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Best Waste Management Programs (BWMPs) for marinas: A case study

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Abstract. Marinas are usually located in coastal waters, but can also be found in lakes and rivers. Due to the activities that take place in marinas various contaminants are discharged. Specific measures have to be taken in order to keep the marina environment clean and healthy. Experiences from developed countries have shown that the most effective way to reduce pollution in marinas is the implementation of waste management programs. To this end, 'Best Waste Management Programs' (BWMPs) have been employed in the USA and other countries. However, in developing countries lack of available financial resources and unawareness of the concept of clean marinas may hinder the activities towards the application of BWMPs. The aim of this study is to address BWMPs in general and explain waste sources and disposal methods for marinas and yachting activities. The Kusadasi Setur marina in Turkey is investigated particularly as an example of a marina in a developing country and management measures taken in this marina are evaluated. The various kinds of waste generated in the marina are described and preventive measures against pollution taken in the marina are reviewed. Finally the importance of management programs towards the mitigation of pollution problems is emphasized.

Keywords: Best Waste Management Practice; Cleansing; Kusadasi Setur; Marina waste; Waste management; Yachting.

Abbreviations: BWMP = Best Waste Management Program; BMP = Best Management Practice; EPA = Environmental Protection Agency; EFEE = European Foundation on Environmental Education; IMCO = Inter-governmental Maritime Consultative Organization; MSD = Marine Sanitation Device; NPS = Non-point Pollution Source; NOAA = National Oceanic and Atmospheric Administration; USEPA = USA Environmental Protection Agency.

Introduction

Marinas and recreational boating (yachting) have become very popular and they have gained importance in Coastal Zone Management in recent years. However, so far efforts have generally been devoted to planning and construction aspects of marinas while environmental impacts have usually been ignored. Therefore, poorly planned marinas and boating activities have often resulted in the deterioration of the environment and impaired the quality of the local seawater. Some countries such as the USA have initiated pollution control programs applied by national organizations in order to eliminate or reduce the problems arising from marinas and boating activities. These programs include sets of management measures to control the pollution from marinas and boating. Discrete sources such as oil, hazardous materials, detergents from faulty septic systems or boat toilets are considered as Non-point Pollution Sources (NPS) and 'Best Waste Management Programs' (BWMPs) are initiated as a part of NPS management approach in marinas[1]. In this respect, management strategies may contain various programs such as solid waste management (separate collection in containers, minimization at the source, and re-use and recycle alternatives), hazardous waste management (mainly for the maintenance and repairing), and waste water management (collection systems, treatment units etc.) as well. In practice, each marina is responsible for the development of its own management program that requires special prevention measures regarding local activities and each marina has to put these programs into operation. BWMPs are based on a wide range of experiences and they do not preclude marina operators from applying additional alternate BWMPs to reduce pollution sources.

[1] www.epa.gov/nps/MMGI/chapter5

The coast of Turkey is particularly attractive to yachtsmen because of its many natural, historical and cultural reserves and at the same time the development of modern marinas and harbours along the coast. The azure waters of the Mediterranean, the Aegean and the Black Sea as well as the Sea of Marmara surround the south, west and north coast of Turkey with over 8353 km of coastline. There are many inlets, bays and beaches that attract yachtsmen, while moderate winds prevail during seven months of the year to make the Turkish coast an ideal place for sailing. Although yacht tourism has started relatively recently in Turkey, largely during the 1980s, it has rapidly gained importance as in other countries with coastal recreation such as France, Spain and Italy which are considered the pioneer countries of yacht tourism. In recent years, Turkey has raised its level of facilities to the standard of other eastern Mediterranean countries, notably Greece, Israel and Cyprus. At present, there are more than 25 marinas in Turkey and 12 of them have been distinguished with the Blue Flag for clean waters by internationally recognized agencies (Anon. 2000a). However, this capacity is still insufficient and the new Turkish target for the next ten years is to increase it to 50 marinas having international standards and a total yachting capacity of 30000 (Anon. 2000b). It should be noted that this development is achieved without creating any hazards to the environment. Pollution control programs, 'BWMPs' covering sets of management measures have to be initiated in order to eliminate the problems arising from such activities.

This paper aims to introduce a general approach for developing BWMPs and to demonstrate this for the Kusadasi Setur marina, one of the most important marinas of Turkey, which provides various services such as boat docking, boat repair and maintenance. It describes the various types of waste generated in marinas and the main procedure required for the development of a BWMP for marinas. Then, the BWMP program for the Kusadasi Setur marina is examined, while paying attention to the environmental dimension of marinas, adverse effects threatening environmental quality, and required remedial actions.

Waste sources and disposal methods for marinas and yachting activities

Marina facilities and waste sources

Marina and boat yard operations include; recreational and commercial boat docking facilities, storage, fueling operations, cleaning, and boat building and maintenance facilities that produce wastes containing various pollutants. In addition, certain commercial and entertainment facilities for yachtsmen such as restaurants, bars, cafeteria, showers, toilets, etc. generate mainly domestic wastes. Thus, there is a strong contamination potential for the marina environment from various sources; and if the necessary measures have not been implemented, substantial harmful impacts will be manifest.

The wastes arising from various activities in the marinas may be classified as (1) fuel and petroleum wastes; (2) hazardous materials; (3) sewage; and (4) solid wastes. Fueling, oil, and other petroleum waste mainly come from bilges, storage tanks and maintenance facilities of yachts. Generally, fueling operations are the basic sources of petroleum contamination, and there is real risk of accidental spills that cause serious environmental hazards. Particularly gasoline spills may lead to explosions and fire. Another source is the repair and maintenance of engines where oil is let out from the crankcase. Materials that are dangerous in the environment such as solvents, anti-freeze, paint, petroleum extracting materials, alkaline salts, detergents etc. have been routinely used in marina facilities like boat scraping, painting or cleaning.

Another waste source in the marinas is marine vessels, i.e. yachts and boats that are used as mobile homes. Boaters are more likely to use inboard facilities resulting in the generation of waste rather than marina facilities are provided. Therefore, waste water originating from human activities on boats should be collected and stored in their own storage tanks. Inter-governmental Maritime Consultative Organization-IMCO defines two types of waste water generating from sea vehicles, i.e. black and grey water. Sewage wastes including flush water is called as 'black water' whereas sanitary waste water from sinks, showers, laundries, galleys etc. is called as 'grey water'. The quantity and some quality parameters of these waste waters indicated by IMCO are given in Table 1.

The data in Table 1 are a good reference for a first estimate of BWM planning practices because coping with waste water is one of the essential components of the BWM approach. The figures indicated in Table 1 partially match with the data obtained in this research and presented in subsequent parts of the paper. Since the waste water discharge has not been permitted into the marina, such data are especially useful in designing Marine Sanitation Devices (MSD) or determining the volume of waste water storage tanks. Commercial and entertainment facilities on land also produce waste water that may be rich in organic matter, suspended solids, nutrients, coliforms, oil and grease and may include certain toxic substances.

Apart from the waste water, solid wastes are generated in marinas during daily operations, and include trash from boat maintenance (such as fiberglass, wooden particles, sand, metallic particles, paints, etc.) and

Table 1. Characteristics of waste waters generated from sea vessels (Anon. 1978).

Sewage/human body wastes	
Average volume of conventional flush water (L.flush^{-1})	20
Daily average volume of sewage (L.person^{-1}d^{-1})	140
Average 5-day biochemical oxygen demand, BOD_5 (mg.L^{-1})	350
Average suspended solids, SS (mg.L^{-1})	350
Sanitary waste waters	
Daily average shower and wash basin waste water (L.person^{-1}d^{-1})	20
Daily average laundry waste water (L.person^{-1}d^{-1})	20
Daily average galley waste water (L.person^{-1}d^{-1})	80
Others	30
Daily average volume of sanitary waste waters (L.person^{-1}d^{-1})	150
Mean 5-day biochemical oxygen demand, BOD_5 (mg.L^{-1})	150
Average suspended solids, SS (mg.L^{-1})	125

recyclable materials (such as paper, glass, cans, plastics, etc.) from social facilities and yachts. If those wastes are not handled properly, they may cause significant hygienic as well as aesthetic problems on the marina and its territory.

Disposal methods

Many significant problems associated with marina activities including boat engine repair and maintenance can be eliminated through a pollution prevention philosophy. Special places, preferably with roofs, must be reserved for activities and any waste discharge should not be permitted from such places without implementing proper infrastructures. Also, use of auxiliary equipment such as vacuum sanders that collect and store dust before it can get disappear into the water or air is highly recommended. Overfills and spills can be prevented by developing a spill prevention plan that should address proper procedures and maintenance of fuel station equipment. For that purpose, sorbent materials may be used to control the spent engine fluids, such as waste oil and used anti-freeze, etc.; and fuel pump nozzles should be equipped with automatic back-pressure shut-off to prevent overfilling the fuel tank. Also, the fuel/air separators on fuel tank vents will further prevent fuel overflows. Waste solvents from cleaning operations can be recovered by using onsite distillation units or off-site solvent recovery services. In addition, washing of boat floors and hull surfaces by using only fresh water will reduce the need of cleansers and heavy-duty (or very durable) products.

Furthermore, domestic waste water containing black and grey components should be properly collected, treated and then disposed. This can be realized either in the boat or on the shore. In fact, boat based treatment, e.g. MSD, is preferable. However, since MSD applications enforce any owner of a vessel to install an onboard toilet and to use certified marine sanitation devices, this application has not become common practice. So, instead of using MSDs, pumps that withdraw waste water from vessels have become common in operation in marinas. Following to the collection of waste water from yachts, this water can be treated in a treatment plant constructed in the marina (ashore) or transferred to central treatment plant by a sewage system.

Besides liquid wastes, solid wastes (garbage) should also be properly handled and controlled. The Marine Plastic Pollution Research and Control Act, and the international agreement MARPOL Annex V as well, prohibit the disposal of solid wastes in an uncontrolled manner to any waters. Therefore, segregation of waste streams and collecting them in containers has been recommended for solid wastes. This can be achieved by using separate containers and sacks for each type of waste. The main components that can be separated are glass, tin-cans, paper and organic parts. Such an effort will significantly decrease the volume of waste to be dumped (or land-filled) and brings a cost-effective solid waste management.

Development of Best Waste Management Practices for marinas

The growth of recreational boating, along with the growth of coastal development in general, has led to increasing awareness of the need to protect the environmental quality of waterways. Fueling, maintenance operations, scraping and painting, the improper discharge of boat toilet contents, and other common activities can contribute significant pollution to water bodies. The most effective way to reduce pollution is to develop pollution management practices and implementing control programs in the area. These programs, recently called BMPs, generally attempt to reduce the pollution at the source or provide mechanisms that prevent the material from entering surface waters.[2]

An excellent study on marina management was carried out by USEPA (USA Environmental Protection Agency) in 1996. The project: '*Clean Marinas-Clear Value'* was initiated to identify marina and recreational boating operations and to adopt BWMPs that will result in economic benefits (Anon. 1996). The goal was to produce a document that will help convince many in the marina industry to voluntarily make environmental changes. Marina industry representatives, boating industry magazines, and representatives of key coastal environmental agencies such as EPA, NOAA (National Oceanic and Atmospheric Administration), U.S. Coast Guard, came together to review the project. As a result of this

[2] www.epa.gov/owow/nps/marinas/#6

effort, 25 of the volunteering 75 marinas were nominated to apply the management programs. Finally, the 25 marina case studies were described and the advantages and/or profits of the clean marinas were documented by EPA.

A similar program was realized in the Florida Peninsula, with ca. 2000 marinas in 1997, to protect its coasts against pollution. The Clean Marina Program for Florida consists of education and information stages, granting, and identification of clean marinas.[3] In this framework, waste problems have been pointed out for each marina, preventive measures have been taken considering the local conditions; later on waste management plans have been developed and implemented to maintain the clean marinas as well as a clean environment. For instance, main waste management problems of marinas and boatyards include special wastes such as bilge water, used oil, used oil filters, contaminated spill control material, paint waste, old gasoline, used batteries, sewage as well as paper, bottles, cans and plastics. BWM programs included the inventory of waste types and sources and the handling, storage and disposal of them.

A case study: the Kusadasi Setur marina

Existing conditions

'Setur Marinas' is the only marina chain of Turkey with its six marinas. At the Setur Kusadasi marina, mooring service is given continuously by a cruiser. At the marina workshop, all kinds of painting and maintenance, varnishing, epoxy-polyester works, boat covering, sprayhood manufacture and repair, all kinds of main machinery, generator and outboard repair, plane, stainless metal and galvanizing works, electric and electronic equipment repair, bilge control, mounting and maintenance are available. Additionally, there are two restaurants and bars, one cafeteria serving totally ca. 700 persons. The capacity of the marina is reported as 175 yachts ashore and 360 in the marina; the number of the staff working in the marina is 29.

The pollution sources in the marina are classified as yacht-based and land-based. In fact, yacht-based and land-based data comprise three different phases: 'existing capacity', 'active winter conditions' and 'active summer conditions'; see Table 2.

There is a well-designed water supply and sewage system in the marina. Potable water is obtained from the municipal water supply network and the artesian well. In some cases, additional amounts of water, especially in the holiday season are supplied by using tankers with water from other sources. Potable water is mainly used in land-based activities (in restaurants, toilets, showers, etc.) but also for yachts. Yachts use water for cleaning and also storage.

Since water consumption and thus its discharge are one of the important potential sources of pollution, this was investigated for Kusadasi Setur Marina. According to the survey conducted for the marina, the daily total water consumption by boats as well as for land activities is about 80 $m^3.d^{-1}$ for winter and 250 $m^3.d^{-1}$ for summer periods. This amount of water consumption covers all the activities carried out on-boat and off-boat in the marina, including restaurants, bars, cafeterias and offices, as well as water boxes. Water boxes that are equipped with flow meters deliver water to the boats. A water box that is located on the dockyard consists of three outlets, and there are 250 outlets in marina; and the total amount of water utilized from the boxes is reported as to be ca. 15000 $m^3.yr^{-1}$. Ca. 90 - 100 boats are docked in the marina, while only 20 - 25 of them are used during the winter ('active yacht' means that people have stayed on board a whole day or day and night). The number of yachts increases to 300 - 350 in the summer and approximately half of them, i.e. 150 - 200 boats area 'active'. Assuming a winter period of 6 months with an average of 25 yachts and a summer period of 6 months with an average of 175 yachts and taking the weighted average, then one yacht extracts ca. 0.4 $m^3.d^{-1}$ of water from water boxes. If we assume that each boat has four passengers, this corresponds to 100 L water per person per day. For the average specific water consumption per yacht only the active boats and mooring boats are taken into consideration, daily visiting boats are ignored because there is another port for such activities.

The data concerning the number of yachts and seasons are based on assumptions and estimations of marina staff that may make the results controversial. However, the data seem to be reasonable values and they give some insight to the readers as well as to planning

Table 2. The data for yacht and land based activities in the examined marina.

Yacht-based	
Existing yacht capacity	360
active yachts in winter	20-25
active yachts in summer	150-200
Land-based	
Existing capacity of land-based facilities* (person)	700
active winter conditions (person)	210
active summer conditions (person)	420

* capacity of the restaurants, bars and cafeteria

[3] www.dep.state.fl.us/law.bosp/grants/clean-marina/bmps

people.

The results obtained indicate that water consumption in land and yacht-based activities show substantial seasonal variations. In winter periods, water has mainly been used in land-based activities, i.e. 85 - 90% of the total water consumption. This may be explained by the decrease in crew and the increase in maintenance facilities during the off-season. Since yachting activities diminish in winter, boat owners prefer to haul boats onto the shore for maintenance, which results in a reduction of the water consumption. Yachting activities enhance during summer and the water consumption in boats may reach 40% of the total amounts. This reveals that the major water consumption in the marina is due to land-based activities.

The main waste water sources in the examined marina are restaurants, cafeteria, bars, offices, showers, toilets, laundries, boat cleaning and repair activities. The discharge of waste water into the marina is not permitted and therefore conveyed to the sewage system of Kusadasi municipality. In the marina, there is no waste stream segregation that means toxic, hazardous materials from any maintenance and repair facilities and domestic waste waters are collected with the same sewer system and disposed together. In the scope of the presented paper the characteristics of this mixture have been determined by taking samples from the sewer system and analysing them at the laboratory. The results are given in Table 3 and it indicates that certain parameters such as COD, TSS, and oil and grease exceed the limits given for domestic waste water.

Among the parameters, organic matter, measured as COD, may cause the depletion of oxygen during the conversion to CO_2 and water . Settleable and suspended solids lead to various problems in the marina environment. They cause turbidity, colour and sediment accumulation on the bottom of the basins which reduces the depth. Turbidity reduces water clarity, reduces photosynthetic depth for submerged vegetation, and interferes with feeding/respiration by aquatic organisms. Oil, which causes problems even in trace amounts, is aesthetically unacceptable and reduces biological activities by preventing solar intrusion to the sea. Here, one of the important parameters that is measured is phenol that may be toxic for biological treatment facilities and also may cause odor problems. In some cases salinity may be a problem.

Bilge water, as mentioned before, has been considered as a high potential pollution source. In Kusadasi Setur Marina, the collection service for bilge water has been provided free of charge by Marina staff through the use of submersible pumps. The bilge water was transferred from sea vessels to the storage tank on land and disposed of in the solid waste disposal site. It is reported that throughout the holiday season, from May to August, 40 tons bilge water has been collected whereas in the rest of the year the total amount of bilge water is ca. 50 ton. Thus, 90 ton of bilge water per year has been collected totally. The characteristics of the bilge water were examined by taking samples; the results are presented inTable 4. This table indicates that the quality of bilge water is quite different from sewage water and needs special treatment techniques to remove oil and grease. The higher amounts of organic matter, suspended particles, oil and grease generate substantial problems stated above. On the other hand, since the quantity of the bilge water is so small, batch-operated systems seem very suitable for treatment of such waste water.

Table 3. Characteristics of sewage waste water in the examined marina.

Parameter	Unit	Concentration
Chemical Oxygen Demand (COD)	mg/liters	1000-1200
Total Suspended Solids (TSS)	mg/liters	250-350
Oil and grease	mg/liters	350-400
Phosphorus (PO_4-P)	mg/liters	15-20
Ammonium (NH_4-N)	mg/liters	20-25
Nitrate (NO_3-N)	mg/liters	2-5
Phenol	mg/liters	4-6
Salinity	‰	1.5
Conductivity	µmhos	3300
pH		6.5-7.0

In addition to liquid wastes, marinas produce solid waste. As mentioned above, a variety of solid wastes are generated in Kusadasi Setur Marina. Wastes with domestic characteristics originate from public places and yachts whereas trash such as fiberglass, wooden particles, sand, and paint come from boat repair and maintenance facilities. The recyclable materials such as paper, bottles, cans and plastics are relatively numerous; however, they cannot be collected effectively although a recycling program has been implemented. There are three different types of collection bins for plastics, glass and garbage and they are located at various points, but the yachtsmen have so far poorly participated in the recycling program. The amount of solid wastes generated is very variable. According to other research by one of us, the solid waste production for yachts is 0.20 - 0.55 $kg.person^{-1}d^{-1}$ (Donmez 1999). If this figure is applied to the Kusadasi Setur Marina by assuming 20 - 25 active yachts in winter and four people per yacht, the total amount of solid waste is calculated as 16 - 55 $kg.d^{-1}$. Similarly, 150 - 200 active yachts in summer give 120 - 440 $kg.d^{-1}$ of solid waste. In addition, the solid waste production of land-based inhabitants (see Table 2), are calculated as 20 - 140 $kg.d^{-1}$ for winter and 40-280 $kg.d^{-1}$ in summer by assuming the specific solid waste production rate is ca. 0.10-0.65 $kg.person^{-1}.d^{-1}$. When those numbers are superposed, the total solid waste

Table 4. Characteristics of bilge water in the examined marina.

Parameter	Unit	Concentration
Chemical Oxygen Demand (COD)	mg/liters	5000-6000
Total Suspended Solids (TSS)	mg/liters	10000-12000
Oil and grease	mg/liters	2500-3500
Phenol	mg/liters	5-7
Salinity	‰	4.5
Conductivity	µmhos	700
pH		7-8

generated in winter and summer periods can be calculated as 36-195 kg.d^{-1} and 160-720 kg.d^{-1}, respectively. On the other hand, according to the information stated by marina staff, ca. 2000 kg of solid waste including 50 kg recyclable material is collected per day during the summer period. This number is very different from the computed values but it should be mentioned that the data related to the pollution sources are too variable and contain uncertain components both in collection and processing phases. Therefore, it is recommended that more research should be encouraged in this field and the importance of more information should be emphasized.

The solid waste generated in Setur Marina is collected daily and transported to the Municipality landfill site. For the time being, no fee is charged by the Municipality; the transfer of solid waste is under the responsibility of the marina administration. The recycled materials, as mentioned above, are collected and stored in separate containers and then sold to companies.

From the studies presented above, the extracted information for liquid and solid wastes is summarized in Table 5. The data given in the table is particularly derived from the Kusadasi Setur Marina but they may likely be used for the other marinas of Turkey as well as for other developing countries. If those data are compared with IMCO 1978 figures (see Table 1) the water consumption values are found slightly lower in the examined case. This may be due to some assumptions (e.g. four persons per yacht, etc.) and also the overall evaluation of summer and winter conditions. On the contrary, the organic matter content of the examined marina is found higher than IMCO 1978 figures. This is because, the marina sewer system not only collects the liquid wastes from the yachts but also receives the waste water generated in maintenance, painting works and repair facilities.

At Kusadasi Setur Marina, among the measures that are stated above, shore stabilization, sewage control, bilge control, solid waste management facilities have been accomplished. Storm water has recently been controlled by constructing a drainage system; thus rainwater introduction into the marina is reduced. Assessment of the marina environment in terms of water

Table 5. Summary of pollution data for land-based and yacht-based activities in the examined marina

Yacht-based wastes*	
The number of active yachts in winter	20 - 25
The number of active yachts in summer	150 - 200
Total water consumption in winter (m^3.d^{-1})	10 - 12
Total water consumption in summer (m^3.d^{-1})	90 - 100
Specific water consumption per yacht (m^3.yacht^{-1}.d^{-1})**	0.4
Solid waste generation in winter (kg.yacht^{-1}.d^{-1})	16 - 55
Solid waste generation in summer (kg.yacht^{-1}.d^{-1})	120 - 440
Specific solid waste production rate (kg.person^{-1}.d^{-1})	0.20 - 0.55
Land-based wastes	
Capacity of land-based facilities (person)	700
active winter conditions	210
active summer conditions	**420**
Solid waste generation in winter (kg.d^{-1})	20 - 140
Solid waste generation in summer (kg.d^{-1})	40 - 280
Specific solid waste production rate (kg.person^{-1}.d^{-1})	0.10 - 0.65

*data are based on total average number of active boats, and 4 persons per yacht

**Water consumption corresponds approximately waste water production

quality as well as habitats is an important issue because otherwise it becomes difficult to determine the effects of the measurements taken by marina operators. In the examined marina, water quality analyses have been performed only for the coliform parameter. Samples are taken monthly from two different points, total and fecal coliform bacteria have been measured.

These measures have been partially taken without implementing any waste management program. This is achieved by establishing policies to protect the environment in general. We believe that the advantage or profits of such applications in economic as well as environmental manners will encourage the persons who are working in the marina and enlarge these practices. Therefore, studies revealing the economic benefits of such practices should be initiated in Kusadasi Setur Marina; they may be an example for the next BWMPs in Turkey.

Conclusions and Recommendations

As stated before, although 'clean marina' projects or programs are not well-known in developing countries like Turkey, certain measures have already been taken in marinas. Experiences from developed countries have shown that the most effective way to reduce the pollution in marinas is the implementation of management programs. However, financial limitations may hinder the activities towards the application of BWMPs in developing countries. Therefore, the programs may be started with minimum investment and operation costs and upgraded successively when sources become available. Finally, extensive programs should be developed and put into practice. In this perspective, such recommendations stated below may be achieved

concerning waste management issues and they may be integrated with the existing precautions that require less investment and costs:

Waste water control; Liquid waste sources in marinas are classified as land-based and boat-based. In practice, control of land-based waste water may be achieved effortless by a disposal facility that may either be the connection of the municipal sewer system or implementing a treatment plant in the marina. The former one is preferable and its treatment is not the task of the marina management. If a treatment plant is unavoidable then it should be operated as complying with the discharge standards of the country. The control of waste water coming from boats should be subjected to more comprehensive monitoring and management practices. Illegal discharges should be strictly prohibited and yachts should be enforced to store waste water in their tanks and discharge it to the sewer (or another collection system). Therefore, pump-out facilities are especially important in marinas in order to collect waste water. In other words, pump-out facilities of boats, i.e., diameter of pipes and outlets has to fit the marina equipment. Collection of waste water free of charge (or against a nominal fee) by marina is recommended.

Bilge waste control; although the quantity of bilge waste is small it has a high amount of oil, suspended matter and organic matter that requires special care. Since introduction of bilge waste water to any treatment plant causes harmful effects it should be collected separately. Marinas can provide a collection service for bilges free of charge or for a nominal fee. Using a storage tank is also required to collect bilge waste, so it can be treated using proper techniques.

Solid waste control; Solid waste management in marinas is important in terms of collection and disposal methods, because due to the life style of yachtmen, large amounts of recyclable material is disposed. Effective segregation of wastes is achieved both by the efforts of the marina staff as well as according to the wishes of the yachtsman. If the land area of the marina is appropriate, simple compost techniques can also be applied to organic wastes.

Others; It is important to control the contaminants before they enter the surface waters of the marina. Therefore maintenance works have to be done in covered places. For boats that are in the water, cleaning operations have to be minimized, and hull scraping or any process occurring underwater to remove paint from the boat hull should not be allowed. Hull washing areas should be directed to stormwater management facilities. The use of environmental compatible cleaning products should be supported.

In addition, certain applications or programs like the Blue Flag may assist to apply such measures against to pollution in marina environments. The Blue Flag, the international symbol of care and sensitivity on the environment, may be used as a tool for prevention of marina environmental pollution. In recent days, the European Foundation on Environmental Education (EFEE) has decided to upgrade these criteria that yield better control on marina environments. In addition, according to the latest amendments, private or commercial yachts can also be awarded with a Blue Flag by the EFEE. Disposal of garbage, bilge waste, grey and black waste water has been prohibited with this judgement. Also, waste segregation has approved for recycling purpose and therefore waste oil, paint, and used batteries will be collected in containers and disposed on land. And, finally, environment- friendly usage of material should be encouraged.

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References

Anon. 1978. *Guidelines on the provision of adequate reception facilities in ports, Part 3 (Sewage), Part 4 (garbage)*. Inter-governmental Maritime Consultative Organization, London, UK.

Anon. 1996.*Clean Marinas, Clean Value*. Environmental Protection Agency, Office of Water, Report 841-R-96-003.Washington, DC, US.

Anon. 2000a. *The Blue Flag and the projects of the Foundation of Environmental Education of Turkey*. Foundation of Environmental Education of Turkey, Ankara, TR (In Turkish.)

Anon. 2000b. *Reports on the Maritime Sector 1999-2000. Commercial Maritime Union of Istanbul and Marmara, Aegean, Mediterranean and Black Sea Regions No. 55*. Imak Publications, Istanbul, TR.

Donmez, I. 1999. *Wasts generating from marinas and yachts, and disposal methods*. Thesis, Dokuz Eylul University, Izmir, TR. (In Turkish.)

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