Disasters, Vol. 3, No. 4, pp. 461-467.
Pergamon Press Ltd., 1979. Printed in Great Britain.

Disaster Technology

Survey on Water Supply and Sanitation for Pulau Bidong

INTRODUCTION

Almost 42,000 refugees from Vietnam are at present housed on the previously uninhabited island of Pulau Bidong, situated 14 km from the closest point of the mainland of Malaya. The nearest port on the mainland is Kuala Trengannu, which is approximately 26 km from the island.

The island is roughly circular with an area of approximately 3 km^2 and a central elevation of 320 m. The slope all over the island is, therefore, steep, with only 30 ha of relatively flat land in the south. It is covered by forest except for the steepest points along the water's edge, which are bare rock. Because of the slope of the land and the nature of the rock the only water sources consist of a few small streams in the flat area mentioned above.

In view of the large number of refugees and the concommitant lack of space, and the lack of any water resources or sanitary facilities, the UNHCR asked a team of experts to go out and assess the situation.

WATER SUPPLY

Present water supply

Water supply is brought in from the mainland by a water barge which is towed by a tug. Presently 15 barge-loads per month are supplied to the island. There are two barges, each having a capacity of 460 m^3. The total water delivered to the island thus amounts to 6,900 m^3 per month. This water supply is augmented by some shallow wells which have been dug by the refugees to exploit the groundwater. The amount, however, is negligible.

The water which is transported to the island is supplied by the Kuala Trengannu town water supply. On the island, the water is pumped by the barge pumps to the land through a 2 in. hose which is kept afloat by some oil-drums. It is fed into fibre-glass tanks of a capacity of 1.8 m^3 (400 gallons) each from where it is taken by the refugees in buckets.

The filling of a barge takes 10 to 11 h, the journey 5 h, and discharging about 12 h. Because two barges are used, turn around time is somewhat reduced and adds up to 22 h: 5 h trip, 12 h discharge, 5 h trip. This, however is adversely affected by two factors. The loaded barge cannot leave the harbour at low tide, because of a sand bar off the coast and because unloading on the island is presently done only during daylight hours.

At present some water tanks (sectional steel) are being erected on the island to increase storage, because under the present system any breakdown or operational failure will cause an immediate cessation of supplies to the island which would create a disaster. These 5 tanks will have a total capacity of 1100 m^3. Two tanks of 229 m^3 each are being installed on the beach of zone C and three of the same capacity near the jetty in zone A.

Island water resources

Several proposals have been made to develop the water resources of the island itself. As has been described, some small streams exist on the south-east side of the island. These are fed by the shallow ground-water, which is stored in the weathered zone of the granitic rock. Unfortunately, however, the rock of which the island is made up has practically no pore-volume beneath the weathered overburden except joints and fissures, the total water holding capacity of which is very limited. Moreover, because of the steepness of the island most rainwater drains off rapidly, as does water percolating into the weathered material. This means that the only source of groundwater is restricted to the small flat area which is presently occupied by the refugees. The water is at a depth of 1 to 4 m below the surface, depending on the elevation of the well above sea level. Wells have been dug into the overburden until the hard, unweathered material was reached. Seepage into these wells is very limited. Even with the very small rate of abstraction they are frequently emptied and the refugees have to pause to allow the water level to rise again. From all this, it can be concluded that groundwater resources are so limited that there is no scope for further development. Moreover the extremely dense population on the only possible source poses a grave health hazard. The groundwater is only some 1 to 4 m under the surface and waste water is discharged into open, unlined channels and the little streams mentioned above. This means that there is a very high danger of polluting

this water, especially in the rainy season, when vertical percolation takes place.

The same topographical features, mainly the steep and rocky nature of the island also makes any other surface water development e.g. water catchment impossible. There is simply no valley that could be dammed up, nor could rainwater be economically collected and stored.

Alternatives to present supply

From the above description of the resources of the island itself, even though these assumptions cannot be backed up by quantitative figures, it follows that there is no possibility of increasing and developing water production from resources on the island. It follows that water will have to be *imported* to sustain the refugee population. There are two methods which are technically feasible – to ferry water in from the mainland or to desalinate seawater. Both methods and their advantages and disadvantages will be discussed below.

(1) *Desalination.* Desalination of seawater is widely used on ships, drilling platforms and similar installations. While earlier technology made use of a distillation process to separate fresh water and brine, newer technology uses the reverse osmosis process.

The obvious advantages of desalination are: the source is unlimited and a desalination plant on the island would make it independent from the mainland -- as far as water is concerned. However, there is a serious disadvantage, in that the technology is relatively sophisticated and any breakdowns of major components cannot be remedied without outside help.

Of the 2 suppliers so far approached, it is known that delivery times are at least 6 months, which means that the plant could be ready for installation in December if a purchase order is made immediately. This again would mean that transport to the island and installation would have to take place at the peak of the monsoon season, which will make it a very difficult operation. Moreover, the equipment is heavy. In an offer a German firm has stated that the plant can be dismantled so that no individual part weighs more than 2 tons. The island jetty cannot take such a weight and there is no possibility of getting closer to the shore with a barge because of the shallow water.

Finally, even if the decision was taken to install a desalination plant, the present supply system would have to continue and be improved for at least another 7 months and even then a back-up system would be necessary to supply water from the mainland in case of breakdown of the desalination plant.

(2) *Improvement of present system.* The present system has one major draw-back, in that during the monsoon it is often not possible to leave the river mouth at Kuala Trengganu because of breakers. This, and the possibility of mechanical break-down, could interrupt the water supply for several days. Other problems, such as the rather low capacity due to the long turn-around time, can be remedied, as will be discussed below.

The main advantage is that the present water transport system has so far been effective in keeping 40,000 people alive and any technical problems can be locally solved. It is therefore the opinion of the survey team that the present system of water supply should be retained, but considerably improved. A prerequisite for both alternatives outlined below, which could both fail for several days, is to increase the storage capacity on the island. It is thought necessary to have a water supply on the island for a minimum of 1 week. If the present ration of 5 l./person/day is taken as a base the total storage capacity required would be approximately 1,500 m^3. Since tanks holding 1,100 m^3 are already under construction (see above) storage tanks holding a further 400 m^3 should be built. However, utilization of the planned increased storage capacity is, at present, not possible because all the water brought to the island is used immediately – there is no surplus for storage. It is therefore necessary to improve the performance of the present system. The main factor which slows the operation down is the long loading and discharging time of the barges. Therefore, provisions are now being made to cut down on these 2 times. It is technically feasible to both load and discharge the water barges in 4 h. This would reduce turn around time to 14 h (2 trips of 5 h, unloading 4 h) and would give the whole operation much more flexibility. In discussions with the local authorities in Trengganu, it has been agreed that they would take care of the technical alterations which are necessary on the loading point. The shipping company will do the same for the water barges as soon as a better discharging system has been installed on the island.

The local authorities have also agreed to allow loading at the increased speed during 9 h, from 9 p.m. to 6 a.m. when the demand on the town water supply is lowest. Moreover they agreed that 1 barge daily could be loaded if necessary.

Proposed water supply system

As already mentioned the installation of additional storage of about 400 m^3 on the island is a prerequisite for any option taken. It is therefore proposed to install 2 more tanks of 229 m^3 each and use these as the keystones of an integral water supply system. Since there is no room left on the beaches, they should be positioned on an elevated site. Thus they could be used to feed water by gravity into the different zones of the refugee camp.

The best site for these tanks would be 'Temple Hill'. However, in that case some buildings may have to be removed. If that is not possible, the tanks would have to be installed on a hill flank next to zone G. The disadvantage of this site is, that the only place where these tanks could

be installed is about 50 m high. They would therefore require additional pumps to fill them and pressure reducers for the water main. Furthermore, the distribution system would be much longer and costlier. Both alternatives are briefly described below and further explained in two sketches. These are only meant to be a schematic diagram and are not to scale.

Alternative I (storage on Temple Hill). Water is fed from the barge through two flexible 4 in. hoses into a 6 in. galvanized steel main which is attached to the jetty. This 6 in. main discharges into one of the water tanks at the beach near the jetty. The three tanks at that site are connected by 4 in. pipes, each fitted with a valve. From these the tanks on Temple Hill are filled by a diesel-driven pump through a 6 in. main and the tanks on zone C beach are fed by gravity from Temple Hill through another 4 in. pipe. This basic lay-out would already represent an enormous improvement to the present conditions. A further improvement would be to feed water through a distribution main (4 in.) from the tanks on the hill by gravity through zone B to zone C. In this way 3 distribution zones could be arranged. Zones A, E and G would get their water from the tanks near the jetty. Zone C would be supplied from the tanks on zone C beach and the gravity main from Temple Hill would supply zones B, D and F. Equipping the 3 distribution points with water meters could be a very effective way to control and ration water should the need arise.

A diagrammatic sketch is shown on Fig 2.

Alternative II (storage on zone G hill). The main disadvantages of this solution have already been mentioned, namely the limited space and difficult construction on the steep hillside and the relatively high water pressure which would require a more complicated distribution system. Furthermore, for this alternative the water tanks on the beaches of zones A and C would have to be connected by a 6 in. main. As in the previous alternative the water would be discharged into the zone A tanks. From there it would be lifted by a diesel-driven pump to the tanks on zone G hill. Zone C tanks would have to be connected to the hill tank. Several possibilities exist for the distribution of water. One would be to go directly through the camp from the hill tanks by using a pressure reducer. Thus zones G, E, B, D and F would be served by distribution points from this main and zones A and C would be served from the beach tanks. Another possibility would be to follow the proposed seawater main around the contour of the hill flank and to feed water into the different zones by 2 in. branch lines.

The cheapest, most easily installed, technically simplest and therefore most foolproof solution is, by far, alternative I. Therefore the necessity should be negotiated with the leaders of the religious communities to make land available for these important tanks (roughly 150 m^2 would be required).

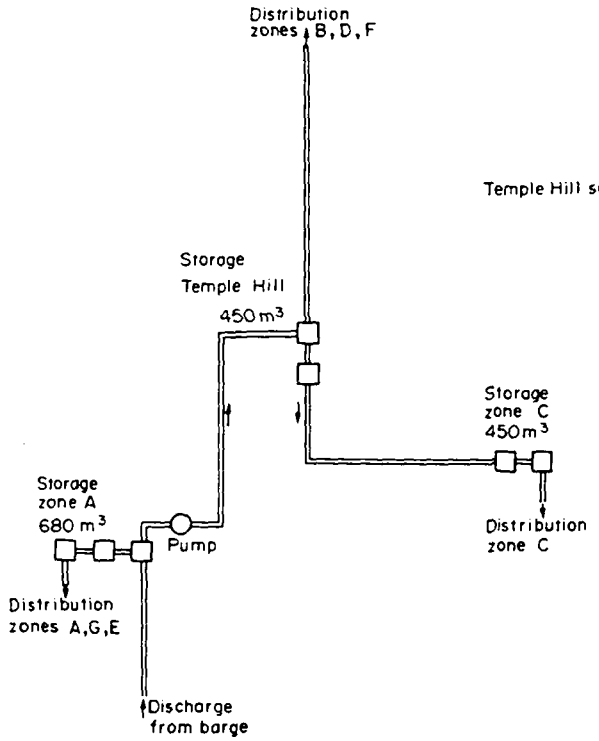

Fig. 1.

To sum up, each alternative requires an improved discharging system from the barges. This would be a 6 in. steel pipe installed along the jetty feeding into one of the tanks on the zone A beach. Water should be pumped from the barges through 2 flexible hoses connected to the proposed main along the jetty. Two heavily anchored mooring points should be provided parallel to the jetty to allow secure anchoring of tug and barges for unloading in the monsoon period.

Cost estimates

It is not possible to cost any of the alternatives, because no definite lay-out can be made at the moment. The main reason being that there is no map on which to base a lay-out and to estimate quantities.

The very rough price estimates for the two alternatives add up to approximately M$350,000 for the Temple Hill solution against M$590,000 for the zone G hill solution. The desalination plant alternative comes to roughly M$3 million.

Running costs cannot yet be estimated, because the contract for increased shipping of water has yet to be negotiated. Apart from that, the running costs will mainly consist of transport and consumption of diesel fuel to drive the pump for the storage tanks.

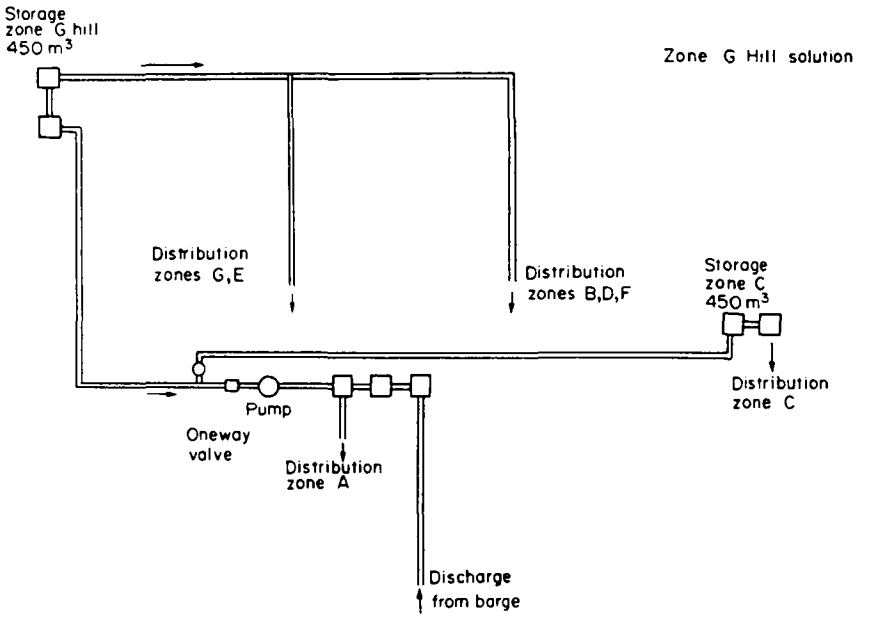

Fig. 2.

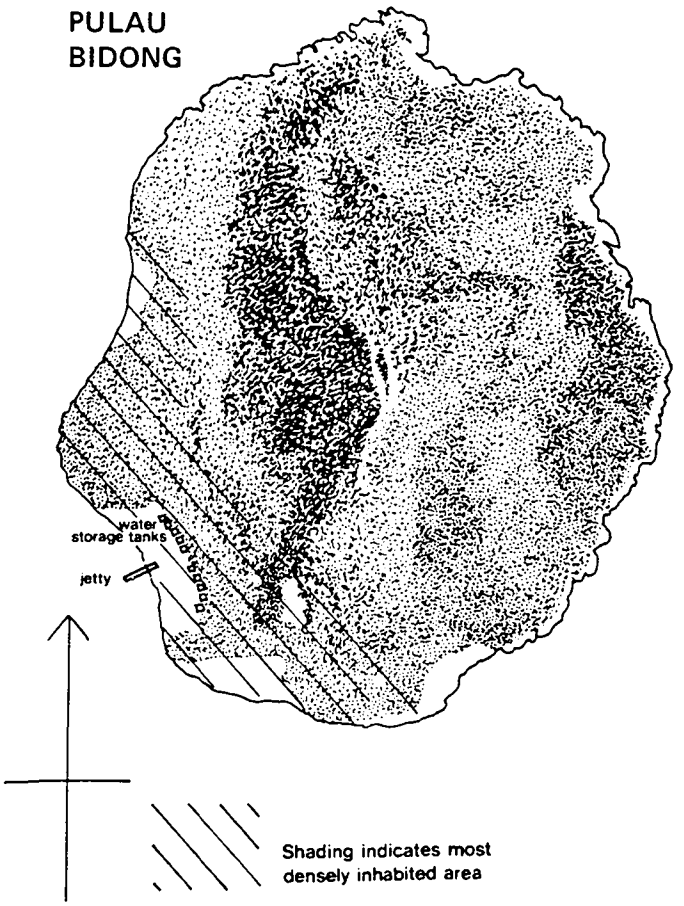

Fig. 3.

If one wishes to calculate running costs of the desalination plants, one has to consider not only the running costs as cited in the offer of the German firm (approx. M$200,000 p.a.) but also the costs of a standby back-up system should the desalination plant fail. It has also to be kept in mind that a desalination plant can most probably not be delivered to the island within the next 7 months. Therefore any calculation has to incorporate the running of an improved shipping service for at least 7 months.

Conclusions

The following conclusions have been reached by the survey team.

1. There are no water resources on the island which can be developed.
2. A seawater desalination plant should not be installed because of the long delivery time and the problems of keeping it running without guaranteed service by a local company.
3. The present system of bringing water to the island by barge can be considerably improved by speeding up loading and unloading of the barges.
4. Added storage of water has to be installed immediately to ensure a water supply for 7 days on the island.
5. All tanks have to be interconnected to have an integral storage system and to have only 1 discharging point for the water barge.
6. The alternative of installing fresh water tanks on 'Temple Hill' should be considered as the cheapest and technically most feasible option for the water system.

7. If the 'Temple Hill' solution is not possible the tanks will have to be installed in the flank of zone G hill.
8. Simple distribution lines are to be laid out to supply the various zones of the camp. These are to be metered to allow for rationing, if necessary, and for fair distribution,
9. All main storage tanks are to be fenced off to prohibit any unsanctioned drawing off of water.

SANITATION

Present situation

Organized sanitation arrangements on the island are non-existent and therefore the 42,000 people are daily promiscuously defecating along the two or three usable beaches and on every available headland area and in the sea itself. The sea along these small beaches is massively polluted with raw and decomposing excreta and this continuing and growing build-up of pollution has fouled these important landing and service points to the island. The sea at these beaches is black with filth.

The situation therefore is one of extreme danger to the health and lives of the refugees and epidemics of diarrhoea and more serious gastro-intestinal diseases are *inevitable* under the present conditions. It is of paramount importance that the earliest possible actions to be taken to alleviate the present insanitary conditions *by any degree possible.*

Immediate sanitary actions

As a first step the camp committees should be supplied with basic hand tools such as shovels and pickaxes to enable them to make some attempts to organize the disposal of the daily output of excreta, mainly by burying the material in the beaches or suitable land areas in as systematic a way as possible.

The first requirement is therefore the immediate supply of 500 shovels and 200 pickaxes for this purpose. There are indeed limited possibilities for disposal in this way due to the restricted land and beach areas available for such a purpose – nevertheless everything practical using the burial technique should be tried. These hand tools should also be used for cleaning and deepening the existing surface drains. Also a motorized boat should be arranged and used to transport daily collections of loose excreta from the beach areas for dumping into the sea clear of the island.

This sea dumping is not a suitable system of disposing of the plastic bags used by many families which are filled with excreta and then carried away from their homes for disposal (these plastic bags are initially provided with the food rations). These fouled plastic bags, if thrown into the sea will float for long periods and will cause much disgust and annoyance to the mainland population.

Main sanitation plan

These then would be the first sanitation measures to be undertaken while the main sanitation proposal is for a comprehensive temporary sewerage disposal system to be installed on the island as quickly as possible.

In this context several preliminary schemes have been prepared and considered, and we are agreed that under the present circumstances the following proposals are the most appropriate.

Because of the temporary nature and great urgency in this matter, in addition to the severe physical and topographical constraints, the sewage system must essentially be of light weight materials – quickly erected – and using materials available in Malaysia as far as possible. A construction time of 8-10 weeks should be the target time – and it is essential that the work is completed before the onset of the monsoon period in October.

Sewage disposal

Owing to the lack of fresh water and available land area on the island, treatment of sewage before disposal into the sea is impractical – therefore the plan is to discharge the collected sewage directly into the open sea from an outfall which will be so sited as to prevent the fouling of the beaches and the avoidance if possible of visible floating solids. The site known as 'Back Beach' is the best location for this sewer outfall.

Use of seawater

With unlimited sea water available it is intended to use this resource to the full. It is planned to pump considerable quantities (say 150,000 gallons per day) to a high level sectional steel storage tank of 50,000 gallons capacity which would command the overall housing area. This water would then be piped across and above the housing sites in conjunction with an above-ground sewer which would traverse the island and discharge into the sea with an extended outfall.

Both the seawater supply from the storage tank and sewer pipes will flow by gravity. The seawater will be used for flushing toilets and transporting excreta out to sea; and also for personal bathing and washing. At regular intervals along the supply pipe fire fighting points will be provided. In addition the seawater supply will be used for flushing the surface drains which presently run across the camp area and which are very foul.

Toilet blocks

Located along the main sewer (which will be composed mainly of 8 and 12 in. diameter lightweight plastic pipes) will be a series of toilet blocks spaced at regular intervals to provide a total of 800 toilet places with individual cubicles and separate facilities for males and females.

Each toilet block in addition to toilet plates would have uice facilities for slop bucket emptying, showers and washing .cilities and a draw-off point for obtaining seawater for the ınd flushing of toilets.

Each toilet block would be under the full time supervision f an attendant provided by the camp sanitation committee.

:reen chamber

Before the main sewer enters the sea a screen chamber ould be provided to screen out undesirable items, including ıe plastic bags filled with excreta. These could be gathered om the screens and disposed off by burial, drying or burning, ıus leaving the main bulk of the sewage to drain out to sea.

:awater pumping station

The seawater intake and pumping station would be in a se- uded location on the island, on the shore of Zone G hill and ıbject to availability would preferably be diesel powered ump-sets, in duplicate, each capable of pumping 150,000 ıllons 10 h day – to a height of approximately 60 m.

In addition to the planned 50,000 gallons seawater storage high level on the slope of G hill it is proposed that these umps could also be utilized when necessary to pump directly ong the seawater pipe for fire fighting purposes.

'ospital and .nain beach drainage

In addition to this main drainage sewer traversing across ıe site, it is planned that a small separate sewer outfall pos- bly drained by gravity (or pumped, if necessary) be provided n the main beach site for the hospital building and 2 toilet locks containing 50 toilets each. These toilet blocks are essen- al for the large numbers of people always working, waiting or ıoving along the main beach.

Again this sewer outfall would be carried well out to sea to void polluting the beach area. Ample seawater would be vailable from the high level pipe and from this a branch line ould be provided to meet the needs of the hospital and main each toilet blocks.

urface water drains

Surface water run-off and general drainage of the housing rea would be improved substantially by improving the natural ream flows and by lining these with either timber or concrete ctional drains. These improved open drains would be regularly ushed by the seawater supply pipe.

GARBAGE DISPOSAL

resent situation

All the refugees receive a food ration pack every 3 days. These ration packs contain 3 tins and other wrapping materials. It follows that more than 120,000 tins and other waste material is thrown away every 3 days – and the size of this output is reflected in the great garbage dumps that are accruing on the beaches. No organized removal of this garbage has yet taken place although 3 incinerators are under construction.

Proposed garbage disposal

These garbage dumps should not be allowed to remain any longer on the island as they are the source of many flies, rats, putrifying smells and are a serious health risks. They also occupy key areas of the beach.

Immediate steps should be taken to organize a garbage disposal team whose function would be to flatten the empty disuse tins and, with a boat provided, take them offshore for dumping in the sea clear of the island. All tins must be flattened to avoid masses of floating debris.

The tins can be flattened in the first instance by heavy 4 lb hand hammers. Twenty such hammers should be supplied at once for this purpose. Enquiries are also being made for the purchase of hand operated crushers which would be suitable for flattening the tins in bulk.

The incineration of plastic and paper refuse must be carefully controlled to avoid smoke nuisance across the housing areas and also that the fire risk is kept to an absolute minimum. The incinerators therefore should be located with the following priorities in mind.

1. No fire risk to the houses.
2. Little or no smoke nuisance to the population.
3. Prevailing wind allowed for.
4. Incineration must only be carried out by responsible operators.

Cleaning the beaches of the existing piles of garbage will also have a positive effect on the morale of the refugees.

EXISTING SERIOUS FIRE HAZARDS

With over 40,000 people crowded on 60 acres of land – with thousands of highly flammable shelters made of timber and plastic sheeting crowded together, there is a very high risk of fire sweeping through the area and destroying most of the shelters, personal belongings and also causing much injury and death. The camp committees must be made aware of this critical situation and measures must be taken to provide fire fighting ability in given areas of the camp; organization and speed are essential in fighting fires.

The priorities are these.

1. Fire fighting teams be organized to cover given camp areas.

2. Area fire fighting points be established with hand operated warning sirens – to warn the local population of outbreaks of fire.

3. The relocation of the available 400 gallon fibre glass tanks throughout the housing area and filled with seawater as a first line ability in fire fighting. This is probably the *most important measure* to be taken immediately on the island. Each tank should have buckets provided strictly for fire fighting. As a first aid measure a small mobile petrol driven pump should be used for filling these tanks from any local seawater source. The UNHCR engineering consultant should decide the actual location of these tanks and ensure that they can be immediately filled with seawater.

4. The proposed seawater main should also be installed as a high priority. This main to be fitted with 4 inch diameter fire fighting points at regular intervals across the area with adequate length of fire hose to enable substantial quantities of water to be delivered to a fire situation. This seawater main will also be used to keep the local 400 gal. open topped storage tanks full.

5. Under serious fire conditions there would normally be 50,000 gallons of seawater ready for use in the high level storage tanks. In addition the seawater pumps could pump directly through the seawater main to the fire fighting points – by-passing the high level storage tanks.

General

No more people should be moved to the island because of the extremely dense population on a very restricted space – with the implicit serious health risks and the danger of a fire disaster.

Burial of the dead. Because of the sheer lack of burial space on the habitable parts of this island – sea burial shall be practised if the refugee community are agreeable to this.

A topographical map of the island should be prepared by using the existing map 1:63:360 or RAF aerial photography of 1960.

Garbage disposal

Immediate action be taken to dispose of the large dumps of garbage being dumped and stored on the main beach. Tins must be flattened and transported by boat daily to seaway for dumping.

Incinerators must be established in safe locations to dispose of the paper and plastic rubbish.

Serious fire hazards

Fire fighting teams must be organized, alarm signalling provided, and the establishment of stored seawater for fire fighting must be given the highest possible priority.

Sanitation

Immediate efforts must be made for safe disposal of the daily output of human excreta. Hand tools have to be supplied for this to be done.

A motorized boat must be provided for carrying loose excreta gathered from the beaches out to discharge in the seaway.

The proposed sanitation/sewerage plan outlined in this report using pumped sea water to flush 800 toilets through a sewer to a sea outfall be approved and commenced. A Kuala Lumpur consultant engineer should be appointed to plan, oversee, and implement these project proposals.

OVERALL RECOMMENDATIONS

Water supply

Provision should be made to speed up loading and unloading of the water barges to allow for more flexibility and to increase the capacity.

Additional storage capacity on the island should be constructed before the monsoon season starts (October) to have a water supply for at least 7 days on the island.

Storage tanks on the island should be connected in a way to allow installation of a simple integrated water distribution system.

The shipping operation should be overseen by a UNHCR official based at Kuala Trengganu.

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June 1979