

Project for Improvement of Solid Waste Management in the Republic of Palau

Monitoring of Environmental and Social Consideration

June 2008

1. Environmental and Social Consideration in the Project

It was conceived that the construction to rehabilitate M-dock landfill and the construction of small scale landfill in the pilot project might cause negative environmental and social impact.

These constructions were executed with considerations of environmental and social aspects. Mitigation measures such as installation of silt fence into excavation area facing coast, which prevented negative impact was adopted. Accordingly, the construction had been completed without causing significant impact to the surrounding environment and people.

M-dock landfill has been used for several decades without any measures to control pollution from buried waste and landfill. Offensive odor, waste littering, unsanitary conditions due to pest as well as flies have caused negative impacts because the landfill was operated as open dumping site. Pollution of sea due to leachate from waste was one of environmental impact as well. It was attempted in the rehabilitation works for M-dock landfill to introduce semi-aerobic system and sanitary landfill operation to mitigate negative environmental impact which existed before the project. After the rehabilitation leachate does not flowing into the sea thanks to the structure which enclose waste dumping area. It was regarded also that the leachate circulation system applied to the landfill contributed to avoid impact of leachate to the environment even though Palau's precipitation is quite a lot. Landscape was considered in designing since the landfill was located close to the places where tourists might visit. As a result, it was evaluated that endeavors in the project had brought about much improvement in terms of environmental preservation. It was especially observed that reduction of pollution at mangrove forest and its ocean was remarkable.

2. Implementation of Mitigation Measures and Evaluation of these Effect

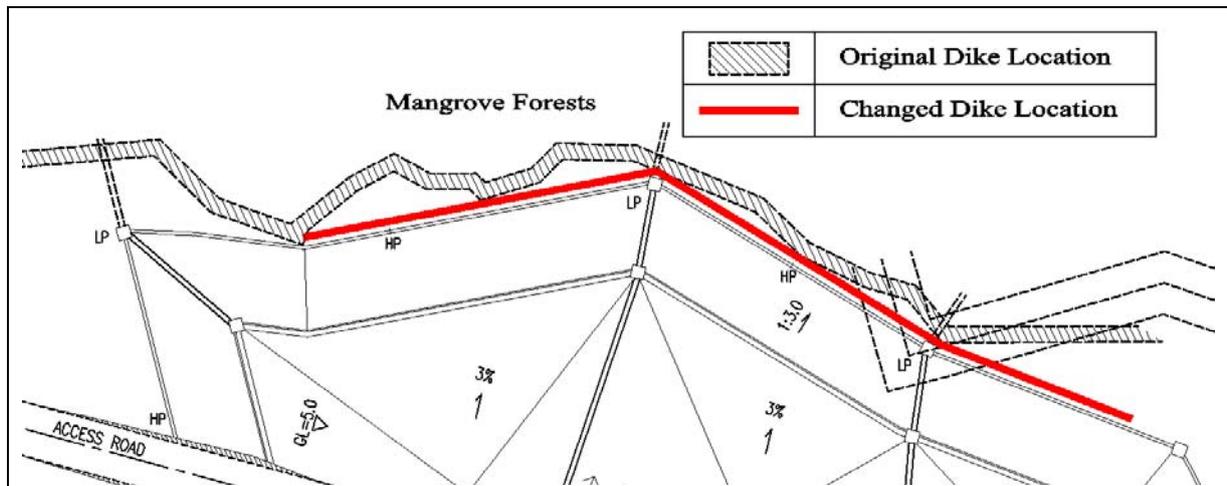
(1) Project for Improvement of the Existing Landfill, M-dock Landfill

The rehabilitation works of M-dock Landfill was commenced in January 2006 and completed December 2007. Results of monitoring of social and environmental considerations during and after the rehabilitation works are illustrated as follows;

Cause of Impact	Phase		Mitigation	Implementation and Evaluation of Mitigation
	Con	Ope		
Felling of mangrove	B	-	Design to avoid deforestation of the mangrove forests	<p>In the designing, it was decided that the location of the dike to shape the boundary of landfill site was set back in order to preserve the existed mangrove forest as much as possible although it would cause reduction of capacity of waste receiving of the landfill. It is illustrated in following drawing: the oblique line shows the original location and the red line shows the changed dike location.</p> <p>The layout of designed dike was adjusted to actual location of the mangrove confirmed during constructions. As a result, almost all mangrove trees were left untouched and remained. Approximate 2,500 m² of mangrove forests were preserved by setting the dike location back to landfill side. Pictures below show the situations before and after the construction of rehabilitation.</p>

Note:

1. Phase Con: Construction phase Ope: Operation phase
 2. Evaluation Criteria A: Significantly effects B: Effects
 C: Effects offset by mitigation or positive effects D: Does not effect



Change in the Layout of Dike at Mangrove Side to Preserve Mangrove Forest



Picture 1. Wastes disposed of at the mangrove forest before the rehabilitation works



Picture 2. Preserved mangrove forest and constructed dike & slope formation

Cause of Impact	Phase		Mitigation	Implementation and Evaluation of Mitigation
	Con	Ope		
Leachate and polluted run-off from landfill	C	-	Silt fence at excavation site	Silt fence was installed to avoid flow out of particles of clayish soil to the excavation area facing coasts including mangrove forest. Environmental Quality Protection Board (EQPB) of the Government of Palau cared about the impact of the construction. EQPB coordinated with and instructed the project to avoid negative environmental impact by the constructions. It was recognized that installed silt fence functioned effectively to prevent causing pollution of the seawater in the neighboring coastal zone.

Note:

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Cause of Impact	Phase		Mitigation	Implementation and Evaluation of Mitigation
	Con	Ope		
				<p>seawater will be improved.</p>  <p>Picture 5. Constructed leachate pond</p>
	C	C	Monitoring of seawater quality	<p>Continuous seawater monitoring based on "Operation and Maintenance Manual for M-dock landfill" is recommended to understand condition of function of landfill facilities and marine environment. Rehabilitation works were designed to shut leakage of all leachate from the site. Periodic inspection by monitoring of water quality is helpful to confirm the effects of the renovation works.</p> <p>For understanding of the condition of water quality at the surrounding water bodies, survey of seawater quality was conducted before the designing of rehabilitation work. The result of survey was used to develop a rehabilitation plan.</p> <p>Pollution at mangrove area was terrible as seen in Picture 1 before rehabilitations. After completion of the rehabilitation works, people who visit the area noticed fingerlings swimming, which got them realize improvement.</p>
	-	C	Monitoring of leachate	<p>It was intended that semi-aerobic system would enhance stabilization of the disposed waste. The result of monitoring of leachate can be utilized as an indicator to check the stabilization progress of disposed waste. It also helps to expect the closing time of the landfill site.</p>

Note:

1. Phase

Con: Construction phase

Ope: Operation phase

2. Evaluation Criteria

A: Significantly effects

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Mitigations for Unforeseen Environmental Impacts

Mitigation	Implementation	Evaluation of Mitigation
1. Improvement of landscape	Green space and tree planting at perimeter area	<p>As for M-dock landfill located beside the jetty where some leisure boats are moored, there is a hotel and an aquarium in the vicinity, and many citizens and tourists visits this area.</p> <p>It was one of targets of the rehabilitation work to upgrade landscape of the site, which will result in impressing people with improvement. The landscape of the landfill site</p>

Mitigation	Implementation	Evaluation of Mitigation
		<p>has been greatly improved through planting trees and greening of the area, and hydro-seeding of slope of the landfill.</p>  <p>Picture 6. Improved Landscape (Slope formation at jetty and hotel side)</p>
<p>2. Measures for impacts to the neighbors due to construction such as dust, waste scattering and odor</p>	<p>[Construction of dike at mangrove side] - No measure was required</p> <p>[Installation of leachate collection pipes] - Small dike at perimeter area - Excavation in wet conditions</p>	<p>No measure was required while construction works of dikes at mangrove side included the excavation of accumulated waste. For, excavated waste at the mangrove side did not cause odor troubles because of a long lapse of time after the disposal of waste and proceeding stabilization. Also, waste below water level was wet, so there were no worries of generation of dust, scattering of waste.</p> <p>It was evaluated that impacts of dust, waste scattering and odor due to construction for installation of leachate pipe was decreased as a result of mitigation measures. Small dike was developed, before instillation of pipes, at the top of slope enclosing the dumping area to prevent waste scattering, dust and noise. Then, in case moving fresh waste was required, such works were executed after rain to make use of the wet condition of waste.</p>
<p>3. Considerations to residents in the vicinity</p>	<ul style="list-style-type: none"> • Stakeholder meeting in 2006 • Direct explanation to residents • Change in the order of construction work according to request of residents • Distribution of newsletters, pamphlets 	<p>Before and during the construction of M-dock rehabilitation works, stakeholder meetings were held twice to explain construction itself, purpose and expected effects of the rehabilitation to local residents. At these opportunities people's perception and opinion were understood.</p> <p>The order of construction was amended paying attention to opinion of residents that the construction of slope formation at jetty side should be prioritized. Direct explanation to the residents was also conducted by visiting the houses of the residents, where the contract term, schedule, scope of work was explained. It was tried at the same time to encourage their understanding and cooperation for the project. General solid waste management, pamphlets for environment enlightenment and newsletters prepared in the project were distributed as well. The improving the landscape of M-dock landfill was one of considerations to residents.</p>

and to provide their data for the purpose of landfill management.

Apart from it, the parameters of water quality that EQPB can analyze are not considered enough. It is recommended to improve its capacity for environmental management in Palau.

4. Result of Water Quality Analysis around M-Dock Landfill

In the technical cooperation project, comprehensive water quality survey for M-dock landfill rehabilitation was conducted once before constructions. The analysis was conducted in Japan due to lack of laboratory capable for analysis for necessary parameters such as heavy metals.

BPW-MoRD has implemented regular inspection of landfill facilities according to the operation manual. As described above, EQPB has been responsible for regular environmental monitoring. The result of regular monitoring conducted by EQPB is given in Attachment-2.

5. Responsibility of Environmental Monitoring and Necessary Actions

It is expected that results of environmental monitoring will be utilized for appropriate maintenance and operation of M-dock landfill. In the case that figure of some parameters show improper values, the following organizations and authorities will discuss and coordinate for necessary actions to solve and improve the environment.

- BPE-MoRD
- EQPB
- Ministry of Health
- Koror State Government

Attachment-1: Plan of Environmental Monitoring at M-dock landfill

JICA
Project for Improvement of SWM in ROP

Operation Manual of the M-dock Landfill

5. Regular Inspection at M-dock

There are three kinds of regular inspection at M-dock: the water inspection for leachate, sea water inspection around the site, and the survey to check the progress of landfill site.

5.1 Environmental Management

The regular monitoring should be conducted to protect neighboring area environmentally safe from disposed waste, leachate and gas inside the landfill site. In case there is environmental pollution, the investigation of cause and action to prevent the pollution should be done quickly.

To promote environmental management at M-dock, there are two kinds of water inspection, one is for sea water around the site and the other is for leachate.

(1) Sea Water Inspection

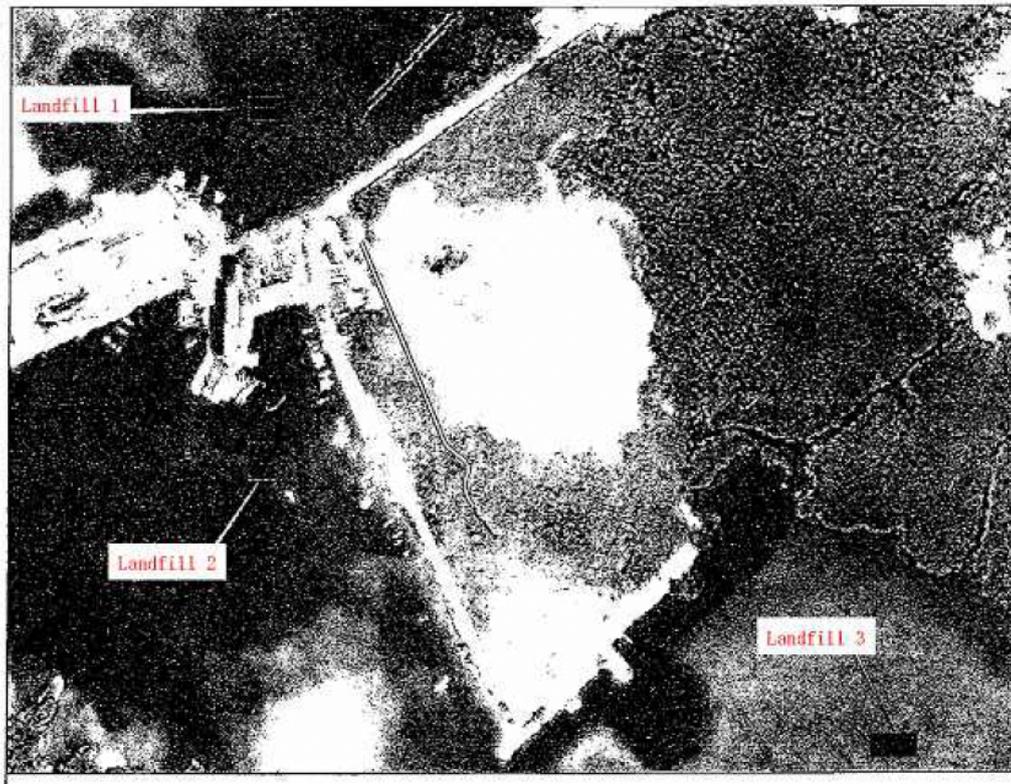
1) Inspection Site

Currently EQPB proceeds sea water inspection around the site. The inspection is carried out at 3 points. One more point at mangrove area where there was dike construction in Rehabilitation Work for M-dock Landfill will be added to this inspection. It is necessary to inspect sea water in all direction.

2) Inspection Types and Frequency

EQPB proceeds sea water inspection every month. The inspection is consisted of 6 types: Fecal Coliform, Turbidity, pH, Temperature, Dissolved Oxygen and Salinity.

In the future, Biochemical Oxygen Demand (BOD) should be additionally inspected more than one time every 3 months.



Inspection Site of Sea Water

(2) Leachate Inspection

After the construction of stage 3, leachate inspection will be conducted with a portable water quality measure which will be provided by the project team. The quality of leachate will be compared with the result of sea water inspection to find out whether leachate leaks out to ocean or not. The analysis of inspection record will be utilized as an indicator to check the stabilization progress of disposed waste. It also helps to expect the closing time of the landfill site.

1) Site Inspection

The inspection will be totally conducted at 3 spots: leachate pond and 2 draining spots where leachate flows out to leachate pond (in other words, the outlets of leachate collection pipes both at jetty side and mangrove side). The inspection of leachate before draining out to leachate pond is effective to check stability progress of disposed waste both at jetty side and mangrove side.

2) Inspection Types and Frequency

A portable water quality measure provided by the project team after May, 2007 is used to measure 5 items of waste quality: pH, Temperature, Salinity, Oxidation Reduction Potential (ORP), and Electrical Conductivity (EC). The stable condition of disposed waste and the effects of circulation system of leachate which is pumped back from leachate pond to the disposal site will be evaluated by analyzing these inspection results.

Moreover, the same types of inspection with sea water should be conducted for leachate by EQPB more than one time every 3 months. It is better to arrange the inspection at the same time with sea water inspection. The types of inspection are Fecal Coliform, Turbidity, Dissolved Oxygen, and BOD (biochemical oxygen demand). The inspection record can be used to evaluate stable condition of the landfill site.

The inspection with a portable water inspection measure can be easily managed by M-dock Landfill staffs. The leachate inspection should be arranged once a week because there is no inspection for leachate before. The inspection record will be used to research the relationship between amount of rainfall and leachate quality, and to check the annual tendency of change of leachate quality.

5.2 Survey

Currently, Bureau of Lands and Surveys (BLS) conduct survey at M-dock Landfill once in every 6 months. This frequency is appropriate compared with the actual disposal progress at M-dock Landfill so the same style of the survey will be continued.

The weight of unit volume can be calculated from the result of the survey work and the weight measurement of waste in hauling management. These data also leads to estimation of the remaining space and possible time that the landfill site can be used as disposal area.

5.3 Other Survey

In addition to the above survey and environmental inspection, sanitary division in Environmental Health conducts inspection at M-dock Landfill in case infections such as dengue fever spread out around the island. They check the waste from hospitals. It means that the waste from hospitals must be disposed separately from other household or business waste.

Attachment-2: Results of Monitoring of Sea Water Quality conducted by EQPB

Note: Locations of sampling of seawater are same as shown in the map in Attachment-1

Landfill 1

Date		5/16/06	6/29/06	7/27/06	8/24/06	9/12/06	10/26/06	11/20/06	12/7/06	1/24/07
Temperature (degree C)		No data	30.1	29.1	28.9	29.5	30.8	30.2	29.4	28.7
pH (-)		No data	8.1	8.2	8.1	8	8.4	8.3	8.3	8.3
Fecal coliform (-/100mL)		No data	120	4	70	>200	0	80	62	4
Turbidity (NTU)		No data	1.3	2.05	1.43	6.01	1.22	2.26	2.16	1.6
DO (mg/L)		No data	4.6	4.8	5.1	5	5.1	4.2	5.1	No data
Salinity (mg/L)		No data	30.9	32.6	33.2	33.1	33.4	33.2	32.9	33.2

Date	4/18/07	5/22/07	7/3/07	8/28/07	9/13/07	10/25/07	11/14/07	12/14/07	1/9/08	2/7/08
Temperature (degree C)	30	31.7	30.3	30.4	29.8	30.7	30.2	30.5	29.7	29.2
pH (-)	8.1	8.1	8.2	7.9	8.1	8.3	7.9	8.0	8.0	8.1
Fecal coliform (-/100mL)	0	1	38	42	3	4	96	0	0	0
Turbidity (NTU)	2.98	2.41	2.4	1.2	3.5	2.4	4.3	2.3	2.8	1.8
DO (mg/L)	7.3	7.8	no data	3.9	no data	no data	6.3	6.3	5.3	4.7
Salinity (mg/L)	34.4	34.3	34.4	32	33.8	32.8	29.0	34.1	33.8	34.4

Date	3/26/08	4/8/08	5/27/08	6/24/08
Temperature (degree C)	29.6	30.0	no data	30.1
pH (-)	8	8	no data	8.1
Fecal coliform (-/100mL)	0	0	0	0
Turbidity (NTU)	1.3	1.4	1.5	1.8
DO (mg/L)	8.9	10.6	no data	5.6
Salinity (mg/L)	33.1	32.5	no data	35.7

Landfill 2

Date		5/16/06	6/29/06	7/27/06	8/24/06	9/12/06	10/26/06	11/20/06	12/7/06	1/24/07
Temperature (degree C)		30.4	30.4	29.1	28.9	29.9	29.9	30.3	No data	28.8
pH (-)		8.2	8.1	8.2	8.2	8.2	8.4	8.3	No data	8.3
Fecal coliform (-/100mL)		84	136	18	60	36	0	4	No data	2
Turbidity (NTU)		1.26	1.5	1.06	0.81	1.06	0.61	0.9	No data	0.8
DO (mg/L)		4.6	4.5	5.1	5.3	5.9	5.3	4.6	No data	No data
Salinity (mg/L)		33.2	32.1	32.7	33.4	33.1	33.4	33.2	No data	33.4

Date	4/18/07	5/22/07	7/3/07	8/28/07	9/13/07	10/25/07	11/14/07	12/14/07	1/9/08	2/7/08
Temperature (degree C)	29.9	30.7	30.3	30.2	29.9	30.6	30.6	30.1	29.7	28.9
pH (-)	8	8.2	8.2	7.9	8.0	8.3	8.0	8.1	8.1	8.1
Fecal coliform (-/100mL)	4	0	2	32	1	6	2	0	0	0
Turbidity (NTU)	1.07	0.89	1.2	2.4	1.4	1.6	1	1.2	1.8	1.0
DO (mg/L)	6.8	7.9	no data	3.9	no data	no data	6.1	6.2	5.8	5.2
Salinity (mg/L)	33.4	34.7	34.5	32.4	33.4	33.0	34.1	34.2	33.7	34.4

Date	3/26/08	4/8/08	5/27/08	6/24/08
Temperature (degree C)	29.3	no data	no data	30
pH (-)	8.1	no data	no data	8.1
Fecal coliform (-/100mL)	0	no data	0	0
Turbidity (NTU)	1.1	no data	1.9	1.6
DO (mg/L)	9	no data	no data	5.3
Salinity (mg/L)	33.2	no data	no data	34.2

Landfill 3

Date		5/16/06	6/29/06	7/27/06	8/24/06	9/12/06	10/26/06	11/20/06	12/7/06	1/24/07
Temperature (degree C)		30.7	30.1	29.4	29	30	30.7	30.2	29.8	29
pH (-)		8.2	8.1	8.1	8.3	8.1	8.4	8.3	8.3	8.3
Fecal coliform (-/100mL)		7200	>200	>400	28	26	0	26	2	4
Turbidity (NTU)		1.38	3.6	2.15	1.08	1.26	1.22	1.29	1.85	1
DO (mg/L)		4.8	4.3	5.1	5.3	6.5	5.1	3.8	5.1	No data
Salinity (mg/L)		33.2	29	32.7	33.4	33.1	33.4	33.2	33.4	33.4

Date	4/18/07	5/22/07	7/3/07	8/28/07	9/13/07	10/25/07	11/14/07	12/14/07	1/9/08	2/7/08
Temperature (degree C)	29.7	30.4	30.2	29.8	29.9	30.5	30.2	29.9	28.6	29.0
pH (-)	8.1	8.2	8.3	7.9	8.0	8.3	8.0	8.0	7.9	8.1
Fecal coliform (-/100mL)	0	1	0	54	2	0	22	2	0	41
Turbidity (NTU)	1.16	0.87	1.4	1.6	1.5	1.9	0.9	1.1	2.3	1.7
DO (mg/L)		6.5	no data	3.2	no data	no data	6.5	6.1	4.7	5.1
Salinity (mg/L)	34.3	34.7	34.5	31.9	34.2	33.1	34.0	34.2	34.4	34.3

Date	3/26/08	4/8/08	5/27/08	6/24/08
Temperature (degree C)	29.2	29.8	no data	29.7
pH (-)	8	8	no data	8
Fecal coliform (-/100mL)	0	0	10	0
Turbidity (NTU)	1.4	0.9	1.8	1.5
DO (mg/L)	3.5	10.2	no data	6.3
Salinity (mg/L)	33.5	32.5	no data	36.2