3.8 Maritime archaeology

3.8.1 Introduction

The port of Galle was situated, till the late 1960s, at the extreme western end of the Bay, in the lee of the headland upon which the Dutch Fort now stands. Its greatest significance is its historicity, being the only historic harbour yet in use today, in Sri Lanka. Forming a historical continuum with the Dutch Fort, a UNESCO World Heritage Site, its heritage value can be easily affected, adversely, by modern development schemes. Such development must be undertaken with extreme responsibility and sensitivity, and only if the anticipated advantages greatly outweigh the destruction inevitably to a heritage site. Galle, in ancient and medieval times, was an international (rather than a domestic) port, with the foreign sailors and their marts located on the foreshore and the indigenous community farther inland. It is referred to even in pre-Christian times, not only in Sri Lankan but also in Greek, Roman, Chinese and Indian historical literature. However, material - as opposed to literary - evidence of its use as a major port is available only for the last 1200 years approximately. Sri Lanka had a sea-going capability, though its fleet may have been considerably smaller than that of India and Arabia. Many ships from both east and west of the island called here and maritime archaeology has found artifacts from many countries in this Bay. Among them are a Southern Song Chinese Celadon Bowl dateable to the 15th century; a unique tri-lingual inscription, indited in China, with text in Chinese, Tamil and Persian (in Arabic characters) left behind by the Chinese Admiral Zheng He; and an Arab-Indian stone anchor of about 1000kgs with a likely C_{14} chronological horizon of very early 14th century.

3.8.2 Underwater Archaeological Sites

The entire of Galle Bay has been systematically surveyed, archaeologically, since 1992, using side-scan sonar, DGPS and magnetometer, as the expansion of the port was foreseen (Green & Devendra: 1992,1993). In 1996-97 the Ministry of Cultural Affairs initiated a detailed study to be used as a control for the first JICA plan for expansion. Even after this was completed there is on-going exploration conducted seasonally. The current status of the ongoing maritime archaeological work in the bay (Green, Devendra & Parthesius: 1998) has been taken into account, and is inventoried and evaluated below. The area surveyed, showing the artifacts found in different sites are shown in Figure 3.17. Areas / Sites identified (25 in number, alphabetically numbered) as positively important are indicated in the Table 3.28.

Table 3.28 Details of the historical sites found within the Galle Harbour & Bay

Name	Type	Lat dec⁰	Long dec⁰	Material	Date Found	General area	Rating No. given (0-10)
Site A	Large iron wreck	6.034394	80.223295	I	1992	N central harbour near marine terrace	9
Site B	Iron wreck	6.0226314	80.226856	I	1992	Central harbour	?
Site C	Iron wreck	6.0147541	80.222056	I	1992	Kadda Rock outer harbour	1
Site D	Iron wreck	6.0346714	80.226675	I	1992	W breakwater Fisheries harbour	1
Site E	Wooden wreck	6.035877	80.223611	W	1992	N central harbour E of site A	8
Site F	VOC Hercules site	6.030260	80.232545	W	1992	S side of Fisheries harbour Closenburg	6
Site G	Wooden wreck with ballast mound	6.023977	80.239845	W	1992	E side of harbour near harbour inn	4
Site H	Two iron cannon	6.029234	80.21924	S	1993	Near Black Fort off Harbour Masters Jetty	1
Site I	Iron wreck reported but not located in 1992	6.021277	80.236845	I	1993	East harbour	NIL
Site J	Large area of ceramic shards	6.0308771	80.221335	S	1993	S Diyamba Lihini	10
Site K	Large iron wreck	6.0313003	80.221143	I	1993	S Diyamba Lihini	5
Site L	VOC Avondster site	6.03465	80.221183	W	1993	N central harbour W of site A	10
Site M	Iron anchor	6.031644	80.223415	A	1996	Central harbour	1
Site N	Iron anchor	6.027810	80.226845	A	1996	Central Harbour	1
Site O	Iron wreck	6.018180	80.228233	I	1996	South Central harbour	1

Site P	Stone anchor site centre on large stone anchor	6.030683	80.22080	A	1996	SE Diyamba Lihini	10
Site Q	Wreckage	6.029862	80.227383	S	1996	S of S Fisheries harbour breakwater	4
Site R	Iron anchor	6.030060	80.222028	A	1996	SE Diyamba Lihini	4
Site S	Wreckage	6.022794	80.227761	S	1996	Central harbour	1
Site T	Iron anchor	6.030566	80.22083	A	1996	S Diyamba Lihini	4
Site U	Iron anchor and wreckage	6.025316	80.222500	A	1996	E of Aurora Bastion	7
Site V	Wreckage	6.025716	80.223000	S	1996	E Aurora Bastion	7
Site W	Iron wreck	6.019366	80.237933	I	1997	Watering Point Bay	4
Site X	Target. possible wreck	6.029650	80.237933	?	1997	Off Gommoliya Rks	?
Site Y	Iron wreck	6.0264167	80.24053	I	1997	Gravet Point	2

(NOTE: The locations are given in decimal degrees using the WGS84 datum. This datum was used since the Admiralty chart of Galle Harbour has a Ceylon 1933 datum (Kandawela datum – Everest) and not common to GPS systems, thus it is not possible to plot GPS co-ordinates directly onto the chart. To locate a WGS84 datum GPS position on the Ceylon 1933 datum chart, the position must be translated 238 m ENE 83.5 º Alternatively, in decimal degrees, to convert a Ceylon 1933 co-ordinate to WGS 84 the point has to be moved 0.002128 º E and -0.000227 º N.)

The importance of each site, in relation to the proposed development ("Rating No."), is indicated on a scale of 10, to be read as follows:

1-3 : Sites that are not expected to cause hindrance to the construction work. Any moveable artifacts, if found, will have to be retrieved/relocated.

4-6 : Sites that will have to be re-surveyed and artifacts retrieved to clear the area for construction work. This is mandatory.

7-9 : Sites that will have to be protected using suitable mitigation measures

10 : Sites where any intervention cannot, under any circumstances, be permitted.

However, it must not be assumed that the ratings given are definitive assessments of the historical or archaeological significance of each site as exploration is on going.

Sites rated 1-3 on the scale

Site C (rated 1): A large iron wrecks, possibly "SS Rangoon" which sank at anchor. It has been looted by divers over the years and no objects removable are to be found. No exploration currently contemplated.

Site D (rated 1): Site inspected and photographed but not yet identified. A large iron vessel approximately 40m long and badly broken up. No exploration currently contemplated.

Site H (rated 1): Two iron cannon, located close to inshore.

Sites M & N (rated 1): Iron anchors of some archaeological value.

Site O (rated 1): An iron wreck, approx. 30m long and 10m wide, possibly the "SS Agra". Extensively worked over by looters and structural remains of little archaeological interest. Lies at 13.8 m depth, amid considerable turbulence. No exploration currently contemplated.

Site S (rated 1): Iron wreck at 12m depth with concretions over an area of 5 sq.m. Not studied in detail.

Site Y (rated 2): Highly degraded iron wreck in shallow water, not yet investigated. No exploration currently contemplated.

Site R & T (rated 4): Large iron anchors, at old anchorage site. The site itself and its potential are greater than the anchors themselves, as it is part of the late medieval harbour.

Site B (rated 4): In 1992 was a modern iron shipwreck, east of the channel. Probably cleared by SLPA as a navigational hazard. If cleared, it can be removed from inventory.

Site W (rated 4): Iron wrecks, probably that of the "Effort", discovered by magnetometer survey and not yet fully investigated.

Site Q (rated 4): Iron wreckage, including some chain, pipes and large rings. Approximately at 12m depth.

Site G (rated 4): Wooden wreck, of a Dutch East Indiaman, which has much historical value, though the remains are not extensive. Given a low rating purely because it was previously decided to sacrifice this site in the interests of development, when the first JICA plan called for a construction on this site.

Site K (rated 5): Iron wreck, possibly the "Marion", not investigated: useful for further study of iron wrecks in Galle Bay.

Site F (rated 6): A very historically important site, damaged in the process of building the existing breakwater in the 1960s. Much archival research has been done and a fascinating picture of the sinking of the VOC ship "Hercules" has emerged. Ship's bell and sounding leads have been recovered, but at least 30 cannon have been located but not yet retrieved. Extremely turbulent waters below surface, making scuba investigation difficult and possible under certain sea conditions only. The sandy bottom was therefore not investigated by magnetometer. In addition to this, since a large number of sailors died in the sinking, this was named "Hercules Kirkopf": this means a Churchyard or Graveyard.

Sites U & V (rated 7): These are accretion sites, where many loose artifacts are found in good condition. They border the western limit of the channel and some very historically valuable material has been found here. Extensively looted in the past but under control now with naval restriction of diving in place.

Site E (rated 8): Remnants of the bottom part of a wooden ship, dateable to mid-19th century. Has great potential for training if left *in situ* as it has the necessary components of a wooden ship to teach maritime archaeology students the structure of such ships. Some artifacts were noted but may have been removed since 1992.

Site A (rated 9): The site of a large iron wreck, valuable as it is an accretion site for a wide variety of artifacts conveyed here by currents. So far, artifacts ranging from 15th century Chinese bowls to 19th century clay pipes have been discovered in large quantities. The site needs to be extensively and continuously explored as it is an important indicator of the archaeological diversity of Galle Bay.

Site J (rated 10): Another accretion site, with many ceramic shards, situated in the historic anchorages area. Important for the finding of a religious statue; others may be still there. Site full of promise and has to be kept inviolate, as in the case of all other sites in the anchorage area.

Site L (rated 10): The most important single site. The remains of a Dutch ship identified and studied in depth achivally, which will have to be preserved underwater for many years for seasonal exploration to carry on. Its good condition is due to have been silted over for centuries but with the building of the Marine drive and Fisheries harbour, it began to emerge from its anaerobic environment and to deteriorate. Rate of deterioration has been monitored. The water is also fouled by sewers emptying into the Bay. Another factor is the turbulence created by movement of ships in the channel, since this lies just northwards of it.

Site P (rated 10): The site where there is a collection of Arabic and Mediterranean type stone anchors and, therefore, both the oldest site in the harbour and the site of the original Galle harbour.

3.9 Social and Economic Parameters of the Project Area

3.9.1 Background

The project area was identified as the area in which the socioeconomic activities will be influenced by proposed harbour development activities. Guidelines for 'Methods of Baseline Survey, Prediction, Evaluation, and Monitoring of the Port/Harbor Environment' by JICA, indicate that the range of investigation for changes in the surrounding flow regime due to the construction of port activities should be '10 to 20 km of the upstream/downstream from the point of port facilities'. Since activities such as fisheries, bathing, diving, etc. are likely to be heavily influenced by changes in the flow regime, the project area was identified as the coastal area 10 km South of Galle Harbour (from Thalpe) to 10 km West of it (Gintota).

The project area was grouped into four zones for the sake of data collection and analysis. The relevant zones and the respective Grama Niladhari Divisions are given in Table 3.29.

Table 3.29 Zones in the project area and the respective Grama Niladhari Divisions

Zone	Grama Niladhari Division
Zone 1 (Bay Area)	Katugoda, Devata, Devathura, Magalle, Pettigalawatte, Weliwatte, Chinagarden, Fort
Zone 2	Bonavista, Yaddehimulla, Unawatuna (West), Unawatuna (East), and Unawatuna.
Zone 3	Dalawella, Talpe (South), Talpe (East), Heenatigala (South), Wellathota, Kahawennagama, Morampitigoda
Zone 4	Kaluwella, Mahamodera, Dadella (East), Siyambalagahawatte, Walawatta, Dadella (West), Gintota (West), Gintota (East), Welipitimodera

3.9.2 Socio-economic characteristics of the population in the project area

Information on socio-economic characteristics of the population in the project area were obtained from Divisional Secretariats of Habaraduwa and Kadawath Sathara. Poulation characteristics are presented by Grama Niladhari (GN) Division, which represent those GN divisions extending up to the coastal belt from Talpe to Gintota.

3.9.2.1 Total Population and families

Total population in all relevant GN Divisions in the area is 53,317. Population density appears to be high along the coastal belt than in the hinterland (see Table 3.30). Total number of families is 9,190, indicating an average family size of 5.8. Number of houses appear to be less than the total number of families, but information on this parameter is not available for Zone 1 and Zone 4. Of all zones under study, the highest population is reported for Zone 1, which includes the coastal area from Fort to Katugoda; a highly urbanised area.

Table 3.30 Population, number of families and number of houses in Grama Niladhari Divisions of the project area

Zone	Grama Niladhari Division	Population	No. of Families	No. of Houses
Zone 1	Katugoda	4833	543	n.a.
	Devata	2661	225	
	Devathura	1042	249	
	Magalle	2365	610	
	Pettigalawaththa	2195	439	
	Weliwaththa	2914	497	
	China garden	2387	341	
	Fort	2800	381	
	Sub TOTAL	*21197*	*3285*	*n.a.*
Zone 2	Bonavista	1083	234	234
	Yaddehimulla	830	189	166
	Unawatuna (West)	655	166	158
	Unawatuna (East)	1721	372	358
	Unawatuna (Central)	1194	151	144
	Sub TOTAL	*5483*	*1112*	*1060*
Zone 3	Dalawella	748	174	170
	Talpe (south)	832	213	198
	Talpe (East)	1035	243	228
	Heenatigala (South)	915	214	198
	Wellathota	1313	234	214
	Kahavannagama	1268	319	254
	Morampitigoda	1113	269	274
	Sub Total	*7224*	*1666*	*1536*
Zone 4	Kaluwella	3720	415	n.a.
	Mahamodera	2582	321	
	Dadalla (East)	784	144	
	Siyambala-gahawaththa	2948	488	
	Walaw-waththa	1835	357	
	Dadalla (West)	1405	305	
	Ginthota (West)	1770	298	
	Ginthota (East)	2016	351	
	Welipitimodera	2353	448	
	Sub TOTAL	*19413*	*3127*	*n.a.*
All Zones	*Grand Total*	*53317*	*9190*	-

n.a. – Not available

3.9.2.2 Education

Educational achievements of the population in the project area are presented in Tables 3.31, 3.32 & 3.33. For Zones 1 & 4, breakdown of information by GN division was not available. There appears to be no significant difference in educational standards between males and females. Educational standards of the population in in Unawatuna (West) in Zone 2 and Talpe (East) and Heenatigala (South) are higher than the populations in other GN divisions in these zones. Available information indicates that the population in Kadawath Sathara DS Division has achieved highest educational standards than the rest of the population in the project area. This may be attributed to the presence of national schools and also to the highly urban nature of the Kadawath Sathara DS division compared to other administrative divisions in the project area.

In all areas in general, the majority of the population has studied up to Grade 5 - Grade 11.

Table 3.31 Educational achievements of the population in Zone 2 - 1999

Levels of Education	Grama Niladhari Division									
	Bonavista		Yaddehimulla		Unawatuna (West)		Unawatuna (East)		Unawatuna (Central)	
	M	F	M	F	M	F	M	F	M	F
No Education	97	81	72	99	18	23	29	22	53	50
Up to Grade 5	107	131	99	87	78	100	27	35	237	205
From Grade 5 to 8	168	143	126	107	50	70	48	42	112	91
From Grade 8 to 11	64	91	43	81	70	50	131	132	100	82
G.C.E.(O.L) passed	87	69	66	57	60	65	192	251	66	96
G.C.E.(A.L) passed	18	22	19	14	23	35	168	181	7	16
Graduates	2	-	7	3	6	7	28	15	2	5
Other	1	2	-	-	-	-	228	192	19	43
Total	544	539	432	398	305	350	851	870	596	598

Notes: M : Male
F : Female

Table 3.32 Educational achievements of the population in Zone 3- 1999

Levels of Education	Grama Niladhari Division													
	Dalawella		Talpe (South)		Talpe (East)		Heenatigala (South)		Wellathot a		Kahawen na-gama		Morampi ti-goda	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
No Education	13	11	80	28	17	13	62	52	114	104	91	93	49	38
Up to Grade 5	111	110	116	152	129	79	34	32	204	106	124	170	90	96
From Grade 5 to 8	121	106	11	104	120	140	56	61	90	80	182	175	140	151
From Grade 8 to 11	100	80	48	57	168	175	118	137	22	31	159	164	79	85
G.C.E.(O.L) passed	42	25	74	105	60	75	145	152	26	30	22	25	99	111
G.C.E.(A.L) passed	15	8	26	21	20	24	32	24	-	-	14	16	34	43
Graduates	3	3	6	4	5	3	2	4	-	-	2	5	5	7
Other	-	-	-	-	3	4	2	2	-	-	14	12	41	45
Total	405	343	361	471	522	513	451	464	446	351	618	650	537	576

Table 3.33 Educational achievements of the population in Zones 1 & 4 (Entire Divisional Secretariat of "Kadawath Sathara") – 1998

Levels of Education	No.of persons
No Education	4147
Up to Grade 5	27140
From Grade 6 to 10	36470
G.C.E.(O.L) passed	17246
G.C.E.(A.L) passed	7633
Graduates	1414
Post graduate degrees	188

3.9.2.3 Employment Pattern

Pattern of employment of the population in the project area is available by GN division for Zones 2 and 3 (Tables 3.34 & 3.35), while that for Zones 1 & 4 is available only for the entire DS division of Kadawath Sathara (Table 3.36).

In all zones, private sector dominates as the major employer. A large percentage of the population in GN divisions of Bonavista, Yaddehimulla (both in Zones 2), Dalawella and Wellatota appear to be self employed. Fisheries and tourism may be the two major types of self employment activities in these areas. The highest proportion of Government and semi-government employees are found in the GN divisions of Unawatuna (West and East), in Zone 2, and in Talpe (South), Heenatigala (South) and Morampitigoda in Zone 3. For lack of information, such a breakdown can not be presented for Zones 1 & 4.

Table 3.34 Pattern of employment of the population in Zone 2 – 1999

Type of Employment	No. of families in the Grama Niladhari Division of				
	Bonavista	Yaddehimulla	Unawatuna (West)	Unawatuna (East)	Unawatuna (Central)
Government	22	17	50	62	14
Corporation	16	-	25	112	6
Private sector	42	107	30	29	102
Self-employed	80	205	80	21	76

Table 3.35 Pattern of employment of the population in Zone 2 - 1999

Type of Employment	No. of families in the Grama Niladhari Division of						
	Dalawella	Talpe (South)	Talpe (East)	Heenatigala (South)	Wellathota	Kahawenna -gama	Morampiti-goda
Government	29	16	46	30	10	20	71
Corporation	11	32	14	10	2	5	18
Private sector	50	43	523	42	6	150	67
Self-employed	162	22	12	10	40	25	29

Table 3.36: Pattern of employment of the population in the Kadawath Sathara Divisional Secretariat - 1998

Employment	No.		
	Male	Female	Total
Government	2250	1748	3998
Semi-Government	2687	509	3196
Provincial council	1291	566	1857
Private sector	11452	5192	16644
Total	17680	8015	25695

3.9.2.4 Income of the population

Information on income of the population is not available for Zones 1 and 4. The monthly income of the population in Zones 2 and 3 are given in Tables 3.37 & 3.38.

In general, the monthly income of the majority of the families in the project area falls between Rs.1000- 5000. N early a half of all families in Unawatuna (both West and East) and Bonavista GN divisions appear to receive monthly incomes above Rs.3000. Families receiving monthly incomes below Rs.2000 predominate in Dalawella, Talpe (East), Heenatigala (South) and Kahawennagama.

Table 3.37 Monthly income of the population in Zone 2

Levels of Monthly Income (Rs)	No. of families in the Grama Niladhari Division of				
	Bonavista	Yaddehimulla	Unawatuna (West)	Unawatuna (East)	Unawatuna (Central)
> 5000	68	-	30	12	-
3000 – 5000	81	-	40	145	19
2000 – 3000	49	36	37	109	46
1000 – 2000	28	76	38	91	26
< 1000	8	35	8	15	60
	234	147	153	372	151

Table 3.38 Monthly income of the population in Zone 3

Levels of Monthly Income (Rs)	No. of families in the Grama Niladhari Division of						
	Dalawella	Talpe (South)	Talpe (East)	Heenatigala (South)	Wellathota	Kahawennagama	Morampitigoda
> 5000	22	-	10	-	-	25	9
3000 – 5000	21	-	43	2	-	17	5
2000 – 3000	18	-	40	3	-	51	23
1000 – 2000	24	135	38	151	175	68	87
< 1000	89	78	112	58	59	158	80
	174	213	243	214	234	319	

3.9.2.5 Fisheries

Fishing is a major activity in the project area providing employment to about 2091 Fishermen. The total population dependent on fisheries as the major source of income is more than 6000 people. Of the four project zones studied, fishing with crafts are carried out only in Zone 1.

Fishing activities in the project area can be categorized according to the type of craft/gear and area of operation. Table 3.39 gives the number of crafts in operation in the project area by type of craft and area of operation.

Table 3.39 Fishing crafts and fishing population in the project area

Type of Craft/gear	No.	Area of operation	Type of catch	Total number of active fishermen (approx.)
Beachseine crafts/nets	4	Near shore (*Dewata*)	Shore-seine varieties	200
Traditional Crafts (oruwa)	57	Near shore (*Dewata and Galle Bay area*)		158
Small mechanised crafts with outboard motor	110	15 km off shore	*Alagoduwa, Linna*, herrings (*hurulla*), *bolla*, etc.	283
Large mechanised crafts with inboard engines: DAY BOATS	45	40 – 92 km off shore	Skipjack, Yellow fin, Seer, *Parawa*, shark, *koppara*	200
Large mechanised crafts with inboard engines: MULTI-DAY BOATS	255	Beyond 92 km off shore and in international waters	Skipjack, Yellow fin, Seer, *Parawa, shark, koppara*	1250
Total	471			2091
Ornamental fisheries		Near shore		

About 471 crafts are beached in the project area but most of them operate in fishing grounds outside the harbour. It is evident from Table 3.39 that Beachseines, traditional crafts and ornamental fishermen are the users of near shore fish resources in the project area. Some of the traditional crafts operate inside or very close to the port channel.

3.9.2.6 Anchorage points and movement of crafts

Fishermen use different locations of the project area to anchor or beach their crafts as shown in Table 3.40.

Table 3.40 Beaching points of fishing crafts and the concentration of fishing units in the project area

Anchorage (Beaching) Point	Type of craft	No. of crafts	No. of fishermen (approx.)	Residence of fishermen
Near Harbour Masters Office	a. Small mechanised crafts (17-23 ft fibre glass crafts with OBM) b. *Wallam*	100 4	250 48	Galle, Boosa and Rathgama
Mapalawella – adjacent to the Navy Camp	a. Small mechanised crafts (17-23 ft fibre glass crafts with OBM) b. Traditional crafts (*oru*) c. Beachseine crafts	8 15 3	25 30 150	Pettigalawatte (Galle), Magalle (Galle) Migrant fishermen from Gandara, Devinuwara (Matara District) and also from Chilaw.
Magalla – Fishery Harbour	a. Boats with inboard engine (Multi-day crafts: 35 – 50 feet in length) b. Boats with inboard engine (Day boats) c. Traditional crafts (*oru*)	255 45 20	1250 200 40	Mainly from Galle, Hikkaduwa and Ambalangoda
Dewata Beach	a. Small mechanised crafts (18.5 ft fibre glass crafts with OBM) b. Traditional crafts (*oru*) c. Beachseine crafts	2 18 1	8 40 50	Galle

Most of the fishermen who beach their crafts near Harbour Masters Office, Mapalawella and in Dewata, are residents of Galle and suburbs, while those who anchor the large mechanised crafts with inboard engines inside the Fisheries Harbour at Magalle come from distant areas like Hikkaduwa or Ambalangoda. However, once the construction work of the Hikkaduwa Fisheries Harbour is completed, these fishermen are likely to shift to this harbour.

3.9.2.7 Movements of crafts

Since most of the crafts are anchored inside the bay area they move along the port channel in making their trips to and from fishing grounds. Any activity in the bay area is likely to influence the movement of these crafts. None of the crafts appear to take the port channel in their way to/from fishing grounds.

The time of the day, during which the crafts are operated to reach fishing grounds and to return with catches, is also important because of its influence on other port activities. The movement of crafts, as indicated by fishermen, is given in Table 3.41

Table 3.41 Movement of fishing crafts

Type of craft	Time of departure	Time of arrival	Route
Traditional crafts	Early morning	2.00 p.m.	Fishing is carried out mostly in the bay waters
Small mechanised crafts	3.00 – 4.00 p.m.	Midnight or around 1.00 a.m.	Move along bay waters outside the channel
Large mechanised crafts (Day Boats)	3.00 – 4.00 a.m.	7.00 p.m.	Move along the channel
Large mechanised crafts (Multi-Day Boats)	Variable	Variable	Move along the channel

3.9.2.8 Fisheries in Zone 2, Zone 3 and Zone 4

The major fishing activities in these zones are Stilt Fishing and Beachseining. While Beachseining is carried out during September-March, Stilt fishing is carried out usually throughout the year. Most of these fishermen are also involved in other fishing activities and also in non-fishing activities and they hardly fall in the category of full-time fishermen.

3.9.2.9 Fisheries in Zone 2

The major landing centres in Zone 2 are Yaddehimulla and Unawatuna. About 20-25 small boats and traditional crafts operate from these centers, providing livelihood to about 125 to 150 persons.

Diving and laying nets for lobsters is the most common fishing techniques employed by fishermen in this area.

3.9.2.10 Fisheries in Zone 3

Only stilt fishing and beachseining are carried out in Zone 3, both of which are employed in near-shore waters. Of the above, stilt fishing is the dominant activity providing means of living to about 300-385 persons (see table 3.42).

Table 3.42 Number of persons engaged in stilt fishing in Zone 3

Village	No of fishermen
Dalawella	40 families (100-125 persons)
Mihiripenna	50-60 persons
Talpe	30 families (150-200 persons)

3.9.2.11 Fisheries in Zone 4

Fishing activities in Zone 4 remains very low. Generally, fishermen residing in the Zone beach their crafts near the Harbour Masters Office, close to Galle Fort. However, few traditional crafts are beached at Kaluwella, Mahamodera and Gintota (see Table 3.43). Net laying for lobster in coastal waters is the major fishing technique employed by fishermen operating these crafts.

Table 3.43 Beaching points and number of crafts in Zone 4.

Village	No. of crafts*
Kaluwella	2-3
Mahamodera	7-8
Ginthota	About 10

* traditional crafts only

3.9.2.12 Ornamental Fisheries

Ornamental fisheries activities are carried out throughout the year. All ornamental fish resources are concentrated within the near-shore area, 3-4 miles from the coast. Occasionally, the fishermen dive quite deep in search of fish resources (100-150 ft). The number of fish species caught in the area is about 100. The price obtained for fish varies from Rs. 2.00 to about Rs. 150.00. Ornamental fisheries is found in all Zones in the project area; zone 3 reporting the highest number of persons engaged in it (see table 3.44).

Table 3.44 Fishermen engaged in ornamental fisheries and fishing locations in the project area:

Zone	Village / Location	No of persons
Zone 1	Fort Magalle Deveta	(In Mahamodera and Fort area, this is carried out by fishermen of kaluwella, Mahamoera, Dadalla and Walawattha villages, belonging to zone 4. Ornamental fisheries is mostly a part-time activity). *No ornamental fisheries exist at Dewata.*
Zone 2	Yaddehimulla & Unawatuna Ganahena	20-30 families 25-30 families
Zone 3 Season: (January to March)	Dalawella Mihiripenna Talpe	10-15 persons 50-60 persons 25 families
Zone 4	Kaluwella Mahamodara Dadalla/Walawattha Ginthota	About 10 persons* About 10 persons* 5-7 families* -

* mainly engaged in fishing for Lobster

3.9.2.13 Tourism

The project area is reckoned to be one of the most popular areas for tourism. The Unawatuna beach is considered to be one of the most beautiful beaches in Sri Lanka due to the presence of the Buonawista coral reef, providing the tourists with rich coral resources and a safe and shallow area for bathing. Moreover, tourists are also involved in various water sports in the vicinity of the Unawatuna beach. An array of tourist hotels, guest houses and motels are present along the coastal belt from Rumassala to Thalpe; in Zones 2 and 3. The number of tourist hotels and guesthouses in the project are provided in Table 3.45 below.

Table 3.45 The number of Tourist Hotels in the project area.

	Zone 1			Zone 2			Zone 3			Zone 4		
	Rooms < 5	Rooms 5-10	Rooms > 10	Rooms < 5	Rooms 5-10	Rooms > 10	Rooms < 5	Rooms 5-10	Rooms > 10	Rooms < 5	Rooms 5-10	Rooms > 10
Sea side	-	5	3	-	3	4	1	1	6	-	-	1
Land side	-	-	-	-	1	2	1	-	1	-	-	-

Most of the tourist hotels are concentrated in Zones 2 and 3. However, a large number of tourists stay in small guesthouses in Zones 2 and 3, many of which are not registered. The total number of hotels and guest houses in Zone 2 and 3 are given in Tables 3.46 and 3.47.

Table 3.46 Tourist hotels and guest houses in Zone 2 of the project area

No. of hotels/guest houses in Graha Niladhari Division of		
Location	**No.**	**No. of employee**
Bonvisa	-	-
Yaddehi-mulla	14	62
Unawatuna (West)	1	8
Unawatuna (East	1	9
Unwatuna (Central	12	62

Table 3.47 Tourist hotels and guest houses in Zone 3 of the project area

No. of hotels/guest houses in Graha Niladhari Division of		
Location	**No.**	**No. of employee**
Dalawella	6	37
Talpe (South)	4	26
Talpe (East)	1	70
Heenatigala (South)	4	18
Wellathota	-	-
Lajawenna-gama	-	-
Morampiti-goda	-	-

The annual number of visitors to hotels in the project area is presented in Table 3.48. This does not include numbers of visitors to guesthouses, which may be considerable.

Table 3.48 Annual number of visitors to all hotels in the project area

Annual number of visitors (range)	No. of Hotels			
	Zone 1	Zone 2	Zone 3	Zone 4
< 1000	5	3	3	-
1000 – 3000	1	1	4	-
3000 – 5000	2	1	2	-
5000 – 10000	-	1	-	1
10000 – 15000	-	-	-	-
> 15000	-	1	-	-

As indicated in Table 3.48, only two hotels receive more than 5,000 guests per year. Using information provided in Table 3.48, the average annual number of visitors to all hotels in Zones 2 and 3 was estimated as 32,000 (for Zone 2) and 20,000 (for Zone 3), with a total of 52,000 visitors per year.

While the tourist visitors engaged in various activities during their stay, all such activities in coastal waters consist of bathing, surfing, scuba diving and snockling. Table 3.49 gives the extent of engagement of tourists in such activities.

Table 3.49 Extent of use of coastal waters b y tourists

Activity	Percentage of tourists			
	Zone 1	Zone 2	Zone 3	Zone 4
Sun & Sea	(Guests use Unawatuna beach)*	95	48	100
Scuba Diving		15	5	-
Snockling		16	32	-
Surfing		-	2	-

3.9.2.14 Cargo handling

Galle port remained mainly as a port with only expects until about 1965. The major cargo handled included tea, rubber and coconut, the volume of which was as twice as that of cargo brought in. After the year 1970, tea and coconut products were not exported from Galle and then subsequently, after 1981 the port ceased to export rubber as well. Today, Galle port is predominantly operating as a one with only imports. The main cargo volumes handled by the port from 1990 to 1991 are given in Tables 3.50 & 3.51.

Table 3.50 Cargo Discharged at the Galle Harbour – 1990-1999 (in Metric Tons)

Year	Iron	Machinery	Rice	General	Fresh Fish	Total
1990	750					750
1991						-
1992						-
1993						-
1994		189	6,544			6,733
1995				1,698		1,698
1996				1,615		1,615
1997				495		495
1998					06	06
1999				940		940

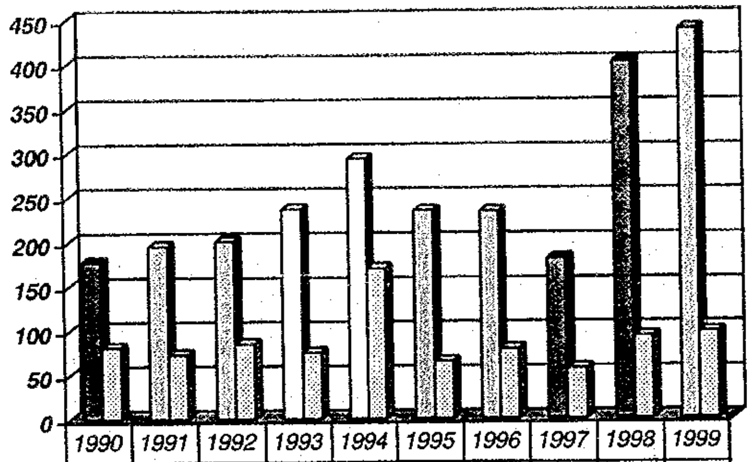
White flour, Clinker and cement (both bag and bulk) are the major types of cargo discharged at the port, amounting to an annual volume of 413,796 m.t., which accounts for (in 1999) 94% of the total cargo volume discharged. Cargo loaded from the port amounts to only 940 m.t. (in 1999).

Tonnage of cargo unloaded at the port showed a decline from 1994 to 1997, but has taken a new turn from 1998, reaching the highest volume of cargo ever handled by the port, in the year 1999.

The same trend was evident in respect of the number of vessels calling at Galle port. The total number of vessels arriving in 1990 was 81, reaching a peak of 170 vessels in the year 1994. The vessel number has then declined until 1997. The years 1998 and 1999 mark a revival of port activities, resulting in an increase in the number of vessels and the volume of cargo handled.(Figure 3.18)

Table 3.52 Cargo Discharged at the Galle Harbour – 1990-1999 (in Metric Tons)

Year	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
Flour	34,462	38,998	42,066	47,539	46,722	49,553	44,815	37,253	32,650	43,316
Clinker	173,822	280,436	100,997	176,991	168,360	202,138	173,950	155,564	159,082	126,300
Bag Cement	118,861	51,582	28,162		4,219	8,789				
Bulk Cement	86,651									
Fuel	12,600	20,340	4,184	1,429						
Gypsum	8,840	10,560	4,400	3,598	11,735	15,301	5,950			5,220
Fly Ash	2,999									
Gen. Cargo			785	3,148	3,925			71		
Rice							11,966	7,593	3,300	3,300
Mald. Fish		95		1,350						
Fresh Fish	217	40								
Sugar			144							
Machinery						403				
Fertiliz						11,022				
Chillie										
Timber						5,202				
Total	438,452	402,051	180,738	234,055	234,961	293,403	236,681	200,461	195,032	178,166



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Cargo (in '000 M.T.)	178.2	195	200.5	236.7	293.4	235	234	180.7	402.1	438.5
Vessels	81	73	85	75	170	65	79	57	93	98

Figure 3.18: Total Tonnage of Cargo Discharged and the number of vessels arriving at Galle Harbour 1990-1999

3.9.2.15 Boat services maintained for ships berthed outside the harbour

Two companies are involved in operating boat services for vessels anchored outside harbour. One company, the Windsor Pvt. Ltd. has one boat, which provides about 2-5 services per week. The other company is Jack Shipping, which too provides about 2-5 services per week. The charges per service are US $ 1,250 per service.

Due to the small number of boats providing various services to vessels and, the extremely low number of service trips made to the sea, the movement of these boats hardly interfere with other harbour activities and the movement of cargo vessels and fishing crafts.

3.9.2.16 Anchorage of Yachts in Galle Harbour

Galle harbour has been a famous stop over for large numbers of yachtsmen from all over the world. At present anchorage facilities are provided to yachts between the right breakwater and the old port located in front of the fort. Conical buoys have been installed by the SLPA and the yachts use a 'two-point mooring' method (using both an anchor and a buoy) when berthing. The average stay of a yacht is around about 30 days, which is highly variable. A charge of $ 100.00/yacht per month is charged by the SLPA from yacht owners.

Table 3.53 provides information on yacht arrivals and their country of origin for the years 1991-1999.

Table 3.53 Arrival of Yachts at Galle Harbour 1991-1999

Country of Origin	1991	1992	1993	1994	1995	1996	1997	1998	1999
Australia	17	24	23	18	29	20	25	22	22
Austria	1						1	1	
Belgium		2					1	2	3
Canada	4	3	6	6	6	9	10	7	5
Denmark	1	2	4	2	4	2	2		1
Finland		1	1		3	1	1	1	1
France	7	12	13	18	11	13	17	5	12
Germany	10	8	7	8	10	12	9	3	9
Gibralta	1								
Greece	1				1				
Hong Kong	1	1	1	2			2	1	1
Ireland		1			1		1	1	1
Italy	1	2		1		4	2		
Japan	3	1	1	1		1			
Mexico	1								
Netherlands	5	1	4	6	6	9	4	1	1
New Zealand	5	8	4	6	9	7	8	2	10
Norway	1	1	3		2	2	3	4	3
Singapore	1								
South/Africa/Africa			1		4	5	1	3	1
Spain	2		1		1	2	2	4	1
Sweden		2	6	3	4	6	2	2	1
Switzerland		3	2	1	1	3	7	1	
United Kingdom	12	19	30	24	26	25	63	18	39
United States	23	14	24	33	32	25	32	20	40
Other		5	6	7	5	4	6	5	4
Total	106	108	137	136	155	150	189	103	155

The average number of yachts using berthing facilities in a given year is around 138. The majority of yachts originate from countries such as the United States, United Kingdom, Australia and Germany; the two former accounting for 1/3 of all yachts using berthing facilities at Galle harbour.

A closer look at the pattern of arrival of yachts given in Table 3.53 shows that, approximately 70% of all yachts arrive during the months of January an February; January being the month bring in the largest number of yachts into the port. Assuming that the average stay of a yacht is about a month, the most important period for yacht anchorage appear to be the months of January, February and March (Table 3.54).

Table 3.54 Pattern of arrival of yachts over and year (Information for 1991-1999)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1991	26	18	5	6	1	3	1	1	6	11	12	8
1992	30	22	5	4	1	1	3	2	7	21	8	7
1993	57	26	9	2	1	1	0	3	11	8	11	9
1994	45	31	9	5	3	0	4	3	5	10	15	8
1995	75	33	5	5	0	3	0	2	7	13	7	5
1996	68	20	12	7	5	2	5	2	11	6	5	8
1997	101	38	11	3	3	2	2	5	4	6	2	22
1998	48	20	10	6	0	1	0	1	2	3	3	9
1999	65	45	9	5	5	0	1	3	7	6	5	4

3.9.2.17 Structures outside harbour

These are considered to be structures that are mainly located along the coastline bordering the bay waters- from Galle Fort to Devata. Structures along the coastline included those found on either side of the Galle-Matara road. Almost all these structures are of permanent nature, while a few semi-permanent and temporary dwelling places were also found (see table 3.55).

Table 3.55 Type of constructions in Zone 1 of the project area

Location	Type of construction					
	Permanent		Semipermanent		Temporary	
Fort	297		-		-	
Galle Town	73		-		-	
Devata to Magalle	Land side	Sea side	Land side	Sea side	Land side	Sea side
	102	100	10	11	21	28

Information on the number and type of structures for Zone 1 and Zone 2 are given in Tables 3.56 & 3.8.57.

Table 3.56 Type and Number of structures in Galle Fort of Zone 1 in the project area

Type	Number
Houses	297
Religious places	5
Banks	4
Hotels	1
Guest houses	4
Educational Institutes	6
Museums	3
Communication centers	4
Groceries	46
Snack bars	3
Government institutes	3
Salons	5
Printing firms	2
Dispensaries	1
Video centers	1
Laundries	1
Foot-ware shops	1
Cycle work shops	2
Jeweler shops	4
Office rooms (Lawyers)	24

Since Galle Fort is archeologically and historically important and has been declared as a protected zone structures in this area are unlikely to be affected by any expansion in the port area. However, they are likely to affected by dust and noise generated by construction work in the harbour area.

Table 3.57 Number of structures in Galle Town area of Zone 1 in the project area

Type of Structure	Number
Grocery shops	199
Book shops	16
Textile/Laundry shops	86
Foot wear shops	28
Communication centres	12
Restaurants	1
Hotel & Bakery	8
Hotels	1
Record Bars/Video centres	6
Electronic shops	22
Jewellery shops	2
Pharmacies	9
Watch repair shops	6

The largest number of structures are found in the Galle town area (table 3.58). Most of these structures are of permanent nature.

Table 3.58 Type and Number of structures from Magalle to Devata of Zone 1 in the project area

Type of structure	Sea side	Land side
Shops		
Hardware	1	6
Vegetables	1	4
Fish	4	14
Textile	4	4
Retail shops	7	14
Furniture	1	-
Cool spots/Hotels	6	21
Pharmacies	3	2
Electrical items	2	5
Garages/Workshops	14	7
Saloons/Beauty parlors	1	2
Communication centers	2	2
Timber mills	1	-
Restaurants	2	1
Tailor shops	2	-
Religious places	2	3
Other	6	7
House	134	133
Government institutes	5	9
Schools	-	3

Structures in Zones 2, 3 and 4 are unlikely to be affected either by any expansion of the harbour area or by noise and dust generated by construction activities in the harbour.

3.10 Built Environment

3.10.1 Background

One of the significant impacts of the proposed port development will be on the built-environment of the project area. The built-environment will be significantly changed, modified or altered to accommodate the proposed development. This part of the report deals mainly with the key features of the existing built environment of the project area.

The built–environment is divided into two regions for the study purposes. They are:

(i) The hinterland and

(ii) Existing Port area

The existing port area is well defined and the available facilities and infrastructure within that area are studied. It is important to assess the impact of the proposed development on the existing port and the way in which the new development could be integrated with the existing port.

It is not possible to determine the extent of the hinterland without details on the proposed development. However, the proposed development will certainly have an impact on the built-environment of the hinterland. Especially, the infrastructure facilities should have the carrying capacity to accommodate the new development both at construction and operational stages. As such, the report will look at initially, the existing land use patterns and the infrastructure facilities in the immediate vicinity of the port. Galle City, the Galle Municipal Council (GMC) area and the immediate periphery are taken into consideration in this study.

3.10.2 The Hinterland

3.10.2.1 Introduction

The Southern Province has been divided into 3 administrative districts, namely Galle, Matara & Hambantota. Galle, the capital city of Southern Province is the only municipal council in the province. Galle has been categorized as a first order city in the structure plan prepared by the UDA. Galle is functioning as an administrative and service center of the Southern Province. The population of Galle district in 1991 was 946,000 and that of GMC was 95,394.

3.10.2.2 Natural Features

As the topography of the Galle City is connected, there is a hillock towards the northern side from the sea that divides the city into two. The height of the hillock varies from about 60–160 ft. In addition, Karapitiya, Labuduwa, Ma-itipe, Malidduwa areas are of hilly nature and scattered around Galle. The Rumassala is another hill towards the southern end of the city which is very closer to the sea.

Towards the center of the city, the Galle Fort, designated as a world heritage site, is located covering an area of 90 acres. One of the major rivers of the south, *Gin Ganga* flows into the sea near the City. A canal called *Dick Ela* that flows into the sea near the cement factory forms a natural boundary of the city to the south.

3.10.2.3 Land Use

Galle is centrally located and functions as a service center, especially providing commercial, educational and health services to the Southern Province. It is now developed so that the administrative functions are located there. In addition, its location has given it another unique feature as a transportation hub of the South. It functions as an integrated center of rail, road and maritime transportation too.

The resident population of the GMC at present exceeds 100,000 and another 75,000 people travel to the city from peripheral areas to fulfil their daily needs. The land use survey of the GMC carried out in Table 3.59

Table 3.59 Land use pattern of the GMC Area as at July 1999

Land Use	Area (Hectares)	Percentage
Residential	976.19	56.02
Public	70.61	4.05
Commercial	39.51	2.27
Industrial	22.35	1.28
Tourism	5.18	0.30
Religious	28.98	1.66
Transportation & Roads	292.17	16.78
Cemetery	5.99	0.34
Water Bodies	36.60	2.10
Playgrounds and open spaces	19.43	1.11
Bare Land	170.36	9.78
Marshy Land	36.60	2.10
Agriculture	38.53	2.21
Total	1742.50	100.0

About 56.02% of the land in GMC is used for residential purposes, and the housing amounts to about 15,250 units. Out of those housing units, 92% has electricity, 88% has piped water supply, and 49% telephone facilities.

Even though Galle is a commercial hub, commercial activities are mainly concentrated in the city center with a land use of only 4%. This is mainly because of the smaller sizes of commercial establishments and restrictions imposed by street lines and other planning controls which inhibits new development.

Another important feature of the land use pattern of GMC is the relative insignificance of the industrial land. Industries consume about 1.2% of the total land. The land use map of the GMC is given in Figure 3.19. As such, the city is trying to develop its industrial base and three major industrial zones have been designated for this purpose. The proposed zoning plan of the Galle City is given in Figure 3.20.

3.10.2.4 Water Supply

Piped systems for water supply have been introduced in major population centers over the last few decades in Sri Lanka. The port and the hinterland, specially the GMC and the peripheral areas are connected to public water supply. Unreliable and insufficient supplies are the common water problems.

The principal national body responsible for overall strategy and coordination as well as for designing and installation of water schemes is the National Water Supply and Drainage Board (NWSDB). However, the Irrigation Department of the Ministry of Land and Irrigation, the Mahaweli Authority along with NWSDB have interests in sourcing, distribution and use of water. With the recent developments in the Government's objectives in the field of environmental infrastructure, NWSDB has realized the need for a revised corporate plan (1999-2005) to face the future challenges and fulfill the Government's priorities. The involvement of private sector participation has also been considered for specific areas of capital investment.

NWSDB supplies water to the hinterland from Wakwella treatment plant from *Gin Ganga* with its maximum capacity of 2 million per day. The water is presently distributed under the management of GMC to the municipal areas. At Present, the plant is incapable of supplying water for 24 hours to all the consumers. The hinterland has 15,000 connections and 14,000 m^3 of water is supplied per day. Water is available for only 16 hours at low pressure. It does not reach the port due to this pressure deficiency. As a remedial measure, the authorities have divided the city into 2 zones and a pressurized supply is provided on alternative days for each zone from 11.00 a.m. to 3.30 p.m. Shallow wells are common source of water for many families. Public water supply to the port is inadequate and ground water sources with good quality are not sufficiently available near the port to increase its own supply of potable water. At present water is brought from municipal bowsers to the port.

NWSDB's objectives for water supply development include:

- Improve level of service in terms of accessibility, duration of supply and quality of water supplied,
- Levy of and affordable tariff,
- Provide additional coverage for domestic, commercial, industrial, tourism and other types of customers when demand exists,
- Improve operational efficiency through the reduction of non-revenue water and resource optimization.

Expansion of the pumping capacity to another 2 million has started recently and to be completed in July 2001. When this project is completed, the current deficiency could be overcome. It will increase the water supply to 28,000 m^3 per day. It is adequate only to overcome the current deficiency. Another project which is earmarked to be implemented in a few years time, called the Grater Galle Water Supply Project, will have a much higher capacity and a grater supply area. A water tank is proposed to be built on top of the Rumassala in view of supplying water to areas as far as Bopepoddala, Ratgama, Habaraduwa and Akmeemana. The planning of this project has been already finished and the implementation is yet to be made. It is envisaged to proceed with the project in two stages. Table 3.60 gives the proposed supply capacity in each phase of the project.

Table 3.60 Proposed Greater Galle Water Supply Scheme

	Stage I	**Stage II**
Target Year	2005	2015
Treatment Capacity (m^3/day)	14,500	29,000
Raw Water Intake (m^3/day)	16,000	32,000

Source: NWSDB

3.10.2.5 Sewage Treatment

Sewage collection through piped systems and the treatment of sewage water falls under the authority of National Water Supply and Drainage Board (NWSDB). Disposal of septic sludge from septic tanks falls under local authorities, i.e. Municipal Councils, Urban Councils and Pradeshiya Sabhas, but the owner of the septic tank is responsible for the timely emptying of the tank. The Central Environmental Authority (CEA) and the Ministry of Health are responsible for the control of the sewage water discharged and sludge disposal. The Industrial Technology Institute (Successor to Ceylon Institute of Scientific and Industrial Research) carries out laboratory analysis of sewage water in circumstances where certified quality of sewage water is required. The Grater Colombo area is in practice the only urban area with a piped sewage collection system in the country. Sewage is not treated, but discharged through silt tanks to the sea with about one kilometer long discharge outlets. There are number of industrial wastewater treatment plants in the area. Some of them are run privately, some run by the NWSDB. Premises that are not connected to a collection system are required by law to have a septic tank for sewage and a soakage pit for the overflow from the septic tank and for other wastewater. GMC have vacuum tanks and sludge sites for the disposal of septic sludge. The GMC charges the client for the vacuum tanker services. The surrounding Pradeshiya Sabhas do not provide emptying services, but there are private contractors who empty septic tanks and tip the sludge in uncontrolled locations.

3.10.2.6 Storm Water Drainage

The canals and drains within the municipal limits are interconnected to have a network of storm water drainage. The Galle fort has an underground drainage system introduced by the Dutch. A preliminary survey conducted by the GMC recently has established that the system is still in working order except for routine cleaning, and erection of the windmill required to lift water for flushing out the drainage. Figure 3.21 shows the network of canals and the drainage system.

There are low lying areas between the hills, and some of these low lying areas get flooded during rainy season causing difficulties for transportation etc., specially the road from Galle to Karapitiya via Milidduwa often experiences flooding in the Ganewatte area which is located very low compared to the surrounding area.

3.10.2.7 Solid Waste Disposal

There is no specific law on solid waste management in Sri Lanka. However, a number of national, provincial and local authority level laws and regulations refer to solid waste management within them. Some of the important laws are given as follows.

- National Environmental Act (NEA)

  Hazardous waste management is well covered in the regulations published in 1996 as an amendment to the National Environmental Regulation No.1 of 1990. The amendment clearly defines the obligations of hazardous waste producers, rules for collection, transport and treatment as well as the role by of Central Environmental Authority in the enforcement of the regulations.

- Provincial Council Act given the Provincial Council the power to supervise local government authorities.
- Nuisance Ordinance gives the Department of Health the responsibility and rights to control water supply, waste disposal and pollution.
- Pradeshiya Sabha Act makes Pradeshiya Sabhas responsible for sanitation.

Solid waste management is the responsibility of the Municipal and Urban Councils as well as Pradeshiya Sabha units. These local authorities are required to supply waste management services and empowered to take action against violators of statutory laws.

GMC and Habaraduwa Pradeshiya Sabha (HPS) are responsible for solid waste collection and disposal in the hinterland. GMC's waste collection and disposal service is much refined and well conducted than HPS. Both uncollected and haphazardly dumped waste is visible all around Unawatuna. Some 7-8 tons of Solid Waste is collected daily in GMC area. This figure is around 3-4 tons/day in HPS. GMC uses mainly communal collection method. However, it uses door-to-door collection for the following establishments;

- Ruhunu Cement Factory
- Sri Lanka Navy
- Hospital
- Port
- Light House Hotel

The collection method in HPS is mainly kerbside collection with some door-to-door service for the tourist hotels. GMC uses four tractors while the HPC uses three for solid waste collection. GMC uses a 6-acre sanitary landfill in Piyadigama for its disposal. However the collected waste of the HPC is dumped at ad-hoc sites. The GMC landfill is a private land and adequate for another 1 ½ years. In both these local authorities, no organized waste separation exists.

3.10.2.8 Electricity Supply

The Ceylon Electricity Board (CEB) is the statutory body administering the generation, transmission and mostly the distribution of electrical power in Sri Lanka. In some specific areas along Southwest coast, the Lanka Electricity Company (LECO) is responsible for electricity distribution.

The planning departments and divisional offices of CEB are responsible for demand forecasting and preparation of rolling master plans for improvement of power generation, transmission and distribution facilities to meet future demands on quantity and quality of electricity supply.

Although electricity services are currently improving, there are still supply problems caused by power interruptions and low voltage. CEB may, during drought seasons, regulate electricity supply because of high dependency on hydropower. Therefore, consumers like the port who depend on continuous electricity supply, must have their own power generation back up.

Electricity supplied from the Galle grid substation has a capacity of 60 MVA. All power lines are installed overhead and transformers pole mounted. The quality of power distribution for existing consumers in the area generally is inadequate, low voltage and of irregular supply.

3.10.2.9 Road Transport

Transport by road is the major form of cargo and passenger transport within Sri Lanka, and the South and Southwest coast is no exception. The alignments of road networks are also an important influence on the location of other distribution networks for water, electricity and sewage collection. Road agencies responsible for maintenance and development of road infrastructure are the Road Development Authority (RDA) for A and B roads (national roads), the Provincial Road Development Authorities (PRDA) for the provincial roads, and the local authorities, i.e. Municipal Councils, Urban Councils, and Pradeshiya Sabhas for local roads.

A2, Colombo-Galle-Hambantota road is the main access to the southern and southwestern coastal regions. This road has become increasingly congested, unsafe, and polluted. The 128 km, Southern Highway from Kottawa to Matara, will greatly improve the access. Construction is due to start in year 2000 for completion in 2003. Using this new highway, travel time to all destinations from Colombo to Matara will be greatly reduced. This includes access via link roads from the highway to major towns along A2, including Galle. The link from highway to Galle will be 5 Km connecting at Labuduwa.

A large part of the existing problem of congestion and traffic pollution on A2 road is caused by the road side access it provides to virtually continuous ribbon development stretching from Colombo to Matara. Between towns the urban sprawl continues. The new southern Highway can relieve these destinations South of Colombo of much of the existing dangerous and air polluting through-traffic presently on A2 Road.
There are five main radial roads (National Highways) starting from Galle which links the city with inland towns (See Figure 3.22). All these roads start from A2 and radiates into the inland. The physical characteristics and traffic condition in these roads and on A2 near Galle City taken from RDA are given in Table 3.61.

Table 3.61 Traffic Volumes in Major roads

Route No.	Name	No. of lanes	Width (m)	Average Daily Traffic (ADT)		
				Location	Year	Volume (vpd) Vehicles/Day
A 002	Colombo –Galle-Hambantota	2 lane	6.8	105th Km 111th Km	'99 '97	8,395 7,644
AB 012	Ditto (Marine Drive)	3 lane	6.8	1st Km	'92	10,380
A 017	Galle-Deniyaya	2 lane	5.2	5th km	'97	2,726
B 109	Galle-Thalapitiya	2 lane	5.6	3rd Km	'92	1,410
B 128	Galle-Baddegama	2 lane	5.2	10th Km	'99	3,399
B 129	Galle-Udugama	2 lane	5.6	13th Km	'91	1,200
B 130	Galle-Wakwella	2 lane	7.0	5th Km	'92	1,360

3.10.2.10 Port Facilities

The port has 7 folk lifts, six 2.5 tons and one 3.5 tons. It has two 7-ton cranes and a very old 100-ton American hoist, and 25-ton Kobelco crane. It has 13 grab clinkers.

The harbour area of the port is 320 hectares. The entrance channel is 130 –160m wide and the port has one pier, which is 300m long. It can have 2 alongside berths. The design draft of the port is 8.9m and alongside draft at the moment is 7.3 m. The basin is about 300m long and 200m wide. An additional pier has been constructed to accommodate one more berth towards the northern end of the port near the Fishery Habour. The new pier will be 165 m long and 32 m wide and the design draft is 9.0 m.

Re-fueling for ships is done by the agents of the vessels and the port does not handle it. The water requirement for the port activities is about 80 m^3 per day. The supply from the main line can only deliver about 20-25 m^3 per day. The rest has to be brought from the GMC in bowsers. As such, the port is experiencing a heavy water shortage and inconveniences associated with that. The maximum electricity demand of the existing port for the last three months was between 320-340 KVA. The port has been recording an average electricity consumption of 130,000 Kwh per month. Low voltage and irregular power supply are common problems in the network. There were instances where port activities got disturbed due to these anomalies. In terms of telephone facilities, port has 8 telephone lines at present. However due to the recent developments in telecommunication sector, the telecommunication infrastructure seems to be in ample supply. The port does not have a piped sewage disposal system. It uses a number of septic tanks and soakage pits for sewage and wastewater disposal. At present, due to the smaller size of the port the existing method is quite adequate. However, with the rapid expansion of the port and related facilities (especially the cement bagging facilities) the bare land available for septic tanks and soakage pits will reduce dramatically. Port does not have a systematic storm water drainage network. However, at the moment the water runoff to the sea has not being blocked by any physical barrier. As such, there is no severe storm water drainage problem at present. Solid waste disposal is one of the main problems facing the port at present in addition to water supply. The municipal council does not collect garbage from the port regularly. As an alternative, the port has it's own dumping site within the port premises. The garbage dumped at this site is only those from the port activities. This amounts to about 2 tons of garbage per day. The solid waste from ships is sent out of the port for disposal and a contractor has been carrying out this service. The road infrastructure within the port is adequate for the present cargo throughput. However, the approach road from A2 is narrow and not adequate for larger trucks. The railway link to the port has been neglected for a long time and even buildings have come up on top. As such, the railway link is not in a good condition for future usage.

3.10.2.11 Navigational Activities

Galle Port has a capacity of 2 berthing facilities at a given time. It has one tugboat for piloting and additional ones if required can be taken from Colombo Port. No Lighters or Service vessels available at present for the Ports Authority. However, two private companies are involved in servicing vessels in the international waters 12 nautical miles away from Port. One company has two such vessels and the other has one. The Port does not have repair facilities and dry docks. Port handles only break bulk cargo and container-handling facilities are not available. The number of vessels called in Galle Port has increased steadily in recent years as given in Figure 3.18. This shows that the development momentum in the Southern Region has set in motion. S hip calls has doubled in just six years time from 1993 to 1999.

Manpower in the Port is adequate to handle the present capacity. Altogether 763 people work in the Port. Table 3.62 gives a breakdown of human resource in various Departments. Out of 763, there are 13 executive staff who are in charge for various sub-divisional activities in the Departments.

Table 3.62 Human Resources in the Galle Port

Department	Executive	Non-Labor	Labor	Total
Security	2	46	-	48
Operations	1	60	370	431
Finance	5	31	-	36
Administration	1	41	-	42
Engineering	3	37	117	157
Habour Master	1	11	37	49
Total	13	226	524	763

3.10.3Galle Fort and the Landscape

3.10.3.1 The Galle Fort

Galle Fort designated as a World Heritage Site, is a walled city covering 90 acres. It was initially founded by the Portuguese, although the Fort as it is currently was developed by the Dutch from 1663 onwards. Galle Fort has been designated as a living monument, while conserving and maintaining the physical fabric of the city and environment. The Fort continues to function as an administrative center even to this day. The Fort with fourteen bastions is unique and is still the best preserved, fortified city of the colonial period in South and South-East Asia.

The historic architectural fabric of the Galle Fort is divisible into a number of categories namely;

1. Ramparts
2. Buildings
3. Open spaces, landscaping and roads
4. Drainage system

The Ramparts are the most visual part of the Fort and the most vulnerable for degradation. Compared to the buildings they have deteriorated more and need extra care to ensure their structured stability. In some places the entire wall has been damaged and fallen down. Much of the foundation has been damaged and needs to be repaired.

Residential Buildings that make up to 71% of the building stock within the Fort were built on narrow plots of land, which were sited perpendicular to the street. The Fort contains a large number of institutional and religious buildings and many of the public institutions still remain intact even now.

A study conducted by the Department of Archaeology on Galle Fort documents the existing buildings in it. Table 3.63 shows the various categories of buildings found in the Galle Fort at present.

Table 3.63 Buildings at Galle Fort

	Number	%
Residential	273	71
Commercial	65	17
Residential/ Commercial	07	02
Institutional	21	05
Religious	11	03
Public	03	01
Industrial	03	01
Total	384	100

Out of these 384 buildings about 47% used bricks, 22% corals and 28% a combination of bricks and coral for the structure. As roofing material, about 76% of these buildings used half round tiles. About 31% of these buildings were of Dutch origin and 30% British origin. Only 39% of the buildings were considered as modern. As such most of the buildings are of historical importance and to be conserved. At present 31% of these buildings are restored or preserved.

The study recommends that altogether about 85 buildings to be definitely conserved, 60 to be recommended for conservation and another 179 to be improved.

A major feature of the Galle Fort is the visual expanse of space immediately behind the rampart wall. This environment should be maintained so as not to deface the existing appearance. At present open spaces available in the Fort are used as playgrounds.

Another unique feature of the Galle Fort is the drainage system introduced by the Dutch. A preliminary survey conducted recently has established that the system is still in working order except for routine cleaning, and erection of the windmill required to lift water for flushing out the drains.

The rampart, buildings, open spaces and the drainage system of the Fort are protected by the declaration made in 1971 under the Antiquities Ordinance No. 9 of 1940, subsidiary legislation, section 27. According to this ordinance, a buffer zone is defined 400 yards from the ramparts to protect this historic site. Within this 400 yards any kind of intervention to the existing monument is prohibited.

3.10.3.2 Landscape

Galle Bay has been taken as the zone of visual influence in this study. Various aspects of the topographic closure have been analyzed together with modifying effect of vegetation, which imparts varying degrees of visual transparency.

Galle Bay could be considered to possess a landscape character that is scenic, unsophisticated, urban and tranquil. The Bay could be divided into four distinct landscape tracts as follows.

1. The Galle Fort area - Located in the Western end, the Fort influences the landscape character to a greater extent. It harmonizes well with the surrounding environment adding a special character and a contrast to the immediately adjoining tract.
2. Beach area - The tract adjoining the Fort on the eastern side is a narrow strip of beach with the marine drive and the urban setting at the backdrop.
3. Existing port area and the Gibbet Island - This tract could be considered as a detractor with man made structures comprising the fishery harbour, naval base and the port.
4. Rumassala - This is a hillock located in the eastern end of the bay with another contrasting landscape character. The contrast is in two folds; land form changes from horizontal to vertical in the west-east direction and the vegetation changes from a shelter belt to that of a woodland including the texture.
   The absorption capacity of the landscape to accommodate the existing Port is low towards the western end. The capacity is heighest in the eastern end towards Rumassala.

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ANTICIPATED IMPACTS

4.1 Coastal Environment

The Japan Port Consultants have given four alternative layouts for the proposed extension of the Port of Galle as shown in Figures 2.1, 2.2, 2.3 and 2.4. The suitability of each alternative has been evaluated by the designers in terms of wave penetration, easy navigation, harmonization with the existing neighboring environment, cost, disturbances to the existing port facilities, access to land and potential for future development. It has been found through this analysis that the layout 1 given in Fig. 2.1 is best suited for the proposed port and is considered as the preferred alternative. In view of this finding, greater emphasis will be given to alternative layout 1. More details are given in the main report & only the environmental aspects are dealt here.

In alternatives 1, 2 and 3, the port occupies the eastern part of the Galle bay whereas the alternative 4 occupies the western side.

The alternative layout 1 consists of two breakwaters; a 800 m long outer breakwater aligned in NW-SE direction at around 15 m water depth and a 350 m long inner breakwater located near the proposed berthing structure. The entrance of the port is located between the outer breakwater and the watering point.

In alternative layout 2, a single breakwater attached to the proposed berthing deck shelters the harbor basin. The breakwater aligned in SE-NW direction is 500 m long and lies between 10 m and 15 m contour lines. The entrance is provided near watering point as in alternative 1. Alternative layout 3 is very similar to alternative 2 except where berthing facilities are provided only along the Gibbet Island. A breakwater segment covers the gap between the berthing deck and the offshore breakwater. The alternative layout 4 consists of two breakwaters, one, a large outer breakwater about 1500 m long and aligned in SE-NW direction at 15 m water depth. The other breakwater, which is the inner, is about 300 m long and aligns in SW-NE direction.

4.2 Wave-current Interaction with Port Structures

4.2.1 Interaction with external structures

Wave-current interaction with harbor structures will change the original hydraulic and sediment transportation regimes of the area. But, in three out of the four proposed alternative layouts, the port structures are located within the Galle bay. Therefore, the effects of the proposed port on the existing coastal environment outside the bay will be marginal except for the fourth alternative layout.

It has been found through field measurements and numerical wave propagation simulations that the waves approach the Galle bay mainly from the directional band between W and SW all throughout the year. Therefore, the breakwaters in alternative layout 1 are well capable of providing adequate shelter for manoeuvering and berthing of ships in the harbor basin. Waves entering the basin through the entrance of the port will meet the shoreline near the watering point. The steep seaward projection at the watering point may acts as a natural barrier to these waves and therefore, harbor facilities will not be disturbed. Only the waves propagating from the directional band between S and SE will enter the harbor basin through the entrance.

As both breakwaters are located in 10-15 m water depth, they will be subjected to a non-breaking wave environment. There will be some wave reflection from the two structures and the degree of reflection depends on the type of structure selected. As the seabed in the area is mostly sandy except where rock patches are found, there exists a potential for bed scouring depending on the wave climate in front of the structures arising from incident and reflected waves.

Waves reflected from the outer breakwater could propagate mostly seaward and therefore, neighboring areas, except the immediate vicinity of the breakwater, will not have any significant impact due to wave reflection. But, southwesterly waves reflected from the inner breakwater may cause wave disturbances in the navigation channel of the existing port. Also, west and southwesterly waves reflected from the outer breakwater may cause disturbances in the proposed navigation channel outside the harbor entrance.

In addition to wave reflection that would take place in accordance with the interaction of harbor structures with waves, there will be wave diffraction through the entrance and through the gap between the two breakwaters. Diffracted waves may disperse behind the breakwaters, with the possibility of generating a complex wave environment near the entrance. This aspect should be inspected via mathematical modeling.

The breakwater in alternative layouts 2 and 3 could also be expected to provide adequate shelter to the basin. They will be subjected non-breaking waves and wave reflections could be expected. The impacts of wave reflection in these two cases will be very similar to those in alternative layout 1.

The impacts of harbor structures in alternative layout 4 will be significantly different to those of the other alternatives. Waves reflected from the outer breakwater will move offshore without causing any disturbance in neighboring areas. However, the adjacent beaches will be subject to altered current patterns as the outer breakwater intervene the current distribution outside the bay. Strong currents associated with tidal fluctuations could be expected at the entrance as the breakwater lies along the tidal current path. The interaction of the attached breakwater with the wave and current fields will be minimal as it is already sheltered by the outer breakwater.

4.2.2 Interaction with internal structures

The interactions of waves, which penetrate into the harbor through the entrance, generate reflected waves in the harbor basin. Waves reflected from these structures increase the level of wave disturbances within the basin. Wave reflection within the basin causes several problem such as manoeuvering difficulties, disturbances to handling operations, damage to vessels, etc. However, it should be noted that the impacts related to wave reflections from inner harbor structures could be minimized by the selection suitable structure types. Also, the sandy shoreline remained at the eastern side of the basin will dissipate a part of reflected wave energy thus reducing associated impacts.

4.3 Sediment Transportation into the Harbor Basin

Siltation of harbor basins is a major problem associated with the operation of harbors. The combined effect of waves and currents transport sediment into the harbor basins through the harbor entrance.

The wave and current environment within the Galle bay will be significantly altered by the proposed development project. In alternative layout 1, sediment can enter the basin through the gap between the two breakwaters and through the entrance. It is possible that a part of the sediment load entering into the basin be deposited near the entrance around watering point and in berthing areas. However, excessive siltation may not be expected as the basin is well sheltered by the breakwaters.

In alternative layouts 2 and 3, water near the berthing structures will mostly be stagnant due to lack of circulation currents. This would enable sediment to accumulate in berthing areas. The amount of sediment transport into the harbor basin through the entrance channel will be higher than that of alternative 1 since the entrance channel in these two layouts are aligned with the incoming wave direction.

The sediment carried by tidal flows will silt the navigation channel and the entrance of the port in alternative layout 4. Even though both the channel and the entrance are sheltered by incoming waves, sediment will enter the basin with the tidal flow (Posford and Duvivier, 1999). A part of the sediment may deposit in the channel and the entrance and a part may enter the harbor basin.

It is recommended to numerically model wave and tide induced currents and associated sediment distribution in the harbor basin and in the entrance channels. Such a study would enable to quantify harbor siltation and to identify critical areas of the design, which requires further investigation.

4.4 Adjacent Shorelines

Coastal structures in general change current and wave dynamics and hence shoreline configuration in neighboring areas. Since the Galle bay is well bounded by two headlands, any shoreline change beyond the headlands may not be expected if the port structures are confined to the bay.

However, the offshore breakwater in alternative layout 1 lies slightly outside the mouth of the Galle bay. Therefore, it is possible that this structure intervenes with the sediment transport regime outside the bay. As a result, the sandy shoreline beyond the watering point may be subject to altered wave and current environment and therefore shoreline changes can be anticipated.

It should be noted that the predominant wave approach direction being in the directional band between W and SW, the along–shore sediment transport should primarily be in NW to SE direction. The offshore breakwater in alternative layout 1 lies along the path of the sediment movement and therefore, any influence from the structure on the existing sediment transport pattern will be minimal thus reducing the impacts on neighboring beaches.

In alternatives 2 and 3, the port structures lie well within the Galle bay. Therefore, a significant effect on the sediment transport pattern outside the bay and hence on neighboring shorelines, would not be expected. In alternative 4, the offshore breakwater is located in the open ocean outside the Galle bay and therefore, intervention of it on the current and sediment distribution outside the bay could not be disregarded. The shorelines beyond both watering point and the Galle Fort will be subject to altered wave and current patterns thus affecting shoreline stability. Impacts on the shoreline can also occur at the eastern side of the bay, as it will be subject to altered wave and current environment.

4.5 Dredging and Blasting

Disruption of the sea bottom by dredging and blasting can cause a variety of environmental impacts. The dredging in Galle bay can cause a very specific set of impacts due to the unique characteristics of the bay and its surroundings.

Bathymetric changes brought about by dredging in the harbor basin and in the approach channels can alter flow velocities and directions. This possibility should be carefully examined to ensure that the planned changes would not affect the existing shoreline configuration in the neighboring areas.

Deepening of approach channels and berthing areas would alter tidal and wave induced flows. Large waves can penetrate into the harbor increasing wave activities within the basin and the wave approach direction can be changed. In addition, a component of along-shore sediment can be silted in the channel, which will then effect down drift shorelines.

Dredging during construction may have adverse impacts on the existing Galle port and its approach channel. Alteration of wave and current environment may cause manoeuvering and berthing difficulties in the existing port facility.

Dredging and blasting work necessary during the construction of the alternative layout 4 will create severe adverse impacts on the existing port structures and on the buildings located in Galle Fort as those structures are in close proximity to the construction site.

4.6 Dredged Material Disposal

The impacts associated with the disposal of dredged material will not be a major issue as the present disposal site is capable of receiving the proposed dredged material. Materials to be dredged during the construction of the port may be mostly fine silts and sands, but will contain rock boulders and coral debris. Disposal of these materials at nearby locations is not recommended in view of the impacts on coral reefs and the shoreline.

4.7 Water Quality of the Galle Bay

With the water quality analysis and observations made it is clear that the proposed port would be subject to pollution due to followings;

(i) Pollution from oil & hydrocarbons
(ii) Pollution caused by dredging activities
(iii) Pollution from sewage effluent
(iv) Pollution from urban runoff
(v) Pollution from cargo processing & handling
(vi) Pollution from litter and garbage

Oil is one of the major pollutants that is split mainly by accidents. Potential sources of oil spills include dry dock activities, off-shore and on-shore loading and unloading, bilge and ballast water, tanker operations etc. Oil spills, it in any case takes place, could damage and destruct coral reef drastically.

When the port is in operation, maintenance work would no doubt release heavy metals and other toxic materials. These could deposit over the sediment simply by adsorption. Dredging of such sediments may cause toxic material to release to the water column thereby they may be readily available for fauna which in turn transfer them to human beings through food chain. Poorly designed or non-availability of sewage system would bring more nitrates into the basin causing nutrient enrichment for flora. In addition, faecal contamination could be pronounced giving threats to recreational activities.

Urban run-off could bring in hydrocarbons and oxygen demanding wastewater into the bay causing severe oxygen depletion in the water column.

Mishandling of cargo would lead to pollution of the bay deteriorating water quality. Improper handling of bulk materials, essential commodities and food items may contaminate the bay.

Litter pollution is not only visually unacceptable but also causes human health hazards. Ineffective removal of such waste from ships & port area may become a threat resulting in unpleasant visual site. This could encourage animals such as crows, pigeons, dogs and rats from rummaging the garbage and their subsequent dropping would enable this to be persistent even in the Galle bay.

4.8 Sediment Quality of Galle bay

Even though there is no pollution of sediments at present, with the proposed port, there could be a possibility of sediments being polluted due to enhanced port activities.

Anti-fouling points from ship hulls would increase the heavy metal concentration in the sediments, ship waste, if thrown into the bay could also contaminate the sediments of the bay. Maintenance and repair work of ships would no doubt release some heavy metals into the bay which could be bound to sediments and they may be directly activate for marine fauna. As a result either bioaccumulation or biomagnification would result in making them not suitable for consumption. Other pesticides and organo-chlorides would also be persistent if they are released into the bay. Tracer quantities of such material would affect the fauna associated with coral reef. Hazardous or industrial cargo could also pollute the sediments if accidentally released into the bay.

4.9 Water Quality of Major Point Sources

As described above, the major point sources of pollution are the three watercourses Moragoda Ela, Waggal Modera Ela and Kepu Ela. All three watercourses are adding pollutants to the coastal water in and around the harbour. However, no significant direct impacts are anticipated on the water quality of these watercourses, due to the project activities of any of the alternatives. However, care should be taken in providing waste disposal facilities for the work forces during the construction period, and providing proper drainage facilities for the loading/unloading areas, especially for bulk cargo, as negligent handling of these may result in creating pollution sources that would be harmful to the aquatic environment in the Galle Bay.

4.10 Water Quality in the Recreational Areas

The water quality near Unawatuna beach will not be directly affected by any of the alternatives proposed, as it is located several kilometres to the east of the Galle Bay. The activity that would have caused some changes in water quality in this area would have been dredging for the approach channel, particularly in the Alternatives 1, 2 and 3. But the design bed level of the approach channel is –12m, and according to the benthic survey plans, the seabed level in the area outside the Galle Bay is lower than this level. Therefore, no dredging is anticipated in this area.

However, the old harbour area, which is also a popular recreational area, particularly among the local people, would be affected due to the project activities. The following activities are the most likely to affect the water quality in the old harbour area:

Alternative 1 - Construction of inner breakwater and revetments (1) and (2)

Alternative 2 - Construction of revetments (1), (1') and (2)

Alternative 3 - Construction of inner breakwater and revetments (1)

Alternative 4 - Construction of outer breakwater, dredging for approach channel, inner breakwater and wharf.

The above activities would deteriorate the quality of the water in the old harbour area during the construction period, and is likely to render the area unsuitable for contact sports during the construction period. This would of course be a temporary impact, as the wave action would remove the water contaminated by the construction activities once the work is over. The dredged material is not expected to contain any toxic material, as the samples tested do not show any toxic compounds (as described elsewhere in this report).

Alternatives 1 , 2 and 3 are not likely to cause any significant impact on the water quality of the old harbour area during the operational phase of the project, as it is protected from the harbour activities by the break waters and revetments. However, alternative 4 is likely to cause negative impacts even during the operational phase, as the vessels would be travelling close to this area, and no protection is offered by the structures. Thus alternative 4 is the least desirable in this respect.

4.11 Noise levels

The proposed project activities would cause increased noise levels around the construction site during the construction phase. However, since the site is away from any noise sensitive locations, this would not cause any major impacts.

However, the noise levels outside the port area are fairly high even at present due to the traffic. This situation is expected to be worsened during the construction phase, due to the trucks transporting construction materials from the quarry sites to the port area. Even during the operational phase, the noise levels are expected to be higher, due to the fact that there would be more commercial activities, together with high traffic volumes, particularly in the city limits. The predicted noise levels due to road traffic could be calculated once the traffic volumes are estimated in the feasibility studies. This will need to be done in the EIA report.

4.12 Air Quality

There will be an increase in the suspended particulate matter in the air during the construction period, due to the dust and cement, and vehicular traffic carrying the construction materials to the site from the quarries. During the operational phase, indirect impacts on the air quality would result from the increased road traffic due to development of the area. These impacts will be the more or less the same for all the alternatives studied.

4.13 Construction Material

The construction of the structures require large quantities of rocks, sand and other construction materials. For example, the estimated volumes of rock required for the construction of off-shore works are shown in Table 4.1.

Table 4.1 Rock Volumes required for off-shore structures in the Alternative 1

Offshore Structure	Net Volume of Rock (m^3)
Breakwaters	729,000
Revetments	381,000
Quay	24,000
Total	1,134,000

These materials have to be mined from the quarries available in the vicinity of the project area and transported by trucks to the site. The quantities required would be available in the nearby quarries, as there are large deposits of rock in this area, and several large quarries are already in operation. However, if new quarries are to be opened up, it is now necessary to obtain environmental clearance from the Geological Survey and Mines Bureau, in order to ensure that no irretrievable commitment of mineral resources is being done.

In the case of sea sand too, the Geological Survey and Mines Bureau grants permits for exploration and removal of off-shore sea sand from specific locations using specific methods.

4.14 Sewage, Drainage and Other Wastewater Systems

No significant impacts are anticipated on the Sewage, Drainage and Other Wastewater Systems due to the project activities, except the temporary effect of need for these facilities for the work force. However, due to the development of the area in future due to the project, some indirect impacts may be expected.

4.15 Solid Waste Disposal

Construction activities would produce solid waste and debris that should be disposed of properly. Some solid waste will also be produced in the workers' quarters. During the operational phase too, solid waste collected from harbour activities as well as from ships will need to be disposed of. Occasionally, some imported consignments of goods need to be discharged, due to unsatisfactory quality or some other reasons.

4.16 Hazardous Meterial & Ship Discharges

As the port is developed, and more activities are taking place in the port during the operational phase of the project, the number of ships that call at the port requiring waste disposal facilities as well as the probability of accidental spills of hazardous materials will be increased. If the port authorities do not provide the disposal facilities for waste oil, bilge water, sewage and garbage, the waste would be disposed of in the sea, or in the harbour. This would lead to pollution of the marine environment. Accidental spills of cargo handled at the harbour also would cause pollution of the water in the harbour. The actual damage to the environment would depend on the type of material that is discharged, the quantities discharged and the sensitivity of the environment to the material discharged. Since the types of materials and the quantities discharged are uncertain, in the evaluation of alternatives, the best approach would be to select the alternatives that avoid the movement and activities of the port near the environmentally sensitive areas, which would be affected mostly by polluted water. The environmentally sensitive areas within the Galle Bay are shown in Fig. 7.1. Thus, the area on the eastern coast, between Gravet Point and Watering Point is demarcated as coral area, and several "forbidden marine archaeological sites" are found to the west of the Port of Galle. Thus alternative 4, which would result in most activities in the western part of the bay would be having the greatest impact. Alternative 1 would cause the least activities in the sensitive areas and would thus cause the least impacts, while Alternatives 2 and 3 would have some impacts on the water quality in the coral reef area.

4.17 Flora of Rumassala Cliff

The activities such as road and building construction will have adverse impacts on terrestrial flora and the whole ecosystem especially during the construction phase. The proposed road is demarcated in already developed area and this will not affect the plant species and forest communities in the undisturbed forest patch in Rumassala. The building construction will also confine to the areas having degraded forest. The exploitation of construction materials might decrease the habitats of plants species and communities.

During the construction, dredging and blasting operations will cause water pollution. This will affect the populations of marine algae species found on rocks and dead corals. Sedimentation will reduce the penetration of sunlight and most of the algae species in the affected area will not survive.

4.18 Coral reef

4.18.1 Water flow and its effect on corals

Clearwater, plenty of sunlight, stable temperature and salinity are required for optimal coral reef growth. However coral reefs are found in many places where conditions are not ideal. In such locations coral have adapted to living under varying conditions. One of the most important conditions for the survival and growth of corals is water flow over the reef which improves the exchange of nutrients, oxygen, carbon dioxide, bicarbonate and other ions as well as larval dispersal, competition, propagation by fragmentation and for the removal of sediment from the corals (Sebens, 1997).

Sebens and Johnson (1991); Sebens and Done (1992); Helmuth and Sebens (1993) had given typical mean flow speeds during non-storm conditions in areas without strong currents as less than 5cm/s (fore reef habitats at a depth >25m), 5 – 15 cm/s (mid to shallow fore reefs) and 20 – 100 cm/s (surf zone). However during storm induced extreme conditions the flow can be as much as 7m/s (Graus et al. 1984). In Sri Lanka the flow rate around the Little Basses reef could be as high as 3m/s (Swan, 1984).

Sebens (1997) has categorized flow rates on coral reefs during non-storm conditions as low (<1 – 5cm/s), moderate (6 – 20cm/s), high (21 – 50cm/s) and very high (>50 cm/s) based on available information. Low flow rates appear to limit the exchange of gases and nutrients between the coral tissues and the surrounding water. Low exchange of gases in turn affects metabolic rates of corals (Patterson and Sebens,1989; Patterson et al. 1991), productivity of the zooxanthellae (Dennison and Barnes, 1988; Shick, 1990; Patterson et al. 1991) as well as the nutrient uptake (Atkinson and Bilger, 1992).

According to Sebens (1997) corals show a wide range of flow rate tolerance from <5cm/s to over 30cm/s with a mid range of 10-20cm/s. However at very high flow rates (>50cm/s) feeding of coral polyps might be affected where they will be unable to maintain polyps in an open position. It has been pointed out that the energy required keeping the polyps open in very strong currents may be greater than the energy that can be obtained by capturing plankton. The other extreme of very low rates of flow (< 5cm/s) could also increase the sediment accumulation on the corals. Sebens (1997) points out that under very low current conditions the polyps may also find it difficult to capture prey as zooplankton can escape from the polyps as soon as they come into contact with the extended tentacles. Furthermore in very shallow water the temperature could increase which is also highly detrimental to corals. Therefore corals depend on a medium flow rate for capturing food particles and for gas exchange, suitable temperature as well as to get rid of sediment particles that settle on them. However much depends on individual sites where the sediment loads and other factors such as water transparency controls coral reef development.

The proposed development and associated construction at Rumassala could decrease water flow within Rumassala area, which could increase the rate of sedimentation on the reef.

4.18.2 Sediment accumulation and impacts on corals

Sediment accumulation is one of the major causes of reef degradation. Increased amounts of suspended particles in the water as well as sediment deposition on the reef degrade reef condition and cause coral mortality. However, much depend on water circulation. Dredging near coral reefs increase turbidity thereby reducing the light available for photosynthesis processes of the symbiotic algae (zooxanthellae) living within tissues of reef building corals. Excessive loads of sediment could also cause adverse impacts on the structure and function of a reef system by altering physical and biological processes (Rogers, 1990). Sediment also affects coral recruitment, growth rates and colony morphology (Rogers et al. 1984). Foster (1979, 1980) has shown that *Montastrea* colonies exhibit changes in their skeletal morphology when transplanted to locations with higher sediment rates. Dodge and Vaisnys (1977) had suggested that larger corals are more susceptible to sediment deposition than smaller colonies because sediment removal from colony surfaces is random and uncoordinated, resulting in a greater probability that particles would remain on the surfaces of larger colonies. However this depends much on the growth form of the coral colony and its height above the surrounding seabed. At Rumassala there is a combination of different growth forms, which include large coral domes, as well as flat colonies. Randall and Birkeland (1978), Morelock et al. (1983), and Hubbard (1987) had reported that reefs are generally better developed with more coral species, higher coral cover as well as faster growth rates when they are located away from sources of high sedimentation. Metabolic rates of corals and other zooxanthellate organisms are also affected by particles in suspension in the water column because they alter the light intensity and spectral quality reaching the corals. Synthesis of field observations and laboratory experiments has suggested that different species have different capabilities of clearing sediment or surviving in lower light conditions. Studies have also indicated that some corals are better adapted to live with greater loads of sediment than others. Suspended particles will also affect water transparency. At Rumassala visibility is about 3 to 4 m during the non-monsoon period and reduces to less than 2 m during the southwest monsoon.

Lasker (1980) has reported that *Montastrea cavernosa,* a species of coral found in the Caribbean is an efficient sediment remover and is capable of cleaning itself up to about 14mg cm^{-2} d^{-1}. Related species belonging to genera *Favia, Favites* and *Montastrea* are found in Sri Lanka and all three genera occur at Rumassala reef. Pastorak and Bilyard (1985) has referred to sedimentation rates for the Indo-pacific region as 0.1 to 228 mg cm^{-2} d^{-1} based on work carried out by Marshall and Orr (1931); Smith and Jokiel (1975); Schuhmacher (1977); Randall and Birkeland (1978). They have also stated that sediment rates could be higher in some areas. Table 4.2 (in Pastorak and Bilyard 1985) indicates the estimated degree of impact on coral communities due to various levels of sedimentation based on work carried out by Dodge et al. (1974); Ott (1975); Loya (1976).

Table 4.2: Estimated degree of impact on coral communities by various levels of sedimentation. (after Pastorak and Bilyard 1985)

Sedimentation rate [a] mg cm^{-2} d^{-1}	Degree of Impact
1 – 10	**Slight to moderate** [b] Decreased abundance Altered growth forms Decreased growth rates Possible reductions in recruitments Possible reductions in numbers of species
10 - 50	**Moderate to severe** [c] Greatly decreased abundance Greatly decreased growth rates Predominance of altered growth forms Reduced recruitment Decreased numbers of species Possible invasions of opportunistic species
> 50	**Severe to catastrophic** [d] Severely decreased abundance Severe degradation of communities Most species excluded Many colonies die Recruitment severely reduced Regeneration slowed or stopped Invasion by opportunistic species

[a] Data used to generate this table are for reef communities at moderate depth and moderate exposure. Some variation occurs among authors in the sediment rates associated with the degree of impact.

[b] Dodge et al. (1974); Ott (1975); Loya (1976); Randall and Birkeland (1978); Lasker (1980)

[c] Griffin (1974); Loya (1976); Randall and Birkeland (1978); Morelock et al (1979); Lasker (1980)

[d] Randall and Birkeland (1978)

4.18.3 Pollution from oil and other effluents

The impact from sewage and urban waste could become a serious problem for marine life within the Galle Bay, particularly if the water flow is reduced due to the construction of breakwaters. Pastorak and Bilyard (1985) had identified 3 broad interacting categories with regard to sewage pollution, namely nutrient enrichment, sedimentation and toxicity. They had also pointed out that there is a greater impact from sewage pollution in embayments and protected coastlines than along open coastlines.

4.18.4 Coral reef associated organisms

Fish adapted to living close to the substrate tend to remain in the same locality even when the conditions become less than favorable whilst larger specimens and the more mobile species would migrate to nearby habitats. In a study carried out by Amesbury (1981) on dredging and filling near a reef reported that the number of fish species had decreased significantly where fine sediments had accumulated from dredging and filling activities. Many reef-associated species such as fish, lobsters, crabs etc. depend on the reef structure to provide shelter and living space as well as food. With severe reef degradation the reef could lose its rugosity and as a result the ability of the reef to support many organisms would be affected.

Table 4.3 Impacts due to the construction of breakwaters and quay

Construction works and port functional aspects	Issue	Possible impacts on coral reef and marine life
Rock blasting	Vibration and re-suspension of sediment	Vibration could damage reef structure, Suspended particles may cause sediment deposition. Blasting could also kill marine life particularly fish
Dredging	Increased loads of suspended particles due to dredging	Smothering of coral reef
Construction of piers/breakwaters etc.	Increased loads of suspended particles. Reduction of water flow	Smothering of coral reef by sediment Adverse effect on corals and other organisms
Dumping dredged material	Adverse impact on the marine life and reefs where dredged material will be dumped	Settlement of dumped material on offshore reef sites
Movement of ships and other vessels	Increased suspended particles	Smothering of coral reef
Oil leaks and spillage from boats etc. (chronic)	Chronic oil pollution in the Bay	Shallow areas could be adversely affected by oil coated suspended particles
Oil pollution from accidental spill	Oil contamination within the Galle Bay	Sudden spill damage may be temporary but depends on the degree of the spill. If large, a spill could coat the entire reef in oil
Antifouling paints and other chemicals	Toxic matter in the water	Toxic to marine life and could adversely affect marine organisms; can bioaccumulate
Garbage	Solid and liquid waste in the water	Smothering of reef and general pollution of the sea

4.19 Marine Achaeology

Construction Stage

4.19.1 Port construction on the Bay as a whole

The construction of a commercial port, even on a modest scale, can have only an adverse impact upon a heritage site such as Galle Bay. As many as 25 archaeologically important sites have been listed in the chapter on the Existing Environment. The major construction work involved in dredging, blasting, pile driving etc. will definitely be a major intervention in the archaeological environment. Further, the change in patterns of water movement consequent upon the building of breakwaters, aprons and other structures, and the increase in shipping would definitely impact adversely on the archaeological fabric of the Bay. It has been confirmed that the Bay itself will be seriously considered as a World Heritage Site if its candidature is proposed: it has also been suggested that the historic waters (i.e. the western part, abutting the Fort) be declared a Protected Site. Attempts are therefore, made to quantify the adverse impact anticipated and suggest means that could reduce it to the least possible level, so as to strike a balance between conflicting interests of heritage protection and commercial development.

4.19.2 Overall archaeological concerns

Of the main environmental impacts that the construction will have on the marine archaeological sites, the areas considered are given in Table 4.4.

Table 4.4 Anticipated impacts of the port construction on Maritime Archaeology

Actions affecting archaeological resources	Damage accruing from such action
1. Dredging and stirring of seabed	1.1 Sediment stirred up enters the water/current flow and creates changes in the topography of the seabed. Effects have already been mapped. 1.2 Known sites will suffer changes and unknown sites will be destroyed
2. Changes in water and current flow within the Bay, and their effects	2.1 While there is no record of changes made due to the building of structures in the Bay earlier than 75 years, the topographical maps and Admiralty navigation charts indicate the changes that have been made by the construction of the present harbour and the smaller boatyards, which have led to silting up, changes in coastal geomorphology and either exposing or submerging archaeological sites. Even in 1936, concern has been expressed on the silting up around the jetties that serviced the ships anchored in the stream in the pre-1967 period. 2.2 Certain archaeological sites are accretion sites, i.e sites which have no wrecks of importance but which have served as sites to which existing water flows have carried artifacts from other, unknown sites in the Bay.
3. Adverse effects on cultural, tourist and recreational facilities in the Bay by the construction or expansion of Port facilities in the waters abutting the Fort	3.1 The area that is protected under the provisions of the Antiquities Ordinance (i.e 400 yds. from the Ramparts of the Fort) is used by schoolboys of Galle as a practice swimming pool as there is no built pool in the town. This is carried on with the approval of the Galle Heritage Foundation and Civic authorities. 3.2 Below the Lighthouse is an area of the beach that is used by families as the only beach area available for recreational purposes in Galle, with the approval of the Galle Heritage Foundation and Civic authorities. 3.3 The area between the eastern face of the ramparts and the Bay is occupied by (among others) the National Maritime Museum and the Maritime Archaeological Laboratory (under construction.) This area is earmarked as a site for cultural activity area under the Galle Master Plan (under preparation), one reason being to improve the visual impact of the Galle Fort from seawards. 3.4 One of the underwater sites, Site L, is earmarked for long-term, seasonal exploration and to be built up as a major Tourist attraction, with a pier leading to it and closed-circuit television links between on-going work and the Museum.
4. Removal of bottom soil dredged up	4.1 Much material of archaeological value will be recovered in the process of dredging the seabed. This material will need to be examined prior to removal. In the past, much material was disposed of with no sensitivity and archaeologically valuable material was lost
5. Blasting of sea-bed	5.1 Blasting, drilling and pile driving will require prior approval of the Archaeological Dept. as damage can occur not only to the underwater sites but the Galle Fort itself. The seabed and the headland form a continuous bed of rock and the Fort's foundations are in an unstable state now. All such activities will pose a threat to the Fort itself and all the underwater sites.

4.19.3 Specific sites identified

The impact anticipated upon each of the sites (A-Y) by each of the four alternatives are quantified in the Table 4.5 and the major cause of anticipated impact upon each is also indicated.

Table 4.5 Anticipated impact of Alternatives upon Sites quantified (varying from A-Z)

SITE	Alt. 1	Alt. 2	Alt.3	Alt.4	Reasons for anticipation of adverse impact
A (9)				H	Close to channel. Widening and deepening will destroy the site
B					(Has now been removed as a navigational hazard)
C (1)		H	H	H	Approach channel likely to be a hazard for maritime archaeologists
D (1)				H	Very close to channel. Widening and deepening will destroy site
E (8)				H	Close to channel. Increased shipping on new channel will prove hazardous
F (6)	H	H	H		Site of an archaeological study. Construction will destroy site completely
G (4)	M	M	M		Will be affected by channel traffic
H (1)				L	(Removal and relocation possible)
I	L	L	L		(Not precisely located nor explored)
J(10)				H	Close to new channel proposed. Increased use by shipping will prove hazardous
K(5)				H	Close to channel, proposed basin, and Archaeological Dept waters
L(10)				H	Close to proposed new channel. Increased shipping will be disastrous.
M(1)				H	Very close to channel. Increased shipping will affect it.
N (1)	L	L	L		(Removal and relocation possible)
O (1)	L	L	L		(Site may be cleared after study)
P(10)				H	In Archaeological waters. Dredging/blasting of channel will affect it badly.
Q (4)	L	L	L	L	(Site may be constructed upon after study)
R (4)				M	(Removal and relocation possible)
S (1)	L	L	L	M	(Site may be cleared after study)
T (4)				M	(Removal and relocation possible)
U (7)				H	Bordering channel. Dredging for increased traffic will destroy valuable site.
V (7)				H	Within Archaeological waters. Dredging of new channel will destroy site.
W(4)	L	L	L	H	Training site for maritime archaeology trainees. Will be rendered unsafe as channel is too close
X	L	L	L	L	(Existence of target known, but not precisely located)
Y (2)	L	L	L	L	Exploration not anticipated

Note: Impacts are categorrized as low-L; Moderate-M; High-H

4.19.4 Evaluation of Alternatives 1-4 in relation to archaeological concerns

On the basis of the evaluation above, Alternative 4 cannot be considered an alternative at all, and it is recommended that it not be forwarded for serious consideration particularly in relation to Maritime Archaeology. While Alternatives 1, 2 & 3 appear to be only marginally different from each other, Alternative 1 takes preference over 2 and 3 in view of Site C. Site C has a low rating only as it is outside the Bay proper. However this site is definitely of archaeological importance, but only precisely located lately and, hence, not yet explored. Alternatives 2 and 3 provide for the approach to the Bay to go near this site (Alternative 4 envisages the construction of a breakwater adjacent to it), while Alternative 1, alone, provides for the approach to avoid this site. Hence, from an archaeological perspective, Alternative 1 is the alternative of choice.

4.19.5 Operation Stage

The changes that take place in topography possibly due to the changes in current and wave climate could affect the archaeological sites in the long run. Nevertheless, the adverse compacts during operation stage would be marginal. Hence no attempt is made to explore the potential impacts during the operation stage on the archaeological sites.

4.20 Socio-economic Impacts During The Construction and Operational Phases of the Project

This section deals with likely impacts of the proposed port expansion project on the socio-economic parameters of the population mentioned under the 'existing environment'. Impacts are assessed for all four alternatives, which are summarised in Tables 4.6 and 4.7. Impacts during the construction phase and operation phase of the port have been identified and would be discussed separately. The impacts due to the location of harbour are discussed under the construction phase.

4.20.1 Fishing Activities in The Project Area

4.20.1.1 Fishing Activities At *Dewata*, Due To Proposed Location Of The Port Facilities

Fisheries activities in the *Dewata* area are likely to be affected by the proposed location of the port facilities. This is true for all four alternatives, but the impacts will be less felt in respect of Alternative 1,2 and 4. The approach channel and other harbour facilities of Alternative 3 are too close to the area of beachseine operations (*padu*). Fisheries activities in the Old Harbour Masters area, *Mapalawella* area, *Magalle* area and at *Unawatuna* and *Talpe* areas will not be significantly influenced by the location of port facilities as per alternatives studied.

The fisheries activities in *Dewata* are likely to be affected in two ways.

1. In case the shore-line is to be fenced and access to coastal waters (in the new harbour area) is denied to the fishermen, then these fishermen will have to be provided with alternative fishing locations because they will not be able to anchor their crafts and to operate them from the *Dewata* area. Moreover, they may not be able to lay their beachseine in coastal waters of *Dewata*.
2. Increased port activities and dredging of the seabed may cause changes in marine coastal ecology. This may results in a change in species composition of fish catches and the quantity of fish caught.

Table 4.6 Impacts during the Construction Phase

Actions Affecting Socio-economic Parameters	Damages to the Socio-economic Parameters	Assessment of the degree of impact Significant Effects			
		A1	A2	A3	A4
1. Actions Affecting Coastal Marine Ecology					
1.1 Location of harbour in fisheries capture zones	1.1a Loss of beaching point for crafts and loss of traditional area of operation for beachseine fisheries and traditional fisheries activities (at *Dewata* in Zone 1 of the project area) if shoreline is fenced and access to coastal waters is denied to fishermen..	M	M	M	L
	1.1b Decline in fish catches in *Dewata* of Zone 1 of the project area.	M	M	M	L
	1.1c Decline in fish catches in *Mapalawella* of Zone 1 of the project area.	L	L	L	M
	1.1d Decline in fish catches in Zone 3 of the project area.	L	L	L	
1.2 Disposal of dredging spoils into fisheries capture zones	1.2a Loss of fish catches in Zone1 and of the project area.	L	L	L	L
1.3 Location of harbour and increased activities in coastal fisheries resource areas	1.3 A decline in fish catches in the coastal fisheries	L	L	L	L
2. Actions affecting Anchorage and movement of other crafts					
2.1 Sea traffic affecting the movement of fishing crafts during the construction period	2.1a. Disturbing the movement of fishing crafts operating from fisheries Harbour premises				M
	2.1b Disturbing the movement of fishing crafts operating from Old Harbour Masters office and *Magalle.*				M
2.2 Sea traffic affecting the movement and anchorage of yachts during the construction period	2.1c Disturbing the movement and anchorage of yachts causing loss of income from yachts and loss of interest in *Galle* port for yachtsmen.				M
2.3 Sea traffic affecting the movement boat services	2.3 Adversely affecting the boat services providing for the needs of the ships anchored outside old harbour premises awaiting entry into harbour				L
3. Actions Affecting Recreation/Resort/Beach Areas Along Coastal Zone					
3.1 Dredging and Construction Activities and disposal of dredging spoils	3.1b Increased turgidity of beach waters and loss of swimming sites, recreational sites and diving sites for tourists. Loss of income from tourism.	L	L	L	
	3.1b Loss of income for local people depending on tourism.	L	L	L	
4. Actions Affecting Existing Port Activities					
4.1 Sea traffic during construction phase	4.1 Disturbing cargo handling activities of the existing harbour				M
	5. Actions causing increased Road Traffic				
5.1 Increased movement of vehicles carrying soil, rock , rubble and cement to construction site	5.1 Traffic congestion in the present A2 road	M	M	M	M

Note: L – Low; M – Medium; H – High

Table 4.7 Operation Phase

Actions Affecting Socioeconomic Parameters	Damages to the Socioeconomic Parameters	Assessment of the degree of impact			
		No Significant Effect		Significant Effects	
		A1	A2	A3	A4
1. Actions Affecting Recreation/Resort/Beach Areas Along Coastal Zone					
1.1 Escape of liquid and solid wastes from harbour area, especially floatables	1.1a Silt and garbage deposition along shoreline in Fort of Zone 1 of project area.				L
	1.1b Silt deposition along shore line affecting the recreational facilities in the *Unawatuna* area (Zone 3 of the project area)	L	L	L	L
1.2 Oil spills/leakage within harbour which escape harbour area	1.2 Oil films on beach waters and shoreline, affecting recreational facilities in the *Unawatuna* area (Zone 3 of the project area)	L	L	L	
2. Actions affecting Anchorage and movement of other crafts					
2.1 Sea traffic affecting the movement of fishing crafts.	2.1a. Disturbing the movement of fishing crafts operating from fisheries Harbour premises				L
3. Handling of Materials to and from Harbour					
3.1 Traffic congestion	4.1 Air pollution and noise pollution and, congestion of present A2 road.	L	L	L	L
4. Actions Affecting Local Population					
4.1 Harbour activities and coastal pollution affecting resident population along the coast.	5.1 Harbour activities and, waste deposition along shore line affecting the residential population along the *Dewata* beach.	L	L	L	L
4.2 Excessive noise from harbour operations	5.2 Causing health problems to residents in the Zone 1 of the project area				

Note: L – Low; M – Medium; H - High

4.20.1.2 Coastal fisheries

Dredging and blasting activities and, disposal of dredging spoils in coastal resource areas may cause a decline in fish catches in Zone 1 of the project area, affecting the landings of seine fishermen and those fishing with traditional crafts. However, these impacts will be greatly felt by the seine fishermen because their gear cannot be moved into deeper waters. In the case of declining catches, the traditional crafts may shift their area of operation beyond the construction sites, into deeper waters. These impacts will be similar for all four alternatives studied.

4.20.2 Sea traffic during the construction phase affecting movement of crafts 'to' and 'from' the existing fisheries harbour

4.20.2.1 Movement of fishing crafts

These impacts will be felt only if Alternative 4 is implemented. The large number of mechanised fishing crafts (both day boats and multi-day crafts) move along the existing approach channel into the offshore and deep-sea waters. Construction activities associated with Alternative 4, may interfere with the movement of these crafts, which number more than 300. This will affect their routine fishing trips and disturb their fishing activities.

4.20.3 Recreation/resort/beach areas along the coastal zone

Dredging and construction activities and disposal of dredging spoils may cause increased turbidity of beach waters and therefore, loss of income from tourism (both from decreased tourist arrivals and loss of income for those local people depending on the tourist trade). However, it should be noted that activities related to tourism are concentrated in Zones 2 and 3 of the project area. Whether construction activities in Zone 1 will increase the turbidity of coastal waters in Zones 2 and 3 will depend mainly on the pattern of wave action. In case the pattern of wave action causes siltation and increased turbidity of coastal waters in Zones 2 and 3, then income from tourism will be greatly affected. Such impacts will be lower for Alternative 4 than other alternatives, since the construction zone is further away from the touristic areas of Zones 2 and 3.

4.20.4 During the Operational Phase

No grater impacts are found during the operational phase. However, there could be a considerable adverse impact on fish catch in the Deweta area with increased ship movement, but it may not be likely to encounter soon after construction.

4.21 The Built-Environment

4.21.1 Introduction

The built-environment would be significantly changed, modified or altered to accommodate the proposed development. In addition to this process of changes, the project would pose a severe strain on the existing physical infrastructure facilities on the hinterland. This section deals with the anticipated impacts of the port development on the built-environment.

4.21.2 The Hinterland

4.21.2.1Construction stage

The construction of the port requires materials and plant to be procured from and stored in different places in the hinterland. Although this will have an impact on the land use, it would be marginal and temporary in nature. Most of the bare land, agricultural land, fringe areas, and the beach may be used as material storage areas. The loss of access to the beach during construction would cause an impact on the local community's recreational activities (in the Dewata Area).

The construction of port would not cause any significant impact on water supply, sewerage, electricity, and solid waste disposal. Transportation of construction materials in large quantities would cause a significant impact on the road and rail transport system. Even at present, most of the roads around Galle are congested and additional traffic due to construction would aggravate this situation. The railway option is also limited due to the narrow scope in the network and strength of bridges.

All four port layouts would considerably affect the transportation infrastructure while having low impacts on utilities. The impact on land use would be low in all four options. Table 4.8 provides the summary of intended impacts on the hinterland.

Table 4.8 Intended Impacts During Construction

Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Land Use	Low	Low	Low	Low
Utilities	Low	Low	Low	Low
Transportation	Moderate	Moderate	Moderate	Moderate

4.21.2.2 Operation Stage

The proposed port is likely to have both direct and indirect impacts on the land use of the hinterland. These impacts are governed by the following factors;

(i) Direct usage of land for port operation

(ii) Improvement in accessibility, and

(iii) Agglomeration of economic activities.

Port terminals, storage and other facilities will use large areas of land. In addition, access roads, parking areas will consume a considerable amount of space in the hinterland. Taken together, the land side operations of the proposed port will change the land use pattern of the hinterland to a greater extent. It is envisaged that the new port would attract local and foreign industries to the hinterland and create an agglomeration of industries and commercial establishments. These will in turn change the pattern of land use in the Galle area to a predominantly an industrial/commercial one.

The port and the prospective industries would require infrastructure services, which are not adequate at present in Galle. Incidentally, there could be a severe impact on the existing infrastructure if measures are not taken to improve them. With the completion of the proposed Greater Galle Water Supply Scheme, there wouldn't be a serious water shortage in the Galle area. However, electricity supply, sewerage and solid waste disposal would be problems that have to be sorted out before the new port becomes operational. During the operational stage of the port, roads and railways are expected to shoulder the burden of distribution of the cargo generated at the new port. The potential cargoes to be received at the new port are not only destined to the Southern area, but also to the whole country. These include both break bulk and container cargo. In 2005 it is envisaged to handle about 1,718,000 tons of cargo, including 27,900 TEU's of containers. This would amount to a huge increase in traffic movement to and from the port each day. The potential impact of this on the already congested road network would be enormous. However, with the construction of the proposed Southern Highway, the traffic congestion in the north-south corridor would be greatly reduced. Nevertheless, the potential impact on urban traffic condition in Galle City cannot be under estimated.

All four port layouts would considerably affect the transportation infrastructure while having low impacts on utilities. The impact on land use would be low in all four options. Table 4.9 provides the summary of intended impacts on the hinterland.

Table 4.9 Intended Impacts During Operation

Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Land Use	Low	Low	Low	Low
Utilities	Low	Low	Low	Low
Transportation	Moderate	Moderate	Moderate	Moderate

4.22 The Existing Port

4.22.1 Construction stage

Transportation of construction materials, their storage, construction work including temporary work could disrupt the existing port in following ways;

(i) Disruption to the access channel and the basin causing difficulty in operation of boats and vessels and disruption to mooring facilities

(ii) Disruption to cargo handling facilities

(iii) Disruption to port related land traffic.

The severity of impact on various elements will depend on the method of construction. However, disruption could be anticipated on the waterways, anchorage and berthing, if materials are brought in by sea. On the other hand, if transported by land, it could affect the land side operations. As such, in one way or the other, construction material transportation would have an adverse impact on the day to day operations of the existing port. The construction work itself, especially dredging, pile driving, reclamation etc., will undoubtedly disrupt the operations of the existing port.

Among the proposed layouts, alternative 4 would have the highest impact on the existing port during construction. Other three alternatives could be ranked equally.

4.22.2 Operation Stage

Except Alternative 4, other options will not affect the existing port during the operation stage. In case of Alternative 4, existing port cannot function independently and a proper integration of the two ports to be worked out. Table 4.10 provides the summary of intended impacts on the existing port.

Table 4.10 Intended Impacts on the Existing Port

Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Construction	Low	Low	Low	Moderate
Operation	Low	Low	Low	Moderate

4.23 Galle Fort and the Landscape

4.23.1 Introduction

The proposed project would significantly change, modify or alter the sensitive areas such as the Galle Fort and the landscape of the Bay. This section deals with the anticipated impacts on these sensitive areas.

4.23.2 Galle Fort

4.23.2.1 Construction Stage

Blasting for dredging, pile driving etc., may generate ground vibration which in turn, can cause damage to the rampart, underground drainage and the historic buildings in the Fort. The Fort has been designated as a heritage site and to be preserved for future generation. There would be an irreparable impact on the Fort, if construction produces ground vibration. The Ramparts are the most endangered part of the Fort and the most vulnerable to ground vibration. Much of the Rampart foundation is in a deteriorated condition and parts of the Western Wall has already fallen down.

4.23.2.2 Operation Stage

Other than for visual quality, Port operation would not cause any significant impact on the Fort. The impact on visual quality is discussed in another section dealing with the landscape. The Table 4.11 provides the summary of intended impacts on the Fort.

Table 4.11 Intended Impacts on the Existing Fort

Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Construction	Low	Low	Low	Moderate
Operation	Low	Low	Low	Low

4.24 Landscape

4.24.1 Construction Stage

Construction is invariably not a pleasing operation to watch. When a project of this magnitude is underway, it's visual impact would be significantly high. The material and plant used in the construction work would destroy the tranquillity of the bay and transform it into a busy construction site. Reclamation of the sea would change the topography of the bay and its landscape character. This will be the case during the daytime as well as nighttime. The night time visual impact will be more due to illumination necessary for the works.

4.24.2 Operation Stage

The new Port would significantly intrude the existing visual quality of the Galle Bay due to the following reasons;

(i) Due to the relative size, new Port would dominate the landscape character of the Bay. The existing port, fisheries harbour and the naval base are relatively small in size and they are not dominant at present.

(ii) The landscape character would change from "naturalness" to that of "mechanised" or "industrial" in character with the presence of the proposed port.

(iii) The Port related buildings, equipment and ships would obstruct the view of the Bay.

(iv) The Port will not harmonise with the existing buildings and architectural feature in the Bay. The "modernness" of the Port will look very much out of place with the historical Dutch Fort.

(v) The tranquil nature of the Bay would disappear soon after the Port starts its operation. Port would create a "busyness" and a "quicker pace" in the Bay.

(vi) It would create a feeling that the Bay is "congested" compared to the present feeling of "vastness".

The first impact would be high in intensity for long distance views. The second impact would be high for medium distance views. Other four impacts would have the highest intensity for short distance views. Figure 4.2 illustrates the impacts and their intensity against viewing distance.

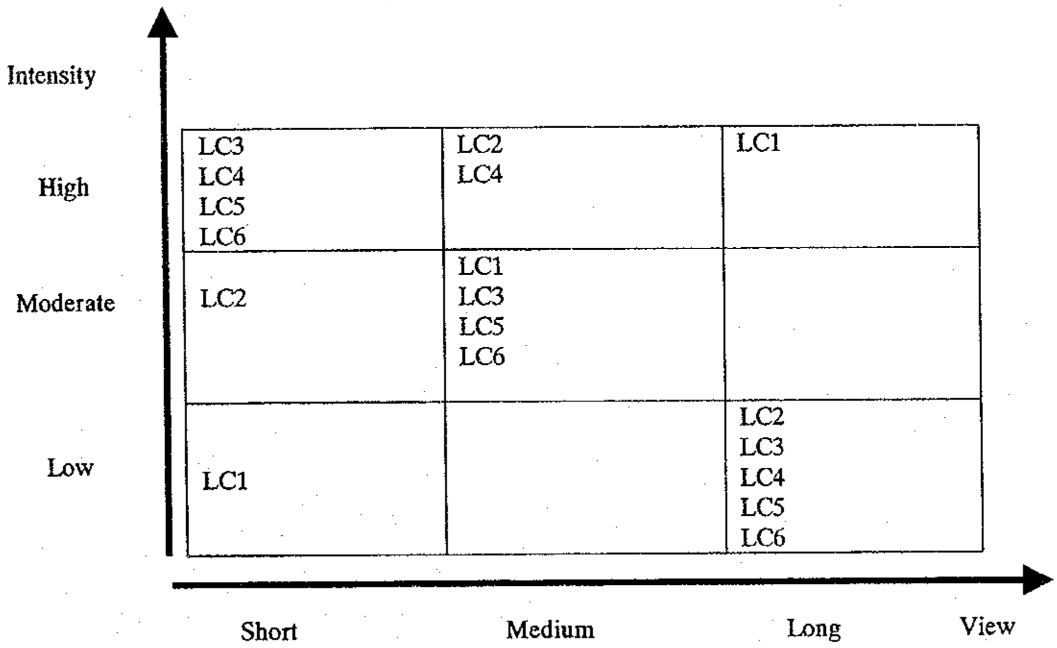

Figure 4.2: The schematic diagram depicting the intensity of various aspects of landscape character over the distance of view

LC1: Landscaped Character is visually altered by dominance

LC2: Landscaped Character becomes either mechanical/industrial

LC3: Landscape is obstructed due to the structures

LC4: Landscape is modernized compared with that of Fort

LC5: Tranquillity is greatly affected and busyness is considerably introduced

LC6: Vastness is reduced and congestion is introduced

The visual intrusion at nighttime will be severe than that of daytime due to illumination. The illumination in the Port would be intense in view of security and work conditions and contrast with the low-intensity lighting in the surrounding areas.

Both during construction and operation, all four layouts would considerably affect the landscape of the bay. Table 4.12 provides the summary of intended impacts on the landscape.

Table 4.12 Intended Impacts on the Landscape

Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Landscape- During Construction	Low	Low	Low	Medium
Landscape- During Operation	Low	Low	Low	Medium