ENVIRONMENTAL IMPACT ASSESSMENT

Existing Desalination Plant

Nika Island Resort, North Ari Atoll, Maldives

Environmental Audit Report 2010

Proponent: Nika Island Resort

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Sandcays

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I hereby certify that the data contained in this audit report represent the site conditions and the analytical summaries incorporated into this report are based upon data collected and analyzed by ourselves in a manner consistent with the requirements of the Environmental Protection Agency. Any deviations in the data collection methodologies have been highlighted.

I further certify that the statements made in this environmental assessment or audit for the desalination plant at Nika Island Resort are true, complete and accurate to the best of my knowledge and abilities.

Ahmed Zahid
EIA Consultant Registration No: EIA 08/07
17 October 2010

1 Introduction

This report has been prepared in order to assess the environmental performance of the existing desalination plant for the purpose of registration of the plant according to the requirements of the Environmental Protection Agency. This report focuses only on the desalination plant and no other operations of the resort are incorporated within the context of this report.

Environmental Impact Assessment is required for the registration of desalination plant under the Desalination Regulation of the Maldives. Also, desalination plant project fall within the list of projects requiring Environmental Impact Assessment study under the Environmental Impact Assessment Regulation of the Maldives. However, since the desalination plant in Nika Island Resort (like many other such facilities in the Maldives) has been operational when the Desalination Regulation, the EIA Regulation. Approval came into effect; the scope for this Environmental Impact Assessment has been based on that of an environmental audit of the existing facilities, focusing on the environmental compliance and performance of the existing desalination facility.

Therefore, this report will include a compliance and performance audit. The compliance audit or review will assess how well the project implementation complies with the existing environmental policies or requirements by the registering authority and the performance audit will assess the actual environmental impacts of the project and how well the impacts have been mitigated during the construction as well operational phase. The performance audit will also include a review of the existing monitoring programme, discussing the deficiencies and suggesting improvements for future monitoring.

There have not been any legal requirements for environmental monitoring as there has not been any EIA report for the resort facilities under consideration. Therefore, this report is based on the findings of site investigations carried out by the consultant and necessary information provided by the management and technical staff at Nika Island resort. However, it is noted that the resort has a system in place to monitor environmental performance indicators of which water quality tests undertaken in the recent past by the Proponent have been used in preparing this report.

In addition to discussing the findings of the audit, a matrix will be presented which summarises the status of environmental compliance and performance for activities involving the operation and maintenance of the facility. This report will also provide recommendations for further environmental improvements to the desalination plants.

2 Description of Audited Facilities

2.1 Location

The audited facility is the desalination plant in Nika Island Resort. Nika, as it is generally referred to, is located on the north west of North Alif Atoll at 72º 46'E and 4º 10'N. The inhabited island of Bodufolhadhoo, a fishing village is located about 0.5 km to the north east of Nika.

Figure 2-1: Project Location: Nika Island Resort in A. Alif Atoll

As per the requirements of the Terms of Reference, this section provides full description of the existing water supply infrastructure using maps at appropriate scales. Details of water supply requirements, land use, capacity, intake arrangements, pump house details, brine reject arrangements, and disinfection and reticulation mechanism have been considered here. The following figure shows the desalination plant and associated infrastructure on the resort with respect to the overall layout of the resort.

2.2 Desalination Plant

Nika Island has two RO units of 48m3/day capacity and 50m3/day capacity. The main production plant is the 50m3 plant and it is operated by the dedicated staffs that are in-charge of both desalination facility and power house. The second plant which has capacity of 48m3/day capacity has been out of order for few months now, since the demand is matched by the existing 50m3/day plant. The second plant is not been repaired and the resort are waiting for some parts for which they have ordered. The product water is stored in a 655 ton concrete

tank which distributes to all taps, toilets, Jacuzzis, restaurants and other facilities. The tank has storage capacity of 20 to 25 days. Since the staffs use rainwater for drinking for which there are plenty of storage capacity, and the tourists are provided with bottled water, the desalinated water is not used for drinking.

Feed water is drawn from a 4-inch pipe placed at reef edge under the jetty and the brine concentrate is discharged into the lagoon by a pipe over 50m inside the inner reef line. The location of intake pipe is quite deep and with low current flow, hence minimising flow of sediments in to the pipe.

Seawater from intake pipe is connected to sedimentation tank through a pump well. The pumps are located on the island close to the desalination plant. The intake water passes through a sedimentation tank or settling tank to help minimize clogging of the membranes from silt present in the water. The sedimentation tank is about 17 m3 capacity. The desalting process at the plant uses a reverse osmosis (RO) membrane which reduces the salt content greatly producing freshwater for use in washing, bathing and flushing toilets and brine, which is returned to sea via a lagoon outfall located under the jetty. Freshwater then is pumped into the storage tank.

2.3 Operation and Maintenance

The desalination plant have been developed quite a long time ago and the first plant which has the capacity of 48m3/day was installed at that time. The plant was imported from USA and assembled at site by engineer of the resort at that time. The first plant was registered at Maldives Water and Sanitation Authority (Now EPA) in 2003. However due to raining demand for desalination, the second plant which has the capacity of 50m3/day was installed. Till today most of the maintenance and repair works are carried out by the operations engineer. The operators are well aware of maintenance and daily operations.

2.4 Need and Justification

While it is almost impossible to justify the desalination facility on environmental grounds, these facilities have enormous socio-economic implications on which they can be justified. Nika has fairly high demand for safe water for non potable water for toilet flushing and overall management of the resort's landscaping and other needs. It is estimated that the resort produces about 50 cubic meters per day (at the time of inspection). This is expected to be higher during the high season. Since the island has production capacity of 98m3/day they can meet the demand very well. With such high demand for water, it would be almost impossible to supply water using rain and groundwater. In addition, the Tourism Regulations prohibits the use of groundwater for any purpose and encourages the installation of desalination plant. Therefore, desalination is the normal practice and the feasible means of catering for the water supply demands in Maldivian resorts.

The Environmental Protection Agency requires that desalination plants are operated only under license from the Agency. Environmental assessment (including audit and monitoring) is a requirement for the registration as well as renewal of the registration. This report will fulfil such requirements for the renewal of registration of desalination plant and help in the verification of regulatory environmental compliance. The report will also provide a status of the current management practices and identify opportunities for improvement.

Figure 2_2: Site Plan indicating the desalination plant facilities

3 Regulatory Aspects

The legal and policy instruments that are of relevance to the desalination plant under operation in Nika Island Resort are the Environmental Protection and Preservation Act, EIA Regulations, Regulation on the Protection and Conservation of the Environment in the Tourism Industry, Desalination Regulation of the Maldives and to some extent the National Energy Policy. These legal as well policy instruments and their relevance to the desalination infrastructure in Nika are discussed below.

3.1 Environmental Protection and Preservation Act

The main legal instrument pertaining to environmental protection and preservation for sustainable development in the Maldives is the Environmental Protection and Preservation Act (Law No. 4/93) passed by the Citizen's Majlis in April 1993. The following clauses of the Environmental Protection and Preservation Act (Law No. 4/93) are relevant to the project:

Clause 5a: An impact assessment study shall be submitted to the Ministry of Environment, Energy and Water (as it is called at the time the Law was amended but now Ministry of Housing and Environment, referred to as Ministry of Environment here) before implementing any development project that may have a potentially detrimental impact on the environment.

Clause 5b: The Ministry of Environment shall formulate the guidelines for EIA and shall determine the projects that need such assessment as mentioned in paragraph (a) of this clause.

Clause 6: The Ministry of Environment has the authority to terminate any project that has an undesirable impact on the environment. A project so terminated shall not receive any compensation.

Clause 9a: The penalty for minor offences in breach of this law or any regulations made under this law, shall be a fine ranging between Rf5.00 (five Rufiyaa) and Rf500.00 (five hundred Rufiyaa), depending on the actual gravity of the offence. The fine shall be levied by the Ministry of Environment, Energy and Water or by any other government authority designated by that Ministry.

Clause 9b: Except for those offences that are stated in (a) of this clause, all major offences under this law shall carry a fine of not more than Rf100,000,000.00 (one hundred million Rufiyaa), depending on the seriousness of the offence. The fine shall be levied by the Ministry of Environment, Energy and Water.

Clause 10: The government of the Maldives reserves the right to claim compensation for all damages that are caused by activities that are detrimental to the environment. This includes all activities

mentioned in Clause No. 7 of this law as well as those activities that take place outside the projects that are identified here as environmentally damaging.

Clauses 9 and 10 are of specific relevance to this Audit. The EIA Regulations, which came into force in May 2007, has been developed by the powers vested by the above umbrella law.

3.2 EIA Regulations

The EIA Regulations, which came into force in May 2007, has been developed by the powers vested by the above umbrella law. The EIA Regulations have been the basis for Environmental Impact Assessment in the Maldives and since its advent it had helped to improve the quality of EIAs undertaken in the country. Today, registered consultants are required to sign EIAs, the EIAs are reviewed by two independent reviewers and final decisions based on the reviews. This Audit would also be subject to these requirements and review criteria.

Schedule D of the EIA Regulations lists the different environmental projects that require an Environmental Impact Assessment study and desalination plants have been included in the list. However, the desalination infrastructure in Nika was developed prior to the EIA Regulations or the Environmental Protection Act. Therefore, the development of the facilities were not scrutinised by an EIA study. With the recent Desalination Regulation of the Maldives, EIA has been mandated for the registration of these facilities. Hence, an environmental assessment in the form of an Audit was required for the re-registration of the facilities as there has not been any EIA done in the past for these developments in Nika Island. Although the EIA Regulations have not set out the requirements for environmental audits, contents of environmental impact assessment has been given in Schedule E and format for monitoring reports have been given in Schedule M. Therefore, these requirements have been taken into consideration in preparing this Audit report.

3.3 Regulation on Protection and Conservation of Environment in the Tourism Industry

The Regulation on the Protection and Conservation of the Environment in the Tourism Industry came into effect on 20 July 2006. Section 6 of the Regulation deals with water supply in tourist facilities. It requires every resort to have a desalination plant registered according to the Desalination Regulation and requires that daily logs of water quality are recorded and maintained. It also asks for the provision of water storage sufficient for 5 days supply.

It further states that groundwater shall not be used for drinking by guests or staff, and shall not be supplied to guest rooms or toilets of guest rooms or for use by staff. Furthermore, any type of oil (e.g. used engine oil) or any other chemical which may damage the environment shall not be drained to the ground.

3.4 National Energy Policy

As one of the first countries to sign and ratify the Kyoto Protocol in 1998 and as a member of the UN Framework Convention on Climate Change, the Maldives is committed to implement national policies towards sustainable energy management and reduction of greenhouse gas emissions. The President has recently announced that the Maldives would work towards becoming the world's first carbon neutral country by 2020. The National Energy Policy introduced subsequently is focussed on this goal. As such the National Energy Policy looks at existing issues, constraints and emerging issues. The policy addresses issues of energy supply, consumption, environment, renewable energy, energy efficiency and sustainability. Sustainable supply and consumption is the main focus of the policy.

The key policies outlined in the National Energy Policy are:

Policy 1: Provide all citizens with access to affordable and reliable supply of electricity

Policy 2: Achieve carbon neutrality by Year 2020

Policy 3: Promote energy conservation and energy efficiency to reduce costs

Policy 4: Increase national energy security by diversifying energy sources

Policy 5: Promote Renewable Energy Technologies

Policy 6: Strengthen the institutional and legal framework of the energy sector

According to the policy document, only 3% of energy is from biomass and solar energy while the rest is from refined petroleum products with diesel fuel accounting to 83% of the total energy consumption in the Maldives. Desalination including bottling plants is also dependent on this energy supply by diesel fuel. Therefore, there is a great deal of work that needs to be done if carbon neutrality were to be achieved by 2020.

3.5 Desalination Regulation of the Maldives

The Desalination Regulation of the Maldives came into force from 2002 when this plant was operational. However, in order to meet the requirements of the Desalination Regulation, the desalination plant at Nika was registered with the Maldives Water and Sanitation Authority in 2003 as required by the Regulation. The Desalination Regulation states the requirements for application, plant capacity determination, intake and source water, plant operation and maintenance, brine discharge as well as water quality monitoring requirements. The Environmental Protection Agency is currently in the process of reviewing the Desalination Regulation to incorporate the current regulatory requirements as well as administrative framework. This regulation is the only

regulation currently in force for the water and sanitation sector and has been established with the primary objective of safeguarding public water supplies, the environment and the interests of service providers.

3.6 Relevant Standards

3.6.1 Water Quality

Currently, there is no national water quality standard in force. The World Health Organisation's Guidelines for Drinking Water Quality are used for reference.

3.6.2 Noise

Similarly, there are no national standards for noise. Noise is one of the major environmental problems associated with desalination plants. The only requirement with regard to noise emissions is the clause in the Desalination Regulation which specifies that adequate noise protection gear shall be provided to staff working in the desalination plant house if the noise inside the premises are higher than 85dB(A).

In the absence of local standards, internationally acceptable noise standards have been adopted in addressing noise emanating from the desalination plant. Table 3-4 gives noise standards implemented by USEPA and Germany, which is similar to European standards.

Table 3-1: Some selected noise standards

Country/Body	Standard	Averaging Times
US EPA	<65 dB(A) <55 dB(A)	Day time Night time
Germany	<55dB(A) <40dB(A)	Day time Night time

The noise standards enforced by the USEPA for residential areas are 65dB (A) during day time and 55dB (A) during night time, slightly lower than the corresponding German standards of 55dB (A) and 40dB (A).

Table 3-2: Noise standards according to World Bank Pollution Prevention and Abatement Handbook 1998

	Maximum allowable log equivalent (hourly measurements), in dB(A)	
Receptor	Day (07:00 - 22:00)	Night (22:00 - 07:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

In cases where the baseline noise level is already above these levels, the plant noise should not cause an increase of more than 3dB (A).

Source: World Bank Pollution Prevention and Abatement Handbook, 1998

4 Existing Environment

This section provides baseline information regarding the relevant environmental characteristics of the study area. These include ground and marine water quality for standard parameters given in the approved Terms of Reference and also the quality of the product water from the desalination plant. Product water quality is regularly assessed at site, therefore, that data would be used to assess compliance and performance. Additional water quality assessment for product water would be done only if there is non-compliance with reference to in-house water testing undertaken in the past few months. Brine discharge location would be assessed in terms of tides, currents and flow of discharge. The coral cover along the brine discharge pipe or intake pipe or part of the pipes that run on reef areas where live corals can be found was not investigated as there are no pipes running on area with live coral cover.

Noise levels in the vicinity of the desalination plant and how they affect recreational quality and public and occupational health would be assessed. These noise levels would also represent noise levels related to the powerhouse operation.

4.1 Methodology

Existing environment was studied using standard methods used in EIA studies. Field visit was undertaken on 4-5 September 2010. Checklists were used to assess site conditions with specific reference to desalination plant facilities. Water quality was assessed using YSI field water quality logger, which was calibrated day before the field trip. Water quality was assessed, as given in the TOR, at mid point where it is shallower than 1m and at about 1m where it is deeper than 1m. Water quality at the receiving environment for the brine discharge was taken at about 3m from the discharge point. Sampling for laboratory testing was not made as it was not possible to do the tests at the laboratory during the period of the survey.

Noise was measured using an IEC Type 2 noise meter. Spot SPL measurements which were recorded are presented in this report. Sensitive areas in the vicinity of the powerhouse and desalination plant were included. Other relevant and useful observations were also recorded on site.

4.2 Water Resources and Supply

4.2.1 Water Resources

Available water resources are groundwater and seawater of which only groundwater can be considered freshwater. Rainwater is collected and the island has good storage capacity. The staff uses rainwater for drinking. Groundwater cannot be depended on either due to the small size of the aquifer or the restrictions on its use

imposed by the Tourism Regulations, which forbids the use of groundwater for any purpose in resorts. Therefore, seawater desalination has to be carried out.

4.2.2 Desalinated Water Consumption

Water production statistics is not maintained in the resort. However, based on the average daily production of 98m^3 per day and a total number of consumers at 178, the resort consumes about 550 litres per capita per day. This is quite high compared to some other resorts in the same category.

4.2.3 Water Quality

The management of the resort has recently started monthly testing of product water. One main concern is there is no disinfectant used during the production or storage process. The desalinated water is not used for drinking. However it is not safe for the guests or staff since the water is easily consumable during use of Jacuzzi, showers, or from the restaurant and bar. Hence it is strongly recommended that use of disinfectant to be practised.

4.2.4 Water Conservation

Water conservation measures are not given a priority but there are certain measures implemented to save water. Guest and staff are aware of importance of water conservation; especially safe rainwater harvesting is given a very high attention. Since the resort is mainly dependent on desalination, water conservation results not only in the reduction of water use but also energy/fuel use.

4.3 Occupational Health

Adequate personal protective equipment is provided. A list of such equipment is given below. The control room is air-conditioned with adequate noise insulation.

The resort also provides health and safety training to the staff working in the powerhouse and the desalination plant facility. The Engineering Department is equipped with the necessary skills while fire fighting equipment is provided in all areas of the resort.

There are no occupational health hazards in the work environment. All hazardous areas are well managed and all risks are minimized. No visible fuel spills have been observed. There are also no wet surfaces in any of the work areas.

Figure 4_1: Illustrated summary of site conditions

5 Environmental Compliance and Performance

This section will identify operational impacts of the desalination plant facilities to verify environmental compliance and address environmental performance issues. As such, the following would be considered:

- Identify if the brine is discharged in appropriate location.
- Discuss the short term as well as long term effects of any emissions or discharges on the environment, especially the health of the staff.
- Identify any information gaps and evaluate their importance for decision-making.
- Determine how well the existing infrastructure complies with existing environmental policies and regulations

5.1 Desalination Plant

5.1.1 Emissions

The atmospheric emissions and GHG emissions related to the desalination plant have not been done due to inadequate data. However, it is noted that the emissions would be well below all international standards due to the small scale of the operations.

5.1.2 Noise levels

Noise levels for the desalination plant as well as powerhouse are well within acceptable levels.

5.1.3 Performance

5.1.3.1 Seawater intake

The intake is located on the reef flat on the reef edge. It is a 4-inch UPVC pipe located at about a metre from mean sea level. There is quite high coral growth in this area and current seems fairly low, hence minimising the sediment movement. However the pipe needs a mesh to prevent fish or other animals to enter the pipe. Impingement (marine organisms getting trapped against intake screens by the velocity and force of water flowing through them) is not a cause for concern for such small plants, even if a screen was present. Therefore, having a screen is important to minimize mortality due to entrainment as there will hardly be any impingement.

The following table shows the water quality from intake water.

Table 5-1: Intake water quality

pH	7.99
Temperature (°C)	29.09
Electrical Conductivity (uS/cm^2)	53,610
TDS (mg/l)	34,840
Salinity	35,290
DO (mg/l)	5.66

5.1.3.2 Sedimentation tank

The sedimentation tank is of good size. The sedimentation tank consisted of 3 chambers which has total capacity of 16.3m^3. The sea water is quite clean and settling of sediments seems well. However the tank needs attention since there is no regular cleaning maintaining. Some plumbing also needs proper fixing. The two pumps which are supplying the raw water to the tanks also require maintenance. These will improve the overall performance and reduce energy demand. Sedimentation tanks work as natural sediment removers and if these tanks are well maintained it will keep filters and membranes from blocking. There is scope for improvement on the preventive maintenance of the sedimentation tank.

5.1.3.3 Desalination units

There are of 50m3/day and 48m3/day capacity, totalling up to 98m3/day. The first plant (48m3/day) was established quite long ago and was registered in EPA) Maldives water and Sanitation authority at that time) on 2003) this plant was assembled at the site after parts were imported from USA. The second plant was installed later due to growing demands and after installation of Jacuzzis at the rooms. The second plant was installed by Static Company (Maldives). Both plants are operated and maintained by the staffs that has good experience and knowledge. It was observed the first plant has not been under operation for some time. The operators inform that it has been under repair for and has not been operated for almost 6 months now. However the new plant has enough capacity to fill the huge storage tank which can store about 20 to 25 days of water.

Figure 5-1: The second plant of 50m^3/day showing the plant room is kept dry and well maintained

The following are the findings and issues;

- The head operator is technically very capable of managing and maintaining the plants and facility.
- Second plant needs to be repaired and maintained.
- The micron filter unit of the first plant is installed outside the plant building. It shows algal growth due to sunlight. It was kept covered by canvas sheet but it doesn't seem to work. It is recommended that the unit to be transferred inside the plant building.

Figure 5-2: Micron filters of the first plant are installed outside the plant building

- The plant house is clean and dry, very well managed and maintained.
- No leaks on the floor or inside the plant chassis.
- Some parts have small leaks and rusting and needs attention.
- There are some spare parts and filters available. Proper spare parts list has to be prepared.
- Plant catalogs and manuals are available for the first plant and for the second plant only high pressure pump manual is available.
- Plant logs are recorded but not well managed. The logs need to be interpreted to carry our preventive maintenance. It was also observed that the operator is not very familiar with pressure and other theoretical aspects of desalination.
- Protective masks and gloves have to be provided at site.
- The head operator is very capable of O&M of the plant, other operators' needs training.
- No operations diagrams, instructions and warning signs are at the plant room.
- No disinfection of water.
- Water quality testing has not been carried out regularly but it was started recently.
- Some pipes and fittings need to be fixed and rusting parts needs oil and grease.
- There are some pressure gauges which were not working and needs replacing
- Display meters and lights which are not working needs to be replaced.
- There are tools available at the plant room which was kept well organized.

5.1.3.4 Disinfection and Chemical Usage

No disinfection of water is used in the island. This is a major concern since the water supplied to showers, Jacuzzi, washbasins and in restaurants can easily be consumable by guests and staff. Hence its highly recommended that chlorine or other mean of disinfection to be established urgently.

Sodium bisulphate is used for the plant. It is estimated that 09 kg of chemical is used per month. The chemical is stored in a dry and clean area inside the power house. Some protection like gloves are provided at the area but masks are not provided and warning signs, preparing methods and safety precautions are not displayed.

5.1.3.5 Product Water Storage

The product water from the plant goes to a small tank (transfer tank) from which it is pumped to the storage tank. This small tank is about 2000 litres and is located outside of the plant house. This tank is not very clean and the top is not well covered. The bottom set on a concrete foundation but the half of the bottom is covered in sand including the drain pipe at the bottom is filled with sand.

Figure 5-3: The small product water tank: (upper left) the tank is placed on open, (upper right) common house lizard observed inside the tank

There are signs that some living things have entered the tank. At the time of inspection some cobwebs and a common house lizard was observed. This tank needs immediate attention.

The main storage tank is made of concrete and has capacity of 655m^3 which can store up to 20 to 25 days of water. The tank is well maintained and covered. However this water needs disinfection to ensure safety.

5.1.3.6 Brine Discharge

The brine discharge pipe is located in the lagoon over 50m inside the inner reef line. The pipe is at an area where the current is quite high resulting in easier mixing of high saline water. The salinity around the pipe was measures and shown in the table below.

Table 5-2: Water quality around brine discharge pipe

	5m left from pipe	5m right from pipe	5m in front of pipe
Temperature (°C)	29.39	29.39	29.35
pH	8.02	8	8
E-Conductivity (uS/cm^2)	53,790	54,090	54,010
TDS (mg/l)	34,960	35,160	35,110
Salinity (ppt)	35.41	35.63	35.58
DO (mg/l)	6.23	6.17	6.34

5.1.3.7 Operation and Maintenance

The staffs in charge are well aware of repairs and maintenance. However scheduled preventive maintenance, record keeping, spare parts management which is essential to keep up with the EPA standards are not practised yet. Also training for these areas is required.

There are tools, basic safety equipment including fire extinguishers present and are well managed. There are also some spare parts available and replacements like filters and chemicals are made available to them.

Plant logs are taken regularly but not interpreted. It seems the purpose of the log keeping is not well understood however the operators can identify the problems at very early stage and major maintenance are frequently carried out.

The plant house is well managed and kept. There are almost no leakages and the floor is kept dry.

5.2 Audit Summary

The following matrix provides a summary of environmental compliance of the desalination plant.

Table 5-3: Environmental compliance matrix for desalination plant in Nika

Environmental and socioeconomic aspects	Compliance/Performance					Remarks/Observations	Recommendations
	None	Low	Fair	Good	High		
Water quality				X		Regular water testing in place	Onsite measurements of free and residual chlorine, TDS and pH desirable.
Environmental noise				X		Noise not felt in sensitive areas	
Occupational health				X			
Risk management					X	Good housekeeping. No accidents reported	
Environmental aesthetics					X	Clean and tidy inside and outside.	
Water conservation				X		Measures for water conservation, efficient technology and a great deal of awareness exist	Annual water audits may be useful and would reduce cost to a great extent. Per capita water consumption figure is too high.
Operation of desalination plant			X			Daily logs taken, all manuals are available but poor maintenance	Improve operational performance by appropriate maintenance and system performance audits
Water quality			X			Water quality monitoring is recently started	Water quality monitoring needs to be improved, data shall be based on average reading of 3 samples

6 Mitigation and Management of Negative Impacts

This section will identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to intake system, brine disposal, emission and noise control and operation and maintenance issues. Cost the mitigation measures, equipment and resources required to implement those measures will also be estimated.

6.1 Desalination

Desalination plants are energy intensive, depending on diesel fuel as solar desalination is not well developed. For this reason they are not considered environment-friendly. However, desalination plants are regarded by some as a tool to preserve natural water resources and therefore as mean to protect environment and the question whether desalination systems are environmentally friendly is not necessarily relevant. Yet, this section looks at the different impacts of the desalination plant and how some of the impacts can be mitigated.

6.1.1 Intensive energy use

The intensive use of energy by the desalination plant results in indirect environmental impacts, since the energy requirements of the plant increase the production of electricity, the burning of fossil fuels and in turn the contribution to global warming. Based on various publications, it is estimated that the amount of electricity required to produce $1m^3$ of water varies between 3.5-4.5 kWh/m3 (Rachel *et al* 2002). The daily water production capacity in Nika Island is estimated to be about $98m^3$ for which an estimated maximum of 392kWh of electricity is consumed for desalination daily. Burning of this fossil fuel contributes to global emission of greenhouse gas which in turn contributes the global warming and climatic change. The CO_2 emissions from burning of fuel in Nika, however, are expected to comply with USEPA standards, which have generally been used in the Maldives, in the absence of local standards. Yet, it is important to minimize water utilisation to the greatest possible extent to minimize net cumulative effect of the operations in Nika Island Resort.

6.1.2 Alternative water resources

Rainwater and groundwater are the only sources of water available for the island. However, use of groundwater is restricted and rainwater catchment is limited by the size of the island. Therefore, desalination has been adopted. However, it may be worthwhile considering the use of groundwater for flushing toilets, which would minimize desalinated water production. However, Tourism Regulations do not allow the use of groundwater for some unknown reasons. There are no technical papers supporting this policy.

6.1.3 Source water intake

Any seawater desalination facility would require an intake system capable of providing a reliable quantity of clean seawater with a minimum ecological impact. There are basically two options for source water intake and they are seawater and groundwater. For seawater, there are two options, i.e. take from 5m beyond the reef or inner lagoon, as prescribed in the Desalination Regulation. In Nika, the intake is at about 5m from the reef flat over the reef slope and the pipeline is located under the arrival jetty close to the seabed at the reef slope. The ecological impact of this setup is moderate if appropriate filters are not placed at the end of the pipe.

For groundwater, there are two options (groundwater direct from the water lens) and brackish water using a borehole drawing water from below the water lens at about 10m below the water table. These options need to be studied further, if they were to be adopted by Nika in the future. Of these, the option of drawing direct from the water lens would reduce costs dramatically, however, may not be allowed as per the requirements of the Tourism Regulations. Even the deep borehole option is expected to be cheaper than the seawater intake option in that the draw water would be generally free of sediments thereby increasing membrane life. However, most resorts use the seawater intake possibly due to ease of installation and for some potential for anoxious conditions resulting in ammoniacal or hydrogen sulphide smell in the product water if groundwater were used.

The trapping of marine organisms against the intake screens by the velocity and force of water flowing to it (impingement) and smaller marine organisms passing through the intake screens and getting into process equipment (entrainment) are two key impacts of desalination. This would be a cause for concern in the case of reef intakes such as that found in Nika. In order to mitigate the impact, the intake end has been capped with a filter restricting entry of marine organisms.

6.1.4 Brine Concentrate Discharge

Brine concentrate is discharged directly to the lagoon where the temperature and concentration of ions rapidly increase in the receiving water. The TDS of receiving water usually increase by 50-80% due to the discharge of the concentrate without treatment and that of differential temperature remains 0-1°C (Sommariva *et al*, 2004). Section 5.2.3 discusses the water quality analysis undertaken for the brine discharge location. There is no impact of hypersalinisation owing to the high degree of movement of the coastal waters, which aids in rapid mixing. Since this observation is based on single spot measurements, it may be necessary to do further studies to ascertain this. However, based on experience and professional judgement it can be said that the receiving water is expected to have acceptable quality and the zone of impact is at a considerable distance from the housereef. Although the brine contains materials originated from sea (source water), its high specific weight and the potential presence of additional chemicals introduced in the pre-treatment may harm the marine ecology within

the zone of discharge, if it was discharged directly onto the reef. However, there is a considerable distance that will help to minimize such impacts on the reef.

6.1.5 Impacts on groundwater

Pipes of seawater laid over the aquifer pose a danger to it as these pipes may leak and salt water may penetrate the aquifer. The aquifers of small islands in Maldives usually are extended to the coastal periphery around the island. Therefore laying of pipes carrying seawater and brine necessitates the use of proper sealing techniques. It may also be useful to install leak detectors. However, small leaks from the intake or brine discharge is not expected to have irreversible, significant impacts on the groundwater. Therefore, this is not recommended.

6.2 Uncertainties in Impact Prediction

Environmental impact prediction involves a certain degree of uncertainty as the natural and anthropogenic impacts can vary from place to place due to even slight differences in ecological, geomorphological or social conditions in a particular place. There is also no long term data and information regarding the particular site under consideration, which makes it difficult to predict impacts. However, the level of uncertainty, in the case of the facilities under consideration may be expected to be low due to the experience of similar projects in similar settings in the Maldives and the fact that the desalination facilities have been operational for quite a number of years. Nevertheless, it is important to consider that there will be uncertainties and to undertake voluntary monitoring as described in the monitoring programme given in this report.

7 Environmental Management and Monitoring Plan

7.1 Introduction

This section will cover the management and monitoring needs of the desalination plant facilities in Nika. The environmental performance evaluation exercise conducted on Nika showed that there are limited environmental management issues with reference to desalination plant. In fact, there is good environmental management and performance. However, there are no written environmental management strategies and monitoring data is lacking. Data relating to environmental management and monitoring helps to not only demonstrate compliance but also helps to measure the effectiveness of or the success of the environmental impact mitigation measures. There are number of good reasons why an effective environmental management plan is needed for any such development, which can be summarised as follows.

- It can help manage environmental matters in a coordinated manner
- It can provide information that can be used for documentation and verification of environmental impacts
- It can help to provide an immediate warning whenever a predicted indicator approaches a predetermined critical level
- It can provide information that can be used for evaluating the effectiveness of implemented mitigation measures
- It can provide information for better decision making and future improvement of environmental quality.

7.2 Environmental Management Plan

The following outlines the environmental management and monitoring needs of the desalination plant infrastructure on Nika Island Resort. It is important to note that some of these measures are currently in place and the resort has an acceptable level of environmental management although there are certain areas in which environmental management is poor due to lack of written procedures and guidelines. Therefore, it may be necessary to have a Resort Environmental Management and Safety Management Action Plan developed for the entire resort operation, which could serve as a manual for environmental management.

7.2.1 Fuel and Hazardous Chemicals

The following table outlines the possible impacts, management objectives, performance targets and monitoring indicators for fuel and hazardous chemicals management in Nika. Please note that although hazardous chemicals are included here, not all hazardous chemicals are covered under the scope of this report.

Table 7-1: Environmental Management Plan for fuel and hazardous chemicals

Potential Impacts	Management Objectives	Performance Targets	Monitoring Indicators
• Marine pollution from diesel fuel spills.	• Resort has the right to refuse fuel deliveries from tankers not complying with national maritime and spill prevention regulations or policies. • Diesel transfers to be closely supervised by tanker captain and allocated resort staff. • Crew and resort staff maintains visual surveillance during transfer operations. • Couplings and fuel lines are evacuated and regularly checked (eg pressure-tested).	• No deliveries from tankers with inadequate fuel line evacuation and flow monitoring equipment. • No leaks from fuel line couplings or resort fuel lines. • No marine oil spill incidents.	• Number of marine spill incidents. • Number of leak incidents involving coupling or resort fuel line.
• Soil contamination and/or groundwater pollution from fuel, lubricant or chemical leaks and spills.	• All liquid chemicals stored in appropriate containers on impermeable floored areas. • Fuel and oil drums are stored on sealed floors or spill trays. • Floor coverings or strong plastic ground sheets at all oily service and repair areas. • Regularly clean out oil traps in diesel tank bund. • Pressure-testing of below-ground diesel pipelines.	• No liquid chemicals, fuel or oil stored on open ground. • No lubricant servicing or repairs on open unprotected ground. • No build-up of oily leaf litter in diesel bund and oil traps. • No diesel fuel leaks from underground fuel lines. • No fuel or chemical leak or spill that threatens groundwater quality.	• Number of petrol or oil drums kept on open ground. • Number of sites with contaminated soils. • Number of bund and oil trap inspections and clean ups. • Annual diesel line pressure-testing results. • Number of land spill and leak incidents.
• Explosion or fire from ignition or mixing of volatile or flammable chemicals during storage, use or disposal	• Flammable chemicals protected from ignition sources by appropriate storage, equipment, warning signs, training & supervision	• No fuel, gas or chemical fires or explosions. • All incompatible chemicals are stored and handled separately.	• Number of chemical ignition accidents. • Number of hazardous chemical incidents reported by staff.
• Injury and health risks from contact/exposure to hazardous chemicals.	• Minimise risks by staff training, protective clothing and equipment, and using MSDS information.	• No injuries or illnesses caused by contact or exposure to chemicals.	• Number of chemical accidents requiring medical attention.

7.2.2 Desalination plant and associated facilities

The types and likelihood of potential environmental and health risk issues posed by the resort's water supply system (including cooling water discharge) can be summarised as follows.

Table 7-2: Hazards and risks associated with water distribution and effluent disposal system

Source	Potential Effect/Hazard	Likelihood /Risk
Power Plant	Marine impact from metals and hydrocarbons entering the cooling water stream	Very low risk if heat exchangers are checked regularly for excessive corrosion and replaced according to manufacturer's recommended life span.
Brine and cooling water discharge	Coral deaths by concentrated natural salts and warm water discharge	Low risk due to short distance between outfall and reef
Leaks in water distribution circuits	Undetected leaks cause wasteful RO water and diesel fuel	Moderate risk unless flow rates along pipeline circuits are checked regularly and pressure tests undertaken to locate suspected leaks.
Water quality testing	Diarrhoeal infections	Low risk if regularly tested and free chlorine levels maintained

The above list shows the important components of the island's water system that requiring regular monitoring and the management plan for the desalination plant and associated facilities is given below.

Table 7-3: Environmental Management Plan for desalination plant facilities in Nika

Potential Impacts	Management Objectives	Performance Targets	Monitoring Indicators
• Marine impact of intake cooling water and brine discharge	• Avoid corrosion of heat exchanges by regular inspection and servicing	• No exceedence of EPA criteria for metals and hydrocarbons in outfall (if such criteria exist)	• Monitor metal and total petroleum hydrocarbon content of discharge
• Incorrect treatment of potable water supply causes health risks to guests and staff	• Adequate treatment, testing and maintenance of potable water supply is conducted on a priority basis	• Levels of contaminants and pathogens meet Water Quality Standards	• Monitor faecal coliform and chlorine weekly • Monitor other parameters monthly and annually
• Wastage of RO water due to leakage in the reticulation circuits.	• Identify and stop leaks in reticulation circuits on a priority basis.	• Water losses via leaks is $<$3% of the total annual output from RO plant.	• Monitor flow rates regularly and do pressure tests if leak is suspected.

7.2.3 Management of Product Water Quality

The following is an outline of the management plan for the management of desalinated water produced for potable as well as other purposes.

Strategy: Operate plant in accordance with manufacturer instructions and service agreements. Monitor pathogen and contaminant levels regularly to ensure supply meets accepted standards depending on the use.

Responsibility: Chief Engineer/Assistant Engineer, Services Manager

Monitoring/Reporting: Collect representative and discrete samples of product water supplied to guest and staff facilities from the water storage tank and at least three different supply points on the distribution system. At least three samples must be taken at each point and submitted for laboratory analysis. Following lab analysis, the results must be reviewed and correct actions taken promptly as and when necessary. The following sampling points must be considered at minimum. In addition sparkling water and ice machine water must be tested regularly. Individual results for each sample are to be filed, and a summary of the year's results provided in Periodic or Annual Monitoring Report.

Table 7-4: Sampling locations for product water from desalination plant

Sample Point	Product Water Sample Point Type	Location of Sampling Point
1	RO treated water storage tank	Storage tank no.
2	Staff distribution supply point	Staff Unit No. ; bathroom basin faucet (tap)
3	Restaurant supply point	Restaurant kitchen; basin faucet (tap)
4	Guest distribution supply point	Guest Unit No. ; bathroom basin faucet (tap)

7.3 Monitoring Requirements

In case of adopting a monitoring programme on seawater desalination it is useful to monitor:

- Fuel consumption (for desalination separate from other electricity needs)
- Marine water quality at source water intake and brine discharge locations
- End of intake pipe for entrainment risks
- Water quality in the sedimentation tank
- Product water quality
- Regular checking of system performance and components

7.3.1 Fuel Data

Fuel consumption data, storage and handling and fuel spill incident reporting are aspects mainly related to the powerhouse operations. However, desalination is also an energy-intensive process and energy requirements have to be separately monitored. Fuel consumption data will help to monitor efficiency as well as emissions related to the desalination plant operations. However, air quality monitoring would not be necessary due to the small size of the operations.

7.3.2 Water Quality

Conducting a good water quality monitoring programme is extremely important for several reasons apart from demonstrating compliance. Water quality monitoring is currently based on product water only. Besides routine

product water quality monitoring, water quality monitoring at the intake, sedimentation tank and brine concentrate discharge location would be necessary.

7.4 Recommended Water Quality Monitoring Programme

Outlined here is the water quality monitoring requirements that should be considered for the desalination plant operations in Nika. This programme shall change if the facilities or resort infrastructure related to facilities are to be changed. Monitoring programmes are to have full spectrum of base line data on various aspects associated with the operation of seawater desalination facilities on the island.

Water quality monitoring programme is for weekly, six monthly and annual basis considering the EPA and WHO guidelines. In addition, daily testing of pH, electrical conductivity and free and residual chlorine on site is recommended.

Table 7-5: Monitoring water quality

Sample type	Parameters	Min. Frequency	Purpose
Product water (desalinated water)	pH, E-Conductivity, dissolved oxygen, free and residual chlorine, total and faecal coliforms	Weekly	-To ensure the quality of water produced -To meet standards -To assure compliance
Product Water (desalinated water)	Chloride, Nitrate, Phosphate, Ammonia, Iron, Total trichloromethanes, Sodium, Pottassium, Calcium, Total Hardness	Six monthly	-To ensure the quality of water produced -To meet standards -To assure compliance
Intake Water (settling tank)	Salinity, Nitrate, Phosphate, Manganese, TOC, Calcium, Sodium, Pottassium, Calcium, Bromine, Bisulphate, Mercury, Copper, Lead, Boron, Arsenic, Flouride, Phenolic compounds, Anionic detergents, Cadmium, Chromium, Cyanide	Annually for two years then revise frequency depending on results	-To ensure the quality of water produced -To meet standards -To assure compliance
Zone of feed water intake	Temperature, pH, Salinity, Turbidity, Total Suspended Solids, TDS, dissolved oxygen, BOD and COD	Every six months	To ensure the quality of feed water and assure compliance
Zone of Brine Concentrate discharge	Temperature, pH, E-Conductivity, TDS, Chloride, BOD and COD	Every six months	To ensure the quality of water at brine discharge and assure compliance

7.5 Cost of monitoring

The following table gives an estimated cost for the monitoring assuming the monitoring will be undertaken by the resort in collaboration with environmental consultants. Transport, food and accommodation for environmental consultants have not been incorporated. This estimate is based on the monitoring programme and management plan outlined earlier and assuming six monthly monitoring by environmental consultants.

Table 7-6: Costs of annual monitoring

No	Details	Unit cost (US$)	Total (US$)
1	Field allowance for 2 consultants for 1 day (two trips)	400.00	800.00
2	Monitoring equipment depreciation and other charges (two trips)	570.00	1,140.00
3	Laboratory charges	1,500.00	1,500.00
4	Compliance reporting (annual report)	2,500.00	2,500.00
5	Digital colorimeter for on-site testing of free and residual chlorine	900.00	900.00
	Total		**6,840.00**

Environment Protection Agency and the project consultants need adequate data to make accurate impact assessment and improve impact assessment methodologies would have several reasons to undertake monitoring at adequate intervals. Project proponents or developers or operators often find impact assessment and monitoring unnecessary for which reason the commitment of the Proponent to undertake monitoring has been made mandatory under the EIA Regulations. The purpose of providing estimated costs for monitoring is to quantify such commitments. It also indicates that monitoring is not a costly exercise given the benefits of long term cost reductions as well as compliance and environmental performance benefits associated with monitoring.

8 Conclusions and Recommendations

In conclusion, the project's environmental performance can be rated good. The findings of this report indicate that there is compliance with general requirements of environmental infrastructure management, especially desalination plant, which form the focus of this report. There are adequate health and safety measures and there are adequate provisions to build awareness and training on health and safety including fire safety. Machinery and equipment are in working condition but there are maintenance issues as identified in this report.

The following recommendations are made:

- The intake pipe should have a screen fixed at the end of the pipe. Regular checks on the screen are also important.
- Relocation the pipes (openings) of the sedimentation tank or the plant intake pipe to higher level is advised but since the existing system is not having a big negative effect it can be considered low risk.
- Repair and start using the second plant.
- Relocate the micron filters (cartridge filters) to inside the plant room. Installing a cartridge filter module is preferred.

- Clean the sedimentation tank and inspect the sedimentation tank regularly. Sedimentation tanks work as natural sediment removers. If these tanks are well maintained it will keep filters and membranes from blocking.
- Chlorine or other disinfectant should be used regularly to disinfect the product water and if chlorine is used, checking the chlorine levels at the site is also important. The requirements of EPA for chlorine levels in drinking water should be met.
- Operations instructions, chemical dosing instructions, safety procedures and warning signs needs to be displayed in the plant room.
- Pressure gauges and flow meters which are not working needs to be replaced.
- Small storage tank (transfer tank) outside the pump house needs to be cleaned and protected from pollutants. Relocation of the tank to a better location is also a considerable option.
- Preventive maintenance is the most important part of smooth operation of any facility. Due to lack of importance given to these areas many industries suffer huge cost of replacing bigger and expensive parts. For an example maintaining filters well will make membrane life longer. To do this the staff must keep the logs regularly, they should be able to interpret the logs, and they should also know by looking at the pressure gauges when the filters need to be backwashed or replaced.
- The plants need regular maintenance. This includes regular checking of plant operation, pumps and modules for leaks, oiling and applying grease.
- The staff should understand how to check the pressure from the system, assess the functioning, flow and production of the plant. Hence training in these areas are required.
- Documents such as manuals and catalogues must be easily accessible to operators for reference and guidance.
- The staffs that are operating the system seem to be very committed and interested in the operations. However they need training in the technical knowhow of the function of plants, maintenance and keeping the water quality constant.
- Proper stock keeping of spare parts, filters and chemicals must be practiced. Especially, care must be taken to store chemicals in appropriate atmosphere.
- It is also recommended to undertake an Energy Audit as well as a Water Audit annually. This will help minimize costs dramatically and improve performance of utilities.
- An Environmental Management System or Environment and Safety Management Plan needs to be in place to show the resort's commitment to maintain good compliance and performance in matters relating to health, safety and environmental protection and conservation. Periodic monitoring of performance is also recommended. Monitoring environmental performance of the powerhouse and desalination facilities would not only demonstrate environmental compliance but also help minimize costs in the medium to long term. It is even better and worthwhile to undertake a corporate environmental monitoring programme incorporating all aspects of the operations so that cost of monitoring and subsequent operational costs are minimized.

9 References

1. Herrmann T, Schmida U (1999), Rainwater utilisation in Germany: efficiency, dimensioning, hydraulic and environmental aspects. Urban Water 1999;1(4):307–16.

2. Rachel et al (2002), the foot print of desalination process on the environment, Journal of Desalination, Vol. 152, pp. 141-154

3. SARI/Energy (http://www.sari-energy.org/PageFiles/Countries/Maldives_Energy_detail.asp#renewable) accessed on 10 February 2010.

10 Appendices

- Terms of Reference

بسم الله الرحمن الرحيم

Environmental Protection Agency

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Terms of Reference for the Environmental Audit on Registration of Desalination Plant and Powerhouse in Nika Island Resort.

The following ToR is based on the application form sent on the 7th September 2010, for undertaking the Environmental Impact Assessment Report for the Registration of existing Powerhouse and Desalination Plant at Nika Island Resort, Aa. Kudafolhudhoo, Maldives.

This document is legally binding document prepared after consulting with all relevant stakeholders and the EIA report must strictly follow the activities under this ToR.

1. *Introduction – Identify the development project to be assessed and explain the executing arrangements for the environmental assessment. Describe the rationale for the EIA and its objectives.*

2. *Study Area – The study will be focused on the registration of existing powerhouse and desalination plant on Nika Island Resort. The specific areas include powerhouse with stacks and immediate vicinity affected by noise and emissions and oil handling areas, the desalination plant including the seawater intake, plant housing, storage facilities and brine discharge locations.*

3. *Project Proponent – Provide details of the project proponent including any joint venture partners.*

4. *Scope of Work - The following tasks will be performed:*

Task 1. Description of the Project - Provide a brief description of the proponent, full description of the relevant parts of the project, using clearly labeled maps, scaled site plan including location of powerhouse and desalination plant, outfalls and saltwater intake.

For the powerhouse provide details of the area of powerhouse, number of and capacity of generator sets, height of smokestack, method of generator sets cooling, water discharge outfall if any, emissions control measures, location and capacity of fuel tanks, condition of fuel tanks and fuel handling methods.

For the desalination plant provide details of area of the plant room, number of and capacity of desalination plants, method of saltwater intake and, location and length of brine discharge outfall.

Provide a brief description of the existing safety measures in place in case of an emergency.

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Task 2. Description of the Environment - Where baseline data is to be collected, careful consideration must be given to the design of the methodology and sampling programme. Data collection must focus on key issues needing to be examined for the EIA. Consideration of likely monitoring requirements should be borne in mind during survey planning, so that the data collected is suitable for use as a baseline to monitoring impacts.

Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area

a) Physical environment: meteorology (rainfall, wind, waves and tides), sea currents, surface hydrology, climatic and oceanographic conditions in the discharge area. Brief description of groundwater quality at the powerhouse location and desalination plant location. Marine water quality at the location of intake and brine discharge locations. Marine water quality parameters shall include dissolved oxygen, COD, BOD, E-Conductivity/salinity and pH. Groundwater quality shall include dissolved oxygen, TDS or E-Conductivity, THC, COD, BOD, nitrate and phosphate. Quality of the product water from desalination plant shall also be assessed, especially for pH, E-Conductivity and coliform bacteria (E-coli and Total coliforms). Describe of the general status of the groundwater in terms of the size and quality of the water lens

b) Biological environment: Assessment of coral cover along the pipe if the brine discharge or intake pipe or part of the pipe runs on reef areas where live corals can be found. Describe the terrestrial vegetation in the location.

c) Human environment: Identify the noise levels in the vicinity and how they affect recreational quality and public and occupational health. Also identify if the existing powerhouse emissions have any negative impact on the living, recreational and working environment.

Characterize the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts. All available data from previous studies of the island, if available should be presented. Geographical coordinates of all sampling locations should be provided. All water samples shall be taken at a depth of 1m from the mean sea level or mid water depth for shallow areas. The report should outline the detailed methodology of data collection utilized to describe the existing environment. Baseline conditions should be presented for the marine environment

An average of at least 5 measurements must be given for each parameter tested and analyzed from a certified laboratory. Provide details of calibration for any onsite data analysis.

Task 3. Legislative and Regulatory Considerations - - Describe the pertinent national legislation, regulations and standards, and environmental policies that are relevant and applicable to the audit, and identify the appropriate authority jurisdictions that will specifically apply to the audit. Determine how well the existing infrastructure complies with existing environmental policies and regulations.

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Task 4. Determine the Environmental Performance and Compliance of the Project –*Identify operational impacts of the powerhouse and desalination plant facilities. Identify if the brine is discharged in appropriate location and if exhaust emissions are appropriately discharged. Discuss the short term as well as long term effects of any emissions or discharges on the environment, especially the health of the staff. Identify any information gaps and evaluate their importance for decision-making. Distinguish between significant impacts that are positive and negative, direct and indirect, and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making.*

Task 5. Mitigation and Management of Negative Impacts – *Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to intake system, brine disposal, emission and noise control and operation and maintenance issues. Cost the mitigation measures, equipment and resources required to implement those measures. A commitment regarding the mitigation measures should be submitted by the responsible person.*

Task 6. Monitoring Plan – *Identify the critical issues requiring monitoring to ensure compliance to energy management and water quality regulations and standards. All requirements for reporting shall be identified and a comprehensive monitoring plan with the cost and commitment of the Proponent to conduct the monitoring programme shall be provided. A detailed reporting time table and ways and means of undertaking the monitoring programme must be provided.*

Task 7. Methodology *Explain clearly the methodologies used for data collections, making predictions and data gaps and also the information on the uncertainties and assumptions involved in interpreting the data.*

Presentation - *The environmental impact assessment report, to be presented in print and digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline given in the Environmental Impact Assessment Regulations, 2007.*

Timeframe for submitting the EIA report - *The developer must submit the completed EIA report within 3 months from the date of this Term of Reference.*

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09 September 2010

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