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APPROPRIATE TECHNOLOGY HYGIENE FACILITY FOR SMALL COMMUNITIES

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ABSTRACT

Small communities will often need alternative systems of water supply, sanitation, washing and wastewater disposal facilities. Numerous agencies supply various models of ablutions facilities. The Remote Area Hygiene Facility comprises laundry, shower, toilet, wastewater disposal trench, solar water heater, chipheater, hand-operated washing machine and washing line. The toilet is a water-seal, low water demand, pit type. A plastic, solar water heater has been developed to overcome the problems experienced by commercial, metallic units such as blockages, breakages and ruptures due to freezing. The plastic design is more durable in the chosen environment and quite easy to assemble. Wastewater disposal is by evapotranspiration which is shown to be more effective than leach drains in tight, clay soils and promotes the growth of trees and shrubs. The Remote Area Developments Group proposes the installation of these units as community-based training projects to provide general construction skills, environmental hygiene education and a commitment to maintenance.

INTRODUCTION

The collection of human wastes from house connections by underground sewerage started in industrialised countries in the middle of the nineteenth century. The deep sewer system can be justified only in areas of high population density. It demands high capital cost, supply of large quantities of water and good maintenance and repair. Rural, small communities in developing countries do not have any such facilities. The problems facing small communities are high expectations coupled with limited resources. This is the situation facing small, remote Aboriginal communities in Australia.

Attention to environmental health and the development of hygiene technologies appropriate to the culture and lifestyle is still necessary in many remote Aboriginal communities of Australia. While the call for European-style housing and facilities may often come from Aboriginal people themselves this technology is rarely accompanied by education and training nor backed up with maintenance. Sometimes it appears that modern European facilities are supplied to conveniently meet conventional building regulations or as a blanket solution to health problems. With wide improvements in medical services and community infrastructure there has not always been an associated transfer of technological understanding to Aboriginal people to enable themselves to create the environmental hygiene necessary for good health.

Officially commissioned advice to government has recognised the need for 'appropriate technology'. The Blanchard Inquiry recommended that: "increased assistance be provided to organisations concerned with the development of appropriate technology for remote Aboriginal communities, and the extension of this technology into the communities" (House of Representatives Standing Committee on Aboriginal Affairs, 1987). Such developments could also aim to support reinforcement of cultural heritage, attainment of political autonomy and self-determination.

This paper discusses the design and construction of communal ablutions facilities suitable for Aboriginal communities in remote areas of Australia. This proposal could be translated to rural communities in other parts of the world with possible design adjustments in respect of cultural and social differences.

BACKGROUND

There still exists in Australia a very wide margin between the standard of health of Aboriginal people, particularly in remote communities, and other Australians. While there have been major improvements in health care over the last twenty years the extent of ill-health related to malnutrition and poor environmental hygiene is high and the increase in lifestyle diseases is alarming (Gracey, 1986; Gracey & Spargo 1987; Hollows, 1986; Thomson, 1984). The lifestyle diseases comprise obesity, diabetes, sexually transmitted and hypertension and are accompanied by alcoholism, substance abuse, vehicle accidents, etc. They have become widespread over the last twenty years due to the dramatic changes wrought upon Aboriginal society.

Recent studies in the Kimberley region of Western Australia reveal "widespread mild to moderate malnutrition amongst children" (Gracey et al. 1989). Poor hygiene results in the high prevalence of many infectious diseases. Diarrhoeal and respiratory diseases are the major cause of morbidity amongst Aboriginal children and contribute strongly to the malnutrition experienced in the first three years. They are responsible for the highest rates of presentation to Central Australian clinics and hospitalisation in Alice Springs (Nganampa Health Council et al. 1987). Pnuemonia occurs eighty times more amongst Aboriginal children in Central Australia than other Australians. Skin infections are the most common problems amongst Aboriginal children while trachoma is endemic amongst two-thirds of the Aboriginal population in Central Australia and more than three-quarters in the Kimberley. Anaemia, intestinal parasites and bacterial pathogens are common ailments amongst Aboriginal children (Gracey et al, 1989). Kidney disease amongst adults is often the result of extensive skin infections.

The main reasons for these problems could be summarised as follows:

1. The inability of remote communities to generate the economic base to develop technologies and deploy systems compatible with their needs, environment, means and capabilities.
2. The low level of priority given to these problems in the community and the corresponding lack of interest shown in them by the research and development community.
3. The general inability of people to provide the relatively sophisticated technology back-up and maintenance required to keep power, water and sewerage systems operating.
4. The rising costs of providing basic services in remote areas using existing technology and fuels.

These problems have developed over a long period and are currently being addressed with a level of support that reflects community interest up to this time. Funding programmes for remote communities have increased in

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recent years although the appropriateness of these is often questioned. The community is now at a watershed in its attitudes to Aboriginal communities. The Remote Area Developments Group (RADG) is looking ahead to provide a base for future developments and a coordinated evaluation to assist in the immediate future.

RADG began their work by focussing on appropriate technology for water supply and sanitation in remote Aboriginal communities. The following work has been carried out by the group so far:

* Evaluation of the needs and available technologies in remote areas based on visits to 18 communities. Guidelines for the provision of water supply and sanitation were prepared.
* A discussion paper series has been instituted. There have been eight dealing with water supply and sanitation for remote areas.
* A training course in Environmental Health is provided each year for trainees of the Aboriginal Health Worker's Education Programme.
* A conference on "Science and Technology for Remote Communities" was held in July 1988. The proceedings of the conference are available.
* An appropriate technology computer data base has been developed with relevance for remote communities.
* The Remote Area Hygiene Facility (RAHF) has been developed and is on display at Murdoch University. It comprises pour-flush pit toilet, shower, laundry, evapotranspiration trench, solar water heater, chipheater, hand-operated washing machine and clothes washing line.
* Rudall River Social Impact Study. RADG made thorough investigations into the likely impact of mining exploration and tourism on Punmu and Parnngurr by consultation with all parties concerned and site visits. Recommendations have been made to the State Government Minister for Aboriginal Affairs.
* The Workshop on "Water Supply, Water Use and Waste Disposal For Remote Communities" was held on 27th September, 1989 including the inauguration of the RAHF.
* Regular visits to and communication with remote communities for consultation and to understand their development aspirations.

RADG is currently engaged in the following research and development projects: a) Windmill and solar-powered desalination by reverse osmosis; b) Evapotranspiration trench for the disposal of waste water; c) Pour-flush pit toilet; d) Low-cost, plastic, solar water heater for remote communites; and in a consulting capacity a national study on the adequacy of the provision of water supplies and sanitation to Aboriginal communities for the Human Rights Commission.

Five major requirements have been identified (Fernihough, 1987; House of Representatives Standing Committee on Aboriginal Affairs, 1987) for supplying appropriate services to remote Aboriginal communities:

1. Small, simple and cheap but effective especially under heavy, sporadic loading.
2. Integrated into the preferred house or shelter design.
3. Technology that can be readily understood, installed and maintained by the community with minimal training and simple tools.
4. Suitable to be maintained and managed by women.
5. Materials which are sturdy, readily available and either long-lasting or easily replaced in accordance with (3) above.

EXISTING FACILITIES

Many remote Aboriginal communities have reticulated sewerage systems. The effluent from the septic tanks which contain all the wastewater produced in the households is finally discharged, via 100 mm PVC pipe connections, into large evaporation/oxidation ponds. These systems are costly, require

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maintenance and typically consume large volumes of water. Communal ablutions facilities are installed at communities in situations where a) houses do not have toilets built inside them; b) modern European housing is not constructed at the community; or c) variable or transient populations need additional facilities. Different types of ablutions facilities are available at present.

Australian Construction Services (ACS, Commonwealth Government) offer an ablutions facility for Aboriginal communities. It comprises separate toilet and shower for men and women, a common laundry area in the middle and conventional solar water heating. The toilets are the aqua-privy type. The entire facility can typically be supplied and installed for $40,000.

Murrayriver North are building contractors based in Pinjarra, Western Australia who manufacture transportable ablutions facilities to ACS specifications. They offer the design described above or a single unit which can be doubled up to make the same male-female unit. These units are fabricated at Pinjarra south of Perth, put on a truck, complete with concrete slab, and transported as far away as the Kimberley, the Eastern Goldfields and the Northern Terrritory. On-site the contractors can dig trenches for the sewerage system and install the ablutions facility in 24 hours and be off.

The Centre For Appropriate Technology (CAT, Alice Springs) will supply the Appropriate Technology Ablutions Facility (ATAF) comprising shower, laundry, concrete base and chipheater for approximately $2,500. The Ventilated Improved Pit (VIP) toilet will be supplied for about $1,300. Installing both these facilities in a remote community will result in a total cost of approximately $9,000. These have both proven to be highly acceptable and function satisfactorily in remote Aboriginal communities. They are prefabricated at Alice Springs by Aboriginal trainees or employees in the workshop and installed on-site with community involvement.

Eco-Tech in South Australia have developed a trailer-mounted shower and washing facility in collaboration with the Oak Valley Community on the Maralinga Lands to compliment their mobile lifestyle between outcamps. Other contractors offer design and construction of ablutions facilities including Nomadic Enterprises of Tanunda, SA and Waringarri Constructions of Kununurra, WA.

DESIGN OF THE REMOTE AREA HYGIENE FACILITY

The Remote Area Developments Group has designed and built an ablutions facility for small Aboriginal communities or outcamps (Figure 1). The unit has been named the Remote Area Hygiene Facility (RAHF) and essentially comprises a laundry, toilet and shower. Several of the group's appropriate technology prototypes will be integrated into the facility: the solar water heater, the evapotranspiration trench, and the the pour-flush toilet. The facility also contains equipment developed by the Centre for Appropriate Technology (CAT) in Alice Springs, namely the chipheater and the hand-operated washing machine. The RAHF would cost approximately $15,000 to install in a remote community while local involvement in construction would reduce this cost considerably. Participation of the community is preferred in deciding on the appropriate design of ablutions facilities, planning, construction and maintenance. The RAHF is a new, low-cost option for remote communities that are seeking ablutions facilities.

The design is based on the ATAF manufactured by CAT. A fundamental difference is that the toilet can now form part of the facility whereas

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CAT has always provided the VIP toilet separate to the ATAF The toilet can be separated though if the community finds the idea objectionable.

The pour-flush toilet is still a pit-type but uses a lower volume of water by having a tap and bucket instead of a cistern - which is highly liable to breakage or failure. The toilet needs about 2 litres of water while a cistern uses about 10 litres. Problems of offensive odours emanating from the toilet in close proximity to laundry and shower areas are overcome by using a water-seal toilet. The pedestal and base are concrete mouldings. The design is based on one used in Fiji. The seat is a white, durable, polyethylene moulding similar in appearance to conventional ceramic pedestals with a U-bend. Spare plastic inserts can be provided or if treatment may be excessively destructive a stainless steel insert can be used. The pit should be offset at the rear of the RAHF with a removeable cover to allow pump-out if necessary. The toilet system can be readily converted to a modern, full flushing cistern type at a later stage if desired and if adequate water is available.
The concrete slab of the RAHF can be poured using either conventional wooden formwork or a C-purlin frame which includes all fittings for attachment of steel wall frames, toilet pedestal, spoon drain, etc.

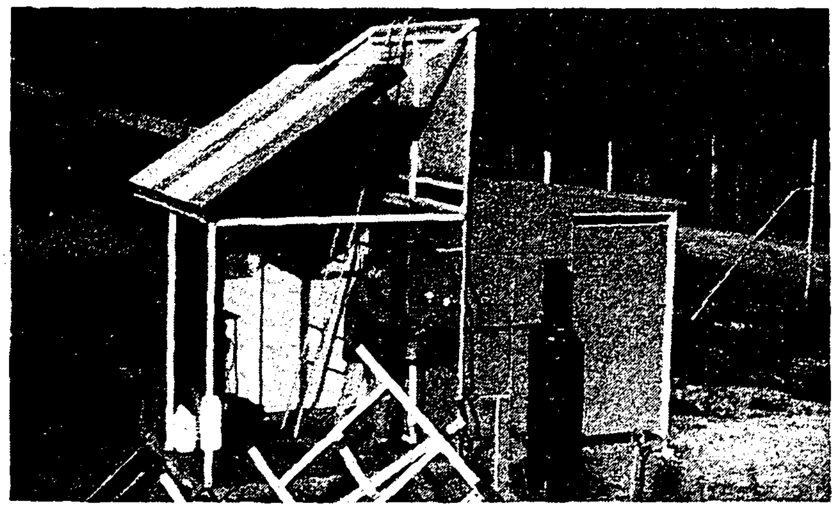

Figure 1. The Remote Area Hygiene Facility under construction

Structurally, the building is the same as the ATAF, using 50 mm x 50 mm square steel tube. The steel frames themselves are 2 metre x 2 metre modules allowing several variations of the layout and orientation. Modifications include the addition of the solar water heater on a redesigned roof and an evapotranspiration trench each being developed by the Remote Area Developments Group. Plentiful, strong shelving made from gridmesh and a heavy duty washing line made from galvanised bore casing and steel rope have been added to the facility. These are being evaluated in conjunction with the RAHF and all combine satisfactorily in a final integrated development.

The layout is such that the facility can be installed in any direction on a north-south or east-west axis. This will suit the desires and

constraints of different communities. The two roof sections are then installed so that the solar collectors will be facing north. The solar water heater itself is fully integrated into the roof rather than being elevated on a separate, often flimsy, structure.
The solar water heater is a plastic unit that overcomes problems of blockage, corrosion and rupture due to freezing. Its design, based on the thermosyphon effect, is simple enough to be assembled in a low-technology workshop. Its capacity is 300 litres and it can also serve as a preheater to the chipheater. The chipheater can then be used for hot water in times of extreme cold or many people using the facility.

Waste water from the shower and laundry trough enters the evapotranspiration trench which comprises several layers of graded sand and gravel with shrubs and trees planted in it. Water is disposed of by transpiration through the trees and capillary action upwards and then evaporation from the surface. In tight, clay soils this mechanism is superior in performance to the conventional leach drain which relies on percolation. The evapotranspiration trench promotes the growth of shrubs and trees which would otherwise be difficult in many denuded communities with limited water supplies and attention to horticulture.

NOTES ON THE ASSOCIATED TECHNOLOGIES

The Pour-Flush Toilet

Various types of pour-flush toilets are popular in many parts of developing countries. Pour-flush toilets have not been offered as an option to the Aboriginal people of Western Australia. They typically have a water seal of about 20 mm and are available in many different designs. Two basic types generally in use are the direct discharge and the offset pit design.

The first type is a modification of the pit latrine in which a seat is provided with a simple water seal. In the second type the bowl is connected to a short length (8 metres maximum) of 100mm pipe that discharges into an adjacent pit. Single leach pits are appropriate in areas where mechanical desludging facilities are available. Twin pits are recommended for rural areas. When one pit is full, flow is directed to the other and the first pit can be desludged conveniently.

In both cases two litres of water are poured in by hand to flush the excreta into the pit. The liquid together with the soluble products of biodegradation pass into the surrounding soil and are disposed of. If the soil has a low infiltrative capacity, the liquid has to be directed to a leach drain or evapotranspiration trench or even to a sewer. The solid product accumulates in the pit. A pit of 1.5m diameter and 3.0m deep will last for 15 years.

A pour-flush toilet satisfies most of the criteria of design of a toilet for remote communities. It is not an alternative to any of the present systems but is another option with special advantages. How the system will be accepted and used needs to be assessed by experience after constructing a few in Aboriginal communities.

Wastewater Disposal by Evapotranspiration

In some regions of the Pilbara, Western Australia, the soil is extremely impermeable, with high clay and silt contents causing water applied to the soil to pond on the surface. In such situations conventional septic tank/soil absorption systems frequently fail when effluent moving into the disposal field is not absorbed by the soil sufficiently rapidly to prevent its rise to the surface. The only alternative currently used in such situations is a reticulated sewage collection system which is very costly, inevitably consumes vast amounts of water in Aboriginal communities and frequently fails due to lack of maintenance. Besides the public health requirement and being capable of wastewater disposal in tight soils, the system must be able to take dramatic fluctuations in loading, be childproof, have a long maintenance free life and relatively low cost. Distribution and/or disposal of wastewater should not require input of energy (such as pumps to move effluent from the septic tank to the disposal field).

Evapotranspiration (ET) systems have potential for use in those areas where soil absorption fields fail. The systems cost considerably less and potentially require less maintenance than reticulated systems. The effectiveness of ET systems in disposing of wastewater and the application of these systems to remote Aboriginal outstations has been investigated. The first prototype trenches will be installed in several remote communities during 1990.

An ET system is a variation of the normal subsurface disposal method with disposal of effluent from the field primarily by soil evaporation and plant transpiration rather than soil percolation.

The ET disposal area is usually 70-100 cm deep in the form of beds (3-8m wide) or trenches (< or =1m wide). The disposal field comprises two layers:

a) base layer: 40-70cm depth of gravel in which distribution pipes are laid.
b) capillary layer: 30-60cm or more of sand chosen for its capillarity properties (sand with d_{50} of 0.1mm has adequate capillary rise). The gravel layer needs to be graded to finer sizes near its top to prevent sand settling into it.

The use of ET systems is restricted to regions experiencing low annual rainfall (700mm) and high evaporation. This is the climate in the vast majority of remote Aboriginal communities. The use of salt tolerant plant species in ET systems is essential in prevention of premature system failure arising from vegetation death.

Solar Water Heater

The Remote Area Developments Group in conjunction with the Appropriate Technology Unit at Newman Campus - Hedland College has been developing a new, low-cost solar water heater for remote area Aboriginal communities. A regular and plentiful supply of hot water is necessary in the communites for showering and laundering to improve the poor environmental hygiene conditions which give rise to diseases such as trachoma and skin infections. Solar energy can help to reduce the demand on local, firewood resources and reduce the environmental impact in these semi-arid regions.

Conventional solar water heaters are plagued with the following problems in remote communities:

* freezing causes fracture of the copper tubes;
* servicing of cracked tubes or other failed components is not readily available within communities;
* glazing is smashed by rocks;
* absence of electricity to boost supply on overcast days;
* Aboriginal people find difficulty relating to that technology in a meaningful way.
* the quality of water in remote areas leads to a rapid build-up of deposits in the copper tubes, resisting flow or causing complete blockage;

* the volume of hot water generated is often insufficient for a given usage pattern;
* contractors have sometimes installed the equipment incorrectly.

With the high amount of solar radiation in north and central Australia there is motivation to provide hot water with a reliable and passive solar system. Freezing has been overcome in some commercial units through the use of glycol heat exchange. Tempered glass will reduce the likelihood of rocks smashing the cover. New devices have been developed which use galvanic or magnetic action to prevent the deposition of carbonates (calcification) on the inside of the copper tube walls which eventually leads to blockages. Each of these add cost and complexity to the device. It is not necessarily appropriate to use second-hand components in this application because the prototype should reflect a unit that can in the future be made in quantity from readily-available materials. The solar water heater will operate on the 'thermosyphon effect', in other words, by natural convection.

Plastic solar water heaters have been developed already in the past. The Solco unit has been designed, tested and manufactured in Perth. It has a glazed batt-type collector integral to the storage tank and is made from high density polyethylene (HDPE). If this unit was left in the sun up north without water in, it would probably melt. A West German company manufactures a very good plastic solar water heater design although it is very expensive to import to Australia especially with a plastic drum for the storage tank which takes up a large volume in transit.

Several prototypes are currently being developed by the group. In each case the collector panels are made from black plastic. One collector type uses tubing - either unglazed low-density polyethylene (LDPE) garden reticulation tubing (Figure 2) or glazed ethylene propylene rubber (EPDM) tubing. The LDPE collector would be suitable for producing hot water at 40°C while the EPDM can produce water at 90°C. Each of these materials is cheap and readily available, but particularly the LDPE. The body comfort temperature for showering is typically around 38°C.

The storage tank is also plastic to avoid corrosion. This is insulated with fibreglass to store the heat overnight or for some time in cold weather. The 200-litre volume was found to be sufficient for showering and washing clothes of 4-5 people, although a 300-litre tank may be more appropriate in most applications. Two options exist for building the storage tank - either from a plastic drum made from high density polyethylene (HDPE) or a plastic bladder made from a laminate of HDPE and nylon. The HDPE plastic drum can store water at up to 60°C and is rather awkward to build and transport. The bladder-type tank is designed like a wine cask. The bladder is supported on the outside by an insulated metal casing. This is collapsible so that it can be transported to remote locations or in bulk overseas without taking up as much volume as a normal empty drum and assembled on site.

Tests were carried out on an earlier prototype during 1988 (Anda, 1989). Without glazing the collector's overall heat loss coefficient was found to be 25-60 W/m^2C mainly influenced by wind, while a conventional glazed collector is typically 6 W/m^2C. The time taken in September to reach the acceptable tank temperature of 45°C was 2.5 hours for the batts and 3.5 hours for the tubing. By substituting the 19mm tubing with 13mm the collector will have a faster response time. Fifty litre draw-offs at 10am and 3pm had minimal impact on the tank temperatures. Final tank temperatures in September in Perth were typically 40°C while in Newman they were 50°C.

Ultimately, a design will be developed that can be assembled by a small, Aboriginal enterprise that supplies equipment to establishing communities. The RADG solar water heater is potentially superior to the West German unit in that the storage tank design will allow transport of greater numbers in a smaller volume and the component nature of the overall design will facilitate specialist subcontract manufacture followed by assembly in a low technology workshop. An aim is to produce a solar water heater that might retail at around $900 which could then be attractive to the wider community.

Figure 2: Tubing-type Solar Water Heater

THE TRAINING PROGRAMME FOR CONSTRUCTION

Apart from the Centre for Appropriate Technology in Alice Springs it seems that no other organisations in Australia offer Aboriginal people training in appropriate technology for environmental hygiene. The Remote Area Developments Group hopes to embark on such a programme in Western Australia during 1990. Initially this will be through offering technical support to Pundulmurra Aboriginal College at Port Hedland and the Appropriate Technology Unit at Newman Campus - Hedland College. The Aboriginal Affairs Planning Authority has recently announced that it intends to convert the former Derby leprosarium into an Aboriginal education and training centre to be called 'Bungurun'. RADG has recently been awarded a grant to prepare itself for participation in this institution in the appropriate technology and environmental hygiene section.

One Remote Area Hygiene Facility has been built at Murdoch University for display purposes and testing of the solar water heater. Government agencies were able to view the construction during a Workshop organised by the Remote Area Developments Group (Ho, 1989). As part of Pundulmurra College's Environmental Health Workers Training Programme the Remote Area Developments Group will install one facility there. The facility, during construction and display upon completion, will be used to demonstrate the relationships between appropriate technology and environmental hygiene. Similarly, a unit will be constructed at Newman, possibly in collaboration with the Puma Jina fringe dwellers there. Once these have been completed similar one or two-day workshops will be held for the local Aboriginal communities. Essentially, in the early stages RADG will offer mobile technical support to communities and later a facility such as the centre for Appropriate Technology may emerge in Bungurun.

Detailed technical drawings of the RAHF have been prepared for prefabrication of components either by subcontractors or in a workshop training situation such as at Pundulmurra College. Moulds have been fabricated to pour the concrete for the toilet pedestal and base and the drainbox to the evapotranspiration trench. Steel benches have been fabricated to serve as jigs in the cutting and welding of the steel frames for the RAHF.

By involving the people from design through to installation of the RAHF the equipment will probably be used and maintained properly. Simultaneously the trainees will be shown how the facilities relate to overcoming environmental health problems. The successful utilisation of the RAHF will improve environmental hygiene conditions leading to an improvement in community health, although subsequent evaluation of trends in health will be necessary. As new outcamps are being established in the region the trained people can be engaged in the provision of facilities there. The opportunity would also arise for some individuals to be employed as environmental health workers.

Training will be on-site rather than moving people to an alien location where home-sickness and disinterest would result. Basic training in plumbing, welding, concrete pouring, building installation, etc. will provide an introduction to technical trades courses offered by TAFE at nearby Newman or Pundulmurra College and Hedland College at Port Hedland.

Members of RADG will live on-site during fabrication and installation thus having a fully-integrated lifestyle approach during the training. The educators will have the benefit of becoming closely in tune with the needs and aspirations of the people which will be particularly important for future training and development work.

CONCLUSION

Aboriginal people commenced the movement away from town fringes some 20 years ago to establish small, extended family, remote communities with the goal of achieving political autonomy, control of resources, access to land and an improvement in lifestyle. Health problems were prominent in many of these semi-sedentary, semi-traditional, communities,typically arising from poor environmental hygiene. Initially, minimal essential services were offered to these new communities. More recently modern European facilities with high levels of technology have been deployed for housing, water supplies, sanitation, etc. There has not always been a corresponding improvement in the environmental health of the community. The Remote Area Developments Group began investigating these issues in 1985 and is now well advanced in the development of a number technologies related to water supply, water treatment and waste disposal. Amongst these is the Remote Area Hygiene Facility which essentially comprises a laundry, toilet and shower. The facility includes unique technical developments of the group namely, the plastic solar water heater, the low-water demand, water seal, pour-flush toilet and the evapotranspiration wastewater disposal trench designed to overcome specific problems experienced in small, remote communities. In collaboration with Pundulmurra College, Newman Campus - Hedland College, the Centre for Appropriate Technology and Bungurun Learning Centre the Remote Area Developments Group intends to embark on this environmental hygiene technology transfer through community-based training and construction programmes. It is likely that the approaches and technologies employed in these developments are applicable to small, rural communities in other parts of the world where the need arises for alternative, low-cost water supply and sanitation equipment.

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