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Proposed Beach Nourishment project at Bajja Ta' San Gorg, San Giljan

An Environmental Impact Statement

- **Non-Technical Summary**

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Non-Technical Summary Report on the Environmental Impact Assessment of the Proposed Beach Nourishment Project at Bajja ta' San Gorg, San Giljan

Introduction

The non-technical summary of the Environmental Impact Assessment (EIA) on the proposed beach nourishment at Bajja ta' San Gorg, St. Julians presents a description of the main findings of the EIA (including the results of an *environmental risk assessment* using the Environmental Risk Assessment (ERA) software package), together with the results of an integrated evaluation of these findings.

This document appropriately presents the EIA as a decision making tool by presenting:

- *The **main study findings***
- *The **alternatives considered available to the project**.*
- *The **environmental changes predicted in each case**.* For each alternative considered, the positive and negative socio, economic and ecological impacts on the natural and human environment are predicted. The potential interaction of such impacts and their synergistic consequences were also considered.
- *The **trade-offs of advantages and disadvantages for each alternative considered**.* The alternatives and their associated impacts were subsequently compared so as to identify that alternative with an optimum mix of environmental, social and economic costs and benefits.
- *A **clear set of recommendations** are finally provided.*

Study findings

1. Introduction

St George's Bay was identified by the Ministry for Tourism and has now been listed by the Planning Authority as a suitable site for potential replenishment of the existing sandy beach (Policy NHCV08 of the North Harbours Local Plan published by the Planning Authority as a Public Consultation Draft in April 2000). Such replenishment is subject to the submission of a satisfactory Environmental Impact Assessment. The benefits of the creation of a more attractive environment for locals and tourists through the implementation of such a project must be weighed against any impacts on the natural environment and must also consider the long-term financial implications.

In this context, the Euro-Mediterranean Centre on Insular Coastal Dynamics (ICoD) was commissioned by the Department for Tourism at the Ministry for Tourism of Malta to carry out an Environmental Impact Statement (EIS) on the proposed Beach Nourishment at Bajja Ta' San Gorg, San Giljan.

2. Project justification

The project justification examines the rationale behind the proposed beach nourishment, from two principal perspectives: the need for a national pilot project, and the choice of St George's Bay as the pilot project site.

a) National Strategic considerations

Pilot project beach replenishment
Beach replenishment should be considered as a partial solution to the lack of sufficient sandy beaches to satisfy the demand from local and foreign bathers in the Maltese Islands. The recommended strategy is for the careful implementation of a selected pilot project in order to assess the viability and potential of future beach replenishment works. While not expected to achieve a repositioning of Malta's tourism policy goal as a sandy beach destination, the upgrading by replenishment of existing beaches will enhance visitor satisfaction, contributing to more repeat visits and promotion of Malta through the generation of positive visitor feedback. It is accepted that it is impossible to quantify these derived benefits from the proposed pilot project and their monetary value is hence represented in the report by a 1% increase in the gross foreign exchange earnings from tourism, equivalent to Lm 2.7 million.

Pilot project Blue Flag beach
Improved standards and facilities at beaches are recognised to enhance the experiences of holiday-makers in Malta, and are thus expected to increase the

perceived value-for-money and visitor satisfaction of the Maltese Islands as a tourist destination. This effect is represented in this study by a financial benefit of Lm 2.7 million, based on an expansion of 1% in tourist arrivals.

b) *Local Site-specific considerations*

Enhancement of San Gorg area through beach replenishment
The St George's Bay area represents Malta's prime concentration of 5 star accommodation, and the neighbouring Paceville area hosts extensive leisure facilities and innumerable bars, restaurants and discos. Considering the impact of a successful beach nourishment project at St George's Bay on such establishments in the area, a total increase in value of Lm 2.01 million was estimated. This figure was calculated by assuming a 13% increase in commercial property values and a 1% increase in hotel property values.

Enhancement of San Gorg area through Blue Flag classification
Although expected to translate into greater visitor satisfaction, and to contribute to repeat visits to the beach and to the surrounding establishments, the magnitude of this effect is difficult to estimate, and is not expected to be significant when compared to the financial benefits of the beach replenishment itself as estimated above.

Additional satisfaction of existing beach users due to Blue Flag amenities
A survey of existing beach users at the San Gorg beach indicated that 50% of beach users would be willing to pay around Lm 0.55 per visit for improved beach facilities. In view of the estimated current beach capacity of 100 bathers, this translates to an estimated Lm 27.5 per peak summer day, equivalent to Lm 3,300 during each bathing season. Assuming that this annual income flow of Lm 3,300 were to be invested at an interest rate of 8% per annum, this would be equivalent to a capital increment of Lm 41,250.

Additional persons using the beach as a result of beach replenishment
The replenished beach is estimated to cater for about 660 additional beach users. The satisfaction that would be derived by these new beach-users, expressed in terms of their willingness-to-pay as given above, can be estimated at an additional Lm 181.50 per peak summer day, equivalent to Lm 21,870 annually, corresponding to a capital increment of Lm 272,250.

Additional revenue to nearby establishments
Although the influx of additional visitors to the beach is expected to generate additional business for many of the establishments in the area, this is very difficult to quantify, and is hence treated as a 'bonus' in the report.

3. Economic Feasibility

The viability of the replenishment project is clearly dependent on its economic feasibility, which reflects the need to cover both the initial investment as well as meeting all subsequent recurrent costs related to operation and maintenance in a sustainable manner.

a) Investment Expenditure

Replenishment of beach
The proposed beach replenishment at Bajja ta' San Gorg should be seen as an additional element in the planned government-funded upgrading of the Paceville area. The simplest possible scenario would therefore be to assume financing of all costs related to the intervention by Central Government. The cost of the sediment was estimated based on a single source commercial source of sample material predicted by the hydrodynamic modelling study to form a stable beach. While the cost of this material would be expected to vary in the case of a tendering procedure for the supply of sand, for the purposes of this study the cost of material on site can be estimated at Lm 500,000. The above is the worst case scenario, since it may also be possible for Government to obtain suitable sediment through bilateral agreements, at much more favourable terms than those estimated above.

Construction of Blue Flag amenities
While many of the Blue Flag criteria refer to standards (e.g. bathing water quality) and services (e.g. information and safety), an initial investment expenditure is required for the provision of certain amenities such as public toilet facilities. A global figure of Lm 100,000 is estimated to be sufficient to cover the required interventions for the upgrading of the area.

b) Recurrent Expenditure

Beach cleaning and related expenditure
Based on information from work-study exercises carried out at specific beaches over the last few years by the Field Services Unit of the Department of Local Councils, it is possible to estimate the expected cost of the regular cleansing of the replenished beach at St George's Bay. The estimated annual cost of Lm 2,000 covers manual cleansing of sand, service of litter bins, mechanical sifting of sand, removal of accumulated seaweed, and sweeping of sand from the road.

Maintenance of Blue Flag amenities
The estimate of Lm 4,420 includes maintenance of public toilets, railings, bollards and street furniture, safety and environmental information boards and telephone, and showers.

Operation of Blue Flag amenities
A total of Lm 9,060 was budgeted for the relevant services required for conformity with Blue Flag standards, contributing to general beach management, visitor information and visitor safety and security. These services include the introduction of a special "Beach Warden" during the bathing season for first aid, lifesaving and enforcement and information duties, as well as a full-time attendant at the public convenience.

Seasonal sand replenishment for beach maintenance
An annual allowance of Lm 10,000 was factored into the study in order to compensate for any losses of sediment from the replenished beach due to severe storm events.

Interest payments on initial expenditure
Considering a notional stream of interest payments corresponding to the initial expenditure (assuming this had been covered by a loan) or to the interest forgone on the amount invested on the project, it is possible to arrive at an annual sum of Lm 48,000.

c) Recurrent Revenue

Local council
Central Government currently provides local councils with a specific financial allocation to cover upkeep of beaches and related facilities within their localities. At present, St Julian's council is estimated to receive Lm 5,000 for interventions relating to St George's Bay. The funding formula provides for an automatic allocation of increased funds in the eventuality of changes in the Council's responsibilities – in this case, the additional beach area and public amenities would justify an increase of Lm 5,920 per annum for beach cleansing, and upkeep of promenade and public conveniences.

Additional amenities required by Blue Flag status and not covered by the present funding formula are primarily related to public information on safety and environmental aspects, and the estimated Lm 500 costs are expected to be covered through sponsorships and paid advertisements.

Beach users
While no fees are envisaged for use of the beach, the provision of certain services at the beach is expected to result in a total operating profit to the beach operator of Lm 39,000. This sum is treated as a bonus within the cost/benefit analysis.

Local enterprises
The report proposes granting one or more concessions to private sector establishments in return for an annual fee of not less than Lm 60,000. It is also suggested that other private sector interests, such as the neighbouring hotels, assist in covering some of the recurrent expenditure, such as either the Lm8,000 interest repayments associated with the upgrading of the beach to Blue Flag status, or the Lm10,000 budgeted to cover potential future sand replenishments.

The above cost benefit analysis for the project justification and economic feasibility study is summarised in Tables 1 and 2.

Two additional scenarios for project funding were also considered. Both scenarios assume no granting of a beach concession and no involvement of the private sector. Table 3 examines the project's feasibility in the case of adoption of Blue Flag standards and Table 4 examines the option of leaving out Blue Flag amenities. Both these options are based on the premise of Central Government providing the funding to cover both the investment costs and the recurrent expenditure necessary to maintain the replenished beach and, where present, the Blue Flag amenities. It must however be stated that it is difficult to envisage a situation where the project is exclusively funded by Central Government, given the necessarily limited nature of public funds available for such projects, and this is hence considered to be a less realistic scenario. It must also be stressed that private sector participation is a particularly relevant option in the

establishment of a sustainable funding strategy for the current pilot project as well as further replenishment exercises to be considered in the future.

Project Justification

Cost / benefit analysis - summary

	Benefit	Expenditure
Local / site specific considerations:		
Investment expenditure:		
• replenish beach		Lm 0.5 million
• construct 'Blue Flag' amenities		Lm 0.1 million
Enhancement of San Gorg area:		
• from beach replenishment	Lm 2.01 million	
• from 'Blue Flag' classification	*not significant*	
Adverse socio-economic effects upon area		*largely negligible*
Environmental impact on the marine ecology		*covered in Benthic Report and in Integrated Evaluation section of report*
Additional satisfaction of existing beach users due to 'Blue Flag' amenities	Lm 0.04 million	
Additional persons using beach as a result of beach replenishment	Lm 0.27 million	
Additional revenue to nearby establishments	*treated as a bonus*	
Totals	Lm 2.32 million	Lm 0.6 million
National / strategic considerations: *(indicative values only)*		
• Pilot project beach replenishment	Lm 2.7 million	
• Pilot project 'Blue Flag' beach	Lm 2.7 million	

Table 1: Project Justification: summary of cost/benefit analysis

Economic Feasibility

Cost / benefit analysis - summary

		Revenue	Expenditure
Recurrent expenditure:			
• cleansing of beach			Lm 2000
• maintain 'Blue Flag' amenities			Lm 4420
• operate 'Blue Flag' amenities			Lm 9060
• maintain beach (seasonal intervention)			Lm 10000
• interest payments (re beach replenishment)			Lm 40000
• interest payments (re Blue Flag amenities)			Lm 8000
Recurrent revenue:			
(a) to Local Council		Lm 5920 *in central government funds* *	
		Lm 500 *from sponsors*	
(b) to Local Council or Central Government		Lm 60000 *rent from beach operator/s*	
		Lm 8000 *levies from other establishments*	
(c) to beach operator/s	Lm 39000 *(as operating profit)*		
Totals	Lm 39,000	Lm 74,420	Lm 73,480

* This item of revenue represents the additional central government funding to the Local Council. It has been calculated strictly on the basis of the existing (present) formula that determines funding for the cleansing and upkeep of beaches and related amenities.

Table 2: Economic Feasibility: summary of cost/benefit analysis

Economic Feasibility

Cost / benefit analysis - summary

	Benefit	Expenditure
Recurrent expenditure:		
• cleansing of beach		Lm 2000
• maintain beach (sand)		Lm 10000
• interest payments	(All of the original investment borne by government, no interest charges specifically linked to project)	NIL
Recurrent revenue:		
to Local Council	Lm 11500 *in central government funds** Lm 500 *from sponsors*	
Totals	Lm 12,000	Lm 12,000

* This item represents the additional central government funding to the Local Council that would have to be forthcoming to maintain the nourished beach (but no blue flag amenities) assuming that the formula that determines central government funding, for the cleansing and upkeep of beaches and related amenities, has been appropriately broadened to cover the additional intervention that would be necessary.

Table 3 provides a reformulation of the relevant costs assuming no 'Blue Flag' amenities, no beach concession and no private sector involvement.

Economic Feasibility

Cost / benefit analysis - summary

	Benefit	Expenditure
Recurrent expenditure:		
• cleansing of beach		Lm 2000
• maintain 'Blue Flag' amenities		Lm 4420
• operate 'Blue Flag' amenities		Lm 9060
• maintain beach (sand)		Lm 10000
• interest payments	(All of the original investment borne by government, no interest charges specifically linked to project)	NIL
Recurrent revenue:		
to Local Council	Lm 24980 *in central government funds** Lm 500 *from sponsors*	
Totals	Lm 25,480	Lm 25,480

* This item represents the additional central government funding to the Local Council that would have to be forthcoming to maintain the nourished beach and the blue flag amenities assuming that the formula that determines central government funding, for the cleansing and upkeep of beaches and related amenities, has been appropriately broadened to cover the additional intervention that would be necessary.

Table 4 provides a reformulation of the relevant costs assuming no beach concession and no private sector involvement but including the 'Blue Flag' amenities.

The overall conclusion of this study was that both socio and economic cost-benefit considerations indicate a largely positive gain to be achieved through the execution of a carefully planned pilot beach nourishment in St. George's Bay. While the adoption of Blue Flag standards has been recommended within this report as part of the socio-economic justification for the project, it should be noted that Blue Flag status is not specified as a requirement within the project's terms of reference, and that the adoption of such measures is thus at the discretion of the developer.

4. Description of existing site

The site is located at St. Julians, approximately 3 km from Valletta and consists of a roughly rectangular bay 600m long by 200m wide and facing NE. There are two small pocket beaches located at the northwest and southeast corners, corresponding to the discharge points of two watercourses within the watershed of the bay. The topography of the San Gorg Bay and surrounding areas is strongly indicative of a drowned river system oriented NNE – WSW and consisting of the main trunk (the bay itself) which is in turn fed by two tributaries arising from Wied Mejxu. The area thus consists of a ravine with relatively steep slopes having a peak height of 22.5m above sea level towards Pembroke and Bay Street to the North and SW respectively and 17.5m above sea level towards Paceville on the southern arm of the bay. The slopes become gentle toward the top of the ravine, marking the change from the Lower Coralline limestone of the valley sides and its Globigerina Limestone bottom.

Although the bathymetric surveys commissioned in 2000 and in 1996 both describe generally similar isobath patterns, the two bathymetric charts were not compared since it was considered that, in the absence of long-term sea bottom profiling necessary to identify trends/cycles of sediment transport, any such comparison would be meaningless.

The bathymetric survey of Bajja ta' San Gorg was carried out in 2000 to provide an accurate description of the seabed topography on which subsequent hydrodynamic modeling could be carried out. The profile of the bay's bathymetry, plotted along the centre-line of the bay reflects a gentle slope of about 1 in 30 which levels out at a distance of about 75.5m from the waters edge and a depth of about 2.6m. At about 100m offshore, the seabed again describes a gentle slope of about 1 in 30 out to a distance of about 193m offshore, leveling off at roughly the -5.6m bathymetric contour. Beyond this point at a distance approximately 200m offshore and water depth of about -5.6m, the seabed topography describes the beginning of a berm which at its highest point, reduces the water depth to about -3.75m at a distance of about 270m offshore. About 315m offshore and at a water depth of -4m, the seabed once more dips, this time with a much sharper slope of about 1 in 14. This slope is broken by a narrow (roughly 45m wide) trough at a depth of about -16m (and 485m offshore) which raises the sea-bed to the -13.5m contour before continuing its downward slope. This seabed depression (describing a drop of nearly 15m in water depth over a distance of 400m to the mouth of the bay) has been ascribed by the geomorphological study as a fault or a relict waterfall along the buried watercourse of the ancient river system.

The 2000 bathymetric survey additionally describes the cross-sectional profile of the bay as having a V or U shaped pattern characteristic of submerged valleys. This feature which also extends up to and beyond the mouth of the bay, is first encountered at the -5.6m seafloor depression about 190m offshore, between the Cresta Quay and the Marina San Gorg hotel concrete shore platform. The bathymetric survey reveals that at this point, the seabed at either side of the bay takes on a much steeper profile than previously encountered.

On comparison of the aerial images taken in 1957, 1967, 1988, 1994 and 2000, the most striking feature is the rapid urbanisation of the area encompassing St George's Bay. This seems to have boomed between the years of 1957 and 1988 when the southern arm of the bay was developed from a fairly rural area (with the exception of what was then the Dragonara Complex to the South, Villa Rosa just behind the beach and the Pembroke Barracks to the North) into suburban Paceville on the southern arm of the bay. The time span between 1988 and 2000 shows an increase in development with the construction of the Pembroke Housing Project and large hotel complexes taking place on the Northern arm of the bay as well as the development of entertainment complexes just behind the beach; all of which have changed the usage patterns of the bay and the beach itself as well as its boundaries.

With respect to the pocket beaches at the beach head, the series of aerial photos indicates that over the time span in consideration (1957 – 2000), there was no appreciable fluctuation in the size of the sandy beach or in the shoreline pattern except for what appears to be an absence of the western pocket beach during 1972. All the photos (except that of 1957, which is not clear enough in this respect) show that the small pocket beach located in the southeast corner has always been longer and wider than the area of sand in the northwest corner.

The colour aerial images of St George's Bay taken in April 2000 also provide clearer information regarding the seabed within the bay than was previously available from the black & white aerial photography of earlier years. In particular, the more recent imagery allows a distinction to be made between individual benthic zones, identifying for example, the predominantly bare sand habitat in the shallow water near the sandy beach, as well as the bare sandy patches within the predominantly algal and seagrass communities. It can also be seen that the benthic vegetation is more continuous towards the sides and mouth of the bay, with a more patchy distribution being seen in the middle and towards the sandy beach. This data was subsequently also used in connection with mapping of the benthic habitats in the bay.

Geomorphologically, St George's Bay was identified as an ancient submerged watercourse, having two tributaries with small pocket beaches established at their discharge points, on either side of the head of the bay. The eastern pocket appears to be a permanent feature while the smaller western pocket beach appears to be unstable as it is not shown on the 1972 survey sheet. These points constitute the locations of minimum water energy for deposition of sediment by longshore currents under the present hydrological regime of the bay. It is suggested that incident waves are reflected by the solid concrete wall that separates the beach from the road, thus directing sand deposition away from the beach and contributing to the reduced beach area present.

A field survey of the local geology and geomorphology identified that due to the nature and composition of the rocky slopes surrounding St George's Bay, friable rock that could yield abundant sand grade particles is largely absent. The examination of sand samples from the seabed at various points in the bay revealed a high content of whole or fragmented tests of marine fauna. The state of preservation of these tests indicated that they comprise different faunal generation, suggesting that the sand is just being seasonally transported to different locations within the bay. The mud content of some samples further indicates that wave energy even at shallow depths, coupled with the baffling effect of sea grass meadows, is not sufficient to sort the sediment.

The contribution of land-derived sand-grade sediment was found to be minor, and examination of sand samples from the seabed revealed a high content of particles derived from marine faunal tests. The mineralogical composition of the sand is calcite with very minor impurities. The sediments within the bay are mostly medium to fine-grained sands, with a coarse gravel fraction derived from whole and fragmented marine shells. In this context, due consideration should be given to the potential contrast in resistance to abrasion and chemical attack of the existing calcite sediment (hardness 4) and any proposed nourishment material. If quartz sand is considered as a potential nourishment material, it is important too note that quartz (hardness 7) is very resistant to both mechanical and chemical attack, and usually constitutes the final composition of mature sediment of terrigenous origin. Replenishment of the existing calcite beach sediment using a material such as quartz sand is predicted to eventually lead to the abrasion and eventual disappearance of the calcareous sand from the beach sand system. Unfortunately, it was not possible for the commissioned study to indicate a timeframe for this effect.

A hydrological study of the St George's Bay watershed identified the bay itself as the point towards which all stormwater flow is directed. The extensive urbanisation of the catchment area and the lack of planning in dealing with the associated increase in overland runoff were identified as the main contributing factors to the increased stormwater flows in to the bay. Overflows of the sewage system during storm events were also considered to be of particular concern to the proposed nourishment project.

The watershed basin or catchment area whose natural outlet is St George's Bay is situated in the North-East of Malta, and is relatively small when compared to the major catchment areas locally. The basin covers an area of about 1.7 km^2 and is bound by Madliena Heights on the West, Pembroke on the North, Swieqi/Paceville on the South and the sea at the Bay on the East. Wied Mejxu constitutes the main original drainage, but intense urbanization since the early thirties has deformed the original drainage direction, and the greater part of the area's stormwater runoff now flows along the road system and reaches the sea via the beach at St George's Bay. The situation was considered to be exacerbated by the predominantly steep gradients and the lack of sufficient natural infiltration and/or accumulation areas. An additional problem identified was that of frequent overflows of the sewerage system, caused by runoff water finding its way into the sewers, which are then unable to cope with the increased flow.

The hydrological study divided the area into seven sub-catchment areas, for the purpose of estimating runoff characteristics of the area. Using rainfall data from the Luqa Meteorological Office, a five-year storm was modelled in order to estimate the peak flows from each sub-catchment, and the following peak values were obtained for the

three main outlets in St George's Bay: 0.24 m^3s^{-1}, and 0.83 m^3s^{-1} for the Paceville and Pembroke sub-catchments respectively, and a peak flow of 3.14 m^3s^{-1} from the outlet combining the runoff from the remaining sub-catchments i.e. High Ridge, Ibragg, Swieqi, San Gorg and Crescent.

The runoff problems within the San Gorg catchment area were identified as having the following causes: decrease in permeability and decrease in catchment response time to rainfall. Decreased permeability results from the construction of buildings, access roads and paved areas associated with the recent rapid urbanisation within the catchment area during the past 45 years. The catchment response time is mainly a result of insufficient stormwater drainage development, which has not been proportional to the rapid urbanisation already noted above. Both these factors were considered to contribute to the increased frequency of significant flood events, and a number of modifications to the existing overland flow network were proposed as mitigating measures. It was further considered that the implementation of full provisions to contain the largest stormwater flow that can ever arise would be extremely expensive. The total costs of such a project would also need to include the social costs of traffic disruption, environmental damage, and expected loss of profits to commercial and business establishments in the area during the construction works. The report therefore proposed an effective management strategy using flow controls, attenuation and storage measures to minimise the consequences of intense storms which are beyond the capacity of the existing drainage system.

The first proposal is for a proportion of the existing stormwater runoff, originating from the Swieqi, San Gorg, High Ridge and Ibragg areas, to be diverted to flow into the sea at a point further out towards the mouth of the bay, thus avoiding having large volumes of water discharging directly onto the beach. The other proposal suggested the use of part of Wied Mejxu as a retention basin from which the collected water discharges by percolation, evaporation or slow discharge controlled by a dam into the bay. This retention pond would deal with runoff originating from parts of Madliena, Ibragg, High Ridge and Pembroke, and the implementation of this recommendation would require only minor construction works in order to divert the existing flow path. Along with the above, the runoff from the Pembroke area, as well as from Ibragg and High Ridge, could also be partially diverted into Wied Mejxu, further delaying and reducing overland flow. The implementation of this proposal would require a prior assessment of the environmental impacts of such measures on Wied Mejxu and the surrounding area.

It should be noted at this point that the above measures suggested within the hydrology study merely represent practical proposals for possible structural alterations to the present watershed in order to mitigate the negative impact of stormwater runoff on the beach. The design of an appropriate stormwater runoff system is currently under discussion between the Ministry of Tourism and the Department of Works of the Ministry for the Environment. Following discussions by the EIA co-ordinators with the Planning Authority and the Ministry for Tourism, it was agreed that the issue of appropriate stormwater system design is external to the terms of reference of the EIA for this project. The issue is consequently being addressed by the Department of Works within its Master Plan for the area, in close consultation with the Ministry for Tourism.

The ecology of the area was appraised by a general survey of the infralittoral benthic habitats and assemblages from the headlands to the head of the bay, and by the

compilation of a detailed species list for these habitats. The benthic survey was carried out to confirm, and update where necessary, a previous study of the St George's Bay area carried out in 1996 by the same consultants, thus obtaining an accurate picture of the present situation. A combination of four survey techniques was employed as follows. The spatial extent of different bottom types and benthic assemblages was mapped from planimetric aerial photographs, supported by information from underwater transects surveyed by SCUBA divers. Quantitative in-situ sampling was employed to compile the species list.

The dominant assemblages of *Posidonia oceanica* seagrass meadows and photophilic algae are generally typical of those found in similar inlets locally. Few changes since 1996 were evident in the marine environment of St George's Bay, the only notable change being a decrease in the *P. oceanica* cover in the central parts of the bay, with a corresponding increase in the number and area of bare sandy patches, attributed to pollution from construction and organic material. The latter is also indicated by the presence at the head of the bay of nitrophilous algal species such as Ulva, Enteromorpha and Cladophora, and of heavy epiphytic growth on seagrass leaves, all of which are indicators of organic enrichment. The abundance and diversity of fauna associated with fine sand and muddy sediments was considered to indicate the prevalence of fine sediments within the bay

It was not considered possible to compare the information on species abundance and community composition collected for this report with similar data for other bays, since the present study is at present unique in detail for the Maltese Islands. However, the data collected in this survey was considered to constitute essential base-line data for evaluation of the results of any future monitoring. The only locally protected species identified is the Noble Pen-shell *Pinna nobilis* (listed as 'rare' within the Red Data Book for the Maltese Islands), which occurred in the *Posidonia oceanica* meadows in the central parts of the Bay and at the mouth. This bivalve is a protected species under the Flora and Fauna (Protection) (Amendment) Regulations, 1999 (Legal Notice 161 of 1999) issued in terms of the Environment Protection Act, 1991. No other locally protected species occurred in the study

It was noted that a number of species found in the bay are listed in international treaties concerning marine protection to which Malta is party. The locally protected *Pinna nobilis* is listed in Annex I (List of Endangered or Threatened Species) of the *Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean* of the Barcelona Convention. Other species present in the study area also listed in this Protocol are the sea urchin *Paracentrotus lividus* which is listed in Annex II (List of Species whose exploitation is regulated), and species of *Cystoseira* and the seagrasses *Cymodocea nodosa* and *Posidonia oceanica* which are listed in Annex I. Additionally, *Cymodocea nodosa* and *Posidonia oceanica* are listed in Appendix 1 (Strictly Protected Flora Species) of the Berne Convention of which Malta is a signatory, while *Paracentrotus lividus* is listed in Appendix III of the same Convention.

As a member of the European Union, Malta will also have to adopt the EU's Habitats Directive, Annex I which lists natural habitats whose conservation requires the designation of Special Areas of Conservation. Some 200 different types of habitat are listed, some of which are further designated as 'Priority Habitat Types'. Amongst these

are "*Posidonia* beds (*Posodonion oceanicae*)" [Natura 2000 code 1120] which is also a Priority Habitat.

Social activities within the St George's Bay area were found to be centred mainly on leisure, tourism and marine recreational activities, and can be listed as follows:

- *Marine-related and maritime activities:*
  - bathing and related activities, such as sunbathing and snorkelling, at both sandy beach and rocky shore areas of St George's Bay)
  - water sports, such as jetski hire and use, pedalboat hire and use, windsurfing, waterskiing
  - boat mooring (for both leisure craft and artisanal fishing boats)
  - rod-fishing from the shore
- *Leisure-related activities:*
  - catering establishments (bar and restaurant facilities)
  - beach-related products/souvenir sales outlets
  - tourist accomodation
  - leisure and entertainment facilities, such as cinema complexes, bowling alley, roller skating
  - shopping malls
  - casino

Also included in the report are details of the existing resource networks, comprising details of the layouts of the potable water, electricity and sewage networks for the area.

5. Project Description

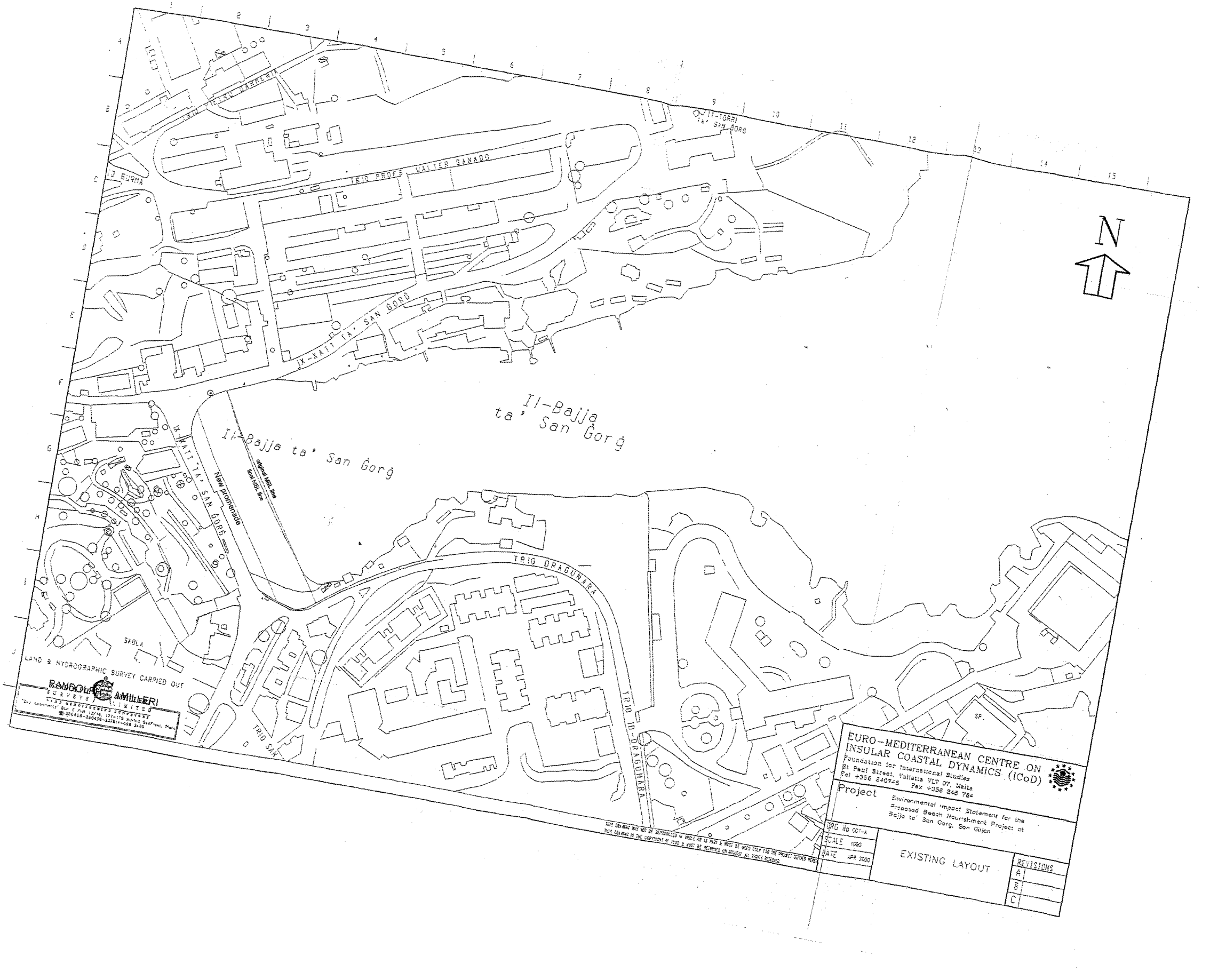
The design of the proposed nourishment project was based on the following parameters set by the Ministry for Tourism:

- The existing road will be retained at its current level.
- A 10-metre wide elevated promenade will be created by land-filling, between the road and the nourished beach
- A 25-metre wide beach will be created by sand replenishment, consisting of a 20-metre wide bathing area and a 5-metre wide buffer/recreation zone between the bathing area and the promenade

A plan view of the promenade and nourished beach in accordance with the above design parameters is shown in Figure1.

Following evaluation of the project within the EIA, the project design specifications being *recommended for implementation* consist of:

- A 25-metre wide beach will be created by sand replenishment, consisting of a 20-metre wide bathing area and a 5-metre wide buffer/recreation zone between the bathing area and the promenade
- The existing road at the back of the beach will be pedestrianised and converted into a promenade with appropriate ancillary facilities such as sanitary facilities, lifeguard tower, first aid station, public phone booths, information boards


TRIQ PROFS WALTER GANADO
TRIQ DRAGUNARA
IX-XATT TA' SAN GORG
New promenade
Original MSL line
Revd MSL line
Il-Bajja ta' San Gorg
SKOLA
SP.
LAND & HYDROGRAPHIC SURVEY CARRIED OUT
RANDOLPH MILLER SURVEYS LIMITED
N
EURO-MEDITERRANEAN CENTRE ON INSULAR COASTAL DYNAMICS (ICoD)
Foundation for International Studies
St Paul Street, Valletta VLT 07, Malta
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Project
Environmental Impact Statement for the Proposed Beach Nourishment Project at Bajja ta' San Gorg, San Giljan
DRG No 001-A
SCALE 1000
DATE APR 2000
EXISTING LAYOUT
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The material to be used for constructing the nourished beach will be imported from overseas, since no suitable sediment sources are available locally. Construction of the nourished beach is expected to involve the transport of suitable sediment to the beach site by either land (trucking) or by sea (using barges/hopper dredgers). Once the sediment is deposited at the site, mechanical means will be used to level it to form a beach as described above. The beach will then reach its equilibrium shape and slope through wave action in the seasons following the intervention.

Implementation of the beach nourishment project will result in an increased beach area of approximately 1,700 m^2, representing sufficient space on the replenished beach for approximately 760 bathers at any one time. In view of this increased use of the site for swimming and beach-related activities, it is expected that the Malta Maritime Authority will create a new Swimmers Zone within the bay in order to avoid potential conflicts with boat mooring and water sports. A list of Swimming Zones is published annually in the form of a Legal Notice, and identification of a new Swimming Zone normally follows a request by the Local Council of the area concerned. The boundaries of new Swimming Zones are usually based on information provided by the council regarding the areas used for swimming, based on past experience of the site. In the case of St George's Bay, the delineation of a Swimming Zone should also consider the current use of the Bay for mooring and water sports, and the identification by the North Harbours Local Plan of the area on the right hand side of the bay for water sports and leisure activities. Discussions have been initiated between the Ministry of Tourism and the Malta Maritime authority to achieve a solution to these issues.

The proposed promenade will also incorporate features for the general embellishment of the area bordering the new beach, as found on other refurbished promenades locally, such as benches, trees, and ornamental railings. In accordance with current practice being implemented in other managed beaches in Malta and Gozo, the following ancillary facilities will also form part of the project:

- 2 information boards located on the promenade, displaying regularly updated information about bathing water quality (in an easily understandable table or figure), site regulations (including beach code of conduct), local bylaws, and information on potential hazards and environmental concerns related to beach management
- lifeguard tower, preferably centrally located to view entire bathing area
- first aid station and public phone booths
- sufficient pedestrian access points along the promenade to cater for the beach capacity. Access ramps for the disabled to the promenade and beach are required.
- adequate public conveniences, connected to the local sewage network.
- Wheelchair access to these facilities is required.
- reserved parking spaces for the disabled

6. Beach Modelling Study

The desirable grain size for nourishment should consist of sediment having either the same grain size, in order to cause the least perturbation of the ecology, or a slightly larger grain size, giving benefits of increased beach stability. Following preliminary discussions with the Ministry for Tourism and the Planning Authority, it was agreed that suitable sources for beach nourishment sediment are not available locally. A wave and

sediment modelling study was therefore performed to predict the behaviour of two foreign sediment options known to be commercially available in the Mediterranean. The sediment types selected had a mean diameter of 0.17mm (approximately equal to the existing sediment) and 2mm (coarser than existing sediment) respectively.

The properties of the modelled sediments were as follows:

I. Natural quartz sand of coastal origin, foreign provenance; specific gravity: 2.685 kg m^{-3}; mean diameter 0.17 mm
II. Crushed quarried granite of terrestrial origin, foreign provenance; specific gravity: 2.650 kg m^{-3}; mean diameter 2 mm

Figure 2 illustrates the nourished beach profiles using the two different sediment types described above. The nourished beach profiles can be seen to intersect with the existing seabed at distances of approximately 53 metres and 95 meters offshore for the coarse and fine sediments respectively. The main implication of these findings is that the use of the finer sediment would lead to smothering of a much larger area of the existing seabed and its associated habitats than would be the case if employing the coarse sediment.

Reasonably frequent (0.1 year and 1 year return period) as well as very extreme (50 year return period) storms were modelled for both sediment types, with a storm duration of 12 hours. Constructing a 10m wide promenade and 25m wide dry beach using the finer (0.17mm) sediment was found to result in beach drawdown and fairly large losses of sand even during moderate storm events, as follows. The 0.1 year event from the 30°N offshore sector is expected to result in a slight drawdown of beach material which is expected to recover naturally. However, the modelling results for the 0.1 year event from the 60°N sector, and for the 1 year and 50 year storms indicate serious losses of nourishment material ranging from 1100 m^3 to 8000 m^3. Since this material is expected to be lost beyond the toe of the beach, it would be permanently lost from the beach, resulting in serious erosion problems. A regular replenishment of the beach would thus be required, leading to large recurrent costs and ecological damage by smothering. Under extreme storms the beach may even erode back to expose the new seawall, resulting in the possibility of overtopping. It is however recognised that this finer sand may be preferred from the amenity viewpoint.

Use of the coarser sediment modelled (2mm diameter) results in a beach face slope of 1 in 10, and gives a beach that is likely to be dynamically stable. For the most frequent storm events (the 0.1 year and 1 year storms), only small changes in beach profile are predicted, and these are expected to recover between storms. Under the more extreme (50 year) storms modelled, some losses of beach material are predicted but most of this would only be drawn down to 2 or 2.5m below mean sea level and would not be completely lost from the system. The report suggested that if necessary, most of this material could be recovered using mechanical plant.

It was estimated that since St George's Bay is a relatively narrow inlet, waves reaching the head of the bay will generally be normal to the beach, and consequently will not cause significant changes to the planshape of the nourished beach due to long-shore drift. The coastline of the beach will essentially remain facing the entrance of the Bay. There may be a slight reorientation at the southern end of the beach due to wave

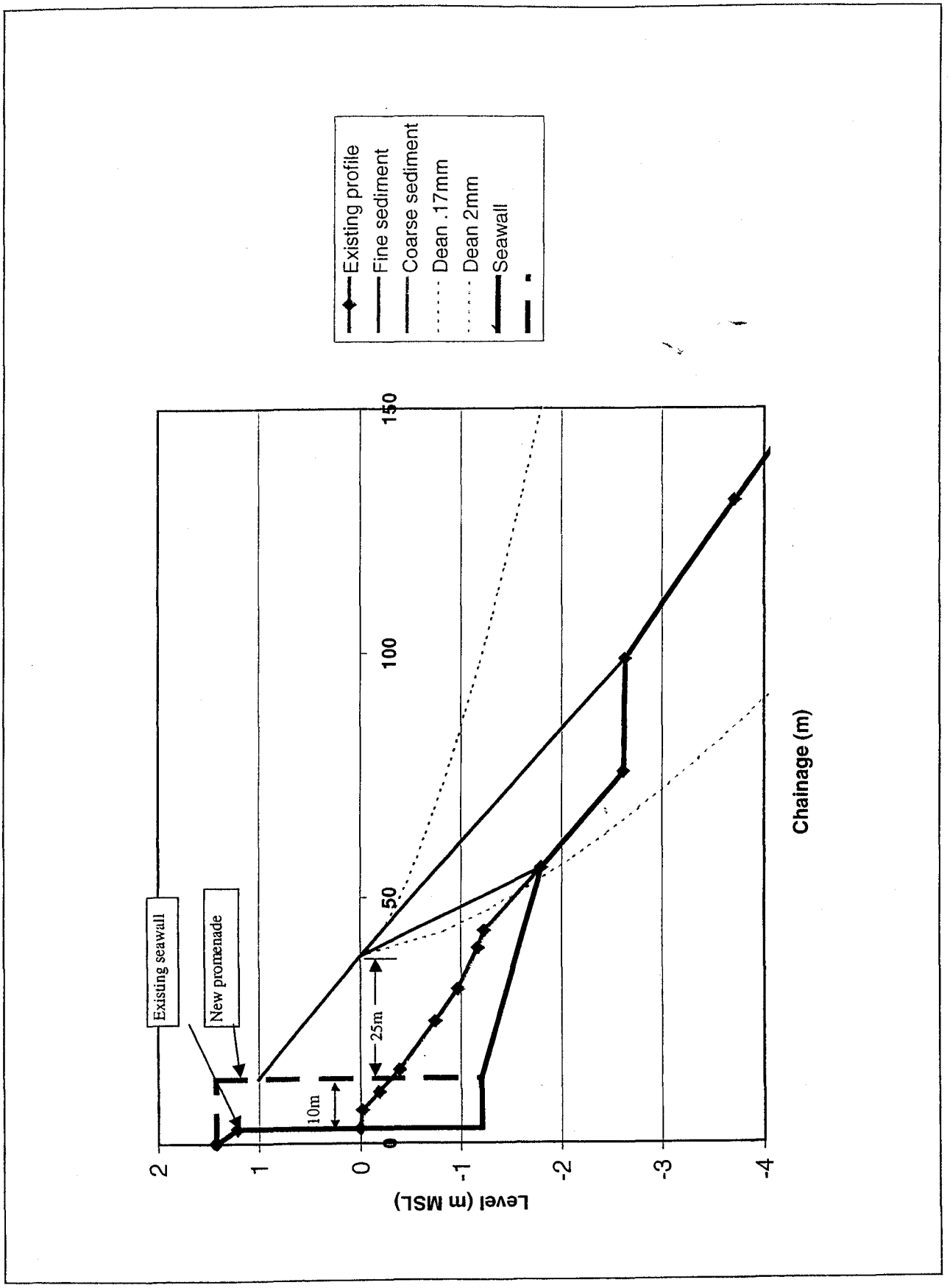


Figure 2 The renourished beach profiles tested

reflection off seawalls along the Western arm of the bay, causing accumulation of sediment in the more sheltered southern corner where there is an existing accumulation of sediment. The beach in the more exposed centre of the Bay may retreat by a few metres as sand moves to the more sheltered ends of the beach. It was however considered that this process would quickly stabilise and not lead to progressive losses of beach material.

7. Anticipated Project Impacts and Mitigation Measures

Project Design: From the outset of the project design process, it was realised that the placement of sand at the beach head in St George's Bay would have a number of environmental impacts. In order to mitigate the negative impacts on the bay, a minimum beach size configuration was proposed for the nourishment exercise at St George's Bay. This comprised a 20 metre wide bathing area, based on the generally accepted statistic that bathers in the Mediteranean tend to utilise the first 20 metres from the shoreline of a sandy beach. In addition, a 5-metre wide buffer zone to separate bathers from the promenade and to provide space for bathing-related recreational activities was proposed.

It can be estimated from Figure 4 of the Ecological Survey Report that the shoreward retreat of the beach footprint (using the preferred coarser sediment option) by approximately 10 metres would largely eliminate direct smothering of the seagrass meadows at the head of the bay. Within the given design specifications for beach and promenade, the most appropriate manner of achieving such a 10 metre retreat of the leading edge of the beach footprint would be through substituting the proposed shoreline extension of the promenade by the full pedestrianisation of the road behind the beach as recommended by the North Harbours Local Plan (Policies NHPV01 and NHPV11, and map PV3).

The hydrodynamic modelling consultants who carried out the original assessment of the stability of the replenished beach have confirmed that a 5-10m landwards shift of the beach is not expected to significantly change the stability of the projected beach constructed with the coarser sediment option recommended in the EIA, provided that the original shape and size of the beach are retained.

Therefore, the EIA co-ordinators strongly recommend that the design of the beach and promenade be amended as described above, through the conversion of the road into a fully pedestrianised promenade. This will allow a 10-metre landwards shift of the beach, bringing about a reduction of the project's impact on the marine environment while retaining the original design specifications for the beach and promenade.

Palaeontological and Chemical Contamination: Use of the proposed crushed stone nourishment material has the advantage of being palaeontologically inert, avoiding cross-contamination with local sediments. It is however recommended that if such crushed sediment were to be used, it should be carefully tested to ensure a minimum dust content that must be specified in advance by the developer. The material should also be certified free of chemical contaminants.

Dredging Impacts: The ecological impact study predicted that should the sediment to be used for nourishment come from the sublittoral sediment present in St George's Bay itself, there will be huge negative impacts on both the donor beds due to the dredging works, and on the sublittoral habitats peripheral to these donor beds. All biota present in the dredged sand will be destroyed, consisting mainly of shallow burrowing polychaetes, bivalves and crustaceans identified as living in the top layers of the sandy patches present in the bay. The populations of the sandy patches would however be expected to recover through replenishment from other undamaged sandy patches in the area.

Increased nutrient enrichment of the water column may occur during dredging, due to resuspension of any nutrients trapped in bottom sediment sinks. This may have an additional negative impact on the benthic algae and seagrasses, through the overgrowth of epiphytic algae leading to reductions in light reaching the leaf surfaces and a consequent decrease in growth and productivity. This effect also leads to the leaves of algae and seagrass leaves being more susceptible to mechanical damage from wave action and sediment abrasion. In consequence, it is recommended that local dredging for beach nourishment material is not permitted.

Smothering: It is evident from the hydrodynamic modeling study that a considerable reduction in the project's overall footprint can be achieved by using the larger grain sized sediment as nourishment material, due to the steeper slope below the water level resulting from the use of a coarser sediment. This option will thus reduce the area of the benthic habitats directly smothered by the new beach material, as well as resulting in less erosion and subsequent deposition of the eroded material. Nourishment with a coarser grained material possesses some drawbacks with regard to the impact on the biota at the head of the bay. Since the existing sediment in this area consists of fine muddy sand, the contamination of the sediment in this area with coarser nourishment material was expected to affect the composition of the infaunal assemblages currently present. This issue is discussed in more depth in the section on integrated evaluation of these findings, where the implications of the project footprint predicted by the modelling study for the two sediment options are considered in the light of the findings of the ecological survey and impact study (section 2 of this document).

While covering up a sandy shore with new sediment is expected to lead to the extinction of the infaunal biota, the beach at St George's Bay appeared to be devoid of infauna, and this effect was therefore not expected to be significant in this case. This effect is more pronounced when the particle size of the deposited sediment is smaller than that of the existing beach material, since this results in compaction of the beach material.

Concerning the important biotic assemblages associated with the fine sediment located at the head of the bay, it was noted that these habitats would be the first to receive any nourishment material transported to the sublittoral. In order to protect the sensitive and rich biota in the bare muddy sand assemblages just off the beach and those of the *Cymodocea nodosa* meadow occurring just beyond, it was suggested that the particle size distribution of the sediment to be used for nourishment is as close as possible to that occurring naturally off the head of the bay.

Increased turbidity: More serious ecological impacts were predicted on the sublittoral habitats peripheral to the dredging donor beds, especially on the Posidonia

meadows which are quite vulnerable to environmental perturbations associated with turbidity resulting from the dredging process. Any increased turbidity of the water column will reduce photosynthesis and will redeposit on the seabed, smothering the benthic biota and causing mechanical damage to the seagrass leaves and other biota. Unless dredging operations are very prolonged, the reduction in photosynthesis is expected to be a temporary problem and this impact was not expected to be a serious threat to the vegetal assemblages in the area.

Turbidity resulting from disturbance of the bottom sediment or from the transport of eroded material from the replenished beach was also expected to result in a reduction of the amount of light available for photosynthesis by the benthic flora. While most benthic assemblages can survive a small and short duration increase in sedimentation rate, they will be severely impacted by a high or prolonged sedimentation rate, and persistent turbid conditions will result in a drastic decrease in the productivity of both benthic algae and particularly seagrasses.

Loss or reduction of the benthic vegetation cover was considered to lead to an overall reduction in species richness and abundance of the associated biota, through losses of habitats, changes in the current regime, accelerated sediment erosion, loss of breeding and nursery grounds, and loss of productivity.

Erosion and Deposition: The main impacts were associated with erosion of sediment from the beach by the effect of waves and storms, and its consequent deposition on benthic assemblages of St George's Bay. As it was not known where exactly this deposition will occur, it was considered difficult to predict specific impacts. If periodic replenishment is found to be necessary in order to replace eroded sediment, it was considered likely to result in the substitution of the present assemblages with others adapted to a disturbance regime.

The most important benthic assemblages that were considered likely to suffer negative effects were the photophilic algae found on the rocky periphery of St George's Bay and on stones and other hard substrata in the central part of the bay, and the seagrass meadows that predominate in the central parts of the bay. These seagrass meadows are an essential component of the coastal ecosystem, due to their high rates of primary production, their ability to trap nutrients and sediments, and their role as breeding and nursery areas for fish and other species. Seagrass meadows are also important in substrate stabilisation, detrital food chains and nutrient recycling, and as a substrate and habitat for many other species.

Settlement of particulate matter on the photosynthetic surfaces of benthic algae and seagrasses was considered to further reduce growth rates and productivity by acting as a direct physical barrier to light. Vegetation may recover from this impact, unless very heavy sedimentation occurs, leading to a partial or complete burial of the benthic vegetation and associated fauna. The seagrass *Posidonia* is particularly sensitive to changes in the sediment dynamics of its habitat, and sedimentation rates of more than 50mm per year will eventually lead to regression and death of the meadow.

In order to best mitigate the above mentioned ecological impacts of smothering and increased turbidity, the EIA recommends that local dredging be avoided and that the

larger sediment option be utilised so as to minimise the beach footprint and erosion and re-suspension of sediments.

The ecological impact study noted that due to the lack of information on sediment source and beach construction method to be employed, the impacts of the proposed nourishment, on the ecology of the beach and sub-littoral habitats at St. George's Bay, could only be assessed in general terms. However, a final review of all EIA findings (presented in this document) addresses an integrated evaluation of all findings.

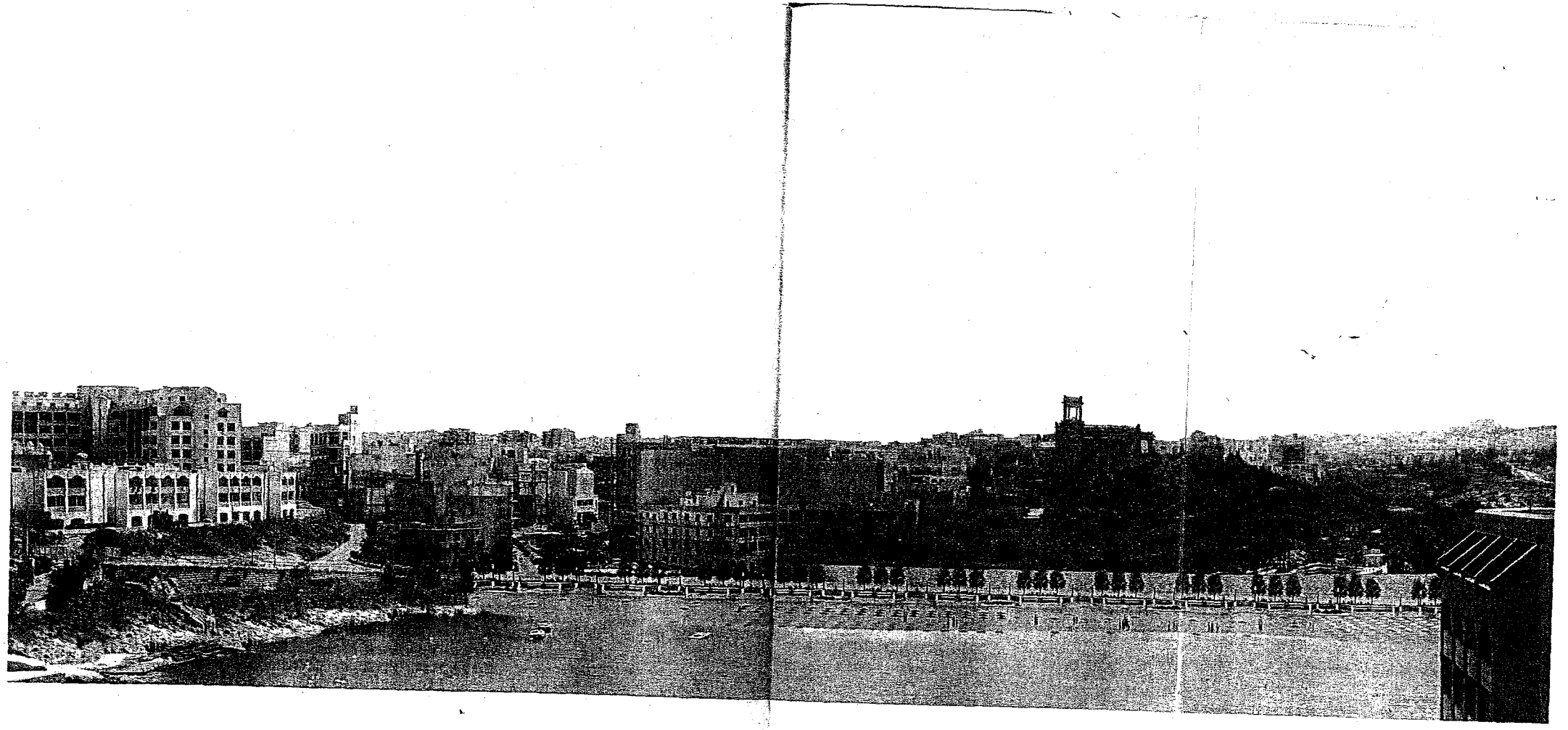
Water Quality: It should be noted that the suggested implementation of the Blue Flag criteria at the replenished beach at St George's Bay would require greatly improved water quality standards within the bay. This would serve to mitigate the current trend for regression of the *P oceanica* meadows in the inner part of the bay, suggested in the ecological survey to result from pollution of the head of the bay by suspended matter from construction activities and by organic enrichment.

Visual impact: The proposed project is expected to have a particularly positive visual impact on the St George's Bay area. The nourishment of the existing beach will result in a small pocket beach similar to typical naturally occurring pocket beaches found elsewhere in the Maltese Islands. The embellishment of the area through the creation of a promenade is in line with similar works currently being carried out in the neighbouring area of Sliema, and is expected to improve both visual and recreational amenities of the area.

The aesthetic impact of the proposed nourishment project is clearly shown in the attached photomontage of the replenished beach and its surroundings (Figure 3). As demonstrated by the photomontage, and in accordance with the recommendations of the North Harbours Local Plan regarding retention of viewlines onto Villa Rosa and its gardens, the changes in landscape proposed will in no way obstruct the seaview from the beach surroundings. In line with the recent promenade embellishment projects carried out in both the Sliema and Bugibba areas, it is considered that this project will enhance the socio-economic value of the area, by enhancing its aesthetic value and land use potential.

Traffic: Potential adverse effects on the area were considered to include traffic related problems arising from the additional visitors to the replenished beach. However, the expected increase in traffic pressure from the estimated beach capacity of about 650 bathers should be considered in the light of the 6,000 cars reported by the 1992 Paceville study, as seeking parking on a busy evening. It was suggested that parking for bathers can easily be accomodated within the various existing car parks which currently cater for these large crowds of evening visitors to the area's entertainment facilities. The demand for additional daytime parking generated as a result of the new beach was in addition, expected to be mitigated by a better utilisation of existing parking space and amenities. It was suggested that this assumption should be further assessed within the ongoing Master Plan for the area, through a detailed seasonal traffic impact assessment examining the combined impact of the many new developments taking place in the same general area.

The expected increase in traffic was predicted to also result in increased vehicle and noise emissions in the area, as well as increased noise. However, it was suggested that



the localised effect on bathers at St George's Bay could be mitigated by the pedestrianisation of the existing strip of road immediately behind the beach, restricting daylight traffic to either side of the bay. Full pedestrianisation of the promenade at St George's Bay is also recommended by Policy NHPV11 of the North Harbours Local Plan. Visitors to the beach would therefore be expected to utilise the new access road and existing parking areas on the Pembroke side, and would not intensify the traffic congestion recently identified on the Paceville side. This approach is further supported by Policy NHPV03, which states that the Planning Authority will seek the construction of an overground multistorey carpark with access/exit from the new hotel access road and convenient pedestrian links to St George's Bay.

Quality of Life: The potential for negative impacts on quality of life arising from noise and increased traffic was therefore considered to be largely limited to the construction phase, and these impacts may be kept to a minimum by effective management practices. Similarly during the operation of the nourished beach, potential visual and odour impacts from accumulated seagrass debris may be minimised by its regular collection, as is done for other bathing beaches.

A number of positive impacts of the beach nourishment project on quality of life were expected to arise from the implementation of Malta Maritime Authority (MMA) regulations and of Blue Flag guidelines. In particular, safety for bathers at San Gorg is expected to increase due to the implementation of Malta Maritime Authority regulations for "Zones reserved for Swimmers" once the nourished beach is operational. Consultation is necessary between the Ministry for Tourism and the Malta Maritime Authority regarding the proper management and zoning of potentially conflicting leisure uses such as bathing and boating within the bay, as recommended by Policy NHPV08 of the north Harbours Local Plan.

A number of health and safety measures were proposed for implementation within the within the proposed project. A number of these were derived from Blue Flag guidelines, and concern the implementation of wardening and lifeguard services, as well as the availability of sanitary facilities and the strict compliance with bathing water criteria mandatory at Blue Flag beaches.

Under the coastal water surveillance programme conducted annually by the Public Health Department during the bathing season, weekly monitoring of faecal coliforms as an indicator of sewage pollution is carried out at a number of local bathing areas. Reports for the years 1997 to 2000 show that seawater at St George's Bay complied with the minimum criteria of the Barcelona Convention at all times during this period. However it was noted that St George's Bay was predominantly classified as a Second Class Bathing Area, and that for the year 2000, one of the two sampling sites within the bay failed to satisfy the EU water quality criteria and was described as "not in conformity with the parametric values" required by the EU Bathing Water Directive (76/160/EEC). The necessary maintenance and/or upgrading of the sewage network was therefore recommended to be carried out prior to the implementation of any nourishment of the site.

Leisure uses: The proposed replenishment project is expected to complement the bay's projected role as a focus for tourism, bathing and leisure uses, as identified by the North Harbours Local Plan. This type of activity within the area is expected to be mainly

enhanced by the creation of a sandy beach within St George's Bay. The space available for bathing and sunbathing would be considerably enlarged, greatly increasing the beach's carrying capacity. Although the replenishment exercise was expected to encroach upon the area currently used for boat mooring, it was suggested that a more orderly planning and allocation of these moorings would resolve this issue, and any such measures should arise from consultations between the Ministry of Tourism, the Planning Authority and the Malta Maritime Authority, in line with Policy number NHPV08. This would also satisfy the Blue Flag requirement for a clear demarcation between bathing areas and zones assigned for the practice of water sports. Furthermore, the project proposal did not envisage any reduction in public access to the foreshore on the nourished beach in line with the both national and site-specific policies on this issue (i.e. Structure Plan Policy CZM3 and, specifically for St George's Bay, Policies NHRL05 and NHPV08 within the North Harbours Local Plan).

Management aspects: Considering that the existing sandy beach has been described in the ecological study report as poor in macroscopic biota, and further that the resulting artificial beach would have no features of conservation value, it was recommended that mechanical beach cleaning be considered as an option for the management of this beach. It was also suggested that further studies should be carried out in order to evaluate the drawbacks of associated beach material compaction and sand loss against any economic benefits of mechanical cleaning.

It was suggested that potential environmental impacts of the proposed beach nourishment project may be further mitigated through the development of a beach management plan specifically designed to meet the particular needs of the created beach. In the case of St. George's Bay, the management plan will be primarily influenced by the absence of other sandy beaches in the locality and a strong tourist presence (both resulting in a high demand for beach related recreational amenities) and the absence of features of conservation importance on the beach. Consideration of the particular flora & fauna identified within the bay should also be catered for within the specific beach management plan developed for this area, and by the enforcement of existing regulations concerning protected species, such as the Noble Pen-sheli *Pinna nobilis*, identified within the bay.

In addition to the measures suggested above, the enforcement of existing legislation such as Planning Policies (Structure Plan and site-specific North Harbours Local Plan policies), Environmental regulations, MMA regulations and Local Council bye-laws was strongly recommended, in order to ensure a well-managed environment on the beach and its vicinity.

Monitoring: The ecological impact study recommended that an ecological monitoring programme, covering physical parameters as well as chemical and biological indicators, should be implemented. It was suggested that the prime aims of this monitoring programme should be to monitor the stability of the nourished beach and the detection of any environmental degradation of the marine ecosystem at St George's Bay. It was further suggested that the duration of this programme should be sufficient to ensure the detection of long-term trends in the measured parameters.

8. Monitoring Programme

A final regulatory measure for the proposed project, required that a comprehensive monitoring programme should be implemented at St George's Bay. The proposed monitoring programme includes aerial photography, bathymetric surveys, and a regular assessment of the benthic communities by a combination of habitat mapping and seagrass biological parameters. The prime aims of this monitoring programme are to monitor the stability of the nourished beach and the detection of any environmental degradation of the marine ecosystem at St George's Bay. A secondary objective is the provision of basic scientific information about the little studied shore and sublittoral ecosystem, thus facilitating the assessment of the potential effects of such projects on the marine environment. Although the project's terms of reference proposed a monitoring period of one year, an amended programme with an initial duration of five years was recommended, after which time the frequency of monitoring of the various parameters may be adjusted as deemed necessary.

In line with the project's terms of reference, the monitoring programme was defined as consisting of four main areas, as follows:

Overhead aerial imagery

A schedule of twice yearly flights was proposed, integrated with a monthly programme of beach profiling, in order to monitor the stability of the replenished sediment. This was expected to provide more appropriate information about the variations in shoreline position than would be obtained from the monthly aerial images proposed in the project's terms of reference. It was proposed that the first survey be carried out immediately following the completion of the project, with a second survey 6 months later. In subsequent years, flights are proposed for March and September.

Bathymetric surveys

Bathymetric surveys along predefined transects were recommended to be carried out seasonally during the first year following implementation of the project, and twice yearly in the subsequent four years.

Sampling of sediment tracer elements

It was considered that the information provided by the aerial images, and topographic and bathymetric surveys would provide sufficient information about the movements of sediment around the bay. However, should further information be required, the use of a foreign sediment as replenishment material would allow this material itself to be used as a tracer element.

Biological and chemical indicators

Biological monitoring should focus on the elements of the marine ecosystem which are considered to be at greatest risk from the beach nourishment project, namely the benthic communities in the bay, and particularly the photophilic algal assemblages and seagrass meadows. The design of the monitoring programme will also depend on the choice of sediment to be employed as nourishment material, and on the frequency of replenishment to replace sand lost from the beach during storm events.

The report on the benthic ecology suggested monitoring of the following parameters:

- Annual survey of benthic assemblages and updating of habitat map of the bay, in order to monitor any changes in spatial distribution of the benthic assemblages during the first two years
- Seasonal estimate of *P. oceanica* biological parameters i.e. shoot density, adult leaf length, leaf biomass per shoot, epiphyte biomass, for a two year period
- Visual inspection of the state of health of the *Posidonia* and *Cymodocea* meadows within the bay, for a two year period

Essential physico-chemical data which should be collected concurrently were considered to include levels of suspended material and sedimentation rates, and water quality parameters such as sulphide levels, dissolved nutrients and chlorophyll may also need to be monitored.

It should be noted that microbiological monitoring of the water quality within St George's Bay is already covered by the ongoing coastal water surveillance programme of the Department of Public Health. During the bathing season, samples are regularly collected from two sampling station within St George's Bay, and analysed for the following indicators of sewage pollution: faecal coliforms, faecal streptococci, total coliforms and salmonella species. Dissemination to the general public of any results showing sewage contamination of the area was also considered to contribute to bather safety in the area.

9. Risk Assessment Analysis

The ABP Research Environmental Risk Assessment (ERA) package is an on-line system that provides a framework for the assessment of the consequences of environmental impacts of a given project. The ERA process aims to quantify the impacts as much as possible and to provide a basis on which decisions can be made in the determination of the significant effects of a project. This is achieved through a semi-qualitative and statistical weighing of probabilities to provide a consistent assessment of impact effects. Information regarding the proposed beach nourishment project at Bajja ta' San Gorg and the assessment of the project's impacts and consequences was entered by the project team, based on the information provided by the various sections of the Environmental Impact Statement.

In order to be able to compare the risks associated with the different phases of the project, and taking into account the two different renourishment materials modelled, the ERA package was run for the following different scenarios:

1) Negative impacts of construction phase only, using:
    i) a fine (i.e. 0.17 mm diameter) sediment for renourishment
    ii) a coarse (i.e. 2mm) sediment type

2) Positive impacts of post-construction phase, using:
    i) a fine (i.e. 0.17 mm diameter) sediment for renourishment
    ii) a coarse (i.e. 2mm) sediment type

3) Negative impacts of post-construction phase, using:
   i) a fine (i.e. 0.17 mm diameter) sediment for renourishment
   ii) a coarse (i.e. 2mm) sediment type

The results of the analysis are shown in the probability table below (Table 5).

	Probability of relevant consequence magnitude occurring				
	Severe	***High***	***Mild***	***Negligible***	Sediment type
Construction Phase – NEGATIVE IMPACTS	0.0	0.99	0.01	0.0	*Fine*
	0.0	0.85	0.15	0.0	Coarse
Post-Construction Phase – POSITIVE IMPACTS	0.0	0.77	0.23	0.0	*Fine*
	0.0	0.57	0.43	0.01	Coarse
Post-Construction Phase – NEGATIVE IMPACTS	0.0	0.05	0.95	0.0	*Fine*
	0.0	0.0	0.14	0.86	Coarse

Table 5: Results of the ERA analysis giving the probability of occurrence for the relevant consequence magnitude

The following conclusions may be drawn from these results:

- Considering the values obtained for the probability of negative impacts during the construction phase, it can be seen that the probability of a high negative impact arising from the use of the coarse sediment is less than that associated with use of the fine sediment. This has been attributed within the report to the higher turbidity levels associated with the use of a fine sediment as replenishment material, and to the risk of palaeontological contamination associated with the use of a natural coastal sand.

For the post-construction phase, the probabilities of positive and negative impacts were considered in separate analyses.

- It can be seen that the likelihood of a high positive impact is slightly reduced for the coarse sediment option. One of the major parameters influencing this outcome may be associated (as described in the report) with beach user preferences for finer beach sands from an amenity point of view.

- A very significant decrease in the probability of a negative impact occurs when coarse sediment is substituted for the fine material. The shift is from a high probability (0.95) of a mild impact with fine sediment, to a high probability (0.86) of a negligible impact if the coarse sediment is used. The negative impact for the fine sediment is largely related to the economic aspects associated with the severe sediment losses predicted for storm events, and to the environmental impacts

resulting from smothering of large area of benthic habitats. The risk analysis results support the findings of the Environmental Impact Statement, in that the mitigation of these impacts may be successfully achieved by the use of a suitable coarse sediment, as recommended.

Integrated Evaluation

It is considered essential to ensure the consideration of all relevant findings of the various studies carried out within the EIA. Nowhere was this more clear than in the EIA section addressing the ecological impacts which states that predictions on ecological impact were necessarily of a general nature in the absence of specific data on beach sediment grain size, sediment origin, nourishment footprint and the estimated frequency of repeated nourishments. As a consequence, the implications of one set of study findings on another are addressed within an integrated evaluation of study findings that considered the different alternatives open to the project, so as to ensure that all possible interactions between individual results would be taken into consideration.

In this respect, one is able to comment on the potential impacts identified by the ecological survey and impact study by referring to the findings of the hydrodynamic modelling exercise which were identified as having paramount importance in predicting the likely ecological impacts of the proposed beach nourishment. Therefore, while the ecological study rightly suggests that retention of existing sediment grain size would be expected to reduce negative ecological impacts by the proposed beach nourishment, the footprint extent for the two sediment options considered (as predicted by the hydrodynamic modelling study) clearly reflects that retention of the fine sediment option would, in the case of St. George's Bay, increase rather than decrease the negative impacts arising from smothering and increased turbidity.

The most important findings of the hydrodynamic modelling exercise were related to:

- The predicted footprint of the nourished beach
- The predicted beach sediment transport characteristics

Table 6 below reflects the main hydrodynamic modelling findings and related implications for prediction of ecological impacts.

Fine (0.17mm) sediment option	**Coarser (2mm) sediment option.**
A beach footprint extending 95m offshore from the existing shoreline	A beach footprint extending 53m offshore from the existing beach
A shallow (1 in 25) beach slope.	A steeper (1 in 10) beach slope
Large beach losses even with moderate storm events (10 year return period), requiring large replenishment effort	Very small and naturally recoverable beach losses with frequent and moderate storm events (0.1, 1.0 and 10 year return periods)
Serious beach losses (up to 8000m^3) in cases of extreme storm events (50 year return period), requiring major replenishment exercises	Small (but naturally unrecoverable) beach losses during extreme storm events (50 year return period) requiring use of mechanical plant or re-nourishment
A generally unstable beach requiring regular replenishment	An increased likelihood of beach stability requiring no or infrequent re-nourishment
Implications for predicting ecological impacts.	
Smothering (also see Figure 4)	
A smothering of about 14.5% of the embayments' benthic habitat including: • The ***entire assemblages*** of bare sand with small patches of *C. nodosa*, photophilic algae on stones and accumulations of seagrass debris and pebbles • Over ***two-thirds*** of the main *C. nodosa* meadow • A small area of predominantly *P. oceanica* meadow intermixed with sparse *C. nodosa* • Two small littoral strips of assemblages of predominantly photophilic algae intermixed with small patches of *P. oceanica* • Two small patches of predominantly bare sand assemblages (see above)	Smothering of about 8% of the embayments' benthic habitats including: • The ***entire assemblages*** of bare sand with small patches of *C. nodosa*, photophilic algae on stones and accumulations of seagrass debris and pebbles • The ***leading edge*** of the main *C. nodosa* meadow • Two very small patches of assemblages of predominantly photophilic algae and *P. oceanica* meadow intermixed with sparse *C. nodosa*
Reduced photosynthetic activity generated by increased turbidity, largely influencing:	
• Higher levels of turbidity • The ***remaining*** (un-smothered) *C.nodosa* meadow • Patches of remaining bare sand assemblages • An area of *P.oceanica* meadow • A strip of predominantly photophilic algal assemblage	• Lower levels of turbidity • The ***leading edge*** of the un-smothered *C. nodosa* meadow • Patches of remaining bare sand assemblages • An area of *P.oceanica* meadow • A strip of predominantly photophilic algal assemblage

Table 6: Main hydrodynamic modelling findings and related implications for prediction of ecological impacts.

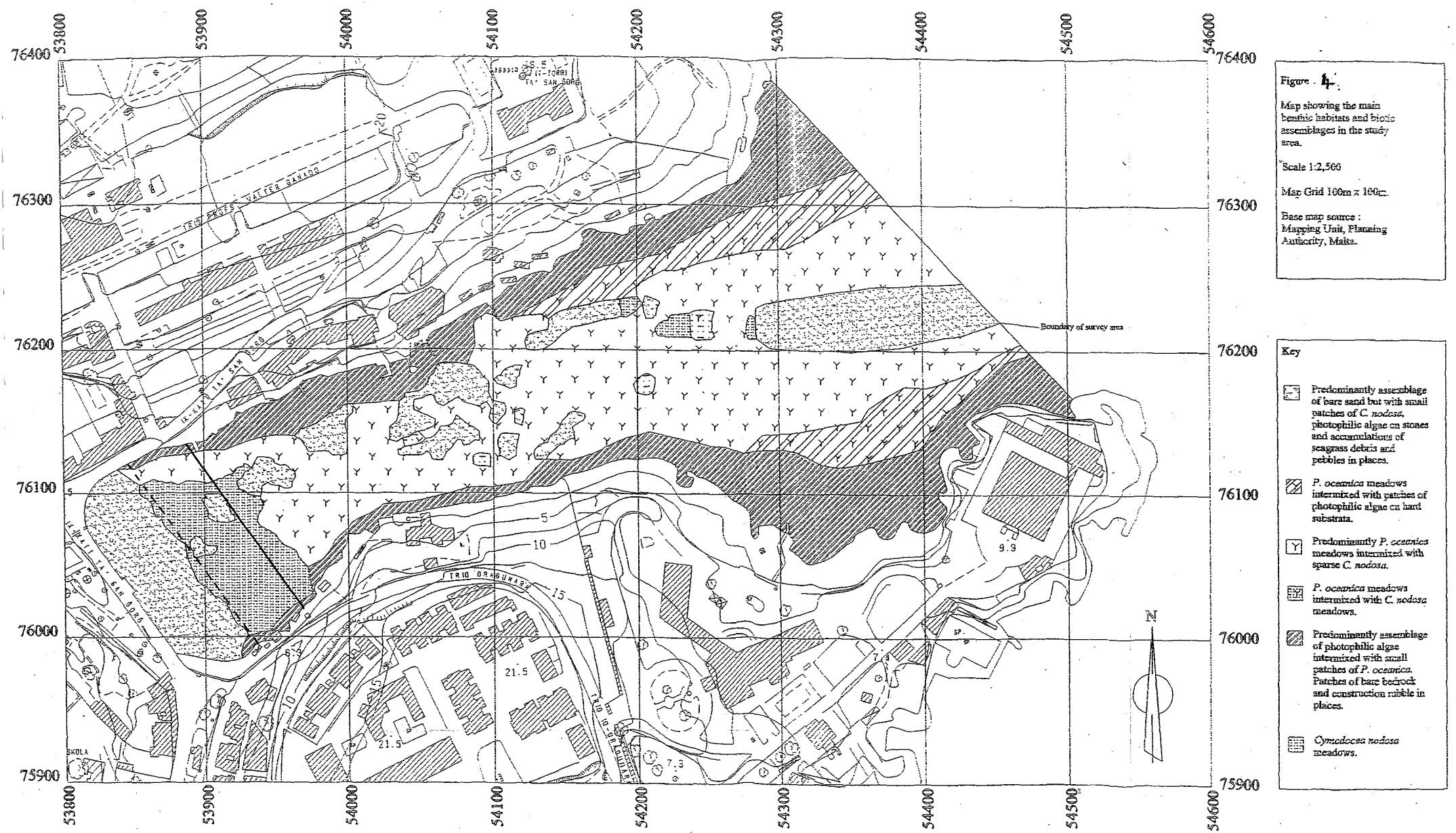


Figure 4.

Map showing the main benthic habitats and biotic assemblages in the study area.

Scale 1:2,500

Map Grid 100m x 100m.

Base map source : Mapping Unit, Planning Authority, Malta.

Key

- Predominantly assemblage of bare sand but with small patches of *C. nodosa*, photophilic algae on stones and accumulations of seagrass debris and pebbles in places.
- *P. oceanica* meadows intermixed with patches of photophilic algae on hard substrata.
- Predominantly *P. oceanica* meadows intermixed with sparse *C. nodosa*.
- *P. oceanica* meadows intermixed with *C. nodosa* meadows.
- Predominantly assemblage of photophilic algae intermixed with small patches of *P. oceanica*. Patches of bare bedrock and construction rubble in places.
- *Cymodocea nodosa* meadows.

Footprint extent with coarse sediment option

Footprint extent with fine sediment option

Generally, beach nourishment material is desired to match in grain size that of the existing beach so as to introduce the least possible perturbations to existing benthic habitats. However, as may be seen from Table 1, considerations of footprint extent (resulting in direct smothering) and reduction in photosynthetic ability (as a consequence of increased turbidity), clearly indicate the increased negative ecological impact which would be caused by the finer sediment option if re-introduced at St. George's Bay. In addition, normal beach nourishment practice is to opt for a slightly coarser sediment so as to increase the beach stability which has presumably, under current conditions, experienced sediment loss. This consideration is also borne out by the hydrodynamic modelling study which clearly identifies the much increased beach stability associated with the use of a coarser sediment option.

There is yet another issue which in the case of St. George's Bay counters the standard practice of recommending use of nourishment material having a similar grain size as that of the existing beach. At this bay, the current highly impoverished beach state has been in effect (according to aerial photographic evidence examined) for at least the last 44 years. In this state, benthic communities became established closer inshore than would be normal in the presence of a healthy (actively dynamic) beach, where inshore sediment dynamics would prevent colonisation by marine flora. As a consequence, minimising the footprint of the nourishment exercise (by increasing the sediment grain size) is in the case of St. George's Bay, considered a strongly desirable option.

The alternatives considered available to the project.

It should be noted that in order to minimise repetition, for each set of alternatives, the positive and negative impacts of only one alternative are listed. It is implied that opting for the second alternative would result in an opposite impact to that listed for the first. Terms such as 'additional', 'higher' and 'increased' should be understood as relative to the second option. Where this is not the case, both alternatives are discussed.

N.B. Beach-user preferences and priorities quoted throughout this document make reference to a number of studies including: Micallef & Williams, (this study) Leatherman, 1997; Micallef et al., 1999; Morgan & Williams, 1995; Morgan et al.,1993; 1995; 1996; Morgan & Micallef, 1999; Williams & Morgan, 1995 (for other studies on Maltese and other Euro/Mediterranean beaches).

Alternative 1:

Beach nourishment using existing (fine) versus a coarser beach sediment granulometry.

For the option of retaining a fine-grained beach granulometry, the impacts identified were:

Positive social impacts:

- An increased beach-user satisfaction associated with a gentle beach slope.
- An increased *local* beach-user satisfaction with traditional beach sediment material.
- An increased beach-user satisfaction with fine grained beach sediment.

Negative Social impacts:

- Reduced beach-user satisfaction with reduced beach area resulting from annual beach sediment loss predicted by the hydrodynamic modelling study for the fine grained beach sediment option
- Reduced recreational enjoyment of promenade and nearby service facilities (bars/restaurants) as a consequence of increased aeolian transport of finer beach sediments.
- Decreased beach-user satisfaction due to increased problems of beach sediment compaction and retention of water associated with fine-grained beach sediments (Sciortino, 1998). The problems of beach compaction and water retention have already been experienced in Malta following the use of dredged sediments from Marsaxlokk bay for beach nourishment at Pretty Bay, Birzebbuga.

Positive economic impacts:

- None identified

Negative economic impacts:

- Increased costs incurred with retrieval / replacement of beach sediment (related to increased beach sediment losses associated with fine sediment option modeled by the hydrodynamic modelling study.
- Increased costs of extending storm-water culvert beyond nourishment (associated with larger footprint of fine-grained beach as indicated by the hydrodynamic modelling exercise. (N.B. This assumes that storm water culvert extension is considered a viable option by the Works Department of the Ministry for Environment, Government of Malta).
- Increased costs associated with the transport of a larger volume of beach nourishment material if a finer sediment is used. In this context, the hydrodynamic modelling study identified that beach nourishment using the fine sediment option would require almost twice the volume of sand required with the coarser grained sediment. This is also reflected by the much larger footprint predicted for the fine sediment option.

Positive Ecological Impacts:

- Retention of a similar grain size to that of the existing beach material was envisaged by the ecological impact study to result in reduced ecological perturbations and an increased potential for re-colonisation of the submerged part of the nourished beach.

Negative Ecological Impacts:

- An increased smothering impact as a consequence of the larger footprint predicted for a fine beach sediment. In this regard, the hydrodynamic modelling exercise predicted that the new beach slope resulting from the proposed nourishment would intercept the existing seabed about 95m offshore for the fine sediment option and 53m offshore for the coarser sediment option.
- Increased smothering impact arising from increased erosion and re-deposition of beach material outside the predicted footprint area.

- Higher levels of turbidity caused by increased suspension associated with fine sediment in the water column during:
  - beach nourishment.
  - as a result of increased erosion of fine nourishment material.

  Increased turbidity was considered by the ecological impact study to lead to an increased negative impact on *Posidonia* and *Cymodocea* sea-grass meadows and assemblages of photophilic algae as a consequence of reduced photosynthesis and direct smothering.

  Should this alternative consider the use of coarser grained sediment, the opposite or reduced impacts are predicted. In addition, the use of coarser grained sediment would entail two additional (though limited) negative ecological impacts, namely:

- Contamination of existing sediment granulometry. However, this negative impact may also be considered from the positive viewpoint that an increased granulometry may be used as a tracer during the proposed monitoring phase of this project.

- Although coarser sediment was predicted by the hydrodynamic modelling study to impact over a smaller area, smothering by a different grain sized sediment was estimated by the ecological impact study to be more severe. However, these effects would only be expected to occur at the leading edge of the new beach slope where smothering is only partial.

Overview

Retention of a fine-grained beach granulometry was associated with predominantly negative social impacts. These were identified in the form of reduced beach-user satisfaction arising from predicted increased losses of beach material , problems of beach sediment compaction and water retention and reduced recreational enjoyment of the promenade and nearby service facilities due to increased sediment erosion/dispersion. To a lesser degree, positive social impacts were predicted for the fine-grained sediment option (largely in the form of enhanced beach-user satisfaction with a fine grained beach sediment producing a gentler beach slope and composed of locally familiar beach sediment).

Only negative economic impacts were predicted for the finer sediment option. Such negative economic impacts were related to increased costs associated with replacement of lost beach sediment, greater costs with mitigation of storm water discharge point (assuming Works Division concur with feasibility of seaward extension of discharge point) and increased costs incurred with transport of the larger volume of sediment required by the fine sediment option.

The use of the finer sediment option was largely associated with negative ecological impacts related to increased smothering produced by the much larger footprint and increased erosion/deposition associated with the finer nourishment option and increased

turbidity during beach construction and subsequent sediment re-suspension by natural processes. The negative ecological impacts associated with use of the coarser sediment option (related to grain size contamination and the impact on benthos by the grain size change were considered to be largely surpassed by the much larger smothering impact associated with the finer sediment option.

In conclusion therefore, considerations of socio, economic and ecological impacts favor the use of the coarser grained (2mm) sediment option in preference to the finer grained (0.17mm) sediment option modelled.

It is also interesting to note that the application of an Environmental Risk Assessment tool (ERA) representing a technique which utilises scientifically acceptable criteria to confirm or otherwise, by semi-quantitative means, general conclusions reached during an EIA, produced similar recommendations as the above. In this respect, the ERA study clearly identified that the probability of a high negative impact during the beach construction phase would be reduced from 0.99 to 0.85 if the coarser sediment option is utilised. During the post-construction phase, the probability of high positive impacts was reduced from 0.77 to 0.57 for the coarser option. More importantly however, it was also indicated that the probability of negative impacts were strongly reduced if the coarser sediment option were used (with a 0.95 probability of mild negative impacts for the fine sediment option to 0.86 probability of negligible impacts for the coarser sediment option).

Alternative 2:

Beach nourishment using local versus foreign sediment sources.

Potential local sediment sources were identified at the start of the project as including:

- Dredged coastal (offshore) sediment.
- Quarry wastes and crushed stone.
- Dredged port sediment.

The option of utilising locally dredged sediment should be ruled out due to the high risk of causing immeasurable ecological damage as a consequence of:

- The effective maximum dredging depth being restricted by technical limitations to about 40m.
- The local abundance of sea-grass meadows on loose sediments up to a depth of 50m.
- The absence of a national inventory of offshore biotic and sediment resources.

In addition, dredging of offshore sediments would require additional investment capital to import suitable dredging plant which is locally unavailable.

Material used for beach nourishment purposes normally exhibits abrasion values not greater than about 15%. In this context, local rock, with an abrasion value of about 25%

(which results in the generation of excessive fines) is considered unsuitable for beach-fill purposes. In addition, quarry wastes and crushed stone are also associated with excessive fines. This is particularly the case where locally available limestone is crushed/quarried, thereby compounding its unsuitability for beach nourishment purposes.

Overview.
Considering that local sediment is ruled out as a potential nourishment material, this alternative is therefore not considered further and it is recommended that imported sediment, whether naturally occurring sand or crushed quarried material, should be utilised. In this context, it is also recommended that any eventual document tendering for the supply of beach nourishment material, clearly stipulates that quarried material should be free of excessive fines.

Alternative 3:

Promenade development through pedestrianisation of existing road at the back of the beach versus shoreline extension through land-filling.

The provision of a promenade as part of the proposed beach nourishment was associated with an increased recreational use-potential by locals and overseas tourists, with an opportunity for greening and improving the general landscaping of the area and with a potential for an increased revenue to local establishments from the expected visitor repeat visits arising from increased visitor satisfaction with the availability of such a promenade.

Positive social impacts:

- Pedestrianisation of the existing roadway at the back of the beach was associated with increased visitor satisfaction due to *removal* of vehicle associated noise and fumes.
- Assuming controlled access facilities for emergency vehicles, pedestrianisation was also associated with the generation of a safer recreational environment.

Negative social impacts:

Pedestrianisation of the existing roadway at the back of the beach was associated with:

- A less direct vehicular access from the St. George's Bay area to that occupied by the San Gorg Marina, Corinthia San Gorg and Radisson hotels.
- An increased susceptibility of non-beach recreational users (including those using local entertainment facilities) to wind/wave transported sediment due to the low-lying nature of the existing roadway. The use of windbreakers and elevation of the pedestrianised roadway would have to be considered to mitigate this impact.

Construction of a promenade through land-filling was associated with:

- An increase in disturbance/pollution factor from noise, exhaust fumes and dust to locals and visiting tourists. However, this is considered a short-term impact associated with the construction phase.
- Construction of a promenade through land-filling was assumed to result in the continued use of the road at the back of the beach for vehicular access. This was

associated with a reduced visitor satisfaction due to vehicle associated noise and fume emissions.

Positive economic impacts:

Pedestrianisation of the existing road at the back of the beach was associated with:

- A reduced capital expenditure otherwise associated with the construction of a promenade through land-filling.

Negative economic impacts:

- Pedestrianisation of the existing road is associated with increased recurring costs associated with clean-up of beach sediment transported to the road and nearby establishments as a consequence of the low-lying existing roadway backing the beach. This is already the experience in several beach areas in Malta & Gozo where a low-lying road backs the beach (e.g. parts of Ghadira Bay, Little Armier, Xlendi Bay). An extended promenade area is considered to present an opportunity for more effective mitigation of this impact through construction of special features e.g. raised promenade, wind-breaks. If such mitigation measures were to be applied to the existing road, the cost of road elevation would need to be considered.

Positive ecological impacts:

- Converting the existing road at the back of the beach as a promenade will have the important consequence of reducing the overall project foot-print thus curtailing the ecological impact otherwise associated with a land-filled promenade (see negative impact below).

Negative ecological impacts:

- Construction of a promenade through land-filling will result in a larger footprint of the beach nourishment which will extend the smothering and turbidity related ecological impacts by a further 10m into the bay. In addition, this option was described by the ecological impact study to result in reduced photosynthesis of sea-grasses and photophilic algae during beach construction and subsequent sediment re-suspension events.

Overview:

From a social point of view, St. George's Bay is ideal for development as a prime recreational area. The area has been described by the project economic feasibility study as one representing Malta's prime concentration of 4 and 5 star hotels, and represents a concentration of high quality recreational facilities (e.g. Bay Street, Eden Leisure Group etc) catering for both local and overseas visitor needs in Malta and Gozo. Once up-graded, the St. George's Bay area, would compliment and enhance the tourist product and local recreational opportunities already offered by the adjacent Sliema coastline.

The North Harbours Local Plan (NHLP) considers a number of actions which support the enhancement of the local recreational potential of this area. These include:

- Improvement and enhancement of public access and enjoyment of the coast.

- Pedestrianisation of the road at the back of the existing beach (NHPV 01).
- Inclusion of public access to the shore on either side of St. George's Bay which should support activities focussing on bathing and leisure (NHPV 08).
- Promotion of full pedestrianisation activities of the promenade at St. George's Bay (NHPV 11).
- Pedestrianisation of part of St. George's Bay shoreline (NHPV 18).

The development of a promenade at the back of the proposed beach nourishment was therefore considered an essential aspect of this project due to the overall increase in recreational-use potential of the area, the opportunity for embellishment and the increased opportunity for revenue generation to local establishments.

In considering the social impact of the two options, pedestrianisation of the existing roadway was associated with an increased visitor satisfaction through elimination of traffic related disturbance and a safer environment. Such a positive impact was however considered to be reduced and limited to beach-users in the case of developing a promenade through a shoreline extension. It was also noted that interruption of direct vehicular access from St. George's Bay to the San Gorg Marina, Corinthia San Gorg and Radisson hotels resulting from pedestrianisation of the existing road at the back of the beach would not apply in the case of extending the shoreline by land-filling which would allow the option of current traffic flow to continue.

From an economic point of view, while the land-filling option was associated with reduced recurrent sand removal expenses, it was associated with much higher capital (construction) costs than the pedestrianisation option.

Ecological considerations strongly favour the pedestrianisation option which is associated with a reduced negative ecological impact than that produced by the larger project foot-print of the land-filling option.

Overall consideration of the above strongly suggests that if re-routing of vehicular access from St. George's Bay to the Radisson/San Gorg hotel complex is viable (i.e. full pedestrianisation of the road at the back of the beach as recommended in the North Harbours Local Plan Policy NHPV11) then the reduced ecological impact associated with the pedestrianisation alternative is highly desirable. If pedestrianisation is not acceptable, then the land-filling option should be considered due to the importance of a promenade to the proposal.

Alternative 4:

Beach nourishment via land transport of sediment (trucking and direct dumping on shore) versus marine transport by barges and fluidized pumping of sediment ashore.

Positive social impacts:

- None predicted.

Negative social impacts:

- Trucking was associated with increased short-term social disturbance (traffic congestion, exhaust, noise, dust) to locals and visiting overseas tourists.
- The negative social impact caused by trucking and direct on-shore dumping of sediment was estimated to affect a much wider public than that caused by barging and fluidised pumping of sediment. Social impact was considered as a function of the duration and number of trucks estimated necessary to transport the imported sediment from Valletta Harbour to Bajja ta' San Gorg versus the duration of barging and fluidised operations.

Positive economic impact:

- None predicted.

Negative economic impact:

- The option to utilise barges/hopper-dredgers to transport the beach nourishment material to San Gorg, where it would be pumped ashore in a fluidised form was predicted as being far more costly due to the necessity of bringing to Malta such specialised dredging equipment (Sciortino,1998).
- The trucking option, (involving an estimated 80 trucks per day over a 6 day period) travelling between Valletta and St. Julians, was also associated with operational damage to the road system used.

Positive ecological impact:

- None predicted

Negative ecological impact:

Marine transport of sediment via barges/hopper-dredgers was associated with:

- A short-term impact related to the beach construction phase, in the form of an increased likelihood of operational marine pollution that could be generated during barging and fluidised-sand pumping operations.
- More importantly, fluidised pumping of sediment may be associated with the generation of considerably higher turbidity and related adverse ecological impacts over a wider area than the on-site deposition of sediment by truck.

Trucking of sediment was associated with complete smothering of :

- The existing beach supralittoral and mediolittoral biota.
- The sublittoral biota and habitat to the level to which the sediment will be spread.
- An additional area of sublittoral habitat due to natural settling of the sediment and spill-over effects.
- Impacts due to deposition of material suspended in the water due to the spreading operations.

Overview

There were no positive social impacts were predicted for either option considered for local transport and deposition of beach nourishment material. While the negative social impacts are, in both options, limited to the beach construction phase and therefore short-term, the negative impacts associated with the trucking option were predicted to be more harmful than those for the barging option. Similarly, no positive economic impacts were associated with either local transport option considered. The investment costs associated with the barging option were however, estimated to be considerably more than those associated with the trucking option.

Considering that the ecological considerations also identified more severe negative environmental impacts for the barging and fluidised pumping option, an *overall conclusion may be drawn that favours the trucking option for local sediment transport and site deposition.*

Alternative 5:

Creation of Blue Flag versus non-Blue Flag beach.

Positive social impact:

- Implementation of a national pilot Blue Flag project will pave the way for introducing Blue Flag beach standards at other beaches.
- Additional beach-user satisfaction of using a Blue Flag beach.
- Additional enhancement of the San Gorg area as a consequence of Blue Flag beach and related standards/amenities.

Negative Social impact:

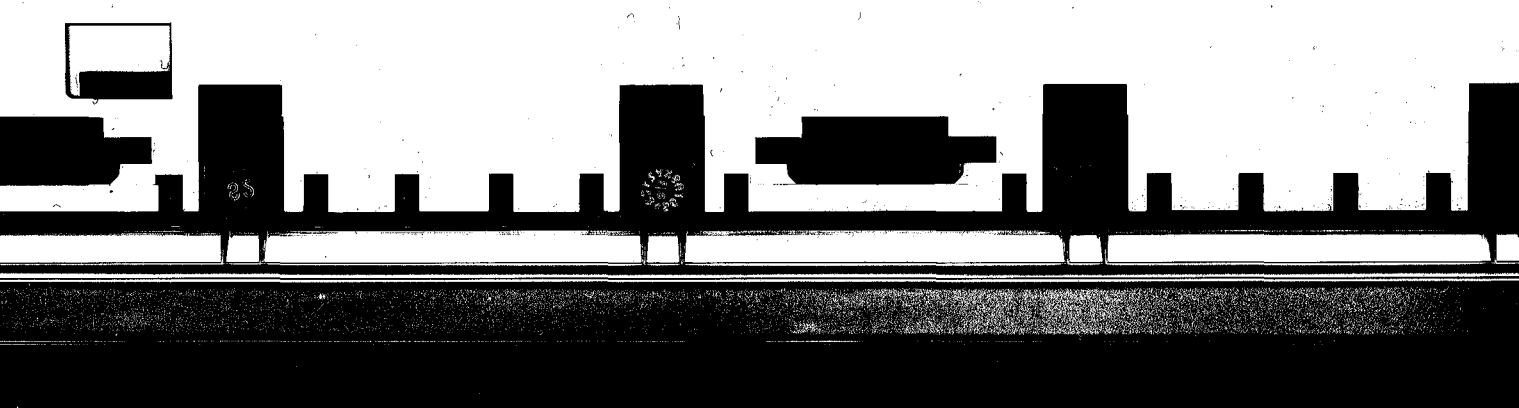
- None predicted.

Positive economic impact:

- Benefits to national tourism earnings from increased level of beach user satisfaction and perceived value for money which would translate into more repeat visits and increased positive visitor feed-back. This was represented by the project economic feasibility study as an annual revenue of Lm 2.7 million.
- Additional revenue to local establishments arising from increased number of persons expected to utilise this high quality facility.
- Additional recurrent revenue from central government to local councils, beach users and local enterprises. This was estimated by the project economic feasibility study to amount to about LM 76,000 annually and was considered to mitigate the recurrent expenditure necessary to operate and maintain the Blue Flag related facilities and standards.

Negative economic impact:

- Investment cost associated with upgrading of beach-related facilities required to attain Blue Flag status, estimated at LM 100,000 by the project economic feasibility study.



- Recurrent expenditure to operate and maintain the beach with a Blue Flag status estimated to cost about LM 21,500 annually.

Positive ecological impact

- Positive ecological impact from high standards and strict control associated with Blue Flag status, particularly those concerned with water quality and sanitation.

Negative ecological impact

- None predicted.

Overview

The socio, economic and ecological impacts associated with the development of a Blue Flag status beach at St. George's Bay, were predominantly positive. The investment and recurrent costs identified with the establishment and subsequent operation and maintenance of the Blue Flag status were the only negative consideration identified with the Blue Flag option. However, these costs were outweighed by the much larger financial benefits predicted from related tourism earnings. In addition, recurrent revenue for local establishments (as a consequence of increased use) and increased revenue from central government to local councils, beach-users and local business enterprises was identified with the Blue Flag option. Blue Flag status at St. George's Bay was predicted to contribute to similar initiatives at other beaches, increase beach-user satisfaction and enhance the quality of St. George's Bay as a whole. At an ecological level, the high quality standards and strict control measures associated with a Blue Flag beach were considered to generate potential spill-over effects on the adjacent marine and terrestrial environment.

In conclusion, consideration of the socio, economic and ecological impacts strongly recommend the development of a Blue Flag beach facility at St. George's Bay.

Review of alternatives considered

The next logical step in this evaluation process would be to consider a final alternative of carrying out a beach nourishment or not. To this end, the socio, economic and ecological issues considered in the above alternatives are reviewed so as to identify the most desirable and/or favorable project characteristics indicated by the integrated evaluation process.

Alternative 1:
Beach nourishment using existing (fine) versus a coarser beach sediment granulometry.

Retention of existing finer grained beach granulometry was associated with:
- Predominantly negative social impacts.
- Negative economic impacts.
- Negative ecological impact.

The coarser (2mm) grain sized sediment option is therefore indicated.

Alternative 2:
Beach nourishment using local versus foreign sediment sources.

- The option of utilising locally dredged sediments was ruled out due to high risk of causing immeasurable ecological damage and the high costs of importing locally unavailable dredging plant.
- Quarry wastes and crushed local stone were considered unsuitable due to their generation of excessive fines and associated negative ecological impact resulting from unacceptable levels of turbidity as well as the negative economic implications associated with high beach sediment losses arising from natural beach erosion processes.
- Locally dredged port sediments were also considered unacceptable for beach nourishment purposes due to their fine composition and potential contaminant content resulting in negative social and economic impacts.

As a consequence of the above considerations, ***the use of foreign sediment having the appropriate characteristics was recommended.***

Alternative 3:
Promenade development through pedestrianisation of existing road at the back of the beach versus shoreline extension through land-filling.

The development of a promenade at the back of the proposed beach nourishment was considered an essential aspect of this project due to the overall increase in recreational-use

potential of the area, the opportunity for embellishment and the increased opportunity for revenue generation to local establishments.

While the alternative of pedestrianisation of the existing roadway was associated with increased visitor satisfaction it was also related to an interruption of direct vehicular access from St. George's Bay to the San Gorg Marina, Corinthia San Gorg and Radisson. In the case of developing a promenade through a land-filling, the reduction of negative vehicular impacts were considered to be of a reduced nature and limited to beach-users. This alternative would also allow the option of current traffic flow along the back of the beach to continue.

From an economic point of view, while the land-filling option was associated with reduced recurrent sand removal expenses, it was associated with much higher capital (construction) costs than the pedestrianisation option.

Ecological considerations strongly favour the pedestrianisation option which is associated with a reduced negative ecological impact than that produced by the larger project foot-print of the land-filling option.

In line with the North Harbours Local Plan Policy NHPV11, consideration of this alternative strongly indicates a high desirability for pedestrianisation particularly as this option would reduce the project footprint and resultant ecological damage. However, due to the importance attributed to the provision of a promenade, the alternative of land-filling should also be considered if pedestrianisation is not acceptable.

Alternative 4:
Beach nourishment via land transport of sediment (trucking and direct dumping on shore) versus marine transport by barges and fluidized pumping of sediment ashore.

- While social impacts identified with either sand transport options were in both cases, solely negative, those associated with the trucking option were considered as more harmful.
- Investment costs associated with the barging and fluidised pumping of sediment ashore were identified as much higher than the trucking and direct sediment deposition option.
- The negative ecological impacts associated with the barging and fluidised pumping option were also identified as potentially more harmful than the trucking option.

As a consequence, ***the option of trucking and direct on-site deposition of sediment was recommended.***

Alternative 5:
Creation of Blue Flag versus non-Blue Flag beach.

The negative economic impacts resulting from the establishment of a Blue Flag beach at St. George's Bay (as related to investment and recurrent costs associated with upgrading and maintenance/operation of Blue Flag facilities and standards) were considered to be mitigated by the overwhelmingly positive impacts produced by socio, economic and ecological considerations of this alternative. As a consequence, ***the creation of a Blue Flag status beach at Bajja ta San Gorg was recommended.***

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Recommendations

The considerations discussed in the Integrated Evaluation allow a set of recommendations pertaining to the desired characteristics of the proposed beach nourishment exercise at St. George's Bay, namely:

i. The design of the beach and promenade to be amended through the conversion of the existing road at the back of the beach into a fully pedestrianised promenade.

ii. Utilise an imported sediment for beach nourishment purposes.
While it would normally be desirable that the properties of the beach fill would be similar to those held by the existing beach, namely a fine (0.14 - 0.22mm) calcareous sediment with an abrasion value of 25% (Los Angeles scale), a hardness value of 4 (Mhos scale of hardness) and a specific gravity of 2.15, these properties are considered as generally poor and undesirable for beach nourishment purposes. The following sediment characteristics are identified as being desirable:
   - A minimum grain size (specifically for St. George's Bay) of 2.0mm.
   - An abrasion value (Los Angeles scale) not exceeding 15% (see foot note).
   - A specific gravity between 2.6 - 2.8 (Sciortino, 1998).
   - Have a light colour as this aesthetically more acceptable to beach users.
   - Have a terrestrial origin and be biologically inert so as to prevent introduction of ecologically new species and reduce palaentological contamination.
   - Imported beach nourishment material should be free of chemical contaminants and excessive fines. Acceptability of renourishment material in terms of its physical and chemical properties should be assessed from an ecological view-point prior to its selection for this project.

iii. Utilise a trucking option for local transport of sediment and on-site deposition of nourishment material at the existing beach head at St. George's Bay.

iv. Include the development of amenities and infrastructure necessary to support Blue Flag beach status within the overall management criteria for the proposed beach nourishment at St. George's Bay.

v. Replace the suggested option of using mechanical plant to retrieve small quantities of displaced beach sediment predicted by the hydrodynamic modelling study for storms having a 50 year return period by standard re-nourishment procedure.

vi. Although potentially difficult to anchor at St. George's Bay, strongly investigate the feasibility of using silt curtains to minimise the impacts of increased turbidity during the beach nourishment phase.

NB: Since local stone has a high abrasion value, there is a potential of abrasion of local sediment at San Gorg if imported nourishment material is chosen with (normally desirable) lower abrasion values. The geological report indicated that due to its negative impact on

the existing calcareous sand, quartz sand should preferably not be mixed with naturally occurring calcareous sand. In this context, a compromise may need to be made on the abrasion value of imported sediment, particularly since a non-calcareous sediment having a higher abrasion value than the existing sediment would also serve as a suitable tracer element for monitoring purposes.

Final consideration: Beach nourishment versus no beach nourishment.

This consideration assumes a beach nourishment project at St. George's Bay, having the above listed recommended characteristics:

Positive social impact:

- Enhanced recreational opportunities for local and overseas tourists arising from new beach and associated promenade.
- Improved land/seascape of the locality.
- Improved public amenities.
- Improved health safety aspects for bathers as a consequence of improved water quality resulting from upgrading of sewerage system and application of Blue Flag criteria.
- Upgrading of tourist product in the locality.
- Improved access to the shore.

Negative social impact:

- Increased traffic in the locality.
- Short-term disturbance impact (noise, dust, exhaust fumes) during construction phase.

Positive economic impact:

- Recurrent revenue arising from central government to local councils and from beach users and local enterprises.
- Additional revenue to nearby localities from increased use by locals and tourists.
- A generally stable beach requiring infrequent re-nourishment.

Negative economic impact:

- Capital expenditure incurred in beach nourishment (purchase, transport and laying of beach sediment.
- Capital expenditure incurred with upgrading of local infrastructure, including specific requirements indicated by Blue Flag beach criteria.
- Recurrent expenditure form operating and maintaining beach particularly those related to Blue Flag status.

Positive ecological impact:

- Creation of an artificial beach will improve water quality in the bay due to imposed upgrading requirements of present sewerage system which in its present state is known to pose some localised water quality problems.

Negative ecological impact:

- Smothering impact of the inshore area, largely comprising of bare sand with small patches of *C. nodosa*, photophilic algae on stones, and accumulations of sea-grass debris and pebbles. Disturbance of a small part of the *C. nodosa* meadow at the head of the bay, which being a pioneer species, is expected to recolonise if the disturbance is not continuous.
- Decreased photosynthesis by sea-grasses and photophilic algae during construction phase. The severity of this impact is expected to be limited by the larger (2mm) grain size nourishment sediment recommended which is associated with decreased suspension.
- Potential impact of accidental pollution/environmental degradation during construction phase.
- Grain size contamination of existing sediments.
- Potential of species and palaeontological contamination of existing sediments.

Overview

St. George's Bay and the entire urban/touristic Sliema area is currently dependant for bathing, on its poorly managed/highly developed rocky shores and a plethora of private swimming pools which are used against payment. The creation of a re-nourished sandy beach in this area of Malta, popular with both locals and tourists is therefore highly desirable. Indeed, the social benefits from an embellishment of this type are clear and considerable to both locals as well as the tourist industry and may be considered to justify the predicted project investment costs. The latter are further mitigated by potential recurrent revenue associated with this project and by the ongoing overall development and upgrading in this area.

The predicted negative ecological impact should not be taken lightly but appears limited to the inshore areas of the bay dominated by an assemblage of photophilic algae intermixed with small patches of *P. oceanica* and interspersed with bare bedrock and construction rubble.