NZAID Cook Island Marine Resource Institutional Strengthening Project (CIMRIS)

AQUACULTURE REPORT No 1.

Aquaculture Development
Aitutaki Marine Resource Centre

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1.0 SUMMARY OF WORK UNDERTAKEN

The CIMRIS Aquaculture advisor spent approximately two weeks (09 to 21 January, 2007) in the Cooks islands performing the duties and requirements as outlined in the TOR detailed in Appendix 1. The consultant spent the majority of this time in Aitutaki working with staff of the Aitutaki Marine Resource Centre. During this time period the consultant and staff undertook extensive training and capacity building programs which included the following;

- Successfully spawned two species of giant clams *Tridacna gigas* and *T. derasa* that have resulted in a successful larval and settlement phases. Two successive attempts to spawn a third species *T. maxima* were unsuccessful as no viable eggs were released.
- During the spawning cycle extensive hands on training and a capacity building program was initiated on all aspect of giant clam reproduction and spawning with all staff,
- Discussions on the management of water and aeration systems associated with giant clams,
- Discussions associated with tank management to maximise clam growth and survival through use of physical cleaning and use of herbivores.
- Site inspection and discussion associated with juvenile management associated with field growout systems,
- Site inspection and discussion associated with broodstock management and handling,
- Detailed assessment of the facility to provide a recommended refit strategy,
- Discussions and site inspection for the potential to cultivate milk fish in Aitutaki,
- Discussions and site inspection for the potential to cultivate hard corals in Aitutaki associated with several tourist operators, and
- Discussions on development opportunities for community base and/or private sector clam farming and linkages to the aquarium industry.

Major issues are detailed in the relevant sectors below.

2.0 WORK SCHEDULE – SUGGESTED

Below is a brief outline of a suggested work schedule for additional aquaculture capacity building and training inputs for the CRIMS aquaculture consultant. These inputs have been based on priority information provided to the consultant by MRD staff. Additional information is located in the relevant sector of this report and is tabulated in Appendix 2.

2.1 Hatchery Refit

The recommended hatchery refit (refer section 3.0) should be undertaken as soon as time permits. Assuming the refit recommendations are agreed upon and money is available it is realistic to assume it will take several months to complete the processes to secure the equipment and supplies and have them delivery and on the ground in Aitutaki.

Therefore it is suggested the next input for the aquaculture consult associated with the Aitutaki Marine Resource Centre should be to advise and work with MRD staff to physically undertake the refit of the facility. This should only be undertaken once all equipment/supplies and staff are available to work with the consultant. Several of the refit items (e.g. the deployment and construction of the workshop) does not need the consultant to be present, however there is merit in having the consultant on the ground during the design and development phase of these items and therefore this tasks should be included in the scope of duties for this position. It is expected that the refit will take about 3 weeks and should be scheduled for a time slot between May - July 2007. During this time period clams are not spawned and the facility can therefore be shut down for short periods of time to allow the systems to be refitted.

In addition to the refit requirements it is also suggested that the consultant conduct training courses for MRD staff associated with the management of juvenile clams in the hatchery and field sites during this input.

2.2 Hatchery – Spawning

The refit of the facility must be completed to allow the system to be fully operational several months before the next spawning cycle. This is a priority that must be attained.

The current hatchery manager and assigned staff are competent and show a high level of commitment to the culture of giant clams and a range of other commodities. To achieve the goals of the MRD and to maximize the production output, improved survival rates, facility maintenance and economic efficiency of the facility it is recommended that there is a need for additional technical capacity and training. It is therefore recommended that a series of continued training courses be undertaken to provide the additional professional skills required to develop this facility. These training courses should be based around the production of animals through the hatchery facility however needs to incorporate all areas of giant clam husbandry, including hatchery, nursery and field grows out sites (including broodstock maintenance) and commercial farm development.

Hatchery production of giant clams and other mollusc species in Aitutaki are restricted to late spring and summer months and therefore all hatchery/production training programs need designed around this time period. Therefore the next window of opportunity for the second giant clam hatchery production training program would be in between October 2007 – January 2008. It is recommended that at least two more 3 week training program be undertaken during this time frame. Additional consultant inputs should be decided upon at this time and may be required during this spawning cycle or postponed to the following year.

It is suggested that a giant clam production manual be written tailored for the production of clams at the MRD Aitutaki hatchery utilising the systems in place. This would incorporate hatchery, nursery and growout protocols. Current training manual available although applicable in content are not specific to the needs of the MRD facility.

The small scale production of algal grazing marine gastropod snails (trochus, turbo) should be a routine procedure at the facility. These animals are to be used to control algal growth the facilities tanks. Additionally the collection and subsequent usage of small algal grazing fin fish (surgeons) and the small species of sea hare should be managed for these purposes. The correct management of algal growth in clam tanks is essential to the long term survival and growth of clams. The management of algae is by the use of water flow, diligent cleaning and utilising algal grazers (this information would form part of the giant clam manual). These techniques should be included in all training programs associated with this facility.

2.3 Hatchery Staff

To attain the production output of giant clams and to provide additional facility space for research and development projects (e.g. milkfish, coral farming) it is the consultants opinion that current levels of staff are inadequate. The additional training of MRD staff in all aspects of culturing the animals as well as a full understanding of the requirements to maintain and operate the facility is required. It is recommended that the permanent hatchery staff compliment be increased to 3 full time staff with access to additional labour when required.

The current short term relocation of MRD staff from the central office in Rarotonga to the facility is commendable and should be a standard operational activity of the department. The more MRD staff skilled in aquaculture activities associated with the Aitutaki hatchery (same applies to the Penrhyn facility) the better management and operational systems can be attained. Access to assistance through part time and or causal staff (labours) to assist the hatchery manager and permanent staff to undertake major activities also needs to be developed.

2.4 Milkfish

Through discussions with MRD staff and the private sector there is considerable interest for the culture of milkfish both for domestic consumption and bait throughout the country. From discussions it is apparent that healthy reproducing stocks of milkfish are present within the Cook Islands and local knowledge associated with their capture (especially fry and juveniles) and their use is widespread. The habitats within the nation are diverse and there are ample locations in Aitutaki (only island assessed) to culture these animals

both within the water and on land. It is therefore recommended that the culture of milkfish should be explored through a development program.

There is a need for a capacity building and training program in all areas of the culture of these fin fish for the MRD staff and community/fish farmer. The training program will need to include the culture methodologies for milkfish utilising a range of growout production methods that will need to be tailored to suit the specific environmental conditions associated with the individual farms. This would include insitu farms located within lagoonal areas as well as land base areas associated with foreshore and man made structures.

There are three areas the consultant can assist MRD to develop milkfish.

1. Assist in the specific planning, design and implementing of the farms, some of which will require EIA and earthen works,

2. Undertake training and capacity building hands on programme for the culture of milkfish for MRD staff and associated community/private sectors insitu at the farm locations, and.

3. The development of a milkfish production manual that is tailored for the production of these finfish associated with the various potential environmental habitats available in the Cook Islands. This would incorporate sections associated with the wild collection of fry, transportation, nursery, growout and production protocols.

The exact timing of these inputs will need to be finalised and balanced accordingly with MRD staff commitments and farm developments. MRD needs to be aware of current staff levels and time available of staff to allow these important development issues to be addresses correctly.

2.5 Coral Farming

Through discussions with MRD staff and the private sector there is considerable interest for the fragmentation of hard corals. Primarily for the commercial tourism sector in Aitutaki and Rarotonga to instigate the rehabilitation of reefs associate with these operations. Additionally, cultured corals can be traded on the international marine aquarium markets. Therefore it is recommended that the culture of hard corals should be explored through a development program.

Lengthy discussions will need to be undertaken in association with MRD, environmental agencies, communities and the tourist operators before any coral culture should be undertaken. This should be coordinated by MRD with assistance when required from the CIMRIS project members.

There is a need for a capacity building and training program in all areas of the culture of hard corals for the MRD staff, community and tourist operator. The training program will need to include the culture methodologies for a range of species that are suitable for the environmental conditions associated with the individual sites. This would include insitu farms located within lagoonal areas as well as it could include land base facilities.

All coral farming should be developed through a nursery phase which in time provides a continued supply of corals to the operation. Removing a coral colony or a fragment and placing it in another part of the reef is not encouraged.

There are three areas the consultant can assist MRD to develop milkfish.

1. Assist in the specific planning and design (which may require EIA) of the coral programs with MRD, other government agencies and Tourist operators as well as overseeing the implementation of the farms and rehabilitation programs.

2. Undertake training and capacity building hands on programs for the culture of hard corals for MRD staff and associated community/private sectors insitu at the farm locations, and.

3. The development of a hard coral production manual that is tailored for the production of these animals associated with the various potential environmental habitats available in the Cook Islands.

The exact timing of these inputs will need to be finalised and balance accordingly with MRD staff commitments and farm developments. MRD needs to be aware of current staff levels and time available of staff to allow these important development issues to be addresses correctly. It is also recommended that private sector is actively involved in all aspects of this development program and need to contribute in terms of man power, equipment and monetary funds, whilst MRD should take on the role of trainer and advisor once staffs have been trained. There is the additional opportunity to involve community members to undertake the production of corals which are in turn provided to the private commercial sector thus creating a sustainable cottage industry.

Coral should not be cultured during high seasonal sea water temperature times and therefore summer most should be avoided.

2.6 Nation Wide Aquaculture Assessment

The development of one concise assessment document addressing individual islands within the nation's aquaculture potential should be considered. Currently, aquaculture assessments for individual species have been undertaken for some islands as well assessments have been undertaken for some islands incorporating a range of species, however there is a not definitive aquaculture assessment for the nation. It is therefore recommended that this be undertaken which would include a through assessment of past documentation, field sites and lengthy discussions with government agencies, island councils, communities and the private sector. The assessment should not be limited to the biology of these commodities but include marketing and financial risks and opportunities. This project could be undertaken within the CIMRIS project or in conjunction with there bilateral, multilateral or regional agencies. Data compiled can then be incorporated into the MRD aquaculture commodity development plans.

3.0 AITUTAKI MARINE RESEARCH CENTRE REFIT

The below information has been compiled by the consultant through lengthy dialogue with the Hatchery Manager (Mr Richard Story), Acting Director Inshore Fisheries and Aquaculture (Mr. Koroa Raumea), Senior Fisheries Officer (Mr. Ngereteina George) and hatchery assistant (Mr. Tuakeu Rio) under the guidance and advice from the Secretary of Marine Resources, Mr Ian Bertram.

The refit has been divided into sections for easy of interpretation and all alterations have been verbally discussed with the hatchery manager detailing the different options available with the final end product mutually agreed upon. The refit has been designed to replace old and or broken essential items required for both the hatchery and nursery phases of giant clam culture (as well as other commodities) and to redesign certain elements of the existing facility to increase its productivity and practicability.

The below list has been developed for consideration. Once the suggestions have been accepted it will require the hatchery manager to provide additional information on equipment required, much of which is associated with building supplies and staffing required to implement the refit and providing final costings. Specification associated with specific items required for the culture of giant clams has been included however costings will need to be finalised. Through discussions with staff it is believed much of the equipment required can be purchased through vendors in Rarotonga. However some specific items will be required to be purchased outside the nation.

Changes recommended to the system incorporate improved water delivery and filtration to the tanks and larval room and some alterations to the production processes associated with the culture of clams. All alterations have been discussed at length with staff. All alterations can be and should be constructed by the MRD staff under close supervision from the hatchery manager and consultant. The construction and implementation of these up grades should be an essential component of staff training and the consult feels it is imperative to be on site when the refit takes place.

The development of a unicellular algae laboratory and it associated water, aeration and power requirements are not warranted for the production of giant clams at this facility. The use of freeze dried algae is a considerably better economic and practical option, which has been successfully used in the past (new fresh product must be purchased). This can be complimented with the production of “green water” however tank space at the facility is limited to mass culture algae however this can be managed.

The development of a unicellular algae laboratory should be considered only if additional species of animals are to be cultured at this facility and at a high enough production requirement to warrant the expense. This could include pearl oysters, fish larvae etc however start up costs and daily running cost must be incorporated into the budget of the facility and provisions for the development of systems to services an algal laboratory will need to be very carefully assessed. Additionally, staff will need to be train and the allocation of at least one full time (24 hour) staff will be required.

The facility does not have a standby generator. Access to 24 hour reliable power is essential for the facility and therefore a generator capable of providing the power requirements of the entire facility should be considered. The generator will need to be

positioned on site in a location that will not be affected by storm and cyclonic weather conditions.

3.1 Buildings

3.1.0 Water Header Tank

It is recommended that the tank itself and its base be assessed by a qualified engineer to evaluate the structural integrity of both units. The current situations where sea water is leaking through the header tank wall, the floor and stand are unacceptable. Once this has been undertaken the assessments recommendation will need to be implemented. Assuming the structures are suitable for their purpose an internal PVC liner (2 mm) built to the exact specifications of the internal diameter of the head tank should be installed. If the engineer's evaluation is unfavourable then a new header tank and base may be needed or the system can be designed to be used without this system.

Items Required	
	2 mm PVC tank liner for header tank

3.1.1 Facilities Tanks

All fibreglass tanks (8 x 5 tonne and 5 x 1 tonne) need to be assessed for any ware and tear and be repaired using fibreglass as has been the practises of the facility. Once completed all fibreglass tanks should have new food grade gel coat applied to the internal surface of the tanks. The colour should not be white and it was agreed that the original lighter shade of gray is preferred. The outside of the tanks should also be repainted to increase the longevity of these tanks. Normal outside house paint is suitable. Equipment to repair the tanks and administer the gel coat and paint will need to be acquired.

Strengthen of the existing PVC central drain in all the 5 tonne tanks (8 in total) is recommended. The application of a circular piece of 5 mm plywood fibreglassed onto the bottom of the tank surrounding the PVC drain will be useful. The circular piece of wood (including a hole for the PVC drain) should be at a minimum 50 centimetres in circumference. This will provide support to the center of the tank and drainage system which will prevent past tank base cracking issues associated with the drains.

The two 5 tonne fibreglass tanks currently not in use (once the above mentioned items are undertaken) should be placed back into the system and utilised to further expand the carrying capacity of the facility. The two tanks need to be positioned to the west of the current cement raceways and circular tank configurations. This area will need to be built up with concrete bricks and backfilled to the same level as the existing tanks. Water delivery, water drainage and aeration systems need to be constructed (refer sections below for specifications). It is suggested the drainage pipes of each tank be discharged into the existing open concrete drainage ditch, thus reducing the work required to lengthen the existing drainage systems. In addition, three lengths of treated timber and additional shade cloth will be required to cover these tanks. Aeration can be acquired from the existing system, however new outlets will be required.

Shade cloth should be utilised on all tanks to reduced ambient light. The current system is workable however improvements using a wooden roof frame creating a permanent structure would be an advantage and should be designed to be removed when required (i.e. hurricane). 50 per cent shade cloth is suitable. Equipment to construct a permanent roof structure and additional shade cloth will need to be purchased.

Clear roof sheets should be purchased and periodically used during outside larval settling runs when raining. The sheet can be loosely placed over the top of the raceways and outside circular tanks to prevent rain water entering the tanks when veligers larvae are still swimming. These sheets should be stored and used for this purpose only.

The wooden walkways associated with the main drain should be rebuilt so as to run perpendicular to the tanks not parallel as they are. Much of the material required can be used from existing system. This alteration will provide a considerable sturdier working platform for all staff and visiting tourist.

Items Required	
	Food Grade Gel Coat – light gray in colour
	Plywood and fibreglass
	House paint exterior
	3 x Treated logs
	Shade cloth (50% minimum) x one roll
	Concrete bricks and landfill
	Clear roof sheets 10 length by 3 meters
	Additional wood for wooden walkways
	PVC fittings to access the aeration system for new tanks
	Equipment to undertake the above items (paint brushes, rollers, nails, tools etc)

3.1.2 Hatchery Building

The hatchery building should be used only for larval culture purposes and therefore all additional items (boats, mechanical tools, fuel, pumps, lawn mowers, PVC spares etc) should not be stored in this building (refer below for additional suggestions).

The facility requires a more structural formate to the daily operations which includes areas allocated for certain purposes. Fuel and oil based equipment should not be any where near the hatchery. Designated areas will greatly increase the effectiveness and practicality of the facility.

The hatchery building is suitable for the facility and remains in good condition except for several sections on the ground that has rusted. This rust will continued to degrade the structural integrity of the building. Concerns were raised to the structural integrity of these areas in hurricane conditions. Structural improvements should be considered from a qualified trade's person.

The collection of rain water off the roof of the Hatchery should be considered. The water can be used in the dry and wet laboratory areas as well as add to the general drinkable freshwater supplies at the facility. The location and size of the storage tank and its connection to the existing water storage facilities will need to be designed by the

hatchery manager and all associated equipment will need to be acquired. Much of the guttering is in place.

The deployment of insulation (bats) and a false ceiling throughout the building should be considered. This will greatly reduce the heat (directly affects water temperatures in larval tanks), prevents roof rust particles and debris from falling into the tanks and will assist in prolonging the life of the equipment in these rooms. It will also provide a much cooler working environment for staff and visiting scientist.

The current layout of the hatchery building is suggested to be redesigned to include an office (computer, phone, book shelves etc) and tourist information/ souvenir shop (this has always been there), a dry lab that houses the microscopes, provides freshwater, benches and laboratory equipment and the wet lab which houses the larval tanks. The alterations include;

3.1.3 Office

This room is situated to the southern end of the hatchery building (closest to the accommodation house). The room is currently used for the storage of a wide range of items that need to be removed and placed into the workshop/storage room building (refer below). The room needs to have all windows screened to allow air flow. The existing outside doors are working and some minor alterations to the windows will be required as well as security measures considered. This room should function as the facilities operational center housing all communications, files, reference material, desks and the like. It is also suggested that this would be a suitable location to house and display merchandise to be sold to the tourist (t-shirts, clam shells etc if the facility develops this) and be used as the central location where all tourist and tour operators report to before entering the facility. The development of colour brochures associated with the hatchery (goals, history etc) as well as other important marine resource information should be available. Refer section 4.0 for suggestions on value added income opportunities from the tourist trade.

The office would need to be repainted once all internal items are completed. The office has a false roof in place.

3.1.4 Dry Laboratory

This room is suggested to be located directly adjacent to the office. The room will require an internal wall to be constructed to separate it from the wet laboratory. The wall should be located were the roof bean is currently position and have at least one layer of concrete bricks on the bottom to prevent wall damage from sea water from the wet laboratory. The wall should have a window constructed to allow visual and verbal access to the wet lab and two doors one that enters the office (this is already in place) and another to the wet laboratory. It is suggested this door be erected on the east side of the building (same side as the existing door to the office). The widow in the new wall can be open, but situated at least 1 metre off the floor (the open area should have screen covering). A sliding glass window is also an option.

The wall to the west side of this area should have a window built (similar to the existing open windows in the wet laboratory) screened and have the wooden storm shutters

located to swing outside the building not inside as the current situation in the wet laboratory. Similar, the east side of this room should have the wall replaced and include windows. It is at this side a door opening to the outside should be constructed. The internal walls should have a number of shelves built and benches to allow the use of microscopes, general laboratory work and storage of equipment.

A freshwater wash basin (large) and freshwater delivery system should be built along the western side wall (below the windows). This should have direct access to freshwater collected off the roof.

A fridge to house items needed for the hatchery is an option (freeze dried algae, nutrients supplements, and serotonin etc), however not an essential item.

The dry laboratory would need to be repainted once all internal items are completed.

3.1.5 Wet Laboratory

This area is currently used for all larval rearing and should remain so. Additional windows on the east and west sides should be added (built as above) and a series of shelves positioned onto the walls should be included to store all equipment associated with larval rearing. All equipment associated with larval rearing should be used for this purpose only and stored when not needed within this area. All other equipment should not be located within this area. The position of the larval tanks are suitable.

3.1.6 Wet Laboratory Extension

Directly to the north of the wet lab between the existing end of the floor and tank base wall, a concrete pad should be constructed. This pad should cover the entire length of the existing hatchery building, slope towards a central open drain which discharges through the existing PVC pipe under the tanks to the facilities central drain. The current hidden pipe drain will need to be removed and replaced with an extension of the wet laboratory open drain. This extension should have a roof which can be either clear plastic roofing (reduced light variety) or shade cloth and associated structural equipment will need to be purchased for this. This area will act as a wet working area for all cleaning and preparation work required for larval and tank work.

A drying rack is needed to be erected (portable) and situated along the wall of the hatchery building.

The water delivery system to the hatchery should be changed. The existing 50 mm delivery pipe diverted from the main tank line is to be removed. The water is to be delivery (see section 3.2 water delivery section for additional information) to the east side of the hatchery building and run along the ground (on top of the new concrete pad) and be positioned on the outside of the eastern side of the building where it enters a series of three cartridge filters before being delivered into the wet laboratory via a 25 mm reinforced clear hose.

The existing aeration system is adequate and can be used.

3.1.7 Workshop/Storage Shed

A workshop and storage shed are required to house the mechanical, electrical and general aquaculture equipment. Currently these items are stored in the hatchery building and or outside.

It is therefore recommended that two shipping containers be purchased (freezer containers would be the better option) and place parallel to each other at the site approximately 12 meters apart. There should be a roof erected that covers both containers and the area in between. Each container will require a single door to be cut into the side facing each other as well as several windows that need to be made secure (mesh screens with close down wooded doors). The containers should be positioned on cement foundations that elevate the containers at least half a meter above the ground. Each container will require power and lights. One container should be used to house all the mechanical tools and other items required for the operation whilst the other container should house all other items such as PVC pipe fittings, filter base etc. The area between the two containers should be closed in on one side (shade cloth) and be used for an undercover work area for all field work construction of cages, repairs of tanks and so on.

3.1.8 Fuel Shed

A fuel shed should be erected to house all drums and container of fuel and oils. The current situation that fuel is stored within the hatchery building is unacceptable. This shed needs to be well ventilated, secure and be placed away from the water systems. The shed can be constructed out of a number of items and therefore is left up to the hatchery manager to decide.

3.1.9 Pump House

A new steel roof is required for the pump house. Guttering and subsequent collection of water from the roof should be considered.

3.2 WATER DELIVERY SYSTEM

The current water delivery system needs to be redesigned to maximise water delivery to the tanks. Improvements in the design of the system will reduce current water friction losses that are related to a number of bends and unnecessary complications in the system.

3.2.0 Pipe Line

The existing pipe line that currently deliveries seawater to the pump is fine. The second pipe line that has been buried for some time should be dug up (not easy job) assessed for damage and reinstalled to act as a backup water line. The 50 mm PVC pipes stored for emergency use in case of pipe line failure (due to storms) should remain.

The water intake line should be extended further out into the lagoon. The extension should be in the order of 30 meters and should be directly connected to the existing

system in front of the one way value. The extension should be undertaken in 90 mm high pressure PVC pipe.

The pipe line needs to be held in place by concrete slabs that are composed of two sections that when installed sit on top of one another and hold the pipe secure. The dimension of the individual cement slabs should be roughly 1 x 1 x 0.2 meters, with an indentation from a 100 mm pipe running through the centre of the slab that is used to secure the pipeline. The bottom slab should have 2 x 20mm lengths of rebar protruding (20-25 cm) from the top of the slab whilst the top slab should have two pieces of 25mm PVC pipe located within the slab that allows the top slab to sit onto the bottom slab with the rebar placed inside the PVC. This is designed to prevent from sliding past each other.

A slab should be placed onto the pipe line extension every 3 meters. The slab should be positions onto of the PVC joins to add additional strength to the joints and wedges of hard wood should be placed into each end of the slabs to hold the pipe still. The pipe should not move around otherwise damage will occur.

The end of the pipe line should be made out of a 90 mm PVC high pressure pipe place onto the end of the pipe line via a (male and female) screw fitting. The PVC intake pipe should be approximately 1 meter in length with numerous (as many as possible) 1cm holds drilled to maximise water intake. The end of the pipe should be closed with an end cap and likewise have a number of holes drilled in the end. Two of these should be made up so they can be replaced regularly and cleaned.

Items Required	
	One way valve for 90 mm
	6 length of 6m 90 mm PVC high pressure
	2 x male and female screw fitting 90 mm pressure pipe
	2 end caps 90 mm PVC high pressure
	20 mm rebar 1 x length
	25 mm PVC high pressure 1 length
	PVC glue and associated tools
	Cement/aggregate and wooden frames
	Drill and drill bits

3.2.1 Filtration

The facilities water intake location is suitable. The area is subjected to relatively strong tidal currents and surges. During periods of high energy (storms action) turbidity levels greatly increase. The suspended sediments are derived directly from the reef (calcium carbonates). These increased levels of sedimentation need to be managed. The extension of the pipe line from its present location will contribute to less sediment in the intake water however there is a need for a sand filter to be put on line before the main pump to remove the larger size particles. It is therefore recommended a sand filter (filters to 200 microns) that can process the required amount of water be installed just in front of the water pump house to the east of the main systems central cement drain. The sand filter needs to be placed on a concrete slab (which should be slightly elevated above the ground) and plumbed to minimise bends and fittings which increase friction and reduce water flow.

For all 90 degree bends the longer sweeping PVC bends should be used or the utilisation of two 45 degree bends with a short length of PVC pipe in between. The latter will be a cheaper but a less effective choice. This system will be utilised for all changes associated with the water delivery system. All PVC pipes and fittings associated with the water delivery systems must utilise high pressure PVC grade.

Similar, the two blue cartridge bag filters currently installed into the water system after the pump are suitable, however should be used to filter the water to 100, 50 or 25 microns in the appropriate sequence. It is therefore suggested that the first of the two filters utilised a 100 micron filter bag whilst the second utilise 50 microns. In cases of heavy sedimentation and/or specific use the bags can be used in different combination to maximise water filtration and flow (e.g. 50 and then 25).

These filters are to be moved from their current location and reinstalled utilising the above mention 90 degree PVC protocols on the front of the pump shed facing the tanks (refer next section).

Items Required	
	Sand filter (200 micron)
	PVC fittings
	Filter bags for the blue filters 100, 50 and 25 microns fifteen of each

3.2.2 Pump and Associated PVC Fittings

The current water delivery system and it management needs to be improved. Maximising water delivery and flow through all tanks is imperative to obtaining maximum growth and survival rates. It is clear from past mortalities and current growth rates that water flow and its delivery to the facility (management) needs to be improved. The aim of a hatchery is to maximise growth and survival as fast as possible whilst balancing costs and man power. The current water exchange rates based on the time the pumps are operating associated with the head tank is not achieving these goals.

Changes to the delivery system of the water as mentioned in this document will allow increased water delivery to the tanks, however if all tanks are used there is an need to operate the existing pump for a minimum of 7 hours to provide the water exchange required assuming all tanks are used. Reduced number of tanks will allow a proportion of the water to be sent to the header tank for storage and later use. If all tanks are operating additional pump time should be used to utilise the head tank.

To reduce cost of the facility the regenerative blower could be turned off periodically in the tanks when water is flowing. However aeration should be used when no water is flowing unless it is raining (freshwater sits on top of salt water) and therefore with water exchange can be removed from the tank via surface drainage.

The below figures have been designed to provide two complete water exchanges each day when all tanks are utilised. Therefore, for the current configuration of tanks as described below the system will require 145,600 litres a day. This breaks down to 6,066 litres an hour or 101 litres a minute or 1.68 litres a second.

Added to this is the periodic requirements of the hatchery which utilises a stead flow of water during operations and any additional programs that maybe undertaken (i.e. the larval fish project). Therefore the figure of 2 litres minute is used for the requirements of the facility.

Current water requirements

6 concrete raceways at 6000 litres each (1.4 x 0.65 x 7.2 m) = 36,000 litres
8 fibreglass nursery tanks at 4600 litres each (3.5m dia x 0.5) = 36,800 litres
5 fibreglass hatchery tanks at 800 litres each = 4,000 litres

Total water requirement for the nursery raceways and fibreglass tanks is 72,800 litres, total requirement for the hatchery tanks is 4,000 litres.

Current water flow rate from the existing pump was worked out to be delivering 6 litres a second whish is more than required for the facility.

A back up pump must be available at all times. The pump should be identical to the main pump so it can directly replace the existing pump and fit the plumbing system. Therefore an additional pump should be purchased and stored away from the pump house (preferably somewhere away from water damage caused by storm events). Additional impellers should be purchased for the pumps. The facilities in the past has lost pumps due to hurricanes and therefore by not placing the spare pump in the pump house both pumps can not be destroyed at the same time.

The water delivery set up exiting the sand filter and the delivery to the pump through the pump shed wall should remain the same. However, an additional hole through the pump house wall maybe required to accommodate the new position of the new pump. The new pumps should be lifted off the ground in the pump house (minimal 15 cm) and firmly secured to the ground to prevent vibrations.

The reduction of the water intake line from the existing black poly pipe to PVC to the size required for the sand filter (most likely 50 mm) should remain the same and enter the pump house. Sweeping 90 degree elbows should be used to deliver the water into the pump. The sand filter therefore should be located as close as practical to the front of the pump house.

The current PVC water pipe delivery system from the pump to the header tank and tanks (raceways and circular) needs to be replaced and streamlined to remove a number of bends and constrictions in the system.

The water discharging from the existing pump and any new pump should exit the pump house wall on the same side as it enters (i.e. the side facing the circular tanks) through sweeping 90 degree PVC bends. The inclusion of a 30 cm length of reinforced black hose between two pieces of 50 mm PVC existing the pump and held in place with stainless steel clamps to reduce vibrations from the pumps and subsequent damage to the PVC fittings should be used. The water then should be directed through the two wall mounted blue cartridge filters utilising the sweeping bend as mentioned above to run along the ground in front of the header tank to end in a sweeping 90 degree bend to deliver the water to the existing PVC systems to the facility. In this line two “t pieces” are

to be placed. A new pipe to deliver water directly to the top of the header tank (replaced the existing system) and the second to connect up to the existing PVC tap and system entering the base of the header tank (this pipe will need to be rearranged in the header tank to accommodate the liner).

The water delivery system for the raceways will remain as it is. However the water delivery system for the circular tanks is to be changed. The existing water deliver system needs to be removed (currently over head) and replaced on the southern side of the circular tanks. In this way the majority of the existing water system to these tanks can be reused. Water will then enter the circular tanks from the ground through individual taps. The existing PVC 50 mm "t – piece" that currently delivers the water to the circular tanks is to be used to channel water to these tanks. A ball valve needs to be installed at the beginning of this line which will run along the ground to the end of the tanks to a sweeping 50mm bends to be connected to the PVC pipes delivering water to the tanks.

The two unused circular tanks need to be placed back into the system (refer above). The water delivery systems for these tanks will come from the circular tank line and an extension of the water delivery line from the raceways. The drainage system from each tank will be delivered into the existing main concrete drain.

A "t-piece" will be placed into the water delivery line between the second and third circular tank to deliver water through a 50 mm PVC high pressure line to the front of the hatchery building. A ball value will need to be put in this line and two sweeping bend are required to deliver the water to the outside of the hatchery wall on the eastern end of the building. The water then is channelled through three in line cartridge filters (25, 10 and 1 microns) that are positioned onto mountings on the outside wall and into a 10 meter length of 25 mm reinforced plastic tube which delivers the water to the hatchery. The cartridge filters are to be designed so that the housing can be removed from the system, to be cleaned and stored when not in use.

Items Required	
	6 lengths of 50 mm high pressure PVC
	PVC glue
	PVC fittings
	3 cartridge filters and associated connection fittings
	Cartridge filters 25, 10 and 1 micron twenty of each item
	10 meter roll of reinforced 20 mm clear tubing
	Stainless steel clams for pumps, small cartridge filters
	30 cm length of reinforced high pressure hose

3.3 Drainage System

The current drainage system for the raceways and circular tanks is fine, however periodic cleaning would be appropriate. The altered drainage system proposed for the extension of the front of the hatchery building will expedite the discharge of water and allow a considerably better wet working area (refer above).

3.4 Aeration System

The basic design of the aeration system is adequate for the facility. The current regenerative blower is old and a replacement should be ordered. The current model is a 1 hp (3 phase) the replacement blower could be the same, however if further expansion of the operations of the facility are expected, especially if smaller individual aeration is required then 1.5 hp unit should be considered. Improvements in the PVC fittings directly associated with the blower discharge should be improved, removing the length of the smaller pipe size to a minimum.

PVC fittings and taps currently utilised for the aeration system should be purchased. Additional black and clear airline tubing should be purchased with the diameter suitable for the existing air stones. No additional air stones are required.

3.5 Hatchery Fittings

The hatchery facility requirements and some equipment has been addressed in the above sections, however there are a number of items that need to be purchased to allow the hatchery to function efficiently and effectively. This includes;

Microscopes.	The low power Olympus microscope needs to be professionally clean. Currently fungi are visible on several lenses inside the unit. Similar, the high powered Olympus microscope has a faulty light system and requires a professional service. Both microscopes should remain at the facility once the dry laboratory has been built. There is a need for a desk lamp to be purchased to be used in associated with the low powered microscope.
Plastic Tubs	The purchase of 6 white nally bins (hatchery use only) and 5 coloured nally bins (farm work) plus lids are required (the consultant left one blue nally bin at the facility). 6 larger plastic buckets should be purchased (UV resistant plastic).
Plastic Wares	Assortment of graduated containers and cylinders are required (ranging from 100ml – 2 litres). Plastic pipettes, 1, 2 and 5 mls required.
Cleaning Items	Scrubbing brushes, brooms etc
Glassware	Microscope depression slides, slides cover slips, haemocytometer for counting algae.
Syringes	2 and 5 ml plastic syringes are required with needles for administering serotonin. The large stainless steel needles are fine.
Plastic reinforced hoses	25 mm and 15 mm lengths of reinforced plastic hose are required. At a minimum 15 meters of each is required.
Chemicals	Another bottle of Serotonin should be purchased.
Algae	Freeze dried algae needs to be purchased. Current supplies are very old and almost finished.

4.0 VALUE ADDED OPPORTUNITIES – TOURISM

The Aitutaki hatchery has been incorporated into “things one must do” when in Aitutaki for both domestic and international tourist, with almost daily visitation from individuals to organsied groups. This adhoc arrangement provides an interesting opportunity for off islanders to witness a unique and interesting program which if developed correctly could provide a mechanism to highlight the importance of the management of marine resources, the goals and activities of the MRD and to generate additional operational income for the facility.

To achieve this there is a need to up grade the facility to accommodate additional information exchange to the visitor both verbally and visually. Improvements in;

- Tourist guides knowledge of the facility, its goals and MRD overall activities.
- Additional tank space allocated to provide a diverse array of marine life, which would include the turtles, representative of all giant clams cultured at the facility and different sizes, sea cucumber, algal grazing fish and the like,
- Access to coloured information handout and pamphlets highlighting a wide range of MRD activities, Cook island laws, marine protected areas and history of the clam project,
- Access for the tourist to purchase items (e.g. t-shirts, clam shells etc) and/or donate to the facility.

The development of this would require a professional who specialised in this field.

5.0 FIELD SITE

The facilities field site is suitable for the culture of giant clams. The shallower water cages are providing faster growth rates however are more prone to damage during storm events. Careful management of these systems will produce the best growth and survival rates. Gastropod snails and to a lesser degree fish cause constant mortalities if the growout farm is not managed. The current cages utilised to culture clams are adequate, however sturdier versions could be made. During storm events cages are damaged resulting in high mortalities due, in most cases to the cage itself being flipped.

It is therefore recommended that all new cage bases be constructed out of a thicker grade of rebar and welded together to provide a much sturdier platform than currently used. This cage base can then be sunk into the lagoon bottom and anchored with cement blocks to provide additional strength. The cages need to be securely attached to the base.

As the production from the hatchery increases the need for additional growout cages will increase (assuming mortality rates are controlled). There appears to be enough cages and/or material available to make cages to culture the required number of juveniles however additional rolls of the uv-resistance black poly mesh utilised as a base on these cages is required. Similarly, the addition of stronger rebar is required. All associated cleaning materials and snorkelling, dive gear will need to be assessed.

6.0 APPENDICES

Appendix 1. TOR for the Aquaculture Advisor.

In conjunction with the Director of the Inshore and Aquaculture Division, Senior Fisheries Officer, Aitutaki, and MMR staff counterparts:

Task 1 Work with MMR to develop skills in hatchery techniques for spawning and on growing of certain species including the giant clam.

Task 2 Identify requirements including modifications/ additions at the Aitutaki hatchery that will improve results for spawning and rearing of identified species.

Task 3 Identify the skills required to establish commercial giant clam production by the private sector.

Task 4 Determine gaps in knowledge and research and information required for future aquaculture development.

Task 5 Work with MMR to develop a program of training, hatchery development and industry development planning to progress aquaculture in the CI.

Appendix 2. Summary of the suggested inputs, timing and duration for the Aquaculture Advisor.

TASK		OUTPUT	TIME	DURATION
1. Hatchery Refit	▪ Facility refit ▪ Train/capacity building juvenile management tanks and field site	Physical up grade of facility and clam management during winter months.	May – July 07	One Input 20 days in country
2. Giant Clam Spawning	▪ Train/capacity building giant clam spawning (all species) ▪ Hatchery management	Staff training in giant clam culture protocols	Oct –Jan 07 and 08	Two Inputs 20 days each in country.
3. Giant clam Culture Manual.	▪ Production of a site specific Giant Clam hatchery and growout manual	Manual	To be determined	One Input Desk Study 10 days
4. Milkfish	▪ Assist MRD to plan, design, construct and implement milkfish farms. ▪ Train/capacity building on milkfish farming for MRD and private sector	Staff/ private sector trained in all aspects of milkfish culture protocols	To be determined	One or more Inputs 15-20 days each
5. Milkfish Culture Manual	▪ Production of a site specific milkfish culture growout manual	Manual	To be determined	One Input Desk Study 10 days
6. Hard Coral Culture	▪ Assist MRD to plan, design, construct and implement coral farms. ▪ Train/capacity building on coral farming for MRD and private sector	Staff/ private sector trained in all aspects of coral culture protocols	To be determined	One or more Inputs 15-20 days each Aitutaki and Rarotonga
7. Coral Culture Manual	▪ Production of a site specific hard coral culture growout manual	Manual	To be determined	One Input Desk Study 10 days
8. Nation wide Aquaculture Assessment	▪ Undertake an assessment with financial advisor of all islands aquaculture potential. Requires desks to reviews and site visits.	Development report	To be determined	One Input Desk top and in country Duration to be determine on scope of works