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AFRICAN DEVELOPMENT BANK GROUP

PROJECT: LAKE HARVEST AQUACULTURE EXPANSION PROJECT

COUNTRY: ZIMBABWE

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN SUMMARY

Date: August 2011

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ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN SUMMARY

Project Details:

Project Title:	Lake Harvest Aquaculture Expansion Project
Project Number:	P-ZW-AAF-001
Country:	ZIMBABWE
Department:	OPSM
Division:	OPSM.2

Objectives of the ESMP:

The ESMP for the Lake Harvest Aquaculture Expansion Project has been prepared in accordance with AfDB's environmental and social assessment procedures. It focuses on the expansion of an already existing aquaculture project in Lake Kariba, on the Zimbabwean side. It is currently operating at a production level of between five and seven thousand tonnes per annum. Lake Harvest "LHA" is now proposing to increase production to twenty thousand tonnes per annum. The project will be based in the area that has been already leased to Lake Harvest by Zimbabwe Parks and Wildlife Management Authority "ZPWMA", who are the custodians of Lake Kariba.

The leased area is 12 km^2 and the existing project only utilized 8 km^2 and it increased to 10 km^2 in 2011. It is worth noting that the current area used for LHA amounts to less than 0.05% of Lake Kariba's water surface area, indicating potential for expansion in terms of surface area. Zimbabwe's environmental legislation stipulates that an EIA is a prerequisite for development projects. However, there is no legislative requirement in Zimbabwe to develop an Environmental and Social Management Plan. Consequently, this ESMP has been developed solely to meet the requirements of AfDB. Although the existing operations are being implemented in line with recommendations of an ESIA that was compiled prior to the project in 1996 and the updated monitoring program, the proposed expansion will require updating of current social and environmental management issues in order to properly manage and mitigate against potential negative environmental impacts, hence the need for this ESMP.

The objectives of the ESMP are therefore:

- to mitigate against the possible degradation of the Lake Kariba ecosystem during the operation of the proposed aquaculture expansion project by reducing negative impacts and enhancing positive effects
- to ensure that the proposed expansion for aquaculture production does not result in excessive enrichment of Lake Kariba thereby modifying the ecosystem integrity
- to outline mitigation measures, in order to manage social and environmental impacts associated with the project
- to ensure that the aquaculture project will be developed and operated according to the stipulated requirements of African Development Bank's ESAP
- to ensure that the aquaculture project will comply with relevant environmental legislation of Zimbabwe and other requirements throughout its operational phase
- to identify roles and responsibilities and the cost involved and
- to propose mechanisms for monitoring compliance

a) Brief description of the project and key environmental and social components

In 1997, Lake Harvest Aquaculture (Pvt) Ltd was granted a license by the ZPWMA to produce Tilapia in cages in the eastern basin of Lake Kariba. The total lake area for the licence was 12 km^2 and the license allowed for production of up to 5 000 tons per annum. Currently, Lake Harvest is utilizing approximately 8 km^2 (8 square kilometers) of this area. In 2010, annual production was approximately 2 400 tons. The estimated annual production in 2011 is 7 000 tons. Lake Harvest plans to expand production in a staggered manner to reach a maximum annual production of 20 000 tons. The increased production will be achieved through the full utilization of the 12 km^2 of the current leased area.

This project is the only one of its kind in Zimbabwe that is involved in cage culture of fish on an industrial scale and is also currently the largest fish farming enterprise in Africa. The project has 3 key operations namely:

(1) rearing and breeding fish in land based earthen fish ponds (Bakerton farm)
(2) on-growing of fish in floating fish cages in the lake and
(3) a fish processing in the factory.

The fish farm is located on the eastern side of Lake Kariba dam wall. The fishes are reared in a series of ponds namely holding, breeding and fingerling ponds and are transferred to the lake where they are raised in cages. In total there are 17 holding ponds, 48 breeding ponds and 24 fingerling ponds within the farm. The farm breeds tilapia fry and on-grows them from 1 gm fry to 25 g juveniles in 0.4 ha ponds. The brood stock is stocked in the ratio of 2:1 females to males in the breeding ponds for 14 days where fry are expected to be bred. Fry from the breeding ponds are transferred to 6 m^3 concrete tanks for intensive care where they spend 21 days. After attaining a weight of 0.5 g the fry are transferred to fingerling hapas where they stay for 4 weeks. The fingerlings are then transferred to nursery cages (1000 m^3) that are moored in the lake at a stocking density of 400, 000 fingerlings per nursery cage. The fingerlings are held in juvenile cages for 8 weeks. The fishes are transferred into production cages at 20 g and they are expected to stay in the production cage for 35 weeks where they attain 750 g. The fish complete a circle of 50 weeks from hatching to harvesting.

The feed is composed of soya bean meal, maize meal, wheat bran and fishmeal. Vitamin and mineral premix is added to the feed to form a practical complete diet. The nitrogen and phosphorus content in the feed is 4.8% and 0.8% respectively. Estimated annual rates of nitrogen and phosphorus discharges into the lake from the operations are 321.2 tonnes and 53.6 tonnes respectively. The food conversion ratio ranges from 2.0 to 1.7. The major water requirement is at the farm where 48 mega-litres per month are pumped and returned to the lake as effluent. The pond effluents are screened to remove suspended solids and passed through settlement ponds stocked with catfish (*Clarius gariepinus*) and then through polishing ponds planted with reed beds for nutrient stripping. The water is then returned into the lake.

Fish cages currently occupy an area of < 0.05% of the Lake Kariba full capacity area of 5 820 km^2. This is insignificant and even at a production level of 20 000 tonnes per annum the water area covered will be very small. The existing operation in 2011 has 137 cage groups occupying 11.2 km^2, where on-growing to market size is done in floating net cages moored in the north-east section of Lake Kariba. Existing cage sites are located at leased Area 1, leased Area 2 and leased Area 3, which are 2 km^2, 3 km^2 and 5 km^2 respectively. Cage sites are separated by approximately 1 km. Each cage site contains 18 cage units. Each site has a feed barge which

acts as a feed warehouse. There are two cage sizes. The smaller has a diameter of 15 m and the large cage has 20 m diameter. The cages are connected to each other in groups, moored using a line of mild steel attached to a concrete block on the lake bed and demarcated by floating buoys. Mooring lines are under water. The Cage Units are connected by walkways.

The fish are harvested and transported live to the factory in oxygenated boxes. Once they are at the factory they are desensitised, slaughtered and bled before processing into various products. Factory activities involve bleeding, descaling, heading, gutting, filleting and packing. Strict hygiene is adhered to along the production line to reduce the bacterial load. Fillets from the factory are exported mainly to the European markets while the whole bream and by-products are sold in Zimbabwe and regional markets. Unsold by-products are fed to crocodiles and also made into fish meal for animal feeds. Estimated waste production in the factory is 300 tonnes/year. Water consumption is estimated to be 504-756 m^3/day and 184 000- 276 000 m^3/year at the current production level.

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b) Major environmental and social impacts

This project has a positive economic value but it is also crucial that it is both socially and ecologically sustainable; thus ecological and social understanding is required to minimize negative impacts and enhance the positive ones. Beneficial and adverse impacts will arise from 3 main operations which are going to be expanded namely (i) pond operations from the fish farm (ii) lake operations and (iii) factory operations. The anticipated impacts are outlined below.

Environmental Impacts

Nutrient enrichment due to input of nutrients and organic material from uneaten fish feed and fish waste and effluents from the ponds can stimulate excessive growth of algae (increase primary production). Accumulation of organic matter in the bottom sediments although not observed at the existing operation level can result in creation of anoxic bottoms (depleted of oxygen). This can occur if the assimilative capacity is exceeded. Waste disposal from the various stages of the project can lead to among others; contamination of environment, nuisance in terms of attracting scavengers, disease spread and the fat can also pose a significant challenge downstream of the project facilities (at the municipal wastewater treatment plant) hence rendering water treatment less effective and ultimately pollution of fresh water bodies. Waste in terms of effluent from the pond may also result in increased phytoplankton activity. Waste in terms of unused feed may also accumulate in the bottom of the cages and can interfere with the natural mechanisms of other organisms in the lake, especially the bottom dwelling animals.

Fish mortalities may also result in increased Ammonia content in the lake. Fish escaping from the cage may result disturb the natural functioning of the lake in terms of gene pool and natural and fragile aquatic habitats and some segments of aquatic environment may be destroyed, spreading of diseases. The project will also result in increased natural resource usage in terms of both potable water and direct lake water abstraction for the ponds. Increased production may result in increased traffic in terms of trucks delivering the products and boat navigational challenges as they will be required to keep a buffer zone around the cages. The cage structures can alter flow regimes, which govern the transport of oxygen, sediment, plankton and fish larvae. The framework/netting of cages can cause drag forces to water flow thereby affecting local water currents. The reduction in water flow regime will cause sedimentation of large dense particles in the vicinity of cages and increased sedimentation can disrupt benthos communities.

If the cages are situated within the pathway of the inflow of large rivers this will cause siltation thereby disrupting the sediment carrying plume which is determined by the horizontal water current speed

Social Impacts

The major socio-economic benefit of the expansion project is employment creation especially in Kariba. Lake Harvest is currently employing about 700 people and the workforce is projected to increase to 2 000 after the expansion. Additional employment will also be created through industries that provide support to the LHA's operations. These include service industries such as fuel suppliers, feed transporters, metal fabrication companies (boat repairs) and fish distributors. Employment will also be created for the feed input suppliers, especially the maize and soya bean farmers. Although quantitative data were not compiled, discussions with two service providers indicated that they would both need to increase their workforce by about 9 employees if the proposed expansion goes ahead. This will significantly reduce unemployment in Kariba. Kariba has a population of between 16 000 –20 000 with a high unemployment rate. In an area where exploitation of the fishery resources is one of the principal employment sources (other than tourism), expansion of aquaculture activities will play a significant social role.

Employment will reduce risky survival strategies such as commercial sex especially among women and teenage girls which in turn can lead to higher risk of HIV spread/exposure. Increased employment may contribute to reduction in illegal activities, as the number of unemployed will decline. The expansion may lead to an increased strain on Municipality services unless the people employed are mainly from Kariba Town. Another sector in which additional employment will be created is the small-scale informal sector. Currently, there is a thriving informal sector that is involved in the sale of the by-products (such as fish heads and belly flaps).

The local authority (Municipality of Kariba), will also benefit from increased revenue from Lake Harvest (municipal rates, water and sewerage charges). In discussions with staff from the Municipality, it was noted that the proposed expansion would result in increased revenue flows that would in turn improve the liquidity position of the municipality. The improved liquidity position would then allow the municipality to improve on service delivery to Kariba residents. Concerted efforts should be made by Lake Harvest to recruit staff from within Kariba town as long as the locals have the requisite skills. Benefits from the proposed expansion should be evident to the local residents, and the proposed recruitment approach would ensure that these benefits are evident.

The project will increase food security in the area and the low-income groups who consume fish heads and belly flaps would have protein in their diet. Expansion will also assist in halving current fish prices of US$3/kg. LHA in terms of its voluntary corporate social responsibility (CSR) program and commitment to contributing to the Millennium Development Goals is already involved in a couple of activities. LHA is currently donating 100 kg of fish heads per month to Tony Waite Organisation to feed orphans and vulnerable children. This support has ensured that these disadvantaged members of society are supported. It is anticipated that if the expansion goes ahead LHA will increase its support for vulnerable groups and extend its CSR to include home based care (HIV/AIDS) beneficiaries, who currently are not receiving any animal protein supplements. Presently, there are about 300 beneficiaries on this program. LHA currently provides animal protein to the patients at the Kariba District Hospital every week (20 kg of fish

heads and 15 kg of belly flaps). This is also anticipated to increase after the expansion. At a pre-school with 153 pupils (Svinurai) LHA supply 10 kg of belly flaps per week. Ideally the pre-school requires 20 kg of belly flaps/week and this need would be met with the expansion.

Gender Issues

Women constitute 42% of the Lake Harvest workforce in the Administration and factory departments. This is a positive situation as it promotes gender equity and the economic empowerment of women. It is envisaged that an additional 2 000 jobs will be created and a substantial number of women will be employed in the factory thereby contributing to further economic empowerment of women.

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c) Enhancement and mitigation program

Enhancement:

The expansion of the project will result in an in-house feed plant which will bring benefits such as reduced amount of feed as the feed manufactured in-house will have enough protein and in turn result in generation of less waste. The development of an in house feed plant will enhance the livelihood of maize and soy farmers which will be more beneficial than the current situation where money is spent outside the country to import of the feed. The major socio-economic benefit of the expansion project is employment creation especially in Kariba. Lake Harvest is currently employing about 700 people and the workforce is projected to increase to 2 000 after the expansion. Additional but indirect employment will also be created through industries that provide support to the Lake Harvest operations. To further enhance the job creation aspect of the project, LHA intends to hire mostly women in the factory. Employment will reduce risky survival strategies such as commercial sex especially among women and teenage girls which if not prevented may lead to higher risk of HIV spread/exposure.

Another benefit of the project is that the Municipality will be supported in terms of tariff payments for services and this will result in growth of the municipality. Furthermore, LHA will hire local people so as to reduce strain on the municipal services. The project will increase food security in the area and also in anticipation of the expansion, LHA has opened a depot where off cuts are also sold to the public. The provision of protein for the low-income groups who consume fish heads and belly flaps will be enhanced because the price will almost be halved as a result of the expansion enabling more people to have afford animal protein.

Mitigation Program:

In order to ensure a sustainable aquaculture industry in Lake Kariba, the capacity of the ecosystem should not be exceeded and environmental degradation should be mitigated against. The table below presents the proposed mitigation measures for identified impacts.

Issue	Impact	Mitigation/Management	Responsibility
Nutrient enrichment	- Exceeding the critical level or load (L_c) would lead to a eutrophic state in the lake and such state reduces light penetration into the waters - Nutrients added increase the phytoplankton biomass to such an extent that it acts as a light barrier	-Establish effluent 'rapids' so as to increase oxidation of nitrogenous matter - Monitor feed rates to avoid overfeeding - Installation of settling ponds to allow the capture of sediment, organic matter and other pollutants	LHA

Issue	Impact	Mitigation/Management	Responsibility
	- Excessive phytoplankton can result in shading and possible elimination of complex benthos associations	by deposition, infiltration, absorption, decomposition and volatilisation	
Disposal of waste	-contamination of environment -attracting scavengers -injure wildlife -spread diseases -emission of odours (air pollution) -fat clogging filters and pipes -fat reducing waste water treatment plant efficiency	-Fertiliser production -Pet food production -relocation of dumpsite -installation of fat processing plant -Installation of fat removal system at the factory -Primary treatment of factory effluent -Effluent passing through settlement ponds -Incineration of protein waste	-LHA -Municipality of Kariba -Lake Kariba Fisheries Research Institute
Flow regimes/ water currents	-Water flowing through the cages is affected by drag forces exerted by the framework and netting - Increase in the rate of waste accumulation in the immediate cage vicinity - Disruption of the dispersion of sediments carrying plume from the underneath large rivers	- Jump nets that extend above the water line should be constructed to prevent overtopping by storm surges or waves - In case of expansion, cages should be installed away from major rivers to the cages e.g. Gache-Gache. Nyaodza and Charara rivers	LHA
Fish mortalities	- Bacterial action and autolysis of dead fish results in the excretion of ammonia in lake waters - Live fish preying on dead fish can result in the spread of diseases if the corpse died of a disease -Mortalities attract fish predators e.g. birds, in the farm and birds, crocodiles at the cages	- Conduct a daily routine of collecting mortalities on the farm -All mortalities should be burnt at the incinerator	Lake Harvest
Pond effluent	- Increase in accumulation of waste in the lake hence affecting the bottom dwelling organisms - Increase in phytoplankton productivity - Organic anions may become a part of the total alkalinity in polluted waters	- Introduction of the hapas system minimizes the rate of nutrient loading from the draining ponds - Reduce rate of disposal by minimizing draining of ponds - Settling ponds retains effluent for 48 hrs allowing the waste to sink allowing for breakdown and hydrolysis of organic matter - Anaerobic bacteria in the settling ponds which hydrolyses organic matter - Ensure that the inlet and discharge points are independent from each other so as to guarantee that water supply and effluent do not mix	LHA
Fish feed waste	- Uneaten feed accumulates as waste and produces ammonia as it decomposes in the ponds - Uneaten feed accumulating at the bottom of the cages where it is synthesized and sinks to the bottom to be mineralized by bacteria	- Feed on response to avoid overfeeding - Practice regular flashing of ponds/tanks - Adjust feed chart in winter to avoid overfeeding and unnecessary feed loss - Monitor feed for macro-minerals	LHA

Issue	Impact	Mitigation/Management	Responsibility
	- Feed contains some macro-minerals which are possible pollutants of the environment - Increase in levels of ammonia, nitrogen and phosphorus in lake waters -Waste can accumulate beneath cages and cause deterioration of water quality, which can have a negative impact on the fish in cages	like phosphorus and nitrogen - Use of extruded feed to improve on digestibility and reduce the amounts of feed lost to the environment -Anchoring of cages on single paint moorings so that waste will be distributed over greater area - Increase feed use efficiency by using high-quality feed that contains desired nitrogen and phosphorus minerals and by assuring that fish consume most of the feed offered - Fallowing of are below cages to allow the breakdown of accumulated waste - Apply appropriate feed type and size suitable for a specific stage of fish	
Fish escapes	- The escape of non-native culture species could lead to interbreeding thereby altering the local gene pool of local fish populations - Non-native species could also lead to competition with native species - Diseases can also be transmitted from escapees to wild fish -Competition can also alter or modify the pre-existing natural and fragile aquatic habitats and destroying some segments of aquatic environment	- Install screens on all inlet and outlet points in the fish farm to minimize the escape of fry, juveniles and brood stock - Filter screens in fish farm shall be designed to retain the smallest life stage present - Filter devices should capable of screening all water -Cages should be made of sturdy, non-corrosive material - Make thorough inspection of nets before they are deployed so as to avoid possible escapees from the cages - Follow protocols when transferring, changing nets or harvesting fish from the cages e.g. use of fish boxes - Divers or underwater cameras must periodically inspect cages for holes, rips and tears	LHA
Fish diseases	-spread of diseases to wild populations -evolution of drug resistant fish pathogens	-practise good husbandry -limit use of chemicals	LHA
Predator /prey interactions	-Fish losses to predation	-putting nets over ponds to deter birds	LHA
Factory water requirements	-increased water demand	-installation of a mini-water treatment plant	LHA
Noise pollution	-Noise	-accommodate concerns as they arise	LHA
Road access congestion	-road deterioration	-assist in road maintenance	LHA & Municipality of Kariba
Food hygiene aspects	-spread of diseases	-engage additional inspectorate staff	LHA
Occupational Health &	-accidents in factory	-annual inspection by National Social Security Authority (NASSA)	LHA

Issue	Impact	Mitigation/Management	Responsibility
Safety issues			
Biosafety measures for factory	-disease outbreak	- use footbaths and restrict entry to factory	LHA
Heath service	-health challenges due to large work force	- consider having a resident health staff	LHA
Encroachment intro Kapenta fishing grounds	-reduction of Kapenta fishing grounds	- restrict expansion to currently leased area	LHA
Conflict with other lake users	-Reduce space for other users	-accommodate issues as they arise	LHA
Navigational requirements	-Boat accidents at night	- install self-extinguishing lights	LHA & Lake navigation control

d) Monitoring program and complementary initiatives

Monitoring includes monitoring of the implementation of the mitigation measures to assess their efficiencies and eventually develop other mitigation measures if the expected results are not reached. To ensure social and environmental sustainability of the project, LHA will continue to have a monitoring program to ensure that proposed mitigation measures and enhancement of benefits are implemented. The table above (section c) shows parameters that will be monitored and management controls required. The table immediately below shows the stage at which mitigation will be done and the responsible party.

Mitigation	Responsible institution	Timeframe for implementation
1. Establish effluent 'rapids' in ponds	Lake Harvest	Construction phase
2. Monitor feeding rates	Lake Harvest	Project duration
3. Installation of settling ponds	Lake Harvest	Construction phase
4. Fertiliser production from waste	Private individuals	Project duration
5. Pet food production from waste	Private individuals	Project duration
6. Relocation of dumpsite	LHA/Municipality	Construction phase
7. Installation of fat processing plant	Private individuals	Construction phase
8. Installation of fat removal system at the factory	Lake Harvest	Construction phase
9. Primary treatment of factory effluent	Lake Harvest	Project duration
10. Incineration of protein waste	Lake Harvest	Project duration
11. Installation of cages away from major rivers	Lake Harvest	Construction phase
12. Daily collecting mortalities on the farm	Lake Harvest	Project duration
13. Burning mortalities at the incinerator	Lake Harvest	Project duration
14. Minimizing draining of ponds	Lake Harvest	Project duration
15. Separating the inlet and discharge points	Lake Harvest	Construction phase
16. Feed on response to avoid overfeeding	Lake Harvest	Project duration
17. Practice regular flashing of ponds/tanks	Lake Harvest	Project duration
18. Adjust feed chart in winter to avoid overfeeding and unnecessary feed loss	Lake Harvest	Project duration
19. Monitor feed for macro-minerals like phosphorus and nitrogen	Lake Harvest	Project duration
20. Anchoring of cages on single point moorings so that waste will be distributed over greater area	Lake Harvest	Construction phase
21. Use of extruded feed to improve on digestibility and reduce the amounts of feed lost to the environment	Lake Harvest	Project duration

Mitigation	Responsible institution	Timeframe for implementation
22. Increase feed use efficiency by using high-quality feed that contains desired nitrogen and phosphorus minerals and by assuring that fish consume most of the feed offered	Lake Harvest	Project duration
23. Fallowing of area below cages to allow the breakdown of accumulated waste	Lake Harvest	Project duration
24. Apply appropriate feed type and size suitable for a specific stage of fish	Lake Harvest	Project duration
25. Install screens on all inlet and outlet points in the fish farm to minimize the escape of fry, juveniles and brood stock	Lake Harvest	Construction phase
26. Filter screens in fish farm shall be designed to retain the smallest life stage present	Lake Harvest	Construction phase
27. Filter devices should be capable of screening all water	Lake Harvest	Construction phase
28. Cages should be made of sturdy, non-corrosive material	Lake Harvest	Construction phase
29. Make thorough inspection of nets before they are deployed so as to avoid possible escapees from the cages	Lake Harvest	Project duration
30. Put dual netting system in cages with outer strong predator net	Lake Harvest	Project duration
31. Follow protocols when transferring, changing nets or harvesting fish from the cages e.g. use of fish boxes	Lake Harvest	Project duration
32. Divers or underwater cameras must periodically inspect cages for holes, rips and tears	Lake Harvest	Project duration
33. Practise good husbandry	Lake Harvest	Project duration
34. Limit use of chemicals	Lake Harvest	Project duration
35. Put bird and predator nets over ponds	Lake Harvest	Construction phase
36. Installation of a mini-water treatment plant	Lake Harvest	Construction phase
37. Road maintenance	LHA/Municipality	Project duration
38. Annual inspection of factory by NASSA	LHA/NASSA	Project duration
39. Use footbaths and restrict entry to factory	Lake Harvest	Project duration
40. Consider having a resident health staff	Lake Harvest	Project duration
41. Restrict expansion to currently leased area	Lake Harvest	Construction phase
42. Install self-extinguishing lights	Lake Harvest	Construction phase
43. Assess phytoplankton, zooplankton and *L. miodon*	ULKRS	Project duration
44. Assess benthos community	ULKRS	Project duration
45. Monitor water hyacinth	ZRA	Project duration
46. Monitor colonisation by *O. niloticus*	LKFRI	Project duration
47. Monitor water quality at cages	LHA/ University of Zimbabwe Research Station	Project duration
48. Monitor water quality at ponds		Project duration

Complimentary initiatives:

Lake Harvest has GlobalGap Certification that requires compliance to all stipulations within the GlobalGap checklist. This includes many environmental related issues some of which complement this ESMP. These include:

(i) requirement to develop a management plan with strategies to minimize pollution
(ii) requirement to have a waste and pollution management plan
(iii) requirement to mitigate the impact of aquaculture on the environment and biodiversity
(iv) pest control to be environmentally friendly
(v) fish feeds to meet stipulated contents
(vi) avoid escapes of non-indigenous species
(vii) ensure that the water quality is monitored

It is important for LHA to meet the GlobalGap Certification requirements because of its importance in exporting to Europe. Lake Harvest has developed measures within all its operations from the ponds, to cages in the lake and in the fish factory to achieve the required compliance. All these activities are complimentary and overlap with mitigation measures proposed for the ESMP. As a tool to meet GlobalGap requirements, Lake Harvest has in place an Environmental Monitoring Plan for their existing operations. This is designed in such a way that the enterprise operates in conformity to the relevant Environmental legislation of Zimbabwe. The Environmental Management plan describes the impacts of the operations, available mitigation measures and monitoring measures undertaken to preserve the environment being impacted by both lake-based and pond-based operations. The objectives of the Environmental Management Plan are to **(**i**)** outline the farming aspects and their impacts on the environment (ii) describe the mitigation measures in place to reduce the environmental impacts of fish farming (iii) outline measures for monitoring the efficiency of the mitigation measures.

e) Institutional arrangements and capacity building requirements

The institutional arrangements for the management of the fishery resource on Lake Kariba are linked to the legislation governing the fishery resource. In order to effectively implement the enhancement and mitigation measures suggested in sections above and the monitoring program during operation the responsibilities have been established among various organizations involved in project implementation and operation as shown in Table 6. Lake Harvest has the primary responsibility for monitoring and reporting the achieved results to LKFRI. It can contract the ULKRS to serve as the institution for water quality analysis and data interpretation. Other external consultants within the University of Zimbabwe Department of Biological Sciences can also be involved if need be and in place of ULKRS for any technical assistance that may be required. LKFRI's main responsibility is to ensure that the proposed monitoring is strictly adhered to and for interpretation of the results to ensure that the Lake Kariba ecosystem is not negatively impacted upon.

f) Public consultations and disclosure requirements

During the preparation of the ESMP consultative meetings were undertaken with a broad spectrum of stakeholders in Kariba in order to obtain their contributions with regards to the envisaged impacts of the project and the mitigation measures that should be instituted. Stakeholders included the Municipality of Kariba, District Administrator, Tony Waite foundation, Roman Catholic Pre-school, Kapenta Producers Association, Eagle Engineering Company, Environmental Health Officer, Cutty Sark Hotel and MacMAster fuel depot Director and the Wild World Foundation (WWF) Director, the National Environmental Management Authority, Zimbabwe Parks and Wildlife Management Authority. Concerns raised by stakeholders are included in the mitigation measures. They included among others, compliance to effluent discharges into watercourses to ensure full functionality of the wastewater treatment facility. A few indirect businesses such as transport were also informed of the expansion plans and have already planned for the increase in the number of employees.

This ESMP will be disclosed in the ADB website for 30 days. LHA has also started an environmental and social impact assessment process for the full expansion to twenty thousand tonnes. This is because the existing ESIA was compiled in 1996. As part of the process, LHA will hold many meetings with the various stakeholders and new issues raised in the process will be included in this ESMP which will be a living document.

g) Estimated costs

Costs for implementation of the ESMP are estimated below and LHA is aware that they may change after completion of the ESIA. LHA also wants to implement continual improvement initiatives such as pre-treatment of factory effluent to trap the fat and such efforts will at the end of the day complement E&S initiatives. It is worth noting that some of the mitigation such as installation of settling ponds already exists. There is also some mitigation which will be the responsibility of parties outside of LHA and they are listed as external. All proposed mitigation measures have been discussed with the relevant parties and while LHA has no control on the timeframe, the symbiotic relationship between LHA and the parties will ensure that they are implemented.

Mitigation	Estimated cost (US$)
1. Establish effluent 'rapids' in ponds	**20,000**
2. Monitor feeding rates	**nil**
3. Fertiliser production from waste	**external**
4. Pet food production from waste	**external**
5. Relocation of dumpsite by the Muicipality	**external**
6. Installation of fat processing plant	**external**
7. Installation of fat removal system at the factory	**30,000**
8. Primary treatment of factory effluent	**10,000**
9. Incineration of protein waste	**6,000**
10. Installation of cages away from major rivers	**nil**
11. Daily collecting mortalities on the farm	**12,000**
12. Burning mortalities at the incinerator	**2,000**
13. Minimizing draining of ponds	**nil**
14. Separating the inlet and discharge points	**nil**
15. Feed on response to avoid overfeeding	**nil**
16. Practice regular flashing of ponds/tanks	**1,500**
17. Adjust feed chart in winter to avoid overfeeding and unnecessary feed loss	**nil**
18. Monitor feed for macro-minerals like phosphorus and nitrogen	**1,000**
19. Anchoring of cages on single point moorings so that waste will be distributed over greater area	**200,000**
20. Use of extruded feed to improve on digestibility and reduce the amounts of feed lost to the environment	**307,000**
21. Increase feed use efficiency by using high-quality feed that contains desired nitrogen and phosphorus minerals and by assuring that fish consume most of the feed offered	
22. Fallowing of area below cages to allow the breakdown of accumulated waste	**nil**
23. Apply appropriate feed type and size suitable for a specific stage of fish	**nil**
24. Install screens on all inlet and outlet points in the fish farm to minimize the escape of fry, juveniles and brood stock	**2,000**
25. Filter screens in fish farm shall be designed to retain the smallest life stage present	**nil**
26. Filter devices should be capable of screening all water	
27. Cages should be made of sturdy, non-corrosive material	**Part of cage construction cost**
28. Make thorough inspection of nets before they are deployed so as to avoid possible escapees from the cages	**20,000**
29. Put dual netting system in cages with outer strong predator net	**1,000,000**
30. Follow protocols when transferring, changing nets or harvesting fish from the cages e.g. use of fish boxes	**nil**
31. Divers or underwater cameras must periodically inspect cages for holes, rips and tears	**20,000**
32. Practise good husbandry	**nil**
33. Limit use of chemicals	

Mitigation	Estimated cost (US$)
34. Put bird and predator nets over ponds	**300,000**
35. Installation of a mini-water treatment plant	**500,000**
36. Road maintenance	**200,000**
37. Annual inspection of factory by NASSA	**nil**
38. Use footbaths and restrict entry to factory	**15,000**
39. Consider having a resident health staff	**nil**
40. Restrict expansion to currently leased area	**nil**
41. Install self-extinguishing lights	**20,000**
42. Assess phytoplankton, zooplankton and *L. miodon*	**16,800**
43. Assess benthos community	
44. Monitor water hyacinth	**External**
45. Monitor colonisation by *O. niloticus*	**external**
46. Monitor water quality at cages	**No additional costs**
50. Monitor water quality at ponds	**above**

h) Implementation schedule and reporting

All the mitigation measure above will be implemented during construction phase. However some monitoring will happen beyond construction for water quality. The ponds and the Lake will be monitored for Physical parameters of water including major cation and anions. Water quality monitoring and reporting will continue to be quarterly in Jan, Apr, and Aug for monitoring and Feb, May and November for reporting to LHA senior management. In addition to the water chemistry there will be (i) assessment of lake's trophic response to nutrient enrichment by assessing phytoplankton, zooplankton and *Limnothrissa miodon* biomass (ii) assessment of the response of the benthos community to sedimentation from cages (iii) water hyacinth monitoring and (iv) assessment of the extent of colonisation of *Oreochromis niloticus* in Lake Kariba to establish the short to medium term impact of the project. Once a year compliance against the ESMP and review of it will occur and the report submitted to AfDB as well.