs northeast of the Southeast Peninsula were formed by living corals several thousand years ago during periods of lowered sea level. At present, live cover consists of small and scattered coral colonies, soft corals, and a few sponges. Though fishes inhabit these reefs, their numbers and variety are much lower than on more diverse coral systems elsewhere. Strong surge conditions caused by waves limit the variety of organisms present, and periodically cause mechanical damage to the reefs. Scattered patches of seagrass (Syringodium filiforme, and occasionally turtle grass, Thalassia testudinum) are also found, but typical seagrass communities are not well developed.

Despite the relatively small size of coral reefs bordering the southeast and southwest portions of the Southeast Peninsula, these habitats are important. Coastal erosion on the northeast coast clearly would be severe without the barrier to incoming waves provided by reef structures, seagrass beds, and large algae. The same reefs provide a source of carbonate sand important to beaches viewed as potential tourist attractions. To a lesser extent, the same functions are provided by reefs on the southwest coast, particularly during storms when these structures tend to cause large waves to break offshore. The same coral reefs provide shelter for juveniles and adults of locally important food fishes, as well as a variety of surfaces grazed by many of the same species. These reefs are the habitat and breeding grounds for adult spiny lobster (Panulirus argus), the most valuable single marine species in the region.

2.4.6 Living Components: Seagrass Habitats

Particularly extensive seagrass beds are located in South Friar's Bay and Major's Bay, typically co-dominated by turtle grass (Thalassia testudinum) and manatee grass (Syringodium filiforme), often intermixed with calcareous algae (Penicillus sp.; Halimeda sp.). The leaves and interwoven roots of these plants provide extensive shelter and/or grazing surfaces for a variety of species including marine turtles (Chelonia mydas), bivalve molluscs (Codakia orbicularis; Arca zebra), queen conchs (Strombus gigas), and spiny lobster (Panulirus argus). Seagrass beds provide important feeding areas for species on nearby coral reefs, and the variety of fishes tends to be higher on reefs close to these habitats. Both Friar's Bay South and Major's Bay contained juvenile (and occasionally adult) conch in greater abundance than is typical of similar habitats elsewhere in St. Kitts. The margins of sandy depressions ("white holes") among seagrass beds in Major's Bay were occupied by large numbers of juvenile spiny lobsters.

In deeper waters to seaward of seagrass beds the bottom is usually coarse rubble with attached calcareous algae (Halimeda sp.,

Avrainvillea nigricans, Peniciluus capitatus). Where water movement is substantial (e.g., the St. Kitts-Nevis Channel), soft corals (Gorgonia flabellum, Plexauridae) and various sponges are also conspicuous. Like the seagrasses, these species stablise the bottom substrate, provide food materials for grazers and generate carbonate sediments which contribute to beach nourishment.)

While coral reefs and seagrass beds are also found on other portions of the St. Kitts coast, the extent of Southeast Peninsula marine habitats and diversity of living organisms is likely to be greater because of lower turbidity and sedimentation associated with drier coastal areas undisturbed by large scale development and landscape modification. The southeastern habitats also have unique importance to certain fisheries. Some of the most productive grounds for spiny lobster and queen conch are found off the Southeast Peninsula, and substantial reproductive activity in both species has been observed in this area. The life cycle of these animals involves a larval stage which persists for weeks or months, during which the larvae are subjected to prevailing currents setting to the northwest. For this reason, spiny lobster and conch populations located in the Southeast Peninsula area may be particularly important to maintaining these stocks along the entire shoreline of St. Kitts.

2.4.7 Human Components

Local fisheries in St. Kitts and Nevis are traditionally focussed upon shallow nearshore habitats, including those bordering the Southeast Peninsula. In particular, conch in the St. Kitts-Nevis Channel and adjacent bays have been heavily exploited by fishermen from both islands. In recent years, Nevis fishermen have increased their catch from the northeast coast of the Southeast Peninsula. Annual exports of cleaned conch, largely from the Southeast Peninsula area, are estimated to exceed 68,000 kg. This represents aproximately half a million animals worth about EC$ 300,000. In 1985, fishermen based in Conaree set traps in shallow reef areas on the northeast coast, catching predominantly juvenile spiny lobsters. Numerous wire fish traps were observed in the vicinity of reefs and seagrass beds on the southeast and southwest coasts. Beach seines are commonly set in Whitehouse Bay and Major's Bay, and nets for gars and ballyhoo are often worked in the Southeast Peninsula area. Fisheries statistics are not available to estimate the relative importance of the Southeast Peninsula marine area to local fisheries, but because 71 percent of fish landed in St. Kitts and Nevis are derived from reef areas, it is reasonable to project that the Southeast Peninsula is significant to the local harvest. Interviews with local fishermen indicate that at least 200 fishermen utilize marine areas of the Southeast Peninsula for at least part of their operations. One fisherman commented that it was "OK to develop Friar's Bay for hotels, but they should leave the rest alone . . . but I'm the only one who feels this way so I know they'll go ahead with the whole thing."

The potential fisheries yield from coral reefs and adjacent environments in the Caribbean has been estimated to range between three and five metric tons per square kilometer per year (Munro, 1977). While such estimates are not specific or reliable enough for serious planning purposes, they serve as a rough indication of the fisheries potential which may be associated with reef Peninsula areas. Given an approximate shelf area of 91 sq km, and assuming that one-fourth of this is productive reef, the total fisheries yield from the Southeast Peninsula marine area would be estimated as between 68 to 114 metric tons per year. Assuming an average sale price of EC$ 2.50 per lb, the potential value of these fisheries would be estimated at EC$ 374,000 - 625,000 per year. Production from non-reef Peninsula habitats (e.g., conch on seagrass) would raise these estimates by EC$200,000 to $400,000.

Recreational uses of Southeast Peninsula marine areas consist primarily of casual boating and beach picnics. At present, only a few dozen persons regularly use Southeast Peninsula marine areas for recreational purposes, primarily because of difficult access. While sport fishing is popular in St. Kitts, the best fishing areas are not within the area of concern to this report. Recreational harvest of other species includes West Indian top shells or whelks (*Cittarium* [= *Livona*] *pica*) which are heavily exploited in accessible nearshore rocky areas, conchs, lobsters, and shallow-water reef fishes which may be encountered by snorkellers. Some recreational users reported collecting clams (*Codakia orbicularis*) from seagrass beds in Mosquito Bay and Cockleshell Bay, though quantities were not significant on even a subsistence scale. Scuba diving on Peninsula coral reefs is increasing in popularity among Kittitians, and spearfishing is common among recreational users of the entire marine area. Spear guns can be rented by anyone at Frigate Bay and from several Basseterre dive tour operators who also provide diving gear and high speed diving vessels on a charter basis. The indiscriminate use of spear guns is expected to have serious negative impact if the practice expands with improved public access to the Peninsula. At present, there is no movement toward regulation of their use as has been done by other islands in the region.

2.5 Sea Turtles and Other Wildlife

2.5.1 Sea Turtle Species Present and Local Exploitation History

The current legal and popular recognition of sea turtles as species in danger of extinction culminates a long history of decline which is probably better documented in the Caribbean than in most other tropical areas. The decline has resulted largely from direct exploitation for food and other products (e.g., hawksbill turtle shell for ornaments), though recently habitat modification and incidental catch in other fisheries have contributed significantly. This section of the Environment Assessment Report assembles published information, interviews and field observations on the Southeast Peninsula of St.

Kitts to evaluate the effect of a proposed road and subsequent development on sea turtles in adjacent waters.

The four species which may be expected as residents or regular seasonal visitors to the nearshore waters of St.Kitts are given below in probable order of abundance:

Hawksbill	Eretmochelys imbricata
Green turtle	Chelonia mydas
Leatherback	Dermochelys coriacea
Loggerhead	Caretta caretta

The loggerhead is scarce, if predictable, around eastern Caribbean islands. A fifth species, the olive ridley, Lepidochelys olivacea, is a rare vagrant in Puerto Rico (Caldwell and Erdmann, 1969) and probably elsewhere in the northeastern Caribbean.

While quantitative local records are lacking, isolated reports make it clear that sea turtle exploitation has a long history on St. Kitts, including the Southeast Peninsula, and that declines in abundance began several hundred years ago. The native fauna, particularly the green turtle, played a major role in the subsistence of early European colonists on St. Kitts (Merrill, 1958). He notes that early records indicate "the French and English had a number of skirmishes near the Salt Ponds over the right to turtle in the area." The hunting pressure was apparently sufficient that" there is no evidence ... the green turtle survived in these waters long enough to become an important slave food." Somewhat later, the 1753 Samuel Baker map of St. Kitts shows roads leading to most beaches on the Southeast Peninsula and habitations scattered over the entire area. It is a reasonable presumption that the beaches there, as elsewhere, were carefully searched during the season for nesting turtles and their eggs. The intent here is not to reconstruct historical variations in the intensity of turtle exploitation, but to make it clear that the present low number of human residents should not be interpreted as indicating unexploited turtle populations on the Southeast Peninsula, either in the distant past, the recent past or now.

2.5.2 Current Status of Sea Turtle Management

Brown (1945) surveyed the fisheries of the British West Indies and noted that St. Kitts-Nevis lacked a turtle protection ordinance. Throughout the British West Indies turtle protection ordinances were suspended during World War II, allowing unrestricted fishing and slaughtering because of the "war-emergency meat shortage." Based on Brown's recommendations, St.Kitts-Nevis enacted a turtle protection ordinance in 1948 with a minimum size limit and a closed season on taking eggs and larger animals.

The comprehensive Fisheries Act of 1984 repealed the Turtle Ordinance of 1948. The draft fisheries regulations of 1984 (not yet enacted) include a provision entirely prohibiting the taking or sale of turtles

or eggs, in accordance with recommendations for uniform regional fisheries regulations which emerged from a FAO-sponsored regional meeting of fisheries officers in St. Lucia. There was a consensus that a five year moratorium on turtle fishing was needed to try to reverse declines in turtle stocks. In this context, it is worth noting, however, that the time from hatching to sexual maturity in green turtles is estimated at 30 to 50 years. This means that any surviving green turtles which hatched when the Turtle Protection Ordinance of 1948 passed, may not yet be reproducing.

Enforcement under the 1948 Turtle Ordinance fell upon the St. Kitts police. Though some level of compliance concerning public sale in urban areas of turtle products during the closed season was obtained by warning repeat offenders, turtle exploitation is generally acknowledged to be otherwise unregulated. The Fisheries Division of the Department of Agriculture has an interest in developing sea turtle management and conservation, but lacks necessary staff, equipment and support to carry out even modest levels of patrol, monitoring and enforcement activities.

St. Kitts-Nevis is not currently a signatory to the Convention on International Trade in Endangered Species (CITES), and there appear to be no regulations specifically addressing the import, export, or transshipment of products from sea turtles or other organisms internationally recognized as endangered. Meylan (1983) reported that much of the tortoiseshell collected from hawksbills by fishermen in St. Kitts-Nevis was exported to other Eastern Caribbean islands by traveling dealers, although the turtle product import ban in the United States sharply reduced the regional demand for tortoiseshell and polished carapaces.

Legislation and regulations relevant to the maintenance of sea turtle habitats (e.g., beach preservation, marine pollution, and wildlife) are treated in Section 2.7.

2.5.3 Recent Reports on Sea Turtles on the Southeast Peninsula

The ECNAMP data atlas for St. Kitts (1980) indicated that greens and hawksbills nested on the beaches in Mosquito, Major's, Banana, Cockleshell and Sand Bank Bays and that leatherbacks also nested at Sand Bank. Fisheries data gathered by Raymond Lynch for ECNAMP in 1979 demonstrated an active net fishery for sea turtles around the Southeast Peninsula by fishermen living on Nevis. The fishery was unusual for the Lesser Antilles in recent years in that they fished for turtles full-time rather than incidentally (Lynch, 1979). Jackson (1981) reported that hawksbills and green turtles had nested recently at Mosquito nd Sand Bank Bays, and leatherbacks were reported to have nested in the past on both sides of Friar's Bay.

Meylan (1983) conducted an extensive survey of sea turtles in the Leeward Islands. For St.Kitts, she reports that hawksbills and green turtles of a wide range of sizes are seen year-round, leatherbacks are

largely limited to the nesting season and loggerheads are rare. "Hawksbills and, to a lesser extent, green turtles nest sporadically on the island. The most frequently mentioned nesting sites for both species are on the tip of the southeastern peninsula -- at Major Bay, Banana Bay, Cockleshell Bay, Mosquito Bay and Sand Bank Bay. These beaches are accessible only by boat, a factor that has probably contributed to their continued status as nesting sites." She notes that leatherbacks nest on the Atlantic beaches of St. Kitts as far south as Sand Bank Bay, but the principal leatherback beaches are to the northwest of the Peninsula. Her map shows the shallows adjacent to the entire periphery of the Southeast Peninsula as a foraging area for turtles, with the widest zone around the southeast tip. Residents of St. Kitts she interviewed indicated that numbers of turtles and net captures were declining in recent years.

In a summary of sea turtle data for St. Kitts-Nevis Wilkins and Meylan (1984) indicate that the main nesting beaches on the island are Sandy Point, Conaree and beaches on the Southeast Peninsula (Major's, Cockleshell, Sand Bank and North Friar's). Green turtles and hawksbills nest on all four (June to September) with leatherbacks using only Sand Bank and North Friar's (March to May). Major's Bay is noted as a foraging area for greens and hawksbills based on observation and an ongoing fishery. They report that most nests are raided for eggs by man, so that few hatchlings are produced.

In July 1985 Arendt and Fuller (Arendt, 1985) examined Southeast Peninsula beaches for turtle nesting. They found remains of a slaughtered female leatherback and a nest on North Friar's Bay, with four additional raided leatherback nests on Cockleshell and two more on Mosquito Bay beach. They also observed a raided hawksbill nest at Mosquito Bay. The latter two leatherback sites are unusual in that these are both low wave energy beaches (Friar's Bay North is more typical of Caribbean leatherback nesting beach profiles).

All sandy beaches of the peninsula (Table 2.3) were examined by Rainey for the EAR in October 1985 for sea turtle activity. This is late in the nesting season so that few recent nests were observed, but raided nests of varying ages were found at several sites. The scattered eggshells at these nests suggest most were destroyed by animals (pig or mongoose likely) because humans rarely break more than a few eggs at the nest site. There is a detection bias in that the persistent eggshells from nests raided by animals may be evident for months, but undisturbed nests or those raided by humans may be obscured on the open beach by a few days of wind and rain. Leatherback excavations are typically recognizable by their large size. Nests well back in the woody vegetation are normally hawksbill. Old nesting attempts on the open beach in which the tracks are lost and the pit dimensions are obscured by predator excavation and weathering may have been either greens or hawksbills. In the following descriptions, nests not labelled by species are in this category.

One recently raided and one older nest were found on Major's Bay, two pits on Cockleshell and one possible raided nest on Banana Bay. On Mosquito Bay beach there were one hawksbill and two unknown nests with eggshell and six older possible nests or nesting attempts. An unnamed pocket beach west of Canoe Bay had two hawksbill nests, a recent unsuccessful hawksbill nest excavation and two older pits. No evidence of recent nesting was found on North or South Friar's Bay, the pocket beaches immediately east and west of North Friar's Bay, Canoe Bay, and Sand Bank Bay. Residents reported that green turtles and hawksbills nested in substantial numbers into the mid-1970's at South Friar's Bay and that some greens nested along with leatherbacks at North Friar's Bay. Table 2.5 is a summary of sea turtle nesting sites on the Southeast Peninsula by species. Although all these beaches undergo cycles of erosion and redeposition in response to seasonal changes and major storms, they are relatively stable and have been recognized as nesting sites for some time. Other sites such as Ballast Bay may acquire a blanket of sand potentially suitable for nesting for several years and then have it stripped away by a major storm.

2.5.4 Long Term Variations in Turtle Nesting Beach Suitablity

Beaches are dynamic in time and space relative to their suitbility as turtle nesting sites. Some disappear in a few years, while others become acceptable over time. For example, a slight seaward advance of the beach immediately east of North Friars Bay would provide a suitable nesting site. On the other hand, Canoe Bay beach has adequate sand above water, but the reef offshore and rocky obstructions in the foreshore probably make it less suitable than several nearby beaches. Prior to Hurricane Klaus in 1984 small pocket beaches were present at Bug's Hole and other locations between Guana Point and

Table 2.5. Turtle nesting activity on Southeastern Peninsula beaches.

	Leatherback	Green	Hawksbill	Source
North Friar's Bay	x	x	x	1,5,6
Unnamed, west of Canoe Bay		?	x	6
Sand Bank Bay	x	x	x	1,2,3,6
Mosquito Bay	x	x	x	1,2,3,4,5,6
Cockleshell Bay	x	x	x	2,3,4,5,6
Banana Bay		x	x	2,3
Major's Bay		x	x	2,3,6
South Friar's Bay		x	x	6

Sources
1. Jackson, *et al.*, 1981
2. ECNAMP, 1980
3. Meylan, 1983
4. Wilkins and Meylan, 1984
5. Arendt, 1985
6. This report (observation and interviews)

Nag's Head which may have been suitable for hawksbill nesting. In other words, site-specific regulation of turtle nesting can easily overlook basic system dynamics and lock an administrative/monitoring unit into an inappropriate and ineffective locational focus.

2.5.5 Turtle Nesting Seasons

Turtle nesting seasons as identified by Wilkin and Meylan (1984) -- leatherbacks (March to May), greens and hawksbills (May to September) -- cover the bulk of nesting on the Southeast Peninsula, but not all of it. Arendt's observation (1985) supports earlier suggestions based on carefully monitored Eastern Caribbean leatherback nesting sites (e.g., Tucker and Hall, 1984) that this species will nest from March to July. The leatherback nesting season is fairly discrete, but this is much less the case with greens and hawksbills. Hawksbill nesting records on islands in the vicinity indicate a season that extends from May to January with a peak around September (Small, 1982; Thurston, 1976; Joseph et al., 1984), but isolated nestings in April have been reported (Tucker and Hall, 1984). Data for green turtle nestings in the region are less abundant, but it would be reasonable to expect a pattern similar to the hawksbill, with a slightly earlier peak (August) and possibly a shorter season (though scattered nesting occurs almost throughout the year at the nearby aggregated breeding site on Aves Island).

As an initial scheduling guideline for designing a beach monitoring programme on the Southeast Peninsula for all species combined, the possibility of nesting in any month cannot be dismissed, but there is an annual winter low with peaks likely in May (leatherbacks) and August-September (greens and hawksbills).

2.5.6 Summary: Sea Turtle Exploitation

The primary threat to the survival of sea turtles on the Southeast Peninsula, as elsewhere in the Eastern Caribbean, is direct exploitation. Available evidence indicates that breeding adults and eggs are now heavily exploited, recruitment is minimal, and stocks are declining. Foraging animals in adjacent shallows are also exploited, but the pressure now may be somewhat less than in the recent past (perhaps because it is no longer as economically rewarding). Boaters often scan the beaches from offshore for turtle tracks and then come ashore to probe for eggs. Peninsula residents, on the other hand, have been observed herding pigs on the beach to feed on eggs. Pigs are effective at locating turtle nests, and similar activities occur elsewhere on St. Kitts.

Informants suggest that virtually all of the nesting females (and perhaps some courting males) in the protected bays (e.g., Major's, Mosquito) are taken by nets set close to the beach. Turtle netting is a specialized fishery involving a significant commitment of capital as well as skill and time. The gear typically used catches only turtles

so that below a certain minimum turtle density the fishery is no longer worth pursuing. While that density may be low, it is above zero, and as turtle numbers have declined in the West Indies, so has the number of fishermen exclusively working turtle nets. Spearfishing, however, has a broad range of target species in addition to turtles, so that the commercial fisherman can continue to operate even after his harvest drives the turtle density to zero. The critical feedback loop (the law of diminishing returns, in this case) is missing.

2.5.7 Other Wildlife

Like many other island nations, St. Kitts-Nevis has lost or severely reduced much of its pre-colonial fauna by hunting, land clearance for agriculture, and the introduction of non-native animals. The number of species lost is not clearly known, but early hunters took iguana (probably Iguana delicatissima) and mountain chicken or crapaud (Leptodactylus fallax). Merrill (1958) notes that Leptodactylus fallax was a delicacy on St. Kitts in the early years of settlement but that it is now extinct.

Nevertheless, the Southeast Peninsula does have a varied and interesting fauna, including approximately 55 species of resident or migratory birds, plus lizards, bats, and various other mammals such as the southern white tailed deer (Odocoileus virginianus) and the green monkey (Cercopithecus aethiops). A recent SEP wildlife survey report by Wayne Arendt (1985) provides a fairly comprehensive profile of Peninsula fauna, as summarized graphically in Figures 1.2, 2.15, and 2.16.

Of particular concern are the confirmed frigate bird (Frigata magnificens) and brown pelican (Pelecanus occidentalis) nesting colonies on Nag's Head. The frigate bird colony is small but important to fishermen and apparently the only one on St. Kitts. The brown pelican is the national bird of St. Kitts-Nevis and appears on the state crest; however, it is not mentioned in current wildlife protection regulations. While it is a highly visible resident, fishing and nesting in protected bays and along the Caribbean shore of the Southeast Peninsula, the breeding colony on the cliffs of Nag's Head is apparently the only one on St. Kitts. Within the Caribbean, there is concern about the status of the pelican because of declines in nesting. In the United States, the pelican is listed as endangered (CFR 35 [233]:18319), largely as a consequence of severe population declines caused by pesticide-induced eggshell thinning.

The major pressure on pelicans on St. Kitts at present is probably human harvesting of eggs and nestlings from the Nag's Head colony, although similar predation by monkeys may occur. Harvesting of seabird eggs and nestlings for local consumption and export is a long established tradition in the region. Pelican nestlings from Nag's Head were harvested particularly actively during World War II when shipping of food in the region was severely restricted. Arendt (1985)

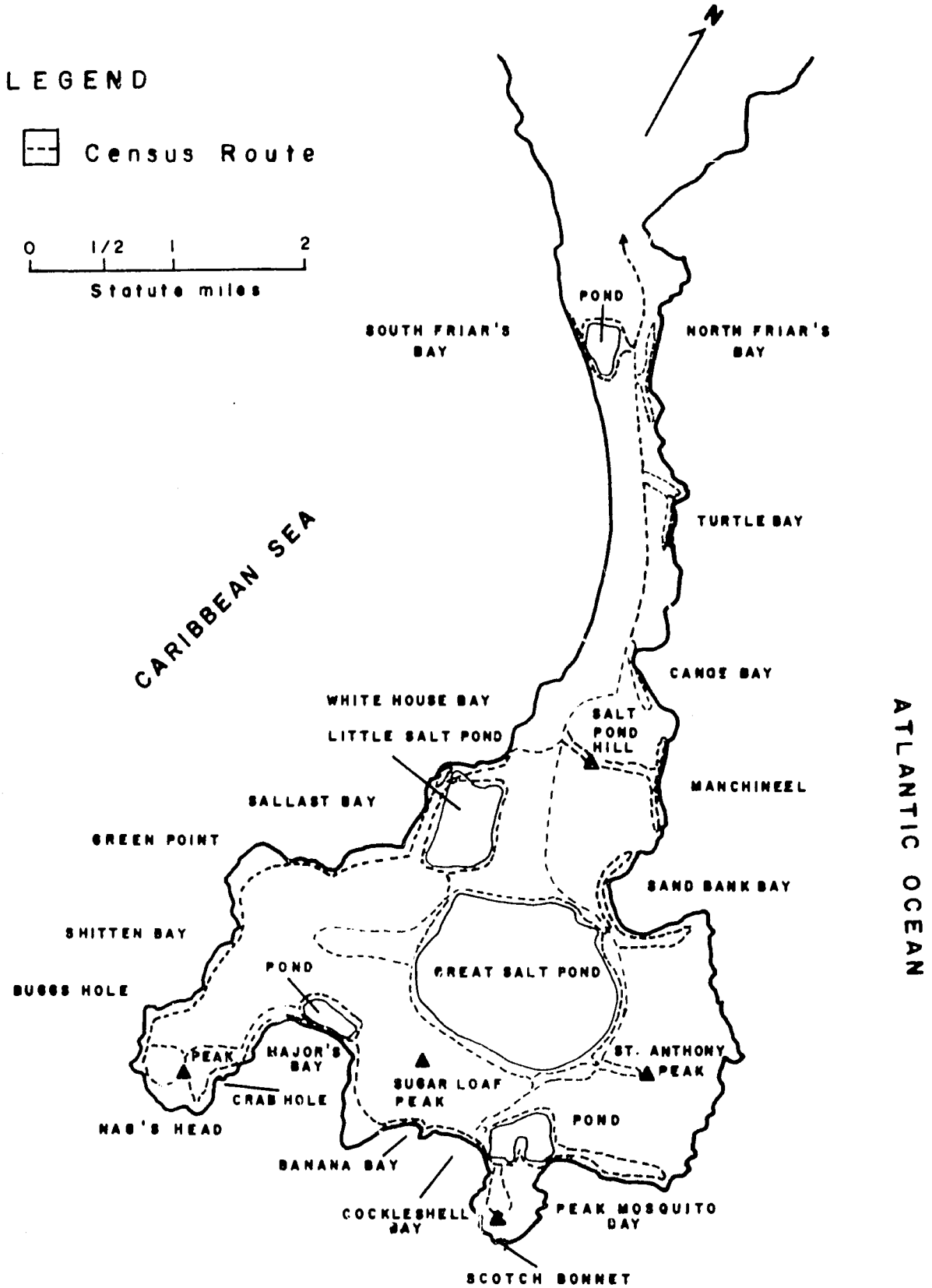

Figure 2.15. Summary of census routes taken during a wildlife assessment of the Southeast Peninsula, July 2-16, 1985 (source: Arendt, 1985).

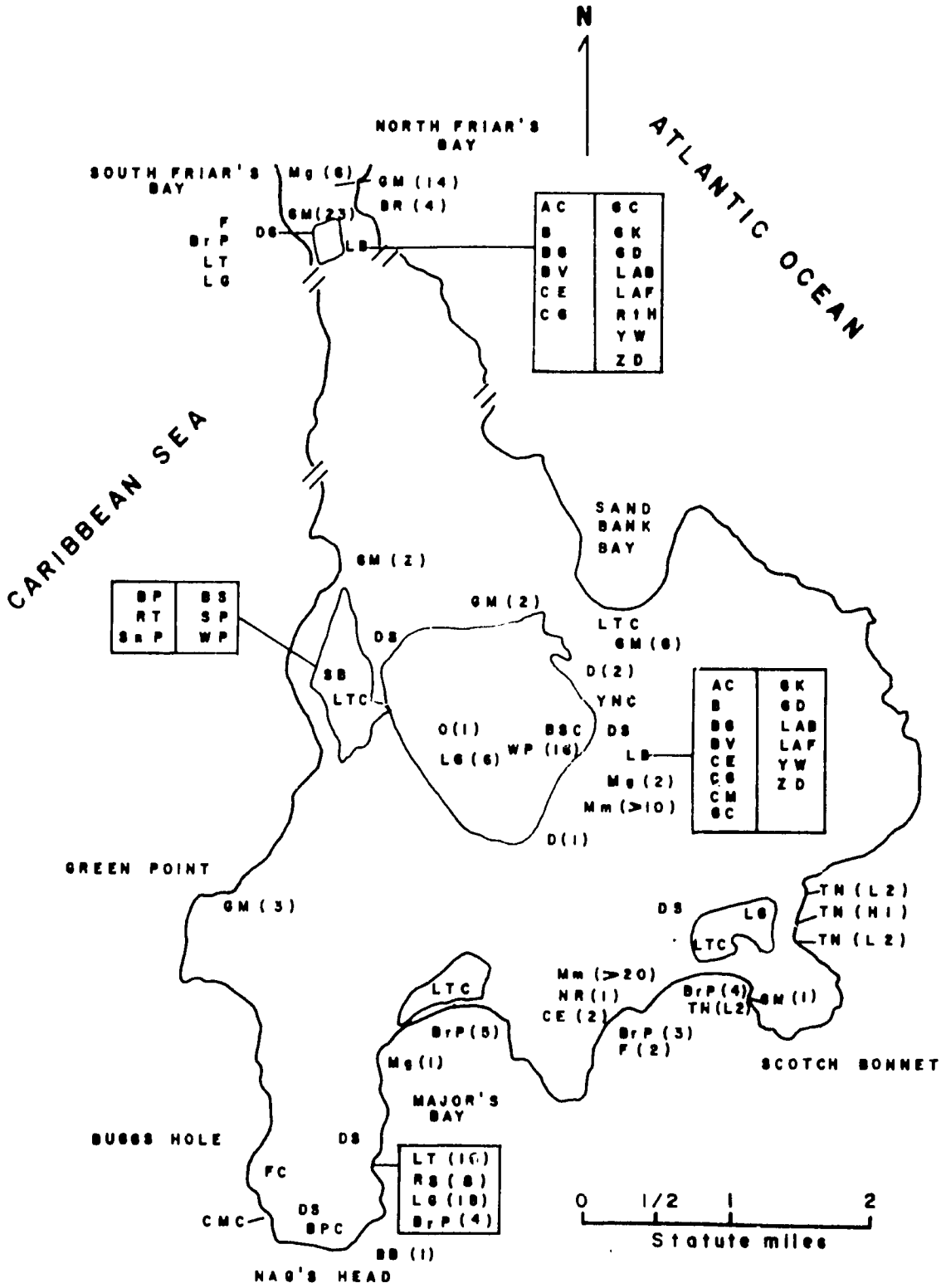

Figure 2.16. Summary of wildlife species and their locations on the Southeast Peninsula (source: Arendt, 1985). [Legend appears on following page.]

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LEGEND - Figure 2.16.

HERPETOFAUNA

Ab Anolis bimaculatus
Hm Hemidactylus mabouia
Ss Sphaerodactylus sabanus
TN Turtle Nest:
- H Hawksbill
- L Leatherback

Tr Thecodactylus rapicauda

BIRDS

BB Brown Boody
BrP Brown Pelican
BPC Brown Pelican Nest Colony
CtE Cattle Egret
F Frigatebird
FC Frigatebird Nest Colony
LB Land Birds:
- AC Antillean Crested Hummingbird
- B Bananaquit
- BG Black-faced Grassquit
- BV Black-whiskered Vireo
- CE Caribbean Elaenia
- CG Carib Grackle
- CM Caribbean Martin
- CMC Caribbean Martin Nest Colony
- GC Green-throated Carib
- GK Gray Kingbird
- GD Common Ground-Dove
- LAB Lesser Antillean Bullfinch
- AF Lesser Antillean Flycatcher
- RtH Red-Tailed Hawk
- YW Yellow Warbler
- ZD Zenaida Dove

LG Laughing Gull
LTC Least Tern Nest Colony
O Osprey
SB Shore-birds:
- BP Black-bellied Plover
- BS Black-necked Stilt
- BSC Black-necked Stilt Nest Colony
- RT Ruddy Turnstone
- SP Semipalmated Plover
- SnP Snowy Plover
- WP Wilson's Plover

SE Snowy Egret
T Terns:
- L Least Tern
- RoT Roseate Tern

YNC Yellow-crowned Night-Heron Colony

MAMMALS

BR Black Rat
D White-tailed Deer
DS Deer Signs
GM Green Monkey
Mg Small Indian Mongoose
Mm Molossus molossus
NR Norway Rat

found evidence of recent human predation, confirmed by local residents, on the pelican and frigate bird colonies at Nag's Head and Bug's Hole, respectively.

Pelicans fare reasonably well in close proximity to humans as long as nesting areas remain largely undisturbed and adequate roosting-loafing sites and feeding areas persist. Therefore, the existing nesting colony site definitely warrants some form of monitoring and protection plan, whether the Peninsula road is built or not.

The Lesser Antillean least tern (Sterna antillarum) populations are not formally recognized as threatened or endangered, but their habit of breeding on open beaches or salinas leaves them extremely vulnerable to disturbance by coastal development and feral or domestic animals since they do not favor the steep-sided offshore keys that provide predator-free breeding and roosting sites. This Peninsula species also will require careful monitoring and probably protective measures for its key nesting sites if it is to survive any significant increase in human densities and activity on the Peninsula.

According to a credible source, several agouti (Dasprocta sp.) have been sighted recently at Frigate Bay on the margins of the golf course. This is a remarkable finding as the animal has generally been considered to be extinct in St. Kitts (as in other nearby islands) since the early colonial period. Agouti are large rodents unfamiliar to most visitors and, indeed, to most native West Indians. If this reported sighting proves to be accurate, it is very likely that the agouti may also be present on the Southeast Peninsula.

2.6 Land Use

2.6.1 Historical Antecedents

The archaeological evidence of pre-Columbian Amerindian occupation of the Southeast Peninsula is indisputable. Several Archaic (2000 to 4000 BC) and Ceramic (post-first century) sites have been reported by Armstrong (1980) and reconfirmed by Nicholson as a part of the EAR in 1985 (see Appendix A). Additionally, Nicholson's brief survey identified eight historic period sites documenting significant levels of use and occupation from c. 1720 to c. 1890.

A more extensive survey would undoubtedly identify even more sites since other cartographic and historical evidence suggest the Peninsula was more heavily used in previous centuries than at the present. A 1660 map of St. Kitts by Andrew Norwood, the Surveyor General of England, shows four active agricultural landholdings at Friar's Bay and 17 in the Great Salt Pond area -- presumably tobacco and possibly indigo farmers as sugar was not introduced into St. Kitts until the late 1650's (Figure 2.17). A century later, the 1753 Samuel Baker map (Figure 2.18) clearly identifies a half dozen estates owned by former governors, officials and other notables -- Lt. General Fleming, the

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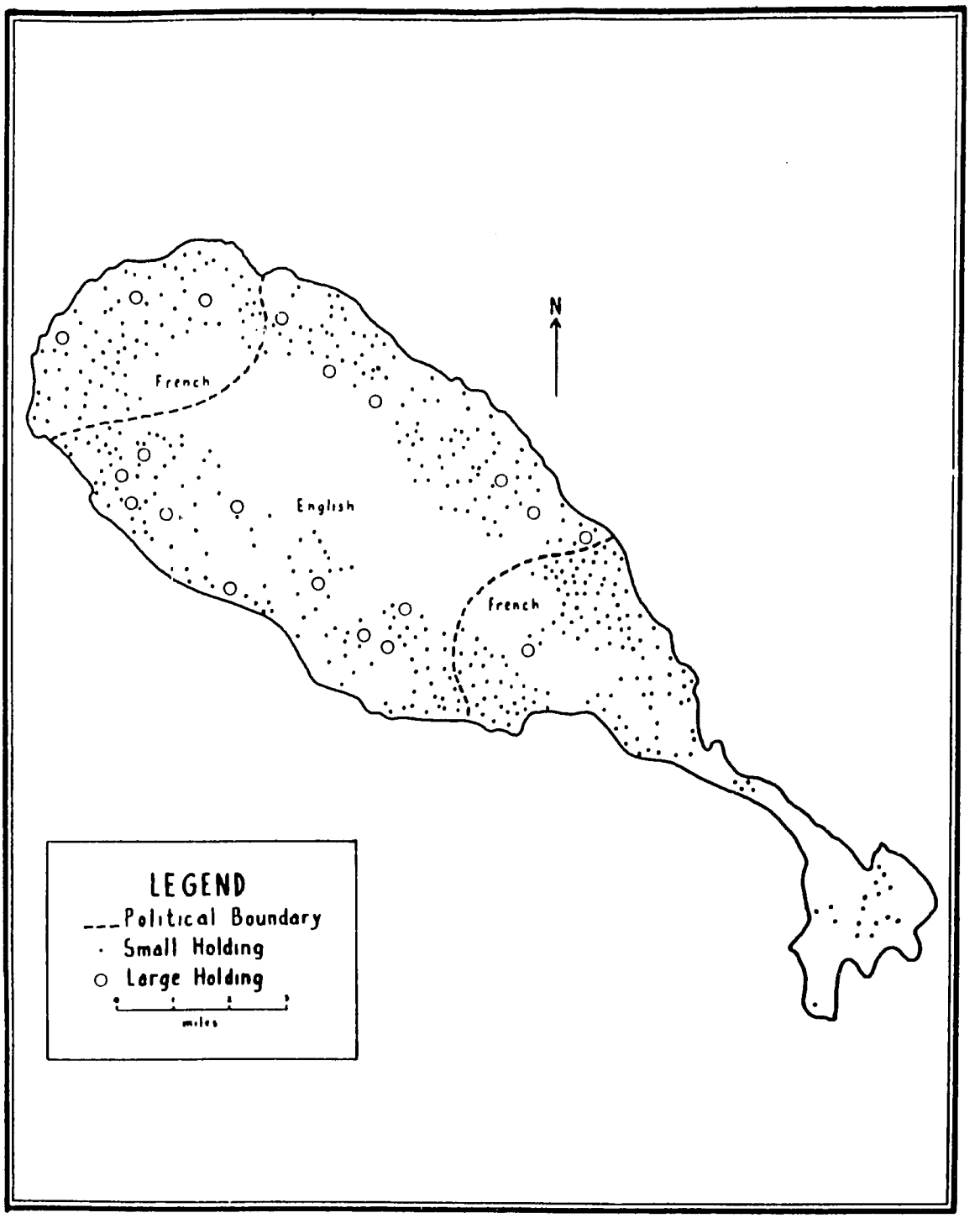


Figure 2.17. Agricultural settlement pattern of St. Kitts in the mid-seventeenth century. Source of map: adapted from Merrill, 1954. Source of data: a map of St. Kitts, 1660 by Andrew Norwood, London.

Honorable Ralph Payne, Lord Romney, William Woodley, Richard Holmes, and Isaac DuPuy. The Fleming Estate, to the southeast of the Great Salt Pond, is depicted with a wind-powered sugar mill, a horse mill, a well, two estate houses, and a fort or defence battery on the point between Banana and Cockleshell Bay. The ruins of General Fleming's sugar mill and his well are still very visible to this day.

Sometime after 1753 Ballast Bay acquired its name (it was previously called Grand Gullette), suggesting cargo vessels dumped rock ballast there prior to picking up a load of sugar or other products. Baker's 1753 map shows a large vessel anchored in this very bay -- and another at White House Bay -- also indicating both were used as regular safe anchorages for larger vessels. (See Figure 2.18.)

The 1753 Baker map also shows an extensive road network extending from Frigate Bay to White House Bay with branch roads leading around both sides of Great Salt Pond and to Mosquito, Cockleshell, Ballast, and Major's Bays. It is remarkable that the route of this 1753 road is almost identical to the new proposed Peninsula road under review at this time. A 1928 map of the Peninsula not only shows the same road system but also two "old village sites," the salt works jetty and place names like Cotton Ground and the Lumber Yard, all of which suggest a relatively significant level of occupation and use until the early decades of this century.

Early aerial photographs clearly record areas with neatly spaced rows of coconuts and cherry trees (some "cherry" orchard remnants are still alive) and confirm an old sluiceway from White House Bay to the salt works at Little Salt Pond, as well as numerous cattle cisterns. Any casual visitor to the Peninsula even today can still perceive vestigial features of a "plantation economy" and a community. According to one source (Jackson, 1981), the pre-World War II resident population numbered about 500, working mostly in salt production and agriculture. There was, apparently, even a school (Matheson, personal communication).

2.6.2 Contemporary Uses of the Peninsula

As in the past, current human use of the Peninsula involves both terrestrial and marine areas. St. Kitts fishermen (principally from Conaree and Basseterre), and Nevis fishermen as well, have historically exploited the marine resources of the Peninsula shelf (see Section 2.4.5, Lynch [1979] and Goodwin, et al. [1985]). Other more recent marine uses include occasional scuba diving, boating, snorkeling and recreational fishing by local boat owners and by visiting tourists who patronize local water sports firms. Marine recreational uses of the upper Peninsula/Frigate Bay area are reviewed in a recent case study of Frigate Bay (Towle, et al., 1985).

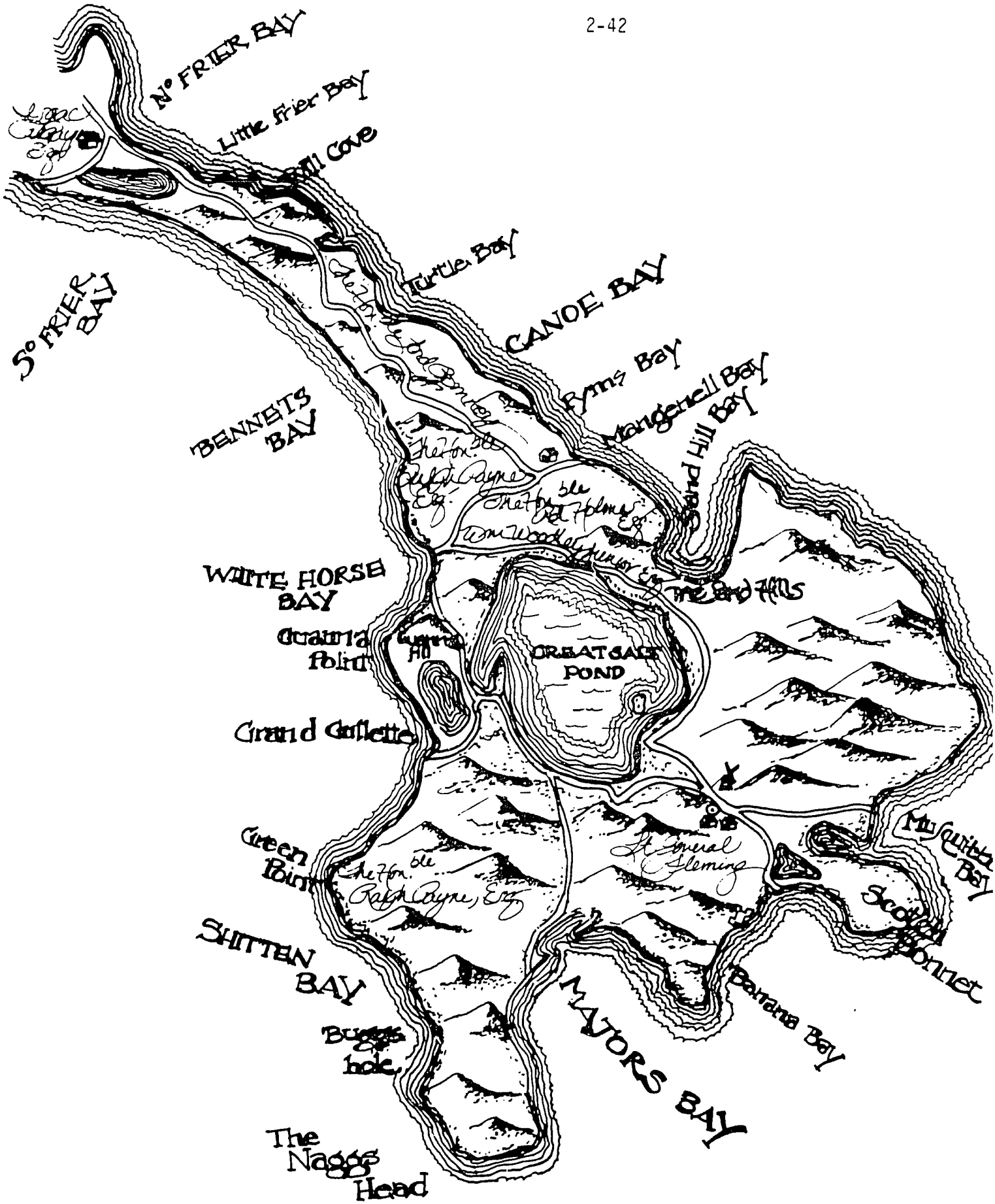


FIGURE 2.18. SOUTHEAST PENINSULA, ESTATE OWNERSHIP AND ROAD NETWORK. ADAPTED FROM LT. S. BAKER MAP, 1753.

Continuing land uses include:

	Estimated # Persons Involved (Jackson, 1981)
(a) Part-time residence (there are five locally owned, seasonally occupied homes).	?
(b) Monkey hunting (harvesting). The estimated Peninsula monkey (Cercopithecus aethiops) population of 5,000 animals (Jackson, 1981) attracts local hunters seeking live specimens to export for laboratory use at approximately EC$80.00 each. Capture methods are reportedly less than humane as the use of dogs, leg traps and brush burning are common practice.	6
(c) Charcoal production. Although small-scale and illegal without a permit, this activity has contributed significantly to the devegetation process and, in the absence of any law enforcement constraint, continues unabated.	6
(d) Livestock grazing -- intermittent, incidental.	6
(e) Coconut cropping -- minor, one location.	2
(f) Sports hunting (birds and deer) - seasonal.	?
(g) Hiking, picnics, and outdoor recreation (residents and tourists).	10/per week
(h) Tourism - Banana Bay Beach Hotel (12 rooms). Access is principally by boat at present since the rough road is essentially impassable for reasons of washouts and fallen rock except for four-wheel drive, high-wheel base vehicles and even then with difficulty, risk and discomfort.	?

Including all of the above, plus perhaps 150 fishermen (Jackson, 1981), there are upwards of perhaps 200 persons who use the Peninsula on a regular or part-time basis. It is impossible to calculate net income derived from Peninsula resource utilization.

Peninsula brush fires continue to be a serious land use problem. Merrill, even back in 1954, noted, "Fires set by islanders are still common on the Peninsula of St. Kitts." It is equally as common in 1985, and there is no simple explanation for this destructive prac-

tice. But theories are legion, and various persons interviewed had widely divergent opinions. For example:

(1) The monkey hunters burn the scrub brush to make it easier to catch monkeys.

(2) Charcoal burning results in accidental fires.

(3) Land owners set the fires as a convenient way to clear brush to make the land look more attractive and accessible to prospective buyers.

(4) Cattle grazers set the fires to accelerate grass growth for cattle.

(5) Squatters or visitors set the fires accidentally.

(6) Lightning.

One suspects that there is an element of truth in all six, but, more importantly, there is no law enforcement nor any fire brigade available in the absence of an access road. Thus, fires, once started in the dry season, are not put out -- they just burn out to the detriment of the Peninsula's wildlife and already marginal vegetative cover.

2.6.3 Land Ownership and Prior Development Planning

The Government of St. Kitts-Nevis, contrary to popular opinion, technically does own land on the Southeast Peninsula. In the first place, it owns all the beach foreshores and land 50 yards (45.5 m) inland. Secondly, the St. Kitts-Nevis para-statal body, the Frigate Bay Development Corporation, owns the base of the Peninsula, the entire northwesterly face of Sir Timothy Hill through which the first kilometer of the proposed road passes. Lastly, since the "old Peninsula road" has been in public use (however intermittently) since at least 1753 (Baker Map) and since apparently no protest has ever been filed by any land owner regarding such use by the public, the question arises regarding its possible formal dedication as a public government road, translating it from de facto to de jure status.

Nevertheless, the Peninsula, save for the above, is privately held, as best as could be determined for purposes of the EAR, by 30 owners (some parcels by individuals, some by partnerships or joint ownership and some by corporations). A tabular summary is provided in Section 1 of this report. However, the roster is not complete, and the full picture is not entirely substantiated. There is apparently no master land ownership tax map or planning map maintained by Government, and it is presumed the assembly of the data needed to construct such a map will be a priority item on the planning agenda. Without it, it is almost impossible to calculate accurately either the present or projected Peninsula tax revenue base. Furthermore, environmental planners need such a map to establish the ownership of key Peninsula re-

sources -- for example, a historic or archaeological site, a drainage gut, a nesting colony of birds, a specific habitat, even a salt pond (which has variable dimensions over time).

Nearly 17 years have passed since the then Government of St. Kitts-Nevis-Anguilla first commissioned and paid the British firm of Brimer, Martin, Maggs, Keeble and Partners, Consulting Engineers to prepare a design and cost estimate for "A Road to Cockleshell Bay From Frigate Bay, St. Kitts" (May 1968), and separately commissioned a land use and tourism development plan which, when submitted, called for eleven 200-bed hotels, two 150-bed hotels, 1,000 residential lots, and 500 apartments. Planners envisaged a Peninsula population of between 9,000 and 11,000 persons and a road cost of EC$360,000 per mile or EC$2,304,000 total. From an environmental perspective, the 1968-69 development scheme was a prospective disaster.

Since that time, at least six other road and/or large-scale tourism development schemes have been commissioned or received by Government (see Beard Dove, 1981 and Preinvest, 1985). It is, therefore, a bit perplexing to find no record of any planning dialogue or strategy agreement between Government and the landowners, no master list or map of who owns what, and no master file on all the various aborted plans, designs, and schemes. It is fair to say, in retrospect, that one "land use" of the undeveloped Peninsula during the past two decades has been to serve as a surrogate laboratory for "hatching" development schemes and consulting reports. Both have done well, and the Peninsula appears none the worse for the experience.

2.7 The Institutional Context

2.7.1 Favorable Factors

The prospect of Peninsula development proceeding in an orderly fashion with minimal environmental damage, at least in early, low density phases, is considerably enhanced by the fact of the Government's thirteen years of experience with developing Frigate Bay as a combined tourist, residential and recreational area under the aegis of the parastatal Frigate Bay Development Corporation (FBDC). This multi-million dollar project has provided a "test run" and learning experience for various officials. Many of its conceptual design and implementation features receive high marks, although it has fallen short in marketing; and as it goes over the 600+ room mark and landscape loading rises, a few unaddressed environmental problems are beginning to surface (Towle, et al., 1985).

Secondly, St. Kitts-Nevis has better than average skilled talent in its Physical and Economic Planning Unit which is at present both hard pressed, understaffed and ill-equipped to move forward with internally generated plans for improved, more systematic approaches to coastal zone resource and environmental management. The spirit is willing but the budget is weak, and insufficient funds have prevented

the acquisition of various basic planning tools (such as a micro-computer or aerial photos) or technical staff (such as an environmental or coastal resource planner). Like many planning units or offices in the Eastern Caribbean, the present staff is so inundated with building permit and development control functions, it has little time to either plan holistically or effectively monitor compliance, performance or deviance.

This malady is easily cured should the road project become a reality, with a modest infusion of capacity building, short-term grant support, a micro-computer with GIS (Geographic Information System) software to track permits, etc., several new technical staff members, a four-wheel drive vehicle, and appropriate short-term consultancies to assist the unit over a few hurdles (see Section 5.5).

Lastly, a similar situation exists relative to the Fisheries Division within the Ministry of Agriculture which has the promise of contributing in a significant way to the environmental management of the Peninsula's marine and coastal ecosystems, but not -- despite its demonstrated competence and diligence -- without a doubling of its staff and miniscule budget.

2.7.2 Unfavorable Factors

At present the Government employs no one with experience, education and training in wildlife management, environmental planning, environmental law, pollution control, marine resource management, impact assessment -- nor are there civil service positions in these areas lacking candidates. Its personnel position vis a vis environmental affairs and natural resource management is very weak. Williams (1983) has summarized the natural resource management problems of the state in a convenient table and also lists training, programme monitoring, and protection needs. At the present time, the Government would be hard pressed to provide adequate environmental management personnel to the Southeast Peninsula road and development project.

Secondly, the absence of any legal basis for even a preliminary "environmental protection strategy" (for example water pollution control, erosion control, historic site protection, wildlife management or park planning and development) means that road and development environmental management issues for the Southeast Peninsula could not be addressed in a direct, holistic, and effective way -- only in bits and pieces by persons from various ministries with perhaps only a passing interest in the problems to be confronted.

It is worth noting, however, that a new Ministry of Natural Resources and the Environment was recently set up, but as yet it has no staff, no Permanent Secretary, no inspectors or enforcement officers, and no mandate to subsume various natural resource and environmental units, personnel or functions under its ministerial umbrella. However, the framework is there, awaiting perhaps some triggering mechanism such as the SEP road project to render it a functional ministry with a mission

-- namely, improved resource and environmental management, critical ingredients for sustainable development in the country.

2.7.3 External Linkages

St. Kitts-Nevis is an active member of the regional Caribbean Conservation Association (CCA) based in Barbados but not of the International Union for the Conservation of Nature and Natural Resources (IUCN) based in Gland, Switzerland. The country is also not a signator to the following international or regional agreements concerning environmental matters relevant to the Peninsula project:

(1) CITES (Convention on International Trade in Endangered Species) - 1973
(2) Cartagena Convention (Treaty for the Protection and Development of the Marine Environment of the Wider Caribbean Region) - 1983
(3) RAMSAR Convention (Wetlands Protection).

Regional environmental NGO's which have worked previously in St. Kitts-Nevis on resource management issues and could conceivably assist with developing the local skills, programmes, guidelines, and institutional requirements for the Peninsula project include (in alphabetical order): Caribbean Conservation Association, Eastern Caribbean Natural Area Management Programme, Environmental Research Projects, and the Island Resources Foundation. From outside the region, the list would include IUCN, Rockefeller Brothers Fund (RBF), and World Wildlife Fund (WWF), among others.

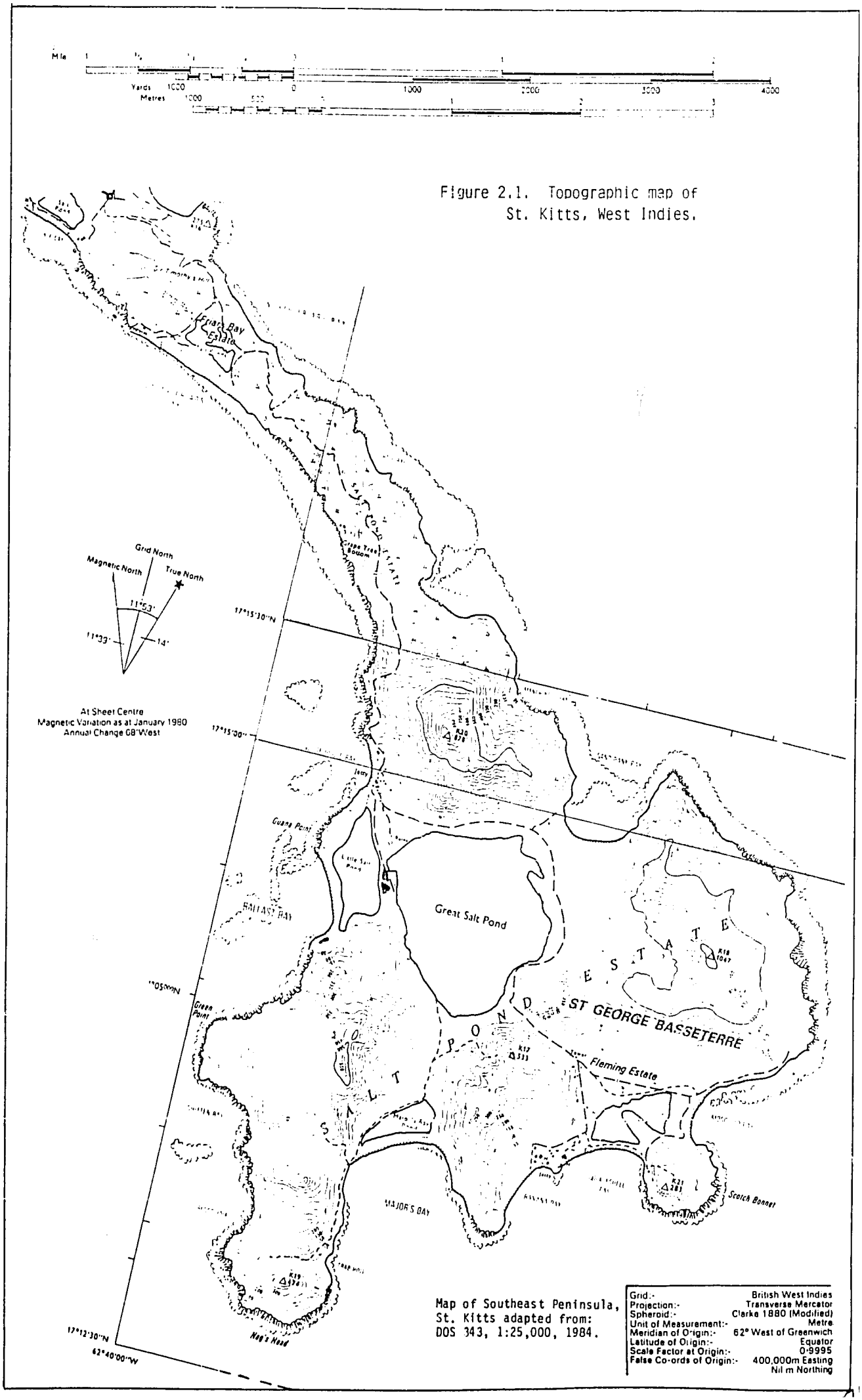
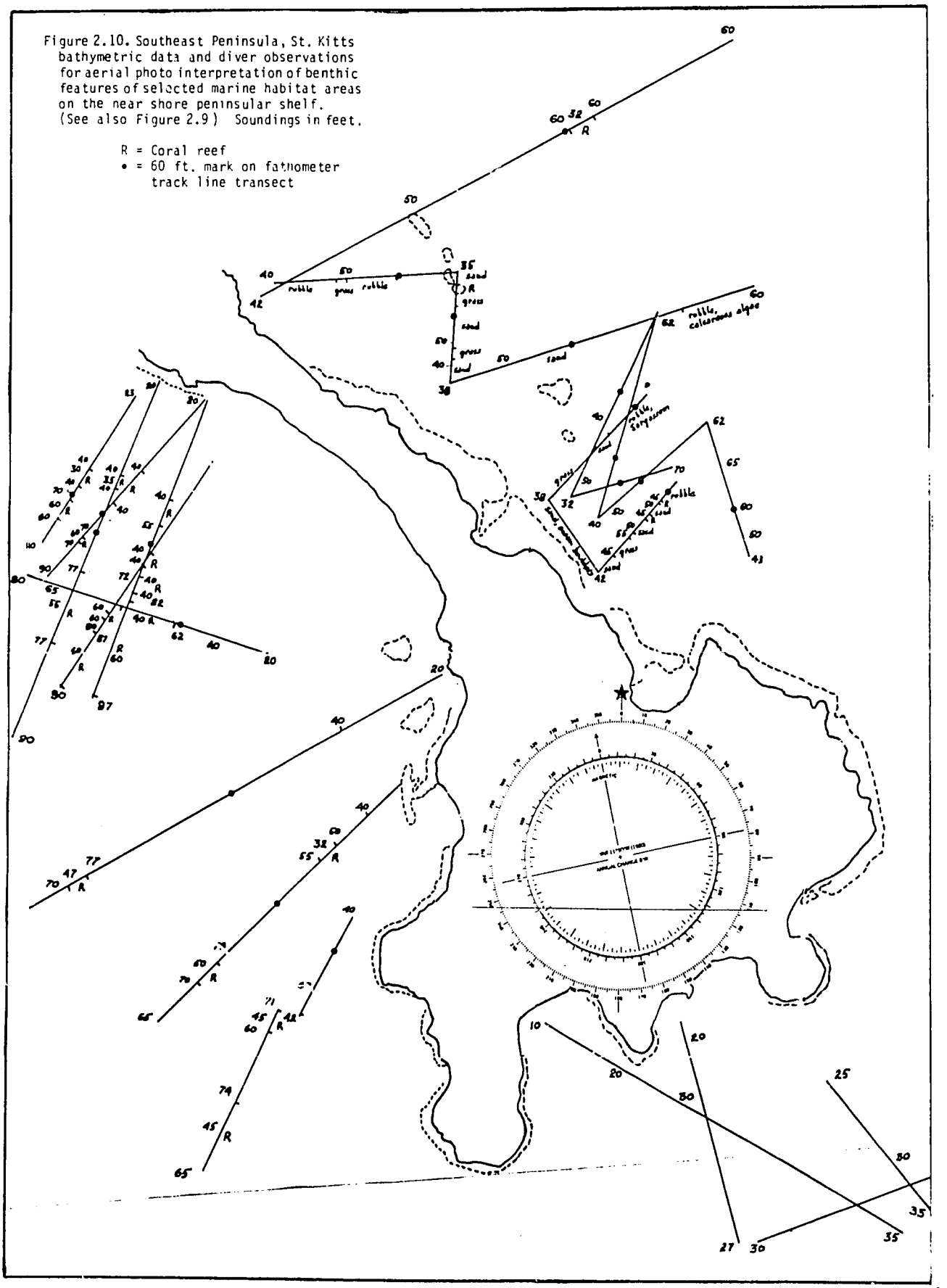


Figure 2.1. Topographic map of St. Kitts, West Indies.

Figure 2.10. Southeast Peninsula, St. Kitts bathymetric data and diver observations for aerial photo interpretation of benthic features of selected marine habitat areas on the near shore peninsular shelf. (See also Figure 2.9) Soundings in feet.

R = Coral reef
• = 60 ft. mark on fathometer track line transect



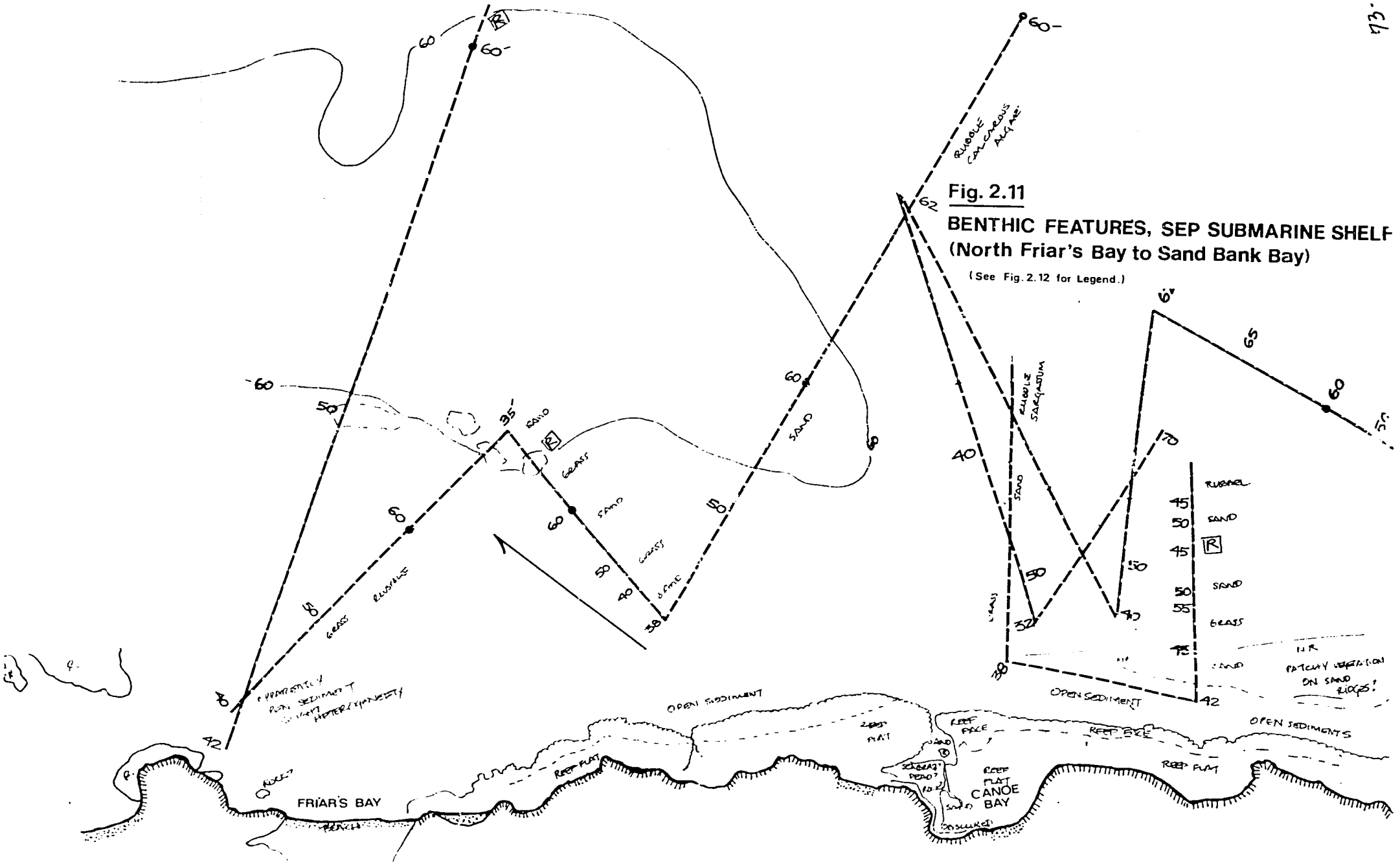


Fig. 2.11

BENTHIC FEATURES, SEP SUBMARINE SHELF (North Friar's Bay to Sand Bank Bay)

(See Fig. 2.12 for Legend.)

Legend

- Bathymetric transect/diver observation. (adjacent numbers = depth in feet)
- 60 feet Contour lines.
- NR — Area not resolvable on aerial photos.
- Limits of coverage for aerial photos.
- Shoreline edge.
- Sandy beaches.
- R — Reef observed during diver survey.
- R — Subtidal rock.
- BR — Beach rock.
- RRR — Reef with ridge and runnel.

Fig. 2.12

BENTHIC FEATURES, SEP SUBMARINE SHELF (Sand Bank Bay to Scotch Bonnet)

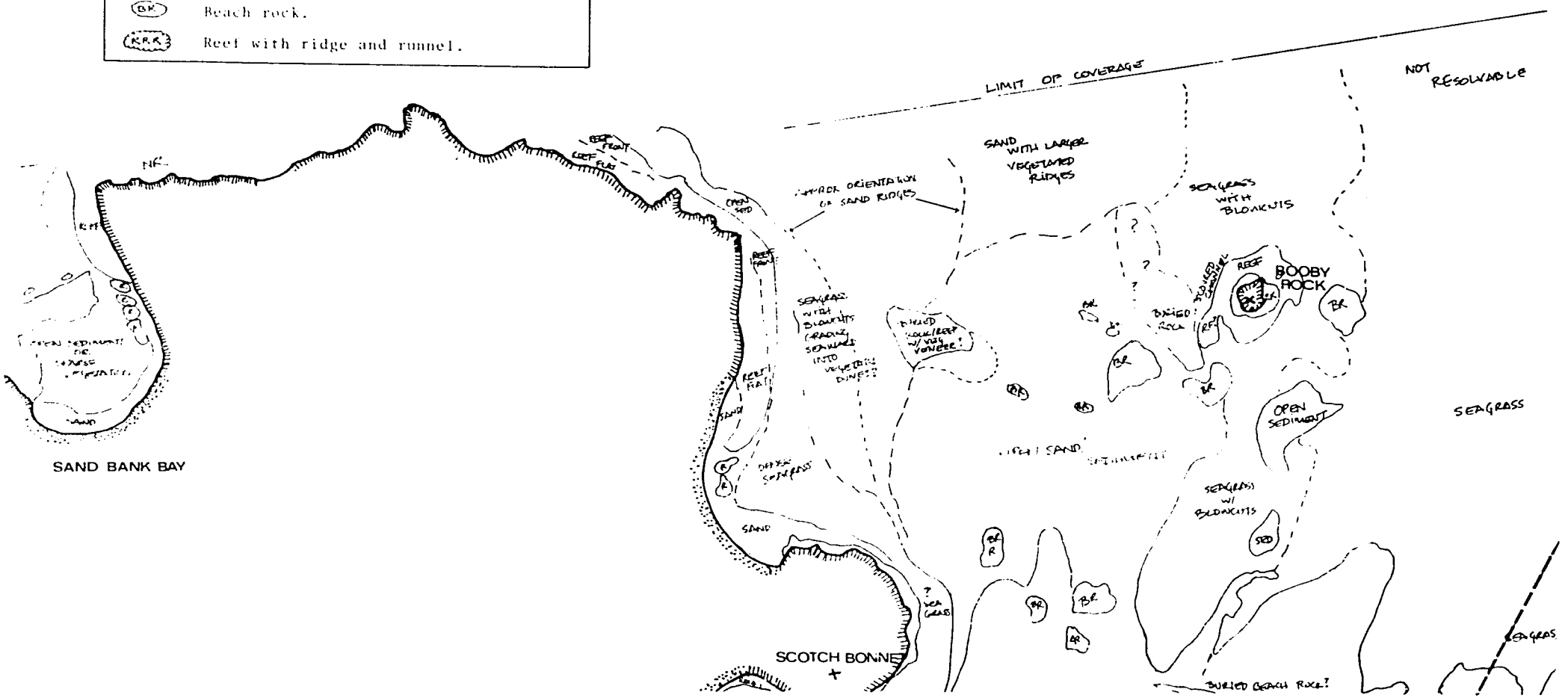
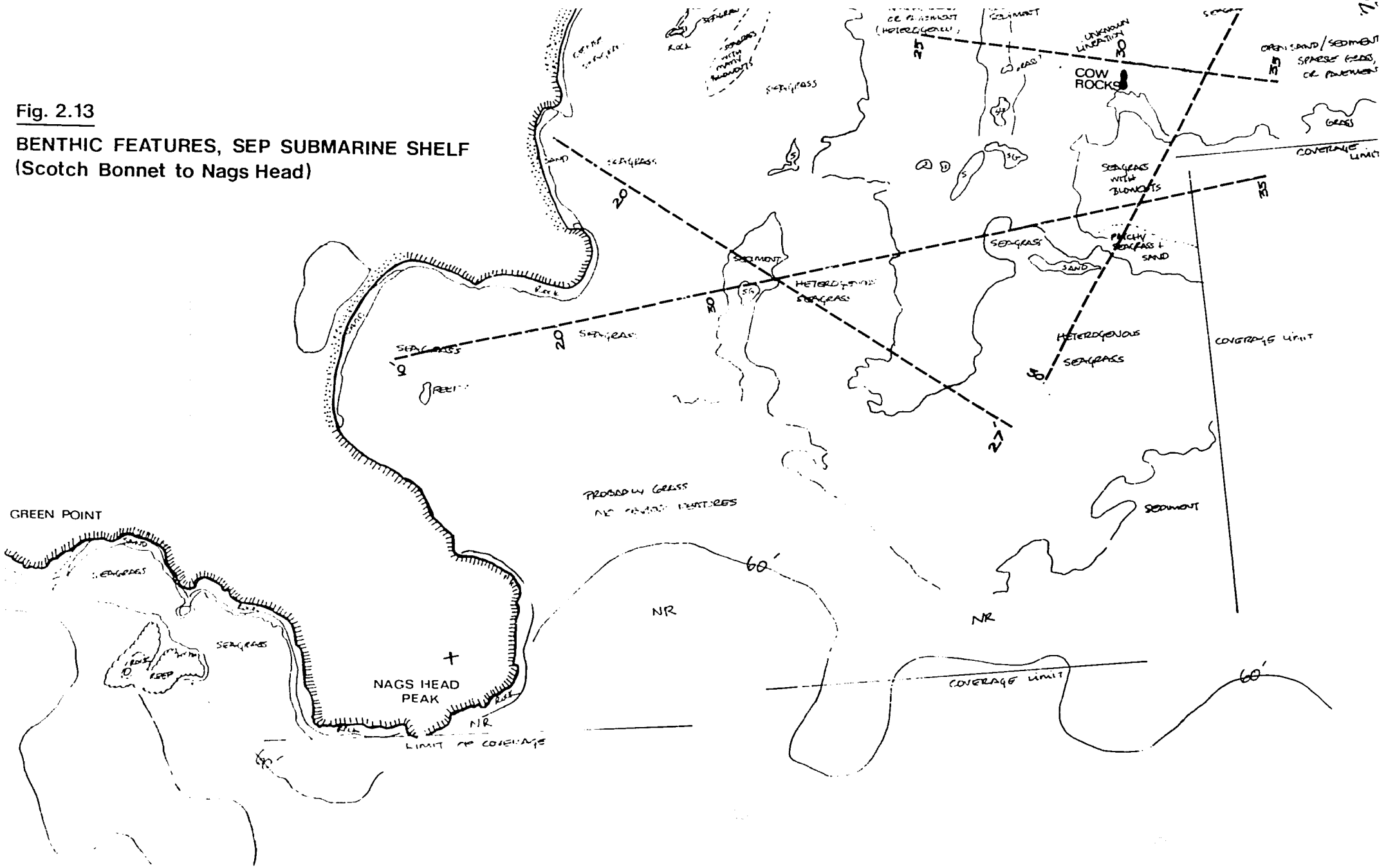


Fig. 2.13

BENTHIC FEATURES, SEP SUBMARINE SHELF (Scotch Bonnet to Nags Head)



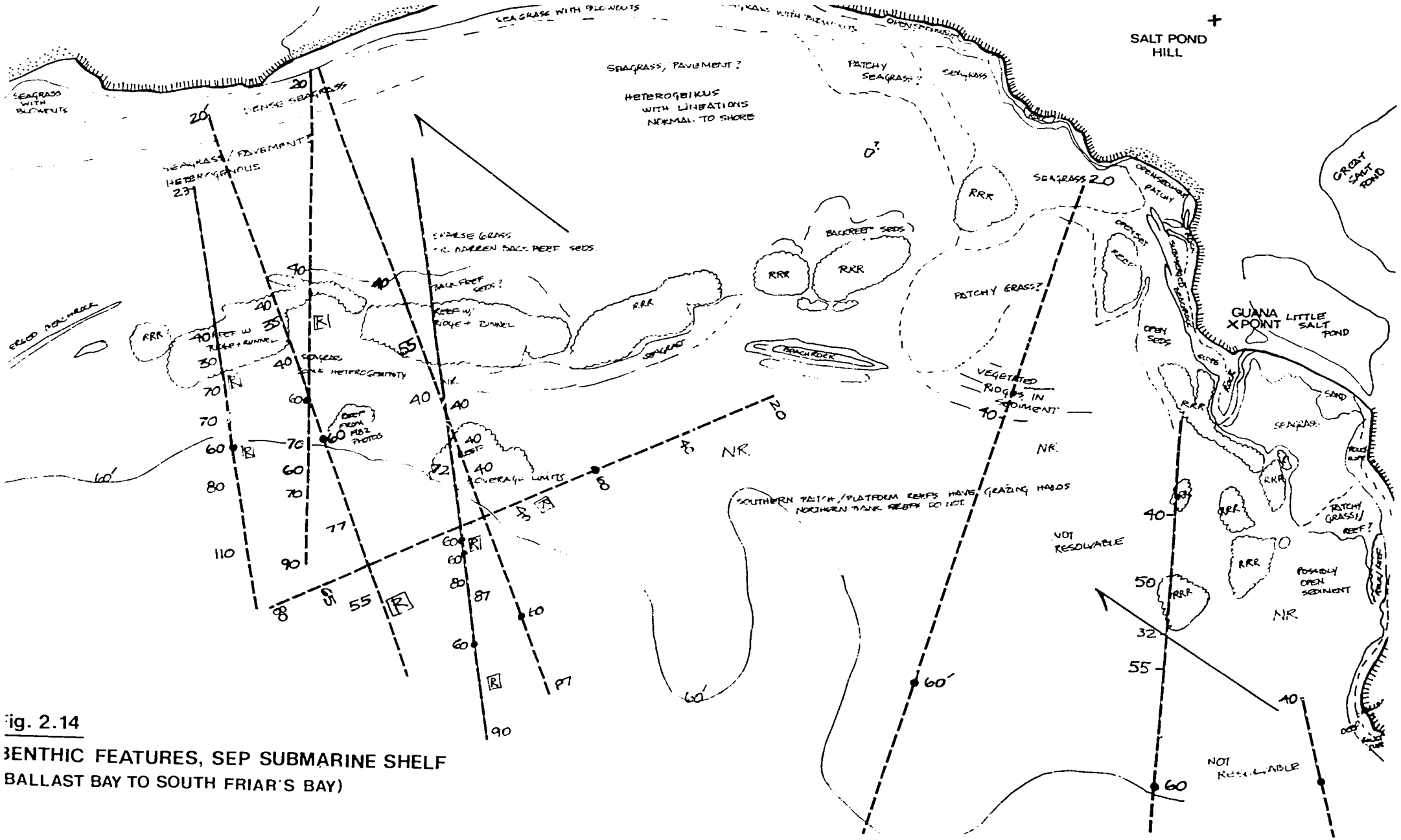


Fig. 2.14

BENTHIC FEATURES, SEP SUBMARINE SHELF
BALLAST BAY TO SOUTH FRIAR'S BAY)

3. PROJECT PURPOSES, DESCRIPTION AND ALTERNATIVE DEVELOPMENT SCENARIOS

3.1 Purpose

The Government of St. Christopher and Nevis and the United States Agency for International Development/Regional Development Office/ Caribbean are designing a project to construct a penetration road into the Southeast Peninsula of St. Kitts for the express purpose of providing access to the undeveloped 4,000 acre area and stimulating economic development, principally marine-oriented tourism. The purpose of this study is to review the nature of the Peninsula's resource base likely to be affected by the project, to establish projected impacts, devise mitigation measures, and determine whether the proposed project involves unreasonable degradation as defined by the U.S. Government (22 CFR Part 216).

3.2 Description of Project

The proposed project will construct a ten kilometer, six meter wide paved road into the Southeast Peninsula of St. Kitts starting at Frigate Bay and extending down the steep rocky spine or isthmus to the Great Salt Pond area with access to Major's Bay, or its equivalent (see Figure 3.1). A construction period of 15 months is anticipated. Some blasting is required, but the corridor along which the road alignment passes presents no major engineering difficulties. Erosion control strategies will be necessary for the 100 hectares of disturbed roadbed area. The final engineering design contract has not, as yet, been let.

3.3 Background

The Peninsula road appears to be an old idea whose time has come. For nearly two decades the prospect of opening up -- "unlocking" was the term often used -- the 4,000 acres of Peninsula resources has captured the imagination of local tourism planners, ministers, off-island developers, and Peninsula landowners alike. The level of serious interest in St. Kitts and the Peninsula as a viable tourist destination is testified to by the large number of costly and elaborate project planning and design exercises undertaken since 1968 -- perhaps a dozen schemes prepared by reputable investor groups or international agencies (see Section 1 of the Reference Section to this report). The problem, however, has always been the road -- no single developer could carry the double (and unfair) burden of his/her own project and also build the longest hotel driveway in the world up the spine of the Peninsula to Frigate Bay! Sir Timothy Hill -- with its sharp slopes and ridges -- was an equally tough nut to crack. So was the question of funding for a Government-sponsored access road project.

Theoretically, the larger landowners could (and perhaps should) have pooled their resources to develop a co-ordinated strategy to build the road. But they have not, perhaps because key owners, although mostly

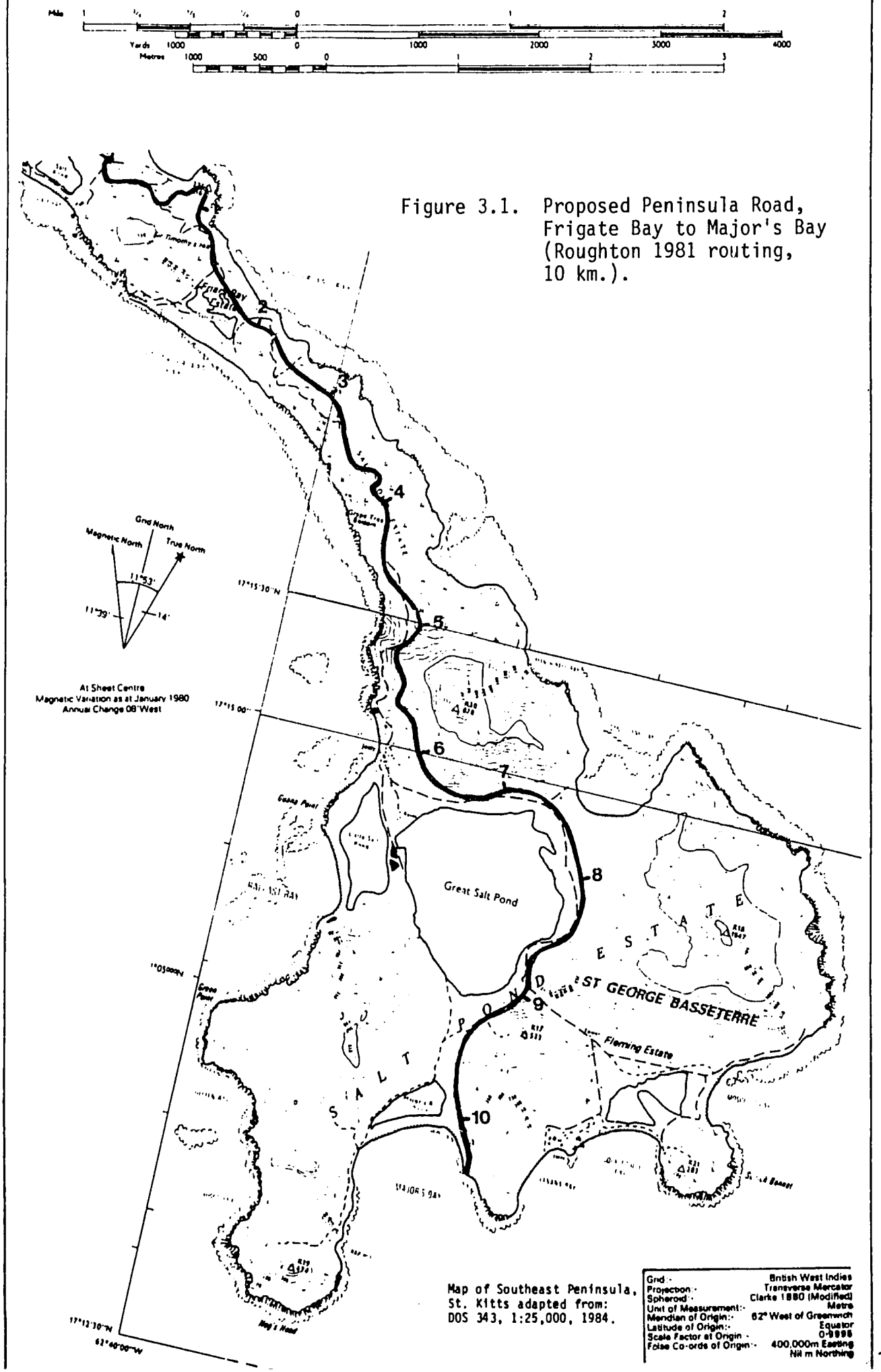


Figure 3.1. Proposed Peninsula Road, Frigate Bay to Major's Bay (Roughton 1981 routing, 10 km.).

Kittitians, are widely dispersed geographically, and a consensus was never reached. Hence, the Government of St. Kitts-Nevis moved ahead with the search for external assistance to construct the Peninsula road as a sine qua non to making the underutilized resources of the area more productive and useful to the state -- for tourism expansion, for residences, for recreation, even for an eventual new "town" site. The depressed future for sugar as St. Kitts economic mainstay is counter-balanced by the promise of St. Kitts' "land bank reserve" -- namely, the Southeast Peninsula.

3.4 The ECNAMP Alternatives

A study carried out by the Eastern Caribbean Natural Area Management Programme in 1980 (Jackson, 1981) explored three hypothetical development alternatives for the Peninsula as follows:

Alternative 1 (small-scale, low impact):

National Park
Small-scale tourism
Recreation (including hiking, bird watching, swimming, snorkeling, coastal boating, etc.)
Research station
Field education

Alternative 2 (medium-scale, moderate impact):

Selected protected areas
Small-to-medium scale tourism
Recreation
Field education
Mariculture
Salt production, limited housing, limited vegetable production, limited grazing and a public jetty (mainly in the Great Salt Pond area)

Alternative 3 (large-scale, medium to high impact):

Major infrastructure, including a road/ferry system, water, electricity and telephone
Large-scale tourism
Increased or higher density housing
Limited grazing and vegetable production
Reduced salt production.

Salt production at economically feasible levels was subsequently ruled out in a study undertaken by the Caribbean Development Bank. At a meeting with Cabinet to present study findings and at a subsequent public meeting, alternative two was the preferred choice, but there was no follow-up action.

3.5 Recent Concepts: Bigger is Better

By 1983 a major scheme by an investment group called "INAFORM" surfaced to "develop the maritime, commercial and touristic/urban potential of the Great Salt Pond area" (Coopers and Lybrand, 1983). The specifics of the Sandy Bank Bay-Great Salt Pond Development included a 300-room luxury resort and 100 two-bedroom detached condominium units. If one counts each bedroom in the condominiums as a unit, the total room count comes to 500. Note the use of the word "detached" for the condominiums; by making each of the 100 condos a separate building, the proposed scheme results in increased infrastructure and building costs, increased land area utilized, and increased risk of environmental damage.

Amenities at the INAFORM complex were to include a casino/night club, pools, bar, 100-seat restaurant, 18-hole golf course, and a 150-boat marina in the Little Salt Pond.

An even larger scheme by Keystone International surfaced the following year, along with a different, more modest, 250-room hotel complex for Sand Bank Bay (Beekhuis, 1985). All of these presumed the Government was on the verge of building an access road to the Peninsula which, of course, was not the case. Funding could not be obtained at that time.

3.6 Current Landowners' Conceptual or Preliminarily Planned Projects

Discussion were held during the EA study period (October 1985) with available landowners or their representatives to assess current intentions to develop their respective holdings. Based on responses, landowners can be grouped in four categories: those actively pursuing development options with investors or joint venture partners; those having conceptual or preliminary plans to undertake developments on their own; those undecided about development plans or having no plans at all; and those seeking to sell their property (see Table 1.1).

The size of most holdings allows a landowner to pursue a combination of the above options, i.e., the individual (or group) can at the same time sell a portion of his/her/their property, joint venture with others, and/or develop a portion. In anticipation of the Southeast Peninsula road and provision of other basic infrastructure, a certain amount of speculation and uncertainty will prevail which will result in a high percentage of aborted conceptual development schemes or ever more detailed development plans.

This is standard for "virgin territories" having enormous but untested tourism potential. It is also normal for proposed development schemes or plans for the same site to remain fairly similar in size. Therefore, when one is aborted, the subsequent scheme comes close to duplicating the original's size, if not actual components.

Therefore, although there is general uncertainty about the implementation of current proposed schemes or plans, it can be assumed that

projects of a similar size and nature will eventually get off the ground on the Peninsula. Based on the current trend of thinking among landowners and also Government, the overall development scheme for the area can be expected to include:

- -- Major hotel developments (200-300 rooms) and/or condominium developments in Friar's Bay, Sand Bank Bay, parts of Mosquito Bay and Banana/Cockleshell Bay.
- -- A marina/safe anchorage harbour either at Little Salt Pond or Great Salt Pond; or perhaps a marina at Friar's Bay Pond.
- -- Residential development (houses or condominiums) in selected areas.
- -- A range of support services buildings, e.g., a service station, supermarket or shopping centre, restaurants.
- -- A public jetty or landing and other appropriate public facilities.

3.7 The Southeast Peninsula: A Development Scenario

Based on current concepts being discussed for the Peninsula, a "SEP development scenario" results in the following:

	Years 5	10	20
Tourism (rooms projected)			
Major Tourism Development Areas:			
-Friar's Bay	350	500	550
-Sand Bank Bay	100	250	350
-Mosquito Bay	50	100	300
-Banana/Cockleshell Bay	50	100	200
-Major's Bay	--	100	200
	550	1050	1600
Residential Condominiums	--	400	700
Totals/Tourism	550	1450	2300
Residential Development			
Developed Housing Lots	30	60	200
Marina Development			
Berths	--	150	200

Tourism hotel development is expected to be focused initially at Friar's Bay and subsequently at Sand Bank Bay, then Mosquito Bay, Cockleshell/Banana Bay and Major's Bay. The marina is likely to be sited in the Little Salt Pond, although the new owners of Friar's Bay plan one there. Potable water demand would be about one-half million gallons/day, and the sewage treatment system would have to process most of this amount.

3.8 Reflections on the "No Development" Option

The carrying capacity of the Peninsula for 2,300 hotel/condominium rooms is probably not realistic, but this cannot be stated with certainty at present. But neither is there any guarantee that the growth rate will be 112 rooms per year for 20 years.

On the other hand, the no development alternative is unacceptable for the obvious reason that St. Kitts-Nevis must find a way to use the resource which the Southeast Peninsula represents as a means to sustain economic growth in the face of declining sugar revenues. It is also undesirable for environmental reasons. The Peninsula's environment is degrading in the absence of an access road and under the assault of unregulated, low level extractive and destructive use of the area's resources. Squatters have begun to move into the remote hill areas near St. Anthony's Peak, monkey and turtle hunters abound, and brush fires continue uncontrolled.

Well-managed and monitored development made possible by the penetration road, therefore, seems to make environmental sense.

4. ENVIRONMENTAL CONSEQUENCES

4.1 The Road Project: Initial Concerns

The proposed construction of the 10 km road which is to open development opportunities for the Southeast Peninsula will be a major introduction to the kinds of environmental changes which subsequent or long-term development will bring over time.

The engineering plan and design is crucial to the protection of the environment both during and after construction, and, therefore, it is important to resolve the final engineering specifications so as to ensure minimal effects from soil erosion. Indeed, the soils and drainage engineering consultant of the EA team cites soil erosion during construction as the principal environmental concern which needs to be addressed.

The major negative effect of soil erosion during construction will be the high intensity, short-term deposition of fine soils which reach the sea, eventually settling on reefs and smothering the organisms which build and maintain the reef structure. The coarse sands and clays between 3.38 mm and 0.30 mm will most likely be suspended for limited periods before settling on the seabed organisms. But the finer particles less than 0.149 mm can be a greater stress factor in reef existence due to their ability to resuspend in the water column during turbulence.

Suspended sediments reduce the penetration of sunlight, an effect which has serious implications to reef and seagrass habitats which are highly dependent upon biochemical processes requiring light (photosynthesis). Suspended sediments can also reduce levels of dissolved oxygen, resulting in further stress to reef species. When suspended particles settle, they can reduce shelter and food supply for bottom feeders, interfere with filter-feeders, silt over spawning beds, and smother reef organisms. Anaerobic conditions (depletion of oxygen to zero) may result, leading to the release of hydrogen sulfide which has an offensive odour and is toxic to marine organisms.

Furthermore, negative impacts on coral reefs from increased siltation affect aesthetics and thus marketability for tourism, as well as productivity for fisheries. The wave regime may also change, affecting the beach and other inshore habitats, and if carbonate production declines, the sand budget of these zones inshore will also change. Excessive turbidity can destabilize an entire beach/sand system.

The Southeast Peninsula road project was originally designed by the firm of Roughton and Partners, Consulting Engineers and is described in the contract report documents of 1980 and 1981. Subsequently, in April 1985, the firm of David Lashley and Partners of Barbados prepared a "Final Report - Estimated Cost to Construct the S.E. Peninsular Road, St. Kitts." In that report, which was a review and update of the Roughton plan, a number of engineering design changes were

proposed which have significant environmental and other consequences. Only those changes which have an environmental effect are discussed below.

The Roughton design has some key features which were selected to minimize adverse environmental impacts largely related to soil erosion. These are:

1. Camber, or road surface cross slope, of three percent toward the hill side (the cut portion of the road) for prevention of erosion by runoff on the outer or fill side of the road.

2. The lining of the road drainage ditches with grouted stone to prevent ditch erosion which would also undermine and damage the pavement edge structure, catch basins and even culvert drains.

3. The installation of grouted stone erosion checks to limit the velocity of water in the drains, thus minimizing the erosion potential.

4. Where the road passes through terrain of extreme steepness, i.e., cross slope over forty percent, gabion retaining walls built on "bench cuts."

The suggested modifications, which would have different impacts, as called for in the Lashley report are:

1. The elimination of the paved drains near ridges, as there would be "no appreciable runoff" and drain the road bed toward the fill section.

2. The utilization of more extensive cutting onto the hillsides to reduce or eliminate the need for gabion retaining walls and benching below the fill slope.

Lashley's proposed elimination of the paved drains and the draining of surface runoff to the fill section will result in erosion of the fill slope, first through small rille erosion eventually leading to larger gully erosion. Such erosion was found on the existing track road at locations near the ridges. With the paving of the road surface, runoff will be increased resulting in higher erosion rates, particularly of fill. Even though the average annual rainfall is less on the Peninsula than on other portions of the island, the typical high intensity tropical rainfall results in high values of runoff which can result in rapid destruction of unprotected fill slopes and transport of sediment downhill where it may damage sensitive coastal environments. Some of the watersheds discharge into flat low lying areas, like Canoe Bay, where sediments would be trapped temporarily; however, at many other points the drainage ways directly discharge down the steep slopes into the coastal waters.

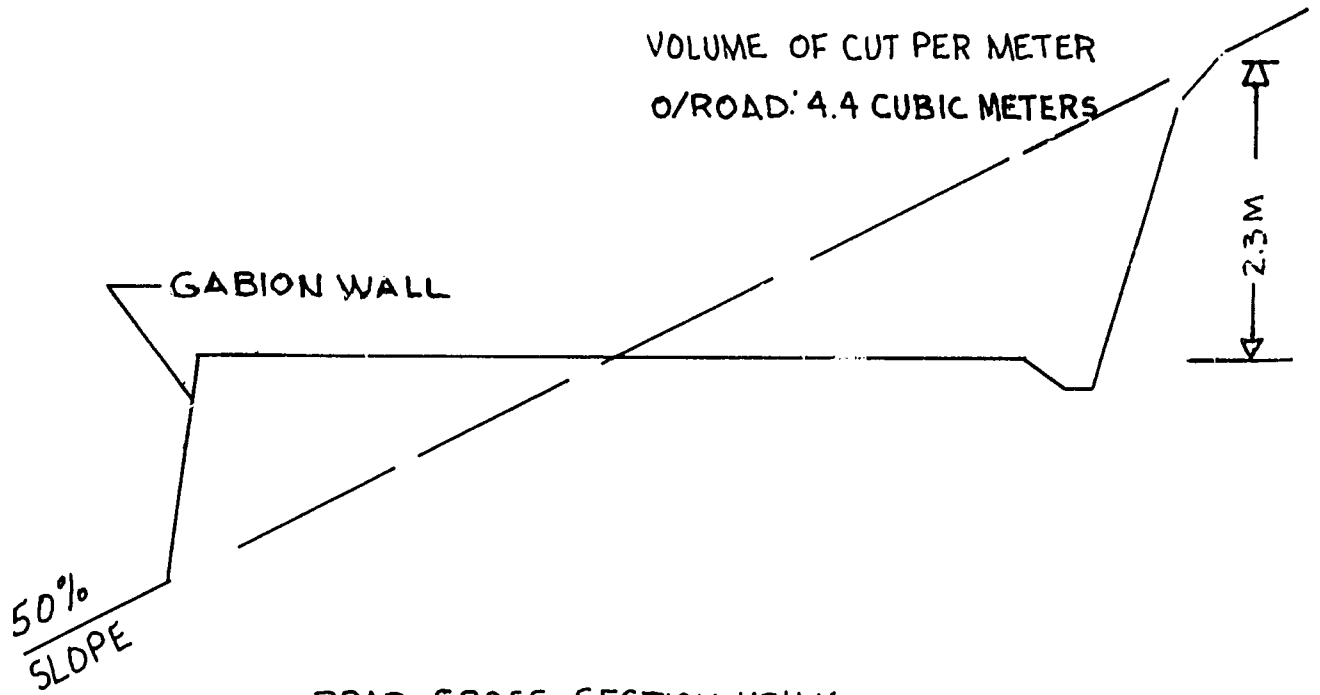
The second design modification, of utilizing more cutting instead of gabion retaining walls and fill, could have even more serious consequences, depending on how the cut material is disposed of. The Lashley report provides two options for disposal of the cut material, either to waste it down the hill, i.e., push the excavated rock and soil over the edge of the road or haul it somewhere else for future use or disposal. The Lashley design alternative will produce over three times as much fill as the Roughton gabion wall design (see Figure 4.1).

The first option, of wasting downslope, will have extremely adverse consequences. This loose material would be dumped downhill on very steep slopes. Much of the vegetation in its path would be destroyed by burial. The new slope would then be subject to continual erosion and sliding as vegetation will find it difficult to take a foothold. Human-assisted revegetation would not be feasible due to the inherent instability and steepness of the slope. Replanting and watering would also not be feasible as large volumes of water, not available on the dry Peninsula, would be required. Such hill slope "scars" would be highly visible and mar the natural attractiveness of the terrain for a long time. The longer cut face of the embankment would also be a permanent scar on the landscape; it is about twice as high as the design called for by Roughton. On the other hand, Roughton's gabion wall, due to its porosity and stability will eventually support plant life which will screen the wall blending it well into the natural terrain. The higher cut face of 4.2 meters will also be more susceptible to rock slides which will be more severe and damaging than from the lower 2.3 meter high Roughton embankment. Roughton's Geotechnical Investigation (1981) has indicated that the rocks are highly weathered with clay in the weathered seams, which when wetted during heavy rain will act as lubricants facilitating rock slides and falls. Further, the seismic activity of the region will induce rock slides, and the higher embankments will be more prone to such slides or falls.

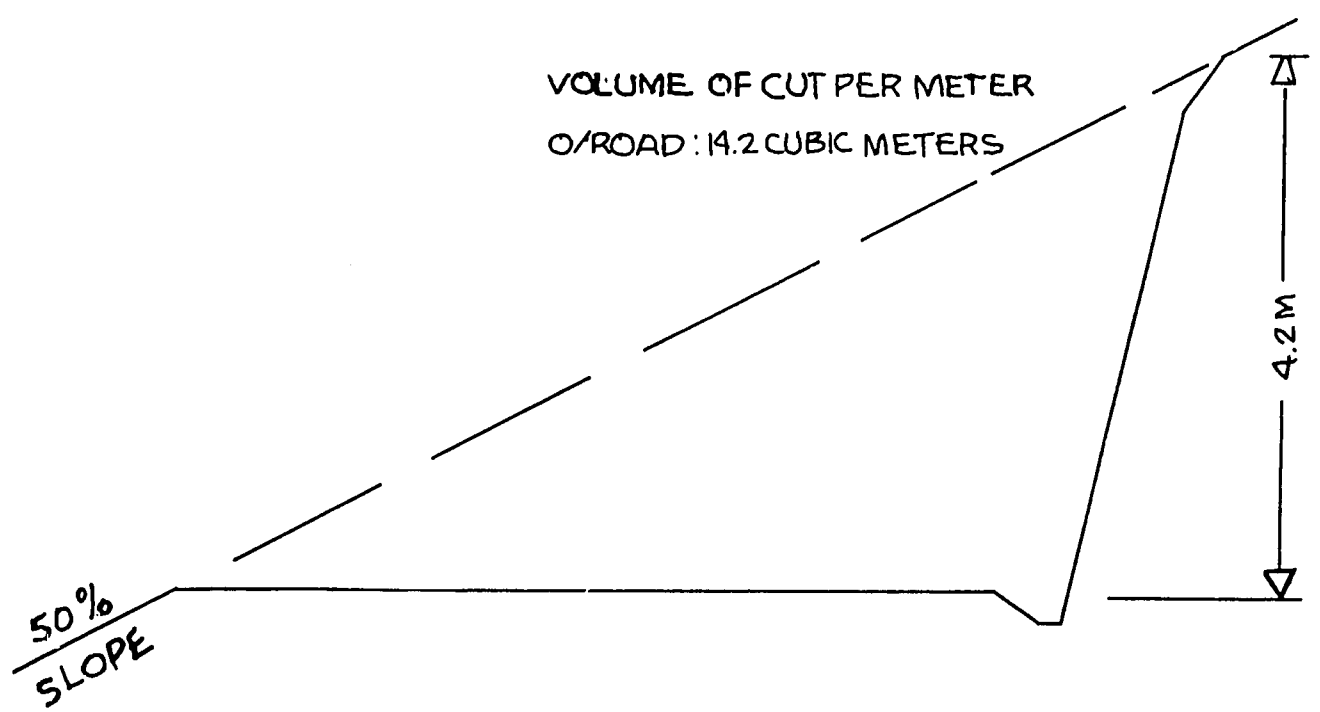
Worse still, the continual erosion of the unstable fill slopes, created by the wastage of the excavated material, will produce a continuous source of sediment either in the shallower sloped low lands or in the coastal waters, thereby adversely affecting the quality of the water and related coastal environment.

The alternative of hauling the material to other locations has not been fully or adequately explored, including such questions as how much material is involved, where it would be stockpiled, and how much it will cost for such extra handling. This haul-away option, of course, would not have the adverse impact of the uncontrollable fill slopes; however, the higher cut slopes would still remain a problem.

Therefore, the engineering design by Roughton is preferable from an environmental perspective. Neither Roughton or Lashley, however, address the matter of erosion and sediment control during the construction activity, and that is the time when serious environmental damage can occur if measures are not taken to prevent it. The construction period of fifteen months will likely extend through two rainy seasons, with rainfall records from Golden Rock Airport indicating that rainy



ROAD CROSS SECTION USING
GABION RETAINING WALL (ROUGHTON)



ROAD CROSS SECTION USING
CUT ONLY METHOD (LASHLEY)

FIGURE 4.1.

COMPARISON OF ROUGHTON AND LASHLEY ROAD CROSS SECTIONS

weather reaches a peak in the months of August through November, as is typical of other Caribbean islands. However, heavy rainfall can occur in any month.

The ten kilometer road would be subject to earth moving activity to approximately ten meters of its width during the construction activity. Thus, when the initial earth work is completed, 100,000 square meters (10 hectares/24.7 acres of earth) will be exposed to erosion which, at an estimated four tons per acre, would generate about 100 tons of "new" sediment per year from the ten hectares of exposed road construction area. Downslopes of readily erodable surplus road cut material would probably double this amount and, when rock is blasted and ripped, significant quantities of finer material will be produced, both from the freeing of the weathered materials within the rock and by the blasting and excavation. This smaller material will be subject to rapid erosion by rain and transported downhill.

Once this material has been washed downhill, it will either be temporarily deposited in the shallow-sloped lower valleys to be eventually washed into the coastal waters or directly enter the coastal environments from discharges down the steep slopes. The coastal waters will increase in turbidity during and after rainstorm events due to the finer soil materials suspended in the water column. The heavier portions will settle to the bottom and bury the existing benthic organisms, while lighter, finer sediments will form coastal sediment plumes covering tens of hectares of seabed organisms and corals.

The arid climate of the Peninsula and relatively small watersheds give the impression that storm runoff may be of little consequence. However, if one reviews the runoff calculations by Roughton (1981) and computes the approximate total volumes, it becomes clear that substantial volumes of water are involved. The largest watershed area, No. 33 (see Figure 2.4 of Engineering Report), produces a peak discharge of 11.77 cubic meters/sec. This discharge, calculated over the time of contentration, Tc(h), of 0.15 hours (9 minutes), will produce a total volume discharge of 6,360 cubic meters (224,100 cubic feet) or 1.676 million U.S. gallons. This would be the runoff discharge for just that one watershed for a design storm of ten years. Even heavier rainfall and greater runoff volumes are possible.

Under severe sediment loads, salt ponds eventually fill up and subsequent storm discharges flow directly to the coastal waters along with their upland granular sediments and suspended soil load. Coral reefs cannot survive under these conditions. Fortunately, the filling of salt ponds takes a long time <u>under natural conditions</u>, i.e., the watersheds not being disturbed. But once accelerated, uncontrolled erosion begins with upland soil disruption and vegetation removal and the rate of erosion increases (Cracknell, 1981; Porter, 1976), the life span of salt ponds as functional sediment traps rapidly begins to shorten.

The sediment discharges into coastal waters have immediate and long-term adverse impacts. The immediate consequences are short-term coral damage, turbidity and discolouration of both the waters and the beach sands. The water colouration will persist until currents have renewed the water and the suspended particles settle or are dispersed. However, the soil fraction will be deposited along the shoreline and, in the case of the beaches, will impart the quality of the eroded material to the beach sands. The light coloured coral beaches will gradually contain a higher percentage of the dark eroded volcanic rocks.

To accomplish the planning and monitoring tasks outlined above, the Government of St. Kitts-Nevis will probably need to establish a small environmental engineering unit headed by an environmental engineer. Details are provided in Section 5.5.

4.2 Road Access Impacts: The Human Factor

The Southeast Peninsula is extremely well suited for recreational activities. The literature, commissioned development planning documents, and interviews conducted during the EA study period indicate there are numerous ideas and schemes for development of the area, most of which have recreational components. But along with the question of how much and what kind of development is suitable for the Peninsula is the issue of how much and what kind of recreation should be encouraged. Will the investment to provide recreation be minimal or extensive; will there be opportunities for passive as well as active recreation?

Presently -- as is also the case with a "no action" alternative -- the Southeast Peninsula is, in fact, open to those seeking day recreational experiences such as hiking, swimming, sightseeing, picnicking, nature observations, hunting, even "adventure." Such persons need only hike, drive a four-wheel drive vehicle, or take a short boat ride from Nevis or elsewhere on St. Kitts to enjoy such an experience. In a sense, the Peninsula is open to anyone who wishes to make the not-so-easy effort. True, it is all private property, except the beaches; but it is also true that few people have four-wheel drive vehicles or boats or the inclination to carry a picnic basket seven miles to a beach.

However, when the road is constructed, then the Peninsula will truly be open to any and everyone with access to a vehicle or a mini-bus. It is before this point is reached that impact has to be addressed or the Government of St. Kitts, hotel operators, and landowners will have to confront difficult environmental, regulatory, and policing problems later.

It is expected that large numbers of Kittitians and even Nevisians will flock to the Peninsula (study team members heard projections from residents ranging from 2,000-5,000 local persons per holiday weekend). Tourists will also join residents in use of Peninsula recreational facilities and amenities. If no regulations and only minimal facilities are in place, the following will happen in rapid order:

-- sanitary/health problems caused by lack of adequate toilet facilities

-- destruction of vegetation along the roadside resulting in erosional problems and loss of aesthetic quality due to uncontrolled parking and pedestrian activity

-- destruction of vegetation which will result in severe beach erosion problems, including massive sand shifts across the road, or loss of the beach itself

-- tremendous litter problems with resulting loss of aesthetic values and increase in sanitary problems due to flies, rodents, etc.

-- traffic problems because of people parking carelessly by the side of the road

-- noise pollution if there are large parties with music and no ordinance regulating the same

-- destruction of grasslands, either through fires started for driving out game for hunting, grazing by goats or sheep, or by being flattened by vehicles (some owners of which may find certain areas ideal for drag racing)

-- loss of wildlife because of severe, if uninformed human intrusion; animals would be displaced by human activities; nesting/breeding areas would no longer be used, leading to a drop in wildlife population; poaching and hunting would also occur and severely reduce existing wildlife populations

-- loss of reef and fish resources by over-fishing, taking of corals, bottom damage from random boat anchoring, etc.

Opening the road will, therefore, immediately launch the Peninsula in the direction of one kind of development -- namely, as an informal national recreation area. What the landowners think and do about this phenomena remains to be seen, but everything from trash bins to toilets, from constables to car parks, and from signs to rules <u>should be in place before the road opens</u>.

Increased human use of marine areas such as those of the Southeast Peninsula often results in negative impacts through contact damage to coral (caused by grabbing or standing on live corals), anchor damage from boats, and collection of corals for souvenirs. Recreational fishing using spearguns can quickly deplete fish populations on shallow reefs. This not only greatly reduces the visual appeal of these systems, but also can result in overgrowth of reef-building corals by algae which are normally controlled by grazing fishes.

Even if selected land and sea areas are put in a temporary reserve status, with certain activities prohibited, there will still be major litter, sanitation, erosion, and vehicular circulation problems on the Peninsula. Therefore, if regulations are not in place before ground is first broken for the road, it will be almost impossible to retrain people to use the area with care and to "respect" the resource base and any regulatory authority put in place. If there is not a strong regulatory body empowered to enforce the laws governing activities on the Peninsula, then the regulations will be shown to lack the full weight of Government and will be largely disregarded. Over time, human use and abuse will take its toll, and the Southeast Peninsula will lose its attractiveness for both recreational and tourism development.

A land use plan must be completed for the Southeast Peninsula prior to start of road construction. Sound planning and ecological concepts can be combined with reasonable development concepts. The resulting land use plan can thus combine elements of public recreation, small and medium scale as well as intensive tourism development, wildlife reserve areas for breeding, resource conservation, and protected areas. As part of this land use plan, a recreation policy with rules and regulations must be established for the entire Southeast Peninsula area. A governing and enforcing entity must exist. The rules and regulations must be inculcated in users' minds through environmental education efforts directed at the local community and elements of the tourist/transient population.

4.3 Impacts on Wildlife

The proposed Peninsula road and subsequent developments are likely to adversely affect the wildlife of the area in several ways:

(1) Disturbance - The noise levels resulting from blasting and general construction activities, combined with increased human presence both during and after road establishment, is likely to significantly disturb nesting and feeding populations of wildlife. It is inevitable that with people will come their domestic animals (especially cats, dogs and donkeys) and an increasing number of opportunist species (Carib grackle, rats, mongoose), all compounding the problem. Most native taxa (especially landbirds) currently present on the Peninsula are tolerant of disturbed habitats (Arendt, 1985), but such species as the least tern, the brown pelican, the frigate bird and the three species of sea turtles are especially sensitive and vulnerable, particularly during their breeding seasons.

(2) Hunting - The establishment of a road will result in ease of access to the Peninsula for all sectors of the population, including hunters. At present an excursion to the Peninsula is quite an ambitious

undertaking. With a road, it is likely that frequency of visits by hunters will increase during the open season.

The taking of turtles and their eggs was legal during the open season but was noted to occur also illegally during the closed season (Arendt, 1985). Under the new fisheries legislation, turtles are scheduled to be protected, but it is likely that the incidence of illegal poaching will increase once the road has been established and land access to beach areas is facilitated -- unless a monitoring and enforcement strategy is put in place and maintained.

(3) Habitat Destruction - One of the more important aspects to be considered with the post-road development construction anticipated on the Peninsula will be the inevitable loss of some wildlife habitat. For example, the salt ponds are currently used by a rich variety of migratory wading birds (Arendt, 1985), and their conversion to a marina by dredging will result in an irretrievable loss of habitat. Hotel and beach front development will result in some impingement on turtle nesting grounds.

The pelican and frigate bird nesting colonies at or near Nag's Head constitute one end of the management spectrum. They are already very isolated and in an inhospitable environment on steep cliffs. They will be relatively easy to protect. Currently, egg harvesters probably approach the colonies by sea; the proposed road and eventual development may provide easier landward access, enhancing the possibility of human disturbance and predation. If adults are driven off the nest by well meaning, but curious, visitors who approach too close, there may be increases in egg or chick mortality. Close approach by small airplanes while sight-seeing can also have devastating effects.

4.4 Sea Turtles: A Special Case

4.4.1 Turtles, Tourists, and Beaches

Three species of sea turtles currently nest in small numbers on Southeast Peninsula beaches and two forage in probably somewhat larger numbers in adjacent shallow marine habitats. Sea turtles are a traditional fishery resource in the region, but excessive exploitation has reduced populations to very low levels -- so low that there is a serious, regionally-based effort in progress to implement a five-year ban on exploitation. The three sea turtle species in St. Kitts are officially listed as an endangered species by the United States and internationally (IUCN).

The primary rationale for the road and subsequent development on the Southeast Peninsula is expanded tourism. While the Peninsula offers

other amenities, most proposed intensive tourism development is focussed on and sited near the beaches. These beaches are viewed as the best on the island outside Frigate Bay and thus are critical assets in government plans to diversify and expand the island's economic base. However, these same areas provide a nesting habitat for the island's sea turtle population, and the impact of the proposed road on such sites must be considered.

Possible negative impacts of the proposed road on sea turtles are treated in two parts -- direct impacts resulting from the road construction and from ready access to the Peninsula when the road is completed and indirect impacts likely to occur or intensify as proposals for tourism-oriented development on the Peninsula are implemented. Under each of those headings the impacts are divided into three categories -- exploitation, incidental mortality, and environmental alteration and disturbance.

4.4.2 Direct Impacts

(i) Increased Exploitation. The primary potential negative impact of the road on sea turtles on the Southeast Peninsula is increased exploitation resulting from increased ease of access. Since it appears most eggs are now taken by man, domestic animals or introduced predators, the situation could become only marginally worse overall. However, the pocket beaches on the Atlantic shore (where seemingly undisturbed nests were found) could easily be checked visually from the road for recent nests, so these areas would likely suffer a marked increase in poaching. As noted earlier, the proportion of nesting females being killed now is apparently high, but, in the absence of monitoring, the pressure is likely to increase since it would be much easier to come by road from Basseterre to spend the night walking beaches looking for turtles than it would be to come by boat from Basseterre or Nevis. Further, heavy seas undoubtedly make the Atlantic shore beaches periodically inaccessible by boat, and this protection would be lost. Given the price of turtle products on St. Kitts and current levels of unemployment, it would not be surprising if people would, on finding a nest, estimate when the turtle will return to nest again and spend 2-3 nights waiting on the beach to capture that single turtle. One form of exploitation which would likely increase is land-based spearfishing, taking fish, turtle and lobster for recreation, consumption, or sale.

(ii) Incidental Mortality. Hatchling turtles emerging from the nest are attracted to artifical lights. Lights on streets, parking areas or beachfront buildings draw hatchlings inland and are responsible for heavy losses best documented in Florida resort areas, but known from Caribbean sites (see Raymond, 1984 for a summary). They may a so die in numbers in campfires left unattended on beaches or aggregate in the water under lights of docks or moored vessels. In these latter cases, they are at increased risk from marine predators which are also attracted to lights. Temporary lights adjacent to beaches associated with construction, temporary lighting used for visitor activity after the road is open and especially parking area lights which spill onto adjacent beaches (assuming electricity

accompanies the road) could be a significant cause of incidental mortality.

Increased traffic on sand beaches by vehicles, livestock and humans may reduce turtle recruitment by damage to incubating eggs or to hatchlings in the process of emerging from the nest. During incubation shallow nests are more vulnerable to mechanical damage than deep ones, but all hatchlings must dig their way to the surface to emerge. Nest location as well as depth influences the effect of traffic. Shallow hawksbill nests would often be unaffected by traffic because they are typically deposited under dense vegetation where traffic is much less likely. Even without overt crushing of eggs or hatchlings, compaction of the sand may immobilize emerging hatchlings or cause elevated carbon dioxide concentrations which trigger premature hatching. Major hazards during road construction would be heavy equipment on beaches (particularly likely if road supplies are barged in to various beaches), construction employee joyriding on beaches and similar activity by residents and tourists once the road is complete. Recent tracks are evident on several beaches close to turtle nests at present. If the hatchlings manage to emerge from the nest, vehicle ruts or even deeply indented pedestrian footprints are significant obstacles which slow their journey to the water's edge and thus increase their vulnerability to terrestrial predators (Hosier, et al., 1984).

Uncontrolled disposal of solid waste in the coastal zone poses a special hazard for sea turtles. They apparently eat floating plastic film or bags readily, perhaps because the debris resemble jellyfish or other diaphanous floating organisms which are part of their normal diet. The plastic film catches on the sharp posteriorly directed spines in the turtles' esophagus, and they are unable to regurgitate it. They are typically found dead, either with the mouth and throat filled with plastic or, if they swallow it completely, with the intestine obstructed. Most sea turtle biologists have seen enough instances of mortality from plastic bags to be concerned about its impact on populations.

As elsewhere in the West Indies, solid waste in St. Kitts is frequently dumped along roadsides, particularly over ocean cliffs (for example, near Brimstone Hill and west of Limekiln Bay). Plastic film is a common, if volumetrically minor, component of construction waste (lunch and sandwich bags, bag liners for cement and drilling mud, disposable tarps, etc.). Unless there are guidelines for disposal of synthetic solid wastes during construction of the road and the implementation of the guidelines are monitored, significant amounts of plastic debris may enter coastal waters. This is particularly likely if construction supplies are barged in to some beaches and stockpiled there. A similar hazard will arise at beaches and other sites where people congregate once there is road access, unless facilities for waste disposal are provided and serviced.

Both during construction and subsequent to the completion of the road, it is likely that the beaches will be used as picnic areas. The tree-shaded areas behind accessible, but undeveloped beaches on Caribbean

islands are often littered with food and beverage containers, campfire remains, toilet paper, etc. Discarded food in particular is a resource which may attract and sustain locally elevated populations of scavengers such as mongoose and rats which prey on sea turtle hatchlings.

(iii) Habitat Alteration. The same or lower intensity lighting (including moving flashlights) which leads to hatchling disorientation, may cause emerging females to temporarily reject a nesting beach, abort a nesting attempt after emerging on the beach, or nest in a suboptimal location (e.g., below the high water mark). Data on this topic are inadequate, but there are clear indications from some localities of turtles abandoning lighted beaches or preferentially nesting on darker portions of beaches. This pattern is better documented for green turtles than the other two species, but is a significant concern for all, as effects of disturbance may emerge with moderate levels of nocturnal human activity on beaches. Roadway and parking area lighting visible from the beach will likely affect the distribution of nesting activity even before private development on the Peninsula begins. Preserving nesting habitat quality can be enhanced by using set-back restrictions designed to preserve the beach and adjacent areas as public land and to avoid construction in a zone where destruction and flooding are likely during storms.

Increased traffic on beaches, particularly by heavy equipment and other vehicles, but also greatly increased foot traffic damages sand-stabilizing beach vegetation and may enhance beach erosion during storms. Sand mining particularly from the berm or primary dune is a frequent cause of beach erosion and disappearance in the Eastern Caribbean. Sand mining for the road construction is unlikely, but project employees should be prohibited from using heavy equipment to, for example, cut roads to nearby beaches through the dune and back-beach vegetation on their lunch hour.

Large persistent debris, -- either natural or human-derived -- on nesting beaches or in the foreshore can obstruct, entrap, or injure nesting female turtles. On continental beaches, flotsam such as logs and branches are locally a barrier to nesting females. On Ascension Island, Hirth and Carr (1971) suggested that World War II military debris made part of one beach unsuitable for nesting. Debris is a potentially important hazard for leatherbacks, both because of the severe difficulty they have in changing direction once they have lodged against an object and because they lack the bony armor which protects the underside of other sea turtles. A specific proscription against discarding construction debris on beaches and on-site monitoring for compliance are needed. Problems are particularly likely if road construction supplies are barged onto the beaches and the back beach areas are used for stockpiling equipment and supplies.

4.4.3 Indirect Impacts

(i) Increased Exploitation. In the absence of beach monitoring to encourage compliance with protective regulations, increasing numbers of people resident or working on the Peninsula will mean that

an increasingly smaller fraction of the turtles nesting on the Peninsula will escape detection and capture. Similarly, spearfishing for both recreation and subsistence is likely to increase unless appropriate restraints on this practice are imposed. Recreational boats anchored in the vicinity will be a major source of divers with spearguns. One incidental benefit of major increases in boating will be that turtle net losses will make it no longer economic to set turtle nets in shallow water; they will be cut by boat propellers.

(ii) Incidental Mortality. Unless facilities lighting near beaches is very carefully controlled the likelihood of hatchling mortality by disorientation will increase greatly as development expands. Nocturnal lights on boats and docks in bays with nesting beaches pose a particularly difficult problem. Increasing development will also increase traffic (vehicles, people and perhaps domestic animals) and the likelihood of compression damage on Peninsula beaches. The high point load (amount of weight per unit of surface area applied to the beach as they walk along) of horses makes horseback riding on undeveloped beaches above the high water mark (as done at Frigate Bay) a potentially destructive activity. Mechanized beach grooming (tractors towing leveling devices) causes substantial loss of nests in Florida. Hand raking poses less risk to sea turtle nests.

Unless adequate provisions are made for solid waste management, the impacts noted above (plastic bags in coastal waters, enhancement of hatchling predator populations) would increase along with development. Dumping of garbage in plastic bags into coastal waters by live-aboard or recreational boaters could increase but is relatively easily managed by providing dockside disposal facilities.

Particularly in areas where turtle activity is concentrated (e.g., in the vicinity of seagrass beds or shallow reefs which are foraging areas) turtles risk injury from accidental collisions with high-speed boats when they surface to breathe. Propeller and skeg injuries are a significant cause of mortality among stranded turtles in Florida. Since the risk of impact almost certainly increases with the speed and frequency of the boat traffic, Southeast Peninsula recreational development emphasizing waterskiing and other high-speed motorized sports could increase turtle mortality. Beach recreation options at Caribbean resorts typically include swimming, snorkeling, sailboarding and other small, wind-powered craft. This mix is fairly compatible, but the addition of fast power craft (speedboats, skiboats, and jet skis) greatly increase the risk of injury to people as well as turtles. Turtles (except mating pairs) usually dive sufficently rapidly when a boat approaches so that (as a rule of thumb) only planing vessels pose a risk.

(iii) Habitat Alteration and Disturbance. As noted earlier, nesting female turtles are particularly sensitive to disturbance by both fixed and moving lights when emerging to select a nest site. Under moderate to strong moonlight, people walking the beach may be sufficient to dissuade an emerging hawksbill or green turtle from nesting in the area. The population level consequences of repeated disturbance are not clear, but a decrease in the number of hatchlings

produced is likely. Given the proposed development intensity, nocturnal levels of light and human activity on most beaches will eventually exceed the low threshold for disturbance. After increased exploitation, this form of disturbance seems the most serious potential impact of the road on sea turtles. Since design of mitigation strategies is hampered by lack of knowledge, the best approach would be to minimize obvious disturbance, while carefully monitoring the turtles' responses to unavoidable changes in the beach environment. The data would be useful not only in St. Kitts but elsewhere in the region.

Setting aside pursuit of turtles with powerboats in shallow water and other active harassment, the significance of incidental disturbance of foraging turtles from boat traffic and other watersports is poorly understood. In the U.S. Virgin Islands, both green turtles and hawksbills continue to be sighted regularly in areas with moderately heavy powerboat traffic. Since the closure of turtle fishing in that area, the numbers of turtles sighted has increased, even though boat traffic is also increasing. This and similar observations elsewhere suggest considerable behavioral accommodation to human activity on the water is possible.

Little information is available on the possible effects of diurnal disturbance in the water on breeding animals. After dusk, female hawksbills and green turtles are easily disturbed in the shallows adjacent to the beach or as they emerge to nest. Thus, nearshore boat activity, particularly with lights, is likely to cause them to postpone nesting or choose another site.

Artificial expansion or restoration by mechanically emplacing additional sediment on beaches is an increasingly common practice. Sometimes sand is trucked in from fossil dunes, but direct deposition of hydraulic dredge spoil is the most frequent approach in developed areas. Either method can destroy existing turtles nests by burial at excessive depth, but dredged sediments present additional difficulties. The sediments are typically less well sorted than beach sand (a higher proportion of silt and clay size fractions) and have lower suitability as a substrate for nesting because of reduced gas permeability. Because the grain size distribution usually does not match that of the existing beach, dredge spoil is typically winnowed rapidly in the zone of wave run-up. Consequently, substantial vertical erosional scarps may form under even moderate wave action, so that back beach areas still suitable for nesting are inaccessible to turtles which cannot scale the scarp.

Unless compliance with beach setback and related regulations is monitored, marked changes in the dune and beach vegetation (indeed, wholesale reshaping of the dune) is likely. This increases the risk of beach erosion and storm washover and back beach flooding, none of which benefits sea turtles -- or the hotelier. Replacing seagrape and other native shrubs with coconut plantings can also degrade beaches as nesting sites. Turtles are frequently unable to excavate nests in the dense root mat of coconuts. When storm waves lead to beach retreat, the root mat quickly generates an undercut scarp which blocks access to suitable turtle nesting sites further inland.

4.5 Hotels and Sewage

4.5.1 Tourism Infrastructural Development

Hotel and related infrastructure development features prominently in development plans which have been discussed for the Southeast Peninsula. Such construction frequently causes erosion and sedimentation problems (although this is not inevitable). Hotel operations may also result in negative impacts due to discharge of domestic sewage. These impacts include increased turbidity, altered nutrient levels, and reduction of dissolved oxygen. In Hawaii, sediments in the vicinity of sewage outfalls were anaerobic and released toxic hydrogen sulfide. Increase in nutrients has coincided with unusually heavy growth of certain algae which eventually overgrow and smother reef corals. High nutrient concentration can lead to eventual domination of coral reefs by fleshy algae. Nutrient increase has been responsible for the demise of Hawaiian and Red Sea reefs (Johannes, 1975; Owen, 1977). Reef structures adjacent to the northeast and southwest coasts of the Southeast Peninsula may cause sewage effluents to be retained in the nearshore area for some time.

4.5.2 Hotel Sewage

In planning for the disposal of sewage, the following constraints must be considered and the most optimal and environmentally sound method or process utilised. These constraints include:

(a) Limited land area;

(b) Permeability of the soil and ability to absorb waste effluents for long periods;

(c) The need to keep technology as simple as possible for operational and maintenance purposes;

(d) The need to protect coral reefs, seagrasses and other marine ecosystems from degradation.

Table 4.1 displays a range of treatment systems shown with their advantages and disadvantages.

Using the recent INAFORM Sand Bank Bay scheme (as reviewed in Coopers and Lybrand, 1983), a design sewage flow of 0.2 MGD is computed based on the following sewage volumes at peak occupancy:

Hotels	
300 beds = 600 persons @ 150 gpd	90,000 gallons
staff 500 @ 15 gpd	7,500

Condominiums	
100 x 4 persons @ 100 gpd	40,000
staff 100 @ 15 gpd	1,500
Restaurant	
100 seats x 5 sittings = 500 patrons @ 5 gpd	2,500
Marina	
3 persons/boat, 50 boats: 150 persons/day @ 25 gals.	3,750
	145,250
25% for increase flows	36,312
	181,562

(approximate total of 200,000 gallons)

Because of the permeability of light volcanic soils and the close proximity of the coral reefs, seagrasses, and shell fish grounds to this area, extensive use of waste water soil absorption methods, e.g., tile fields and soakaways, must be viewed as impractical for larger, multi-unit dwellings, hotels, and facilities. A collection system for the hypothetical hotel-condominium development would seem appropriate with the option of utilising one of the treatment methods in Table 4.1.

To facilitate the application of a less complicated, less costly, low energy treatment technology, and still obtain an effluent of acceptable quality, a faculative lagoon would seem to merit consideration as the effluent, disinfected for public health protection, could conceivably be reused for irrigation for golf course and garden areas. The required surface of such a pond is estimated at 2.2 acres.

If this land area is considered too large, then the use of an aerated lagoon may be considered where only 0.5 acre of land will be required, but a significant cost for energy will be unavoidable.

Irrespective of what methods are used for sewage treatment, the disposal of effluents and sludge must be done in a way to prevent additional stresses on the inshore marine ecosystems. This will require carefully applied screening and selection strategies to choose treatment and disposal techniques appropriate to the circumstances. It is impossible to say at this point what specific technical approach should be taken at any given site or for the Peninsula as a whole.

4.5.3 Hotel Desalination

Information provided to the EA Team indicates that immediate water requirements associated with increased occupancy of the South-

Table 4.1. Evaluation of sewage treatment processes.

TYPE OF PLANT	ENERGY UTILIZATION	EASE OF OPERATION	LAND REQUIRE-MENTS	REPLACEMENT PARTS	SLUDGE GENERATION	AESTHETICS	COST CAPITAL	COST OPT'G
Lagoons								
-Facultative	L	L	H	L	L	H	L	L
-Aerated	M	M	M	L	L	M	M	M
Trickling Filter	L	L	L	L	H	M	M	M
Rotating Biological Disc	M	M	L	M	H	L	M	M
Activated Sludge								
-Conventional	H	H	L	H	H	M	H	H
-Extended Aeration	H	H	M	H	M	M	H	H
-Contact Stabilization	H	H	L	H	H	M	H	H

L = low level of concern
M = medium level of concern
H = high level of concern

east Peninsula can be provided from existing supplies. Mention was also made, however, of possible use of desalination plants to provide for future water needs. These plants produce discharge "waste" water of higher salinity and temperature than normal. Temperature in near-shore tropical marine systems is normally rather constant, usually between 20 and 28 C. Increases of only a few degrees can be lethal to many tropical species. A rise of one to four degrees can seriously damage seagrass communities (Thorhaug, 1981). Slight temperature increases have been found to interfere with feeding, reproduction, and coral growth, particularly in species which normally have rapid growth rates. In Hawaii, an increase of four to five degrees killed nearly all corals present. Even if conditions do not cause immediate death, fish exposed to warmer water for long periods experience weight loss, impaired reproduction, higher disease rates, and increased overall mortality. Damage should also be anticipated if salinity increases to more than 40 parts per thousand (Johannes, 1975).

4.6 Agro-chemicals and Petroleum

Pesticides and other agro-chemicals may be used in connection with certain development projects (e.g., the proposed golf course), as well as with increased institutional, commercial and residential landscaping, on the Southeast Peninsula. Exposure to some of these chemicals has caused an increase in the respiration of certain corals and a drop in the photosynthetic rate of their zooxanthellae. Pesticides can be lethal to fishes, as well as to humans who eat them. The death of a coral reef in Grenada has been linked to excessive use of pesticides coupled with heavy rains and sediment load. Land runoff often carries such substances which are rapidly incorporated into submarine sediments. Subsequent resuspension of these sediments (for example, by storms or dredging) can expose marine communities to significant quantities of toxic material. Many marine organisms are known to be capable of concentrating chemicals from seawater. The concentration of DDT by such processes is well-known, and the capability extends to other organic chemicals and heavy metals which are potentially toxic to other marine species as well as humans.

Petroleum products for road construction, hotel vehicles, generators and boats are another potential source of pollution. Studies of corals exposed to various types of oil have shown responses ranging from no apparent effect to decreased growth rate and death. Some of these effects are not immediately apparent and take several weeks to occur. Oil in seawater is degraded by bacteria, and this process can reduce dissolved oxygen needed by other organisms.

4.7 Marinas, Safe Harbours, and Water Sports Centres

Marinas have been proposed, at various times in the past, for the Great Salt Pond, Little Salt Pond, Major's Bay Pond, and just recently by the new owners (see Table 1.1) of Friar's Bay Pond. At Frigate Bay, adjacent to Timothy Hill, a marina has been "planned" for the southerly salt pond for more than a decade. St. Kitts does not need

-- all at one time -- five new marinas, as it does not have (nor does it have the immediate prospect of having) enough vessels to fill one of even modest dimensions (e.g., 100 boats).

Marinas are expensive to build, maintain and stay at or visit. Further, a marina is not the same thing as a harbour of refuge or safe harbour, despite continuing reference to both in St. Kitts as if they were interchangeable facilities. A marina is a wet parking lot and service station for boats, usually including an associated bar/restaurant and other tourist/transient facilities such as a water sports centre. When storms and hurricanes loom over the horizon, the marina operation says to each and every boat owner -- leave! Pilings, high tides and high winds punch holes in boats tied along side docks.

A safe harbour, on the other hand, is a reasonably large, protected area of open water with suitable depths, a good sandy bottom (and no pilings), and usually a protected entrance leading to an enclosure where boats, often kept elsewhere, can go to anchor or moor when a hurricane or storm threatens. Sometimes a marina facility is sited inside a safe harbour but remains a distinct and separate entity.

Little Salt Pond, east of White House and Ballast Bay and Guana Point, is the most frequently mentioned for a marina site. The Peninsula Land Use Plan presumably will address this specialized aspect of land (and submerged land) use, with the Little Salt Pond most often considered as the most ideal location for development of a marina.

Such facilities, however, are notorious for being polluted water bodies. Strict statutory controls and policing will be necessary to ensure that pollution from vessel and marina wastes does not adversely affect the pond system and the adjacent coral reefs which are vital to the stability of the beaches. Suspended particulate matter and elevated nutrient levels can adversely affect coral life through eutrophication and light restriction.

Dredging will undoubtedly be required for the salt ponds as marina, dock, and water sport centre development plans emerge in anticipation of road construction. The potential impacts of dredging on reef fauna are due to sediment loading, increased turbidity, reduction in dissolved oxygen, and mechanical damage. In addition, waters over dredged areas can contain massive amounts of bacteria; there have been reports of 50-fold increases in bacterial biomass compared to non-polluted seawater. These conditions were associated with the disappearance of 20 fish species out of 29 in a dredged lagoon in Guadeloupe and almost total disappearance in neighboring areas which are moderately or extremely disturbed (Galzin, 1981).

Considering the importance of nearshore habitats and the presence of an unusual reef structure off Guana Point, a detailed independent impact analysis should be prepared for specific proposals to construct docks and marinas on the Southeast Peninsula. Most coastal facility feasibility studies tend to ignore the effects of the dredging process itself and comment instead upon the impact of dock and marina operations. This approach is misleading and inadequate; the effects of

dredging and salt pond modification must be included in impact studies. Chmura and Ross (1978) provide useful guidelines on the environmental impact of marinas and their boats.

In the specific case of the Little Salt Pond, dredge spoil could be utilized to build a small "wildlife island" in the centre of Great Salt Pond, a strategy which would eliminate coastal dredge spoil disposal near Guana Point. Dredge spoil artificial islands have been extremely successful as new protected wildlife habitats (DuBois and Towle, 1984).

4.8 Carrying Capacity Overload

4.8.1 The Southeast Peninsula Ecosystem

Estimating the cumulative effects of the road and some indeterminate level of development impacts on the Southeast Peninsula environment and establishing what is acceptable is very difficult. The EA team simply does not have enough data or understanding as yet to say, for example, that 1,000 new hotel rooms in ten years is acceptable but that 2,000 in a ten year period would overload the system.

There are, of course, components of the problem that we can address with some certainty. The sea turtles will be lost without any addition of new turtle poachers or tourists on the beaches if nothing is done to protect surviving stocks from existing predation levels. Even ten curious, careless tourists a week with only cameras wandering around the frigate bird, pelican and least tern nesting colonies are ten too many and would drive the colonies elsewhere. A ten meter man-made breach in the windward dune system at Friar's Bay or Sand Bank Bay for the convenience of tourist access to the beach would substantially raise the risk of serious inland flooding and guarantee damage in the event of a severe storm or hurricane. A 200,000 gallons per day raw sewage discharge through an ocean outfall (pipe) at Nag's Head to the nearest 100 meter drop-off point would not constitute an environmental disaster, but the same volume of waste water would render any given bay unusable as a recreational area because of the resultant serious health hazard and noxious algal growth.

It is obvious that ecosystem component overload forecasting (i.e., the maximum number of cars on the road or tourists on a given beach) can be approached more or less rationally, even quantitatively, seeking to establish the point where "one more X" is too much. However, when it comes to aggregate ecosystem effects (i.e., will one more year of inaction on the sea turtle problem make any difference to tourist satisfaction?), we confront a situation where far more subjective kinds of judgment are needed by the very few persons who perceive the intricate interrelationships between, for example, a road, erosion, a reef, a beach and a red ink vs. black ink or the net return question. The Land Use Management Plan should address these issues, but such forecasting is still an imprecise, almost arcane art. The best one can aim for is cautionary guidelines and an identification of danger

signals and indicators to warn that preventative action is needed to avoid later, more costly remedial action.

4.8.2 Human Systems

As in the case of the natural environment, socio-economic and institutional environments also can be overloaded. Building 200 new hotel or condominium rooms in a year may be feasible from the perspective of the availability of skilled labor, but to build 500 would result in a skilled labor shortage and would probably require in-migration of non-belongers, an undesirable option. Opening and staffing a 500 room complex all at one time would raise labour costs above the norm, decimate the skilled labour pools in existing St. Kitts hotels, and result in reduced levels of service, efficiency, and visitor satisfaction. This is also undesirable.

It is important to consider the capacity of the system to absorb "change", i.e., impacts within a given time frame without the creation of serious damage. With a project such as the Peninsula road, impact mitigation planning is in order for the entire environment -- human as well as natural and physical. Ideally, the strategic design of the SEP development programme should (1) calculatedly improve and expand employment opportunities without disproportionately escalating the cost of labour (by creating a labour shortage); (2) increase public tax revenue without inhibiting private sector investment incentives; (3) expand recreational opportunities for Kittitians and visitors without injuring the environment or upsetting the social order; (4) add to the St. Kitts-Nevis "tourism plant" or infrastructure without hurting existing hotels and support services; and (5) substantially enlarge the GNP without exerting undesirable inflationary pressure on the economy or excessively increasing imports and foreign exchange losses.

In sum, protecting the natural and historical environment of the Southeast Peninsula is only one of the requirements of achieving sustainable development. Strategies to protect the human environment from the adverse effects of change are equally important.

5. RECOMMENDATIONS, INCLUDING REMEDIAL STRATEGIES AND MANAGEMENT ALTERNATIVES

5.1 Remediation Strategies

5.1.1 Protecting the Coastal Environment from Road Construction Impacts

The construction of the proposed road as well as subsequent development encouraged by the access road will need to incorporate soil erosion and sediment control methods in order to protect both the man-made facilities and coastal/marine habitats. The terminal point or discharge location of the eroded materials will be the nearshore coastal waters.

Three strategies need to be employed in any construction or other activity which disturbs the vegetation and soil to minimize damage due to accelerated soil erosion (Porter, 1976):

1. Prevention of or minimizing the effects of the erosion.

2. The entrapment of the eroded materials (sediments).

3. Coordination of erosion control, sediment control and control or management of the flow of water leaving the site for a complete, well-integrated programm.

Erosion control is the first line of defence. If no erosion occurs, then no sediment is produced. While it is not possible during construction to prevent all erosion, it can be minimized by the application of the above noted strategies which are elaborated upon below.

(1) Land use should be fitted to the features of the physical environment, such as soils, topography, vegetative cover, and the natural drainage systems. Steep slopes of eroding soil should be avoided; drainage ways and other vulnerable areas should be protected during construction. The proposed road project, particularly the Roughton design, has generally followed these guidelines. For example, by not routing the road over or into the sand dunes at Friar's Bay, the sensitive and important protective features of the dunes are retained. These dunes, and their vegetation, should be strictly off-limits during and after the road construction. The windward dunes protect the Friar's Bay area from the impact of wind and waves of the Atlantic Ocean. The vegetation on the berm minimizes its erosion by wind.

(2) Any disrupted and exposed soil needs to be protected from the impact of raindrops and running water which are the agents responsible for water-related erosion. Temporary mulches, such as cut guinea grass (Panicum maximum) and other native grasses, should follow grading wherever possible. Such grasses also contain seeds which will grow in the environment of the Peninsula. Exposure of the disturbed

area can also be minimized by the careful scheduling of certain stages of the project to avoid high rainfall season (August through November).

For the road works, the drainage channels will be paved to prevent erosion of the channel, as well as culvert inlets and discharge structures. Likewise, the sloping of the roadbed into those drains will minimize erosion. The road construction area, however, will be vulnerable to erosion during the construction phase. The mulching of fill slopes in the hillside alignment would likely not be very effective due to the rocky soil and poor soil conditions. Examination of the area during the October 1985 field inspections showed that vegetation has great difficulty in maintaining a foothold. However, in the lower slopes of the salt pond area, such measures would be functional and appropriate and are recommended. Staging of the road project may not be feasible due to the need for the contractor to maximize the use of equipment. This may also account for Lashley's (1985) reluctance to use labour intensive, slow-to-build gabion retaining structures and the preference for larger cuts done by machinery.

(3) The infiltration function of the land should be maintained to the maximum possible extent. Layouts and designs should minimize impervious areas, while areas of unique vegetation (vegetation on sand dunes, mangroves, etc.) should be protected. Effort should be made to prevent compaction of soil by construction machinery in areas not requiring compaction, for compaction of soil will increase runoff.

(4) Runoff velocities should be kept low, and mechanical measures should be used to shorten slope runs.

The above measures are found in the Roughton design by the proposed installation of rock erosion checks in the drainage ways. Such measures should be utilized on other projects where appropriate.

(5) Sediment needs to be controlled at the construction sites by retarding runoff and filtering or trapping sediments.

In the shallower sloped areas, all drainage should be vegetated with grasses suitable to the environment. All drainage from the construction areas should be filtered or routed through temporary sediment traps as illustrated on Figure 5.1. Other materials or designs could be utilized if they meet the same objectives, i.e., to slow down the runoff so that the sediment carried with it will settle out. Such downslope traps would need to be cleared on occasion to maintain their effectiveness and be removed when the final road surface is in place, but should be installed immediately after the drains are excavated. On the lower slopes, such as at Friar's Bay and the salt ponds, larger basins can be built through which all runoff from the construction area is routed. However, the larger existing drainage paths should be kept unobstructed and their modification kept to a minimum, keeping in mind the large volumes of water concentrated in them during heavy rainfalls. The U.S. Virgin Islands Conservation District (1976) recommends that sediment basins be sized according to the drainage

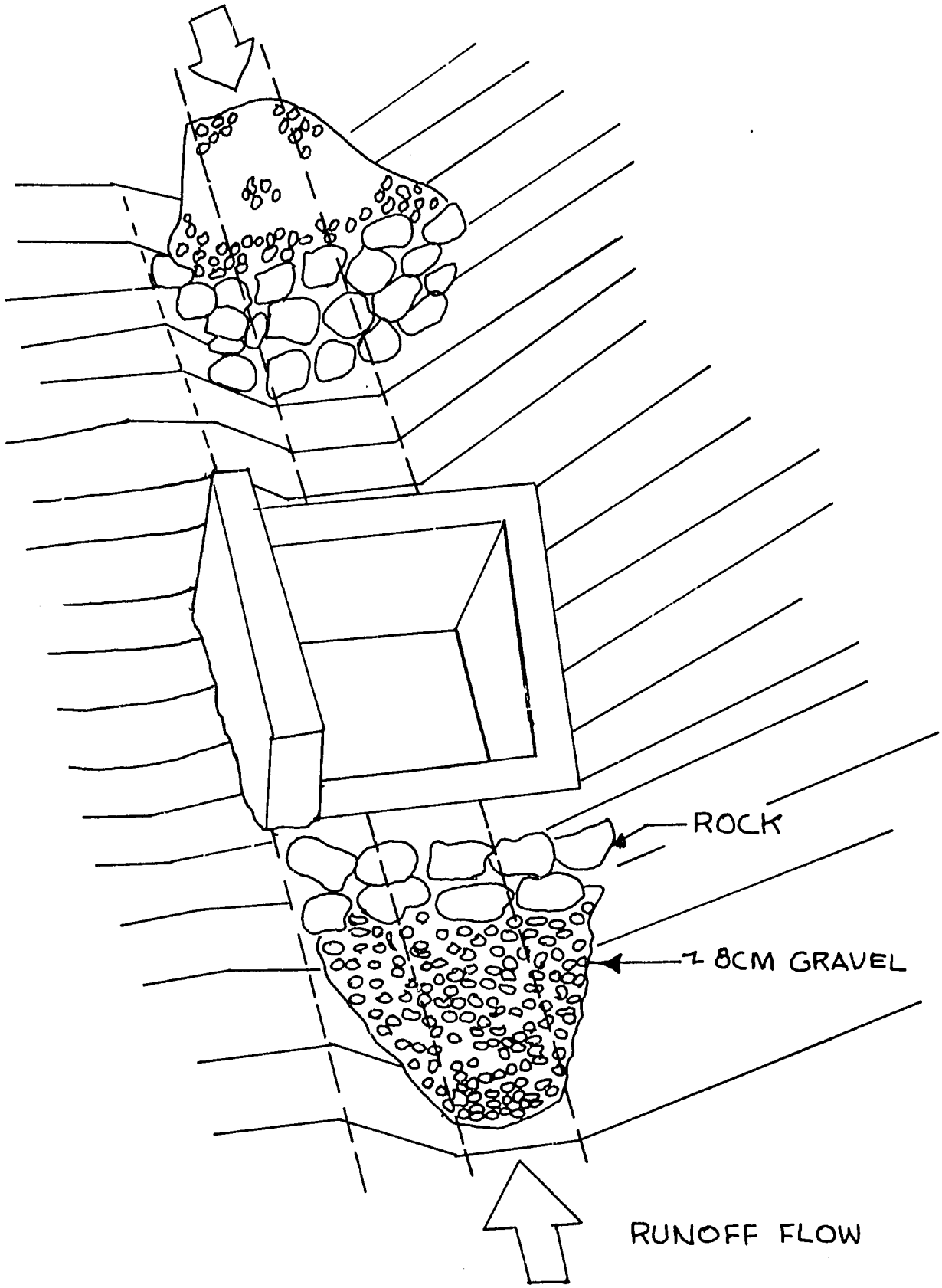


Figure 5.1. Recommended road sediment traps at drop inlets.

area. For a hectare of drainage area, 128 cubic meters of sediment basin should be provided.

The Virgin Islands Conservation District Handbook (1976) also contains other structural and non-structural design guidelines for the abatement of soil erosion, both from a standpoint of conserving the soil for uses such as agriculture and also to protect downstream uses, e.g., drainage facilities, coastal marine environments, etc. It is recommended that similar soil conservation measures be adopted by the Government of St. Kitts-Nevis in order to minimize soil loss and guarantee protection of downstream beneficial uses.

(6) The management of drainage is exceedingly important. In general, a development should not be built in a drainage way. Surface runoff above a construction area should be diverted around it.

While the road design is generally adequate with respect to drainage, the selection of a ten year design storm for culvert sizing appears inadequate, given the overall expense and difficulty to construct the road. The ten year design frequency means that on the average, or statistically, the ten year storm will occur once in ten years. However, in such a ten year period, larger storms may also occur, and when that happens, portions of the road, particularly at the larger drainage ways, may be seriously damaged by overtopping and washouts. We recommend using a larger 25 year design storm and the installation of appropriately larger culverts. Note that the culvert size will <u>not</u> increase by a factor of 2.5, and the cost increase will be minimal, compared to the overall construction costs, and will prevent future costly repairs at which time the larger culverts will likely be installed in any event.

Lastly, in order to ensure that the road contractor performs according to specifications and efficiently carries out required erosion mitigation and sediment reduction practices, it is recommended that a separate A&E supervisory contract be let with a qualified firm, preferably one with experience with tropical climates, volcanic soils, and smaller insular systems.

5.1.2 Protecting the Peninsula From Development Impacts

Development impacts on the Southeast Peninsula will be both general and specific to certain sites. The extent of such impacts will depend on mitigation mechanisms and measures adopted, some of which are outlined in other sections of this Environmental Assessment Report. Major focus should be given to maintaining and improving the attractive Peninsular landscape, based on the perception firmly endorsed by Government, land owners and others that one of the area's major assets is its landscape.

Government ministers (Powell and Heyliger, personal communications, 1985) indicated that Government's policy will continue to encourage the maintenance of an attractive landscape through appropriate design and building measures. For example, the maximum allowable building

height is to be the equivalent of three floors, and building design is expected to be harmonious with the environment and "authentic" to the island's character.

In seeking to reduce the overall impact of development on the Peninsula, Government should seek, through policy, to clarify and synthesize three generally discussed objectives for a Southeast Peninsula development programme, specifically:

(1) To carefully exploit its tourism potential.

(2) To maintain an attractive landscape.

(3) To conserve, through effective management, selected areas for wildlife protection, recreation and other appropriate uses.

The proposed land use plan should provide the basis for the execution of such a policy and should also outline the mechanisms that will seek to bring co-operation between the public and private sectors in the design of an overall development programme for the Peninsula. For defining such mechanisms, three major components should be addressed:

(1) Promotion and acceptance of an agreed upon Southeast Peninsula "development concept and programme";

(2) Co-ordinated and controlled implementation of the programme to minimize impacts on the area's resources;

(3) The institutional or administrative and legal arrangements necessary to ensure the above.

The scope and nature of developments presently under consideration for the Southeast Peninsula require that major focus be given to minimize impacts on its beaches. For example, it is assumed that developers will want to site facilities on or close to sand berms and beaches, which may destabilize such areas by accelerating erosion. The preliminary development plans for Friar's Bay indicate there may be substantial risks to its beaches, sand berms and overall delicate environment unless mitigating measures are built into the specifications for the development project. It is recommended that an "environmental impact assessment report" be requested of the developer and carefully evaluated by a qualified government team to provide the basis for decision making on the environmental implications of the scope and the design of the Friar's Bay project.

As a matter of policy, an environmental impact assessment should be considered a necessary and integral component of all major development projects on the Southeast Peninsula. Developers should be required to carry the cost of preparing such assessment reports, which can be categorized as a professional fee in their investment cost profile. Table 1.1 and Figure 1.4 show resources that are likely to be sub-

jected to impacts if development occurs in the respective Southeast Peninsula land holdings.

Beach development should be sited to ensure adequate public access and parking. Provisions should also be made to discourage encumbrances to horizontal movement along the beach by inappropriately placed structures such as beach cabanas and water sports facilities and equipment. Measures will also be needed to minimize the impact that the construction of residential homes and condominiums will have on the slopes of the Peninsula. Such measures should consider erosion and soil loss, modifications to drainage, modifications to the landscape, access roads, and parking areas.

A wide range of building control measures should be officially established and enforced, governing building setbacks, height, density, plot coverage, sewage disposal and the like. Guidelines such as those presently used by the Frigate Bay Development Corporation (see Appendix F) need to be adapted and officially adopted to shape the design and installation of the built environment on the Peninsula. In addition to the above, such guidelines would also address site drainage (swales, ditching, sheet runoff, etc.), underground utilities requirements, landscaping, coastal setback of buildings from the shore, energy and water conservation, car parks, signs and lighting, architectural design, hurricane protection, green space requirements, beach grooming, dune protection, private access road standards, and solid waste disposal. For a general setback rule, we suggest 100 meters as the standard with exceptions allowed only by special permit after an impact assessment is carried out.

Separate guidelines will eventually be needed regarding vessel moorings, anchoring, speargun use (which should be restricted if not banned), scuba diving, water skiing, and vessel waste discharges -- in order to resolve conflicting uses and minimize adverse impacts in the Peninsula's semi-enclosed bays where such activities will be concentrated. Each of these is necessary to prevent a specific undesireable "impact." We presume the various guidelines will be addressed in some detail within the Land Use Management Plan.

5.2 Sea Turtles and Pelicans: Endangered Species Protection

5.2.1 Legislation, Regulation, Enforcement and Monitoring

A critical step toward improved prospects for survival of sea turtles in St. Kitts waters is enactment of the regulations for turtles in the proposed Fishery Regulations now under consideration. Penalties for violation should permit fines at least commensurate with the value of the product and enforcement officers should have the discretion to impound attended or unattended turtle fishing gear in use (e.g., nets). The possibility of losing a boat for illegal turtle fishing would be a strong incentive not to take the odd turtle encountered while spearfishing. Since a complete prohibition on turtle products is proposed, a short grace period with a firm cutoff date for possession of perishable turtle products is probably in order. Some

procedure for marking and registry of existing durable products (e.g., stuffed turtles) is essential to prevent the trade from continuing. Specific provisions for import and export should probably be incorporated and brought to the attention of customs officers. A blanket or site specific prohibition of spearguns would benefit turtle conservation since visiting neophyte spearfishermen tend to shoot any available target.

The Government of St.Kitts-Nevis should be encouraged to become a signatory to the International Convention on Trade in Endangered Species (CITES). Other Eastern Caribbean states (e.g., St. Lucia) are active participants. Once a signatory, it is essential that implementing legislation and regulations be prepared and enacted (models are available from within the region). The process of enacting the legislation (and subsequent participation in policy development under the Convention) is in itself an important form of environmental education for the goverment officials involved. With enabling legislation and enforcement, there is a vehicle to slow regional traffic in hawksbill shell which is a major force driving the species toward extinction in the region.

With enabling legislation in place, the second critical step to maintenance of stocks of nesting sea turtles on the Peninsula is an active program of beach patrols. Road access will make the SEP more amenable to enforcement as well as exploitation, and a well-executed monitoring programme should reduce exploitation below the current (pre-road) levels. Design of the programme should be undertaken in consultation with the St. Kitts Fisheries Unit and outside groups or agencies with relevant technical expertise (e.g., the U.S. Fish and Wildlife Service has overseen several similar programs on Culebra, Mona and St.Croix).

Even though the total number of nests appear low, the area is substantial, and many issues need to be addressed in the first year to develop a programme viable in the long term. Experience elsewhere indicates that the effort is not likely to be effective unless a person is assigned to the task full-time. During the assessment phase this would be year-round for one year, but some seasonal volunteer assistance could be obtained if needed, preferably locally, but also from external sources. A manual for sea turtle field work is available (WATS, 1983), but if the candidate lacks field experience, hands-on training should be obtained at another monitored site. Expenditures for such a programme might include salary, vehicle and operating costs, field gear (rechargeable lamps, binoculars, shovels, predator traps, nest protection supplies), production of permanent signs, and production or acquisition of educational/advisory printed notices, radio and television spots on turtle conservation/regulations. Interim funding for initial programme start-up costs might well be obtained from one of the international wildife conservation NGO's.

Initially the field programme should focus on determining the seasonal and geographical distribution of nesting, the causes of egg, hatchling and adult mortality, and devising ways to reduce losses. Since our understanding of many demographically important aspects of sea turtle biology is so poor (e.g, the recent finding that egg incubation

temperatures control hatchling sex ratios), the minimum possible nest intervention consistent with high hatchling survival should be sought. For example, nests can be sometimes obscured or disguised as already raided, rather than moved to a hatchery. Simpler solutions are also less labor intensive, but nesting success must be monitored to evaluate the approaches used. Other duties might include monitoring for evidence of hatchling disorientation by artificial lighting, posting signs and acquisition or preparation and dissemination of public education materials.

5.2.2 Environmental Education and Sea Turtles

Recommendations for enviromental education are treated elsewhere in this section and in Appendix D. Turtle conservation issues should be addressed in that programme, focussing, after the regulations are in place, on the rationale for and local implementation of the regional five-year ban on turtle fishing. The success in reducing exploitation of turtles to sustainable levels is ultimately more dependent on developing public acceptance through education than on enforcement. The local public can be involved and the limited personnel available to the Fisheries Unit can be expanded by volunteer participation in beach monitoring (interested high school students, etc.). Sport diving operations could provide information on the abundance and distribution of turtles if fisheries personnel prepared, distributed and subsequently compiled simple turtle sighting records. Since users of the Peninsula come from throughout the country (e.g., fishermen from Nevis) any programme should be country-wide. A useful listing of approaches to sea turtle public education is given by Hopkins and Richardson (1984). Some educational packages on sea turtles are available at nominal cost from The Center for Environmental Education in Washington, D.C.

5.2.3 Incidental Mortality

To reduce losses from hatchling disorientation, fixed lights visible from nesting beaches (particularly bright lights such as road or parking area lights elevated on poles which illuminate the beach) should be avoided both during the construction of the road and in the design of public and private facilities. The negative impact of lights regarded as essential near beaches can be reduced by keeping their number, height, intensity and hours of operation as low as possible. Natural vegetation or plantings, and directional reflectors function to prevent unnecessary light from reaching the beach. Raymond (1984) discusses mitigation measures (most undertaken after lights and structures were in place on the beachfront) and lists manufacturers of directional lighting. In view of the impact on turtles and, moreover, given such issues as the rate of foreign exchange and the high recurrent costs for generating capacity and outdoor lighting, more emphasis in the planning and design of both public facilities and private developments should be placed on careful assessment of lighting needs. Tourism facilities designed abroad where power costs are low often overlook substantial opportunities for energy cost reductions, including highly directional, low wattage outdoor lighting which would incidentally benefit wildlife.

As use of the Peninsula intensifies so that trampling damage is highly likely for any nest on an open beach, options are to either identify nest positions by fencing them (which increases the risk of poaching or vandalism) or by moving them to a small fenced hatchery area.

Provision of an controlled system of solid waste disposal both during and subsequent to the completion of the road (when public use of SEP beaches expands) would reduce the risk of increased incidental turtle mortality from ingesting floating plastic debris and from increased hatchling predation by increased beach scavenger populations (rats and mongoose). Public waste disposal containers should be readily available at roadside turn-outs, beaches, picnic areas and other locales where people congregate. The issue of litter should be incorporated in the environmental education effort. Boaters anchoring in coastal waters should be informed via posters and brochures prominently available at docks and in marinas about the problems of discarding solid waste in the seas. Adequate provision for onshore disposal should be provided.

To reduce turtle mortality from boat strikes, as well as liability for human injury, beach recreational facilities developed on the Southeast Peninsula should favor swimming, snorkeling, sailboards and other small wind-powered craft and avoid water skiing and other high-speed motorized sports.

5.2.4 Tourism and Turtles: Conflict or Co-existence on the Peninsula

Exploitation aside, the most serious confrontation between tourism and sea turtles is on nesting beaches. For reasons detailed earlier, sea turtle nesting rarely fares well on developed beaches. Given the importance of beaches to viable development and the ownership pattern, it is unrealistic to expect that any of the larger beaches on the Peninsula will be maintained intact for turtle nesting (and other wildlife). This following scenario, therefore, examines what is likely to happen if beach monitoring for turtle protection is coupled with efforts via zoning and development guidelines to preserve, insofar as possible, the natural beach environment from the primary dune seaward.

After the road is completed and use of Peninsula beaches by local residents and visitors expands, beach monitoring (which may include mongoose control) based on the proposed protective regulations should result in considerably reduced pressure on breeding adults and incubating eggs. As development on some beaches begins, with accompanying increases in nocturnal lights and activity, nesting turtles will shift from those sites to less disturbed beaches. Some animals may shift away from the Peninsula to other sites (e.g., the north shore of the rest of St. Kitts) where the risk of poaching will be higher if beaches are not monitored. Initially shifts within the Peninsula will not likely result in declines in nesting success, but when few low-disturbance beaches remain, turtles will probably begin to use less suitable sites (e.g., nesting below the high water mark).

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As foot traffic on beaches becomes more intense, the prospects for in situ survival of nests on the open beach declines, and the beach monitoring programme will need to move most nests, either into the protection of the remaining adjacent vegetation or to a hatchery enclosure.

Thus, as development expands and intensifies, efforts to maintain or enhance the remaining sea turtle breeding population will gradually shift from largely in situ monitoring and protection to salvage. With (1) increasing disturbance of limited nesting habitat, (2) severely depleted populations (which are probably subject to additional human-induced mortality elsewhere in their migratory pathways), and (3) relatively long times to sexual maturity (30-50 years estimated for green turtles, probably less for hawksbills and leatherbacks), rapid restoration to population levels which could provide a sustained yield of food and other goods is highly unlikely. However, the monitoring effort is not costly, aids the survival of what are probably genetically locally-adapted breeding animals, and provides valuable continuing feedback on the effects of development which can shape planning guidelines. Most adjustments in tourism development which help to preserve sea turtle habitat actually involve cost reductions, if incorporated at the planning stage, and are desirable for other reasons, including reduced recurrent costs (e.g., lower wattage, screened beach lighting) and long-term maintenance of environmental quality basic to attracting visitors.

Assuming commercial and recreational exploitation is stopped, the effects of reasonably well-managed tourism development on foraging turtles in coastal waters are likely to be much less negative in the short- and moderate-term than for nesting animals. Observers in the U.S. Virgin Islands have noted significant increases in numbers of foraging turtles in coastal waters subsequent to closing the commercial fishery, even though the period has been one of intensive and poorly-controlled tourism development with considerable damage to shallow water habitats from siltation, dredging and some eutrophication. Obviously, this is not to argue that extensive habitat alteration will not ultimately affect sea turtles, other marine organisms and human populations, but that past turtle exploitation has greatly outpaced habitat alteration and that extant habitats could support larger numbers of turtles than currently exist. Fluctuations in nesting success will not be tracked closely by changes in numbers of foraging animals in adjacent waters, not only because of long generation time, but because turtles have extensive, poorly understood movement patterns (both passive drift of hatchlings and active migration). Foraging animals may not belong to the same populations which nest on St. Kitts. For example, significant numbers of adult green turtles caught foraging near Nevis were tagged while nesting on Aves Island.

5.2.5 Pelicans

A protective strategy for the pelicans of the Southeast Peninsula is far less demanding and diffuse than is required for sea turtles. Major near-term concerns are reductions in predation by re-

gular monitoring during nesting season and education (posters identifying the pelican as the national bird and a protected species, noting penalties and reasons for the same). Zoning guidelines (perhaps relying on existing or modified coastal set-back rules) should preserve roosting and loafing sites on coastal rocks and cliffs (identifiable by heavy guano whitewash). More ready human access potentially means more frequent disturbance by even well-intentioned intruders such as photographers. Pelican and other seabird roosting sites should be examined in more detail and consideration be given to the maintenance of substantial, relatively disturbance-free stretches of rocky shore.

Redrafting of the existing wildlife legislation and regulations should include protection of the national bird. A reserve encompassing the pelican and frigate bird colonies with reasonable buffer zones allowing for expansion is highly desirable. Prominent signs in the vacinity of the nesting colonies, readable at 200 meters, prohibiting approach within 100 meters, should be installed when there is some capability to monitor compliance during the nesting season. The breeding colonies are an asset for natural history-oriented tourism. Well-designed blinds or look-outs could eliminate random incursions into the area and attract and educate visitors and residents.

Pelicans are relatively confiding birds and readily move into marinas and similar coastal developments using pilings, masts and sometimes roofs as roosting sites. Problems with complaints about excrement should be anticipated, and such facilities should display posters indicating the protected status of the birds. Non-destructive methods (such as rounded piling caps) should be implemented where the pelicans' presence becomes a problem. However, where possible, such steps should not be taken as the additional roosting sites may benefit the population.

Pesticides played a major role in pelican declines elsewhere. Agricultural chemicals used for grounds maintenance and for expanded horticulture/gardening on the Peninsula should be reviewed and applied carefully as some will eventually find their way into ground water and adjacent coastal waters.

5.3 Waste Treatment and Disposal

Treatment and disposal of wastes on this comparatively small land mass must be rigidly controlled if the initiative to develop tourism facilities and coastal amenities is to be successful on a sustained basis over time. With peak density tourism facilities projected by some for the Peninsula at over 2,000 hotel beds, plus condominiums and lower density residential development, the selection and design of proper and effective waste disposal measures need to be planned and preparatory investigations -- e.g., soil and water quality -- carried out prior to commencement of the building and other infrastructural development. Assuming that a small environmental engineering unit (EEU) is established by Government (see Section 1.5.1 and Section 5.5), the following sub-sections outline our recommendations.

5.3.1 Liquid Wastes (Sewage) Treatment and Disposal

The design of a proper sewage treatment and disposal strategy will require the antecedent execution by Government of soils investigations in the southern portion of the Peninsula and in the lowlands of Friar's Bay. The appropriate government agency also should mount hydrological studies to determine the rate of travel of water towards the sea and the transmissivity of the various soils which may be encountered. Percolation tests should also be carried out to determine the rate of absorption of waste water and the level of ground water in the lower lying areas. Ideally the above investigations should precede the preparation of the Land Use Management Plan and must precede the actual layout of specific development sites, roads and house lots.

Using as an example one projection for the development of over 2,000 hotel beds, possibly 200 condominium apartments, restaurants, a marina at Little Salt Pond and some residential development in the southern area of the SEP, about 0.6 MGD to 0.75 MGD of sewage would be generated from approximately 5,500 persons. From this projection, estimations can be made for sewage generation levels for other proposed development schemes. In any event, to avoid the environmental pollution problems generally associated with the use of septic tanks in high density, high ground water situations, it is recommended that a collection (sewer) system and plans for treatment and effluent disposal should precede such any development. There are essentially three "treatment" options -- individual package plants, sewage lagoons, or a centralized system. (The Frigate Bay example and history is instructive here [see Towle, et al., 1985]). In each case, the final effluent requires disposal via polishing ponds as irrigation water or must be discharged into the sea via an ocean outfall.

The method of aerated (facultative) lagoon treatment is a likely candidate for the Southern Peninsula basin area (see Table 4.1), which will require an area of 1.5 acres. Studies would be needed to identify and determine the feasibility of other disposal locations. With the low rainfall pattern on the Peninsula, the reuse of sewage effluent must be considered. With removal of pathogens by disinfection of the effluent, the irrigation of the mooted golf course and gardens at hotels, etc. could be an alternative or complementary means of disposal of all grey water and possibly partially treated sewage effluent, with the prospect of recovery of some revenue for such a service.

Government will need to assign responsibility for monitoring the quality of sewage treatment plant effluents for standard five-day BOD (biological oxygen demand) and suspended solids (making recommendations for effluent quality adjustments where necessary). These important monitoring and quality control tasks (and those mentioned below in Section 5.3.2) will require the development of a modestly equipped pollution testing laboratory facility and the services of a laboratory technician trained in standard procedures.

5.3.2 Residential Sewage Disposal

For dispersed residential houses at Friar's Bay, and perhaps in other areas of the SEP where topography and cost render a collection system impractical, the tendency would be to dispose of sewage by means of a septic tank for treatment and a tile field or soakaway for effluent disposal. This is quite acceptable for low density, detached smaller residential units and isolated buildings with low density use.

It is nonetheless important to monitor the performance of the tile fields and soakaways in coping with effluent volumes, to monitor (by periodic sampling) any wells dug for irrigation or other purposes and to test for pollutants such as coliforms, chlorides and possibly pesticides.

5.3.3 Marine Effluent Disposal

A decision to dispose of sewage plant effluent via a marine outfall will require careful site selection and planned regular monitoring of the quality of marine water and the condition of the marine ecosystem receiving waters. Detailed water circulation investigations should be made prior to authorising any activity which will introduce foreign materials into nearshore waters (although ultimately land-based nutrients reach inshore waters through seepage). The alternative of a deep, extended ocean outfall for primary sewage discharge should also be examined carefully (see Officer and Ryther, 1977).

Water quality monitoring should be carried out in the areas around any outfall and off beaches around the entire Southeast Peninsula. Parameters for which samples should be taken are listed in Section 5.7.

The objective of the monitoring programme is to evaluate the effectiveness of wastes disposal control measures and to maintain the quality of marine water by control over the discharge of land- and coastal-based pollutants. Considering the width of the shallow coastal shelf surrounding the Peninsula, land-based disposal with treatment and reuse of grey water is probably a better option than marine disposal.

5.3.4 Marinas

Any one of the marinas proposed for various ponds, if built, will require stringent control over the discharge of wastes. The Government of St. Kitts-Nevis will need to legislate controls over the discharge of wastes in any developed marina area within a salt pond and into the state's territorial waters.

In addition to enacting legislation for wastes disposal control in marinas, Government must ensure that sanitary facilities -- toilets, lavatory basins, showers -- for yacht and other boat crews, visitors and inhabitants are provided; these facilities should be connected to the central collecting (sewer) system or served by a small package plant.

5.3.5 Solid Wastes Management

With a projected population of 5,000 in the southerly or Great Salt Pond area of the Peninsula, and a comparatively smaller concentration of population in other SEP areas (approximately 500 as an estimation), the volume of refuse generated daily on a per capita basis of 1 kilogram/day is approximately 12,000 kilograms or 12 metric tons. Refuse collection should be done by a packer capable of transporting 16 compacted cubic yards of refuse per trip to the Conaree landfill, on two trips per day. The collection fleet should include a ten cubic yard side-loader or an eight cubic yard flat bed truck to remove rubbish not suitable for collection in the packer.

The operation of a landfill site on the Peninsula is not recommended at this time as these often become air pollution nuisances through fires, and such a site could encourage the breeding of rodents and flies. Further, the resultant short travel of dump site leachate to the coast could impose added stresses on fringing coral reef and other marine ecosystems.

It is also noted that waste flotables in semi-enclosed areas like marinas and safe harbours are a recurring problem and require a specialized management strategy, as do derelict and abandoned, grounded vessels -- a point best illustrated by the Basseterre waterfront.

5.4 Legal Aspects of Managing the Peninsula Environment

The areas identified for needed legislative action are the sea and its environs, including fishing; protection of the beaches; protection of wildlife and areas of public concern, such as parks; sanitation; roads; housing and other legislation intended to preserve the environment. The following existing Acts are summarised in Appendix E:

1. Maritime Areas
2. Fisheries
3. Marine Pollution Prevention
4. Beach Control
5. Wild Birds
6. Roads
7. Petroleum
8. Pesticides
9. Building
10. Land Development Control
11. Town and Country Planning
12. Public Parks
13. Forestry.

The areas identified for new or amended legislative activity are wildlife protection, a national trust act (which is to include national parks, historic buildings and archaeological sites) and an environmental protection act. Detailed recommendations are incorporated in our review of existing legislation (Appendix E) concerning the need for amendment of existing laws (e.g., wildlife protection) or for new legislation (e.g., a national trust act). What follows below is a discussion of the need for more comprehensive environmental legislation which cuts across ministerial lines.

Many Governments today are not yet structured to make a co-ordinated attack on the practices and pollutants which are degrading our Eastern Caribbean environments. And although, despite its complexity, the environment should be perceived as a single, interrelated system for pollution control purposes, the legislation to be found on the statute books in St. Kitts-Nevis as elsewhere tends to deal with matters which concern the environment in piece-meal fashion and along sectoral lines. The principal role and function of new legislation for the environment should, therefore, be:

(a) to establish and enforce environmental protection standards which are consistent with national environmental goals (the goals should therefore be set out in the legislation);

(b) to make provisions for research, planning and monitoring on the adverse effects of pollution and on methods and equipment for controlling it; and

(c) to assist others who are already in the field, (including units of government) working to arrest environmental pollution by making grants and technical assistance available to such persons or bodies.

Almost every part of Government is concerned with and affects the environment in some way. Yet each Ministry also has its own immediate concerns, such as health, defence, communications and works, or agriculture which necessarily affect its own view of environmental questions. It is precisely because environmental problems cut across so many jurisdictions that general legislation of the environment should be able to set national standards which the other Ministries should follow even where they may be in conflict with a local departmental interest.

A typical Environmental Protection Act, or by whatever name it is called, should place certain general responsibilities for matters of policy on a particular Ministry (as Barbados has just done), as distinct from the power to make regulations on matters which are intended to give effect to or carry out the purpose, intention and provisions of the Act. Such policy directions would require the Minister to en-

sure the conservation and maintenance of the environment in the interests and protection of public health generally. In particular, he should be empowered to regulate, monitor and control any actual or likely contamination or pollution of the environment and to set the minimum standards required for a clear, healthy and aesthetically pleasing environment.

Such legislation should clearly be based on the best available standards or criteria to regulate the conservation, protection and improvement of the environment. Currently, there are scattered provisions in a number of Acts which represent a sectoral concept of the environment. The objective of a new Ministry being the development of a holistic concept of the environment, it should, therefore, establish co-ordination mechanisms to achieve this approach, since existing pieces of legislation were not necessarily passed with this aim in view.

The list of duties or activities to be undertaken by the Minister under the general power to declare policy and set environmental standards might include:

(a) investigate problems and institute preventive and remedial measures in respect of environmental pollution, the management and disposal of solid, liquid and gaseous wastes, food and drink management, nuisances, rodents, insect pests and general sanitation;

(b) conduct research, studies and monitoring programmes related to the matters in sub-section (a) above;

(c) gather, collate, analyse, publish and disseminate information relevant to the foregoing;

(d) promote the planning, approval, funding and implementation of measures designed to ensure the wise and safe use of the natural environment;

(e) provide ways and means for the training of persons involved in environmental health services; and

(f) generally promote public education and participation in maintaining a clean and aesthetically pleasing environment conducive to good health.

The Minister should also have power to make regulations as may be necessary and appropriate to carry out the policy of this piece of legislation. The following areas are deemed necessary and appropriate. To give effect to the purpose, intention and provisions of the Act the Minister should have the power to make regulations in respect of:

Pesticides	Harmful effects on water, land and air; effect of pesticides on fish and wildlife; set pesticide standards and monitor compliance; research; educational programme on pesticide use, pesticide registration and monitoring. Pests and vector control.
Nuisances	Definition, prevention, abatement and removal of nuisances or insanitary conditions on any premises.
Human Settlements	Facilities for treatment and disposal of human waste.
Food/Drink	(a) Setting chemical standards for food and drink, e.g., limiting pesticide residues in food. (b) Inspection of factories, markets, slaughterhouses or other similar places for the enforcement of standards.
Water Pollution	Prevention and abatement; monitoring and ensuring safety of water supplies, i.e., protection of ground water from pollution and pollution and improvement of water quality control services.
Liquid Wastes and Sewage	Setting of standards; regulation and control of public/private liquid waste disposal systems.
Solid Waste	Management of solid waste; storage; collection; transportation; processing and disposal of solid waste (domestic, commercial and industrial).
Air Pollution	Emission of smoke, gases, dust, fumes from motor vehicles and fuel burning industries; offensive odour; excessive noise from vehicles, vessels, factories.
Erosion	Prevention and control.
Disasters	Measures in cases of emergency with respect to natural and man-made disasters.
Beaches, Foreshores and Dunes	Removal of sand; preservation and conservation.
Marine Pollution	Both land and sea sources affecting coastal water quality.

Industrial Processes	Control of the working environment, e.g., factories. Control and treatment and disposal of industrial waste; identification and examination of the impact of industrial practices on the environment. Establishment of standards and criteria.
Habitat and Wildlife Protection	Both terrestrial and marine; parks and protected areas.

Primary focus for immediate legislative drafting activity are (as indicated above) wildlife protection amendment, a national trust act and environmental protection legislation. Such activity would entail, where a legal draftsperson is not permanently resident in the State during the relevant period, two or at most three visits by an expert consultant to provide counsel, assistance and review services with preliminary drafts.

It is also strongly recommended that the State of St. Christopher-Nevis should ratify as soon as it is reasonably convenient to do so, the Treaty for the Protection and Development of the Marine Environment of the Wider Caribbean Region, as well as the Protocol concerning Co-operation in Combating Oil Spills, which were signed in Cartagena, Colombia in 1983. As noted elsewhere in this report, it should also become a signatory to the CITES (Endangered Species Trade) and RAMSAR (Wetlands Protection) Conventions and consider membership in the International Union for the Conservation of Nature and Natural Resources (IUCN).

5.5 Environmental Planning, Monitoring and Management: Institutional Considerations

5.5.1 Required Plans

The environmental protection strategy for the Southeast Peninsula, as developed in this study, presumes the preparation of a series of issue, problem, or resource specific action plans. Some will be required early on, even before starting road construction. Others can be deferred until the road nears completion. Some will be simple, requiring only a few days of effort by perhaps two or three persons. Others will take weeks, a sizeable amount of field work and research, and will be fairly complex, requiring legal counsel and specialist input. One or two are more comprehensive and will, when finished, subsume or incorporate most of the other lesser plans as components or elements of a coordinated programme strategy for environmental protection. Some focus solely on the Peninsula, whereas others may start off as or develop into broader, nationally focussed activities -- in effect using the Peninsula development project as a launching or test vehicle.

The various plans recommended are summarized as follows:

(1) Erosion Control and Sediment Reduction Plan
(2) Wildlife and Endangered Species Management Plan (with separate plans for sea turtles and pelicans)
(3) Beaches and Dunes Plan
(4) Land Acquisition Plan for the Southeast Peninsula
(5) Marine Resources Plan
(6) Recreation Plan
(7) Parks and Protected Areas Plan (including historic sites)
(8) Environmental Impact Assessment Programme Plan
(9) Reforestation Plan
(10) Tourism Infrastructure and Utilities Plan
(11) Southeast Peninsula Tourism Marketing Plan

Since an operating framework is needed for all of the above, there is a need to prepare a comprehensive:

(12) Environmental Management and Protection Plan.

Items 1, 2, and 3 should be completed and operational prior to starting the road; items 4 through 7 and 12 should be in progress at that time and finished before the road is; items 8 through 11 are open as to scheduling.

To accomplish these various planning tasks and mount proper implementation strategies on a timely basis certain Government agencies will require institutional strengthening if they are to function effectively in the face of added responsibilities. Until the newly created Ministry of Natural Resources and the Environment is fully established and functional, several interim measures are recommended in the following sections. Included are the establishment of a new governmental unit to deal comprehensively with environmental affairs and an upgrading of the capacity of the Planning Unit, the Fisheries Unit and Public Works to deal with technical aspects of protecting and managing the environment.

5.5.2 Required Institutional Development: The Environmental Management Unit (EMU)

The actual design of a new Environmental Management Unit (EMU) of Government falls outside the terms of reference for the EAR and, in any event, would be presumptuous. What we can suggest with some certainty, on the basis of direct evidence of continuing environmental degradation in St. Kitts-Nevis, is that such a unit is sorely needed and will be critical to the successful development of the Southeast Peninsula road and tourism/residential complex.

The EMU would be the custodial manager of the environment, namely, St. Kitts-Nevis' natural and physical resource base. Its primary objectives would be to manage those resources and resolve conflicts between development goals and environmental values, limits, and imperatives. It would require comprehensive enabling legislation (as described in

Section 5.4); and, to function effectively during an initial start-up phase, it would need a staff of approximately five persons, including at least one wildlife specialist, a coastal or marine resource specialist, one field inspector/technician, a secretary and a director with environmental management training and experience.

Such a unit could conceivably (a) be attached to Planning, (b) be subsumed in the recently established Ministry of Natural Resources and the Environment, (c) be established as a joint ministry with tourism (as in the case of Barbados), or (d) be constituted as a separate entity within the Ministry of Development. It would need the authority to coopt technical support persons from other appropriate ministries, to approve all development schemes (including those proposed by other governmental ministries), and to set standards (i.e., for coastal water quality, resource uses, pollutant discharges, etc.).

5.5.3 Required Institutional Development: The Environmental Engineering Unit (EEU)

Well in advance of starting road construction and ideally before the contract is let, a strategy with standards for dealing with erosion mitigation methods and contingencies needs to be developed. This will be a technical document requiring technical expertise for monitoring compliance by the contractor. To accomplish this, we recommend establishing an Environmental Engineering Unit (or task force or group).

The EEU should be headed by an environmental engineer, presumably drawn from Public Works or Health. He/she would be assisted by some combination of the following: a forester, an environmental health engineer, a hydrologist or water engineer, a sanitary engineer, a soils engineer, and possibly a marine engineer. The actual composition of the EEU would depend largely on which specialized skills are presently available in St. Kitts-Nevis and can be tapped by assignment to serve, in a part-time or adjunct capacity, to assist the EEU with its review, monitoring and advisory functions. The Unit could be attached to Public Works or Health or even report to the Physical Planning Unit. But where it is located is not as important as what it does -- namely, to become the eyes and ears of the Government regarding what environmental damage any engineering work by Government or private sector developers might be inducing. It should have stop-work-order authority <u>on site</u> (subject to <u>ex-post-facto</u> review within a given time period, e.g., 24 hours, by a designated higher authority). The point is that the Unit would be Government's primary line of defence against irreparable, costly physical damage and careless engineering practices.

5.5.4 Other Institutional Considerations

The existing Physical Planning Unit and the Fisheries Division will both require additional professional and technical staff if they are to fulfill their proper roles ensuring that Peninsula development is carried forward on a "least possible environmental cost" basis.

At the very least, the Planning Unit will need an environmental planner (with vehicular, secretarial and micro-computer support services), and the Fisheries Unit will need a marine/wildlife biologist (with vessel and laboratory support and secretarial services). A modest environmental resource map and reference library, a basic laboratory, and a micro-computer data storage/word processing centre will eventually be required to support the expanded environmental responsibilitieis of the EMU, the EEU, the Fisheries Unit, and the Planning Unit.

5.6 Conservation and Recreation Areas

5.6.1 Assumptions

The recommendations which follow do not foreclose upon or preempt a variety of alternative approaches to protecting and managing unique, fragile or critical resource features of the Southeast Peninsula environment. They are put forward as a base for further analysis during the SEP land use planning project. We have, however, made certain assumptions which need to be stated.

(1) Both the Government and the land holders have a mutual interest in not only maintaining the general environmental quality of the Peninsula but they also have a stake, albeit in different proportions, in maintaining both the viability and diversity of the ecosystem and its unique features. This can only be done by a co-operative, mutually reinforcing strategy.

(2) Any Government built or protected and managed amenities or attractions, such as parks, bird nesting colonies, historical/archaeological sites, key habitats, and recreational areas and facilities, enhance the overall marketability of the area. The long-term development and management costs of these, borne by Government, represent a significant investment to which the landowner beneficiaries should contribute their fair share.

(3) Until the Government and the owners come to terms about such issues as land donation, easements, tax breaks, sequestration, compensation or various quid pro quos, it is premature to be concerned with how an area is to be acquired, protected or managed. We, therefore, only address what features of the Peninsula should be protected or managed in the public interest.

5.6.2 Conservation

While conservation should be considered an integral part of and apply generally to the overall land use of the Peninsula, the status and value of some resources may require special legal and/or administrative arrangements to achieve management objectives. At this stage of development planning for the Peninsula, it is only suggested that these resources be classified into three management categories, with the further recommendation that (1) this suggested management approach be made an integral part of subsequent planning phases and (2) the legal, institutional and administrative details for its execution

should be subjected to a more thorough analysis during the preparation of the Land Use Plan (see Figure 1.3).

It is proposed that Category I should include areas requiring formal preservation through implementation of a protected area status. Effective management of such areas would require that:

1. The lands be acquired by Government in the case of terrestrial areas presently in private ownership (although conservation easements might suffice if tightly drafted).

2. An appropriate statutory "trust" or "parks" authority be created to manage both terrestrial and marine protected areas.

Five areas are recommended for protected area status (see Figure 1.3). The first is the proposed Nag's Head Wildlife Preserve, covering approximately 300 acres. Major objectives for management of the site should include the protection of the magnificent frigate bird and brown pelican nesting colonies and other wildlife in the area.

The second proposed protected area is the South Friar's Bay Marine Reserve to be managed as a habitat for juvenile conch. No conch fishing would be allowed in the area (boundaries to be determined after a detailed study of the site by the Fisheries Unit).

The third proposed protected area is Outer Guana Point reef, a superior assemblage of corals, fish and other reef associated organisms, suitable as a recreational reserve exclusively set aside for snorkeling, diving, and underwater photography. Spearfishing and possibly all fishing should not be permitted within this unique living resource -- probably the best example of marine biological diversity in the coastal waters of St. Kitts.

The fourth proposed protected area is Major's Bay, which is at present an excellent juvenile lobster nursery. No lobster fishing should be permitted in this bay.

The fifth proposed protected area is the small pocket beach northwest of Canoe Bay, an important turtle nesting beach which would lend itself well to being kept free from human traffic and interference.

It is proposed that Category II should include landscape features where special conservation and related resource management requirements could perhaps be met without recourse to acquisition and the establishment of legal boundaries. Management tactics could include special regulations, easements, setbacks, monitoring and resource use limitations, such as licensing, setback rules, permits, and user fees. The kinds of areas falling into Category II are as follows:

1. Lands on steep slopes not easily accessible for building; lands that are vulnerable to accelerated erosion from most forms

of development impact; and lands (or "green space") where preservation of a natural state is important to preserving the aesthetic and ecological quality of the Southeast Peninsula landscape.

2. Friar's Bay beaches and dunes which are environmentally sensitive and vulnerable. Both the Atlantic and Caribbean beaches of the Bay were severely damaged during Hurricane Klaus and receded to their dune lines. They are expected to recover in due course unless human-induced impacts restrict such recovery efforts. Any development that presents a risk to the integrity of dune deposits may severely restrict the ability of the area to resist damage from natural hazards such as storms and hurricanes.

3. Dunes at Sand Bank Bay and Mosquito Bay.

4. Scenic hilltops or peaks (especially Sir Timothy Hill, Salt Pond Hill, St. Anthony's Peak).

5. Salt ponds.

6. Beaches (all but especially Mosquito and other turtle nesting beaches).

7. Least tern nesting areas east of Great Salt Pond and other key wildlife habitat clusters as identified by Arendt (1985) and displayed in Figure 1.2 and 2.16.

It is recommended that existing legal and administrative mechanisms be used to manage this category, although certain codes and regulations will require modification. Through appropriate legal and administrative mechanisms, beach management should ensure that buildings are set back to an agreed minimum distance from the high water mark, sand is not removed (except for authorised beach stabilization and defence measures), beach vegetation is maintained, and public access to the beach is free and unencumbered.

It is proposed that Category III should include the protection of historical and archaeological sites (see Appendix A and Figure A-1 for details). No site should be disturbed except under the supervision of a professional archaeologist, and legal ownership of all artifacts should be vested in the Government of St. Kitts-Nevis. If an SEP site is likely to be damaged or destroyed by any proposed development activity, an antecedent detailed site assessment and salvage archaeology effort should be mounted and carried out by Government. Detailed suggestions for the proper management and development of archaeological

and historic sites should be included in the SEP Land Use Management Plan.

5.6.3 Recreation

The Southeast Peninsula has outstanding potential for recreation. To ensure that this potential is realized, the status and quality of the resources used for recreation must be maintained and, secondly, effective planning to promote, encourage, and accommodate recreation should be undertaken.

Since recreation at the Peninsula will be essentially linked to conservation strategies, it is recommended that the responsibility for recreation planning and management be given to the "authority" entrusted with the management of conservation areas under Categories I and III above, i.e, the Nag's Head Wildlife Preserve and the Southeast Peninsula Beach Authority.

Like other forms of land or water use, recreation exerts impacts on resources which must also be mitigated. We assume the Land Use Management Plan will explore the linkages between potential recreational activities at the Southeast Peninsula, site constraints to such activities, site alterations that may be necessary to accommodate them, their impacts and ways to mitigate such impacts.

It is recognized that further analysis is required to outline a comprehensive package of recreational opportunities at the Peninsula. Nevertheless, it is recommended that consideration be given to:

1. Establishment of a network of scenic road "turn-outs" and viewing areas (Figure 5.2). One such area identified is Timothy Hill, using lands owned by the Frigate Bay Development Corporation.

   It is suggested that in exchange for the construction of the first part of the Peninsula road on the Corporation's land, thereby benefiting its development, it should be asked to set aside the top of Timothy Hill to be developed and managed as a scenic look-out "park" with viewing platforms and telescopes to all directions, an interpretation centre, a rain/sun shelter, a picnic area, and a restaurant/snack bar concession.

2. In addition to making provisions for adequate access and parking at the Southeast Peninsula beaches, steps should be taken to acquire an appropriate beach land area to develop a public beach recreation facility, complete with shelter, change rooms, benches, other

FIGURE 5.2

St Kitts Southeast Peninsula Road Project (EAR/IRF)

(ADAPTED FROM ORGANIZATION OF AMERICAN STATES, GRENADA TOURISM ATTRACTION PLAN, 1985)

amenities, and a refreshment/snack bar concession.

5.7 Marine Resources Management

The follow specific recommendations are made with respect to management of the marine environment:

1. A programme to establish the development potential and status of nearshore marine habitats should be implemented immediately. This programme will provide information needed to evaluate various development options, as well as to establish water quality and other environmental standards. The Fisheries Division has access to expertise needed to undertake this task, which could also involve local school groups, landowners, fishermen, and recreational users of the Southeast Peninsula. Because of obvious implications for improved public understanding of the value and potential of the Southeast Peninsula, it is suggested that this activity be closely coordinated with environmental education activities suggested in Section 5.8 and detailed in Appendix D.

The programme should provide for:

- characterization of marine communities in major habitats on the southeast and southwest coasts of the Southeast Peninsula
- identification and quantification of commercially important species in these habitats
- periodic acquisition of water quality data from these habitats, including

  turbidity
  sedimentation rate
  biochemical oxygen demand
  dissolved oxygen
  temperature
  salinity
  fecal coliform.

2. Regulations discussed in Section 1.4.2 and more specifically in Appendix E pertaining to the marine environment should be implemented. For example, operation of beach seines in nursery areas (i.e., where the catch is likely to be primarily juvenile fishes) should be regulated, with enforcement of proper mesh size restrictions.

3. Specific management plans should be developed for marine habitats associated with Major's Bay, Friar's South, and particularly Guana Reef, as the size and quantity of typically exploited species (reef fishes, spiny lobster, precious coral) suggest that this area is, as yet, not heavily utilized by humans. Such management plans

should incorporate associated beaches and shoreline areas and be consistent with the beach and sea turtle management plans.

Improved public access to the Southeast Peninsula will provide a variety of opportunities to expand environmentally compatible human uses of SEP marine areas, including the following development options:

- Recreational fishing might be improved through the use of fish aggregating devices and/or artificial fishing reefs which have been extremely successful for this purpose in other parts of the world. These devices can be installed in areas lacking naturally productive habitat, and can be strategically located with regard to shore facilities.

- Improved picnic spots in certain areas (e.g., Major's Bay, Mosquito Bay) would attract local users and visitors alike, including yachting visitors (note that attraction to the latter group does not require marina-type facilities). A small fee similar to that charged for use of some state and national parks in the United States could offset costs. Several caveats are stressed, however: extractive uses (collection of shells, coral, live plants or animals, etc.) should be prohibited; adequate waste disposal and facilities for cooking fires must be provided; permanent moorings should be installed for visiting boats, and use of anchors prohibited to avoid repetitive, cumulative damage to reefs and seagrass beds.

- Major's Bay, Banana Bay, Cockleshell Bay are suitable for water-skiing, but buoyed ski areas should be designated to protect swimmers and divers.

- The presence of juvenile conch and spiny lobsters, respectively, in South Friar's Bay and Major's Bay offers important potential for improving management and possibly the yield of these stocks by designating protected nursery areas, as well as for research directed toward the same goal. Preliminary work along these lines has already begun under the auspices of the St. Kitts Fisheries Unit.

- Major's Bay, adjacent to the St. Kitts-Nevis Channel, appears to be suitable for cage culture of fin fish. Juvenile fishes currently captured by beach seines at Major's Bay are often discarded, but could be placed in such cages for captive rearing. Experiments of this sort in Martinique have demonstrated impressive growth rates with extremely simple technology. Such activity is compatible with other tourist-oriented activity and could improve local food production as a means of retaining foreign exchange presently lost to food imports.

- Several of the salt ponds -- notably Great Salt Pond, Little Salt Pond, and the tiny pond behind Ballast Bay Beach -- have documented natural brine shrimp (*Artemia*) populations (Goodwin, *et al.*, 1984) and offer the clear possibility of being superior sites for *Artemia* mariculture if the ponds are largely kept in their natural state and protected against land-based sources of pollution.

- There also may be potential for culture of ornamental marine species (e.g., aquarium fishes; tritons, Charonia variegata; helmet shells, Cassis tuberosa); starfish Oreaster reticulatus) which naturally occur in the marine habitats of the Southeast Peninsula. Production of this type may be significant not only as a means of generating additional income from tourists, but also as a means of reducing harvest pressure on wild stocks of these species for the curio market.

5.8 Environmental Education Programme

In the smaller islands of the Eastern Caribbean, environmental concerns are often considered less critical than other pressing social and economic development issues. Therefore, the effectiveness of any mitigating strategies developed as a result of the current Environmental Assessment will depend to a large extent upon the priority assigned by Kittitians and Nevisians to protection of their natural and physical environment, in the face of increased pressures on the resource base and an altered national climate for development.

The interviews conducted as a part of the Environmental Assessment process (October 1985) revealed that with the exception of the radio and television advertisements produced by the Chamber of Industry and Commerce as part of an anti-litter campaign, there is no established environmental education programme in St. Kitts-Nevis. This suggests the absence of an active local support base for environmental education, and, therefore, the first step in the formation of a national environmental education programme should be development of community support, perhaps through formation of a core group of interested individuals.

Recommended subsequent steps for Phase One of the programme might include: (1) establishment of specific programme objectives and an evaluation plan; (2) identification of themes and topics perceived as important; (3) selection of target groups for programme activities; and (4) development of possible tactics or approaches for implementing the programme and for reaching the targeted audience. The latter might include exposing certain members of the core group to programmes in other Caribbean islands, design of pre- and post- tests for programme evaluation, definition of the types of materials to be produced, assembly of available materials, and determination of equipment/supply needs.

Phase II of the environmental education programme should focus on implementation, with initial emphasis during this phase placed on securing necessary funds to carry out planned activities. Subsequent activities might include production of new materials, the implementation of project activities as determined in Phase I, and administration of pre- and post- evaluation tests.

The study team recommends that any environmental education effort should address issues perceived locally as generally relevant and not necessarily specific to the Southeast Peninsula, although -- within the overall programme -- some materials/activities should be designed

to focus on the Peninsula and an effort made to target sections of the population which will affect, or be affected by, the proposed road project or subsequent development activities at the SEP. During the interviews conducted by the EAR team in October, several issues were identified by respondents as constituting existing or potential environmental problems, all with implications for future development activitives on the Southeast Peninsula.

(1) Litter and Solid Waste Control
(2) Natural History Features (including the marine environment)
(3) Soil and Water Conservation
(4) Standards and Criteria for Development
(5) Wildlife

Four primary target groups or institutions have been identified by the study team as appropriate beneficiaries of programme outreach efforts. They are: (1) the formal school system (where no structured programme exits at present for environmental education but where outreach efforts could effectively reach the majority of the population); (2) the general public (in order to increase levels of environmental awareness within the local community); (3) developers/contractors (to sensitise those who will be involved in road construction and subsequent development activities to the importance of resource protection and environmental management); and (4) decision makers (to sensitise politicians and other government officials to environmental issues and their importance in national development strategies).

Several appropriate strategies, some of which have been used successfully in environmental education programmes in St. Lucia and Dominica, were discussed in EAR interviews. and as a result of these discussions several tactics have been identified as having potential for incorporation into the St. Kitts-Nevis environmental education programme.

-- for schools: teacher training workshops, production of teaching aids, poster competitions, slide presentations, technical support for existing organzitions;

-- for the general public: radio and television programmes, poster campaigns, distribution of leaflets;

-- for developers and contractors: a handbook to provide information about development regulations, permit requirements, and guidelines for specific development activities (including environmental management strategies for seagrass beds, coral reefs, beaches, coastal waters, erodable shorelines, etc.)

-- for decision makers: briefings and an executive summary of the "developers' handbook" supplemented by possible video tape presentations on critical environmental issues which could be shown to ministers and other government officials.

The programme will require initial funds to cover costs for: an on-site coordinator; travel and per diem for core group members' exposure

to environmental education programmes in St. Lucia and Dominica; materials production; short-term consultancies.

It is strongly recommended that an environmental education programme (as briefly suggested above and in more detail in Appendix D) be implemented prior to the commencement of road construction activities for the Southeast Peninsula as it will facilitate the implementation of impact mitigation strategies and environmental management programmes recommended elsewhere in the Environmental Assessment Report.

5.9 Recommended Action: Summary

As the Environmental Assessment team concluded its data analysis relating to preparation of this report, several operational questions remained unanswered: where to begin? What can be deferred and until when? Who does what? Who takes the initiative and who assists? And, of course, the critical issue of costs and funding sources also arises. Understandably, the 21 action recommendations made in this report may, at first glance, appear overwhelming but in actual fact are quite manageable within the projected 24 month time frame available before the opening of the projected SEP penetration road. The EA contractor is quite confident that some combination of USAID, CIDA, WWF, IUCN, and other NGO funding support is eminently feasible and will be sufficient to the task without placing an undue, added financial burden on the Government of St. Kitts-Nevis.

While this concluding section of the SEP/EAR falls far short of being a full fledged strategic plan for developing a new, comprehensive St. Kitts-Nevis (or SEP) "Environmental Planning, Monitoring and Resource Management Programme," it does outline an agenda, specifies target products, sets out a tentative schedule and provides suggested priorities and some estimated costs (in most cases, it has not been possible to break out costs for anticipated funding totals or sources for GOSK activities). It is assumed, however, that a more detailed strategy plan (and costing profile) will fall out of the LUMP effort as a consequence of anticipated close interaction of the LUMP contractor, Government, and the principal landowners.

We have separated the various tasks required of Government into six logical and topical (but unequal) categories, partly to ensure that redundancies and conflicts are eliminated among similar initiatives and partly to identify scheduling, equipping, and staffing options that are mutually reinforcing and possibly synergistic because of the "critical mass" effect. Phrased another way, some projects will work better together than separately.

5.9.1 Unresolved Issues Requiring a GOSK Decision Or Choice

Those needing local action are listed in Section 1.4 as follows:

(1) Government/SEP landowners meeting(s) -- schedule and format.

(2) Issuance of new Fisheries Regulations under the recently enacted Fisheries Act (1985).

(3) Selection of the final SEP road route and terminal point or destination (i.e., Ro-Ro terminal -- Yes or No?).

(4) Decision as to whether there will be an SEP Nevis jetty (and parking lot, etc.) and where it will be located (to link with the SEP road).

(5) Resolution of the status of the Keystone Agreement.

None of the above require specialist input. Numbers one and five are needed before the LUMP effort and two, three, and four during the LUMP project. No funds are required -- only decisions.

Additionally, the GOSK needs to proceed immediately with arranging for a formal SEP land holdings inventory and boundary survey and, secondarily, when the road construction job is tendered, the Government must be ready to insist that applicant firms submit a detailed erosion control and sediment reduction plan for evaluation and approval.

5.9.2 Required Plans and Strategies

The first eleven of the plans listed under Section 5.5.1 above should average about one person month each of external assistance at approximately US$10,000 per person month. Task 12 (essentially a "National Conservation Strategy" fundable by IUCN) should not require more than six person months (US$60,000) if plans 1 through 10 are completed simultaneously and the St. Kitts-Nevis Environmental Profile (see below 5.9.6) has previously been completed by USAID and GOSK (cost estimate: US$50,000). A draft Environmental Education Programme is included in this report as Appendix D and would cost an estimated US$36,000. A pollution control plan would be subsumed under plans 5, 8 and 12 at no additional cost.

5.9.3 Required Institutional Development

In order to strengthen the capacity of the Government to address the environmental dimensions of growth and development in both the SEP and the state, we have proposed certain upgrading, staffing, and support system changes for Public Works, Planning, and Fisheries as well as the establishment of a wholly new Environmental Management Unit. These and various support system requirements are reviewed in some detail in Sections 5.5.2 - 5.5.4. At the present time we estimate an approximate first year start-up cost for Government at US$100,000 with US$50,000/year of externally provided counsel, training, and technical assistance (probably by an NGO with appropriate regional experience in resource management and institutional development). More precise costing and a more detailed institutional development plan will be generated by the LUMP project team.

5.9.4 Legal Requirements: Revised and New Environmental Legislation

The agenda for this set of tasks is set forth in Section 5.4 and Appendix E. Preliminary drafting will be done within the scope of work for the LUMP, but the full requirements, as outlined, will involve about two person months of additional legal consultancy at an undetermined cost.

5.9.5 Required Regulations, Guidelines and Handbooks (see also Section 5.1.2)

The SEP Building and Development Guidelines to be developed by the Planning Unit (with local and external assistance) should involve approximately two person months of effort (three-quarters, GOSK; one-quarter, external). Planning guidelines in the form of an SEP (or statewide) Developers' Handbook should also be prepared, printed and distributed by the Planning Unit. This will require four person months (two for external consultants) for a total external cost (including the first printing of each) of approximately US$35,000.

5.9.6 Requirements for Baseline Research, Country Environmental Profile (CEP), and Monitoring

In addition to the scope of marine resource assessment work outlined in Section 5.7 (estimated to cost about US$30,000), there is a need to carry out long-term (12 month minimum) baseline profiles of:

(1) the larger marine "protected areas" recommended in Section 5.6 (South Friar's Bay, Guana Reef, Major's Bay);

(2) water quality and sediment loading in all bays at the base of larger SEP watersheds scheduled to be affected by the erosion/sedimentation impacts of road construction (this will establish a turbidity reference base against which to measure any expanded erosion effects);

(3) beaches associated with sites in (2) above;

(4) sea turtles associated with sites in (3) above (as outlined in Section 5.2).

Each of these should not cost more than US$10,000 for a total one-time, first year marine resource baseline survey cost of US$70,000 (monitoring costs for year two should be about US$20,000.). The USAID Country Environmental Profile (CEP) programme, which is currently being considered for the Eastern Caribbean, falls in this category of baseline work and ought not to cost more than US$50,000.

5.9.7 Additional Requirements and Priorities

Table 5.1 presents a reformatted summary of the above recommendations, along with additional equipment, facility and service requirements needed to enable the GOSK to improve and expand its environmental and resource management capacity.

Table 5.1. Listing of recommended St. Kitts-Nevis environmental protection programme planning elements, principally for the Southeast Peninsula.

Task/Action	Priority/	Schedule	Action Participants	Estimated Time/Costs* GOSK	Consultants	Notes
UNRESOLVED ISSUES:						See Section 1.4
1. GOSK/Owners Dialogue and Negotiations	H	1A	GOSK, landowners, LUMP & PMPP teams	?	LUMP	Establish a joint steering committee?
2. Fisheries Regulations Promulgation	H	1A	GOSK/Attorney General and Fisheries Unit	To be Determined	none	Fisheries Unit to prepare implementation plan; suggest public meeting to explain
3. Select SEP Road Route and Destination	H	1A	GOSK, LUMP, SEP land owners	?	none	Negotiate swap with owners or solicit bids RE "terminal"
4. Resolve Keystone Agreement Status	H	1A	GOSK, LUMP, PMPP	?	LUMP PMPP	Formally void if possible
5. SEP/Nevis Jetty Location (decision)	H	1A	GOSK, LUMP	?	none	Keyed to #3 and LUMP
			Sub-Totals	?	?	
PLANS AND STRATEGIES:						See Section 5.5.1
6. Erosion Control & Sediment Reduction Plan	H	1A	GOSK, LUMP, and Consultant(s)	1 person mo.	$5K	Illustrated guidelines for contractor, Public Works, developers
7. Wildlife/Endangered Species Mngmt. Plan	M	1B(draft) 2B(final)	GOSK and Consultant(s)	1.5 person yr. (Fisheries)	$20K	Some work done in other tasks
8. Beaches and Dunes Management Plan	M	1B	GOSK and Consultant(s)	1 person mo.	$5K	

*all figures in US$

Task/Action	Priority/	Schedule	Action Participants	Estimated Time/Costs* GOSK	Consultants	Notes
9. SEP Land Acquisition Plan (recreation, parks, utilities, etc.)	M	1C	GOSK (AG, Planning) LUMP, PMPP	2 person mos.	$10K	
10. SEP Marine Resources Management Plan	D	2C	GOSK (Fisheries), Consultant(s), ERP	3 person mos.	$10K	See also #22 below
11. SEP Recreational Development and Management Plan	M	2B	GOSK, LUMP, Consultant(s)	2 person mos.	$10K	Assumes 9 and 12 draft completed by 2B
12. Parks and Protected Areas Plan	H(draft) L(final)	1C 2B	GOSK, LUMP, Consultant(s), ECNAMP	3 person mos. 1 person mo.	$10K $ 5K	
13. Environmental Impact Assessment Programme Plan	M	1C	GOSK, LUMP, Consultant, UWI	3 person mos.	$10K	Assumes IRF is consultant
14. Reforestation Plan	M/D	2C	GOSK (Forestry), LUMP, Consultant	2 person mos.	$ 5K	Consultant: Institute of Tropical Forestry (Puerto Rico)
15. Tourism Amenities/ Utilities Plan	M	3	GOSK (Tourism and Planning), LUMP, Consultant(s)	2 person mos.	$10K	
16. SEP Tourism Marketing Plan	H(draft) M(final)	2A 2C	GOSK (Tourism and Planning), LUMP, Consultant(s)	2 person mos.	$10K	
17. Environmental Education Programme	H	4	GOSK (Education), Consultant(s)	3 person mos.	$36K	Draft plan completed; see SEP/EAR
18. National Conservation Strategy	M	2B	GOSK, LUMP, IUCN, and IRF	$30K	$30K	USAID support?

Task/Action	Priority/	Schedule	Action Participants	Estimated Time/Costs* GOSK	Consultants	Notes
19. SEP Environmental Mangmt./Protection Plan	M	1C	GOSK, LUMP, and Consultant(s)	2 person mos.	$10K	#19 would become a part of #18
			Sub-Totals	28.5 person mos. + $30K	$186K	
INSTITUTIONAL DEVELOPMENT:						See Section 5.5.2-.4
20. EMU/EEU, Planning/ Fisheries Units Upgrading and Capacity Building	H	2A	GOSK, LUMP, and Consultant(s)	$100K	$50K	Concept to be defined in LUMP
			Sub-Totals	$100K	$50K	
LEGAL REQUIREMENTS:						See Section 5.4
21. New and Revised Environmental Legislation	M	4	GOSK (Attorney General), LUMP, Consultant (Liverpool)	?	LUMP + 2 person mos.	USAID to assist
			Sub-Totals	?	?	
BASELINE RESEARCH, ENVIRONMENTAL PROFILE AND MONITORING:						See Section 5.9
22. SEP Marine Resource Assessment	M	2A	GOSK (Fisheries), Consultant(s), ERP	?	$30K	
23. SEP Marine Resource Profiles	H	1B & 5	GOSK (Fisheries), Consultant(s), ERP	?	$10K	S. Friar's Bay, Guana Point Reef, Major's Bay
24. SEP Bay Sediment Profile	H	1B & 5	GOSK (Fisheries), Consultant(s), ERP	?	$10K	To establish 12 month turbidity baselines
25. SEP Beaches and Sea Turtle Baselines	H	1B & 5	GOSK (Fisheries), Consultant(s), ERP	?	$20K	Assistance from Peace Corps volunteer?

Task/Action	Priority/	Schedule	Action Participants	Estimated Time/Costs* GOSK	Consultants	Notes
26. Country Environmental Profile (CEP)	H	2B	GOSK, LUMP, and Consultant(s)	$20K	$30K	USAID $
			Sub-Totals	?	$100K	
REGULATIONS, GUIDELINES AND HANDBOOKS:						See Section 5.1.2
27. SEP Building Guidelines	H	1C	GOSK (Planning), LUMP, Consultant(s)	1.5 person mos.	$10K	For statewide use; includes printing
28. SEP Developers' Handbook	H	1C	GOSK (Planning), LUMP, Consultant(s)	2 person mos.	$25K	
29. GOSK Participation International Environmental Treaties, Organizations	M	6	GOSK, Consultant(s)	?	$10K	See Section 2.7.3
30. Equipment/Facilities (library, laboratory, vessels, vehicles, micro-computers)	M	6	GOSK	$100K		Details in LUMP
31. Geographic Information System (GIS) for Planning/EMU	M	2A	GOSK, LUMP and Consultant(s)	6 person mos.	$20K	Includes training, software, testing, and turn key
			Sub-Totals	?	$65K	

Table 5.1 (continued)

Priorities Key	
H	High
M	Medium
D	Draft only or defer until SEP road is complete

Scheduling Key	
1A	Complete before road construction contract is let
1B	Complete before road construction starts
1C	Complete before first SEP development project is approved
2A	During road project (8 month period?)
2B	Complete before road is open for limited use
2C	Complete before road officially open
3	Complete before first SEP hotel/resort opens
4	Continuous, as required for periodic upgrade
5	Intermittent
6	Optional or open

Note: In using the all inclusive cost estimate figure of $10,000/person month for external consultants, we are including the following: fee, per diem, air/surface travel, salary fringes, materials, communication costs, printing, basic equipment, computer software, institutional overhead or indirect costs (i.e., it is fully loaded and averaged).

5.9.8 Conclusion

In small islands like St. Kitts with limited resources, the margin of error is thin, and the narrow Caribbean path to sustainable growth and development is constrained by both insular economic and ecosystem limits, processes, and imperatives. Under these circumstances, keen political will, creative development planning and sound socio-economic policies are not enough to reduce to acceptable levels the very real risk of inadvertent degradation of the resource base, namely, the living natural environment which is the habitat for all Kittitians and Nevisians. This requires that the state also equip itself with skilled resource managers and institutions -- both in short supply at present.

St. Kitts-Nevis has made some progress in this direction on its own, and this upgrading and self-education process now underway would be both enhanced and accelerated by implementation of the recommendations outlined above.

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Mr. Campbell EVELYN, landowner, Southeast Peninsula

Mr. C. FINNERAN, St. Kitts Biomedical Research Foundation

Mr. Dereck FRAITES, Philatelic Bureau

Mr. Aubrey E. HART, Director of Planning; member of Advisory Body for Southeast Peninsula Environmental Assessment

The Honourable Hugh HEYLIGER, Minister of Agriculture, Lands, Housing and Development

Mr. Michael HUERTA, Coopers and Lybrand

Mrs. Cynthia HULL, daughter of landowner (Mrs. E. Walker)

Mr. Mike ILKIEW, Dive Tour Operator

Inland Revenue Office, general staff

Mr. Joe JONG, Recreational User

Mr. F. E. KELSICK, landowner, Southeast Peninsula

Mr. Sam LAKE, Fisherman

Mr. William LIBURD, Managing Director, Frigate Bay Development Corporation

Mr. Kenneth MARTIN, Chief Agricultural Officer

Mr. Lloyd MATHESON, President, Society for the Restoration of Brimstone Hill

Mr. Erroll MAYNARD, Head, St. Kitts-Nevis Peace Corps Office; former Assistant Secretary of Agriculture

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Mr. Eugene PETTY, Permanent Secretary, Ministry of Agriculture, Lands, Housing and Development

The Honourable Michael O. POWELL, Deputy Prime Minister and Minister of Tourism and Labour

Mr. Athil RAWLINS, member of the Advisory Body, Southeast Peninsula Environmental Assessment; Chief Engineer, Water Department, Public Works

ROTARY CLUB, Dr. Edward Towle spoke at regular monthly meeting on October 17, 1985

Mr. Kenneth SAMUELS, Fisherman

Mr. Tapley SEATON, Attorney General

Mr. Richard SKERRITT, Executive Director, St. Kitts-Nevis Chamber of Industry and Commerce

Ms. Hilary WATTLEY, Assistant Director of Tourism

Mr. Errol WEBSTER, Acting Superintendent, Department of Public Works

Mr. Wesley WHARTON, Head of the Media Centre, Ministry of Education

Mr. Charles WILKIN, landowner, Southeast Peninsula

Mr. Rudolph WILKIN, Head of the Extension Division, Ministry of Agriculture

Mr. Victor WILLIAMS, Physical Planning Officer, Planning Unit

ENVIRONMENTAL ASSESSMENT
SOUTHEAST PENINSULA, ST. KITTS
MEMBERS OF THE PROJECT TEAM

(In Alphabetical Order)
[Information in brackets following name indicates position on Environment Assessment Team]

ARTHUR B. ARCHER [Sanitary Engineer Consultant]. Born in Barbados, Mr. Archer holds an engineering degree from The Johns Hopkins University. He presently works for the Government of Barbados as the director of the South/West Coasts and Greater Bridgetown Sewerage Studies. He has participated in a number of consultancies in the Caribbean on behalf of UNEP, CARICOM, PAHO, and OAS in the areas of marine/coastal pollution, beach erosion, sewerage systems, and solid waste management.

PAUL J. BUTLER [Environmental Education Consultant]. Mr. Butler, who was educated in London, currently is attached to the Forestry Department of the Ministry of Agriculture in St. Lucia as the Department's Conservation Advisor. In this post, he has been charged with responsibility for the establishment of an Environmetal Education Programme for St. Lucia and has subsequently developed a wide variety of educational and mass media materials for distribution throughout the country. For his work in wildlife conservation, he has been presented with a Certificate of Outstanding Achievement from the Prime Minister.

KATINA E. COULIANOS [Land Use Planner and Landscape Architect]. Ms. Coulianos, who was born in St. Thomas in the U.S. Virgin Islands, holds a Master's Degree from the University of Michigan, where her thesis explored the subject of tourism and the environment in Eastern Caribbean islands. Formerly employed by the Virgin Islands Coastal Zone Management Program, she now works as an independent contractor in St. Thomas in the area of environmental planning and landscape design.

MELVIN H. GOODWIN [Assistant Team Leader and Marine/Coastal Environments Consultant]. As head of Environmental Research Projects (ERP), Dr. Goodwin (who earned a doctorate degree in marine ecology from the University of Toronto) has lived and worked in the Eastern Caribbean for 12 years. In cooperation with Island Resources Foundation, he recently completed an AID-funded mariculture study for the Eastern Caribbean and a fisheries sector assessment of seven Caribbean islands for U.S. AID/RDO/C. He currently serves as a fisheries advisor to the Government of St. Kitts-Nevis, is a director of the Gulf and Caribbean Fisheries Institute, and director of the Caribbean component of the South Carolina Sea Grant Consortium Program for International Marine Development Assistance.

SANDRA T. GOODWIN [Environmental Education Consultant]. Ms. Goodwin has been affiliated with Environmental Research Projects (ERP) since 1980, participating in its programs in Carriacou, St. Lucia,

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IVOR JACKSON [Land Use Planner]. Born in Antigua, Mr. Jackson received a Master's Degree in regional planning from the University of Rhode Island. Currently affiliated with the Eastern Caribbean Natural Area Management Program (ECNAMP), Mr. Jackson has also worked as a Town and Country Planner in Antigua/Barbuda and the British Virgin Islands and as a consultant to a variety of international assistance agencies in the Caribbean, including IUCN/WWF, OAS, and the Commonwealth Fund for Technical Cooperation. He has served as a Director of the Caribbean Conservation Association and is currently the Caribbean regional representative on IUCN's executive board. He is the author of an earlier study on the Southeast Peninsula (Jackson, 1981).

NICHOLAS J.O. LIVERPOOL [Environmental Legislation Advisor]. Born in Dominica, Dr. Liverpool has been Dean of the Faculty of Law of the University of the West Indies Cave Hill Campus since 1984. He has extensive experience throughout the Eastern Caribbean and the Bahamas as a legal advisor to governments, more recently serving as a consultant to the newly established (1985) Ministry of Tourism and the Environment in Barbados and assisting in the drafting of the St. John's (Antigua) urban renewal/redevelopment legislation. He holds a Ph.D. degree from Sheffield University in England.

DESMOND V. NICHOLSON [Archaeologist]. Born in England, Mr. Nicholson has been a resident of Antigua since 1949. In the last 35 years he has established a reputation as a leading regional authority on Antiguan and West Indian archaeology and history. He is the founder of LISA (Leeward Islands Science and History Associates), has served as a director of the Caribbean Conservation Association and president of the Antigua Archaeological Society. Most recently, with funding provided by the Canadian International Development Agency, Mr. Nicholson has been involved in the establishment of a national museum for Antigua/Barbuda in St. John's.

WILLIAM E. RAINEY [Wildlife and Turtle Specialist/Coastal Environments Consultant]. A former resident of the Eastern Caribbean, Dr. Rainey holds a Ph.D. Degree from the University of California at Berkeley. As a research consultant in the areas of marine/terrestrial ecology, coastal and fisheries management, and endangered species, Mr. Rainey has also served as team leader and chief scientist for a number of Caribbean Conservation Association-sponsored sea turtle nesting and exploitation surveys in the southern and eastern Caribbean. He has also participated in impact assessment and economic development consultancies in the British Virgin Islands.

EDWARD L. TOWLE [Team Leader]. With 17 years of residency and program management experience in the Eastern Caribbean, Dr. Towle's area of focus has been on the development of interdisciplinary team management approaches to addressing critical resource development issues in small island systems. A co-founder of the Island Resources Foundation (1971), Towle is also a past president (1968-1974) of the Caribbean Conservation Association. He is an appointed member of two IUCN Commissions, serves on the U.S. Man and the Biosphere Program Directorate for Islands, and has been a consultant to UNDP, U.S. AID, CIDA, SIDA, WWF, FAO, and UNESCO. He has published over 30 books, articles and technical reports dealing with island systems, most recently a broad overview of the theory and practice of island system research and development planning, including guidelines for project design appropriate to smaller island areas. He holds a doctorate degree from the University of Rochester.

JUDITH A. TOWLE [Assistant Report Editor/Public Management Specialist]. With a Master's Degree from American University in public administration and international development, Ms. Towle has been a resident of the Eastern Caribbean for over 15 years. She is co-founder of the Island Resources Foundation and serves as its chief administrative/fiscal officer. She has published in the areas of West Indian environmental education, historical resource management, and development administration.

WERNER WERNICKE [Soils/Drainage Engineering Consultant]. With a M.S. Degree in Engineering from the University of California at Berkeley, Mr. Wernicke has been a resident of the U.S. Virgin Islands for over 15 years. He is the former head of the Virgin Islands Coastal Zone Management Program and has since worked as an independent consultant in the areas of coastal resource management and environmental impact assessment.

APPENDIX A

ARCHAEOLOGICAL SURVEY OF THE SOUTHEAST PENINSULA, ST. KITTS

I. INTRODUCTION.

The former British West Indian islands are rapidly being developed, often resulting in the destruction of historical and archaeological sites. These cultural resources, singularly and regionally, remain largely unappreciated, undefined, and underutilized. Yet, collectively, they constitute an asset of not inconsiderable value for strengthening national strategies of self-determination; while their inherent value for social, economic, and educational development requires their full integration into the national development planning process of Eastern Caribbean island states (Towle, J., 1985). St. Kitts is fortunate in that a high percentage of its archaeological heritage has survived since development has not been as rapid there as in some Lesser Antillean territories.

In October of 1985 an archaeological survey was carried out for the Southeast Peninsula of St. Kitts as a part of the environmental assessment project then being carried out by the Island Resources Foundation. Prior to that date a study of the prehistoric archaeology of the Peninsula south of Salt Pond Hill had been reported by D.V. Armstrong at the Ninth International Congress for Precolumbian Cultures of the Lesser Antilles held in St. Kitts in 1979. Seven sites were listed and designated (Armstrong, 1980). The present survey, therefore, consisted of an effort to confirm the Armstrong sites as well as identify new ones, both prehistorical and historical.

II. THE SITES.

Table A-1 lists all sites now known and those newly found during the October 1985 survey. Those marked C are confirmed, D are newly discovered and R were previously reported. Undoubtedly, there are others below the surface or under some of the characteristically impenetrable dry evergreen thickets. Sites have been dated by use of South's formula for the dating of historic sites (South, 1977) which has been tested for sites and ceramics in the West Indies by Nicholson (1979).

Generally speaking, the Peninsula is a prime area in which to search for archaeological sites because:

Table A-1. Summary of the archaeological sites of the Southeast Peninsula, St. Kitts. (See also Figure A1 for site location map.)

Name of Site	Site No. [CDR*]	Period	Priority Ranking
White House Bay No.	SPP-1 [C] (SKI6930001**)	Ceramic	6 - in area likely to be developed early
White House Bay So.	SPP-2 [R] (SKI6930342**)	Ceramic	7 - in area likely to be developed early
Ballast Bay	SPP-3 [R] (SKI7180001**)	Arc/Cer	1 - two component site in a location to be developed
Great Salt Pond	SPP-4 [C] (SKI7290001**)	Archaic	2 - near road; little Archaic period work done in Lesser Antilles
Major's Bay West	SPP-5 [R] (SKI7460001**)	Ceramic	8
Major's Bay East	SPP-6 [R] (SKI7380001**)	Ceramic	3 - should be investigated further as in proximity to the road
Cockleshell Bluff	SPP-7 [C] (SKI7400001**)	Ceramic	5 - small test should be made before further development
Fleming's Mill Bldgs.	SPH-1 [C]	18th C.	9 - first priority of stabilization; only walls standing on Peninsula
Sand Bank Bay Junction	SPH-2 [D]	c.1720-70	4 - further investigation before road built
Sugar Loaf Pass North	SPH-3 [D]	c.1830-90	12 - house site connected w/ Fleming's Estate
Sugar Loaf Pass South	SPH-4 [D]	c.1820-55	13 - another site connected with Fleming's Estate
Cockleshell Bluff	SPH-5 [D]	c.1850	5 - to be investigated with SPP-7, the prehistoric component
Canoe Bay Valley South	SPH-6 [D]	c.1720-70	10 - site connected with farming
Canoe Bay Valley North	SPH-7 [D]	c.1765-00	11 - very intact, small colonial agricultural homestead
Friar's Bay "Friary"	SPH-8 [D]	c.1780-25	14 - only a few scattered sherds found

* C/confirmed; D/newly discovered; R/previously reported.
** See Armstrong, 1980.

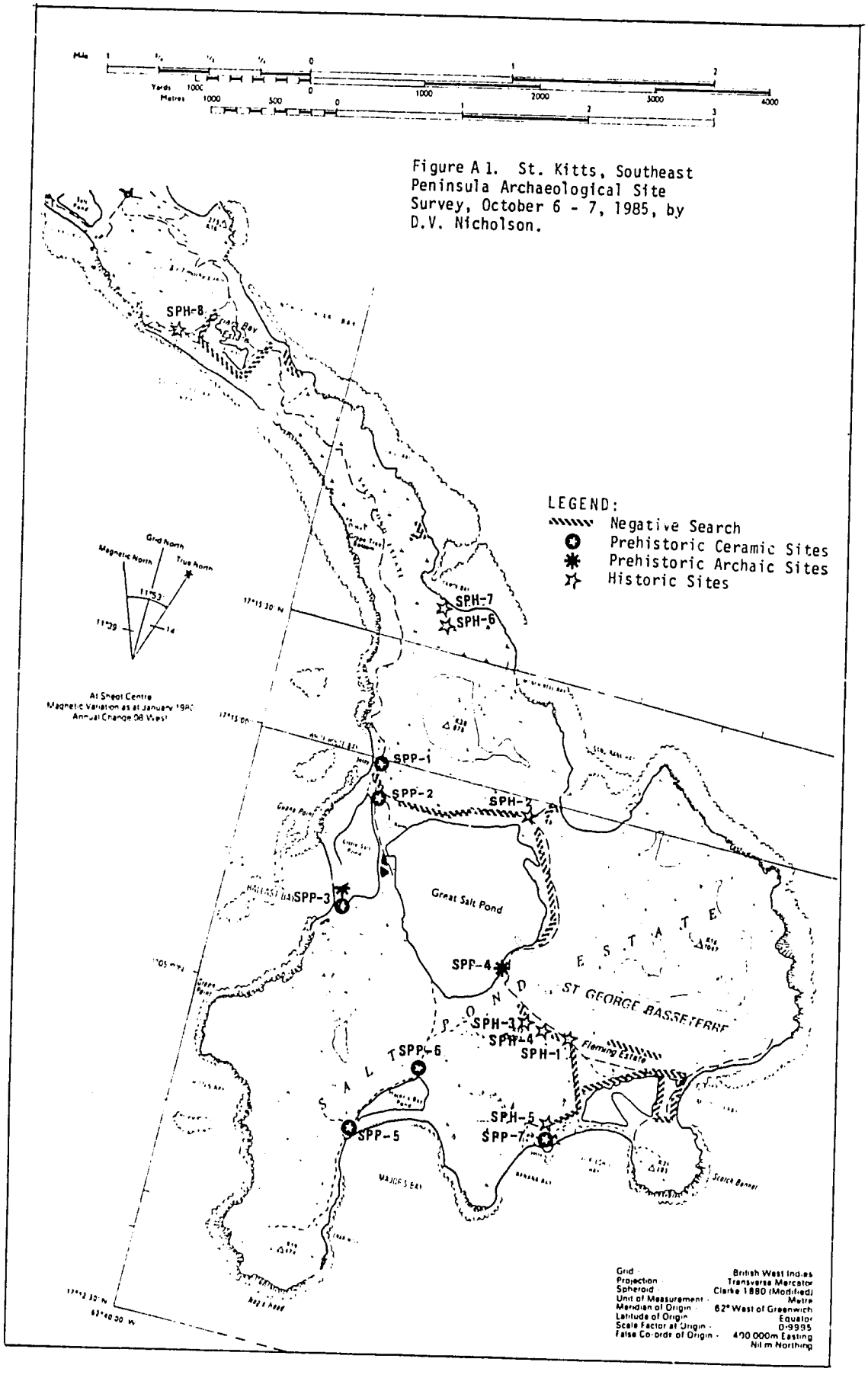


Figure A 1. St. Kitts, Southeast Peninsula Archaeological Site Survey, October 6 - 7, 1985, by D.V. Nicholson.

(1) a great number of the natural resources on which the Amerindians thrived are obtainable on the Peninsula;

(2) no volcanic ash covers sites as on the remainder of St. Kitts;

(3) the Peninsula has received fewer modifications due to low levels of historic settlement and little modern development.

Three time periods or ages of occupation are found on the Southeast Peninsula. They are:

(1) ARCHAIC - characterized by non-agricultural nomadic gatherers dating about 4100 and 2175 B.C. at the Sugar Factory Pier site.

(2) CERAMIC - characterized by maritime agricultural Ameridians from the Orinoco arriving at about the time of Christ.

(3) HISTORIC - marked by arrival of European colonials arriving first in 1623.

III. SITE PRIORITIES.

The following priorities have been preliminarily established for the sites identified on the Southeast Peninsula.

1. BALLAST BAY. This is a two component site (Archaic/Ceramic), with very little work having been done in the Lesser Antilles on the Archaic period. While the exact temporal sequence or overlap of the two periods is not known, sites with two components are invaluable and also very rare. This site was not visited during the present survey due to difficulty of terrain and lack of time.

2. GREAT SALT POND ARCHAIC SITE. Small tests should be made wherever the road is to run, to determine if the site which is now partly underwater extends to the development area. This is not a large site.

3. MAJOR'S BAY EAST. Should be tested as it is in the proximity of the road.

4. SAND BANK BAY JUNCTION. This historic site of c. 1720-1770 on the present track should be further investigated, especially for the location of the house.

5. COCKLESHELL BLUFF. A small Amerindian site, but should be looked at as further development will probably occur here. There is also evidence of occupation in the Victorian era.

6. WHITE HOUSE BAY NORTH. On prime coastal land and near the road; it is likely to be developed soon.

7. WHITE HOUSE BAY SOUTH. Also on prime coastal land.

8. MAJOR'S BAY WEST. Needs investigation.

9. FLEMING'S MILL BUILDINGS. Here may be seen the only eighteenth century walls still standing on the Southeast Peninsula. Priority should be given to having them stabilized. They consist of a windmill tower and sugar manufacturing buildings.

10. CANOE BAY VALLEY SOUTH. This is a house site of the first quarter of the eighteenth century.

11. CANOE BAY VALLEY NORTH. Here is the site of a small colonial homestead, to be found just as it was left about 1800 (see Figure A-2). A circle of stones remains on which a small wooden house once rested. Outside is the kitchen midden complete with shells, bones, and broken china. Also found was the tine of a shoe buckle. Sherds of slipware, delft, white salt-glazed stoneware, and creamware predominate. The home was enclosed with a wall, and the footings of the garden gate posts near the stream remain. Nearby the ground was prepared for agriculture as there are two piles of stones made when the ground was cleared. An archaeological site so undisturbed is rarely found.

12. SUGAR LOAF PASS NORTH. A site connected with the sugar works nearby. Victorian era china sherds predominate.

13. FRIAR'S BAY "FRIARY." Legend has it that here on the slope of a hill of this bay friars escaped persecution in times past. No ruins of the friary were found on this site, only sherds dating approximately 1780-1825.

IV. RECOMMENDATIONS.

* An archaeologist should make tests for the sites of priority listed above as 1-8, for these are the most threatened with extinction as a result of proposed development activities on the Peninsula. Numbers 10 and 11 are interesting and unusual. All sites, properly interpreted, would add to the historical and archival knowledge of St. Kitts. It is likely also that new artifacts would be found for the Amerindian section at the Brimstone Hill Museum.

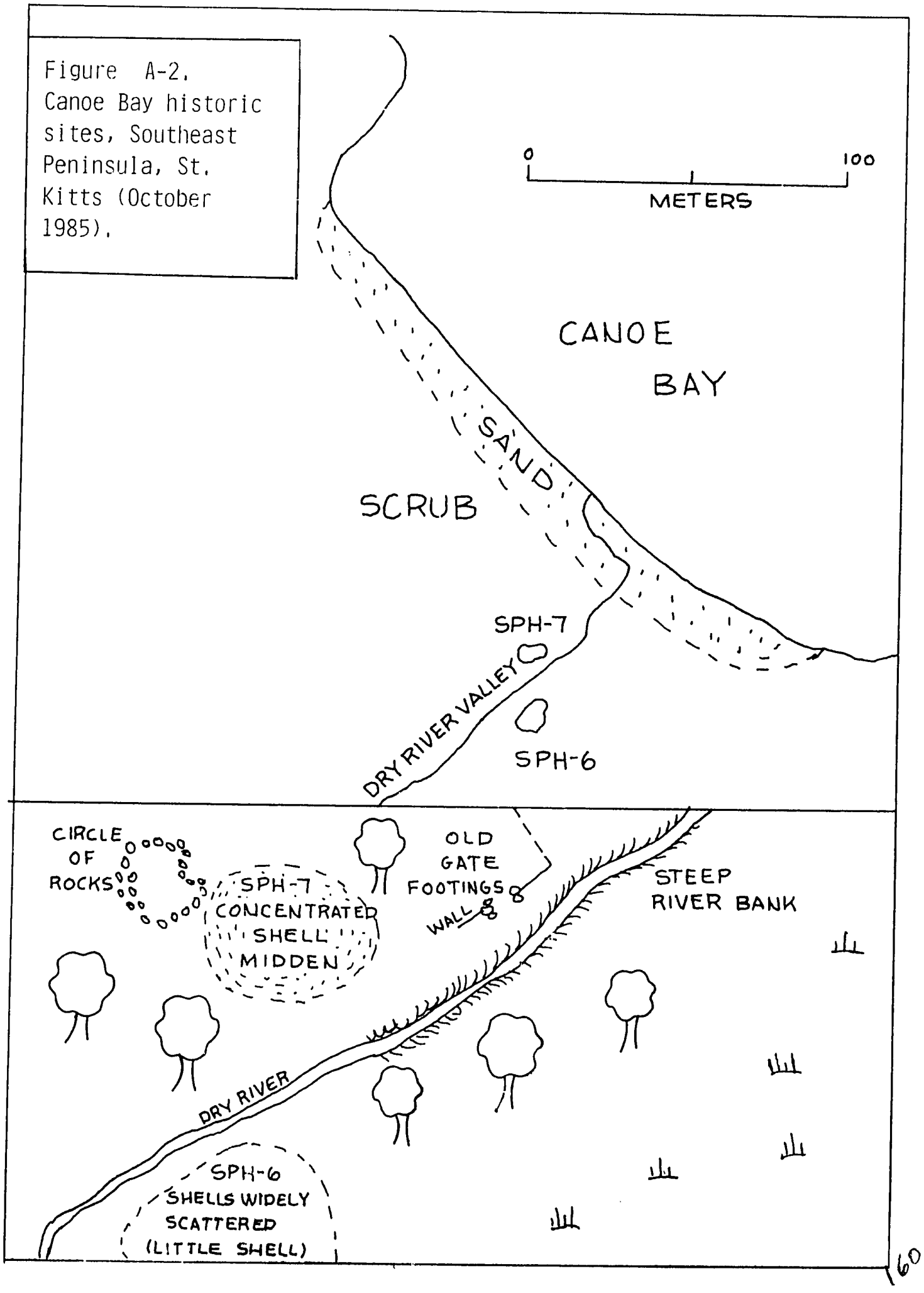


Figure A-2. Canoe Bay historic sites, Southeast Peninsula, St. Kitts (October 1985).

* Any development project in the area of an identified site should be required to incorporate elements of the cultural/historical heritage represented by the specific site. For example, the use of Amerindian style houses as a beach bar, vendor's stall or sports headquarters would add an element of unique local character to development projects and make them more meaningful to visitors and local people. The archaeologist(s) employed to carry out the first recommendation (above) could work with developers in incorporating archaeological/historical features into development plans.

Figure A-3. Site dating documentation, Nicholson archaeological survey of Southeast Peninsula, St. Kitts, October 1985.

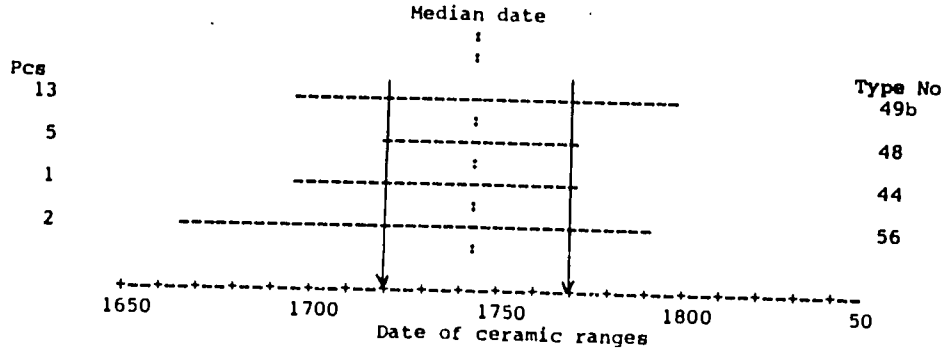
SANDBANK BAY JUNCTION, SPH-2.
All surface sherds collected on 6th Oct 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
2	9 %	Stoneware, grey. Rhenish, sprig molding,manganese.	58	c.1650-1725	
13	57 %	Tin enameled, 18th cent. decorated delftware.	49b	c.1700-1800	1750
5	22 %	Stoneware, white salt glazed. Slip dipped.	48	c.1720-1775	1745
1	4 %	Stoneware, grey, Westerwald, floral, geometric.	44	c.1700-1775	1738
2	9 %	Slipware, lead glazed (combed yellow).	56	c.1670-1795	1733

21 pcs from SANDBANK BAY JUNCTION, SPH-2.
gave a mean date of 1746

BAR GRAPH for SANDBANK BAY JUNCTION, SPH-2.



Theoretical period of occupation is c.1720 to c.1770 .

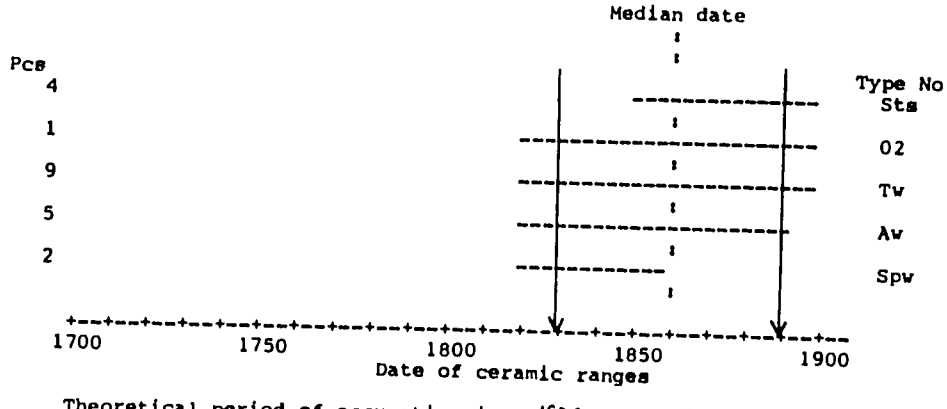
SUGAR LOAF PASS NORTH, SPH-3.
Sample only of surface collection, 6th Oct 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
4	19 %	Earthenware, refined. Stick spatter ware.	Sts	c.1850-1900	1875
1	5 %	Earthenware, refined. General whiteware.	02	c.1820-1900+	1860
9	43 %	Earthenware, refined. Transfer whiteware.	Tw	c.1820-1900+	1860
5	24 %	Earthenware, mocha & annular whiteware.	Aw	c.1820-1890	1855
2	10 %	Earthenware, refined. Sponged ware.	Spw	c.1820-1860	1840

21 pcs from SUGAR LOAF PASS NORTH, SPH-3.
gave a mean date of 1859

BAR GRAPH for SUGAR LOAF PASS NORTH, SPH-3.



Theoretical period of occupation is c.1830 to c.1890 .

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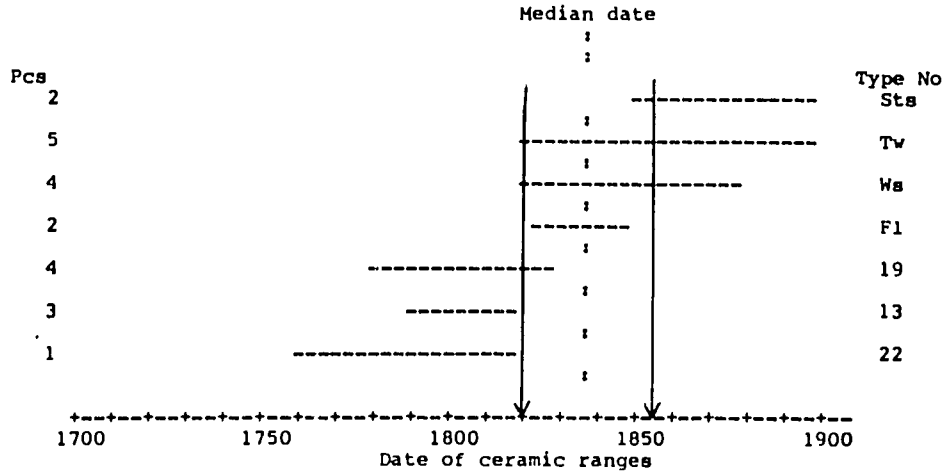
SUGAR LOAF PASS SOUTH, SPH-4.
Sample only of surface collection, 6th Oct 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
2	10 %	Earthenware, refined. Stick spatter ware.	Sts	c.1850-1900	1875
5	24 %	Earthenware, refined. Transfer whiteware.	Tw	c.1820-1900+	1860
4	19 %	Refined, Shell edged & embossed whiteware.	Ws	c.1820-1880	1850
2	10 %	Earthenware, refined. Underglaze p/chrome floral.	Fl	c.1825-1850	1835
4	19 %	Pearlware, blue & grn shell edged.	19	c.1780-1830	1805
3	14 %	Pearlware, annular pearlware.	13	c.1790-1820	1805
1	5 %	Creamware, general c.	22	c.1762-1820	1791

21 pcs from SUGAR LOAF PASS SOUTH, SPH-4.
gave a mean date of 1835

BAR GRAPH for SUGAR LOAF PASS SOUTH, SPH-4.



Theoretical period of occupation is c.1820 to c.1855 .

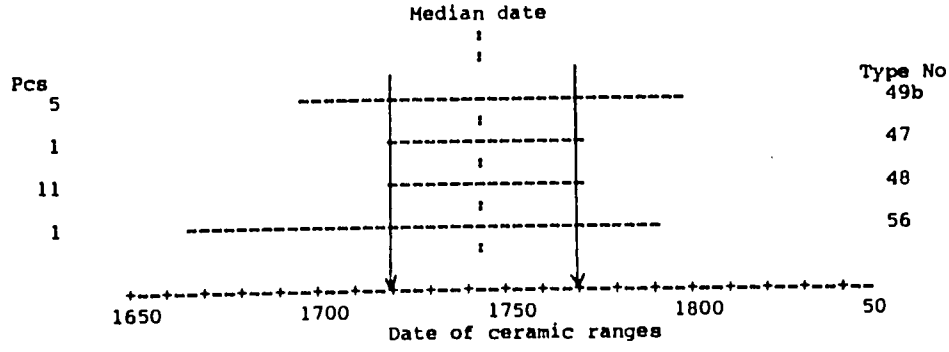
CANOE BAY VALLEY SOUTH, SPH-6.
All surface sherds collected, Oct 7th 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
5	28 %	Tin enameled, 18th cent. decorated delftware.	49b	c.1700-1800	1750
1	6 %	Earthenware, coarse. Buckley ware.	47	c.1720-1775	1748
11	61 %	Stoneware, white salt glazed. Slip dipped	48	c.1720-1775	1745
1	6 %	Slipware, lead glazed (combed yellow).	56	c.1670-1795	1733

18 pcs from CANOE BAY VALLEY SOUTH, SPH-6.
gave a mean date of 1745

BAR GRAPH for CANOE BAY VALLEY SOUTH, SPH-6.



Theoretical period of occupation is c.1710 to c.1770 .

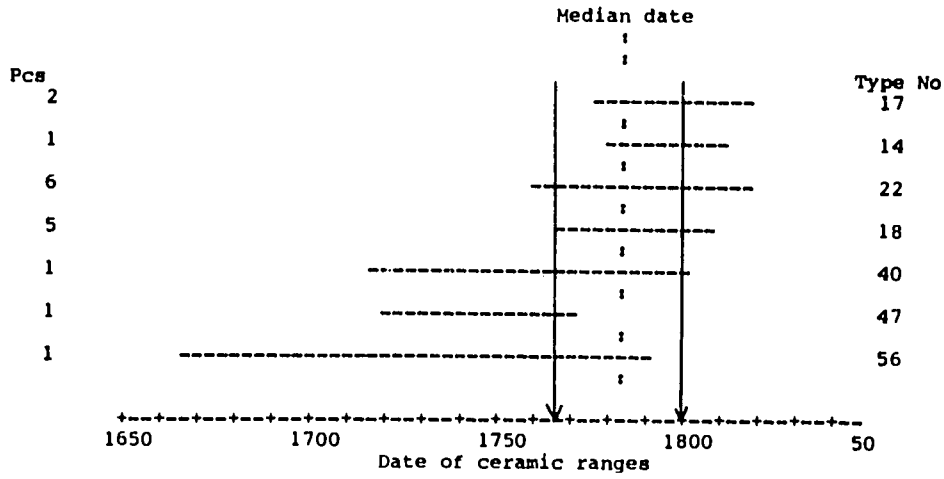
CANOE BAY VALLEY SOUTH, SPH-7.
Surface sample from kitchen midden, 7th Oct 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
1	6 %	Porcelain, Chinese export.	39	c.1660-1800	
2	11 %	Pearlware, underglaze blue hand painted,House & F.	17	c.1780-1820	1800
1	6 %	Creamware, annular c.	14	c.1780-1815	1798
6	33 %	Creamware, general c.	22	c.1762-1820	1791
5	28 %	Creamware, overglaze enamelled hand painted cr.	18	c.1765-1810	1788
1	6 %	Stoneware, white salt glazed. General s.	40	c.1720-1805	1763
1	6 %	Earthenware, coarse. Buckley ware.	47	c.1720-1775	1748
1	6 %	Slipware, lead glazed (combed yellow).	56	c.1670-1795	1733

17 pcs from CANOE BAY VALLEY SOUTH, SPH-7.
gave a mean date of 1784

BAR GRAPH for CANOE BAY VALLEY SOUTH, SPH-7.



Theoretical period of occupation is c.1765 to c.1800 .

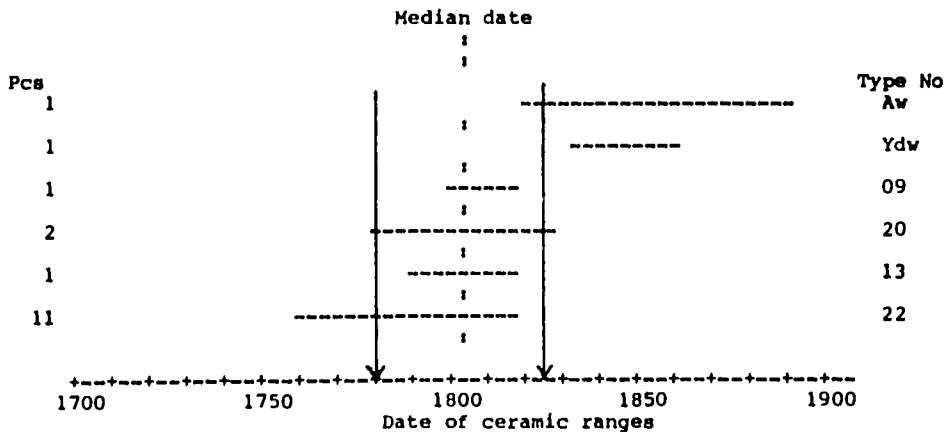
FRIAR'S BAY "FRIARY", SPH-8.
All surface sherds found on Oct 7th 1985.

PERCENTAGE OF CERAMICS COLLECTED AND MEAN DATE

Pcs	%	Description	Type	Range	Mid
1	6 %	Earthenware, mocha & annular whiteware.	Aw	c.1820-1890	1855
1	6 %	Earthenware, refined. Yellow drabware.	Ydw	c.1835-1865	1850
1	6 %	Pearlware, embossed feathers, scales etc.	09	c.1800-1820	1810
2	12 %	Pearlware, undecorated plain p. General p/ware.	20	c.1780-1830	1805
1	6 %	Pearlware, annular pearlware.	13	c.1790-1820	1805
11	65 %	Creamware, general c.	22	c.1762-1820	1791

17 pcs from FRIAR'S BAY "FRIARY", SPH-8.
gave a mean date of 1801

BAR GRAPH for FRIAR'S BAY "FRIARY", SPH-8.



Theoretical period of occupation is c.1780 to c.1815

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APPENDIX B

METHODS USED IN MARINE AREA SURVEYS FOR THE SOUTHEAST PENINSULA ENVIRONMENTAL ASSESSMENT REPORT

Preliminary locations of major marine habitats were established with the aid of aerial photographs obtained from the St. Kitts/Nevis Physical Planning Unit. Interpretations of these photographs were verified by direct visual observation and bathymetric profiles.

Qualitative visual surveys were conducted with the aid of a towed diver sled. Divers wearing snorkelling equipment were towed at about 1.5 kn over depths of 9 - 20 m. Using hand signals, divers communicated bottom type (coral, rock, grass, etc.) to an observer on the boat. At ten to twenty minute intervals, divers returned to the boat to report details of the area covered.

Bathymetric profiles were obtained in selected areas using a Uniden model 250 whiteline chart recorder. Sounding runs were typically begun in depths of 5 - 10 m. The survey vessel was run at constant speed on a constant heading until a depth of 18 - 30 m was reached. Cross bearings on suitable landmarks were taken at the beginning and end of the runs. These data permitted the vessel track to be plotted and the depth recordings transferred to the plot.

Currents were measured with the aid of a drogue constructed from a 1.5 m square of nylon sailcloth, weighted along one side with a length of steel reinforcing rod and supported along the opposite side by a sealed length of plastic pipe. The drogue was attached to a small surface float by approximately 5 m of 6 mm polypropylene line. This design insured that wind would have relatively little effect on the movement of the drogue. In use, the drogue was dropped at the desired starting point and simultaneous notations made of release time and cross bearings on conspicuous landmarks. After an interval, the drogue was recovered, the time noted, and a second set of bearings obtained. The direction and distance of drift were found by plotting the bearings to determined release and recovery positions, and the current velocity calculated by dividing the distance by elapsed time between release and recovery.

The interval between release and recovery must be long enough to provide an measurable drift, but not so long that the drogue is difficult to relocate. Two drogues were lost in the course of this study due to overly long drift intervals. For future work, it is suggested that drift interval be limited to 30 minutes. A variety of alternative drogue designs are also possible. Perhaps the simplest (which has been used with success in St. Lucia and Dominica) consists of a large wicker basket attached to a small surface float. The basket is weighted with stones to achieve a slight negative buoyancy, and the buoy tether adjusted so that the drogue is suspended at the desired depth. Detailed studies of water circulation in bays were not undertaken in this study, but can be accomplished with a combination of drogues and dye markers. The latter provide a visual indication of flow patterns which can be particularly useful when siting effluent outfalls or determining longshore littoral sediment movement.

APPENDIX C

SPECIES LIST
SOUTHEAST PENINSULA MARINE ENVIRONMENT

ANNELIDS
Spirobranchus giganteus
Hermodice carunculata

CNIDARIANS (except corals)
Bartholomea annulata
Condylactis gigantea
Gorgonia flabellum
Gynangium longicauda
Palythoa caribbea
Parazoanthus swiftii
Pseudopterogorgia sp.

CORALS
Agaricia agaricites
A. fragilis
A. nobilis
Colpophyllia natans
Dichocoenia stokesii
Diploria labyrinthiformis
D. strigosa
Eusmilia fastigiata
Isophyllia multiflora
Leptoseris cucullata
Madracis decactis
M. mirabilis
Meandrina meandrites
Montastrea annularis
M. cavernosa
Mussa angulosa
Mycetophyllia danae
M. ferox
M. lamarckiana
Porites astreoides
P. furcata
P. divaricata
Solenastrea hyades

CRUSTACEANS
Stenopus hispidus
Panulirus argus (adults on reefs, juveniles on seagrass)
Periclimenes pedersoni

ECHINODERMS
Diadema antillarum
Echinometra lucunter
Nemaster sp.
Oreaster reticulatus *

FISHES
Pomacentrus partitus
Priacanthus arenatus Cuvier & Valenciennes
Myripristis jacobus Cuvier & Valenciennes
Chromis cyanea (Poey)
Thalassoma bifasciatum (Bloch)
Acanthurus coerulus Bloch & Schneider
Chromis multilineata (Guichenot)
Cephalopholis fulva (L.) 1758
Paranthias furcifer (Cuvier and Valenciennes) 1828
Clepticus parrae (Bloch & Schneider)
Acanthurus chirurgus (Bloch)
Pomacentrus fuscus Cuvier & Valenciennes
Pomacanthus paru (Bloch) 1787
Petrometopon cruentatum (Lacepede)
Synodus intermedius (Spix)
Lutjanus analis (Cuvier & Valenciennes)
Epinephelus striatus (Bloch) 1792
Acanthurus bahianus Castelnau
Halichoeres radiatus (L.)
Abudefduf saxatilis (L.)
Bodianus rufus (L.)
Pseudupeneus maculatus (Bloch) 1793
Holocentrus vexillarius (Poey)
Haemulon aerolineatum
Lactophrys trogonus (L.)
Mulloidichthys martinicus (Cuvier and Valenciennes)
Microspathodon chrysurus (Cuvier & Valenciennes)

MOLLUSCS
Cassis tuberosa *
Charonia variegata *
Codakia orbicularis *
Cyphoma
Pinna carnea *
Spondylus americanus
Strombus gigas *

PORIFERA
Cliona sp.
Iotrochota birotulata

PLANTS
Avrainvillea nigricans *
Caulerpa racemosa *
Codium sp. *
Dictyota sp.
Halimeda opuntia
Penicillus capitatus *
Sargassum sp. *
Syringodium filiforme *
Thalassia testudinum *

* -- *Characteristic of seagrass or algal habitats; others characteristic of coral reef habitats*

APPENDIX D

PROPOSED ENVIRONMENTAL EDUCATION PROGRAMME FOR ST. KITTS-NEVIS

I. INTRODUCTION AND RATIONALE FOR STATE-WIDE ENVIRONMENTAL EDUCATION PROGRAMME.

The effectiveness of any mitigating strategies developed as a result of the current Environmental Assessment and implemented by the Government of St. Kitts-Nevis will depend, to a large measure, upon the priority placed on protection of the natural and physical environment by Kittitians and Nevisians in the face of increased pressures on the resource base and an altered national climate for development.

Measures such as the enactment of legislation, introduction of building and development codes, or establishment of parks and protected areas will only be viable as mitigating exercises to reduce, or negate, the adverse environmental effects of road building, hotel or marina construction if they are implemented methodically.

But in the lesser developed countries of the Eastern Caribbean, environmental concerns are often diminished in importance in the face of more pressing social and economic development issues. Similarly, "resource management" is viewed as an abstract concept, with little bearing on day-to-day life and is given little consideration in national development planning.

In 1980 a questionnaire survey was carried out by UNESCO's Man and the Biosphere Eastern Caribbean Project in four countries (Barbados, St. Kitts-Nevis, St. Vincent and St. Lucia). The objective was to study the relationship between population parameters, development and the environment in the Eastern Caribbean. When questionned about the "perceived seriousness of environmental hazards," respondents -- who were given a list of such hazards and asked to state if they were considered "very serious," or "not a hazard" -- replied as per the information provided in Table D-1. (Note: Information on barbados is deleted from the Table presented.)

It can be noted from this table that perceptions of environmental hazards recorded as "very serious" tended to be confined to those that had either been experienced personally or were of an imminent nature (for example, hurricanes). Infertile soils, landslides, and deforestation were rarely mentioned by respondents on most islands surveyed. The report noted, however, that 73 percent of St. Lucian respondents described deforestation as a "very serious" environmental hazard (compared with 26.4% in St. Vincent and 18% in Nevis, where similar conditions exist); it was suggested that the proportion of St. Lucian

residents who were more aware of the damage done to their environment by rapid deforestation was perhaps indicative of the success of the St. Lucia environmental education programme which has been in place for seven years (summarized in "Environmental Education -- The Keystone to A Successful Conservation Programme?" [Butler, 1983]).

Table D-1. "Very serious" environmental hazard responses in MAB Eastern Caribbean survey, expressed as a percent of total responses.

	St.Kitts	Nevis	St.Vincent	St. Lucia
Hurricanes	79.4	92.2	83.0	79.9
Volcanic Eruption	43.5	82.4	98.7	44.6
Drought	58.3	58.8	50.8	68.2
Infertile Soil	43.9	38.0	33.7	33.4
Landslides	45.4	27.5	47.7	66.6
Floods	53.7	25.5	33.7	55.8
House Fires	67.5	54.0	45.8	50.2
Bush/Cane Fires	75.9	21.6	23.8	25.7
Beach Erosion	43.5	24.0	25.2	44.4
Earthquakes	54.6	80.4	51.8	50.2
Deforestation	43.3	18.0	26.4	73.0

Source: Institute of Social and Economic Research, 1980.

Unfortunately, the low level of environmental awareness in St. Kitts-Nevis was repeatedly referred to during interviews by the EAR team in October of 1985 with Osbourne (P.S., Education), Wharten (Media Centre, Education), Matheson (Brimstone Hill Society), Nisbett (Government Information Service), and Skerritt (Chamber of Industry and Commerce). This is, in part, accounted for by the lack of an environmental education programme in St. Kitts-Nevis as reported in a recent UNEP Regional Seas environmental education publication (UNEP/FAO, 1985) and confirmed by our interviews.

Furthermore, if we were to adapt the list of environmental hazards cited in Table D-1 to be more appropriate to anticipated adverse risks and impacts on the Southeast Peninsula, for example by adding SEP hillside erosion, salt pond eutrophication, sediment impact on corals, toxic and solid wastes, wildlife losses, and sewage and nutrient impacts on coastal water quality -- all with generally less visible, longer term effects -- our index of local environmental perception of the level or seriousness of these risks would be even lower.

Nevertheless, even though the teaching of the natural sciences is restricted to a general science course in the first three years of

secondary school and in the Caribbean Examination Council's single subject courses (biology, chemistry, geography, etc.) run in the fourth and fifth years, the introduction of an environmental education programme in St. Kitts-Nevis has a high potential for success because:

(1) The Permanent Secretary of the Ministry of Education recognizes the importance of environmental education and wants to incorporate it into the curriculum (Osbourne, personal communication, 1985).

(2) A small population base (43,800, 1982, St. Kitts-Nevis [World Bank]) enables programmes to be developed at a low cost and yet reach large segments of the population.

(3) The distribution of age groups is such that a significant proportion of the population is attending some form of academic institution (approximately 40 percent, St. Kitts-Nevis, 1980-81); therefore, environmental education materials introduced into schools will reach a large percentage of the population.

(4) The absence of an adequate number and variety of teaching aids in the local school system (Wharten, personal communication, 1985) makes the production of materials which could be incorporated into the curriculum attractive.

(5) Government controls the State's only television and radio stations (ZIZ), as well as one of the two local newspapers (The Democrat), which would facilitate access for coverage of any proposed environmental outreach efforts.

(6) Independence (1983) has instilled a sense of national pride in the local population, which is is important to the promotion and acceptance of a national resource protection and environmental education programme.

However, it is inadvisable to design an environmental educational programme that pertains exclusively to the Southeast Peninsula because:

(1) The majority of St. Kitts' population resides in or around Basseterre, and few people have ever visited the area of the Peninsula. It would be more effective to begin by cultivating environmental awareness about those issues perceived as more generally relevant and then to move on to more specific concerns.

(2) St. Kitts-Nevis is a twin island state, and the introduction of a major education strategy which identifies itself exclusively with one area or one island runs contrary to Government's policy of integration.

Therefore, it is recommended that a broadly-based environmental education programme should be developed and implemented in St. Kitts-Nevis,

one designed to raise local levels of environmental awareness, to cultivate an appreciation of the importance of local natural and historical resources, and to help ensure that the mitigating strategies recommended in this report are more fully understood and endorsed. However, within the overall programme, specific material should be designed to focus on the Peninsula and a direct effort made to target sections of the population that will affect, or be affected by, the proposed road project or subsequent development activities in the area. The Southeast Peninsula perhaps could be a "demonstration project" within the programme and, at the very least, should be the vehicle by which St. Kitts and Nevis students are encouraged to work together (since the Peninsula is a conceptual bridge between the two and is also used by both Nevisians and Kittitians).

II. DEVELOPMENT OF AN ENVIRONMENTAL EDUCATION PROGRAMME.

The interviews conducted as a part of the Environmental Assessment process (October 1985) revealed that with the exception of the radio and television advertisements produced by the Chamber of Industry and Commerce as part of an anti-litter campaign, there is no existing environmental education programme in St. Kitts-Nevis. This suggests that there is no active local support base for environmental education, and, therefore, Phase One in the formation of a national enironmental education programme should focus on developing local support, perhaps through formation of a "core group." Once established, the core or support group would determine its objectives and means for accomplishment.

It is imperative that local resource personnel be closely involved from the outset in the design of any environmental education programme if it is to have a long-term impact. It has been demonstrated repeatedly that projects with the main impetus coming from outside usually lose their momentum when the external support is withdrawn. It is also important to avoid "putting all eggs in one basket" by sharing programme responsibilities among several individuals or local community groups.

Once a core group has been formed, subsequent steps in programme development could include: (1) identification of testable objectives for Phase Two (2) identification of themes and topics perceived as important; (3) selection of target groups for programme activities; and (4) development of possible tactics or approaches for implementing the programme and for reaching the targeted audience. These might include exposing certain members of the core group to programmes in other islands, defining materials needed, assembling available materials, and determining equipment and supply requirements for producing and disseminating new materials. An evaluation plan, designed to quantify the cost effectiveness of strategies employed, target groups selected, and programmes implemented with regard to an improved information base and attitudinal changes, should also be established.

Phase Two might focus on actual programme implementation. The first step could be to secure necessary funding to carry out the project. Once support has been identified, subsequent activities should include administration of evaluation pre-tests, the production of new materials and implementation of project activities as defined in Phase One.

There are several organizations and individuals who have demonstrated an interest in environmental concerns which might be considered for inclusion in the core working group. For example:

Richard Skerritt, Chamber of Industry and Commerce
Richard Lupinacci, Nevis Historical and Conservation Society
Wesley Wharten, Media Centre
Victor Williams, Planning Unit
Lloyd Matheson, Brimstone Hill Society
Vincent Innis, The Technical College
Claudia Nisbett, Government Information Service
Sidney Osbourne, Ministry of Education
Campbell Evelyn, Ministry of Agriculture.

Once the working group has been formed, specific themes and topics can be identified and ranked according to priority. Some of the themes and topics identified during the course of the Environmental Assessment and relevant to the development of the Southeast Peninsula include:

(1) Litter/Solid Waste Control. The construction of a road to the Southeast Peninsula will inevitably result in increasing numbers of locals and tourists visiting the area for recreational purposes. Extensive public use of the Frigate Bay beaches for example (Towle, et al., 1985) suggests that beach recreation is a favorite pastime of Kittitians on weekends, and it is likely that the Peninsula will become an additional focal point for picnic and swimming excursions. This will conceivably result in an increase in litter which, besides being a visual disturbance, may be a health hazard. Matheson (personal communication, 1985) indicated that at Brimstone Hill the indiscriminate throwing of litter by tourists is a particular problem.

The collection and disposal of solid waste must be carefully planned in road (and subsequent) development schemes. Maynard (personal communication, 1985) indicated that during the Frigate Bay development, construction spoil had been indiscriminately dumped both on the beach and in the bay. For road building activities and subsequent waste disposal planning, educational materials will be required specifically for road/hotel contractors and local and external developers.

(2) Terrestrial and Marine Environments. Protection of marine and terrestrial environments has received very little attention in St. Kitts-Nevis. The only wildlife legislation that exists, aside from a turtle ordinance, covers birds, and this is both outdated and not im-

plemented. Hunting is constrained more by the scarcity of game species and the high cost of ammunition (Evelyn, personal communication, 1985) than by any concern for wildlife preservation. Despite existing legislation (1959 Turtle Ordinance), the taking of turtles and/or their eggs from the beaches is a common practice and was evidenced on Cockleshell, Mosquito and North Friar's Bay (Arendt, 1985).

Natural environments throughout the state are under threat as a result of man's activities, including the drainage of swamps and ponds and the clearing of forests for agriculture and charcoal production (Evelyn, personal communication, 1985). The disturbance resulting from the construction of a road and ancilliary facilities will without doubt have an effect upon the terrestrial and marine ecosystems of the Peninsula. In addition, the resulting destruction of habitat arising from the construction of hotels, condominiums, marinas, etc. will place increased pressure on the feeding and nesting habitat of wildlife species.

While other options may exist, one proven technique for the protection of some species is through the establishment of parks or protected areas. In view of the fact that all land on the Peninsula is privately held, land owners may have to either sell, lease, or donate lands for such purposes. It is, therefore, important to to establish an appropriate educational effort concerning wildlife and the interrelationship between terrestrial, marine and human systems.

(3) Soil/Water Conservation. On an island with a very limited resource base, the importance of soil and water conservation cannot be over-emphasized. Beard (1949) comments, "In general the well wooded appearance of the central mountains of St. Kitts does not unfortunately mean that they were covered in heavy forest." He indicates that the opposite is the case, "with trees usually being of small size, principally due to the natural prevalence of elfin woodland and palm break; and in part due to past interference by man, where the slopes were formerly cultivated to a greater height than now, and succession to high forest is not yet complete." With particular reference to the Peninsula, Beard notes that "the hills of the South-East Peninsula were probably forested at one time, presumably with deciduous seasonal forest, but constant cutting had reduced this to a low thicket of variable stature and composition."

It is likely that past deforestation resulted in considerable soil erosion, and it is equally likely that the construction of the road will lead to a similar scenario. Unless mitigating measures are introduced during road construction, much of the soil lost will end up in the sea, smothering and perhaps killing the reefs which are critical for providing: (a) food, shelter, breeding and nursery space for valuable food species and other marine organisms; (b) a physical barrier for beach protection and nourishment; (c) recreational areas for tourists and locals; (d) biological diversity.

While recommendations for remedial measures form a part of the EAR, implementation of such measures will be left largely in the hands of contractors and/or Government personnel. It is, therefore, essential that the proposed environmental education programme emphasize the importance of taking preventative measures to protect against soil erosion and its consequential impacts. Since vegetative cover also serves a critical function in maintaining the water-holding capacity of soils and in protecting watersheds, the concepts of deforestation, re-forestation, and afforestation should be introduced as a part of the overall environmental education programme.

(4) Standards and Criteria for Development. In its broadest sense, the environment is managed by people. Policies, legislative acts, and codes of conduct are laid down by political decision-makers. It is important that the content and implication of such environmental standards and regulations be effectively disseminated and understood by construction personnel, architects, builders, tourism facility planners and others engaged in development activities which impact upon the natural and built environment, in order to encourage full implementation and compliance.

[Note: The above are not comprehensive nor listed in order of priority. Environmental education should be viewed as a concept broad and flexible enough to encompass additional themes or topics to be introduced as and when required.]

Following selection of suitable issues and themes to be addressed, an appropriate next step in the development of an Environmental Education Programme would be to identify target or "client" groups for programme activities and the strategies or tactics to be used to reach them. The four primary target groups recommended by the study team are: (1) schools, (2) the general public, (3) developers/contractors, and (4) decision makers. While it is impossible to know which tactics or approaches will be selected by the core working group, several strategies have been used successfully in environmental education programmes in St. Lucia and Dominica. Some of these were discussed by the study team in interviews (October 1985), but they are by no means the only available options for consideration in development of a St. Kitts-Nevis programme.

Target Group One: Schools and Academic Institutions.

(1) Composition of Target Group:

-- There are 17 Government primary schools on St. Kitts, 9 on Nevis, as well as 5 private schools on St. Kitts and 3 on Nevis, with a combined enrollment of approximately 12,000 (Osbourne, personal communication, 1985).

-- There are four Government and two private secondary schools in St. Kitts and two Government and one private secondary school on Nevis, with a total enrollment of approximately 6,200 (Osbourne, personal communication, 1985).

-- There are two tertiary academic institutions in the state (Teachers Training College and Technical College), with an enrollment of approximately 220 (Osbourne, personal communication, 1985).

-- There are three vocational schools (deaf, blind, and handicapped).

(2) Objective. To introduce environmental education into the school system.

(3) Proposed Tactics.

-- A one-day workshop for teachers could be held, the objective of which will be to introduce them to environmental education and to seek their participation in the design of relevant materials for St. Kitts-Nevis.

-- A series of printed teaching aids could be produced and distributed to all schools. Topics might include:

(i) The Southeast Peninsula of St. Kitts: Its Physical and Natural Environment

(ii) The Marine Environment of St. Kitts-Nevis

(iii) Fauna and Flora of St. Kitts-Nevis

(iv) Litter Control

(v) Soil/Water Conservation

Sample literature which has been produced by the St. Lucia Environmental Education Programme might be secured as prototypes.

-- Slide-tape presentations could be designed and produced on general environmental issues for use in schools.

-- Field trips, e.g., to the Southeast Peninsula (with guides/interpreters).

-- Poster competitions could be held.

-- Students entering the Caribbean Examination Council syllabus could be encouraged to complete projects on the environment in general and on the Peninsula in particular.

(4) Comments/Constraints. The Permanent Secretary in the Ministry of Education has indicated his full support for an en environment education programme and further indicated that such an effort was needed in St. Kitts-Nevis.

A new Media Centre, headed by Mr. W. Wharton, has been established within the Ministry of Edcuation. The Centre's objective is to produce educational materials for schools, but at present the facility lacks equipment, including video equipment and printing capabilities.

The Media Centre could be one vehicle for the introduction of environmental education in schools. It might be useful for Media Centre personnel to undertake a short attachment course in St. Lucia and/or Dominica to expose them to environmental education tactics which have worked on other islands.

Target Group Two: The General Public.

(1) Composition of Target Group. Local business persons, recreational and other community groups, divers, fishermen, marine resource users, hunters.

(2) Objective. To increase the general public's level of environmental awareness and to introduce the concept of sustainable use of natural resources as an integral component of national development.

(3) Proposed Tactics.

-- In conjunction with the Government Information Service and/or the Media Centre, series of ten minute radio programmes could be produced for airing on ZIZ Radio. Topics could include:

(i) Landscape zones of St. Kitts (see "Development Guidelines for St. Kitts" by J. Bebb and S. Ervin)

(ii) Litter and Solid Waste Disposal

(iii) Fauna and Flora of St. Kitts-Nevis, including marine resources

(iv) The Southeast Peninsula

(v) Resource Legislation.

The series could conclude with a radio "telephone-in" programme.

-- The winning poster produced in the schools competition could be replicated and distributed throughout the State. In addition, the winning poster design could be used as a central theme in a stamp issue examining the life zones of St. Kitts-Nevis. (Fraites [Philatelic Bureau, personal communication, 1985] gave full support for this idea and suggested that the set comprise three stamps. He indicated that once approval had been received from the Postmistress and Cabinet, this proposed activity could be integrated into the formal stamp-issuing schedule. He foresaw no difficulty in securing such approval.)

-- The printed educational materials outlined above could be replicated and inserted in a National Newspaper as a monthly educational series.

-- The Chamber of Commerce has indicated its willingness to co-operate in any way it can and might possibly provide funding for certain environmental education materials, such as newspaper inserts.

-- The slide-tape presentation described for school use could also be shown to community and church groups, and other interested bodies.

(4) Comments/Constraints. Wharten (personal communication, 1985) indicated that Government had an agreement with the Cable Television Network to allocate a channel for educational use. At present, this is not used due to a lack of materials, but this outlet should be investigated and utilized where possible.

Target Group Three: Contractors and Other Developers

(1) Composition of Target Group. Architects, engineers, planners, designers, road and hotel contractors, and local and external developers involved in construction work in St. Kitts-Nevis in general and for the Southeast Peninsula in particular.

(2) Objectives. To disseminate the regulations pertaining to development to those persons involved in construction work in St. Kitts-Nevis, including landowners, developers, contractors, architects, engineers, etc., and to provide information on permit requirements, existing legislation, and guidelines for environmentally sound project design. Types of uses and sites which present varying types and degrees of environmental problems, as well as more environmentally sensitive siting, design, and construction practices will be outlined.

(3) Tactics. A "developers' handbook" could be prepared, in conjunction with local resource personnel, for distribution to the target audience outlined above and might include (see, for example, "Handbook for Homebuilders and Developers" as prepared by the U.S. Virgin Islands Coastal Zone Management Program):

-- Guidelines on site suitability and appropriate system-specific development strategies, including environmentally sensitive features such as salt ponds, mangroves, sea grass beds, coral reefs, coastal waters, wildlife habitats, eroding shorelines, flood-prone areas, sand beaches, and historical/archaeological features.

-- Guidelines for erosion, sedimentation and storm run-off control, as well as for aesthetic quality and energy conservation.

-- Guidelines for specific uses to include commercial uses, waste disposal and transportation facilities, marinas, recreational facilities, piers, and ramps.

-- Outline of permitting requirements and existing legislation.

(4) Comments and Constraints. It is recommended that the proposed handbook be produced by an external agency in conjunction with the St. Kitts-Nevis Planning Office and other local resource personnel.

Target Group Four: Decision Makers.

(1) Composition of Target Group. Ministers of Government and other government officials or career civil servants who will survive elections and will serve as advisory personnel to ministers.

(2) Objective. To sensitise politicians and other government officials to environmental issues and their importance in national development strategies.

(3) Tactics. Briefings and an executive summary of the "developers' handbook" could be provided for public officials. Video tapes on critical environmental issues might also be prepared and shown to ministers and other government officials in their offices, rather than in a large group setting.

III. REQUIREMENTS FOR A NATIONAL ENVIRONMENTAL EDUCATION PROGRAMME FOR ST. KITTS-NEVIS.

Note: It is recommended that the National Environmental Education Programme be put in place and become operational prior to commencement of road construction activities for the Southeast Peninsula.

Phase I Anticipated Programme Costs (all figures quoted in US $):

Personnel	
Coordinator --on site for entire Phase; salary for 3 person months	$ 4,000
Travel and per diem	
Selected members of the core group -- airfares to SLU and DOM for exposure to environmental education programmes in those countries and per diem	3,000
Postage, Phone, Secretarial, Supplies	1,000
	$ 8,000

Phase II Estimated Programme Costs:

Personnel	
Coordinator -- 2 person months	2,500
Materials (reference texts: science, art, design, media, etc. plus other relevant environmental education materials)	1,500
Production of materials	
Newspaper inserts (6 per year)	3,000
Simple printed materials (estimated: 20,000 at .05/pg.)	3,000
Photographic production (slides, prints, posters)	2,500
Video production	2,500
Equipment	2,000
Local transport	1,000

Short-term consultants	
Honoraria (20 days @ $150/day)	3,000
Travel	2,000
Per diem	2,000
Secretarial, Layout, Graphics Services	3,000
TOTAL PHASE II	$ 28,000

If and when a National Park, Nature Reserve or Protected Areas Programme is established, a second set of environmental education materials will be required. Until such time when the extent and nature of the park is known, it is difficult to be specific as to appropriate environmental education programme requirements. However, signs indicating "no littering" and "no dumping and waste" will be required at roadsides and at scenic viewpoints.

An interpretive centre to include information on the natural, physical, and historical features of the Southeast Peninsula will enhance the educational value of the area for residents and visitors alike. Attached to such an interpretive centre could be a resturant or snack bar, and the unit (constructed by Government) could be leased to a private individual or group. Any nature trails established within a park would require the production of interpretive leaflets, signboards and trail markers. It is strongly recommended that once a park has been demarcated and established a comprehensive Management Plan be drawn up to identify specific manpower, material and financial requirements for the effective interpretation and management of the area.

Individuals who are aware of their surroundings and who feel a sense of pride in their natural environment are less likely to take actions to harm those natural features which enhance the quality of their lives. The national environmental education programme outlined herein is designed to alter attitudes and perceptions about the environment in which the local community lives and works. In a country with a limited resource base, high unemployment and a low GDP, it is naive to expect Government not to proceed to implement any project that is perceived as being able to achieve diversity of development, generate employment and raise local revenues. However, without sufficient environmental awareness and an action programme in place to ensure continued educational outreach both in the formal school system and to the general public, the long term effects of many development activities can be devastating to the natural, physical, and historical resource base.

APPENDIX E

REVIEW OF ST. KITTS-NEVIS ENVIRONMENTAL LEGISLATION RELEVANT TO THE DEVELOPMENT OF THE SOUTHEAST PENINSULA

The Petroleum Act (Chapter 301, 6 November, 1951).

This law makes provision for the importation, storage and exportation of volatile petroleum, kerosene, diesel and gas oil. The concern seems principally to avoid the incidence of fires, and no provision is made for dealing with possible damage to any land, water supply or the sea and marine environment by a failure to transport or to store the commodity safely.

The Wild Birds Protection Ordinance (Chapter 113, 3 November, 1913).

This law has as its main purpose the protection of wild birds which are specified in two schedules. Schedule A contains a list of eighteen protected birds, and the law places an absolute prohibition on interferring with them. It is a criminal offence to kill, wound or take them, to expose them for sale, or even to have them in one's possesion. In addition, one may not take, remove, injure or destroy their nests or eggs, and it is also forbidden to export or attempt to export their skins, plumage or nests.

The birds listed in Schedule B (nine in number) may be hunted except during the closed season which extends from 1st February to 15th July in each year. The Minister may vary the closed season by publishing a proclamation to that effect in the Gazette and also in a newspaper circulating in the State. If a person is found in possession of such a bird or its nest or eggs, the onus is on him to prove that he has not committed an offence against the law.

The penalty for a contravention of the law is remarkably small by present standards, and the ubiquitous "informer" may even claim a half of the penalty paid by an offender. The following provisions of the legislation are particularly relevant, either by virtue of their oversights or inclusions: (a) the exclusion of certain species (only 26 of the 72 species recorded on the island are covered), (b) the inclusion of others which are not recorded in St. Kitts, (c) the low penalties, and (d) the failure of the dates during which the hunting season is regarded as closed to reflect nesting periods accurately.

The legislation as drafted seems competent to deal with all these shortcomings if there is the will in the administrators of the law to take the necessary action. Section 14 empowers the Minister to add to or remove the name of any bird from either of the two schedules, and he may also vary the closed season in respect of any bird listed in Schedule B (S.13), so that by regulation made subsequently, the closed

season for the mountain dove extends from 31st October to 9th August (in Nevis from 16th December to 14th October); partridge from 1st February to 15th July; and wild pigeon, 1st January to 30th September. The fine which is ridiculously low was increased from EC$24.00 to EC$100.00 in 1976, but any further change must be effected by an Act of the State's parliament.

A more comprehensive Wildlife Protection Act should be drawn up to include birds, mammals, and reptiles. Copies of the St. Lucia and Dominica legislation should be secured as models.

The Forestry Ordinance (Chapter 92, 15 July, 1904).

This Ordinance, which was passed in 1904, attempted to prevent deforestation and encourage reforestation. The law was originally administered by two Forestry Boards, one located in St. Christopher and the other in Nevis. These were abolished in 1976.

In order to discourage and prevent deforestation, it was forbidden to clear away forest land or to cut or fell timber without a written permit. Exceptions were made to permit the cutting and felling of timber found growing on sugar estates for purposes connected with those estates; and one general exception permitted timber to be cut and felled -- subject to regulations to be made -- if that timber was to be sold for domestic use, or for the use by bakeries, potteries, lime businesses, the ice factory or any public institution.

The regulations which were made in 1927, in respect of St. Christopher, only provided that no trees were to be cut even for those limited purposes without a written permit, which had to be applied for in a specified form. Further, even where an application had been approved, the trees had first to be inspected by a forest ranger.

No charcoal may be burned without a written permit which is to be issued free of charge and remain in force for one year. The application for such permit must be made in the prescribed form, but the grant of a permit does not authorise the exportation of the coal from the State without a further written permit.

The provisions which apply to reforestation are contained in Part III and are even more stringent. The Cabinet may simply declare by resolution that an estate is subject to the provisions of Part III. "Estate" is defined to mean any plantation, property or lands -- a meaning which is much wider than the word is commonly understood.

After an estate has been declared to be subject to Part III of the law, the following procedure takes effect:

(a) A scheme is prepared by the Chief Agricultural Officer. This scheme which must include plans, specifications and estimates of cost are forwarded to the Minister.

(b) The general public is to be notified as to the time, when and place where the plan, etc. may be inspected. This notice must be given in at least one newspaper circulating in the State.

(c) The scheme must remain available for public inspection for a period of at least three months after which the plans, etc. and the objectives, if any, are submitted to the Cabinet. Any person who is likely to suffer loss by the execution of the scheme must lodge an objection within this time limit, quantifying his estimated loss.

(d) After considering the scheme and hearing the objectors -- if this is deemed necessary -- the scheme is confirmed and becomes binding after it has been published in at least one newspaper circulating in the State. However, no cultivated or pasture land may be reforested without the written consent of the owner.

After a scheme has been approved, the work must be carried out by the owner of the estate under the supervision of the Ministry of Agriculture, and he is to be paid for carrying out the reforestation work.

A provision which empowered the Board to execute the work if the owner refused or neglected to do so was repealed in 1976. The Minister may remit the land tax payable on land which is being reforested for such period as he thinks fit -- a very salutary provision against an increasing tendency to deplete the forests for burning charcoal on the one hand, and the determination of Government to ensure that systematic reforestation takes place, on the other.

The regulations were made in 1924, 1927, and 1940. As noted, the 1927 regulations applied solely to St. Christopher and were intended to provide a licensing requirement for the cutting of land for fuel. Earlier in 1924 regulations were made, again confined to St. Christopher, to control the burning of charcoal. Both these regulations were consolidated when made to apply to Nevis in 1940. The law in Nevis is, therefore, almost identical to that which applies in St. Christopher.

The law provides very strict regulations to control the burning of charcoal and the setting of fires generally. In cases where supervision is lacking, indiscriminate setting of fires has caused destruction to nearby forests and trees, e.g., in the Southeast Peninsula. The construction of a road will no doubt assist in stemming this practice as it will provide the forest rangers or wardens with access to hitherto inaccessible areas.

All persons who wish to burn charcoal must apply in writing for a permit. The application must state the number of bags of coal it is in-

tended to produce, the number of trees it is intended to fell and the location where it is intended to burn the coal. The intention clearly is that no coal burning should take place in the areas reserved for forests. Before any tree is felled, it must be inspected and marked by a forest ranger, and there must be a distance of at least ten yards from any two trees to be felled. Further, every person who is engaged in burning coal must carry the permit with him to be produced on demand to a forest official (and to a police officer in Nevis).

In order to provide further protection to the forest areas, it is forbidden to burn grass, brushwood or other material within 100 yards of the fringe or skirt of the forest unless notice has been given to a forest ranger, who should then have the land inspected in order to ensure that preparations have been made for the protection of the forest by destruction by fire. Further precautions include that there must be two males of full age present who are to take up positions between the fire and the forest, armed with sticks or spades to beat out the fire if it spreads. The material to be burnt must be gathered in heaps at least 100 yards away from the forest, and a corridor or belt 50 feet wide must be cleared between the fire and the forest in order to prevent the spread of the fire.

The fine for breach of the provisions of the Forestry Law which was originally EC$24.00 was increased to EC$100.00 in 1976. A further and substantial increase is overdue when one considers the potential damage which is likely to be caused and is, in fact, being caused in certain areas of the State by indiscriminate burning of coal and wood and because of the lucrative returns of the coal business. Supervision by forestry officials also needs to be greatly strengthened.

The Building Ordinance (Chapter 284, 22 April, 1943).

This law applies only to such places or areas within the State as may be published in the Gazette. The only publication in force is St. Kitts Ordinance 42/1978 as three previous proclamations have all been repealed. Its provisions are to be administered by a Building Board which is charged with the responsibility to determine applications made in respect of building work.

The Board may relax the requirements laid down in the Building Regulations. It may also require the removal or alteration of work which has not been undertaken in conformity with the regulations. For these purposes, it is empowered to inspect any work between the hours of 9 a.m. and 6 p.m. of any working day.

The Minister may make regulations with respect to the construction, siting, layout, design, drainage, sanitation and removal of buildings, and also the supply of water and electricity to buildings.

Public Parks Regulation Ordinance (Chapter 304, 11 October, 1944).

This law empowers the Minister to make regulations for the protection, management, and good government of any public park.

The regulations may provide for the appointment of a committee to manage and control the park, to appoint park keepers, and to regulate the use to which such parks may be put.

The provisions extend to the following parks:

1. Warner Park
2. Pall Mall Square (now Independence Square)
3. Sandy Point Recreation Ground
4. Grove Park
5. Verchilds Playing Field
6. Garden Playing Field.

This law could be used to regulate any open spaces and other recreational areas set aside for that purpose in the Southeast Peninsula, but it is clearly not intended to apply to preservation areas such as the proposed Brimstone Hill National Park or to such other similar areas in the Peninsula which may need to be designated for preservation because of environmental concerns.

Although the Forestry Ordinance empowers the Minister to undertake reforestation work, it was noted above that this cannot be done on private land without the previous written consent of the owner. Even where this permission will have been obtained, it may still be necessary to preserve the restored areas in their new state.

Some excellent voluntary work has already been undertaken by the Society for the Preservation of Brimstone Hill, and that particular area is about to be designated a national park under the name of the Brimstone Hill Fortress National Park. Legislation is contemplated to give effect to this decision.

There is need for some general legislation, under the umbrella of which all such present and future preservation areas could be accommodated, while having their own separate rules and management bodies. The recommendation here is for an umbrella National Trust Act. The name is quite suitable as all the areas which will fall to be formed under its provisions are being held in trust for future generations of the State. This could be based on a St. Lucia Act of the same name. The Trust should be empowered to make rules for the conduct of its business; and, after being requested to do so by any management body which controls a national park or other similar "protected area" (such as a wildlife reserve, a marine park, or a scenic park) could incorporate the area under the aegis of the Trust. In effect, the area would be vested in the Trust which would establish policy for its operational management by the existing body (which could be a unit of

government or a non-government entity like the Brimstone Hill Society). The executive members of the separate bodies could form the nucleus of the membership of the Board of such a National Trust, which would, however, by design maintain a balance of government and private sector representation of the highest calibre and technical competence.

Roads Ordinance (Chapter 268 (5 July, 1912).

The Roads Ordinance is the law which regulates the declaration, maintenance, and abandonment of roads in the State. A road is defined to mean any public road or street and includes any roadway, bridle-path, lane, causeway, footpath, or bridge.

The Minister may declare that any road or part thereof be constructed and maintained at the public expense out of moneys provided by Parliament; and may also in similar fashion abandon and cease to maintain any road. All roads and all land taken for their construction are the property of the Government. Further, whenever a private road is repaired at the public expense with the written consent of the owner, it is thereafter to be taken and used as a public road for all purposes whatsoever.

Land Development (Control) Ordinance (No. 15 of 1966, 24 September, 1966).

As its name implies, this law controls the development of land in the State. Notwithstanding the provisions of any other law to the contrary, no development of any land in the State may be commenced without the prior written permission of the Minister.

Development is deemed to have commenced if any of the following have been done:

(a) laying out of roads;
(b) laying of water pipes;
(c) clearing or levelling land;
(d) filling of ravines or swamps;
(e) any other preparatory work which indicates an intention to improve land or increase its value or to make it ready for:

  (i) the development of housing estates
  (ii) the development of more than 9 house lots of land for sale
  (iii) hotel development
  (iv) the development of apartment buildings, or
  (v) the development of beach facilities.

The application must be made to the Minister in the prescribed form, and where he refuses, he must give reasons for the refusal. Development must be in accordance with the approved plans, and any owner who commences development in contravention of the law is guilty of an offence.

A UNDP Physical Planning report on the environment in St. Kitts-Nevis (dated 1975/1976) made the following recommendations:

(a) Introduction of (i) a Land Development Control Act, 1976; (ii) Legislation for the Protection of the Environment.

(b) Preservation of historic buildings.

(c) Designation of areas as National and Marine Parks.

A draft Protection of the Environment Act, 1975, is attached to the Report as Appendix A. This draft attempted to provide for the listing and preservation of historic buildings; the control of cultural property (which was very widely defined); and the establishment of National or Marine Parks.

No action has been taken on the draft. The ideas contained therein do, however, seem well intentioned and worthy of follow-up action. It is felt that the comments made to the Land Development Control Ordinance should be focused and a new Environmental Protection Act should be drafted and passed. Special legislation should be passed to preserve historic buildings, and the Barbados Act could be used for reference. National Parks should be created under the umbrella of a new National Trust Act; and Marine Parks could be established under the provisions of the new Fisheries Act.

Town and Country Planning Ordinance (Chapter 264, 1 January, 1949).

The duty of carrying out the provisions of this Ordinance rests with the Central Housing and Planning Authority established under the provisions of the Slum Clearance and Housing Ordinance, Chapter 263. For the pruposes of this law, the Authority may prepare or adopt and approve of schemes for development of land.

Since Government owns no land in the Southeast Peninsula and does not intend, as at present advised, to purchase land for or to expend money on development there, the provisions of this law will not apply to any development undertaken solely by private individuals and at their own expense. The "Betterment" provisions contained in Section 31 could, however, be recovered by reason of the fact that a road and various utilities will be provided by Government to enable development to take place.

Beach Control Ordinance (Chapter 281, 30 September, 1961).

This law vested in the Crown, subject to certain limited exceptions, all rights in or over the foreshore and the floor of the sea. In so far as it tends to make provisions governing the floor of the sea, these provisions would seem to be superceded by the provisions of the Maritime Areas Act, No. 3 of 1984; or at the very least the two laws must be read together since that area falls within the interpretation of the "internal waters" of the State.

Land adjoining the foreshore extends to a distance of fifty yards beyond the landward limit of the foreshore or beyond the high water mark. It is forbidden to use the foreshore or the floor of the sea for any public purpose or in connection with any trade, business or commercial enterprise without a license. A commercial enterprise includes the business of carrying on a hotel or a proprietary club, and the erection, construction or maintenance of any dock, wharf, pier, jetty or other form of encroachment.

In granting a license for the use of the foreshore or the floor of the sea, the Minister must consider the public interests in regard to fishing, bathing, recreation or the future development of adjoining land, and he may provide for the protection of those interests in the terms of the license which is being issued by him. Such terms and conditions would necessarily include proper provisions for sanitation and the disposal of effluent, although these are not specifically mentioned in the body of the law. There should also be power to prevent the disposal of rubbish, litter, etc. on the beach or into the sea. This should be dealt with by regulations to be made under the provisions of the law.

In determining, and making provisions for, the needs of the public in relation to the use of the foreshore and for any adjoining land, the Minister may acquire land or rights in or over land either in perpetuity or for an indefinite period on a year to year basis, paying therefor compensation or an annual rent charge as the case may be.

The Minister has power to make regulations, but none have so far been made. In drafting regulations, therefore, all environmental concerns ought to be addressed. This area of law needs to be brought into harmony with the two other Acts which have already been passed viz., the Maritime Areas Act and the Fisheries Act.

The power of the Minister to make regulations includes such areas as: (a) securing the observance of sanitary and cleanly conditions and practices on the foreshore, adjoining lands and parts of the sea; and (b) controlling the erection or placing on any beach or adjoining land of bath-houses, huts, booths, tents, sheds, stands, and stalls (whether fixed or moveable).

In both instances, however, the power to make regulations is confined to areas "to which members of the public habitually resort." It is recommended that this power should be exerciseable in respect of any beach and any adjoining land.

Special mention must be made of the "berm" which lies on the landward section of the beach. In many cases, large stretches of berm are covered by vegetation, and this serves as a form of natural protection to the beach itself since it is more difficult, in stormy weather, for the entire sand area to be eroded. This also provides protection to buildings constructed on the beach or on adjoining land. In addition, the vegetation limits considerably the effect which the wind would normally have in moving large areas of sand, thus exposing low lying areas further inland to flooding.

Administrative arrangements should be made to police whatever regulations are made, and the penalties for breach should be more consistent with the harm done and damage caused. The removal of sand from the beach should be strictly controlled and very closely monitored.

Fisheries Ordinance (Chapter 91, 19 August, 1961).

This law has been repealed by the Fisheries Act, No. 4 of 1984. The regulations which were made under the provisions of the old law have, however, been saved since the new regulations are still being circulated for comment.

Turtle Ordinance (Chapter 99, 1 January, 1948).

This law was repealed by the Fisheries Act.

No regulations were made under its provisions and, in fact, there was no power in the parent law to make regulations.

Pesticides Act (No. 20 of 1973, 1 February, 1974).

This law which empowers the Minister to make regulations on a variety of matters does not make specific provision for the disposal of pesticides or other waste matter which may contain traces of pesticides.

A minor amendment only is required to empower the Minister to ensure that pesticides are not disposed of anywhere in which they could contaminate sources of water or the air or the environment generally.

Maritime Areas Act (No. 3 of 1984).

This is a law to make provision with respect to the territorial sea and the continental shelf of the State, and to establish a contiguous zone and an exclusive economic zone adjacent to and beyond the territorial sea.

The baseline is to be measured from the low water mark along the coast of the State. The territorial sea extends to a distance of twelve nautical miles from its baseline. The contiguous zone is 24 nautical miles outwards from the baseline; and the exclusive economic zone (EEZ) and the continental shelf both extend to a distance of 200 nautical miles from the baseline.

The law provides for controls with respect to sanitation, pollution, and the protection and preservation of the marine environment within these areas. The Minister is authorised to make regulations prescribing measures for the protection and preservation of the marine environment of the territorial sea. These regulations are now being drafted and will shortly be circulated for comment; but they await a proper delimitation of the zones and areas mentioned above. Both the FAO and the Commonwealth Fund for Technical Cooperation (CFTC) have expressed a willingness to assist through the auspices of the Secretariat of the Organisation of Eastern Caribbean States (OECS), which is based in St. Lucia.

Marine Pollution Prevention (Draft Bill).

This is a preliminary draft of a law which, it is intended, will provide for the prevention, reduction, and control of pollution in the waters of the State and to give effect to the provisions of international conventions on the matter. It is being circulated for comment.

Although its provisions are mainly meant to apply to the territorial sea, the contiguous zone, the exclusive economic zone and the continental shelf, provision is also made for civil liability in respect of pollution of the foreshore of the State or of any interests related thereto, so that sewer outfalls may be controlled under this law. A related interest is defined to include:

(i) marine, coastal, port estuarine or fisheries activities;
(ii) the promotion of tourism and the preservation and development of tourist attractions in the waters or on the foreshore, beaches and coral reefs;
(iii) the health of the coastal population and their well-being; and
(iv) the protection and conservation of living marine resources.

A Competent Authority is to be appointed for the monitoring of marine pollution. The draft Bill has designated for the time being the Chairman in charge of the Committee established for Disaster Preparedness as the Competent Authority.

The main functions of the Competent Authority are:

(i) to administer and implement the policies and objectives of the Pollution Contingency Plan of the State;
(ii) to co-operate in the taking of measures to respond to pollution emergencies;
(iii) to assess the environmental impact and the effects of any projects on the marine environment;
(iv) to provide training facilties to persons connected with the prevention and reduction of marine pollution.

Fisheries Act (No. 4 of 1984) and Draft Fisheries Regulations.

This law has been passed, among other things, to provide an institutional framework for the management, planning, development and conservation of fishery resources in the State. It has repealed both the Fisheries Act (Chapter 91) and the Turtle Ordinance (Cahpter 99); but it saves the regulations which had been made under the provisions of the earlier fisheries law, until the present draft regulations have been brought into force.

The administration of this law is the responsibility of a Fisheries Advisory Committee. The Minister may establish fishing priority areas in order to ensure that local fishermen are not disturbed in those areas. He may declare any suitable area to be a marine reserve, and prohibit any activity in that area without permission in an effort to afford special protection to the flora and fauna of such areas; and he may grant permission to undertake research into fisheries.

Certain fishing methods are prohibited. It is, therefore, an offence to use or attempt to use any explosive, poison or other noxious substance for the purpose of killing, stunning or catching any fish. It is also an offence to use certain prohibited fishing gear. These are listed as:

(i) Any net, the mesh size of which does not conform to the minimum size for that type of net; and
(ii) any trap or other fishing gear which does not conform to the minimum standard set for that purpose.

The Minister is empowered to make regulations for the following purposes, among others:

(a) regulating sport fishing;
(b) regulating the use of Scuba gear, hookah gear, spear guns or other similar devices;
(c) prescribing measures for the protection of turtles, lobsters, and conchs;
(d) prescribing management and conservation measures including minimum species sizes, closed seasons, closed areas, and prohibited methods of fishing and fishing gear;
(e) regulating the taking of coral shells and the setting of fishing fences.

The provisions of the Act are clearly wide enough to make adequate provision for the protection of fish and to regulate fishing methods, but much must depend on the regulations to be made thereunder and the administrative ability to support and enforce the legal provisions.

The draft Fisheries Regulations, 1984, establish the membership of the Fisheries Advisory Committee and make provisions for the granting of foreign and local fishing licenses, and the conditions which may be attached to them. They establish procedures for the issuing of licenses to fish processing establishments and institute fishery conservation measures in respect of lobsters, turtles, conch, coral and aquarium fish. It appears that when the regulations are brought into force, there will be a complete prohibition on fishing, selling, purchasing, or disturbing turtles and their eggs and nests.

APPENDIX F

FRIGATE BAY DEVELOPMENT CORPORATION BUILDING GUIDELINES

Each application received will be considered in relation to the 'Master Plan' for the development of Frigate Bay Estate.

Plans can be viewed at the office of the Corporation at Frigate Bay. Copies to a scale of 1:5000 may be obtained on application to the Managing Director, Frigate Bay Development Corporation, P O Box 315, Basseterre, St Kitts, at a cost EC$15.00 or US$6.00 each.

Three (3) complete sets of drawings must be submitted to the Corporation along with development notes and descriptive notes.

1. Building Use

The proposed building shall not be used for any other purpose than that specified when the application to build or alter, was originally approved, without prior sanction by the Frigate Bay Development Corporation.

2. Additions and Alterations

In the case of additions and alterations, the proposed changes should be shown in colour or otherwise clearly indicated.

3. Building Density

Building density within residential areas will be restricted to four residential dwelling units per acre, with a site coverage not exceeding 25% of the total lot size. Only one dwelling unit is permitted on each lot.

3.1. Density for Condominium and Other Group Unit Development

(a) Maximum number of units - 16 per acre

(b) Maximum number of bedrooms - 32 per acre

(c) Maximum site coverage - 60% (this includes all buildings within the site)

(d) Maximum number of storeys - 3

(e) Minimum distance between buildings - 30' for 1 storey buildings
- 45' for 2 storey buildings
- 60' for 3 storey buildings

(f) Maximum gross floor area ratio (F.A.R.) - 1.0

3.2. Density for Individual Residential Development

(a) Maximum number of units per acre - 4

(b) Maximum number of units per lot - 1

(c) Maximum site coverage - 25%

(d) Maximum number of storeys on the flat areas - 1

(e) Maximum number of storeys on the slopes - 2

(f) Maximum gross floor area ratio (F.A.R.) on flat area - 0.30

(g) Maximum gross floor area (F.A.R.) on the slopes - 0.50

[illegible] and sloping areas are determined by the Corporation.

3.3. Density for Hotels

(a) Maximum number of rooms per acre - 32

(b) Maximum number of beds per acre - 64

(c) Maximum site coverage = 60% (and this includes all buildings on the site)

(d) Maximum number of storeys - 3

(e) Maximum gross floor area ratio, (F.A.R.) = 1.2

4. Building Setbacks

Dwelling houses will be restricted as to the distance that will be allowed between the building and the boundaries containing the site. In all cases buildings must be set back enough to prevent a loss in the amount of daylight, view or to prevent harm to adjacent buildings.

Front Setback	-	10 ft minimum
Side Setbacks	-	10 ft minimum
Rear Setback	-	30 ft minimum

5. Size Restrictions

The minimum net floor space for individual residential units shall be 1200 sq ft. This should not include garage spaces, patios, balconies, terraces etc. The Corporation will introduce flexibility when dealing with minimum size for hotel room units or condominium units. The Corporation reserves the right to reject a proposed condo unit based on inadequate room size.

6. Roads and Access

The Corporation may determine the points of access from the road to the lots. Buildings, fences, walls or hedges that are located close to or on road corners or road junctions must be aligned and constructed in a manner that would not restrict the view of vehicles on the roads, or emerging from the lots.

Major access road to any development shall have a road reserve of 30' with a carriageway of 16'.

Minor access roads within a development shall have a road reserve of 22' with a carriageway of 14'.

Main footpaths within a development shall have a path reserve of 10' with a paving of 6'.

Minor footpaths within a development leading from separate units shall have a path reserve of 6' with a paving of 2'.

Private driveways shall have a minimum width of 8'.

Typical cross sections shall be shown for the different types of access roads showing relative elevations at centerlines, edge of pavement or gutter line, top of curb or bottom of ditch, back of sidewalk or natural grade, as well as fallouts for surface course, base course, subsurfaces preparation or subgrade, curb and gutter and sidewalk material and thickness.

7. Car Parking

Provision for the parking of at least two cars within the individual lot boundaries must be made. One of the two parking spaces should have a roof covering and a paved flooring.

18. Room Heights

Habitable spaces shall have a floor to ceiling height of not less than 8'-6", non-habitable spaces shall have a floor to ceiling height of not less than 7'-0".

19. Stair Widths

Stair widths within individual units should be no less than 3'-0" clear between handrails or between handrail and opposite wall surface. The rise and tread of the stairs shall total 17½". The minimum rise shall be 6" and minimum tread shall be 9½". Stairs used in common areas should have a minimum width of 4'-6

20 Cisterns

Dwelling houses must provide a cistern with a capacity of 750 gallons or 120 cubic feet.

Commercial development must have at least two days' water supply storage.

21. Ventilation

All habitable spaces should be provided with ventilation in accordance with either of the following:

1. Natural ventilation through openable parts of windows or other openings in exterior walls that face legal open spaces, or through openable parts of skylights, providing total clear ventilation area not less than 5% of the total floor area of each habitable space;

or

2. Mechanical ventilation providing at least two air changes per hour either of outdoor air or a mixture of outdoor and recirculated air in such a proportion that a mixture of one air change per hour shall be outdoor air.

3. Kitchens, bathrooms and toilets can be provided with natural ventilation as described in the above section or with mechanical ventilation exhausting not less than 150 cubic feet per minute (cfm) discharging directly to the exterior.

Minimum Openable Areas for Natural Ventilation

S P A C E	Min. Openable Space
Kitchenettes, bathrooms, toilets or shower rooms connected to or in habitable space	3 sq ft
Bathrooms, toilets or shower rooms used by public or employees	1 sq ft per W.C. and minimum of 3 sq ft

22. Natural Light

Habitable spaces should be provided with natural light through one or more windows, skylights, transparent or translucent panels or a combination of all these, that face directly on a legal open space. The amount of light should be equivalent to that transmitted through clear glass equal in area to 10% of the floor area of the habitable space.

Kitchens, bathrooms and toilets can be provided with artificial lighting equipment or be provided with natural light.

No part of any habitable space shall be more than four (4) times its clear height distant from the lighting opening.

23. Development Notes and Descriptive Notes

23.1. Development Notes

Each development proposal shall have development notes that will accompany three (3) sets of plans that will be submitted to the Frigate Bay Development Corporation. For individual building units, forms which should be used to present the development notes will be available at the Corporation's offices. Group unit developments are required to present development notes in text. Development notes shall include information on the following:-

(a) Individual Unit Development

i. Name of development
ii. Name, address and telephone number/s of owner/s and date
iii. Total area of the proposed development
iv. Area of unit
v. Size of spaces
vi. Site coverage
vii. Total floor space
viii. Number of storeys
ix. Phasing considerations
x. Approximate cost of building
xi. Expected commencement date
xii. Date of application

(b) Group Unit Development

i. Name of development
ii. Name, address and telephone number/s of owner/s and date
iii. Total area of the proposed development
iv. Breakdown of land uses and land area under various uses
v. Types and sizes of units and number of units
vi. Site coverage
vii. Total floor space
viii. Phasing considerations
ix. Number of storeys
x. Approximate cost of building
xi. Expected commencement date
xii. Date of application

In condominium development there must be one parking space for every two condominium units to be provided on the development site in close proximity to the units. In hotel/condo development there should be one parking space for every three hotel/condo units. Parking spaces shall be at least 7' wide except that a parking space adjoining a walkway shall be at least 8'.

Restaurant development shall require one parking space for every 100 sq ft of public floor space or the part thereof. Parking spaces should be on a properly prepared surface that has been well compacted.

Hotel development shall require one parking space for every three hotel rooms.

8. Landscaping

All developers are required to include landscaping proposals as a part of their overall proposals.

On hillsides, the clearing of trees and bushes should be restricted to a minimum in order to reduce the likelihood of soil erosion and landslides.

9.. On Site Drainage

Storm water that accumulates on a building site or development site must be taken care of on site. This water should not be lead to the end of the site and disposed of on or in front of a site that is owned by another developer or the Corporation.

10. Fire Fighting Provision

Condominium and hotel developments should make provision for fire fighting by providing one fire extinguisher per unit or providing a sprinkler system for the entire building with a sprinkler outlet for every 50 sq ft. A fire hose system with a reel is also acceptable.

Building must be 100' or less from a street, road or driveway providing access for fire fighting equipment.

Interior staircases shall be separately enclosed with material that is able to withstand one hour of fire.

On second storey, the maximum distance of travel from an exit door of a room or space to a stairway is 100'.

On the third floor, the maximum distance of travel from an exit of a room or space to an exterior door is 120' and the maximum distance of travel from a stairway to an exterior exit door is 50'.

Developers are required to include fire hydrants in their development at every 300' and the minimum water line size should be 4" in diameter.

11. Topsoil Removal

The removal of topsoil during site preparation should be carefully monitored. Topsoil removal causes an increase in water runoff which leads to soil loss. As a result, soil should only be removed from those areas that will have building activity during the first phase of a development whether it be a single building or a group of buildings. Sitework information should be sub- [illegible] in detailed note form or presented in drawing form.

12. Sewage Disposal

In areas where it is possible for a building or a development to connect to the Frigate Bay Development Corporation sewage mains, such connection must be made.

In addition to an individual building having a two-chambered septic tank it is necessary to provide a soakaway or a distribution field for final disposal of the effluent.

For condominium developments, there must be connections to the Frigate Bay Development Corporation's sewage mains. In the event that such a connection is not presently possible, the development must make provisions for its own onsite sewage disposal with a view to eventual connection to the sewage mains.

13. Solid Waste Disposal

Every household, tenant, hotel/condominium building or apartment building owners/operators shall be responsible for providing his/their own garbage bins with suitable covers, which must be suitably protected against being knocked over. Provision should be made for a concealed bin storage area or areas and for access for the removal of garbage.

14. Building Material

The materials proposed for external finishes to all buildings should be of a nature and type that will not rapidly deteriorate, or require constant maintenance, nor should they, for any other reason, present an unclean or untidy appearance. Some materials that will not be accepted for external use on individual residential units, or condominium or on hotels are: galvanise sheets, bamboo, untreated timber.

15. Elevation Control

Dwellings will be subject to control in regards to the external appearance; that is elevations and the materials proposed for the external finishes. The Corporation will make the final decision as to whether or not the external appearance of a building or buildings is/are to an acceptable standard, and will make recommendations when it is not, in order to bring it up to such a standard.

16. Roof Slope

It is recommended that roof slopes be no less than 30°. Any roof with a slope less than 30° will be in danger of being torn off in the event of a hurricane.

Roofs of zero slopes should be of reinforced concrete only.

17. Minimum Room Sizes

Bedrooms	90 sq ft excluding cupboard space
Bathrooms	36 sq ft
Kitchen	60 sq ft

23.2. Descriptive Notes

Descriptive notes shall accompany drawings. These are compulsory for both individual unit and group unit developments. The following descriptive notes will be needed for individual unit construction:-

i. Structural system
ii. Concrete and masonry
iii. Steel work
iv. Roofing
v. Doors and windows
vi. Flooring
vii. Electrical system
viii. Drainage system
ix. Sewage disposal system
x. Special works

The following descriptive notes are required for group unit development:-

i. Structural system
ii. Site work
iii. Concrete and masonry
iv. Steel work
v. Roofing
vi. Flooring
vii. Doors and windows
viii. Toilet and kitchen accessories
ix. Electrical system
x. Drainage system
xi. Road and foot path system
xii. Sewage disposal system
xiii. Landscaping
xiv. Telephone system
xv. Special works

Infrastructural Plans

For all types of proposed group unit developments, infrastructural plans shall be prepared and should give an overall picture of the various infrastructural layouts.

Plans are required for the following:

1. topography
2. roads
3. electricity
4. water
5. sewage
6. drainage
7. telephone

Infrastructural plans shall be of the same scale as that of the site plan.

Required Plans

The drawings submitted to the Corporation must include:

25.1. Location Plan

Scale not less than 1:5000 showing position of lot in relation to the immediate area or the surrounding development.

25.2. Site Plan

On a scale not less than 1" = 100' show:

(a) Boundary lines and dimensions along with all pertinent data regarding the lot;

(b) Building/s location, required setbacks, clearing lines, levels on the building/s, dimensions of building/s or other features and in dotted lines the layout of any planned additions;

(c) All utility lines on the property and connections to street utilities for water and electricity;

(d) All existing physical features whether to remain or to be removed;

(e) Fences, structural retaining walls, walkways and pools;

(f) Storm drainage on both paved and unpaved areas, water catchment and drains;

(g) Sewerage disposal: location of proposed system;

(h) Finished ground elevations;

(i) Access to building/s from road;

(j) Wind direction;

(k) Parking provision;

(l) Legend showing all symbols and construciton materials to be used on the site;

(m) Name of designer, location of building/s etc;

(n) North point;

(o) All other relevant information.

25.3. Floor Plan [A horizontal section cut 4'-0" above the floor level]

On a scale of ¼" = 1'0" give:

(a) A description of the use and overall dimensions of each room including staircases, emergency escape routes;

(b) Levels of various floors;

(c) North point;

(d) Built-in cabinets, shelves, closets, medicine cabinets;

(e) Location and dimensions of all openings including windows and doors showing door swings; numbering doors and windows by type;

(f) Symbols for plumbing fixtures in the kitchen, baths and laundry;

(g) Show all structural features cut by the horizontal plane such as columns or beaming walls;

(h) Stair symbols and notes showing the direction of rise, up or down, the number of risers per run;

(i) Indicators of cross sections;

(j) All other relevant features.

25.4. Elevations

On a scale ¼" = 1'-0" or $\frac{1}{8}$" = 1'-0" indicate:

(a) Front, rear and at least one side view;

(b) Overall vertical dimension;

(c) The external appearance of the building/s;

(d) Texture and type of materials to be used on walls and roofs;

(e) Extension steps, roofed-over areas;

(f) Roof slope.

25.5. Cross Sectional Elevations

On a scale ¼" = 1'-0" show:

(a) A transversal section and a longitudinal section;

(b) A structural profile of foundation floors, walls, beams, roofs, balconies, projections, out-buildings etc;

(c) All internal vertical dimensions;

(d) Angles of roof;

(e) The level of the adjoining ground and footpaths or driveways;

(f) Sections, wall sections or details;

(g) Notes that include special features;

(h) Footing and foundation lines;

(i) Interior features;

(j) All other relevant information.

25.6. Foundation Plan

On a scale ¼"=1'-0" provide:

(a) Dimensions and location of all foundation cuttings;

(b) Columns and footings showing dimensions;

(c) Location of column centerlines;

(d) Description of floor slab and its height above ground;

(e) Indicators of section details;

(f) All other relevant information.

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(a) a transversal section and a longitudinal section
(b) a structural profile of foundation floors, walls, beams, roofs, balconies, projections, out-buildings etc
(c) all internal vertical dimensions
(d) angles of roof
(e) the level of the adjoining ground and footpaths or driveways
(f) sections, wall sections or details
(g) notes that indicate special features
(h) footing and foundation lines
(i) interior features
(j) all other relevant information

25.6. Foundation Plan

On a scale ¼" = 1'-0" provide:

(a) dimensions and location of all foundation cuttings
(b) columns and footings showing dimensions
(c) location of column centerlines
(d) description of floor slab and its height above ground
(e) indicators of section details
(f) all other relevant information

25.7. Plumbing Plan (Drainage)

On a scale ¼" = 1'-0" give:

(a) pipe chases
(b) pipe runs connecting to fixtures
(c) location of grease trap
(d) pipe sizes
(e) cistern locations and capacity
(f) all other relevant information

25.8. Mechanical Plan (if necessary)

On a scale ¼" = 1'-0" give:

(a) location and sizes of ducts for air conditioning
(b) description of system - i.e. water, air etc.
(c) all other relevant information

25.9. Electrical Plan

On a scale ¼" = 1'-0" give:

(a) electrical conduit locations
(b) location of lamps, outlets, distribution box etc
(c) description of switching and distribution system
(d) all other relevant information

25.10. Roof Framing and Cover Plan

On a scale ¼" =1'-0" give:

(a) framing of roof, spacing of rafters, size of rafters
(b) sub sheathing and roof cover details

(c) roof slope
(d) roof guttering and down spouts
(e) flashing
(f) roofing material
(g) all other relevant information

25.11. Details Sheet

On a scale ½" = 1'-0" or ¼" = 1'-0" show:

(a) all vertical details to be grouped together and all horizontal details to be grouped together
(b) typical corner and column details
(c) flooring details
(d) structural components connections details
(e) all structural details including those between exterior footing and roof; including details of roof cover and roof sheathing
(f) interior footing to interior wall
(g) special construction details
(h) all other relevant information

25.12. Schedules

Provide:

(a) door schedules
  (i) door type and a description by height, width, thickness, material and finish
(b) window schedules: by type, height, width and material
(c) finishes schedules (when applicable)
  (i) name of room and number
  (ii) floor finish, wall finish, base finish, ceiling finish and remarks
  (iii) ceiling height
(d) if necessary, prepare column schedules and footing schedules

26. Hoarding

No advertisement or hoarding or notice board of any kind may be displayed without the authority of the Corporation.

27. General

There shall be a yearly review and evaluation of the Frigate Bay Development Corporation Building Guidelines by the Corporation with the objective of continually updating the guidelines to keep pace with new developmental situations as they arise. In the event that such situations arise within a proposed development which is not fully dealt with in the Guidelines, the Frigate Bay Development Corporation reserves the right to present recommendations to deal with these situations. These recommendations will be binding.

3-2-83

APPENDIX G

NATURAL HAZARD CONSIDERATIONS

A variety of natural hazards common to St. Kitts-Nevis, as well as throughout the Eastern Caribbean region, should be taken into consideration in planning for any development scheme for the Southeast Peninsula area. These hazards manifest themselves as hurricanes, flooding, and seismic events (earthquakes).

Hurricanes occur frequently in the West Indies, and regional designers and builders are well aware of the potentially destructive forces of high speed winds. However, developers not as familiar with this type of natural hazard need to be made aware of preferred or required design features for built facilities which enable them to better withstand such forces. Building codes utilized in the United States, particularly in the southeastern part of the country, address these design issues, as does the new draft Caribbean code.

Coastal flooding is generally associated with severe storms and hurricanes which can produce a rise in sea level up to six feet above mean sea level. Superimposed upon the general rise in sea level caused by the approaching storm are waves which can reach heights of up to 27 feet (8.2 meters) (Tetra-Tech, 1977). Any built structure within the reach of such waves would sustain damage or be totally destroyed. Only the massive sand dunes offer some protection to buildings and facilities in low lying areas when waves such as these occur. Consequently, any important structures should be situated out of reach of wave action and subsequent flooding. Flooding due to heavy rainfall may also cause damage to coastal structures, but at the Peninsula, such flooding would be very localized at the base of the larger watersheds. In any event, structures should not be located in drainage ways unless designed to accommodate the water flow under the building.

The island of St. Kitts is located on the western and northern rim of the Caribbean Crustal Plate, which is overriding the Atlantic Plate (Hays, 1984). The tectonic activity of this region results in periodic earthquakes which can have damaging effects on structures and, in the event of partial or total structural failure, personal injury and/or loss of life can occur. It was observed that the windmill tower on the Peninsula (the old Fleming Estate) is partially collapsed, the likely cause being ground shaking. To minimize future damage to life and property, it is advisable that all reviews of building plans take the "earthquake factor" into consideration. The Building Guidelines referred to in Section 5.1 also contain provisions regarding earthquakes and suggest proper design features.

A related hazard is that of rock falls and land slides from the steep cliffs in the Peninsula area, particularly on the slopes around the Great Salt Pond. Evidence of such exists in the form of large boulders situated on the gentler slopes which had obviously rolled down the hill. Rocks which may fall in future earth tremors are still present on the high rock outcrops, and any development of such slopes needs to take that risk into account.

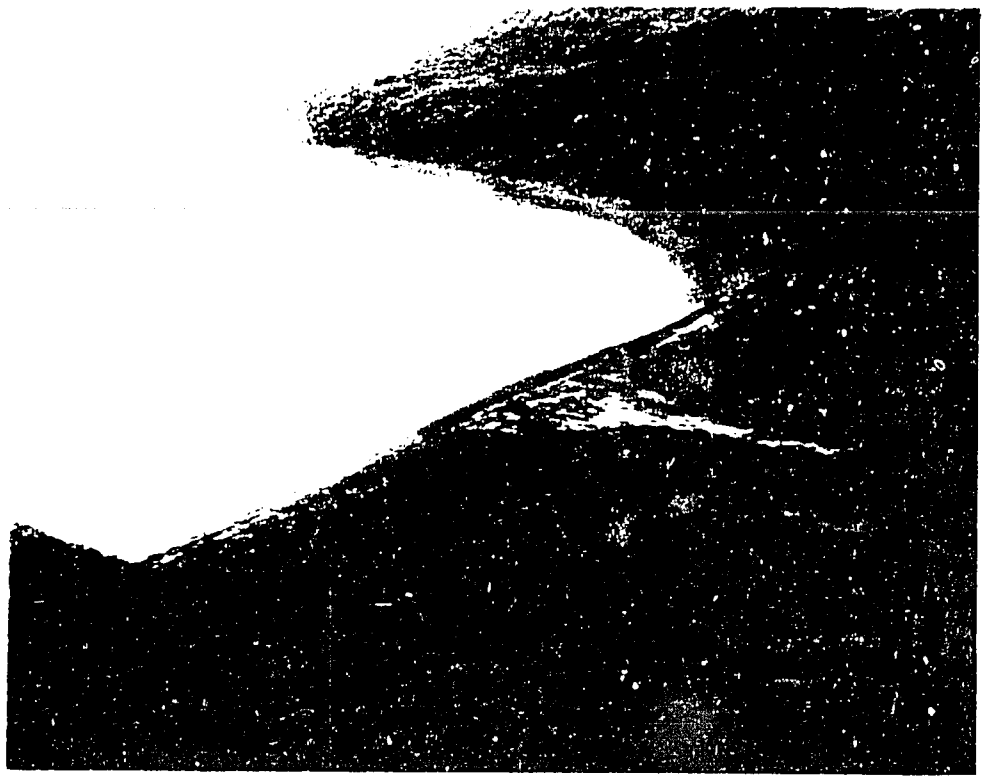
APPENDIX H

PHOTOGRAPHS AND SELECTED LANDSCAPE FEATURES

SOUTHEAST PENINSULA
ST. KITTS, WEST INDIES
October 1985

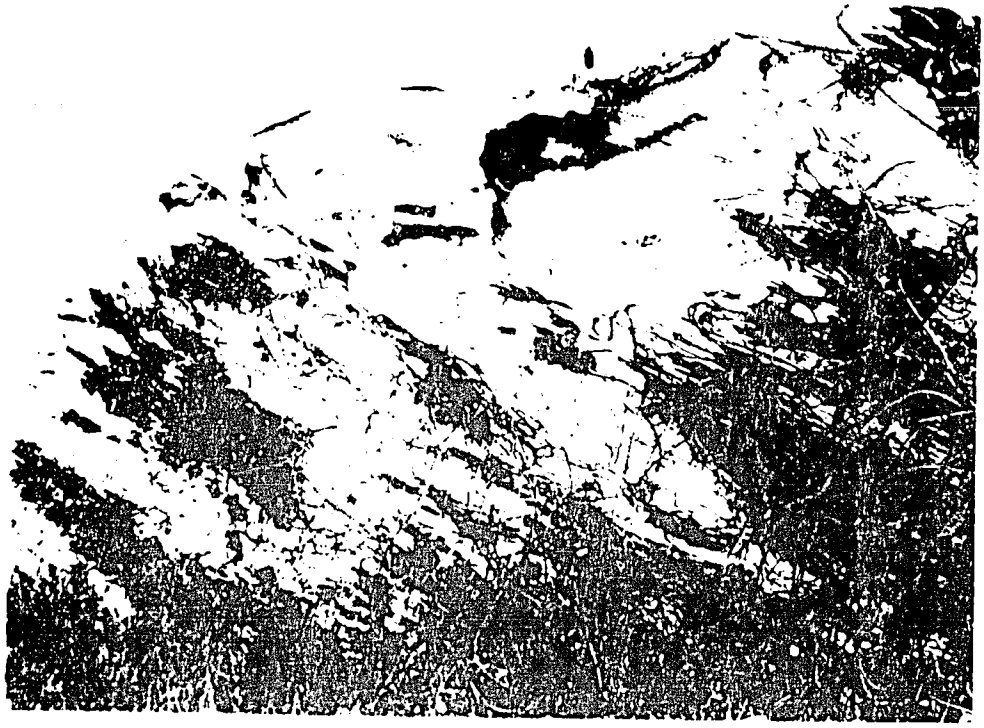
William E. Rainey, Ph.D.
Photographer

NB. A larger, more representative group of photographs taken by Dr. Rainey in the course of carrying out the field work for the Southeast Peninsula Environmental Assessment has been placed on file with the Central Planning Unit in Basseterre, St. Kitts.



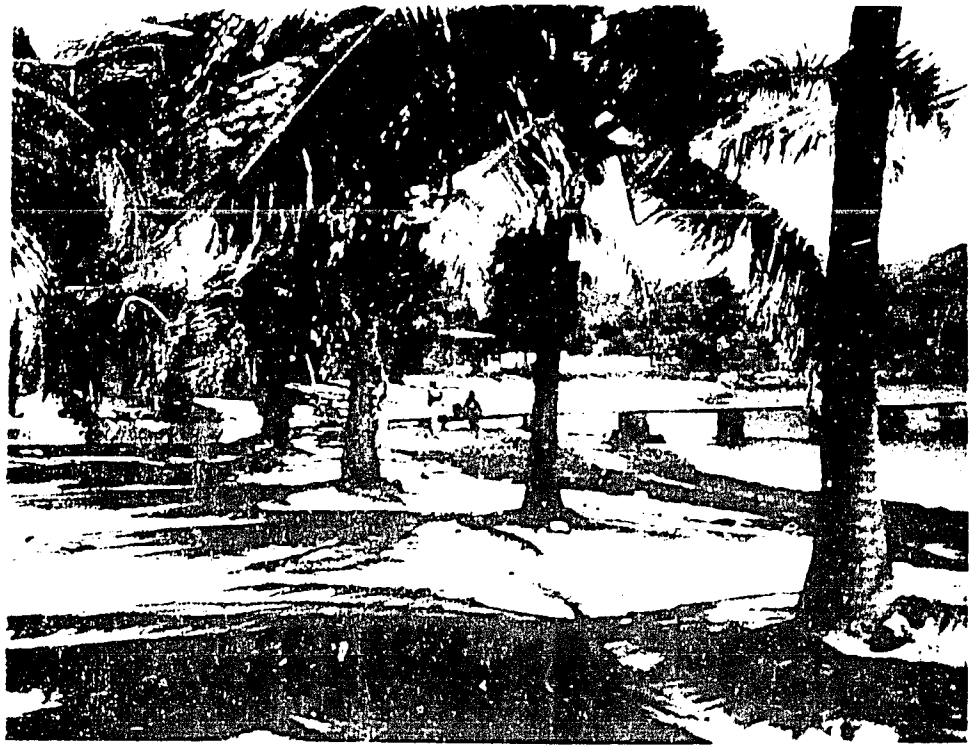
SEP-A. Eastern sandy portion of Canoe Bay, pool at terminus of gut, channel to sea now closed by sand.

SEP-B. Major's Bay Beach from western end looking east along beach. An attractive beach with a littoral forest (seagrape grading into manchineel and gumbo limbo with black and white mangrove at the pond margin) reasonably well developed at the western end. Low dune height and a heavy accumulation of seagrass beachwrack particularly at the western end.



SEP-C. Sand Bank Bay Beach, scarp showing recent erosion back to foot of primary dune, but beach has since widened considerably, and wind-borne sand is again accumulating at the foot of the dune.

SEP-D. Sand Bank Bay Beach and dune from face of dune looking east.



SEP-E. Northern end of Banana Bay Beach looking northwest toward rocky headland. Natural dense woody beach vegetation has been cleared and replaced with well-spaced coconut palms. Open structure of pier has only small effects on longshore movements of sand. Note structures on low dune potentially vulnerable to storm damage.

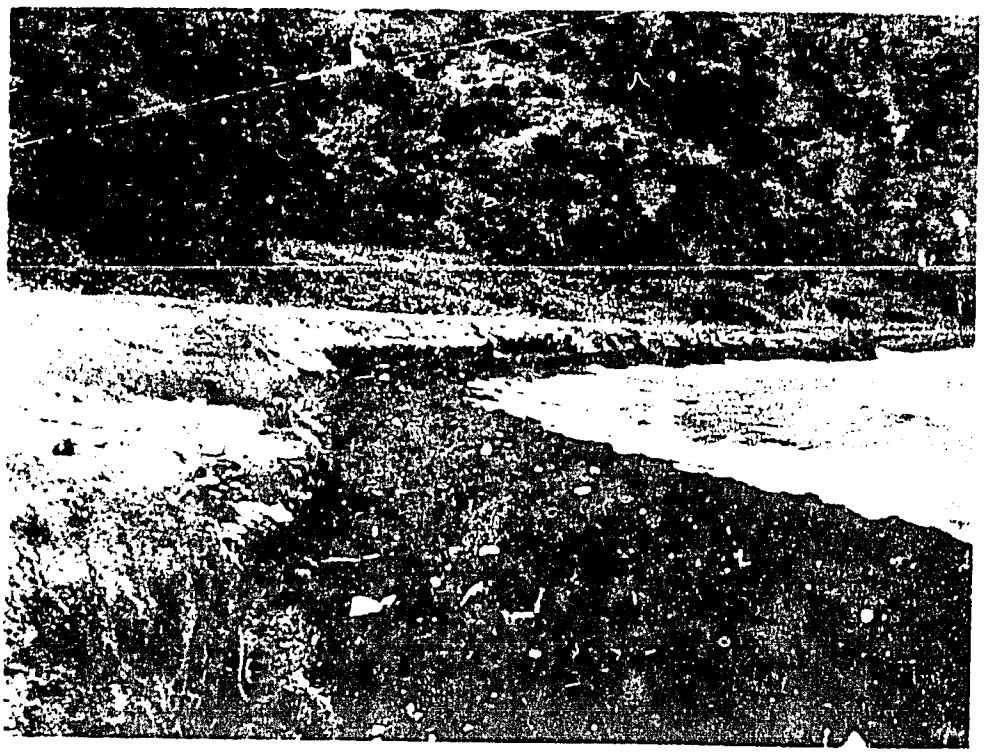
SEP-F. Western end of Cockleshell Bay Beach below hotel, looking east. Recent erosional event cut away face of elevated sandy area exposing roots of planted coconut trees. Since that event vines have partially revegetated the scarp, and the beach has advanced seaward. Seagrass beachwrack is accumulating in foreground.

SEP-G. The collapsing mill tower at Fleming Estate, northwest of Cockleshell Bay. The foundation of other facilities including a deep stone-lined well are near the tower. Damage to the tower indicates possible seismic activity.

SEP-H. Unamed sandy beach northwest of Canoe Bay from eastern headland, looking northwest.

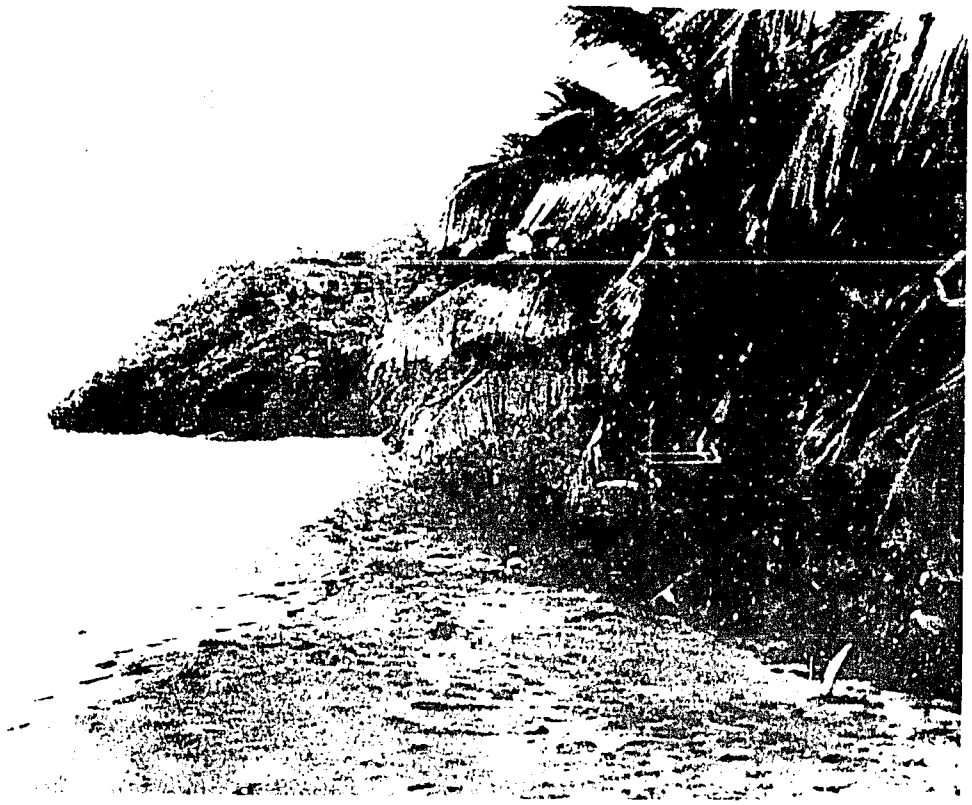
SEP-I. Eastern sandy portion of Canoe Bay, from western headland looking east. Note open sandy area in center where gut emerges on beach.

SEP-J. Ballast Bay cobble beach, looking south from near northern end. Deposits of cobbles cover bases of trees on beach. Extensive beach-rock in the foreshore. This beach was a cobble beach in 1974, became at least partially a sand beach by 1980, but the sand was removed by Hurricane Klaus in 1984.



SEP-K. From central portion of Mosquito Bay Beach looking north. Note erosional scarp. Beach has advanced forward from this point, but much of the material deposited is a mixture of sand and seagrass beach-wrack. Note low distinct dune with a dense cover of wind-sheared woody vegetation.

SEP-L. Western margin of Little Salt Pond (east of Guana Point), looking southwest toward mangrove fringe of pond margin of Ballast Bay. Note large scale mudcrack patterns from drying and dead stumps of mangroves further out in pond. Shorebirds were common here.



SEP-M. South of the center of South Friar's Bay Beach looking northwest.

SEP-N. Mosquito Bay Beach from northern end, general aspect looking south. Note thick, extensive accumulation of beachwrack, almost entirely manatee grass, Syringodium filiforme.