ASIA AQUATECH 1980

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ASIA AQUATECH CONFERENCE WORKSHOP '80
"Water Quality Management"

PROGRAMME

DAY ONE, 5th March 1980

Chairman Basil Rossi

8:30 am Registration of delegates

9:30 am Opening remarks from the Chairman

9:40 am Water Quality Management
Peter Grombach, Physicist, Ingenieur Bureau Grombach Switzerland.

10:10 am Water Quality Management Aspects of the 1973-1974 Study of Laguna de Bay (Philippines) Water Resources Development
Ernest Pariset Sogreah - Ingenieurs Conseils, France.

10:40 am COFFEE BREAK

11:00 am Quality Water for the Masses
P. Soundararajan, Project Co-ordinator, National Research Corp. of India

11:30 am Adaptation of Western Technologies in Developing Countries
Dr. W. A. Osenga, P.V. Pacific, Singapore

12:00 pm Water-Quality - A Consultant's Point of View
Robert L. White, President, Engineering Science, USA
Open Forum

12:30 pm LUNCH

Session Chairman : R.L. White

2:00 pm Water Quality Management in Malaysia
Dr. Ariffin Suhaimi, Dean, Facility of Science and Environmental studies. University Pertanian Malaysia.

2:30 pm Application of Aerobic Composting in the Disposal of Liquid Palm Oil Wastes.
R.L. White; C.D. Ponniah; D.R. Anderson, Engineering Science, USA

3:00 pm — The Use of Recycling as a Water Pollution Abatement Tool.
Basil A. Rossi, Asian Recycling Association, Philippines.

3:30 pm — COFFEE BREAK

4:00 pm — Large Area HDPE Liner System
Dr. Ing. F. W. Knipschild, Schlegel Engineering Germany

4:30 pm — Economic Valuation of the Lake Water and Water Pollution Abatement Project
Dr. Ben-Chieh Liu, Principal Economist, Midwest Research Institute, USA

DAY TWO, 6th March 1980

Session Chairman: (Dr. Trevor R. Smith)

9:00 am — Disposal of Radio-active wastes in India
A.C. Chaturvedi, Cheif Engineer, Minor Irrigation Dept., India.

9:00 am — Materials for Water pipelines - Value Engineering Analysis
Dr. Trevor R. Smith, Technical Sales Manager, Stanton & Stavelely UK.

10:00 am — Application of Computerized forms of simple do-bod models for rivers.
Dr. M. J. Gromiec, Inst. of Meteorology and Water Management, Poland

10:30 am — COFFEE BREAK

11:00 am — Recovery of Energy , Fertilizer and Water from strong organic wastes by the Anox Process
D. Evers, Managing Director, D. Evers Associates, UK

11:30 am — Denver, Colorado: Case History of the Development of a Water System in a semi-arid area
W.H. Miller, Manager, Denver Water Department. USA

12:00 pm — Water Pollution Control in England
Water Directorate, Dept. of the Environment, London, England

12:15 pm — LUNCH

Session Chairman: B. A. Rossi

2:00 pm — **Biological Control of Aquatic Weeds**
Dr. Ken Harley, Office-in-Charge, Commonwealth Scientific & Industrial Research Organisation , Australia

2:30 pm — Wastewater Reuse in the United States
Curtis J. Schmidt, SCS Engineers, USA

3:00 pm — COFFEE BREAK

3:30 pm — Workshops
Selection of topics from lists submitted by delegates and Speakers Syndicates and Consultative panels formed from speakers and delegates.

DAY THREE, 7th March, 1980

9:00 am — Workshop Sessions
Discussion on formation and role of Asian Water Association

2:30 pm — LUNCH

2:30 pm — Field Trip (optional)
1) Seletar Reservoir - fish culture
2) Chestnut Ave. Treatment Works.

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WATER QUALITY MANAGEMENT

by Peter Grombach, Physicist, Zurich, Switzerland

Effective water quality management is based on these four steps:

Choice of the best raw water available
Thorough technical tests by pilot plants
Careful choice of appropriate treatment
Extensive continous quality monitoring

1. Choice of raw water

There are many elements which influence water quality but one of the most important is the correct of raw water from the start.
To do this one has to start off by investigating all possible purposes of the the Project. It may be that additional consumers or water supplies will be connected in future. The water is often also needed for irrigation, waterways, recreation, industrial cooling systems. On the other hand, it is sometimes better to take the water from an already existing catchment or water works. All these questions influence the choice of the water to be treated. (Fig. 1)

The second investigation deals with the quality of treated water to be acheived. The minimum quality is defined by law in most countries, but in many cases better quality is necessary or at least desirable. But a demand for quality "as good as possible" is to be avoided, because such quality aims to be associated with unlimited costs. "At lowest cost" is not enough either. The best procedure is to define the necessary quality in detail and at the same time give the maximum investment that may be made for the water. If it proves impossible to produce water at these costs, either the desired quality has to be lowered

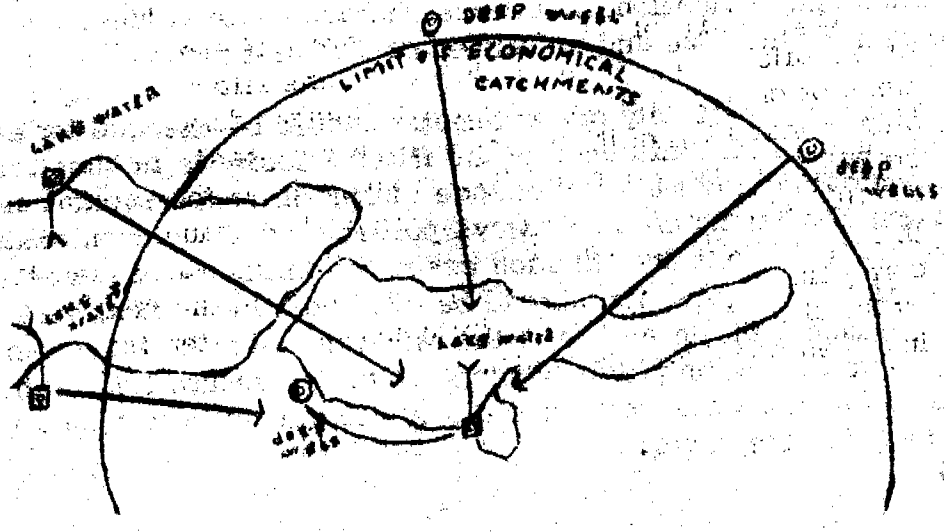

Fig. 1: Investigations of all existing water resources around a small town.

or the raw water resources have to be sought elsewhere. The raw water quality must be evaluated for every resource within acceptable distance of the consumers and this evaluation is necessary over a longer period of time, usually at least one year to allow for seasonal changes. Short term pollution peaks may often be omitted if water is available from storage for such short periods. Step by step construction of treatment plants is advisable in all cases where the water quantity increase with time. But this procedure is also appropriate if the quality of the raw water or the necessary quality of the treated water is expected to change in future.

As an example of such investigations I mention a small town on a lake with ground water some distance away. It had to be decided whether the lake water or the ground water should be used. The quality of the treated lake water had to be equal to that of the ground water. This condition defined the necessary treatment of the lake water. On the other hand the ground water needed higher pumping and the construction of a long feeder pipe line. It was found that a highly pushed treatment, removing even pollution traces, was more economical than the transport of the untreated ground water.

2. Pilot plant operation

Pilot plants are always necessary if raw water quality is not known exactly, if, as with river water, it changes with time, or if any new treatment technologies are to be used. But pilot plants only deliver references for the planning of treatment works if the data to be acquired are well defined from the start. It is not enough to ask if the pilot plant is able to make potable water from the raw water; the influence of the process on specified quality parameters must also be evaluated. Careful interpretation of the results is most important. Dependences often become visible only after appropriate representation and evaluation of suitable characteristic values. Results should be independent of the size and properties of the pilot plant.

It is desirable that only one parameter should be changed for each run of the pilot plant. If the influence of the filter velocity is in question, filter mass or chemical dosing must not change during the experimental series. Such constant conditions are not always possible, due to uncontrollable changes of raw water quality. In such case, the influence of raw water quality on pilot plant operation should be evaluated in the first series of runs. In later experiments, the influence of the raw water must be eliminated by correcting factors. The only disadvantage of the procedure lies in the fact that evaluation of the raw water influence alone often takes more than a year and involves considerable costs.

If only a single treatment is to be investigated, it is often possible to get constant raw water by pretreatment of the water. This is the correct procedure, for instance, in choosing the brand of activated carbon suitable for removing trace pollution. In other cases the pollution peaks of the raw water are of special interest. In such case, changes of operation during the passage of the peak must evidently be avoided too.

Provision of sufficient time for pilot plant operation is most important in many treatment design programs. Final design and construction can only start when the pilot plant experiments are not only finished but also evaluated and interpreted.

Pilot plant operation should always show dependences between physical or chemical parameters ans not just single measuring points. It is quite insufficient to declare that a perfect drinking water is achieved with a filter run of 12 m/h velocity. The relevant qualities of the filtrate, e.g. turbidity, floating matter, plankton, iron content, must rather be measured for filter velocities of 5 to 25 m/h in a sufficient number of small steps. The diagram derived from these measurements will then show which filter velocity is appropriate for the desired quality of filtered water.

If the raw water quality undergoes large scale changes, it is often deceptive to calculate the efficiency of the treatment. If the efficiency of a sterilizing treatment is 99 %, it is quite insufficient for a raw water with over 1 000 000 germs per ml. On the other hand, an efficiency of 90% might be quite sufficient for a slightly turbid water. So it is much more the absolute quality of the treated water rather than the efficiency of the treatment process that is decisive for the evaluation of the appropriate treatment. Specially dangerous are pollution peaks of the raw water that cause deficient drinking water from treatment of constant efficiency instead of constant quality which is safe.

As a sample of such investigations I mention the pilot plant that was installed on the River Rhine to prove that micro- flocculation followed by double filtration will produce water of sufficient quality for chemical works. First of all, filter velocity and chemical dosing were kept exactly constant for many months so that only the raw water quality of the river changed. The result was that the treated water was of sufficient quality up to a raw water turbidity of 500 ppm and deficient with higher raw water turbidity. In a second series of runs, it was shown that up to a raw water turbidity of 20 ppm, no flocculation was necessary at all. A third series showed that deviations of quality were distinctly stronger with filter velocity of 10 m/h than with 5 m/h. In the last series, only chemical dosing was varied between 0.5 to 10 ppm and the optimum was found to be 2 ppm. These few questions required a i... pilot plant operation of more than a year.

3. Choice of appropriate treatment

The first step in quality management lies in the choice of treatment appropriat e to the properties of the raw water and to the desired quality of treated water. There are several treatment processes suitable for each treatment and each treatment process can meet several purposes. Optimizing the treatment therefore means finding a combination of the treatment processes such that all purposes are met with least expenditure. It may be that a very expensive process used for one special purpose is quite economical because it is able to fulfill some other treatment at the same time, so that no secondary treatment is necessary. It is, for example, possible to remove the slight turbidity after ozonization by using cheap fine sand filter instead of an expensive activated carbon filter. But if the removal of high molecular organic pollution is also a requirement of the treatment, the activated carbon filter will perform both treatments at the same time, while the fine sand filtration has to be followed by some polishing treatment. A quick survey of existing treatment processes for each purpose will help to indicate the appropriate combination. A matrix was therefore assembled showing the most important treatment methods horizontally and the treatment purposes or quality shortcomings vertically. To limit the size of the matrix, only the main processes are indicated, and not small variations, such as upward filtration. All the same, it shows the importance of defining the purpose of treatment from the very start of planning, and the possibility of choosing multipurpose processes for one single installation.

The most economical dimensions of treatment installations are almost as important as the choice of the right process. Such optimization needs careful distinction between limiting conditions and the objective function. Limiting conditions are specifications that reduce the range of possible decisions. Example of such limiting conditions are the desired quality of water, the quality of the available raw water, the regulations concerning waste water and sludge disposal as well as the size of the plot of land, the situation relative to the center of demand and regulations of environmental protection. The total acceptable cost is a limiting condition too. Objective functions, on the other hand, are the minimizing of costs of investment and operation, maximizing of quality and availability. Optimization must be confined to one single objective functions are regarded as limiting conditions. If minimizing cost is the objective function, then the minimum acceptable quality and availability are limiting conditions. If maximizing quality is the objective function, the maximum acceptable availability are limiting conditions. An example for cost minimizing is the optimization of alum dosing and filter depth in relation to filtrate quality and the cost for deep filter beds, alum and wash water. An example for quality maximizing on the other hand is the choice of appropriate filter masses and depth in multilayer filters, taking into account the acceptable cost for back wash and for sludge disposal.

Simultaneous optimizing of all treatment parameter is an impossible task. On the contrary, it is necessary to limit optimization to the few most important parameters, task needing profound knowledge of the theory of the treatment process. Fortunately, many optimizations can be made in the operational plant by varying operational conditions. Such a task is one of the most satisfying and interesting duties of every water works manager.

4. Quality Monitoring

No management is possible without sufficient data. While quantity monitoring is quite common in the water industry (if you think of water meters, level gauges and manometers), quality monitoring is mostly restricted to a few laboratory tests once in a while. This is not enough. The main parameters, such as turbidity, pH, iron content, redox potential and chlorine content have to be monitored by continously working meters. There have been quite a number of such meters on the market lately, mostly as combined monitoring stations. Though the price of such stations is not low, it is quite negligible compared to the cost of water catchments or pipe networks. Constant monitoring is the only way of ensuring that a public water supply does not become a source of disease instead of a means of prosperity.

Quality monitoring also includes trace analysis of heavy metals, such as copper, cadmium, mercury and lead as well as carcerogenic materials in concentrations of one part per billion (ppb). With the new instruments even non-specialists can perform such analyses.

Quality monitoring is necessary in three distinct fields namely: monitoring the environment for its influence on raw water; optimization of treatment operation with its special influence on chemical costs; and monitoring the treatment process and the treated water to guarantee the good quality of the drinking water.

Monitoring the environment must take the whole water basin upstream from the catchment into consideration and this goes for groundwater too. Monitoring the raw water must be so complete as to enable the works manager to take steps in case of water deterioration before the quality of treated water is affected. Monitoring the treatment process is much easier because only a limited number of parameters is influenced at each treatment stage. It is very important to avoid insufficient quality of drinking water due to treatment breakdown. Monitoring the water at the works exit is also important to prove certain cases that water quality was adequate; but it must be realized that once the water leaves the treatment plant no further steps are possible; so it is certainly better to control the water quality earlier, that is, in the catchment basin or during treatment as described above.

Nowadays many works managers realize that it is also necessary to monitor the water quality in the distribution network. Unfortunately, many cases are known where water leaves the water works in perfect condition (or apparently so), and deteriorates in the network or in the consumer's house installations. If such cases come to the knowledge of the works manager, he must not search for the fault in the distribution network or at the consumer's home but improve the treated water quality in such a way as to make it proof against interaction with pipe or reservoir material. This can be done in several ways: pH-control against corrosion and rust-colour, fine filtration against sludge depots in the pipe network, oxidation of organic matter to prevent germ development are among them.

Many cases have proved that quality monitoring is not only advisable but also economical.

Thus water quality management nowadays becomes as important as water management in general.

Questions and Answer:

Dr. Liu — I think you have some truth here. I want to know how you can set up some kind of standard quality. Presumably you have to have a certain composite indication so that there is a level of quality. I want to know also how each country can set out its water quality with no difficulty of social and economic concerns. It is not the job of the government as a whole but rather the authority in each area concerned. They, perhaps, can come up with the standard of quality.

Dr. Grombach — Yes, of course I agree and if you think of the WHO, they also give some quality limited for quite a lot of projects, such as turbidity and germs, but please remember the second item I mentioned about the Maximum Possible Investment. Unfortunately, I have seen in my life so many good projects that have ended in the drawer. This is because you cannot afford to talk about things which are much too high in cost and if you combine these 2 then it is really a question of necessary quality because with limited investment you cannot obtain every quality you want. The engineer, the chemist and the scientist have a tendency to get as much quality as possible. It does not exist because you can acheive any quality if you pay the money for it and again that is why I say try to develop the necessary quality to limit investment even if you know it would be better to get a better quality. This is why I created the expression "necessary quality". Of course, I know it would be the best thing to have quality water that is

beyond any complaint.

Dr. Osenga — In the economical and secondary venture, there are apparent effects of water. The water quality should be just from the source and not endanger life when water is consumed. That should be the desired result. The government authorities have the facility to supply water to fulfill this condition.

How would you define water quality parameters?

Dr. Grombach — Necessary quality in the first place is of course quality according to the law. In my country there is a law governing nutrition which applies not only to water but other things as well and which is sometimes difficult to achieve. There is a certain turbidity which is acceptable because it is not seen, but for certain industries such turbidity is not acceptable and the necessary water quality must be of a lower turbidity. Sometimes you need more than that. To give an example, beer would need water of very special quality especially about residual germs and water which is absolutely sterilised so that you will have to be very careful with the project. The wrong kind of germs will make the beer acidic.

Dr. Osenga — In your own context you have described the effects of water on the preparation of beer and also that in many countries you have the law lagging behind demand. I think that there is danger and it does make more sense that you make water quality suitable. At the same time water is used over the country for the same need so there will be one quality parameter.

Dr. Grombach — Yes, it seems you are right. You have said that in my country there is a law following every demand and we have understood that in the area concerned, there is pollution in the drinking water. Drinking water must not contain poison. There is a difference in the minimum water quality for each area.

It is actually the action of the Water works management to say and to define what quality he wants to acheive and again I say of course if there is an area, the area has a main quality but we cannot and do not wait for the law. We do not wait for the law but should decide for ourself what is necessary. If you say that there are universal parameters then I do not agree. When you open the tap here, the water has a temperature of 20-25 degrees and it is quite impossible to get cooler water. In my country, water has a 4-6 degrees temperature and you realize that it is more dangerous here than in my country for germ aftergrowth.

WATER QUALITY MANAGEMENT ASPECTS OF THE 1973-1974 STUDY OF LAGUNA DE BAY (Philippines) WATER RESOURCES DEVELOPMENT [1]

by E. Pariset, Sogreah, France

Laguna de Bay, in the Philippines, is a shallow brackish lake of 900 km^2 discharging into Manila bay through the Napindan and Pasig rivers (slide no. 1). These rivers flow through Greater Manila (5 million inhabitants) and receive most of its wastes. The water resources of the lake are not efficiently used mainly because of periodic salinity and large scale pollution. However, around 1990-2000 Laguna de Bay water will be needed for the supply of the expanding population expected to reach 14 to 16 millions by the year 2000 and therefore the formulation of a water management plan for the optimum development of water resources was needed.

I will summarize the main water quality aspects of the study carried out in 1973-74 and sucessively present:

- the diagnosis of the present health of the lake
- the assessment of main possible water uses and corresponding water quality objectives
- the definition of a preliminary coherent medium and long term programme for reaching the above objectives.

To conclude I will present some personal views on institutional aspects.

Little reliable information on the water quality of the lake, except temperature

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1: The views expressed in this article are those of the writer and should not be considered as necessarily those of the United Nations Development Programme, Asian Development Bank or the Philippine Government.

and salinity, was available at the outset of the study. The first step was therefore the construction of a fully equipped water quality laboratory which thanks to the efficient collaboration of Laguna Lake Development Authority was operational in seven months. Systematic sampling, analysis and studies were immediately started by a team of forty people including water chemists, biologists, limnologists, engineers and auxiliary staff led by two experts in limnology.

The average depth of the lake is only 2.8 m. Under the nearly permanent presence of wind, waves easily mix the water to the full depth and stir the soft bottom sediments into suspension. The turbidity is high limiting the light penetration to the upper 20-50 cm of water and algae production to the top layer of the lake.

Water temperature is always high 25° to 32°C and bacterial activity, biodegradation in particular, is high, digesting most of the BOD load coming from organic pollution around the shoreline before it reaches the centre of the lake.

At the end of the dry season the lake level may drop below the level of the sea and a reversal of the flow in the Pasig and Napindan rivers introduces saline and highly polluted water into the lake. Slide no. 2 shows the progressive distribution of salinity from April 73 to March 74. In April-July 1973 nearly 2 million tons of chloride entered the lake.

During a one year period, March 1973 to March 1974, samples of water, sediments and plankton were taken systematically at various stations in the lake, along main tributaries and along the Marikina, Napindan and Pasig rivers. The analysis of these samples involved the study of about sixty parameters. Analysis of nitrogen and phosphorus cycles was started as research on plankton, fish, and algae.

Dissolved oxygen content is greatly influenced by photosynthesis action of algae. On a sunny day, DO increased from 8 mg/l at 6 am to 23 mg/l at 2 pm, a large overconcentration.

During cloudy and calm days and where algae blooms are present it can drop to 2 mg/l in the early morning.

Nutrients play an important role on the ecology as they cause a large proliferation of blue-green algae. The average value of the total nitrogen content was of the order of 0.9 to 1.2 mg/l mostly accounted for by the stirred up sediments that contained about 3 g/l nitrogen.

The average value of the dissolved phosphate was below 0.1 mg/l .

Algae growth stimulation experiments were conducted. Addition of orthos-phosphate did not increase algae growth, indicating that the phosphate supply was already sufficient and was not the controlling factor as often the case in temperature climate. A stimulation of about 2.7 times was observed by increasing the nitrate concentration from 0.2 to 1 mg/l. Additional experiments confirmed that nitrate was the main factor controlling algae growth.

Laguna de Bay has already reached a critical stage of pollution causing a very large blue-green algae production. The main cause is the excessive nutrient waste loadings, mainly nitrogen compounds from urban, agricultural, and industrial sources around the lake.

Algae growth follows a seasonal cycle. Production increases in March or April, peak concentrations occur in June-September, and the algae population declines to a very low count in December-March for reason not yet clearly understood. This cycle appears irrespective of any reverse flow from the Pasig. But since the Pasig inflow, if present, occurs towards the beginning of May-June and introduces a large quantity of nutrients, the inflow effects may well serve to accelerate algae production to high levels.

Slide 3 shows the evolution of the concentration of blue-green algae in the lake from June 1973-March 1974. Anacystis cyanea (microcystis aeruginosa) was by far the dominant species. Surface counts of up to 1,000,000 cells/ml were measured in Central Bay in July and August giving the water a distinct green pea soup aspects.

Pesticides and Heavy Metals

Three hundred and ninety-five tons of various perticides were sold in 1973 in the catchment area of Laguna de Bay. Heavy metals such as mercury and chromium are found in the factory effluents and in the lake sediments in some zones near the shore. Apparently, neither the concentration of pesticides nor that of any of the heavy metals has reached a critical value. Nevertheless, high concentrations of methoscychlor, dieldrin, DDT, and lindane were found in some fish species by other researchers.

The problem of these hazardous substances is not only their presence in the lake water or sediments, but their possible concentration in the successive steps of the food chain. Special attention should be given to this problem in the future and less hazardous types of pesticides should be selected for agricultural purposes.

Present Pollution and Forecasted Evolution

The most objectionable pollutant is presently the excessive discharge of nit-

trogen compounds. The nitrogen pollution reaching the lake in 1973 was evaluated at 5000 tons, main sources being:

- Livestock and poultry	36%
- Domestic	26%
- Pasig river reverse flow	22% for an average year
- Fertilizers	11%
- Industry	5%

In addition, it was found that some industries discharge toxicants and considerable grease and oil wastes. The transportation of 13,000 barrels of crude oil a day by barges across the lake poses a large potential threat to the whole ecology of the lake.

If nothing is done, the quantity of nitrogen pollution reaching the lake will triple by the year 2000 as indicated in slide 4. Public health problems would worsen with the increase in population. Algae concentration is likely to triple. Large algae blooms will be present during much of the year, practically wiping out fish pen production and probably most of the fishery in the open lake. Larger concentrations of heavy metals and pesticides would make the surviving fish dangerous for human consumption.

During calm days, algae would float on the surface, forming a thick crust, the top of which dry and decay, producing large lake areas with a very offensive odour that would be obnoxious in Manila and in communities around the lake. The possible use of the lake as a water supply source would become very costly if not impossible. The Pasig River would continue its massive injection of saline and polluted water preventing the use of the lake water for irrigation and water supply.

Main possible water uses, corresponding water quality objectives

Fishery

The original fish population consisted of relatively low value species, less than 3% feeding on the abundant phytoplankton and algae resources of the lake. In 1971, LLDA introduced fish farming, mostly based on the milk fish (chanos chanos), an herbivorous and phytoplankton feeder reproducing only at sea. The operation was very successful and in 1973 there were 4800 ha of fish pens in operation with a mean productivity of nearly 4 tons/ha/yr.

The study of the productivity of the lake suggests that the area of fish pens could be increased to 20,000 ha or 25,000 ha, with a potential production of 90,000 tons/yr having a market value (1973) of 350,000 pesos. Water quality is a very important consideration in fish-farming, since fish in pens cannot swim away when local water conditions deteriorate. During the summer of 1973, the damage caused by algae blooms reduced the value of the harvest by 15%. It can be assumed from algae productivity tests that the percentage of damage will increase linearly with the nitrogen pollution, posing a big threat to the survival of fishery if steps are not taken urgently to keep pollution within the limits obtaining in 1973.

Irrigation

Projects exist for the irrigation of approx 30,000 ha fromlake water allowing the production of two crops per year instead of one. A prerequisite for their implementation is the construction of a dam across the Napindan river that will stop saline intrusion. The corresponding benefit would be entirely attributed to this dam.

Water Supply

Existing studies of Greater Manila water demand up to the year 2000 were reviewed. The possibilities of other sources were studied at prefeasibility level. For Laguna de Bay, the study was carried out at feasibility level with the help of a 8 m^3/hr pilot plant. The study has shown that by 1995 at the latest the resources of Laguna de Bay which can provide 2.5 million m^3/year will be badly needed bu their availability is conditioned by effective control of Laguna de Bay pollution.

A part from the necessary control of poisonous substances, the main problem is algae. No experience exists of industrial treatment of water containing more than 300,000 algae/ml and most likely existing processes, even if microstraining is added, will not allow continuous treatment of algae concentrations of 1,000,000/ml or more.

The pilot plant which was operated 8 months on the South shore of the lake has shown that with proper use of alum sulphite and polyelectrolyte, coupled with efficient sedimentation (floating sludge blanket type) and filtration it is possible to eliminate 99.9% of algae up to concentration of the order of 200,000 anacystis/ml. Larger concentrations did not occur on the site. At this stage and pending further research it has been estimated that algae concentration in 1973 has already reached a limit value and consequently the 1973 nitrogen pollution has been taken as the maximum tolerable for water supply.

Pollution Control Programme and Economic Justification

The 1974 knowledge of Laguna de Bay ecology was far from complete and limnological phenomena are not identical from one year to the next. Forecasts, based on a single year of systematic analysis, are only a preliminary approach and the corresponding programme of pollution control will have to be periodically revised according to the progress of our knowledge of Laguna de Bay ecology. In addition, due to strict limitations of time, only a brief study could be made of the works needed for pollution control. However, the pollution control programme proposed seemed realistic enough to provide a resonable demonstration of the economic justification of the control and of its financial feasibility through a system of levies.

To attain the objective of maintaining the pollution, mainly by nitrogen, at its 1973 level, that is 5,000 tons/yr of nitrogen, the proposed programme included the following works and measure, the effect of which is shown in slide 5:

(1) Prevention of pollution from the Pasig River by the construction as soon as possible of the Hydraulic Control Structure on the Napinden river.

(2) Livestock Pollution - It is practically impossible to collect the pollution from back yard rearing of livestock. Refuse from industrial farms can be collected and disposed of by sanitary land fill for instance. Imposition of a levy on such large farms, high enough to cover the cost of refuse d disposal will induce owners to take the necessary measures to avoid the the levy or pay for the disposal by others. A permit system must be imposed to avoid the creation of large livestock farms near the shores of the lake and along its tributaries.:

(3) Industrial pollution - Most of the industries in the Laguna de Bay watershed are either along the northern part of the lake's west shore, or just east of the Marikina River. The cheapest and safest way to protect the lake is to build two interceptors collecting the industrial wastes and bypassing them to Manila Bay for the first area and to the Marikina and Pasig Rivers for the second one. Treatment plants are not yet mandatory. In any case, nutrients are not likely to be a real nuisance in Manila Bay for a long time to come and classical treatment plants would be be sufficient. In addition the location of polluting industries outside of the areas mentioned previously, will be stopped by a system of permits complemented by high levies on the nitrogen, BOD and sediment content of the wastes.

(4) The existing rules concerning pollution by pesticides, heavy metals, hydrocarbons, and other toxic substances will be made more stringent,

and strictly enforced.

(5) Municipal pollution - A preliminary study based on surveys of three towns established the cost of a minimum system of interception and treatment. The system studied included a minimum network of interceptors for collection treatment by lagooning, and the use of treated effluents for irrigation. The objective was to serve 1,000,000 inhabitants by the year 2000. Immediate reservation of the necessary land was recommended.

(6) Fertilizer pollution - It does not seem advisable in a period of food shortage to limit the use of fertilizers. In addition, it would be one of the costlier methods of reducing the quantity of nitrogen reaching the lake. However, farmers must be made conscious of the cost of the pollution they cause and trained to use cultivation methods reducing the leaching of fertilizers to the lake.

The total cost of this programme, operation and maintenance included, up to year 2000 has been estimated at 360,000,000 pesos (1973 prices), the greater part, 270,000,000 being necessary to provide municipal sewerage systems that would in any case become necessary in the future for public health rea reasons.

The economic study based on benefits from fishery and water supply shows an internal rate of return higher than 30% justifying the pollution control programme which in addition will improve the health conditions of 1,200,000 inhabitants.

Institutional aspects

I will now present some personal views on the institutional aspects to show the diversity of the methods used in various countries.

Water management implies a multidiscipline analysis: economic, social and political aspects must be taken into account as well as engineering aspects. Priorities must be established. Interaction of water projects on each other and their long life usually implies a basin wide approach with long term planning. Enforcing and financing the selected programme require legislative and financial action. Such a broad approach usually covers the field of numerous Administrations but on a regional more than national basis. Therefore, the coordination of water management is generally entrusted to an administrative body having authority over the whole river basin and the financial ability to ensure the timely implementation of control measures. The detailed organization depends on administrative practice of the country.

The programme itself must of course be approved by the Government to check its compatibility with the general development objectives of the region.

For pollution control two basic approaches may be considered either separately or concurrently: legal enforcement of water quality standards financial inducements to reduce pollution by the imposition of levies on water users and polluters.

Water quality standards can be imposed on receiving water; they are based on the present and future uses of the water. Their main advantage is that they take into account the dilution and assimilative capacity of the receiving body of water and consequently lead to savings in costs of treatment works for pollution abatement. On the other hand, such standards are difficult to formulate and define and even more difficult to administer.

Standards on the quality of effluents have the advantages of simplicity and ease of administration. Their primary disadvantage lies in their possible uneconomical use of the assimilative capacity of receiving waters.

Levies based on pollutant quantities or concentrations are used in several countries to ensure a fair contribution by industries, municipalities and others, in the cost of the municipal sewerage system they utilize. Levies have been used systematically in France since 1964 to fight water pollution. The rationale is the following. The river administration establishes long-term objectives, based on proper studies and the schedules where may be attained. The corresponding yearly cost of the pollution control programme is determined. The administration then imposes annual levies based on water consumption and the quantity of pollutants discharged to cover the yearly cost of the pollution control programme. Thus inhabitants, industries, and communities of a basin are made directly aware that obtaining or maintaining the water resource in quantity and quality is their collective responsibility. They participate in the financing and through their representatives in the evolution of the pollution control programme.

The levy system is flexible. Each reduction of the quantity of pollutant is encouraged by an automatic reduction of the levy and there is a permanent incentive to reduce pollution step by step. Industries are not obliged to spend immediately the full cost of treatment; to a certain extent they can programme the schedule by which they will reduce their pollution. If necessary the schedule can be speeded up by an increase in the levies. The levies strongly induce polluters to apply pollution control measures that are cheaper than the cost of levies and thus treatment automatically begins by the most efficient steps, which is in the overall interest of the community.

The levy system, by providing the necessary financing, allows the administration to put the maximum effort where it is most needed and to start with the

most efficient or sociologically useful works, including regional sewerage systems and treatment plants.

However, poisonous substances pose a different problem. Poisonous substances usually have a well-localised origin and it is cheaper to treat them at the source before they are diluted. Accordingly, it was recommended that a standard be imposed on effluents for these substances.

The introduction of a permit system was also recommended, to facilitate the identification and control of polluters.

Conclusions

I hope that this brief expose of the Laguna de Bay problems clearly shows the complexity of the task and the impracticability, or large corresponding financial losses of applying universal water quality standards without proper study. Each water quality programme must be desgned according to the particular needs of the water body and continuously improved according to the progress of our knowledge, and the aim of reaching perfectly clean water standards everywhere is almost certainly out of the financial reach of even the richest network.

I want to thank the United Nation Development Program (UNDP) which financed the study, the Asian Development Bank which was the executin and authorised the presentation of the paper, and all the participants in the study in particular LLDA, which contributed greatly in the gathering and analysis of data on Laguna de Bay. I also acknowledge the input of WHO in providing a water quality management expert attached to ADB.

QUALITY WATER FOR THE MASSES

by P. Soundararajan, National Research Development Corporation, New Delhi, India

When nature designed the planet earth, and filled two-thirds of it with water, it had some definite intentions. So much water was required to keep the rest of the earth air-conditioned, lest the living beings in it would perish under the fury of the sun. Also, such a huge water storage was required to provide drinking water using the nature's distillation apparatur -- the sun. That all the water contained in the oceans and seas are salty was also intentionally done. Firstly, it provides the ideal environment for the millions of underwater life to live (it is known that pertshable things are preserved in salt) and surely such a salty reservoir is required to receive the excreta from the land (both human and industrial). If the ocean and sea waters had been pure, disposal of wastes and effluents would have been a problem.

Thus, ocean and sea waters being not suitable for human requirements, life depends much upon other sources for its water needs -- rivers, lakes, tanks, ponds, well, and underground water. Except, perhaps, for underground water, most of the other sources of water are not safe for drinking without treatment. Water treatment is rather expensive and the municipal water supply which is treated is only within the reach of the relatively-rich urban population. Millions of the rural population, particularly in the developing countries, are consuming water without any treatment, thus exposing themselves to the hazards of water-borne diseases. A WHOsurvey indicates that about 30% of urban population and 88% of the rural population do not, even today, have access to safe drinking water. Even municipal water supply sometimes needs some kind of treatment, like filtering, boiling, etc., before they are used.

This, therefore, confirms the point that urgent action is called for to devise systems whereby the poor urban population living in villages could make the raw water available to them for safe drinking. The design should be such that it does not interfere much with their existing traditions and practices. Also, it should be cheap and easily adaptable within the framework of existing habits and practices of the people.

An analysis of the problem reveals that the probable system for water treatment should take care of two things:

(1) Removal of suspended impurities, and
(2) Bacterial disinfection ,

If these can be achieved by the application of simple and inexpensive techniques, the rural poor would feel grateful to the scientists and technologists of the world.

Techniques do exist for filtration and disinfection. For example, the Barkefield using filter candles of diatomaceous earth impregnated with silver catalyst has been in use for a long time. But this is rather expensive and such type of filters is used mainly in hospitals, public buildings, schools and colleges mostly in developed countries, and to a certain extent, in the developing countries. The same technique has been made cheaper by a process developed by the Regional Research Laboratory, Jorhat, Assam and the Central Glass & Ceramic Research Institute, Calcutta, India.

In this process, suitable grade of clay, a binder clay and bacteria inhibitor, are wellground separately and passed through a sieve to obtain the required particle size. Appropriate quantities of these substances are then blended with an aqueous solution of pore size modifier to obtain a slurry of a definite consistency. Candles are then prepared using this slurry in specially designed moulds, dried overnight, and baked in a furnace at controlled temperature for a specific time. Buff-coloured candles (shown in Fig. 1) are obtained after slow cooling. These candles can then be fitted into earthen pots as shown in Fig. 2 and could be used for filtering the suspended impurities; and to a certain extent, for the removal of bacteria present in the raw water. A small unit capable of producing 50 to 100 candles per day could be set up in a central location in a village or a group of villages. The investment would be about U.S. $3000. The equipments required are a small ball mill, aluminum moulds, mixing drums, sieve, weighing machine, buckets, etc. The down draught kiln required for baking the dry candles can be easily constructed. Table 1 below gives some of the salient features of the candles which are made using the RRL (Jorhat) technique. This know how has been successfully exploited by a number of entrepreneurs in India. One candle would cost about 50 to 60 cents.

Table 1. Some Detail of Water Filter Candles

(1) Weight 320 gm
(2) Dimension 7" long 2" dia.
(3) Filter Rate, Stationary Tyep Filter 1 gallon/day
(4) Some bacterial Tests of Candles made in the laboratory:

1. *(710,10)
2. (77,1)
3. (1600,0)
4. (2600,2)
5. (480,0)

*(x,y) x = Raw water bacterial counts per ml.
y = Filtered water through candle bacterial counts per ml.

The results indicate reduction in bacterial counts.

The candles made by the process can be fitted in earthen, brass, or porcelain vessels as shown in figure 2.

For disinfection of the water filtered as above, chlorine in the form of tablets or ampoules could be used. Inexpensive techniques have been developed at the National Environmental Engineering Research Institute, Nagpur, India. Details of raw materials, equipment, and capital investment are given below:

	Chlorine Tablets	Chlorine ampoules
Suggested plant size/day of 8 hrs.	100 bottles of 10 tables each	5000 ampoules of different capacities (2ml-25ml)
Raw materials	Common salt, sodium carbonate, stable bleaching powder, chalk powder.	Bleaching powder, sodium carbonate boric acid and distilled water.
Equipment	Dry mixer, tableting machine, bottling & labelling machine.	Mixer, polythene containers, automatic ampoule fitting & sealing machine.
Approximate investment on equipments	U.S. $5000	U.S. $4000

Approximate cost of production: US $10/100 bottles of 10 tablets each.

The suggestion, therefore, is that small entrepreneurs could be encouraged to produce water filter candles and sell them to potters, brass vessel makers, and others. Chlorine tablets could be encouraged to be manufactured by some entrepreneurs and the Governmentitself can buy the tablets and distribute them to the people either free or at nominal cost. Simultaneously, a systematic and effective campaigning programme has to be launched so that the people may become aware and understand the usefulness of the concept and the tools being offered to them. The district health and water supply authorities could be the implementing agencies of this new concept.

The above processes have been very successfully adopted on a commercial scale in India. The National Research Development Corporation of India, which has the licensing rights for the sale of the technologies, would be pleased to offer the technologies to other developing countries.

ADAPTATION OF WESTERN TECHNOLOGIES IN DEVELOPING COUNTRIES

by Dr. W.A. Osenga, P.V. Pacific Pte. Ltd., Singapore

Water Treatment in Developing Countries

The need of man for a reliable source of water needs no explanation anymore. Everywhere in this world, water is a precious, though indispensable good.

As a result of increasing human activity, many sources become gradually unfit for consumption or industrial use. This process has been observed for a number of years already in the western world; at present, also the developing countries are discovering the ill effects of water shortage and water pollution.

The western trained engineer has been able to acquire knowledge of the latest technologies during his education and professional career. Implementing his way of thinking and problem solving in developing countries will in many cases lead to disappointment.

Some of the major problems the engineer may encounter in developing countries are:

- the chemicals that are most suitable in his design, are either of a different, often lower quality, or are not obtainable on a regular scheme.
- as long as the equipment is new, the plant will run fine. However, problems may arise when special tools or measuring instruments are required for plant readjustment and maintenance.
- the ways of communication can be long. Ordering spare parts in the western world can be a matter of hours only. In developing countries ordering may take a very long time, especially when the goods have to be imported.
- climatic conditions play an important role in the plant design. Factors, that are of no importance in moderate climates can be extremely important in most of tropical countries.
- in many developing countries, water and waste water treatment are new disciplines. Proper university training is still new and a highly skilled supporting c adre is in a developing stage.
- water and waste water treatment asks for investment, which also can be

applied for building up the nation's industry.

Irrespective of the problems he may encounter, the western trained engineer, working in developing countries had the moral obligation to design treatment systems that are most suitable for those countries. He has to design his installations in such a way, that the best attainable performance is guaranteed now and in the future. Never, he will have the excuse that in developing countries, the requirements of the population for safe and reliable drinking and industrial water are lower than in western countries.

What is a bad or in efficient design in the west, cannot be and cannot be made appropriate in the other countries. Only the best possible design is just good enough, anywhere, in the world. Where local authorities have been lenient up to now, their attitude will change as problems increase and the popular demand for a safe and healthy environment cannot be suppressed.

ADAPTATION OF PLANT DESIGN

Local Availability of Equipment

When the engineer has the choice between locally manufactured or available products and imported goods, he should give local products priority, even when he has to modify his design.

For instance, properly coated, mild steel chemical tanks can be manufactured, almost everywhere.

Polyester or polypropylene/polyethylene tanks have often to be imported.

Another examples can be an imported self priming pump. In case a locally manufactured non self priming pump is available, the design can always be adjusted, so that such a pump can be incorporated.

Sometimes it is even possible, that the engineer promotes local production of part of his equipment. Although initially, this may appear an expensive procedure, it often will turn out to be profitable on the longer term. Import duties and shipping cost can considerably increase prices of imported goods, especially when local equivalents are available.

Requirements on Imported Goods

When import of materials cannot be prevented, the most suitable type is to be chosen.

Some of the requirements of imported goods are:

- their construction and way of operation has to be as simple, though reliable as possible.
- maintenance is to be minimal,
- the equipment must withstand the prevailing climatic conditions, and retain their full efficiency and reliability under those conditions during their full life time.
- in case of failure it should be possible either to have it repaired locally, or to replace it immediately by a spare unit.
- special tools and readjustment equipment, when absolutely necessary for proper maintenance are to be supplied with the equipment.

pH controllers, for instance, are mostly to be imported. Modern technologies offer such items as virtually maintenance free gel filled combined electrodes of high precision and stable solid state controllers. These components should be preferred above the old fashioned, outdated and inaccurate colorimetric methods or high maintenance saturated KCl solution filled electrodes.

Automatic free chlorine analysers are available in the form of colorimetric analysers or as electronic galvanometric direct measuring units the latter is highly preferable, though more expensive, as it does not require a daily make up of imported analysis chemicals. In the long run the more expensive analyser will prove to be cheaper and more reliable to operate.

Chemical dosing systems in moderate climates are often built up from chemically highly resistant PVC, ABS and similar materials, unless specially adapted material compositions are applied, in tropical areas these materials frequently give difficulties due to ultra violet radiation instability, high temperature creep or accelerated ageing. For long term, maintenance free stainless steel and stabilised nylon are preferable.

Solid state process controllers or "chips" have been developed for many industrial applications.

At present, these process controllers have reached an outstanding reliability and durability under a wide range of conditions though, at first sight these solid state controllers may appear expensive, they offer the plant owner ultimate reliability and stability. Maintenance has been minimised; a defective unit is just replaced by a complete preprogrammed unit.

Fault detection, if economically feasible, is done by the manufacturer and not

on site.

Local Labour

It is not always necessary to import complete systems, because part of the components of that systems are not locally available.

Switch and control panels, for instance, can be built locally, with the same or sometimes better characteristics as the foreign article.

Most countries equally offer sufficient facilities for machining of imported semi products or assembly of e.g. pumps, valves etc. A proper planning and organisation of the assembly and installation works safe guards proper quality; its extreme importance cannot be ignored.

It goes without saying that the overall design of the plant should be such that the installation works can almost completely be done by the local labour force. Only when necessary, the plant designer should give technical assistance and coordination. Naturally, the local activities are assisted and supported by comprehensive instructions and installation manuals.

Where a specified skill is required, the engineer is to reconsider his design in such a way that slight modifications may render the high skill unnecessary.

Treatment Economics

The total water treatment cost consists of both capital and operation costs.

In the western world, where labour cost maybe much more expensive than in developing countries, automation is an almost universal feature of treatment plants.

In many developing countries sufficient, low cost labour is available for those unit operations, which do not need automation.

Such unit operations are for instance the chemical preparation, chemical dosing adjustment (when the raw water quality changes just gradually), filter back washing and sludge dewatering.

A wide range of waste can be treated directly in a biologic treatment unit, or first cost efficiently be pretreated physico-chemically.

Such a waste water is for instance the effluent from an alkaline edible oil re-

finery and soap stock splitting plant.

Some characteristics of this effluent are:

COD	-	8,000	-	16,000 ppm
BOD	-	3,000	-	7,500 ppm
TFM	-	up to 5,000		ppm
pH	-	105 - 3		ppm

A direct biologic treatment of this effluent is almost impossible, regarding the low pH. Minimally a neutralisation is required.

A complete physico-chemical pretreatment will reduce the BOD and COD by approx 75-80%, thus reducing the power requirement of the subsequent biologic treatment.

An average of some S$0,25/$m^3$ extra chemical costs more than balances the S$0,65 - $0.78/$m^3$ to be spent on extra electrical power, when the effluent is treated biologically only.

Even more important becomes the proper system of treatment when an under capacity of electrical power supply is observed, then the system with the lowest energy consumption is prefarred.

In general it can be stated that where possible cost saving western technologies have to be applied.

Local Availability of Chemicals

In most countries will alum and lime be locally manufactured. Only occasionally ferric salts are local products (a.o. in Sri Lanka).

Caustic soda and liquid chlorine are often imported. Bleaching powder is almost exclusively imported.

When using these chemicals, their physical and chemical stability should be considered carefully, together with their safety in handling, transportation and storage. Especially in remote areas, the chemicals have to be stored long time and it is then useless to use instable or highly hygroscopic materials. Stable chemicals are to be prefered in those situation.

Polyelectrolites

Physico-chemical treatment of heavily polluted industrial effluents often requires the application of polyelectrolitic flocculant aids. These chemicals need special attention, as due to their hygroscopic nature, they tend to absorb water and thus deteriorate rapidly.

In dosing solution, their stability is often not more than 12-24 hours; the higher the ambient temperature, the shorter their time of stability.

A proper chemical make up and dosing system has been designed according to those data.

Polyelectrolites in drinking water production are hardly acceptable and a properly designed installation does not need them.

By a correct chemical dosing adjustment and incorporation of a flocculator that has been designed and calculated according to the process requirements a floc with a high settling velocity and strength is formed under all conditions.

That a number of drinking water production plants need polyelectrolites is a result of an optimistic interpretation of design data for the same type of plants in moderate climates.

Even in western countries only a very limited range of synthetic organic flocculant aids are accepted by the authorities.

Level of Technology of the Design

Water and waste water treatment plants often incur high investment costs, which only can be justified when the installation performance meets the specifications during its full life time at minimised operating costs.

Designs which are outdated or unacceptable in the west, have equally no more place in developing countries. At the present rate of development of these aids, the moment at which the adapted high technology equipment becomes most economical will be reached much sooner than the installation is depreciated. Outdated designs will only mean a rapid loss of precious money.

Equally the adapted high technology units are designed to operate at minimised energy and chemical consumption, extremely important features for developing countries.

Naturally, renovations of existing plants are always feasible, but only useful

when the core of the installation has been properly designed according to latest technologies.

Some Influences of Climate on the Design

The relatively high water temperature in tropical areas has a distinct influence on the design of both the water and effluent treatment plant.

The higher water temperatures increase the speed of many chemical and physico-chemical reactions as well as sedimentation velocities. Using data derived from experience in moderate climates may result in highly instable systems, which do not result in any good treatment result. Upgrading the system by incorporation of more equipment or by using more chemicals does not hide the fact that the basic design is not an optimium one.

Frequently, it is found that the aeration capacity of aerobic biologic treatment plants in tropical areas has been over estimated.

Whereas in moderate climates oxygenation capacities of aeration devices are stated to be in the range of 1.8 - 2.2 kg 02/kWh, in tropical areas, these figures have to be reduced considerably.

At a water temperature of 30°C, the oxygen saturated value of clean water is approx 7.3 ppm; at 10° it is 10.0 ppm. This means that the driving force, being the difference between oxygen saturation value and actual value is decreased equally.

On the other hand, the biochemical reactions taking place in the waste water are accelerated by the high temperatures; normally the reaction speed doubles at each 10°C temperature rise.

Summarised, it has to be concluded that in tropical areas, the oxygenation capacity of aeration devices has to be reduced from 1.8 - 2.2 kg/O_2/kWh to not more than 1.3 - 1.5 O_2/kWh, while the O.C./load factor should be not less than 1.2 - 1.4 kg O_2/kg BOD instead of 1.0 - 1.1 kg O_2/kg BOD.

Only then, a well balanced biologic system is obtained.

TRAINING & SERVICES

Operators Training

Operators training on new installations are an important factor in the scope of

the project.

Once the installation has been started up and adjusted a period of familiarisation of the operators with the plant will commence. To have full benefit of the new technologies, the project is to be completed by a thorough introduction in word and print to the operating authorities.

This introduction, both theoretically and practically, will greatly enhsnce the smooth running of the plant and will prevent unnecessary damages or maladjustments.

After Sales Services

The designer has to discuss in the design stage already what after sale services are required for the project.

Initially, a regular check on the operation will be required, together with an occasional retraining or re-instruction of the operators.

Equally, already in the design stage, the arrangement of spare parts storage is to be discussed.

A supply of spare parts for a period of 2 years will cover initial needs.

After that period, an arrangement between supplier and client for spare parts supplies will safe guard the proper operation of the plant.

A careful design of the plant will in many cases restrict the number of spare parts to a minimum. Incorporation of vuluerable equipment or equipment that is not suitable for the prevailing climatic condition are to be prevented optimally.

Conclusions

No arguments are found to assume that developing countries are helped, when they are offered water or effluent treatment installations that are outdated or aunacceptable in the western world.

However, it is not always possible to use the same designs in developing countries, due to different qualities of chemicals, availability of chemicals, energy supply situations and climatic conditions.

It is the challenge to the western trained engineer to design his system in such a way that he combine the newest knowledge and local conditions, to an opti-

mally satisfactory design.

A proper education, operators training and after sales service will further guarantee best possible performance of the plant.

Question and Answer:

Dr. Rahman: I am not in the consulting business but it comes as a surprise to me that certain equipment is utilized without regard to local conditions. Shouldn't they take climate into consideration, for instance, rather than get into trouble?

Dr. Osenga: Of course equipment supplied to these areas, such as switching equipment are utilized, but the performance of such units is a completely different story. It is sad but you have to admit there are too many failures of treatment plants in the Far East to say that they know what the climate condition is.

Mr. Rossi: I think you are both right. Problems do exist and cannot be simply ignored.

Dr. Osenga: Thus treatment plants are in many cases disigned overseas. I have discussed with Dr. Grombach and studies are extremely expensive. They take a long time to acquire data. Once there is data, there is again the problem of application.

Dr. Komolrit: I would like to point out one of the problems which we have in the developing countries: the problem of keeping the system operable after it has been installed. We have experience of some US firms installing flotation systems in Bangkok and after sales, we face the problem of the system not working properly. Many of our water systems must have waste control treatment plants. We have more than 70% of these plants which do not operate properly; many due to local incompetent operators, but the main problem which should be kept in mind is that of importing parts. Firms just sell their equipment and do not have a programme of follow-up. Perhaps we can have local representatives to follow up on equipment after installation.

Dr. Osenga: The same argument might be used about a year ago to go where the problems are. This is why my firm was set up in Singapore from where we supervise and survey this area and

and in our philosophy, after sales service is as important as the supply of the equipment itself. We have built installations in all corners of the world but we keep a tab on all installations and owners can always come back to us for assistance. It is also the reason why we have 9 such regional organizations all over the world to take care of the installations and if any installations breaks down say, in Egypt or the US, we have our own organization to take care of it from a nearby area.

Dr. Grombach: I would just like to say one word. It is not always the fault of the supplier or the equipment but it is also the question of maintainance. In developing countries the people are, by nature lazy, and it is the task of the manager to force people to do good maintainance where it is possible. Of course it is much easier to say the motor has broken down instead of taking a screwdriver to find out the problem. So really my friend from Bangkok, you must agree it is also the task of the developing countries to ask from the labourer to do a good job and do good maintainance.

Dr. Osenga: It is also part of the duty of the designer of the plant to supply equipment which is as simple as possible. His next step is to train the operator, which is not a one-week job. It takes weeks and months; and after that, if he still makes mistakes, then it is no longer the responsibility of the supplier. He must learn why such mistakes are made and try to solve the problem for the future.

I E 1

WATER QUALITY- A CONSULTANT'S POINT OF VIEW

(To lead up to an open forum on water quality)

By Robert L. White, President, Engineering Science, USA

ABSTRACT

Adequate quantities of water are essential for the social and economic well-being of every country. Of equal importance is the requirement that the quality of the waters supplied fit the desired uses for domestic supply, industrial supply, agriculture and recreation.

In most countries there is a direct relationship between the quality of drinking water and public health. An unsafe drinking water supply results not only in human suffering, but also in major costs from health care and lost productivity. Agricultural productivity is also affected by water quality, particularly salinity, and industries have widely varying quality requirements.

Rational development of water resources should be based on providing water quality adequate to meet the minimum needs of the water uses being considered and on avoiding the unnecesary costs of providing water quality greater than needed.

OPEN FORUM

WATER QUALITY MANAGEMENT IN MALAYSIA

by Prof. (Dr.) Ariffin Suhaimi, Dean, Faculty of Science and Environmental Studies, University Pertanian Malaysia, Serdang, Selangor, Malaysia

Introduction

Resource by itself is not a problem; it may not cause pollution. But poor use of resource is a problem, ultimately polluting other resources which form the basic need for all living things. In this case the basic resource is water, which men have taken for granted as being plentiful for thousand years, until today when we suddenly realise that there is a limit to this resource and the need to conserve it.

Polluted water can still support some form of life, and may even support a stable ecosystem, but it will not be fit for human utilization water quality management is, therefore, not a mere ecological management; it requires technology, Legislations and a national policy, to control and regulate the many conflicting demands upon this basic resource, and upon which our modern civilization has put a heavy stress.

Problems of Water Resource Management in Malaysia

Malaysia has no national water resource policy. Like land, water is a state matter, with no Federal area of jurisdiction. All the state within the Federation have almost a complete control in the way they develop their water policies and decide priorities. Nevertheless, there are a number of Federal agencies cooperating to manage water resources within the states. There are, at the moment, about twelve government departments, whose activities are related to water, with varying responsibilities and overlapping legislations. Under these conditions it is legally difficult to directly impose a Federal standard for water quality management. Cooperations among agencies, between Federal, States and Local Authorities level, have always been stressed, and at official levels these always lo k good on paper. In practice there have been delays and errors of implementations, generally for reasons of poor coordinations.

In earlier days when pressure of demand for water for domestic supply, agriculture and limited industries were low, the management of water quality presented little problems. A state may still allow a small food precessing industry be established upstream, and the natural absorbing capacity of the river would allow time for recovery of BOD load to be of no impact to a water intake

point downstream. However Malaysia's rapid developments, beginning in the sixties, with wide ranging economic activities, such as mining, agrobased and other industries, urban developments, and regional land schemes, must necessarily affect heavily on our water system and in conflict with other uses for domestic purposes, irrigation for agriculture, and fisheries, not to mention the need for recreational and other aesthetic values. Yet, the old attitude of unconcern continued to allow worsening pollutions of our inland waters and our seas.

There has been no real, organised estimate of the total availability of water throughout the year in Malaysia, estimates that would show future trends due to changing microclimates. The assumption has been that, since Malaysia has a wet tropical climate, water should be always available in abundance throughout the year. Today it is becoming obvious that Malaysia is experiencing more and more water stress periods. Large scale land developments, and logging activities, have reduced stream flow during periods of low rainfall, and pollution problems can become worst during these periods. Most rivers in Peninsular Malaysia are polluted at varying degress of severity, and a few like the Kelang and Juru Rivers are considered dead. Clearly the old system of water resource management by various agencies has not been adequate to control the deteriorating conditions.

Fifty six percent of our water pollution problems is caused by rubber factories and palm oil mills. Pollution from these causes are perculiar to this region, and in particular to Malaysia. Knowledge of treatment technology to control these wastes has not been known, and under these circumstances it will not be possible to introduce stringent measures, without adversely affecting the growth of these industries, when about fifty percent of Malaysia's economic growth has been dependent on agriculture. Efforts to introduce water quality management measures must be undertaken with cautious approach.

The Evolution of Environmental Quality Act 1974

The concern on environmental quality by the Malaysian Government was felt in the early seventies. This concern was reflected by the evolution of an Environmental Quality Act which was passed and made law in 1974 under Laws of Malaysia Act 127.

Water being a state matter, the Act provides no powers to the Federal Government, either to specify directly any quality standard to any water within a state, nor to classify into various users any water body within that state. The constitutional basis in the promulgulation of Environmental Quality Act 1974 with regards to water quality standard is indirect, through such matters as public health which is a Federal responsibility. Since pollution does effect health

directly and indirectly the implication is valid practical, but the legal system is complex and can slow down implementation. Inter departmental understanding and cooperation is paramount to formulate a working system within the overlapping legislative framework. Nevertheless, the Environmental Quality Act 1974 provides a common legal basis to coordinate all activities on environmental control throughout the country, and in cases where there are conflicting interests between Federal and State Legislature, the Federal Act will prevail.

Since the control of water quality by the Federal Government under the Act is indirect, this is best done through the promulgulation of permissible discharge standards at source. The Act provides powers to a Federal Minister, who is responsible for environment, to promulgulate an Environmental Quality Legislation wherein regulations on discharge are formulated. To assist the Minister to administer and enforce the Act, a Division of the Environment (DOE), headed by a Director General, was also created in 1975 under the provision of the Act, and was placed under the Ministry of Science, Technology and Environment, with the Minister of that Ministry being responsible for the environment. This provision of powers to the Federal Government on pollution control does not impinge State responsibilities on such matters as the State Water Anactment to govern the supply of water for domestic, agricultural, industrial and other uses. This division fo Legislative Powers into a Federal List and a State List is not inconsistent with the spirit of the present Environmental Quality Act 1974 to control pollution and regulate environmental management; it provides checks and balances to prevent abruptness and excessiveness when actions are taken, with of course the inherent danger of bureaucratic delays, against which the DOE is being safeguarded.

The Effects Of Water Related Legislations

The main sources of water pollution in Malaysia are from the agrobased effluents; sewage and industries, and siltation. Among the three categories, pollution from the agrobased effluents is considered the most severe. Hence, among the first water-related legislation formulated by the DOE are related particularly to palm oil and rubber. Since these effluents contain very high organic contents and very little toxic materials, the present regulations use BOD criteria as standards for control of discharge.

A discharge from a palm oil mill generally contains a BOD load more than fifty times higher than that of untreated sewage, with figures quated ranging from 18,000 ppm to 25,000 ppm, indicating the degree of severity of water pollution problems faced by Malaysia, especially if these mills are scattered throughout the country. The recommended quality standards for discharge under the regulation for palm oil mills in terms of BOD load are still high-

higher than untreated sewage (see Table 1), with the expected increase of palm oil mills from the present 130 to about double this figure in 1985 (each new mill with increased capacity to 30-40 FFB), the combined total of BOD load discharge into our streams will probably bear no improvement to our water quality under the existing Regulations; though it may be argued that the situation can be worst, if without these Regulations.

With regards to effluents from rubber factories, the prospect, of an early solution is better than palm oil. The BOD load from rubber is generally much lower, and the recommended quality standards of rubber waste discharge under the Regulation is correspondingly lower than those for palm oil (see Table II & III). However, it must be pointed out that these effluent limitation standards are still very high when compared to the maximum permissible level of BOD for aquatic life. Hence, we cannot really say that Malaysia will have a fairly good water quality after the present Regulations have become effective. All that we can say perhaps is that situation will improve or will not get worst.

Pressure upon the industries-(palm oil and rubber) to reduce their discharge is heavy. Palm oil and rubber mills come under the Prescribed Premises Regulations 1977, where a mill must apply for a licence to operate, and mills must pay a separate fee to discharge. For palm oil the fees are $100/- per metric ton of BOD load above a permissible limit, and applicable throughout the four generation of standards as scheduled.

In the first year of enforcement of Regulations, mills were permitted to dispose of their effluent on land and fees were charged at the rate of $50/- per 1000 metric tons of effluent disposed on land. It has been reported (Maheswaran 1979) that the Government collected a total of M$2,500,000/-by way of fees during the first year of implementation of the palm oil Regulation.

Similar procedure of fees is enforced on rubber but as a treatment technology is becoming available to meet the standards, only licence fees will be charged and will become mandatory for rubber mills to conform to the standards applicable at the respective dates.

With these high pollution fee, as well as the granting of incentives by way of waiver of fees for research on effleunt treatment technology, have forced the industries to take actions. The impression one gets by listening to what the industries have to say in public is that of optimism; the standards as set in the Regulations will be met within the target period. However, when one listens to the industries in officeial circumstances there seem to be problems and difficulties. Privately it is known that the palm oil industry is working hard to find an early solution. It has been reported (DOE, personal communication) that Dusun Durian Palm Oil mill in the State of Selangor, belonging to Harrison and Crosfield Ltd,. has even achieved a BOD discharged of 100 ppm. from a

mill capacity of 40 FFB. The treatment technology used by this mill is an improvement of the basic principle of anaerobic digestion followed by a series of aerobic stabilization ponds. It may be a recommended practice where much land is available.

The prospect of a solution to the pollution problem from rubber mills seem to be encouraging. Research to find this solution has been actively carried out by the Research Institute Malaysia (RRIM). By following good House Keeping Rules as prescribed by the DOE, pollution loads from rubber factories can be reduced to about half, and indications are that the industry may be able to bring down the BOD load to about 50 ppm by using appropriate treatment technologies within the schedule period as stipulated by the Regulation. Since the rubber industry is responsible for about 20% of our total pollution load, this reduction in BOD will be a significant contribution towards a gradual improvement of our water quality.

In industries, other than palm oil and rubber, technologies for control of discharge is fairly known. Hence, these are not included in the Prescribed Premises Regulations 1977. Plants established within the nonprescribed premises category will need to comply to the recommended standard of discharge as stipulated in the Environmental Quality (Sewage and Industrial Effluent) Regulation 1979 which came into force on 1st July 1977. However, if a plant is unable to meet this standard, the firm may apply for licence to discharge with fees imposed at the rate of $100/- per metric ton of BOD discharged into inland waters within a catchment area, and $100/-or $500/- (depending on the toxicity of the substance) per kilogram of toxic chemical discharged. For any other inland water the corresponding fees will be $10%/- per ton of BOD and $10/- pr $50/- for toxic chemicals. In this respect a new control concept is introduced namely categorising inland waters into two standards- Standard A for catchment areas (in practice all arees above a water intake point) and Standard B for areas outside a water catchment, where discharge fees are lower, (see Table IV).

Water-borne sewerage system have always been in operation in the big towns in Malaysia. However, until about the time when the Environmental Quality Act 1974 was introduced, extensions to this system had been slow and not in keeping with the population growth. When the system was then reviewed it was found that only 11.9% of our urban population were using flush toilets connected to the community water-borne sewerage system. The majority of our urban population (44.3%) were using flush toilets connected to septic tanks, and 34.7% were served with conservancy (or bucket) system while a further 9% (mainly in squatter areas) had no facilities (Maheswaran 1979)

During the Second Malaysia Plan (SMP 1971-1975) the Government started a drive for rural sanitation programme including safe water supply schemes.

This was carried forward in the Third Malaysia Plan (TMP 1976-1980). In view of the problems faced and experiences gained, the Government has revised the target to be achieved in TMP so as to cover only 59% of the rural population by end of the Plan Period. In the meantime programmes to improve the sanitary system in urban areas has been in progress. In Kuala Lumpur the conservancy system is being withdrawn and being replaced by flush toilets connected to the community water-borne sewerage system. The City by-Laws now require private developers to construct a treatment plant with oxidation ponds for a new housing estate.

The system can then be handed over to the relevant authorities. Due to problems and difficulties the progress has been slow in the implementation of community water supply and sewage disposal system in Malaysia. Some of the constraints have been lack of trained personnel, poor interagency coordinations, insufficient local production of materials, and cumbersome financial framework. With these shortcomings the schemes may be extended into the Fourth Malaysia Plan (1981-1985).

The third cause of water pollution in Malaysia is siltation, which provides about 18% of public complaints to the DOE. Siltation is due to a number of activities, such as mining, land developments, urban developments, highway constructions and logging. In many of these not only is the technology for control available, but there are also the legislations by-Laws for compliance. Enforcements, however, have been very poor. In most of these, the Environmental Quality Act 1974 has no direct jurisdictions. A programme for effective control of these source of pollution requires a multi-objective planning for Legislation and Enforcement, in place of separate agencies, each looking after their own interests.

It is to be admitted that the progress in water-quality management in Malaysia is slow. The complex Legislative systems, and the present inadequate establishment within the DOE are some of the factors that do not allow for a rapid development in environmental control measures. There have been priorities set in the national programme for water quality management, while public pressure must grow to exert influence for environmental concern throughout the country. This is best guaranteed through the activities of such organisations as the Environmental Protection Society of Malaysia, the Malayan Nature Society and the various consumers' associations. Public reaction to pollution problems tend to erupt when or where environmental situations have become critical. Such eruptions have been prevented from becoming big political issues by responsible cooperations from all concerned. Within our Democratic System of Government, public awareness of environmental problems can be a healthy force to promote progress in water quality management.

Limitations of Environmental Quality Act 1974

When the Environmental Quality Act 1974 was introduced, water quality management was one area, where the Act will exert regulatory control. However, the Act must be introduced within an existing system of three-tier government-Federal, State and Local Authorities. It has been claimed that the Environmental Quality Act 1974, which is a Federal Act, provides broad powers for the protection and enhencement of the quality of the aquatic environment. But when an Act is evolved within a limiting constitutional framework, the powers of the Act cannot be pervasive and comprehensive to cover all aspects of the environmental dimension, without impinging on State rights and the responsibilities of Local Authorities. It is partly for this reason that it may not be easy to introduce Federal regulations under the Act to control pollution from non point sources, such as the application of chemicals in agricultural practices and the dumping of solid wastes in authorised and unauthorised landsites. The best that the DOE can do is to call for cooperations and coordination of efforts through committees to introduce non-statutory control measures in the form of "Codesof Practices", and hope for support for funds to be made available for the improvement of various measures for environmental management, and to consider environmental control as part of development strategy, effecting all the way from the Federal to the Local Authority level, which is now being restructured.

The concern for environmental quality that had led to the introduction of the Environmenal Qualtiy Act 1974 was mainly inspired by economic considerations. Since Malaysia is dependent for more than 50% of her economic growth on renewable resources, environmental degradation can threaten the continued renewability of this resource. The main problem threatening the environment at the time of the evolution of the Act was pollution from industries, particularly agro-based. Hence, the spirit of the Act is mainly responsive in nature, leading to the promulgulation of regulations that are corrective in character to arrest pollution at source.

The Act is weak in areas of environmental management for resource conservation, and was introduced without the backing of a comprehensive National Environmental Policy. This policy appears later in the TMP (1976-1980), that really provides the basis for anticipatory type of environmental management in the form of Environmental Impact Assessment Procedure (EIA), now being formulated by the DOE. This EIA does not have the strength of a legislation and is proposed to be introduced as an integral part of a planning for a development project, private or public, and as part of a requirement for approval of a project proposal. The procedure provides sufficient flexibility to be in harmony with the countries need for economic development as required by the policy as stated in the TMP (1976-1980). If there is any objection to the proposed EIA, it is more on the lack of access for direct public reviews of project proposals,

than on the lack of its Legislative powers.

Since environmental management must be balanced with requirements for economic development, a flexible approach has been adapted. Hence, different policies are generally adapted for different categories of pollution sources in formulating various Environmental Quality Regulations. After considerations of the enormous amount of BOD reductions the industry need to achieve and the current state of technology then available, four generation of standards were recommended for palm oil effluent, scheduled to be achieved within four years (see Table I), and three generation of standards for raw natural rubber to be achieved within three years (see Table II), as incorporated in the respective Regulations. The palm oil Regulations came into force on 1st July 1978 and the rubber Regulation came into force on 1st April 1979. As indicated in Table I and Table II & III, the limitation standards for discharge are still far above the Maximum Permissible Limit for propagation of fish and acquatic life. In fact it is still higher than that of untreated sewage. While standards have been specified in terms of BOD values, other quality criteria will still need to receive attention. It is quite obvious that the tradeoffs are very much in favour of the industries, as against the really acceptable water quality standards that would be fitting for other users, such as fisheries and recreation. These tradeoffs have been recommended in view of the mitigating circumstances against the industries, besides giving time for the industries to find more lasting solutions. The approach has been officially considered justified for short term contingencies against the prevailing circumstances.

The above arguments give reason to speculate that a review will be needed to examine the effectiveness of the various Regulations that have been introduced. There will also be a need to review the existing Environmental Quality Act 1974, and to find means of incorporating those aspects of environmental management which now must fall under Non-Statutory Control Procedures as Codes of Practice and Procedures, and to encompass the broader concept of Environmental Resource Management into the Act.

Water Quality Monitoring

Essential to water quality management, the DOE has established a water quality monitoring programme. Two methods have been adapted. One is by analysis of water pollution complaints from the public, and the second is by physical and chemical analysis of samples from selected water bodies. In implementing this monitoring programme, the river basin concept has been adapted and a total of 65 river basin control regions have been established - 49 in Peninsular Malaysia, 9 in Sabah and 7 in Sarawak. A report from the DOE (Abu Bakar and Hilmi 1979) summarises the monitoring programme of 1978 as indicated below. (Figures are for Peninsular Malaysia).

a). Total number of river basins = 13
b). Total number of rivers = 98
c). Total number of stations = 208
d). Area coverage = 29,933 square miles
e). Total number of samples taken in 1978 = 1,234
f). Covered monitoring frequency: - = Once a month for 50% of the stations. The rest is covered once for every two months.
f). Number of sub-professionals engaged = 4

The criteria for selection of river basins for the monitoring programme were as indicated below:

a). The number of formal public complaints received from the river basin.

b). The number of rubber factories and palm oil mills in the river basin.

c). The siting of an industrial estate within the river basin

d). Major development for example land clearing, the creation of new towns and resettlement being carried out within the river basin.

e). The river is of beneficial use to the population, including irrigation, fishing, and domestic uses.

Data have shown pollution pattern along certain rivers, as shown in Fig. I for Kelang river, which is one of the worst polluted in Malaysia. The pollution load as shown will require more than the powers of the present Regulations to clean this river. When the river recovers from its BOD load of about 8 mg/l. twenty miles downstream, the level is still slightly higher than the maximum permissible limit for propagation of fish and aquatic life.

Analysis of complaints from the public serves as a primary source of information for planning the monitoring programme, and keeps a direct communication open between the Government and the people. The complaints are analysed in ranking orders of severity according to the number of complaints received from a point source of pollution within a unit time (6 months). Results of this analysis show relative degrees of severity of pollution sources as follows:

Palm oil	-	33%
Rubber	-	23%
Pig waste	-	5%

Industrial effluents	-	20%
Mining, Earth-works	-	18%
Quarry		
Others	-	1%
Agro-Industrial E Effluents (excluding pig waste)	-	56%

Research and Training

Research on pollution control for water quality management is only a recent activity in Malaysia. In the case of problems from rubber wastes, Malaysia has been fortunate to have an established Rubber Research Institute of Malaysia (RRIM) to carry out the bulk of research activities for solving this problem. Because of the fees to discharge being very heavy, the palm oil industry has been carrying their own research efforts, with some complementory activities being carried out at the Malaysian Agricultural Research and Development Institute (MARDI), at universities and recently at palm Oil Research Institute Malaysia (PORIM). Almost all aspects of these problems are being looked into, including:-

1). Biological treatment
2). Chemical/Physical treatment
3). and disposal
4). Utilisation
5). In plant processing technology

The Ministry of Science, Technology and Environment has recently designated the Standard and Industrial Research Institute Malaysia (SIRIM) as the Government agency responsible to promote environmental research in Malaysia, but funds for this purpose are very inadequate and research grants to universities are negligible. An effective national research coordinating body is needed through which environmental research may be presented for priority status for funds to be established for this purpose. In the absence of this coordinating body research funds will have to be acquired individually with little effectiveness.

The training of personnel is also imperative in promoting water quality management. Most Local Universities give environmental related courses, which are available to students doing various academic programmes in a university. A programme of studies leading specifically towards an Environmental Science Degree is available in Universiti Pertanian Malysia, while a degree related to Environmental Engineering is available in Universiti Teknologi Malaysia. These academic programmes on the Environment are fairly recent and have not produced enough manpowers to fulfill the needs of Government agencies and industries. In the meantime, Environmental Control Office recruited by the DOE have been undergoing on the job training, while a national inservice training programme for these officers is now being organised at Universiti Pertanian Malaysia with the assistance of the WHO Regional Center for Environmental Planning and Applied Studies (PEPAS).

Conclusion

We believe that with the introduction of Environmental Quality Act 1974 a machinery to promote environmental control and management in Malaysia has been established. With this establishment we can hope to improve our water quality management throughout the country. The process may be slow and complex, but this demonstrate cautiousness so that efforts for environmental quality management and economic development do not negate each other. The experience may be unique to Malaysia due to our peculiar constitutional provisions within our Federal system of Government, and social-political traditions. Nevertheless, we believe that our approach towards environmental management is stable and will lead to satisfactory solutions.

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Table I - Four Generation Sets of Effluent Standard For Palm Oil

Parameter	Standard A 1.7.78	Standard B 1.7.79	Standard B 1.7.80	Standard D 1.7.81
Biochemical Oxygen Demand (BOD), 3-Day, 30^0: mg/l	5,000	2,000	1,000	500
Chemical Oxygen Demand (COD); mg/l	10,000	4,000	2,000	1,000
Total Solids; mg/l	4,000	2,500	2,000	1,500
Suspended Solids; mg/l	1,200	800	600	400
Oil & Grease; mg/l	150	100	75	50
Ammoniacal-Nitrogen; mg/l	25	15	15	10
Organic-Nitrogen; mg/l	200	100	75	50
pH	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0	5.0 - 9.0
Temperature, ^oC	45	45	45	45

Table II - Three Generation Sets of Effluents Standards for SMR & Conventional Grade Factory Effluent

Parameters	1st Generation standards effective on 1.7.78	2nd generation standards effective on 1.7.79	3rd generation standards effective on 1.7.80
pH	6.0 - 8.0	6.0 - 8.0	6.0 - 8.0
BOD ppm (3 day at 30^oC)	500	300	200
COD ppm	1,000	750	500
Total solids, ppm	1,000	1,000	1,000
Suspended solids ppm	250	250	250
Total nitrogen ppm	100	100	100
Ammoniacal Nitrogen ppm	80	70	70

Table III - Standards for Latex Concentrate Factory Effluent

Parameter	1st generation standards effective on 1.7.78	2nd generation standards effective on 1.7.79	3rd generation standard effective on 1.7.80
pH	6 - 9	6 - 9	6 - 9
BOD ppm (3 day at 30°C)	450	300	200
COD ppm	1,500	1,000	500
Total solids, ppm	2,500	2,000	1,000
Suspended solids ppm	1,000	800	250
Total nitrogen ppm	450	350	350
Ammoniacal Nitrogen	350	300	300

Table IV - Standards for Sewage and Industrial Effluents

Parameter	Unit	Standard A	Standard B
(1)	(2)	(3)	(4)
(i) Temperature	°C	40	40
(ii) pH Value	-	6.0 - 9.0	5.5 - 9.0
(iii) BOD5at 20°C	mg/l	20	50
(iv) COD	mg/l	50	100
(v) Suspended	mg/l	50	100
(vi) Mercury	mg/l	0.005	0.05
(vii) Cadmium	mg/l	0.01	0.02
(viii) Chromium, Hexavalent	mg/l	0.05	0.05
(ix) Arsenic	mg/l	0.05	0.10
(x) Cynide	mg/l	0.05	0.10
(xi) Lead	mg/l	0.10	0.5
(xii) chromium trivalent	mg/l	0.20	1.0
(xiii) Copper	mg/l	0.20	1.0
(xiv) Manganese	mg/l	0.20	1.0
(xv) Nickel	mg/l	0.20	1.0

(xvi) Tin	mg/l	0.20	1.0
(xvii) Zinc	mg/l	1.0	1.0
(xviii) Boron	mg/l	1.0	4.0
(xix) Iron (Fe)	mg/l	1.0	5.0
(xxii) Sulphide	mg/l	0.50	0.50
(xxiii) Oil and Grease	mg/l	Not detectable	10

Question and Answer:

Dr. Rahman: By imposing a flat-rate fine above a certain BOD level the industries may find it economical to concentrate their wastes and discharge them. Does the sewage from urban areas go through some treatment process before being discharged into the environment or is it discharged without any treatment?

Dr. Suhaimi: In answer to your first question on the BOD, this is in fact quite unique in term of palm oil and rubber. They are actually concentrated to 100 times BOD load above the raw sewage. Because they are scattered, the pollution problem is all over the country. Of course there are reasons why these mills are not concentrated in one area because they have to be located near the palm oil source. There are quite a few mills concentrated on one river basin and in fact one factory was taking water polluted by another factory upstream. The Director-General of the Environment Division had to order zero discharge from the mill concerned.

With regard to your second question, some of the untreated sewage from the bucket system does go to the sea and this affects the waters around the state of Penang (Georgetown) but the State Government has taken steps to improve the sewage system of the city. Recent complaints on the presence of raw sewage around Penang beach was also blamed on the hotels whose septic tanks were malfunctioning. The bucket system in KL is being withdrawn. I was told that by the end of the 3rd Malaysian Plan (ends 1980) the withdrawal of the bucket system will be complete, but I think it will spill over to the 4th Malaysian Plan.

Dr. Osenga: When I made a calculation of your figures, I think it is cheaper for the industries to pay the fine than to treat their water.

Dr. Suhaimi: I would agree on that observation. Anyway there are other pressures besides the fine. One factory which mismanaged the effluent discharge drew so much protests from a village that the Environment Division ordered temporary closure of that factory until they corrected the problem. So there are other ways of twisting their arms.

Dr. Osenga: But as a general rule, for any treatment plant to be run efficiently, in terms of power consumption it will be more expensive than the fines imposed.

Dr. Suhaimi: There are also other means like a paper mill in the state of Penang where their waste discharge drew protests from the farmers and the state government threatened to cut the water supply and it forced the mill to take action to install a treatment plant.

Dr.Osenga: Yes, but this is still incidental.

Mr. Ponniah: I was pleasantly surprised to read about the achievement of the mill in reducing BOD. Is this the composite sample?

Dr. Suhaimi: This is one mill which has been able to develop their technology to reduce BOD load to 100 ppm

Mr. Ponniah: Is this ppm based on the composite sample or on individual samples.?

Dr. Suhaimi: On a few samples; but there is need for further sampling.

Mr. Ponniah: There are other organizations doing research on palm oil, e.g. Guthrie. They are basically using the same concept.

Dr. Suhaimi: So far as I know the best result was from this mill. Others were not very good. There was one mill owned by a Perak motor firm. They claimed their BOD load was lower than 100 ppm but we have not checked this. We also felt that the process had too many stages. I think the one that was established at the mill we saw was the cheapest and quite simple.

Mr. Ponniah: A reduction of 99.996% is pretty hard to believe...

Dr. Suhaimi: I tend to be optomistic that if one mill can achieve it then so can others.

Mr. Leong: In this mill, do they treat 100% of the discharge? I find that most of these factories in Malaysia are actually operating below capacity, or at times they are actually by-passing some part of the effluent plant. As a result they are able to show samples which are below 45 BOD. I believe your University has made some studies on this. Would you confirm that it is 100% of the effluent passing through this treatment plant?

Dr. Suhaimi: We cannot, because we have only looked into this about 2 weeks ago when we went on a visit and we were impressed but we still have to do a lot of monitoring on this. As far as we could see, it is 100%. They do other things besides the anaerobic- aerobic process. If you are interested, we can always exchange notes.

Mr. Leong: Particularly in a place in Sabah, we would have a very few palm oil factories but most of them are located very near the sea. In this respect, don't think there is some value to it?

Dr. Suhaimi: Actually my paper is based on the legislative aspect. Of course there are other considerations, like biological treatment, in-plant improvement, technology, or chemical and physical treatment and disposal area.

APPLICATION OF AEROBIC COMPOSTING IN THE DISPOSAL OF LIQUID PALM OIL WASTES

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Introduction

The disposal of liquid wastes from palm oil production represents one of the major water pollution control problems in southeast Asia. The flow is large and the organic strength of the waste is such that the application of conventional and advanced wastewater treatment processes will result in an effleunt quality which will, even under the most optimistic forecasts, severely tax the environment. Present practice involving application of the waste to land results in severe odor problems coupled with rampant reproduction of soldier flies which are a nuisance to plantation personnel and residents.

This paper presents a new concept for the management of palm oil wastes. The concept biologically utilizes the energy available in the waste to aid in the evaporation of the waste stream while at the same time stabilizing the material and returning essential nutrients to the plantation soils from whence they came. This latter benefit is particularly significant in that approximately 1 kg of potassium is removed from the soil for every metric ton of fresh fruit bunches harvested.

The Palm Oil Production Process

Palm oil derived from the fruit of the palm tree arrives at the processing plant on stalks or in bunches from the fields. The fruit is first separated from the bunches; the residue is subsequently incinerated. The fruit is then mechanically coverted to a shredded pulp or mash. The mash is then pressed, rerulting in the extrusion of a water-oil mixture. The water and oil fractions are separated using a clarification system. The oil is subsequently purified and vacuum-dried to produce the final principal product.

A secondary product, palm kernels, is produced from the cake which remains after the mash is pressed. The cake is broken and the fibre is removed using air classification. The remaining nuts are then cracked resulting in a mixture of kernels and broken shells. The kernels are separated from the shells using both air and water classification. The kernels are then dried and stored as a secondary product.

The principal product of the industry is palm oil. The palm oil begins to break down rapidly into fatty acids as soon as the bunch is picked. Accordingly, it is important to quickly stop the enzymatic breakdown before significant product is lost. This is accomplished in two ways, first transportation and storage time is minimized by using many relatively small facilities; and second, the bunches of fruit are steam treated as soon as they arrive at the palm oil mill. The steam treatment serves to stop the enzymatic oil destruction and to loosen the fruit from the bunches.

Quantity of Wastewaters from Palm Oil Production

A total of 0.6 kg of waste is produced from each kg. of fresh fruit bunches harvested. Three main effluent sources exist in the palm oil production process:

(1) Liquid wastes from the oil clarification process
(0.45 kg/kg ffb) = 75%

(2) Liquid condensate from the steam pretreatment process
(0.10 kg/kg ffb) = 17%

(3) Liquid waste from hydrocloning of kernels
(.05 kg/kg ffb) = 8%

Quality of Wastewaters from Palm Oil Production

The palm oil clarification process produces a very strong waste, which is 75% of the total, therefore its characteristics dominate the total wastewater flow. Table 1 presents typical analysis of palm oil mill wastewater.

The large concentration of potassium, iron, and phosphorus indicates high mineral requirements by the palms, hence return of these elements to the soil in some form is undoubtedly essential to continued productivity.

The ultimate BOD approximates 75% of the COD. Since BOD is a measure of biodegradable organics and COD, total organics, it must be concluded that the waste is almost totally biodegradable.

The waste has approximately 2.2% suspended solids. This constitute a thin sludge. Studies of this waste show that it is very difficult to effect solid/liquid separation. The particle size is very small as particle density is close to water hence gravity or centrifugal separation has been found ineffective. This same small size makes filtration nearly impossible because of rapid blinding of the pores of the filter. For this reason, effective application of

the waste to the land is very difficult because these suspended solids also blind the soil pores.

Effluent Discharge Specification

Where palm oil mill wastes are discharged to ordinary surface water courses, the BOD of the mixture of wastes and surface waters probably should not exceed a maximum of 50 mg/l.

In a large stream, where there may be 10:1 dilution of the wastes, this implies a discharge requirement of 500 mg/l which represents 98% removal from the raw wastes. Recognizing the nature of the waste and that a 500 mg/l requirement could only occur in the most ideal conditions, it becomes very clear that current wastewater treatment technology, both conventional and advanced, is incapable of managing this problem.

Table 4 - Characteristics of Palm Oil Mill Wastewaters (From various sources)

Constituent	Average	Maximum	Minimum
pH	3.7	5.2	3.4
BOD_5	25,000	35,000	8,500
COD	50,000	88,000	30,000
NH_3-N	30	60	20
Organic - N	600	800	400
Nitrate - N	30	60	20
Phosphorus - PO_4	140	250	70
Total Solids	37,000	55,000	30,000
Suspended Solids	22,000	30,000	14,000
Dissolved Solids	15,000	25,000	16,000
Ash	3,000	5,000	1,300
Oil and Grease	6,800	10,000	4,400
Minerals			
K	1,620	1,928	1,281
Mg	295	344	254
Ca	315	405	276
Na	43	71	29
Mn	3.3	4.4	2.1
Fe	117	164	117
Zn	1.5	1.8	1.2

Cu	1.2	1.6	.8
Cr	.17	.43	.05
Co	.05	.06	.04
Cd	.01	.02	.01

Disposal to the Land

Extensive work on land application of raw and anaerobically digested palm oil waste has been conducted[1]. This work resulted in the following findings:

(a) When the wastes are applied, soild clog rapidly
(b) Rainfall washes out dikes and causes losses from the beds.
(c) Maggots of the soldier fly find the waste an ideal medium (1/2" to 3/4" fly). These flies create a large nuisance on the farms and mills.
(d) Odors are a serious problem.
(e) The shading caused by the trees inhibits drying and causes water-logged soils.

The Ideal Solution

The ideal solution would be one in which no discharge, direct or indirect, of palm oil wastes to streams would occur. All nutrients contained in the wastewater and bunches would be returned to the soil. The palm oil product is essentially all carbohydrate; nutrient substances taken up in the plant are all found in the waste; where return of waste products is feasible, the plants will be in a near state of ideal equilibrium with their nutrients. The exported product is actually nothing more than water, carbon dioxide and sunlight, combined in the form of palm oil.

Problem in Achieving the Ideal Solution

Palm oil wastes are not readily assimilable into the soil due to waste characteristics, tight soil conditions, and abundant rain. If the wastes were assimilated into the topsoil, the high carbohydrate content would undoubtedly cause denitrification and a resulting decrease in the fertility of the soil.

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(1) Guthrie Research, Chemara, Serembon

Characteristics of the Ideal System

(1) The system would render all the wastes ideally assimilable into the soil.
(2) The system would be simple, not requiring extensive, difficult to operate, sophisticated equipment.
(3) The system should destroy excess carbohydrates in both the wastes and the bunches.

The Ideal System

The foregoing description accurately describes aerobic composting. (In many parts of the world, anaerobic composting of human and animal wastes is practiced; anaerobic composting of these materials would probably not be suitable for these wastes. Care should be exercised in not confusing aerobic with with anaerobic composting).

Composting

Composting as a wastes management process utilizers a biological system.

The factors that make biological systems so attractive in waste treatment are applicable to both liquid and solid waste management. A few factors are of significant importance. Biological systems require less energy than chemical or physical systems; reduced energy needs, coupled with inexpensive equipment requirements, make biological systems economically attractive; biological systems have less of an adverse environmental impact inasmuch as biological treatment processes are nothing more than carefully controlled and accelerated applications of those that occur in nature; biological systems result in a more complete conservation of resources.

As with any system, biological systems have certain disadvantages. Such systems are relatively slow in accomplishing treatment, i.e., exposure times are specified in terms of several days rather than minutes or hours. Usually, such systems are "bulky" with respect to volume and space requirements. Biological systems are unpredictable and highly sensitive to treatment conditions.

Composting is a method of treatment which involves the biological decomposition of the organic fraction of solid wastes under controlled conditions. A basic principle of biological treatment in reclamation is the fact that microorganisms constitute the active component. Therefore, the sucessful operation of a composting treatment system depends upon exposing the or-

ganisms to an environment inductive to a suitable microbial population at the density and degree of activity required to carry out the requirements of the system.

Composting operations consist of controlled microbial reactions, yielding a stable end product at a high rate. Composting produces a stable material that can be utilized to rejuvenate the land.

Fungi and actinomucetes are a significant group of microorganisms in composting, since these organisms are favored in the semi-moist conditions that prevail in the process.

The major microbiological control parameters for optimum composting include:

1. Temperature. Optimum thermophilic composting occurs at approximately 140°F. Microbial decomposition proceeds at a faster rate at elevated temperatures, thereby speeding up the composting process.

2. Moisture. The desired range of moisture content is from 40 to 70 percent with an optimum content of 55 percent. Moist conditions will favor bacteria over fungi or actinomycetes, thereby enhancing the rate of the composting process.

3. Hydrogen Ion Concentration (pH). Satisfactory composting occurs in a pH range from 4.5 to 9.5 with optimum conditions at 6.5. This pH range is required for optimal microbial metabolism and consequently, proper composting.

4. Nutrients. The desired carbon to nitrogen ratio is 40:1 while the optimal carbon to phosphorus ratio is 100:1. Nitrogen and Phosphorus must be present in the compost at these ratios to ensure an adequate nutrient content for microbial growth.

5. Air. 10 to 30 cu. ft. of air/day/lb of volatile compost solids is required for proper aerobic biological metabolism.

6. Particle Size. Particles sizes ranging from 1/4 to 1 in. provide an optimal surface area for the microbes to begin the degradation process.

Windrow Composting

In the windrow composting system, materials to be composted are stacked in piles which are usually arranged in long parallel rows or windrows. Such windrows are turned over at regular intervals. In cross section, the windrows

are somewhat triangular, the shape depending largely on characteristics of the composting material and the method used for turning. The windrow system has been used successfully for composting of a wide variety of organic residues. In general, windrow composting is relatively low in cost because of the simplicity of the system, but it can also be relatively land intensive.

Aerated Pile Composting

The aerated pile process differs from the windrow process in that composting material is not turned. Aerobic conditions are maintained by mechanically drawing air through the pile.

In this process, liquid waste is mixed with a bulking agent, such as woodchips, which serves as a moisture absobent and provides porosity to the material. The required ratio of liquid waste to bulking agent has been reported to be 1:2 to 1:3 on a volumetric basis.

Following mixing with the bulking agent, the mixture is placed in large piles. A loop of perforated drainage pipe is placed beneath each pile and connected to a suction fan whose operation is controlled to maintain aerobic conditions throughout the pile. Both size and quantity of the bulking agent must be controlled to maintain porosity throughout the pile and assure adequate air flow without excessive blower headloss. Detention time in the aerated pile is reported to be about 21 days after which the pile is distributed to the soil or stored.

Mechanical Composting

Mechanical composting is a general term used to describe systems which involve use of mechanized, enclosed units desgined to provide control use of major environmental factors. Numerous mechanical systems are available on the market. While details of the mechanical systems may vary, basic principles governing the composting process are similar for all such system.

Major desgin differences among the mechanical systems are in the method of aeration. A relatively constant tumbling or turning action is commonly used to provide aeration. Nevertheless, the principles applied to windrow composting can generally be applied to mechanical systems. Since the turning action is usually more frequent than with the windrow technique, the need for a friable or porous mixture may be somewhat reduced.

Moisture in Composting

Decomposition of organic matter is dependent upon the presence of moisture

to support microbial activity. Permissible moisture contents for various wastes are listed in Table 2. The values shown are related to the structural strength of the composting material. Fibrous or bulky material such as straw or wood chips can absorb relatively large quantities of water and still maintain their structural integrity and porosity.

Application of Composting to Liquid Palm Oil Wastes

In aerobic composting, the oxygen source will be gaseous oxygen and the predominant species will be bacteria, fungi, and actinomycetes. The desired environment will be a moist porous matrix capable of allowing the free flow of air. The moisture will contain the major source of the organic substances to be degraded.

Table 2. Maximum Recommended Moisture Contents for Various Composting Materials

Types of Wastes	Moisture Content % of Total Weight
Straw	75-85
Wood (sawdust, small chips)	75-90
Rice hulls	75-80
Municipal refuse	55-65
Manures	55-65
Digested or raw sludge	55-60
"Wet" wastes (lawn clippings, garbage, etc.)	50-55

In the case of palm oil production, the bunches, presently discarded and burned, could be processed to provide such a matrix. The major problem is to render the bunches such that they can accept the liquid waste.

The waste production rate is 0.6 kg/kg ffb. Assuming the oil and kernels represent 25% of the ffb's, and assuming the bunches themselves are 50% moisture, the moisture content of the mix of bunches and wastewater will approximate 72% moisture, or 28% solids. This consistency is too wet for composting. Accordingly, additional solids must be obtained to produce the optimal environment. This problem can be solved by the reintroduction of previously composted bunches.

In order to make the bunch material hold water, it will be necessary to optimize a chipping and shredding process. The chipped material needs to have

a maximum of surface area, since water will be held to the chipped materials through surface attraction. Obviously, the maximum surface area will occur as the material is pulverized to finer sizes. Too fine a size would, of course, prevent the free flow of air essential to the composting process. Accordingly, there is some size of chipped particles which is optimal for the process and which must be determined.

In addition to achieving control of the consitency of the chipped material, it will be necessary to determine the optimal recycle rate of composted material. The total composting process will be as shown in Figure 1.

Heat Balance

As shown in Table 1 the incoming raw liquid waste has a COD of approximately 50,000 mg/l. COD can be a measure of energy content. For common substances, heats of combustion are readily available; for these same substances it is possible to calculate the COD. Using these calculations one can express energy available in terms of Kilocalories of energy per gram of COD satisfied for any desired compound. Table 3 represents such calculations for some common organic compounds. As can be seen in Table 3 an energy yield of 3.3 Kcal/gr of COD satisfied, is a reasonable value for most organics.

With a COD of 50,000 mg/l = 50 gr/liter, the total possible energy yield will be approximately 165 Kcal/liter.

The theoretical heat requirement to evaporate 1 liter of water from an ambient temperature of 25°C is 615 Kcal. Thus the energy contained in the liquid waste can provide up to approximately 25% of the requirement to evaporate the water. The balance of the energy must come from solar insolation and decomposition of parts of the bunches. (If available, other solid wastes can be adde added to the compost to supplement the energy requirement).

Table 3. Energy Yields of Organic Compounds

Compound	Energy of yield Kcal/mol	Energy of yield Kcal/gr of COD satisfied
Methane	2.3	3.47
Ethyl Alcohol	327	3.40
Acetic Acid	208	3.25
Amyl Alcohol	794	3.20
Lactose and Sucrose	1,350	3.51
Glucose	670	3.48
Palmitic Acid	2,385	3.24

Conclusions

(1) The severe problems created by the disposal of liquid wastes generated in the palm oil production industry are solvable.

(2) The controlled use of aerobic composting has the potential to eliminate the entire waste stream flow to the aquatic environment.

(3) The return of the nutrients in the liquid effluent (particularly potassium) to the soil will benefit the industry.

(4) The elimination of this breeding material for soldier flies will improve the plantation environment.

(5) A full scale demonstration of this technology should be undertaken as soon as possible.

Question and Answers:

Dr. Komolrit: The conclusion on your problem seems to be quite over-simplified. You concluded that the problems can be solved if you have money.

Mr. White: How much money do you think it will cost? It will take 2 trucks, a chopper and a tank mounted on a trailer. We are talking about very simple technology. We are not talking about tertiary treatment with expensive equipment from far away countries but we are talking about a chopper and a small tank mounted on a trailer.

Dr. Komolrit: My point is how do you get rid of the compost?

Mr. White: Just spread it out under the trees.

Dr. Komolrit: Over a period this will become accumulated.

Mr. White: 15,000 acres is the average estate area. You can use it over the entire 15,000 acres. It will have all the high-powered chemicals that presently the plantations are buying, to put under their trees.

Dr. Komolrit: Of course you have to prepare the bulking material.

Mr. White: It is very simple.

Dr. Komolrit: Well once you have to prepare it, it can be a chore.

Mr. White: I disagree totally.

Dr. Osenga: First I must say that the idea is one of the best I have heard about palm oil but I think you over-estimated some points and one of the things is that at the moment a palm oil mill is, in term of energy, a very balanced system which means they are supporting in their energy supply. When you take away the their branches you have to replace these by fuel oil which is another headache for the industries because of the present energy crisis.

Mr. White: That is one of the deficiences because we did not know of the energy trade-offs. You are correct in that we will be depriving the mill of their energy. I think a lot of that power will have to be supplemented with gas or other material in order to get it to burn. Secondly with the advent of the energy crisis, the need for palm oil is growing rapidly because palm oil can be supplementary source of energy.

Dr. Osenga: How much organic material is converted into inorganic material?

Mr. White: I don't have the answer to that - Mr. Ponniah?

Mr. Ponniah: About 6%

Dr. O senga: That is again important for the preparation of your water.

Mr. White: I do not claim to have all the answers. We just have a concept which is a better alternative than trying to treat water because of the simplicity of the system.

Dr. Osenga: At the moment they are also recycling ashes as fertilizer. Do you take this into account?

Mr. White: One of the things we do not know is the effectiveness of the ashes.

Mr. Ponniah: There is a scheme going on in Malaysia using palm oil waste and applying it to the land, and we have found that quite a certain amount of benefit can be gained by recycling it into the land. I do not know myself whether the ashes itself will be as beneficial than actually putting back the waste product.

Dr. Osenga: That is what I do not know. One thing which has not appeared in this study is transportation costs. You have to truck away 40 tons a day over 15,000 acres.

Mr. White: We made those calculation and the period is not extensively long. The problem in transportation is taking material back to the outer boundaries of the plantation along with the liquid waste and doing it at selected locations. One of the alternatives is to do it at the side of the mill and bring the compost back. The primary problem is not getting down to macroeconomics but to prove to mill-owners that it will work and if it can be shown to work, then I can assure you that the people in the palm oil business, being good businessmen themselves, will be persuaded to accept it.

Dr. Osenga: I wish you extremely good luck. Maybe it is a better alternative.

Mr. White: At least it will not require 99.996% probability.

THE USE OF RECYCLING AS A WATER POLLUTION ABATEMENT TOOL

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The Use of Recycling As A Water Pollution Abatement Tool

This presentation is basically a paper to be presented in August at Solid Waste '80 on the subject of annelidic recycling of solid waste and is included because we believe that organic waste recycling not only removes serious water pollutants in the nitrate production area (solid waste, animal wastes, sludges and human wastes) but that the major product of organic waste recovery a blended organic /chemical fertilizer--also reduces the nitrate run off problem from irrigated areas and farmlands which are now deposited in lakes and reservoirs resulting in excessive nitrate loads, weed and algal growths and subsequent eutrophication of the water body. The secondary product is worm meal a high protein value feed ideal for agriculture.

Whilst on this occasion I am concentrating on the use of organic recycling it is also worth considering further benefits of the removal of other pollutants by recycling. Amongst these are the recycling of oil and chemicals.

It is true that all waste must go somewhere and in Asia much of these wastes do end up as water pollutants. They remain a very serious polluter of ground water of drainage, rivers, lakes and oceans. The more waste that can be removed by profitable recycling the less our water will be polluted. Thus the establishment of recycling has direct benefits to Asian Water Management. Water Management can do much to stimulate such activities. The establishment of recycling centres in water catchment areas, the establishment of waste exchanges where one factory waste can be utilized as the raw material of another plant. The passing of laws requiring more recycling and a higher usage of blended or organic fertilizers in water catchment areas.

Using concepts dating back to Aristotle and Charles Darwin, many governmental agencies and universities worldwide have now begun to study the use of vermicomposting (earthworm recycling) as a method of sludge and solid waste management. They are obtaining positive results.

The function of the vermicomposting system is to effectively and efficiently turn bio-degradable mixed waste materials to a balanced consistent, high quality top soil and provide for the production of earthworms. The materials which may be used to form an acceptable mix are almost limitless and include most organic "wastes," industrial pulp and paper "wastes," cannery and related

food processing "wastes," manures and sewage sludge, and solid waste which is considered an ideal worm feed.

Earthworms are also reproductively prolific. Under optimal conditions, earthworm populations double in number in a ssixty-day period. This allows for expansion of the system and the use of earthworms as a protein supplement in the food chain.

The earthworm recycling system offers several important "plusses"

- It provides a method of eliminating the pollution created when organic "wastes" are landfilled, burned, or dumped at sea
- It utilizes these biodegradable materials in a formulated, blended mix for digestion by earthworms. The result is casting compost and additional earthworms to be used productively in raising food
- Vermicomposting completes the process of recycling "waste products" into useful commodities.

When considering large scale organic stabilization operations, the vermicomposting system stands in contrast to the less efficient methods of conical or windrow composting. Latter technologies of controlled aerobic decomposition utilize only bacterial and fungal decay necessitating the use of air blowers or machinery to turn the pile and thereby providing oxygen to the decay organisms. Vermicomposting is superior to these methods for the following reasons:

- Turning of the compost is minimized; the movement of wet material is less.

- Extended forced aeration of the compost is not necessary, as the earthworm movement channels oxygen into the compost.

- It is usually not necessary to use bark chips or extraneous materials to prevent the compost from packing.

- There is no need to maintain high temperatures. Although a rapid temperature build-up is desirable for initiating thermophilic bacterial activity and destroying certain pathogenic bacteria, by using vermicomposting methods, the maintainance of high temperature is neither necessary nor warranted.

- Earthworms radically decrease pathogens present in the organic material. The environment and bacteria associated with earthworms facilitate the destruction of the coliform group and Salmonella.

- Earthworms, in a proper mix, can digest large amount of pulverized fibrous material. This allows cellulosic substances such as paper to be composted more quickly than is possible with conventional methods. Earth-

worms have the highest cellulase activity of any invertebrate.

- A protein-rich animal may be cultivated on material once considered a waste since pulverized and properly mixed refuse is a food source for earthworms. Dried earthworm meal has an actual protein content better than 60% and has a higher percentage of sulfur-bearing and essential amino acids than meat meal. Earthworm meal is comparable in quality to fish meal as protein supplement.

- Earthworm excreta (castings) are a superior soil-conditioning material. Worm castings (a) exhibit low misture levels which allow greater water retention, thereby slowing down erosion when applied to the soil; (b) display a "natural time release" for releasing total nitrogen over a six-week period; and (c) may be mixed and bonded with chemical fertilizer, forming a casting pellet, for large scale agricultural crops resulting in less "run off" in high rainful areas.

- Castings have a nitrogen content which equals or surpasses the original nitrogen content of the undigested food due to volume reduction and carbon utilization.

- Earthworms accelerate the degradation and stabilization of various sludges. This is possible because the surface area of the sludge is greatly increased as it passes through the earthworm. Earthworms stabilize sludges as much as two and a half to five times faster thanother methods. Earthworms return organic wastes to the eco-system in a safe, sane, and easy manner which is completely harmonious with nature.

Castings are the end result of the feed (waste) taken in by earthworms; they are the fece of earthworms. Earthworm castings are fine cylindrical excretions containing a considerable quantity of humus and are the finest (highest quality) top soil produced by nature.

The quality of castings varies with the type of feed or wastes being fed to the earthworms. For example, earthworms can digest low nitrogen, high fibrous organic sybstances like straw and paper wastes and will produce a good soil amendment, but an overall low quality casting. On the converse, earthworms can digest aerobic sewage sludge which contains 4 to 6% nitrogen and the castings from this source will be of very high quality. The analysis of castings, although variable, show a high soluble calcium, potassium, sodium and phosphoric acid content. Most of the nitrogen is in the organic form as mucoproteins, peptides, urea, uric acid, allanton, and humic acid; the remainder as ammonia and nitrate nitrogen.

The recycling system designed by the Japanese Aoka Sangyo Company produces

a high quality casting having a total NPK content (dry weight) above 3%, with some castings above the 5% NPK level. In some areas of the country this is high enough to be considered a fertilizer. The castings have a high cation-exchange rate with a carbon to nitrogen ratio under 20:1; excellent for good plant assimilation.

The entire dry granular composition of castings is under 4.0mm., with over 50% of the dry castings under 1.0 mm. The AOKA earthworm castings have a humus content above 20% (dry weight) of which better than 10% is humic acid. The humus portion of castings is responsible for stabilization of organic matter, binding of water to slow leaching, release of water during drought, and binding of metals for appropriate plant use. Humus also acts as a nitrogen recycling sink; it imparts a good texture and fertility to soil due to pore space and tilth and, most importantly, acts as a plant growth hormore stimulant. As such, castings are indeed a favorable organic soil amendment among gardeners.

Air-dry earthworms castings have a density lower than most potting soils due to the fine porous structure permitting air entrapment. Transportation coasts are thereby reduced.

Castings, due to the mineral, nitrate and high humic acid content, must be mixed 1/4 to 1/2 with low nutrient materials for making a good potting soil medium for seedlings and house plants. For soil amendment fertilizer usage, castings are generally applied at the rate of 1.0 to 2.5 tons per acre depending upon soil and environmental conditions, and the crop grown.

Earthworm castings are also very unique in that they are protected by a peritrophic membrane secreted around the castings during egestion. This membrane aids in the mineralization and time release nature of castings. The earthworm comminutes the organic matter into very fine particles and as such fresh castings have a very high respiration rate. The microbial activity has been greatly increased due to the increase in the surface area.

The castings of earthworms contain more fungi, Actinomycetes spp. and cellulolytic type bacteria than if the organic matter is left alone in the soil without earthworms. As such, the earthworm castings are the foci for dissemination of the beneficial microorganisms.

Thus it is quite evident that castings hold a great potential for agriculture. Their potential marketing usages are varied and near limitless. Sales range from bulk tonnage and large cubic foot packages for home gardeners, to potting soil supplements in two-quart sizes. Castings can be combined and transformed with chemical fertilizers for modern large-scale farming, holding a great promise for the future.

Three major earthworm casting products are available for marketing:

- Bulk sales; as soil amendment for household and small farming gardens.

- Nutrient component in potting soil.

- Castings pelletized with chemical dertilizers for modern farming operations.

It is this last product that AOKA feels will be the agricultural fertilizer of the future.

Herein is listed a brief summary of the major research reports of significance on castings in the U.S.; also included are the research excerpt and land tests of the Japanese casting products.

- Excerpts from Edwards abd Lofty, Biology of Earthworms: Chapman and Hall. The reports in the book indicate that earthworm castings have a higher base-exchange capacity, with more exchangeable calcium, magnesium, and potasium, and available phosphorus than soils without earthworms. The over-all evidence is that earthworms make more mineral nutrients available for plant growth, which is important for improving soil fertility, than soils without earthworms.

- Studies have shown that addition of live earthwroms to garden soils increased yields of peas, oats, soybeans, clover and other crops over similar fields without additions of live earthworms.

  Microorganisms of the Actinomyces spp. and Streptomyces in particular have been found in high concentrations in fresh earthworm castings and their antibiotic effect in reducing the non-acid-fast pathogenic microorganisms has been observed. Microbial activity increase up to a thousand fold while passing through the earthworm's gut.

- Earthworms and Wheat Yields. From "Availability to Wheat of Elements in Sludge-Treated Soil with Earthworms," by Ms. B. Kirham; in conference proceedings; Utilization of Soil Organisms in Sludge Management.

  In her experimental trials she used small pots containing a "sludge treated silt loam soil," some with earthworms and some without. Wheat was used as the growth crop. Her results indicated that the sludge treated soil with earthworms contained more extractable minerals and had a greater dry-weight wheat harvest than that without earthworms.

- "Biodegradation of Animal Waste by Lumbricus terrestris;" Journal of

of Dairy Science, Vol. 55 (1972)

In this study, earthworms were used to digest cattle feed lot and dairy manure. The resulting castings were analyzed and used in potting soil tests.

"The excretion (castings) of the earthworm was a loose, friable humus type of soil containing 3.0% nitrogen (dry weight) 0.32% P and 0.4% K.

"One hundred flowering plants were planted in the worm dirt each week for 12 weeks. The same number was planted in the normal soil mixture to serve as control. Six pairs of each 100 plants were put on a common watering system. There was no difference in growth rate, but the plants in the worm dirt had heavier root systems. A panel of four men subjectively evaluated the six pairs of each 100 plants which were on separate watering systems for growth rate, root systems and number of blooms per plant. The plants in the worm dirt required more water, grew faster, and had larger root systems and more blooms. The nitrogen content dropped from 3.0% N (dry matter) to 1.25% N during the first 3 weeks and then down to near 0% during the next 3 weeks. This indicated that the nitrogen was readily utilized by the plants and that it was available to the plants over 6 weeks."

It is in Japan, through the research work and sales of castings products by AOKA SANGYO CO. LTD., in co-operation with Nippon Agriculture Shizai Co. Ltd., Chichibu Chemical Co., Ltd., and field test plots done by the Tokyo Agricultural University and its related testing stations that most of the convincing evidence for large-scale use of castings and their true agricultural value can be seen. The castings were used directly on small and large farms.

The Japanese companies produce three products for marketing:

- "Soirich," bagged fine-screened earthworm castings.
- "Fand," low-quality castings for potting soil.
- "Soirich Organic Transformation," the fine screened earthworm castings from "Soirich" chemically bonded with chemical fertilizer to form a casting pellet spreadable by large farming implements. (e.g., a vegetable No. 1 package, being 8-8-8-24; 8% Nitrogen, Phosphoric Acid, Potassium, and 24% Soirich). Most of the "Soirich" is used in this process. Over 2,000 tons a month of the transformed casting pellets are produced.

In brief summary is the "Soirich (earthworm castings) Composition Tests," first report, Tokyo Agricultural University. (Trans., Robert Kono).

- "A pot test was done on the relationship between the effects of phosphoric acid and the drained Soirich, and the effects of increasing fertility through the absorption of phosphoric acid. In comparison to the contrasting portion, the Soirich portion was greater in terms of yield; in the "above surface" category, it showed a 13% increase on rice seedling.

- As to the analysis of the yield, the "above-surface phosphoric acid" section of the Soirich portion showed remarkable increase; potassium also increased slightly (i.e. rice seedling and plant absorption analysis of material).

- Soy beans, effectiveness of Soirich in raising crops, and tests at the Tokyo Agricultural University Testing Station, Soil Fertility Division, Dr. Kawat Noboru . . . . . .

- The Soirich was used as a fertilizer with proportion of 30% and 10% mixed with 3-10-10 fertilizer (3% Nitrogen, 10% Phosphoric Pentaoxide, and 10% Potash). Composition 1 was 30% mixture composition 2 was the 10% mixture.

Test Results

In the beginning, the growth rate was good and the plants flourished without showing signs of toppling over. In proportion of yield, composition 1 at 3-10-10 30% Soirich was greater than composition 2 at 3-10-10% Soirich. The Soirich alone was greater in yield than the contrasting section of 3-10-10 alone. The yield in fruit weight percentage: the Soirich alone was 2% higher than the contrasting section, and composition 1 (3-10-10-30% Soirich) was 24% higher than the contrasting section and composition 2 (3-10-10-10% Soirich) was 12% higher than contrasting section.

Chinese Cabbage Test Results were:

Soirich of 30% mixed with 16-10-14 fertilizer increased yields by over 42% than just contrasting section (fertilizer) alone. The 10% Soirich with 16-10-14 increased yields by also 42% over contrasting section.

Green Soybean Test Result Were:

Soirich at 30% with 3-10-10 increased yields by 20% over contrasting section (3-10-10 alone) and when Soirich was used alone the yields increased by 10%.

The results of the crop-raising tests overall indicate that earthworm castings produce greater yields than usual compost substitutes and can be considered an effective substtitute for compost. Also, earthworm castings alone equaled or often increased yields over the contrasting chemically fertilized section; and earthworm castings transformed with chemical fertilizer, in the 30% combinations, increased yields between 14% to 42% over the contrasting chemical fertilizer sections.

Therefore, castings take on a value at least equal to the local price of fertilizer and in Japan blended fertilizer is sold at a premium of approximately 20% over chemical fertilizer.

This we believe such a system offers Asia and Asian and profitable answer to its organic solid waste disposal problem.

Question and Answer:

Mr. Rossi: You have all visited the (Asia Aquatech '80) Exhibition; What were your impressions of the Exhibition?

Dr. Komolrit: I paid 2 visits to the Exhibition and I found it quite informative because it is composed of various equipment and I think we have not been able to get hold of much of it.

Mr. Rossi: Regarding the people in the stands - were they able to answer your questions? We were talking of sales back-up service yesterday. Did the exhibitor know Asia or were they working through an agent or was he just working in Singapore?

Dr. Komolkit In my opinion, I think the exhibitors are their own representatives. They know their products well but did not know how well it can be adapted to the local condition. They are new to the area and they did not know the constrainst of the area. They just know their products are good but they have not studied in depth what are the cost, constrainsts or handicaps. They think it is easy in Asia to get mechanics to correct any problems, but if they try to use their products in the developing countries they will have some problems because they have no experience.

I think they did not take the market seriously yet. I think to make a good market they have to exhibit themselves and at first you cannot expect to gain and they will have to take the initial losses. This of course means that you need capital investment and I think they have not taken this risk yet.

Mr. Rossi: What is the next step from there? Where do you go as a sales organization to get knowledge? Dr. Osenga?

Dr. Osenga: As a sales organization working in the Far East, you have to learn the hard way by making 100 mistakes. That will take you as a non-Asian company a number of years. It is the most natural way to do it, learning from your mistakes. The next step after you have learned your first lesson is to go to the cities and stay there long enough to discover the real needs of the people. Try to understand their way of thinking and marry that into a proper solution to the existing problem.

Mr. Rossi: Here we have an extremely rich market in Asia and here we have new companies which spend enormous amounts of money on research in their own countries. Are they willing to spend large sums on local research to organize, install, administer?

Dr. Osenga: I cannot speak for other countries but my own company spent here and I would continue to spend until my 50th birthday.

Dr. Suhaimi: When I purchase equipment I have 3 criteria in mind:

1. The Equipment must be reliable;
2. The price should be reasonable;
3. After-sales service must be available.

After I get these 3, then in the tender this company gets because we do by tender. When it comes to after-sales service, most of the companies now have after-sales service for one year, after that we enter into a service agreement with the company concerned. Quite a few companies are doing that in Kuala Lumpur and those companies which do not have agents in KL have them in Singapore who can send their experts to KL easily.

With regards to some US firms, they have local agents in Malaysia itself. The local agents usually give advice to the companies concerned of local problems. If they select the the personnel properly then they will get proper advice. Of course that is a personnel problem. In terms of research I would like to give an example of the rubber industry. In this industry we have well established Rubber Research Institute in Malaysia. When it comes to research of rubber

effluents, most companies gives funds to carry out the research. But in the Palm Oil Industry, there was no such institute until recently. They call it the Palm Oil Research institute and even at this moment they do not have permanent building. So most of the companies like Harrisons & Crossfields do their own research for the oil problem.

Mr. Rossi: One ommission in your 3 criteria. Whose words do you take for reliability?

Dr. Suhaimi: This is where we sometimes face problems because when we want to purchase certain items we make specifications and usually we borrow one of the company's specifications and modify it to suit our problems. Usually before we do that we consult the local agents. If there are some equipment presented in our University or Institute we will go to find out the reliability of that equipment.

Dr. Liu: We bring in the producers to the Exhibition here but ha ve we brought the purchasers? Amarket has to be met by 2 purposes- seller and purchaser. For a developing country the purchasers are not individuals particularly in regard to water control equipment. These are government officials. At the exhibition I did not think the government officials were present. I doubt how successful this Exhibition can be.

Mr. Rossi: The specifier has not the authority to come. This is a short-sighted policy but it is the economic policy of the countries. It does not affect the future of the country. On the other hand if he came, can he get the answers he wants? Notwithstanding the financial constraints, would there not be certain advantages for testing the equipment locally?

Dr. Suhaimi: There are many countries in this region like Malaysia where we have the Standards & Industrial Research Institute. From there it can be introduced to the market but not enough people use it.

Dr. Osenga: You mentioned reliability, finance and after-sales service criteria to decide which system to choose. We as the supplier supplier in many countries face big problems why at this conference you don't see government officials. I do not want to insult anybody but many times we have the feeling that they are extremely self-satisfied. In Malaysia you have a very big organization, JKR. It is impossible

to offer anything on their attendance. They do not accept it. The system may be much cheaper, much more reliable and have a better purpose but it is still not acceptable. It is the same in Singapore as in Malaysia, the Philippines, Indonesia. About six months ago, we had a project in Surabaya for a very big sewage plant. There was a consultant and that consultant made mistakes in his study and the plant could not work. I was admitted by the consultant that mistakes had been made but the report was ready and the government did not accept any modifications of the design.

Mr. Rossi: You are saying people are using the consultant's decision rather than consider the suppliers' recommendation?

Dr. Osenga: They are tied to their designed system rather than to use something else.

Mr. Rossi: It is true; in our industry the same thing can be said. There is a book and they go by the book. The consultant is, in many cases, the specifier, not the client.

Mr. Pariset: In some countries, you are not allowed to change anything. If you tell me who the consultant is, I will tell you who will get the contract. But in a lot of the countries I have great difficulty to convince them that it is not in their best interest and I always put a clause in my contract that they are not obliged to accept it.

Mr. Rossi: How many of your companies contracts are with the French Government and how much with other countries?

Mr. Pariset: 80% of our jobs are abroad.

Mr. Rossi: Usually they are getting the wrong thing because the consultants they are getting are from abroad and these the government rely on.

Mr. Pariset: Being a consultant, I cannot follow you very far on this line I work mostly in France and Canada. My thinking may be biased, but basically there are 2 lines and the basis is political and administrative.

Mr. Rossi: What is the trend there? What is happening in Asia? Is Asia going to rely on consultants forever? In a peer group many of you attended the same universities in the U.S., whether Asian or not. Some returned and take up

directional positions, few became consultants. Back here you meet on different terms, each telling the other what to do- one a consultant, the other talking from directional position. Why are there not more Asian Consultants? I am a consultant; I am talking against myself. We are talking here of meetings of consultants and specifiers and if you boil it down, it is a horrible mess. We have a water quality conference- we move into equipment - we come back to water quality but who wants to know? That is the point. Otherwise we would have 300 delegates and a thousand exhibitors but they are getting tired of not meeting th· specifier.

Dr. Liu: As a person born in China, raised in ormosa and now living in the US, I have observed some basic problems here. In the US or European Countries, we do things differently. But the difference has not been well accepted by the people in Asian countries particularly among decision-making. Where asin the US we try to bring suppliers and consumers together so that they can exchange ideas, it is not only the supplier. Unless we can bring the consumers and suppliers together, this conference will be a waste of time and money. Unless we can find out what the Asian developing countries want, we cannot market nor can there be technology transfer. It will continue to be one-sided and no tangible effects can be expected. Can we try something out in the next conference and try to get information out to the developing countries, particularly people who make decisions for purchasing equipment?

Mr. Rossi: This is what we hope to achieve by the formation of a Water association.

Dr. Osenga: The Asian people will not need the Westerners indefinitely I feel that I have done my job properly and in 5 years' time they will not need me anymore. That comes to a completely different point. What they need is education. Not education on how to depend more on the foreigners but education on how to depend less on foreigners. Let them design their own solutions for their own problems. I think it is a much realistic approach. Personally I think it is even much better that my company is run by local chaps who do as good a job or a better job that I can in a few year's time.

Mr. Rossi: You will not lose any money doing this?

Dr. Osenga: What is money except that is needed to live, eat and sleep?

Dr. Liu: The purpose of this conference is to transfer information : the needed countries and transferring does not mean one way. Transferring can have a feedback and here we have the good intention to transfer our information so that there can be water quality all over the world. However we cannot have our informa tion transmitted if no people from the developing countries are attending the conference.

Dr. Komolrit: As a technical man we really have a lot to say; but when we say something, you have to clarify. For example if you use certain equipment, you have to give reasons why you use it. If I say that equipment is used in Malaysia, Singapore, then I get more weight to my proposal. But as a technical man I have to convince the top as to why we use that equipment. many times we do not have the backing of sufficient informa- tion.

Dr. Grombach: I am a little late. I want to answer Dr. O senga. I don't think it is true that you can train people in 5 years and then go back and allow people to manage themselves. Because you can'tg do that either. You must learn all your life. You did and I did. I think knowledge transfer and tech- nology transfer has to take place all the time and the Asian people will need that exchange indefinitely. It is not negative to say that the cooperation has to take place indefinitely. I think even if Asian people have great success there will be some difference in technology between the developing and developed countries for a long time. Some new technologies will spring up in Europe, America or Japan and will have to be transfered to other countries to southern countries and not developing countries. There is another way way around too, and I would like to emphasize that. We heared yesterday the paper from India about drinking water for the masses with the very simple technology and the tech- nology is really proper to small villages. If I think of it, it is a question of North and South.

Mr. Rossi: Would we be right to say it is a problem of communication?

Dr. Grombach: Yes, it is, I agree. I see no problem in that concerning the consultants from developing countries. I feel that I can bring knowledge and technology to the big cities but I must admit I did not feel competent in the rural regions and I am sure the local experience and local experts- and we

met one yesterday - can do a better job than I do or you can do. Thus I say the only problem towards these local experts is the attitude of their government who will easily believe the foreign experts especially when they come with academic titles, rather than the local experts who have better opinions. That is wrong and when we say the local experts' opinion should be considered the government will ask, what do I pay you for? Then it is very difficult to answer.

Mr. PJ Harvey: There are 2 different things:

1. Bringing the demand to the consumer.
2. Bringing East to West.

As a consultant, to bring demand to the consumer is our role especially in developing countries. There is a role for everybody. But demand is usually from government bodies. Especially when the organization grows, there are not enough technical people to carry out specialized technology roles. As between them, whether the consultant is local or foreign is again a matter of whether there are enough locals or enough knowledge. If they have enough knowledge, then they can do it. Otherwise they need help from outside. Such outside help need not bring foreign knowledge. Many consultants have experience throughout the world and indeed consultants from Asian countries are bringing technology to the west. That is the market thirst for knowledge. From the point of view of the manufacturers, I think it is a question of who has the goods to sell and who needs it.

Mr. Rossi: The constraints go beyond finance and Asia has many government bodies who do not accept local consultants. It is a question of communication between governments and between suppliers and specifiers or sales organizations and the market: there is a great communication gap which local consultants could help bridge.

Dr. Osenga: Consultants are not willing to do more. They want to design the building itself. But reliability, new developments-that is a very important thing. As a supplier working with a a consultant it is extremely difficult to introduce new technologies for they do not have the experience and they do not ao the responsibility for which they cannot be blamed but on the other hand, they should have flexibility and allow alternative designs.

The gentleman from Bangkok mentioned essentially the same - as long as the design has proven its virtues, then we have much sales but how about new developments? With that attitude new developments specifically for these areas are useless.

Mr. Rossi: This is the policy of Asian governments. To accept what is proven rather than what is innovative because they can't afford mistakes.

Dr. Osenga: It is no exageration that a supplier has to be one step ahead of his competitors and one step ahead means constantly new developments; but here it is impossible for new developments.

Mr. Rossi: One thing is whether a manufacturer is prepared to spend time and effort as he would in his home market. This is one of the serious drawbacks. The man who is building a whole recycling plant will spend weeks working to produce a plant in his home area free but as he is asked to build a plant in Bangkok, it becomes foreign expertise and he becomes a consulsultant. How are you going to do that in Asia where there are different conditions?

Dr. Osenga: That is why my company is different. Each unit we have in the world works entirely independently and the unit in Singapore works in this area, not in Europe.

Mr. Rossi: Is this after all totally a question of communication? It is probably the wrong word to use but it is part of the communication gap that we have here. One thing is that the industry is probably fragmented. It is voiceless because it is a group of people spread over Asia. But with the weight of the group- we have 100 members now - people listen. We can ask them to assist in research. There is power in a group.

Dr. Suhaimi: Going back to JKR. As a government department, its function are no different from other departments. They have to obey Treasury circulars. The problem is breaking through the communication gap in order that the equipment can be included in the Treasury list. As long as there is a communication gap in terms of trying to convince, the respective government departments will tend to favour equipment already on the list because if there is something wrong, they will not be blamed.

If there is a new product, we would like to get independent

opinion which we think is not the supplier's. If there is an organization which the government department can consult perhaps there will be a lot more weight.

Mr. Rossi: Because it is one of the few organizations, we have not restricted membership in any shape or form. The composition of the Association is made up of suppliers, consultants, governments, specifiers, etc.

We have found the grouping successful and a water association can go a long way to break into that list in JKR. I think the subject is naturally leading to the construction of this bridge as the first workshop session tomorrow morning. If this conference ended with just a set of papers being read, it would not have achieved much. Do you think the bridge of the gap is a pertinent subject for the workshop tomorrow morning? I should mention that the dissemination of the proceedings may be many times the attendance. I find that in Asia proceedings will go on moving out of the office for the next 3 years but water quality as a subject for workshop session may not be quite suitable when the countries are having different water quality.

Dr. Liu: Is there any need at all for a workshop tomorrow?

Mr. Rossi: I believe there is a real need but can we achieve anything from the workshop?

Dr. Osenga: Unfortunately I cannot be there tomorrow morning or afternoon In any case I think in a workshop people speak more easily when seated comfortably.

Dr. Suhaimi: First we would like to be quite sure whether the concern for water quality in this region or Asia is going to be very high. If it is, then the technology for water quality management will be improved and if the technology is improved for this region, then there will be a need for getting together all the suppliers with theconsumers to form some sort of association to bridge that communication gap. But if we feel that conciousness for water quality is not very high, then it is perhaps not yet the time.

Mr. Rossi: We are getting less concerned with quality but more with the product. Therefore a water association is one of the possible bridges in all forms, shapes and sizes.

Dr. Grombach: I am in favour of the workshop and I thin your original idea of water quality management is to be defended even against yourself. For the Association it should be more general but for the workshop to orrow, I think we should have one and I think it should be about quality because conciousness for water quality is one of education. Everybody knows that the conciousness for water quality in in the Western world is not a hundred years old perhaps 50 years old or 20 years old in some countries, or does not exist at all. If there is conciousness for water quality, it is be cause people like us have said and talked about it again and again and if we find some arguments that can be used towards the politicians or economists who want to save money because it is much cheaper to have dirty water, and some of us go home and have some new ways of saying it, then it was worthwhile. It is just that this conference was so poorly visited and have so few attendance that we should talk about it.

Dr. Suhaimi: I support it from the environmentalist point of view. I think it is important that we consider seriously this problem even if support for this conference is not very high because water is becoming a scarce resource so that the association can be formed to act as a catalyst.

Dr. Liu: I am in favour, but we have to ask the participants who will be attending.

Mr. Rossi: Can we see a show of hands from those who will be attending? There will be a workshop tomorrow as we have enough participants attending. It will start at 9:00 a.m. in the boardroom. We will try to come up with something which we can publish.

Can we get some more Singapore participation.?

Mr. Rossi: I organized the speaking panel from Manila. You do not know the difficulty we had in trying to get participants from Singapore. Either they did not want to know or did not need to know. I think we have one Singapore delegate only. In every other branch and division, it is impossible to get their cooperation. There are 2 things to cover, the subject and the method of getting it across; so we will have a workshop.

LARGE AREA HDPE LINER SYSTEM

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The Schlegel Area Sealing System

Increased environmental safety standards in recent years have led to development of new and improved sealing systems including synthetic liners of polymeric materials. A leading system from both technical and economic standpoints among synthetic large area liner systems is SCHLEGEL* sheet, a heavy duty HDPE liner produced in particularly large individual sections. The dimensions of the system required development of a unique technology for production and jointing and offer numerous advantages, especially for large sealing projects.

Raw Materials

Extensive field experience and materials testing has shown one HDPE resin particularly well suited as a synthetic liner material for large area sealing applications. This resin is a HDPE with high flexibility and good physical strength properties, VESTOLEN A 3512**, the resin used in SCHLEGEL sheet production. Under the various aspects of physical properties required in sealing applications, including:

- tensile deformation properties
- behaviour in aggressive media
- flexural fatigue properties
- biaxial tensile strength under compressive loading,

this material fulfills the requirements of today's liner technology in an excellent manner.

Further information on the physical properties spectrum of this resin has been described in another article by the author with special emphasis on their de-

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* Registered trademark of Schlegel Engineering GmbH, Hamburg, Federal Republic of Germany.

** Registered trademark of Chemische Werke Huls Ag, Marl, Federal Republic of Germany.

pendence on density of the resin and thus its cristallinity. In addition, polyethylenes in the high density range can be expected to show extremely good long term weathering resistance.

Quality of each incoming raw material lot is monitored by several test criteria including melt index, moisture content, density, and average molecular weight. Values for these tests must fall within narrow tolerance ranges to b to be accepted for use in production.

Production

SCHLEGEL sheet is produced in a patented extrusion process in sections 10 m wide and in any length desired (standard length ranging from 100 to 200 mm) without need for any form of intermediate prefabrication. The thickness can be varied from 1.0 to 4.0 mm, the standard thickness produced is 2.5 mm. Dimensions and thickness of sheet produced are tailored to the needs of individual projects.

Constant quality of the sheet is quaranteed by an extensive quality control program including tensile testing, thermal dimensional stability, stress-crack resistance and melt index. Samples for testing are taken from each sheet section produced.

Welding

The individual SCHLEGEL sheet sections are jointed by means of extrusion welding conducted with welding devices automated to a large extent. This process gives mechanically sound and watertight bonds under field conditions. Outside disturbances, such as changing ambient conditions are compensated by manual adjustment or automatic control of machine parameters, such as hot air temperature, welding speed, etc.

As in the production process, installation quality, in particular weld seam quality, is assured by internal control as well as inspection by outside institutions.

Application Fields

The application fields for SCHLEGEL sheet liner systems can be divided into three groups:

- Ground Water Protection

- Sealing Systems for Conduction or Storage of Water and other Media
- Sealing Systems for Structures

Ground Water Protection

A new development in the disposal pit planning sector has emerged over the last ten years. Previously, planning for disposal pit was limited to simply determining a suitable location from the standpoints of availability of natural sealing layers and local pollution ordinances. N w, increased emphasis is placed on design and construction of synthetic sealing systems. In this application field, where individual projects on the order of several hundred thousand m^2 sealed area are encountered, the advantages characteristics of large area liner sections such as SCHLEGEL sheet can be utilized fully. Both the large area of the individual liner sections and the liner thickness are of decisive importance, especially in projects of this order of magnitude, as these properties ensure low specific weld seam length, i.e. ease and security in installation, and the physical strength required in the installation of such large scale projects.

Sealing applications in the field of ground water protection include:

- Disposal basins for municipal, industrial and other wastes
- Basins and landfills for disposal of oil sludge or other industrial sludges
- Catchment basins and systems for other potential pollutants in tank farms
- Retention basins for contaminated surface water
- Pumping stations, loading stations, storage facilities gasoline stations
- Road in regions which are sources of potable water

The increased emphasis on engineering solutions to these applications is apparent in the activities of official technical commissions entrusted with drafting of guidelines for installation and testing of plastic liners. One such technical commission is the Institut fur Bautechnik (transl.: Institute for Construction Engineering) in Berlin which has issued an official approval document certifying the suitability of SCHLEGEL sheet for use in sealing catchment systems containing potential ground water pollutants. Similarly, the Municipal Council of the City of Vienna, Austria, has issued an approval document for SCHLEGEL sheet with the regard to use in ground water protection applications. In the course of both approval proceedings, authorized German and Austrian testing institutions conducted extensive tests concerning the application suitability of the SCHLEGEL sheet. As a condition of official approval in both cases, the Suddeutsches Kunststoff-Zentrum

(transl: South German Plastics Center), an officially recognized testing institution in Wurzburg, Germany conducts independent inspections of the SCHLEGEL sheet production plant and internal quality control on an unannounced basis. Similar approval proceedings are currently in progress in several other European countries as well as in the United States.

Conduction and Storage of Water

The type of problems posed in this application field is similar to those found in conventional hydraulic engineering projects. Sealing applications in connection with water conduction and storage are primarily found in newly industrialized areas or cultivation projects in areas previously not used for agricultural purposes, areas in which conventional materials and mineral sealing materials are often difficult to obtain and install. Solutions to these problems using HDPE liner systems have proven to be satisfactory both from a technical and an economical viewpoint in the following sectors:

- Full perimeter lining of canals and rivers for irrigation and navigation purposes
- Lining of dams and dikes in connection with canals, rivers and hydroelectric projects
- Lining of reservoirs for potable and industrial waters.

Conventional materials such as clay, loam, bitumen, and concrete are still often selected over plastic liners because of unsatisfactory performance of thin plastic membranches employed in the past. However, recommended guidelines for safe engineering design of plastic liner systems in earthwork and hyraulic construction projects are available.

Sealing Systems for Structures

SCHLEGEL sheet is usually only employed in structures if the sealing system is to cover a relatively large surface or must be of particularly high quality. Today's construction technology usually calls for this plastic membranes or bitumenous layers for structural sealing both fixed to the structure over their entire surface. Full surface connections such as these have the advantage of facilitating location of leaks, as lateral seepage in the sealing system is blocked; on the other hand, deformation behaviour of such systems on shifting of the structure is inhibited by the full surface connection.

Applications

SCHLEGEL sheet has been employed in large area sealing projects for over seven years. In ground water protection applications in Germany alone, 500,000 m^2 have been installed in projects ranging in size from 1,000 to 100,000 m^2. Similar projects have been installed in other European countries such as England, Austria, and the Netherlands as well as in the United States, the Middle East and the Far East. Individual projects in the United States and the Middle East ranging in size from 300,000 m^2 to 600,000 m^2 have been recently completed.

Subgrade Preparation

Most hydraulic engineering or ground water protection applications of SCHLEGEL sheet are in the form of earth basins, i.e. lined ponds, lagoons or disposal basins. As in other engineering structures, individual components, i.e. in this case the liner, should not be viewed alone but rather as part of the system as a whole. Figure 1 illustrates two such entire systems, one being the maximum security lagoon solution and the other the minimum solution acceptable from a technical standpoint. The system as a whole must guarantee that

- subgrade shifting is kept to a minimum
- all surfaces in contact with the plastic liner are formed such to prevent mechanical damage to the sheet
- seepage fluids are drained off in a quick and secure manner

More detailed information here is given in other publications.

Whereever possible, embankment slopes should be chosen low enough that the liner can be covered with a filtering or protective layer. If danger of mechanical damage by outside influences can be reliably discounted, the design need not have a protective layer due to SCHLEGEL sheet's physical properties and excellent weathering resistance. In the projects installed to date, embankments have ranged in slope from 1: 1 to 1: 4 and ranged in length up to 50m. A covering layer can be applied on embankment slopes up to a maximum slope of approximately 1: 2. Protective layers on steeper slopes with longer embankment lengths can be very costly and thus often not included in the overall design for economic reasons.

Guidelines for SCHLEGEL Sheet Installation

Site installation of SCHLEGEL sheet is conducted without exception according to the installation guidelines set by Schlegel Engineering GmbH. The first

step of the overall procedure is design of the liner, including an installation diagram specifying positions of the individual liner sections. The liner sections are transported as rolls 1 m in diameter and 10 m wide to the site. Each roll is accompanied by documents identifying the raw material used in production, the date of production, and the result of quality control testing. Progress of installation work is recorded on the installation diagram along with pertinent data such as weather conditions during unrolling. Unrolling of the sheet with suitable equipment must not significantly disturb the surface of the subgrade. The unrolled sheet sections must be positioned with sufficient overlap for production of weld seams. All weld seams are produced by trained plastics welding technicians using special welding devices automated to a large extent. Weather conditions during welding, including precipitation, relative humidity, presence or absence of solar radiation, ambient temperature, are recorded in a welding report form along with process parameters such as extrudate temperature, welding speed, and temperature of hot air preheating system. All welds are tested for continuity and strength in Schlegel internal quality control and/or quality control by outside firms or institutions. Continuity testing is conducted on all overlap welds using nondestructive ultrasonic testing equipment; testing of weld strength is by determination of tensile yield strength on a random sample basis. Samples for tensile testing are selected in accordance with the local contractor of official authorities.

The results of the continuous ultrasonic testing are recorded in a complete site report specifying the quantity, type and exact position of any inhomogeneous spots located. The points of removal for the tensile test samples are recorded in the installation diagram. An additional test for weld continuity which can be carried out in small basins is actual water filling with subsequent control of the water level.

SELECTED INSTALLATION PROJECTS

Industrial Waste Disposal Basin in Nordrhein-Westfalen (Figure 2)

This industrial waste disposal basin constructed in the German state of Nordrhein-Westfalen is an exemplary solution for safe disposal of chemical waste products in that several complementary sealing methods were combined into a high security overall system. The final size of the disposal facility will be 250,000 m^2 of which 120,000 m^2 have already been lined with SCHLEGEL sheet.

The embankments were designed with a slope of 1 : 2,5 to facilitate installation of the embankment portions of the SCHLEGEL sheet liner. The average daily installation rate was 1,500 m^2, reaching up to more than 3,000 m^2 under favorable weather conditions.

Municipal Waste Disposal Basin in Nordrhein-Westfalen (Figure 3)

This disposal basin for municipal waste located in an exploited gravel pit roughly 30 km west of Cologne. This project will encompass several hundred thousand m^2 when completed and will be one of the largest municipal waste disposal facilities in Europe. The first of four installation stages has been lined with SCHLEGEL sheet, comprising almost 80,000 m lined area.

A high quality liner system was required for this disposal facility due primarily to subsequent operational conditions, including:

- Embankment heights in the first installation stage of more than 20 m with slopes ranging from 1 : 1 to 1 : 4.
- Compressive loading from the waste contained, over 40 m high for basin in completely filled condition.
- Long term weathering exposure of embankment sections of liner uncovered due to high slope.

Of all sealing systems considered in the selection process, only SCHLEGEL sheet could provide a workable technical solution for this application. In spite of the relatively high percentage of embankment liner (roughly 50%), average installation rates of around 1,500 m^2 per day were attained with one installation crew.

Industrial Sludge Disposal Facility in Northern Germany (Figure 4)

Construction of this sludge disposal facility was begun in 1974. Installation of the liner was carried out in four stages. Completion of the project in 1977 was marked by raising of the perimeter dikes to their final height. The perimeter dikes are surrounded by a municipal waste disposal facility which serves to stabilize the dikes against shifting and settlement in the soft subgrade. The total lined area in this project is roughly 125,000 m^2. The suitability of SCHLEGEL sheet for this particular application was confined before beginning construction by laboratory testing for resistance to the industrial sludge stored as well to outdoor weathering. A particularly important property of the liner system in this application was waterproof and physically sound jointing at the borders of installation stages, i.e. welding with material already exposed to the elements for some time.

Salt Water Reservoir in Ireland (Figure 5)

Exploitation of large surface coal deposits by strip mining required displacement of the River Lash in Wales over 1.5 km of its length. Design of the new river bed included an impermeable liner to ensure workable conditions in the

strip mines in the surrounding area which would subsequently reach a depth of 50 m below the surface. The lining covered a perimeter of 18 m as indicated by calculations of the river's average cross section. Requirements on the subgrade beneath the liner were the same as those for earth basin applications. After completion of placing, welding, and quality control testing of the SCHLEGEL sheet liner, a sandy gravel covering layer was applied which in turn was then covered with rock packing. Approximately 28,000 m^2 of liner were installed in this project. Again, the decisive factor in physical strength and good deformation properties in the light of the nature of the soft subgrade, i.e. its susceptability to settlement and shifting.

Oil Sludge Disposal Basin in Northern Germany (Figure 7)

Disposal of by products in the oil drilling industry, for instance sludges encountered in initial phases of exploitation, must be reliable to ensure protection of the ground water supply in neighboring areas. The disposal facility illustrated in Figure 7 is an earth basin lined with SCHLEGEL sheet on the embankments and floor sections. The installation plan illustrated shows the location of the individual sheet sections, 10 m wide and varying in length as required by the basin dimensions. The total weld seam length was less than 700 m. The width of the individual sheet sections proved especially advantageous on the concrete embankments as no weld seams were required here, only mechnical connection to the conrete structure. This project is an exemplary solution of its type for secure disposal of potential pollutants of the oil drilling industry.

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ECONOMIC VALUATION OF THE LAKE WATER AND WATER POLLUTION ABATEMENT PROJECT

by Dr. Ben Chien Liu, Midwest Research, Kansas City, Missouri 6411, U.S.A.

Abstract

The primary objective of this paper is to analyze, through a welfare model of efficient resource allocation, the value of fresh lake water as depleting and/or non-renewable capital resources under three major categories: the stock attributes, the flow of goods and services, and the economogically transformed resources through the productive and consumptive process with the flow and the stock input factors. A recreation demand model is employed to illustrate conceptually and empirically how different economic values for fresh lake water might be derived or estimated for impact assessment under the National Economic Development Account.

Introduction

The science of economics deals with the problem of how we can best utilize society's limited resources to satisfy our unlimited needs and promote the general welfare. It is essentially concerned with the identification, allocation, distribution, consumption, and expansion of resources over time so that the overall social well-being and quality of life of human beings can be improved and enriched. In other words, economics is a study to identify what stock of resources is available and what and how goods or services can be most efficiency produced and supplied from this stock per unit of time; who benefits from the consumption of these goods and services and how much is needed to meet basic human needs and satisfy additional human needs; and, finally, how the "stock" of resources and the "flow" of goods and services can be increased relative to the evergrowing number and wants of the human population.

While the issues of the availability, accessibility, utilization, management, conservation, and distribution of natural resources for economic well-being have been among our nation's oldest policy concerns, the application of economic theory to the recreational use and ecological and environmental protection of fresh lake water in the United States is not only a relatively new development, primarily within the last 2 decades, but also raises controversial issues. Probably the greatest impetus to this rapidly growing effort came with the Principles and Standards of the Water Resources Council which established four accounts--National Economic Development (NED),

Regional Economics (RE), Environmental Quality (EQ), and Social Well-Being Improvement (SWBI) for project impact assessment and evaluation. While an increasing level of environmental awareness has caused concern for the diminished stock of certain drinkable and swimmable fresh lake water there are conflicting opinions regarding the value of resource conservation and water pollution abatement, let alone the divergent evaluation of project impacts in these four accounts and the interdependent trade-offs.

The primary objective of this paper is to seek alternative means by which the value of fresh lake water can be explored and assessed so that both types of values--the nonrenewable resources and the consumptive uses can be better defined and the cost-effectiveness of the lake restoration projects adequately evaluated.

Welfare Aspects of the Lake Water Supply and Demand

Fresh water lake resources, whether the existing stock of water body, the terrestial and aquatic, or other natural resources directly attached to the water body and/or the aquatic resources, should be valued as a capital resource, the stock of which can be transformed, directly or indirectly, into some positive physical attributes. These attributes, in turn, become either final outputs or factor inputs for the production of a flow of output (or goods and services) over time, and the flows are utilized, directly or indirectly, in satisfying human needs and wants. The kinds, quantity, and intertemporal patterns of the flow of goods and services transformed and produced from lake water depend upon the complex inter-action of man's resource allocation decisions with biological, geological, hydrological, and ecological conditions over which man has little influence. When water resource considerations became important in the evaluation of alternative projects and programs under the 1973 "Principles and Standards" established by the Water Resource Council, decision makers were most often faced with the evaluation of adverse impacts on the productive capacity of the resource stock.

With the exception of calculations of economic losses due to reduced recreational fishing and hunting of game species, the Principles and Standards address the loss of water-related services solely in the context of the environmental quality account. Economic valuations of the loss of other natural resources and their associated goods and services essentially have been missing from project evaluation, let alone the loss of stock values themselves. Normally, the demand for the stock of water resource is a derived demand, and the physical attributes of the lake area are consumed indirectly as a result of complex interactions between environmental factors, (e.g., lake aesthetics) and human needs (e.g., lake recreation). In addition, almost all goods and services (output) produced by a lake water body (the flows) are delivered and consumed in an extramarket fashion and frequently

are valued at either zero or nominal price. Furthermore, the social opportunity costs of these capital resources have hardly been addressed.

The welfare considerations of lake water restoration and the associated economic valuation of the lake restoration projects may be analyzed through a neoclassical model of utility maximization over time. In other words, we shall begin with an equilibrium model in which the value of goods and services is determined in a similar manner with the supply and demand cleared in the market at the equilibrium price level and all individuals assumed to be rational consumers in that they always attempt to maximize their utility or satisfaction subject to their budget and income constraints over time. The intertemporal utility function for individuals of certain preferences for cer certain lake stocks (S) and the flows of goods and services using lake water body or fish and wildlife species as an input (Q) may be expressed as follows: 1/

$$U_i = U(Q_{i1} \ldots Q_{it};\ T(S_1 \ldots S_t);\ X_{i1} \ldots X_{it}) \quad (1)$$

where X is the amount of other goods and services consumed by the individual i in time period t.

The ransformation function of lake water and its associated attributes $T(S_t)$ depends on the natural characteristics of the existing volume of stock resources and the rates of improvement or growth (G), and quality and quantity changes of the attributes, such as catching of fish or wildlife species harvest, (H), under consideration

$$T(S_t) = T\ (G(S_t - 1) - H_t) \quad (2)$$

and the production relationships between Q and X are the following, with R the amount of composite resource inputs used to produce both Q and X:

$$Q_t = ,Q(H_t,\ R_t^{g})$$

$$X_t = X(R_t^{z}) \quad (3)$$

The conditions for optimal intertemporal resource allocations are obtained by maximizing a social welfare function encompassing individuals in the

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(1) The lake water bodies are general terms; they refer to the overall capital resource including the entire ecosystem and the population stocks of fish and wildlife species living in or around the lake.

present and future generations within a finite planning horizon. Following Baumol and Oates (1975), R. Smith (1975), V. Smith (1978), and Miller and Menzi (1979), the social welfare function to be maximized is

$$V = V(U_1 \ldots U_n) \tag{4}$$

Subject to the following constraints:

$E_i Q_{it}$ SQ_t
$E_i X_{it}$ SX_t
$R_t^g + R_t^z$ SR_t

or $T(G(S_t-1) - H_t = T(S_t)$ or $G(S_t-1) = S_t + H_t$ for stock changes, quantitatively or qualitatively.

To maximize the social welfare, we form a Lagrange maximization equation with appropriate multipliers a B y 8 ø snf 7 and solve the equation for the necessary condition by taking the partial derivative with respect to each individual variable and setting it to zero:

$$\begin{aligned} L = V(U_1 \ldots U_n) \quad & Ea_t \ (Q_t - E_i Q_{it}) - EB_t(X - E_t X_{it}) \\ & Ey_t \ (R_t - R_t^g - R_t^z) \\ & E8_t \ (S_t - G(S_t-1) + H_t) \\ & E\phi_t \ (Q_t - Q(H_t, R_t^g)) \\ & E7_t \ (X_t - X(R_t^z)) \end{aligned} \tag{6}$$

The procedures above highlights many criteria for efficient resource allocation in an economy where both the stock (the existence value plus the size and other physical characteristics of the lake attributes) and the flow of goods and services produced from the lake attributes in conjuction with ot other resources are considered. For individuals who consume non-negative amounts of Q,S, and X in any time period t, the necessary conditions for utility maximization are that the marginal rate of substitution (MRS) between goods Z,S, and X in time t must equal their respective marginal rates of transformation (MRT); and in turn, these ratios must be equal to the respective ratios of the marginal resource costs of Q,S, and X. For any individual i, an MRS between the consumption of non-lake related goods and services, X, between time periods t and t plus 1 must equal its price ratio in utility units and the ratio of its marginal costs between time periods t and t plus 1. For any two individuals, the weighted marginal utilities of Q or S must equal the ratio of marginal resource costs between the two periods.

Let us consider the supply of lake water goods and services Q_i (i = 1,.. .,n). Physically, lake water possesses directly or can provide indirectly a vector of attributes (A_t). The production functions for lake attributes are ecological input-output relationships uniquely determined by biological, geological, hydrological, and meteorological relationships, among others. These have been referred to as the physical production functions which transform the lake water into attributes and hence into productive factor in-

puts such as the drinkable and swimmable water and the stock of fish to be caught, or (H_t).

In other words, man enters the system for production or consumption purposes as a modifier of the lake water and its attributes with other resources and effort such as time and travel costs involved, (E).

$$H_t = h(A_t\ (S_t^g)\ E_t^g) \text{ or} \qquad (7)$$
$$Q_t = h(A_t\ (S_t^g)\ E_t,\ R_t^g)$$

Recognizing the ransformation and production relationship between S and Q through H, there exists obviously an externality-type relationship between the stock and flow variables and hence the side-effect and/or cross-impacts between Q and S. In addition to their independent values, there are also synergistic values between the two. For example, cleaner lake water is definitely better for swimmers and fishers but not necessarily good for scarce wildlife species. For us, then, lake water has three types of values: the existance and the uniqueness at a particular point in time (S), the goods and services produced from the lake water per unit of time (Q), and the resulting interaction between S and Q over time through natural system changes and man-made improvements. As a result, the demand for the stock and the flow of goods and services which are produced by lake water attributes of satisfying human wants, or utility maximization, may be expressed as a function of the opportunity cost or the willingness to pay (WTP) and the cost of the service supplied (COST):

$$Q_t = F(WTP_t),\ aQ/af \quad o, a^2 Q/af^2, \text{ o or} \qquad (8)$$
$$Q_t = F(COST_t)\ aQ/af \quad o, a^2 Q/af^2 \quad o$$

It is fairly clear from Equations (1) through (8) that we have illustrated a model for valuing lake water stock and its associated goods and services from the individual factor input demand and marginal utility framework. Specifically, we suggest that all human beings are rational and they all attempt to maximize their utility, subject to taste, time and income constraints. To maximize their utility, they demand lake water attributes, either transformed or untransformed, and goods and services which are produced by the water either directly or indirectly. The value of these stocks and flows of goods and services are reflected in the demand functions either in terms of an individual's willingness to pay or the costs of obtaining the goods and services. The demand curve for the goods and services is negatively sloped with respect to WTP or cost if they are normal goods and services and if the marginal utility derived from each additional unit diminished after a certain level of total consumption is reached, all other factor inputs being held constant.

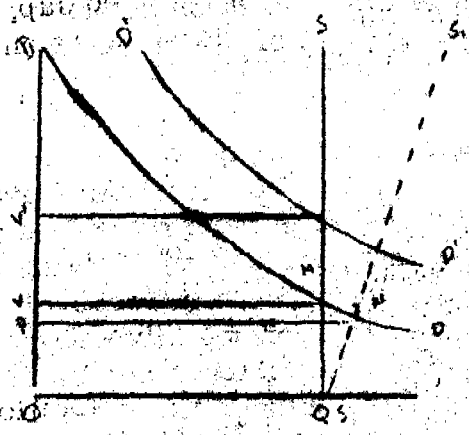
The general conceptual model for valuation of lake water may be summarized as follows:

Lake water is a capital resource whose value can be evaluated from:

1. Stock characteristics of the existence, uniqueness and/or non-renewability of the lake water itself;
2. Flow characteristics of the input factors that the lake water directly and indirectly provides for the production and consumption of goods and services; and
3. The synergistic characteristics of (a) and (b) alternated under varying biological, natural and human forces over time. Lake water and goods and services produced from the lake attributes are demanded by utility-maximizing individuals intratemporally and intertemporally and are thus valued differently among individuals according to their marginal utility and cost comparisons, and marginal rates of substitution and transformation calculations.

Value Assessment of the Lake Water Restoration

The lake water bodies have been considered as capital resources. Since they are primarily publicly owned capital resources and there are complicated problems such as nonmarketability, indivisibility, externality and social welfare interdeterminancy and uncertainty involved in pricing the stocks and flows of the resources from the seller's reservation price (i.e., the minimum price at which the owner of the resources is willing to sell), the last section suggests a demand model in assessing the value of the lake water. Employing a demand model for evaluation has been the most popular and scientifically acceptable approach for empirically estimating the economic value of goods and services which are fixed in supply at any time. Under the fixed supply assumption, the demand curve, which resembles the marginal utility of the individual, determines the value of the goods or services as shown below:



The demand curve, DD, shows the maximum willingness to pay for the service at a fixed supply of OQs. The maximum value or willingness to pay is then OV, and the consumer's surplus is hence DVM. Given a resource alteration that increases the demand by shifting it from DD to D'D', the value of the fixed service becomes OV' per unit.

If the supply of the service is not fixed and the attributes of lake water can be physically increased (or decreased) through resource management decisions or other natural system alteration, the supply fo goods and services is represented by positively sloped S'Qs. Under this condition the equilibrium price OP will be employed to derive the value of the service being studied. Thus, OP is a market price jointly determined by the seller and the demander. Market price are the prices at which trade takes place, in this case trade which results in the diversion of resources from their present use to the proposed use. Trade takes place between a willing demander and a willing seller if and only if the demander's willingness to pay is equal to or greater than the seller's willingness to accept, i.e., the resource's social oppotunity cost in this case. The resources simply will not be diverted from other uses to the proposed use in a competitive market or competitive market-like context unless the seller's opportunity cost or reservation price is met or exceeded by the buyer's WTP at the margin. The corresponding consumer's surplus is thus represented by the area DPN under the old demand curve.

The economic valuing concept stressed previously is the marginal utility theory, which considers only that the maximum willingness to pay may over (or under -) estimate the value of the lake water related goods and services by VP (OV minus OP) depending on whether or not the resource supply is fixed. Similarly, the difference may also result from externality or the synergistic impact between resource stock and resource flow interaction. This problem may be avoided if the social oppotunity costs of lake water attributes and services are predetermined. However, empirically this is not the case. Most economic valuing are generally confined to the demand-oriented concept of valuation for fixed supply of public owned goods and attributes, let alone the value assessment on deteriorating or depleting lake water stocks and the cross-impacts of the stock-flow trasformations and interactions.

In addition to the fresh lake water supply, one of the most significant demands for clean lake water or lake water restoration is that for outdoor recreation. The number of trips for outdoor recreation that each individual participates in, including swimming, fishing, boating and even picnicking and walking around the lake, are apparently positively related to the quantity and quality of lake water. To economically value the water quality improvement resulting from the lake restoration projects, it is necessary that the demand for lake water related outdoor recreation be investigated and studied, since the marginal utility underlying the demand schedule may be

employed to approximate the generated benefit from water quality improvement. To be specific, economists frequently employ either the willingness to pay approach or the consumer's surplus concept to derive, on the average, the marginal utility (or benefit) function for recreation.

To develop such a recreation demand model for lake water improvement benefit evaluation, one cannot help but rely on a neoclassical micro-economic model of individual utility maximization. Using the von Neumann-Morgenstern approach to the theory of decisionmaking under uncertainty, followed by a similar approach employed by Clawson and Knetsch (1966) and others in utility maximization for recreational analysis, the following section illustrates how a recreational demand model can be developed for water resources valuation and pollution abatement project assessment.

Recreation Demand Models and Problems in Measuring Recreational Benefits

The most direct and significant impact of a lake restoration or water quality improvement program on human beings probably lies in the satisfaction of human wants in two major categories, fresh water supply and recreation. At most fresh water lakes in this country, the demand for lake-related recreation has normally played a relatively more important role than as a water supply. Consequently, most studies of project benefit evaluation have centered around measures of recreationa benefits, as does the proposed BCCIPA model.

Water quality, or its improvement, is of value to us not only because it is a capital resource that can satisfy human needs and wants, but also because the availability of quality water per capita is decreasing over time as population and pollution sources increase.

Scarcity creates more value. As a result of the relative scarcity of a supply of clean lake water, it is more valuable to us today than it was before. Hence, to measure the benefit of a lake restoration project necessitates measuring the human satisfaction derived from the consumption or use of the lake water, i.e., the utility of lake water as valued by the human beings who consume (use) it. However, the utility of anything is entirely subjective, and it may vary from person to person, place to place, and over time. How is this value determined? The marginal utility theory that underlies the demand curves discussed in the last section may be employed for value determination.

As long as trade and exchange are feasible under various marketing conditions, it is well known that price is determined jointly by the supply and demand forces in which the marginal utility theory of value plays a critical role. Analogically, one may refer value determinations of clean lake water

to its supply and demand forces. Nevertheless, fewer marketing conditions exist presently for lake water and its quality level because most lakes are publicly owned and the exclusion principle does not apply here. Thus, non-marketability is one of the obstacles in assessing project benefit quantitatively. In addition, there are other problems, such as induced or derived demand, externality, indivisibility, interpersonal utility incomparability, etc., which may impede the conventional demand approach for valueing lake water. For instance, clean lake water may increase its recreational value to swimmers, but an increased number of swimmers may disturb the fishing environment and hence decrease the recreational value to fishers.

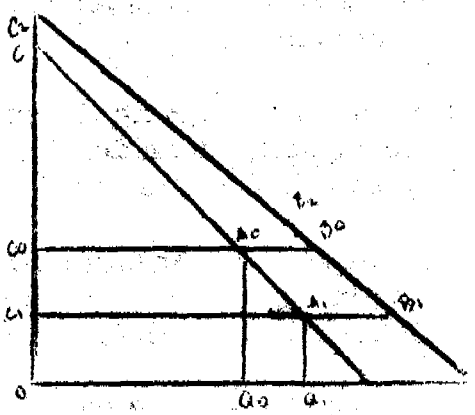
The dominant and still most difficult benefit measure of lake restoration is the improved or increased recreational activity directly resulting from the project. The use of reservoirs and lakes for recreational activities has been increasing at a rapid rate, and yet the recreation benefits have not been considered "tangible". They have been evaluated in quantitative terms only after authorization by Senate Document 97. The inclusion of recreation benefits in the conventional B/C analysis is certainly a great advance over the previous B/C studies that did not count recreation benefits at all, according to Herfindahl and Kneese (1973).

Several methods of computing recreation benefits have been considered, including the conventional federal agency procedures (FAP) based on an arbitrarily assigned value of a visitor-day; the Hotelling (1969) and Clawson-Knetsch (1966) approach; Gum and Martin's (1975) monopolistic approach; Crocker's (1971) expenditure approach; Cicchetti, Fisher and Smith's econometric approach (1976); etc. However, because they recognize the problems in public goods and services such as improved water quality and the demand for recreation and its associated measures of consumer's surplus, the models suggested by Hotelling, Clawson and Knetsch, among others, are employed. In other words, the value of the improved lake water quality may be reflected by the changes in the consumer's surplus as computed under two demand curves for lake recreation--one demand curve before and another after the project.

Simply defined, consumer's surplus measures the surplus satisfaction that a consumer receives from a commodity above the price actually paid for that commodity. Given a negatively sloped demand curve in the price-quantity demand domain, the consumer's surplus is equal to the area under the demand curve but above the actual price level. The consumer's surplus is then used to approximate the economic value of those goods and services not presently being priced and marketed, such as the improved water quality being studied. This value is in turn used to represent the project benefit in the final benefit/cost evaluation. In short, the BCCIPA model suggests the development and employment of demand models for project impact evaluation, especially the

water quality improvement impacts on recreational demand for watercraft activities.

The demand curve is used to measure the recreation benefits through the consumer surplus change for each type of activity that people participate in. Without shifting the demand curve, the increased number of visitations indicates the change in consumer surplus in the first year. With the demand curve shifted in the second or third year, the consumer surplus change will probably be indicated by the product of the number of visitations and the cost or price index (C): The following chart shows how recreation benefits may be measured by consumer surplus:



$O_O^O O$ = Number of visitations without the project, baseline information.
$O^1 1$ = Number of visitations with the project, first year.
$C_O A_O C$ = Consumer's surplus without the project.
$C_O C_1 A_1 A_O$ = Increased consumer's surplus with a constant demand in year one.
$C_2 C A_1 B_2$ = Net recreation benefit, or increased consumer's surplus with shifted demand in year two.

It should be noted that we have intentionally kept constant the supply of water stock and its flow of goods and services that are transformed and produced from the stock for recreations for purposes of illustration. For a dynamic adjustment between supply and demand shifts, readers are referred to Figure III-1 in the previous section.

Although the value of a lake water restoration project cannot be fully reflected by the growth in demand for lake water related recreation, and consequently the consumer's surplus measured under varying demand curves may substantially underestimate the project benefit, the general welfare model delineated in Section A and the individual consumption expension patterns presented in the preceding section do provide a reasonably sound analytical framework upon which empirical evaluation techniques can be developed to

estimate the major benefit of lake restoration. To be specific, the demand for lake water recreation may be simplified and reduced from a simultaneous equation system of models as mentioned previously to as follows:

$$V_{ij} = F\,(COST_{ij}\ (D, T, Y),\ CAP_{ij}\ (Q,S),\ Z_{ij},\ DUM_{ij})$$

Where V_{ij} stands for the number of visitations in the i^{th} activity at the j^{th} lake.

$COST_{ij}$ is a weighted cost index comprised of traveling distance (D), time (T), and income level (Y). This is somewhat of an index for opportunity cost which reflects the minimum level of physical and psychological benefits the recreationist can expect.

CAP_{ij} is the recreation capacity index consisting of water quality and capacity, including character variables such as depth, water teperature, surface area, and fish species.

Z_{ij} is other exogenous variables affecting the visitation participation in the i^{th} activity, such as regulations, crime rate, lake-front facilities, and environmental conditions.

DUM_{ij} represents a number of dummy variables taking the values of "1" for positive and "0" for negative answers, e.g., whether or not a visitor noted water quality improvements; will or will not come back for the same activity, single or multiple-purpose trip, etc.

As pointed out by Dwyer, Kelly and Boes (1977), and Thomas, Liu and Randall (1979), among others, there are more than a dozen quantitative approaches ava available for valuing water resource attributes and services through the measure of the consumer's surplus. Although each of them has its own weakness and strength both conceptually and practically, the statistical inferential methods, particularly the travel-cost methods associated with a recreation demand model as just mentioned have been perceived as preferable technique over many others and have been employed most frequently in the empirical applications for assessing the consumer's surplus, or for approximating the true willingness to pay. Hotelling (1947) pioneered the travel - cost method for evaluating a recreational resource, and further refinements were provided by Clawson and Knetsch (1966), Davis (1964), Gum and Martin (1975), Hammack and Brown (1974), Cichhetti, Fisher and Smith (1976), Liu and Christiansen (1979), among others, for measuring the recreation demand and/or the consumer's surplus.

As Cocheba and Langford (1978) correctly pointed out, the longstanding

challenge of establishing values of extra-market recreational resources has been met for the most part by attempts to value recreational activities of recreation sites. The demand model for lake water-related recreation just described is, in essence, a modified Hotelling - Clawson - Knetsch or travel-cost method which employs demands estimates to compute a value to the set of resources in existence at the site where the activities take place. In this case, the sites are the two lakes, Lake Ronkonkoma and Long Lake and Chain of Lakes. However, the differences in model derivation, specification, and, finally, model estimation between the conventional travel-cost approach and the one proposed in this study ought to be noted.

Aside from those fundamental postulates upon which the general welfare framework and individual demand models are developed, this study recognizes specifically the significant differences among the values of the stock of lake water, the flow of goods and services transformed from the stock and produced by the lake water attributes, and the synergistic effects between the two, and/or the externalities created by them jointly over time. Conventional benefit/cost analysis tends to be oriented toward the appraisal of individual projects, and it has been gradually recognized that any evaluation methodology which treats each project in isolation and statically can lead to inconsistent decisionmaking, especiallly under the condition of high uncertainty.

The synergistic effects between the stock and flow resources associated with any lake water body can be either risk-spreading or risk-pooling. While risk-spreading may lead the decisionmaker to reject an entire group of projects which would have been accepted individually, risk-pooling may result in the rejection of any individual projects separately but that are acceptable as a group.1/ Optimal decisions may require, in the presence of uncertainty, an additional reduction in the benefits from development beyond the preservation benefits foregone in order to take into account the loss of options such a decision would entail. In other words, the oppotunity cost associated with the project must be taken into account.

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(1) For similar and relevant arguments, see K.J.A. Arrow and R.C. Lind, "Uncertainty and the Evaluation of Public Investment Decision," American Economic Review Vol. 60, pp. 364-378 (1970); E. James, "A Note on Uncertainty and the Evaluation of Public Envestment Decisions," A.E.R. Vol. 65, pp. 200-205 (March 1975); and V.K. Smith, "Uncertainty and Allocation Decision Involving Unique Environmental Resources," J. of Environmental Economics and Management, Vol. 6, No.3, pp. 175-186, September, 1979.

Concluding Remarks

Conceptually the paper has suggested a welfare model for water resource valuation and for water pollution abatement projects benefit/cost assessment. Technically, the consumer's surplus over time under various demand schedules for recreation site visitations was discussed as a useful measure for resource valuation and project impact assessment. Instead of employing any given constant demand schedule for the lake recreation site visitations, various compensated demand schedules can be derived, and, thus, the changes in the consumer's surplus so obtained may better represent the net project benefit of lake water restoration. The net benefits resulting from changes in lake site attributes, and water quality improvement, have been illustrated. Range estimates obtained from a regression model are suggested as the measures for water quality improvement under varying assumptions concept of the welfare of the consumer's surplus.

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Question and Answer:

Dr. Smith: For your top left-hand corner diagram using distance as the objective, when the price of gas goes up, how do you tie this up with your approach?

Dr. Liu: You certainly are right, when the price of gasoline goes up the price of lake recreation goes up,too. Therefore the price of consumer surplus also increases.

Mr. Rahman: Actually what you are trying to say here is cost analysis in a survey environment project. But when more people go to the lake there will be more pollution. Perhaps you have to take into consideration other things besides economic and social benefits.

Dr. Liu: You are right, more people going to the lake will indirectly result in increased pollution. That is why when we developed this model we had to use economic valuation by seeing what the causal effects will be over time. We have as indicator of water quality, asking people what they have perceived to be the change in water quality and we use a scale indicator ranging from better to worse.

Mr. Grombach: I think it is very interesting to consider the distance people travel for recreation on the lake but certainly you will agree that it is just one point to see. It is the task of the engineer to make cost benefit analysis and it is very often easy to find the cost but it is usually difficult to define the benefit. I would like to ask whether you consider other methods of measuring benefit and why you choose only distance.

Dr. Liu: We did select other criteria for benefit measurement; e.g., property value changes over time, because people find there is a greater demand for lake recreation and more people like to reside closer to the lake but in view of the property value procedure, i.e., if you include both property value change as well as distance traveled as a benefit

measurement, you will probably be double counting.

We feel distance is more reliable, but the property value change overtime can be regarded as a probable alternative. There are other measures, including the direct state of willingness to pay approach but again people tend to shy away from this direct question and answer differently. As in our survey we did ask how much they are willing to pay for this recreation but they are unwilling to give a positive figure. But if you ask them based on our estimate that each trip is about $2-$3 and what they thought of it, we get a response that ranges from reasonable" to"a little high". That is why we choose this travel-cost method.

Dr. Smith: You are looking at this analysis from the recreation point of view. In this particular area of the world the use of the lake in irrigation is quite common. Pollution of lakes and hence, of water, can be vital. How do you set about doing an analysis when you have different use of the lake?

Dr. Liu: The approach here is applicable in many areas. Of course the use of lake water can be for irrigation projects or water supply. But in dealing with these problems we have developed a similar kind of model to measure demand for water supply or irrigation. The approach here is easily adapted to other areas.

DISPOSAL OF RADIOACTIVE WASTES IN INDIA

by A.C. Chaturvedim ASCE, Chief Engineer, Minor Irrigation Department, India

Abstract

Radioactive liquid wastes were classified according to activity, conductivity, and detergency, and collected separately so that they could be processed and reused. High purity, low conductivity wastes were routed to a waste collector tank. Low purity, dirty radiowastes (drain wastes0 were routed floor drain tank regenerators; and centrifuge decant water was routed to waste neutraliser tanks.

High purity wastes were filtered to remove particulates; ion-exchanged for the removal of radioactive and other dissolved solids; and reused by feeding back to the system. Low purity wastes having low radioactivity were discharged to the sea after filtering to remove particulates. Low purity waste having high radioactivity were concentrated, filtered to remove particles up to 5 millimicrons, and discharged after sampling. Concentrates were solidified in a cement mixer using cellulose powder as absorber, loaded in standard drums, and stored in a temporary yard. Spent resins and filter sludges were processed through a centrifuge where the solids were separated. The separated solids were loaded in drums, capped, and cooked. All these drums were stored in underground trenches and concreted.

The continuous migration of people into otherwise uninhabited areas poses problems of accidental release of pollution and calls for a serious study of radioactive wastes. There exists serious contamination of water by industrial wastes, pesticides, chemical fertilizers, detergents, etc. Water was found to be polluted biochemically, physically, physiologically and biologically.

Mathematical models for fixed bed absorbers for surface diffusion must also be provided for the predominant intraparticle mass transfer system. When a mixing zone was allowed for the accidental release of effluents from the point sources, it became necessary to know and to predict the dilution of the effluent before it reached the boundary of the permitted mixing zone. The maximum width, the maximum length, and the enclosed surface area of the mixing zone must be determined and controlled.

Introduction

There are two main types of Indian nuclear wastes. One comes from atomic power plants, the other from weapons production. The main waste product from power plants is in the form of spent fuel rods. These rods contain uranium and some of its deadly by-products such as plutonium, which remains toxic to humans for over 200,000 years. Another waste product from power plants is radioactive iodine, which can cause cancer of the thyroid gland. The main radioactive ingredient used in atomic bombs is plutonium, which produces as waste radioactive strontium and cesium, both cancer-causing substances. Like the waste products from power reactors, these materials generate heat and penetrating radiation for centuries.

The Problem

Wastes from defense production are immense -- an accumulated total of a half million tons of highly radioactive material in addition to over 60 million cubic feet of lower level radiation. The nuclear waste from nuclear power plants is considerably less -- about 6,200* tons of spent fuel. Nevertheless, most scientists have focused their attention on power plant waste which contains more radioactivity and is increasing faster than military waste.

Virtually all waste from nuclear power facilities is stored under water in gigantic "swimming pools" at plant sites, but many plants are running out of such storage space. Some low level reactor waste is buried in government licensed repositories. Military waste in solid or liquid form, is buried temporarily in huge underground tanks at government installations. Thousands of canisters of low level atomic trash, mostly from weapons production, were buried off the coast in the Atlantic and off the California coast in the Pacific.

Stored nuclear waste is a point of great contention. Critics point to accidents that have occured at waste disposal sites. In a Military Reservation on the West Coast, nearly 500,000 gallons of atomic waste into the soil around the storage tanks. Such incidents have led many communities to object strongly to dumping nuclear wastes in their area.

Both critics and supporters of atomic power agree that waste disposal is the toughest problem faced by the nuclear industry. It is estimated there will be seven times as much power plant waste by 1990 as there is today. Some facilities could be forced to close as nearly as 1993 unless a permanent and safe disposal method is found.

Solutions

A number of far-fetched solutions, such as rocketing the wastes into space or burning them, were tried and rejected as unsafe, impractical, or too costly. Until recently, little has been done to solve the problem. This year, however, the Department of Energy will spend nearly half a million dollars on disposal technology. There is a plan to drill deep holes into salt beds near Kota, where tons of nuclear waste can be permanently stored. If the project is given final approval, it will be at least 1988 before a permanent storage site could be in operation even for testing. But the plan is encountering widespread opposition from Rajasthan citizens, and court fights could drag on for years.

Indian radioactive wastes are proposed to be disposed into space by an orbital transfer vehicle ejecting the waste package into a solar orbit. This would involve huge costs and is not altogether free from risk. There are large risks from the rocket blowing up on the launch pad itself. Specific plans are needed to specifically dispose of the wastes by early 1990's.

It is necessary to examine the geologic formations: the fractures, voids, moisture pockets, etc. A well-chosen repository would be sufficient to prevent wastes from getting into the biosphere through underground water coming into contact with the salt repository. Wastes leaching into solution found its way into food and water supply through the soil.

The authorities in South India recently refused to allow a shipment of low level waste from the crippled Three Mile Island plant to be brought into their state for burial at a government licensed site. Eight more states have banned nuclear waste depositories and others are considering similar action. Piles of tailings containing radioactive substances have been left everywhere, such that uranium has been mined mostly in Kota, Nyveli, and Tarapur. These piles contain pulverized ore from which uranium has been extracted.

India, with 20 years of experience in nuclear technology, has power stations at Kota, Nyveli, Tarapur and Narora. There have been many advances in design operation and disposal of radioactive wastes. The efforts of chemists and biologists solved coolant channel-clogging problems due to fungus growth, and provided safety from radioactive wastes. The radioactive wastes, especially the highly radioactive defense wastes, present problems in the development of fission nuclear power. Liquid high level wastes are formed in great quantities from the nuclear reactors in the production. It takes a lot of water to dispose of the radioactive fuel. Spent fuel rods present a lot of hazard to the environment. They were stored in pools of water in the Indian reactor plants, giving out intense heat. The highly radioactive salt beds were buried deep in an underground surface, in salt, granite, shale, and basalt, using conventional mining methods.

Some of the wastes were implanted several hundreds meters into the deep sea in the Bay on Bengal, Arabian Sea, and Indian Ocean by a free fall penetrometer. In the overland itself, the radioactive wastes were kept in 4000-ft. tall columns at least 775m. below the earth's surface. Another method for the disposal of wastes was to pump them in a cavity in a very deep and impermeable geologic formation. Heat from the radioactive wastes was found to mealt the adjacent rocks, the radioactive material ultimately becoming an integral part of the rock.

The spent fuel bays were located above ground level so that the irradiated fuel lowered into the buggy in the fuel transfer trench is immersed in bay water even after a short travel downwards from the fuelling machine. In addition to washed air ventilation for the building, arrangements were made for maintaining the bay water temperature below 40°C, thereby reducing the rate of evaporation and hence the spread of radioactivity from the bays. The inside surface of all the bays were lined with S_8 to enable chemical cleaning of the bay surface. Sloping floors and removable strainers were provided for easy removal of metallic and dust particles from the bay floors. Care shall have to be taken to permit repair of valves from all the bay lines through proper layout and provision should be made for freezing of lines to introduce ice plugs. A direct approach to the spent fuel storage buildings became possible through the personnel air lock provided at the top of the storage block. This offered better coordination between the personnel involved in the handling of spent fuel in the reactor and in the spent fuel storage buildings.

In the absence of process computers and extensive physics calculations, some time on an hour to hour basis during power escalation periods was needed to monitor the neutron fluxes within a reactor. Correlating the movements of constant rods and the histories of the fuel bundles involved has permitted a high degree of understanding of this phenomenon. Correlation of this experience with considerable amount of theoretical work has led to the development of fuel management capacity in India, which has averted the need for rather significant foreign echange expenditure on a recurring basis.

Non-accessibility of reactor and associated equipment during operation, as well as very strict requirements, resulted in a much larger amount of automation and instrumentation for monitoring and controlling processes in nuclear stations than in thermal stations.

Chemical reactions involving metal-water, metal-air, hydrogen-oxygen, and deuterium-oxygen reactions, and the chemistry of fission product releases from the fuel and their chemical treatments minimize environmental releases. Radioactivity of the erosion products is induced and carried over to the different parts of the system. The attendant radioactive waste treatment manage-

ment and disposal problem can be solved from many disciplines.

Waste Management

The Indian programme of work on radioactive waste management was started a decade ahead of the commissioning of the nuclear power reactors. Extensive research and design work on the treatment of low and intermediate level wastes were carried out in pilot plants. The problem of effluent management is the quantity of wastes -- more than 3000 tons of tailings/day, which is an effluent stress. The wastes were dumped in a pond. Natural depressions, available near the river site, was used for storage of the tailings, which contained chiefly insoluble radium, and found its way to the environment along with the clear water overflowing from the pond. In view of the very low MPC for radium, at 5 pci/l, controlling the chemistry of the tailings to prevent the radium from escaping to the environment is a problem. Storing significant quantities of radium in the tailing pond has important implications. This is particularly important, as operation would cease at any particular mine after some years, and the site may need decommissioning. In the future, much effort on the part of these management people would have to be diverted to the aspect of uranium tailing wastes.

Thorium Processing Plants

Effluents from thorium processing plants were characterized by a large volume of liquid with the concentration of radioactivity, along with inactive pollutants like phosphates and fluorides. Taking into account that effluents from the thorium plant were always discharged into a river, strict requirements were complied with in the matter of discharges from the plant.

Plans are now underway to put up a treatment plant for decontamination of the effluent, particularly with respect to the medium and other inactive pollutants. Soil wastes that result from the deactivation step for the rare earth salt products are contained in the R.C. channels for storage.

In one of the fuel fabrication steps, the uranium oxide preparation at the nuclear fuel complex, the level of activity in the nuclear stage of the effluents is very low but the volume is considerable. A study of the geohydrological environs at the site indicated that any release of radioactivity, however small, to the public domain would not entirely meet with the safety criteria. Hence total containment of radioactive effluents was adopted and a set of solar evaporation pans are being used for the concentration of the liquid wastes.

Power Reactors

Operation of power reactors was found to be one of the major stages of the fuel cycle as far as radioactive waste management is concerned. To a large extent the types and quantities of wastes generated depend upon the type of reactors that are being operated in the country. The boiling water reactor is being operated at Tarapur and the pressurized heavy water reactor at Rajasthan. In terms of volume of liquid wastes, the heavy water reactor generates less effluents for discharge than the boiling water reactors. This essentially is due to the fact that D_2O is being used in the primary systems of heavy water reactors and hence operate in a closed cycle. All the clean-up is carried out by cartridge filters and regenerating type of ion-exchangers, and only leaks from the system is collected for recovery of D_2O. On the other hand, in the case of BWR, the equipment drains may not always be suitable for reuse and also, there is a stream of regenerate in solution from some of the demineralising units.

In the particular case of Tarapur units, leaks in the primary system have been rather excessive on occasions, often leading to significant increase in effluent volume. In terms of radioactivity levels, effluents from Tarapur station have also been higher by almost two orders of magnitude compared to the Rajasthan Reactor. This is obviously due to two reasons: first, because the effluents contain the activity seen by the primary system; and second, the primary system activity itself is high due to increased clad failure and significant inventory of the corrosion products which are active.

The major radionuclides that are of concern in the effluents are the iodides in the BWR and the tritium in the heavy water reactor. Tritium situation is one of the few areas where areas where a satisfactory solution is yet to be arrived at. An augmentation of the Radwaste capability has been achieved with an additional plant for treating TAPS radwaste using chemical treatment and ion-exchange on vermiculite. On an assessment of the environmental capacity, it has been decided to contain as much of the activity as is practicable in the liquid effluents. A solar evaporation facility is under construction at the site.

Disposal of liquid effluents from the Tarapur Power Station did warrant an augmentation of their Radwaste capability. This has been achieved with an additional plant for treating TAPS radwastes using chemical treatment and ion-exchange on vermiculite. In the Rajasthan Reactor, the original design intended for radwaste has not been met throughout the station operation so far. However, on a reassessment of the environmental capacity to accept radioactive releases, it has been found to contain much of the activity as is practicable in the liquid effluents. A solar evaporation facility is now under construction at that site. When completed, this facility would perhaps be

the first facility of its size in India.

Radioactive Waste Management units at the Kalpakkam site inclusive of the power reactors and research units of the BRC are being centralized, and this centralized Radwaste Management facility is now under consideration. The importance of an integrated approach while planning for a nuclear installation site is borne out readily in our experience. By centralizing the Radwaste Management for that site and optimizing the capacity of various equipments and systems, considerable cost reduction is at Tarapur for PREFRS plant and TAPS.

Models

The migration of people into wider areas entails problems of accidental release of pollutants and calls for a serious study of radioactive wastes. This problem was studied on models and by computers, and the results revealed heavy pollution of the air, deterioration in the quality of the soil and of a surface and underground water near Delhi. Drinking water was found to be contaminated heavily in underground aquifers and in the pipelines, especially by infectious diseases. This also brought in contamination of wells. There was serious contamination of water from industrial wastes, pesticides, chemical dertilizers, detergents, etc. This accidental release was also found to have an adverse effect on natural estuaries or wetland areas. Water was thus found to be polluted chemicallly, physically, physiologically, and biologically.

The soil was found to be an unsaturated zone which formed a link between the atmosphere and surface and sub-surface water. The response of the unsaturated zone to the accidental pollution was found to severely affect human and animal health. To preserve the biophysical environment and prevent damage to the environment through accidental releases, adequate planning is necessary. Failure in this sphere can be caused by many factors; including lack of adequate structure in the biophysical environment, defective conceptions, unsuitable forecasts, neglect of ecological knowledge, neglect of scientific multidisciplinary methods for the solution of individual problems, neglect of existing socio-political factors, sector approach in the solution of complex problems and neglect of other approaches, lack of basic data, and last but not the least, lack of knowledge necessary for the comprehension of the mutual relationship between the various phenomena and the potential danger of various reactions.

Mathematical models for fixed bed absorbers for surface diffusion must also be provided for the predominant intraparticle mass transfer system. When a mixing zone is allowed for the accidental release of effluents from the point

sources, it is necessary to know and to predict the dilution of the effluent before it reaches the boundary of the permitted mixing zone. This information has to be made available to the operator for all river and discharge conditions in an easily retrievable form so that the effluent flows can be readily adjusted in rate and concentration whenever necessary, in order to meet specified water quality standards beyond the mixing zone. The maximum width, the maximum length, and the enclosed surface area of the mixing zone may be thus determined and controlled.

Project Indentification, Formulation and Appraisal

To make the experience of radioactive waste analysis available, it is proposed to use training institutes as the main forum for collection, analysis, documentation, and dissemination of information and maintaining personnel for the exchange of their experience. Proper codification is needed to make it available in the form of a unified computerized foundation system.

The need of trained personnel is increasing rapidly and project requirements must be kept in constant view while deciding on the number of training personnel. For information exchange to be really useful between various operators, the experience should be analyzed, evaluated and communicated. The engineers should cultivate the capability for sophisticated analysis of events during their training. Also it is necessary to have a single forum a regular intervals for exchange of nuclear units. There are reports and investigations of unusual occurences. These may be documented. There is no set requirement for reporting such occurences. It is only with the cooperation of various authorities in the mutual and common interest that we expect these to be reported.

Orther Radioactive Wastes

Handling of radioactive spent ion-exchange resin has received considerable attention. The ion-exchange design is such that the spent resin can be dried in situ and the resin cartridge as a whole can be lifted into a shielding flask and transported directly for waste disposal. Additional operations have been eliminated. Based on experience, the capacity and the number of ion-exchange beds in the purification circuit have been chosen so that the heavy water radioactivity levels could be brought down to near normal levels following a split rod concurrence within the position out period of the reactor. Special care shall have to be taken in the design of the duplicate gas balance lines between the reactor vessel and the dump tank to ensure that condensed heavy water does not pose a problem under any circumstances.

In the helium purification circuit, several new features have been incorporated to achieve a smoother and more efficient working of the system. Precasting and adequate drainage facilities have been provided in the precombination circuit to prevent condensation and to achieve higher recombination efficiencies. In the freezer-dryer units, care shall have to be taken to prevent ingress of refrigeration into the helium circuit. Liquid nitrogen cold traps have been introduced prior to the sorbers to improve sorber efficiency and to eliminate the problem of condensation in sorber vacuum pumps.

Normally, process water was circulated in a closed loop consisting of heavy water and sea water. When the process water recirculating pumps are stopped due to any reason, gravity flow from a high head process water tank if established through the system to provide emergency process water flow through the heavy water heat exchangers to dissipate the decay heat from the reactor. The water is then collected in an underground deep tank for reuse. This gravity flow of process water and the head available from the high head process water tank have been utilized to provide an alternative source of motive power for the auxiliary heavy water pumps in addition to the normal power supply.

The existing curves jetty and caisson may be utilized for supplying the necessary quantity of sea water to projects in addition to meeting the requirement of curves. However, a separate outfall structure may be provided near the shore to discharge R-5 sea water. It may be observed that the existing pump chamber design results in the deposition of salt in the pump chambers and also gas leaching of the pumps during low tides. To eliminate these problems and to cater to combined sea water requirements of curves and R-5, the following modifications may be planned:

(1) Lowering the pump sump door to accomodate larger capacity pumps and to provide adequate submergence even during the lowest tide conditions.

(2) Removal of the existing baffle walls in front of the individual pump sumps to prevent starbing of pumps at low tide levels.

(3) Installation of flow guide walls to provide for proper distribution of sea water flow to all the pumps.

Six pumps may be installed, three in each of the 2 chambers, after the modifications have been carried out to meet the requirements of curves as well as R-5 reactor. Since in the new set up the sea water flow velocities in the pump chambers will be more than double the existing velocities, the salt accumulation in the pump chamber will be reduced considerably. Provisions shall have to be made for back washing of heat exchangers and strainers at full flow. Embodied piping may be kept to a minimum for easy maintenance.

Fresh fuel as well as irradiated fuel removed from the reactor may be handled and stored in a vertical position. The fuel transfer buggy situated in the fuel transfer trench at a depth of about 1 meter from the top surface of the bay water will permit easy approach to the buggy for maintenance without having to drain bays.

Proper installation of the Hepa filters was ensured with uniform and sufficient compression of the scaling gaskets to achieve a satisfactory filter bank efficiency. Provisions for carrying out in situ tests were made in all filter installations for periodic testing of the bank.

Often, defective and improper filter mounting was found to be a major cause of poor bank efficiency. The major wastes treated were liquid from system leaks, system draining from maintenance works regeneration waste, and flow down. The solid wastes were the spent ion-exchange resins, filter sludges and concentrates. The gaseous wastes treated were the radioactive gases produced in the reactor and other noncondensible gases removed from the main condenser. The gaseous wastes were estracted from the main condenser by an air ejector and routed up through a hold of line to give proper passage time and allowed to decay during its passage to the slack. The radioactivity of these gases was continuously monitored. Isolation valves, provided downstream of the hold up line with loop seal drains, close on a high radiation signal from the monitoring system to prevent release of gases.

An improvement in desalination and the removal of calcium phosphate was achieved by precipitation with barium sulphate. A two-stage precipitation was adopted providing for the removal of calcium and strontium. Replacing the filters alone did not solve the problems of a reduced filter bank efficiency.

Stainless steel was selected as the liner material as aluminium did not meet the criteria. Estimates of the induced radiation field did not preclude the use of stainless steel. The assessment proved correct during the maintenance of the door. The frame work was anchored to the existing liner and was made up of mild steel channel sections to suit welding of stainless steel sheets. Mild steel flanges were welded to the channels using openings of 20 cm^2. The gap between the existing wall and the liner was filled with cement liner.

In certain cases, isolation of valves or pipes directly connected to the reactor without any isolation valve in between became difficult since the reactor could not be drained without removing all the fuel from it. In such cases, seal plugs, freeze plugs, or alternative methods of temporary repair were used. At one time, all fuel and drain water had to be removed for proper isolation of control rod drain housings.

Equipment Protection

It became necessary to reduce radiation fields around the equipment to reduce the radiation dose received by technicians and supervisors. Decontamination was effected by flushing with water or chemicals, working from a distance using longer or remote-controlled tools, and provision of lead, concrete, or water shielding to limit radiation doses. However, the extent to which decontamination and shielding could be carried out depended on estimates of the radiation dose required for these works as compared to that required in the actual work and the availability of personnel.

Narora Site

The Narora power reactor site would be posing serious challenges in effluent management. This hinterland location combined a very highly potential aquifer of groundwater with a number of rivers and canals that are extensively used for agriculture. It would be quite a difficult task to evaluate the environmental capacity for release of radioactivity due to the reconcentration possibilities in the highly salted river or canal beds and the considerable recharging of aquifers along the river or canal bank certain periods of the year.

It will be necessary to move towards restricting the release of liquid effluents to as low as practicable limits and to completely prevent the permanent storage of radioactive wastes on sites. This vulnerable nature of the site aggravated the situation further with regards to storage of radioactive wastes. No direct disposal of waste is made to the ground, if the waste are known to be carrying any significant contamination. In many westerns countries, direct disposal of wastes into the ground is done for economic reasons. Engineering containments of reinforced concrete with waterproof barriers and additional protection are being invariably made use of in India for storage of solid wastes. All storage sites are evaluated in detail with respect to the geological and geohydrological characteristics and a regular surveillance is made in and around those areas by montoring the ground water and soil samples as an additional check against the unlikely failure of the containment in which liquid or solid wastes are stored.

Researchers shall have to monitor the ecology of forest areas outside the Kota Atomic Plant and the Narora Atomic Plant to obtain a basis on which to judge possible future environmental damage due to increased energy production. U.P. has long been dependent on atomic plants for its power needs.

Scientists will study the effect of radioactive wastes on air quality and the impact of air pollution on the forests of the region. Other studies will include

testing birds and mammals, and aquatic studies will concentrate on the productivity and population of aquatic organizations as well as chemical analysis of water and sediments. By maintaining constant surveillance on the sites, ecolofical scientists hope to be able to detect alterations in the forest and aquatic ecosystems, thereby preventing serious damage. A year's high level waste from the 100MW power plant reached 100 m^3.

Conclusion

It is evident that a large amount of experience has been accumulated in India in the field of atomic waste pollution control with power plant components diverse in size and manufacture. Yet inspite of the large experience, mistakes mishaps of identical nature occur, indicating that lessons from these experiences are not satisfactorily communicated to the actual operators. It is necessary that an effective information or data bank is buildt up which reaches all the people concerned so that not only the performance of systems can be improved, but also necessary improvements in design can be undertaken as a result of this feedback. To achieve this, it would be necessary to take an objective look at the faults and the problems met. More specific workshops and action-oriented discussions are necessary.

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MATERIALS FOR WATER PIPELINES - VALUE ENGINEERING ANALYSIS

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Introduction

To a certain extent the degree of sophistication, industrialization and civilization of a country may be measured by the attention paid to the importance of its pipeline systems. Emerging and developing nations are paying increasing attention to their infrastructures and water supply networks since they play a vital part in their economic and social progress as well as improve the health of a nation particularly if equal attention is given to the other part of the water cycle - sanitation. Various International sources of finance are available for water projects whether they are for raw or potable water transportation, desalination plant pipelines (most important in arid countries) or large scale irrigation projects.

Throughout all fields of industry there is a basic underlying need to derive maximum benefit from design specification whilst keeping the total costs to a minimum. Value engineering is a management analytical concept to ensure this that the use of sound engineering principles give greater value for money or to put it another way, "borrow less money and buy more schemes".

Today's pipeline designer faces a formidable set of options as he prepares to select the most appropriate pipe material for his particular water supply scheme. Manufacturers are constantly striving to introduce new materials, higher performance, modified or new joints, in order and fittings selection is essential for maximum cost effectiveness.

Value Engineering for Water Pipelines

Given a basic conceptual scheme for conveying water from point A to points B, C, D, E, etc., it is usual to allow for both short term and long term future developments which have to take into account population growth and shift, industrial development, weather and several other factors which can govern the design and choice of pipeline. Usually, lifetimes of 60 - 100 years are taken as a basis and generally speaking a conservative approach to water demand is likely to be less costly in the long run. Nevertheless, there may be occasions when it is cheaper to build for the short term and reinforce later. Once these parameters are established it is feasible to undertake a more detail detailed value engineering analysis.

Such an analysis has to consider all factors and these can be grouped or categorized as follows:

1. System Requirements

   1.1. Hydraulic characteristics
   1.2. Route survey
   1.3. Health (and safety) considerations
   1.4. Type of water

2. Pipeline Requirements

   2.1. Basic pipe options
   2.2. Efficiency of joint
   2.3. Pipe performance
   2.4. Total system concept
   2.5. National/International Standards
   2.6. Availability and interchangeability

3. Installation Requirements

   3.1. Type of soil, pipe bedding, backfill consolidation
   3.2. Method of jointing
   3.3. Resistance to handling and transportation damage
   3.4. Leaktightness
   3.5. Cost of installation

4. Operational Requirements

   4.1. Life expectancy
   4.2. Resistance to surge
   4.3. Resistance to changing soil/traffic loading
   4.4. Minimum maintenance
   4.5. Ability to insert branches or connections

The sections that follow discuss these different aspects and set out to illustrate diagrammatically how the parameters can influence the selection of materials.

System Requirements

One the quantities of water to be transported and pipeline routes have been outlined, pipe diameter and pressure requirements can be computed. Hydraulic flow in a pipeline is governed by the pipe internal diameter and a friction co-

efficient. These vary for the different pipe materials and methods of manufacture. Some pipe materials have a standard bore diameter and increase the wall thickness, and hence the external diameter, to meet pressure requirements; whereas others have a standard outside diameter (easy for jointing) and increase the wall thickness internally for higher pressures. For some materials, one class of pipe covers the majority of requirements (e.g. ductile iron class K9). Table 1 gives an index of flow capacity for the different pipe materials against a range of pipe diameters.

Table 1. Index of flow Capability Ductile Iron = 100

	Internal diameter (mm)				
	200	300	400	500	600
Ductile iron	100	100	100	100	100
Grey iron	93	94	94	95	-
PVC	100	96	82	82	82
Polyethylene	57	64	72	71	71
Asbestos cement	90	92	98	102	93
Steel	103	103	93	92	93
Prestressed concrete	-	-	-	-	98
GRP	96	95	98	98	98

As previously mentioned, there are a variety of classes of pipes to cover the usual operating pressure ranges. Figure 1 illustrates this variation in the form of a bar chart.

The route survey will indicate not only the static head condition but will also identify the type of ground, traffic loading, water table, rivers, likelihood of subsidence, local civil engineering disturbances, proximity to other mains and service, ease of access, etc. All of these factors can have a significant effect on the choice of materials, pipe classes and joints. For instance, ductile iron or steel are preferred in earthquake zones. Figure 2 gives an indication of the relative performance of pipeline materials in ground liable to subsidence or settlement.

Whilst the provision of piped water supply improves the health of the community, consideration has to be given to providing wholesome supply at the tap. This means not only checking on the incoming water quality but also ensuring that no contamination of the water occurs in transportation through the mains. Generally speaking, coal tar coatings are now considered unwise for potable water pipes, (bitumen being preferred) and in some areas, fears of pick up of asbestos fibres limit the use of that material. W.H.O. provision or guidance

should always be followed. The type of water can also affect choice of materials. Certain types can be aggressive to ferrous materials (cement mortar lining recommended) or cause softening of cementitious products(bitumen coating recommended).

Basic Pipe Options

Within this category there are several factors which are related, and therefore it is worth considering the different pipeline systems that are available for water supply projects.

Ductile Iron Pipe

Ductile iron is probably the most widely used material for water supply projects. It is widely available in the range 80 - 1600 mm with push-in, mechanical or flanged joints. Limited supplies are available in sizes outside this range. Pipes are made in different lengths according to National standards, but 5.5 or 6 m are the most commonly used lengths. Longer pipes up to 8 m are available in the larger diameter sizes. Ductile iron pipes and fittings are made in accordance with British Standard 4772 and have a maximum working pressure in the range 25-40 bar dependent on size. Pipes made to British Standard 4772 are also in compliance with the requirements of ISO 2531.

Grey Iron Pipe

Like its derivative ductile iron, grey pipe is widely used throughout the Water Industry and there has been a long tradition of use stretching back to the 17th Century. Pipes are available in the size range 50 - 500 mm and are suitable for working pressure up to 16 bar, dependent on the class of pipe. Grey iron pipes are made in accordance with B.S. 4622.

Prestressed Concrete Pipe

Prestressed concrete pipe is made in the diameter range 600 - 3,200 mm by one of two methods. The "cylinder" pipe, which has been used in the U.K. for 25 years without a single operating failure, incorporates a watertight steel cylinder membrane within the wall thickness of the pipe and the prestressing wire is wound helically onto the outside of this cylinder. Prestressed non-cylinder pipe, as its name implies, does not have a steel cylinder. In this pipe, prestressed wires lie longitudinally within the wall thickness of the concrete core of the pipe anf this core is subsequently provided with a helical

winding of prestressed wire. In both cases the windings are protected by a cement mortar cover coating. Prestressed concrete pipes are suitable for working pressures up to 12 bar according to class and they are manufactured in accordance with B.S. 4625. However, prestressed concrete pipes are relatively heavy and are usually installed in the country of manufacture. The export potential for such pipes is usually limited by the high cost of transport.

RPM/GRP Pipe

Glass reinforced plastics are new pipeline materials for the water and sewage industry. Many of the original designs were really developed for industrial applications for above ground conveyance of corrosive fluids. More recently, GRP pipe has been developed for buried applications. There are several techniques for making GRP pipe and all methods result in a lightweight flexible pipe. The use of sand and resin to increase the thickness and hence the stiffness results in a pipe which is usually described as reinforced plastic matrix (RPM). Whilst RPM pipes are available as large diameter pressure pipes, many of the other GRP systems are only available for non or low pressure applications. Pipes are manufactured in accordance with B.S. 5460. All these pipes are susceptible to handling and installation damage and care must be taken to protect the pipes in transit. Usually, GRP pipes are exported in open crates but this is an additional expense which is reflected in the final price.

Steel Pipes

Steel pipes are still frequently used for water mains and can be made seamless or by welding plate or strip. If a welded joint is to be used, skilled labour is an essential requirement. Frequently, a mechanical joint such as a Viking Johnson collar is preferred. The similarity of the mechanical performances of the cheaper ductile iron and steel pipe has led, in general, to a diminishing market share for steel pipe in the water market.

PVC Pipe

PVC pipe is widely used for water mains and is available in the size range 25 - 600 mm for pressures up to 12 bar. PVC pipes are jointed using solvent cements, but a larger proportion of applications now utilise push-in joint systems. Care should be taken when designing PVC pipe systems, not only from the installation point of view but also to give full consideration to the effects of surge and pressure fluctuations, since there have been several reported failures attributed to pressure variations. Other factors which should be

taken into account are the deterioration in performance which takes place as temperature increases, i.e. reduction in working pressure ratings and the susceptibility of the material to inference damage. PVC pipes are made in accordance with B.S. 3505.

Polyethylene Pipe

Polyethylene pipe is not widely used for water mains, it tends to be more frequently used for services or for temporary irrigation schemes. Two systems are available one based on low density polythylene made to B.S. 1972 and the other based on high density polythylene made to B.S. 3284. Polythylene is generally inert in most corrosive environments, but it is subject to temperature limitations and has limited resistance to interference damage. In many respects, these limitations are similar to those of PVC pipe.

Asbestos Cement

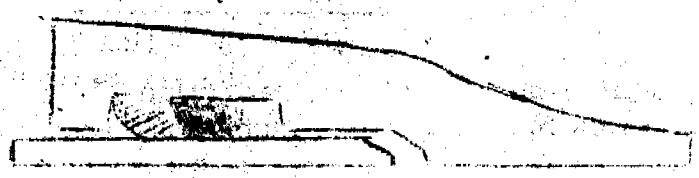
Asbestos cement pipes have been used for water and sewer mains for approximately 50 years. Pipes are available in the size range 50 - 900 mm with pressures up to 12 1/2 bar dependant upon class. Pipes are made to B.S. 486. Because of the method of manufacture, different classes of pipe have different outside diameters and consideration must be given to jointing when handling varying classes of pipe.

Efficiency of Joints

Each pipeline system tends to have a different range of jointing concepts. The most commonly used types of joint for the Water Industry tend to be mechanical or push-in joints because these can be made without the need for highly skilled labour and sophisticated machinery and perhaps more important, can be made in any weather conditions. Rubber ring joints are particularly easy to assemble in Asia where rainy seasons occur. The joints can be made very quickly so that the pipes can be quickly installed in the trench.

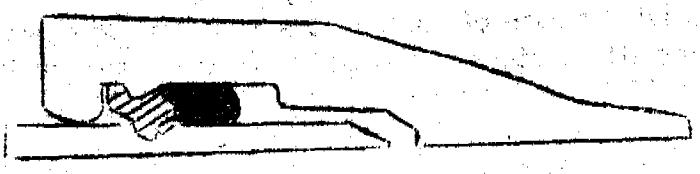
In the case of ductile and grey iron pipes the joints have to be suitable for their high operating pressure ratings. Because the joints are design for this high duty performance their sealing capability is such that they will resist full vacuum conditions should these ever arise. For applications where water tables are high or river crossings are constructed, the ability of a pipe joint to withstand external pressure is of paramount importance to ensure there is no infiltration into the pipeline network.

There has been an increasing demand for anchored joints to facilitate the installation of pipes in more demanding application and the iron pipe manufacturers now offer a wide range of such joints to cater for most demands. The following sketches illustrate a range of joints that are available for iron pipeline system.



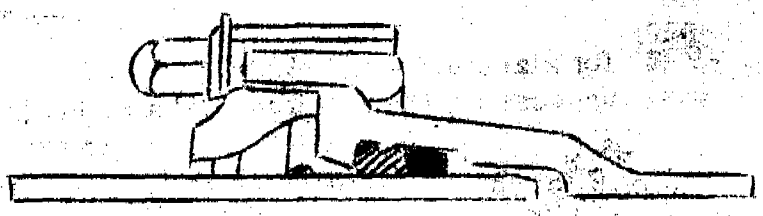
Tyton Joint (Ductile and Grey Iron)
Push-in flexible joint
Size range DN 80-600
Deflection up to 5° (4° for sizes above DN 300)
Normal maximum working pressure Ductile iron Class K9 uti DN 300 - 40 bar
above DN 300 - 25 bar
Grey iron Class 1 10 bar
Class 3 16 bar

Stantyte Joint (Ductile iron)
Push-in Flexible joint
Size range DN 700 - 1600
Deflection 2 1/2° - 4° according to size and design
Normal maximum working pressure Class K9 - up to 25 bar depending on size.



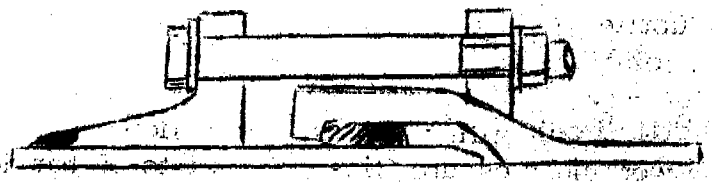
Tyton Anchor Joint (Ductile iron)
Push-in self-anchoring flexible joint
Size range DN 80 - 300

Deflection 3°
Normal maximum working pressure
10 bar



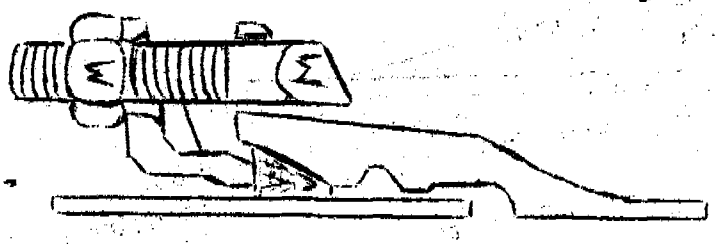
Stanfast (Ductile iron)
Push-in self-anchoring flexible joint
Size range DN 350 - 1000

Deflection 2-4 depending on size
Normal maximum working pressure
Class K9 - 16 bar

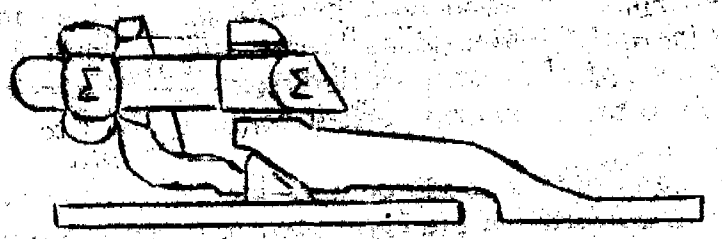


Tie-Bar Joint (Ductile iron)
Push-in self-anchoring flexible joint
Size range DN 350 - 1200

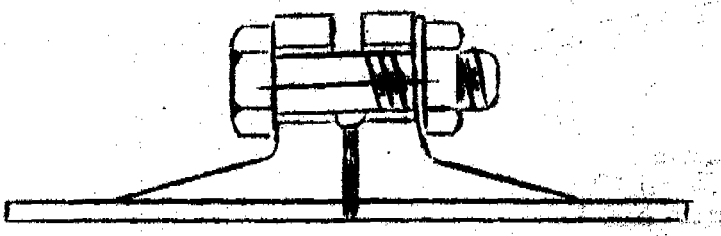
Deflection 2 1/2°
Maximum working pressure up to
25 bar purpose designed



Stanlock Joint (Ductile iron)
Mechanical flexible joint
Size range DN 100 - 600
Deflection 4°
Normal maximum working pressure Class K9 uti DN 300 - 40 bar
above DN 300 - 25 bar



Bolted Gland Joint (Grey iron)
Mechanical flexible joint
Size range DN 100 - 500
Deflection 4°
Normal maximum working pressure Class 1 - 10 bar
Class 3 - 16 bar



Flanged Joint (Ductile and Grey iron)
Self-anchoring rigid joint
Size range Ductile iron DN 80 - 1600 Grey iron DN 80 - 500
Maximum working pressure Ductile iron up to 40 bar - depending on flange rating
Grey iron up to 12.5 bar - depending on flange rating

Pipe Performance

In the past, the majority of pipes were rigid conduits with thick walls, now pipe manufacturers have improved their technology, new and higher strength materials have become available and economies have been achieved in wall thickness. Generally, thick walled rigid pipes are required to withstand the majority of the vertical loads applied. Thin walled flexible conduits require that consideration be given to the supporting effect of the soil.

Asbestos cement, grey iron and prestressed concrete pipelines must be regarded as rigid conduits. The ability of the rigid pipe to carry external load is directly related to the structural ring strength of the pipeline. In order to maximise performance of a rigid pipeline, it is necessary to have good pipe bed preparation.

Steel and plastic pipes are treated as flexible conduits. As the sides of the pipe distort under topload conditions, the flexible pipe material places greater reliance on the ability of the backfill and surround to withstand the vertical loads. Thus considerable attention has to be paid to the embedmer and backfilling of such pipes with greater attention being necessary for the less

stiff and more senitive materials. Ductile iron is unique of all the materials, in that it combines the properties of both rigid and flexible pipelines. In the smaller diameters, its behaviour is very similar to a rigid pipe but its ability to absorb deflection gives it a superior performance. In the very large diameters it can be considred to be flexible pipe and considered to be flexible pipe and consideration has to be given to the installation of the pipe. For the majority of instance, simple tamping of the backfill material will be sufficient. Design codes are available to give greater guidance in this matter. Figure 3 shows the relative pipe stiffness of different materials. Table 2 shows a comparison of the properties of various pipeline materials.

Total System Concept

It is usual for the pipeline designer to concentrate on the selection of pipe material and then to make an appraisal of the fittings. In some cases, it is not possible to have the fittings made in the same material and thus the installation crew may have to be aware of the different performance and installation criteria that may be necessary for fittings as opposed to pipe. For instance, for medium and high pressure requirements in GRP pipe it is necessary to use steel or iron pipe fittings. These fittings will be relatively rigid compared with the pipe and therefore it is necessary to consider the implications of a rigid flexible transition in the pipeline system. The ability of joints to perform under topload and sheer loading conditions can be critical at such a rigid flexible interface. Similarly, for other plastic materials, corresponding plastic fittings may not be available throughout the size and pressure range. Whereever feasible, the first consideration should be given to using fittings made of the same or compatible material as the pipe. Iron and steel fittings are frequently used with all the pipeline materials, since a wide range have always been available to an iron pipeline system. It is, of course, necessary to adapt the iron fittings to meet the dimensional criteria of an alt alternative pipeline system.

Availability and Interchangeability

In laying distribution networks, it is usual to ensure that the system can be extended or repaired without any difficulty, thus security of supply and interchangeability between manufacturers is an important criteria regarding the selection of a pipeline system. International standards provide great assistance along these lines. British standards are often in compliance with International standards and they are widely accepted as standards for manufacture in many countries. However, there can be a significant problem in respect of pipeline systems based on inch series and their equivalent based on metric series. It is therefore essential that the pipeline designer knows the differ-

ence between a 4" PVC main and its metric equivalent 110 mm. The use of International standards to get a greater world wide commonality is to be applauded if full security of supply and interchangeability is to be achieved. The ductile iron pipe manufacturers have gone a long way to meeting customer requirements in this respect, and pipes made to International standards are now available from the UK, France, Germany, Japan, America and several smaller sources of supply. In each case, there is complete interchangeability in that a pipe spigot from any one country can be joined to a pipe socket of any other country.

INSTALLATION REQUIREMENTS

Type of soil, pipe bedding and backfill

As mentioned previously, a route survey will give an indication of the type of ground the nature of the soil and whether it is suitable as pipe bedding material and backfill. In the case of fully flexible pipes, the type of soil becomes of paramount importance and it is necessary to check whether soil can be properly compacted to give the necessary support to the pipeline. If the soil is suitable for the pipe surround, it will be necessary to achieve the required degree of compaction of the soil so that the necessary soil modulus and Proctor Density are achieved for the correct performance of the pipeline system. In the case of rigid pipes, it is necessary to have a bedding material which is going to support the pipe evenly and it is often necessary to import granular bedding materials to site. Figure 4 gives a comparison of the grades of embedment conditions that are necessary for different materials under a typical set of loading circumstances. Ductile iron pipe requires the least amount of compaction and the soil modulus of 3 MN/m^2 can usually be achieved with minimal compaction. For higher toploads, flexible conduits require higher densities in all cases.

Some pipeline materials are more sensitive to imperfections in the backfill than others, such imperfections can include rocks, uneven bedding, voids, imperfect compaction, variations in water table, etc. Figure 5 serves to indicate the sensitivity of certain materials to imperfect backfill. It is possible to determine whether a soil is aggressive to a pipeline material. A resistivity survey will establish whether an iron pipe system needs any corrosion protection. The simpliest form of corrosion protection is achieved by encasing the iron pipe in a tubular film of polyethylene. This is undertaken on site immediately prior to jointing. The film is snugly fitted along the barrel of the pipe and after jointing the protection is made continuous by bringing the polyethylene sleeving over the joint area or by wrapping the joint with a wrapping tape. Polyethylene sleeving has been found to be very effective and relatively cheap, 2% of pipe cost being typical. Corrosion protection systems are

always advocated for steel pipelines and it is usual practice to back them up by cathodic protection in order to avoid any rapid corrosion at defects in the coating system. High chloride and high sulphate soils can be identified by soil sampling, since they can cause degradation of cementatious based materials. Special protections may be necessary. Figure 6 indicates the premium over pipe costs for protecting different materials.

Method of Jointing

It is possible to make most push-in joints very quickly indeed using simple jointing tackle or the digger bucket of an excavator. Being quick and simple to make, it allows pipe laying to keep up with trench excavation and reinstatement can quickly follow. Mechanical joints although taking slightly longer to make, do not delay pipe installation. Welding techniques can take much longer and necessitate skilled labour which in many countries is a scarce commodity. Furthermore, the critical nature of a weld necessitates higher levels of site supervision and inspection and the possibility of a greater incidence of leaking joints under test. Clearly, the length of pipe is one of the factors to be taken into consideration. Figure 7 gives an indication of the number of joints per kilometre of pipeline with 170 being about average. In certain system using collar joints, it should be noted that the number of joints is double. At times, manipulating small push-in jointed collars can be a tricky operation. For distribution systems a large number of fittings will be necessary and this will increase the number of joints involved in any one system.

Resistance to Damage

Robustness is an important characteristic for a pipeline system if it is to be handled many times between the manufacturer and installation on site. For those materials which are more sensitive to impact damage, greater care has to be taken at each stage. Some materials are prone to spigots cracking whilst others will shatter upon impact. The relative sensitivities to on site impact damage of different materials is indicated in Figure 8.

Leak Tightness

Once a pipeline has been installed, the pipe should be hydrostatically tested according to the codes and practices established for that country for the particular pipeline material involved. The level of pressure test reflects the nature of the material and the types of defects or damage that could have occured during installation. For a brittle material, a searching test is necessary to ascertain if there are any cracks in the pipe wall; with a tough

material, cracking is an unlikely occurence, and the test is more one of pipeline and joint integrity. Some materials absorb large quantities of water, e.g. prestressed concrete pipe, and it is necessary to make due allowance for this water absorption. The cost of testing reflects the anticipated pipeline integrity and the speed of achieving an acceptable test result (see Figure 9).

Cost of Installation

Installation costs vary for all the different materials. This can be dependant upon the actual trench width influencing excavation and reinstatement costs, the type of backfill, the number of joints, resistance to damage, ease of testing etc. In general terms, for small diameter mains the cost of installation is the predominant factor. The selection of a cheap pipeline material could result in significantly increased installation costs which could more than offset the initial material savings. In the larger diameters, the cost of pipe predominates in the total installation cost and therefore it is of paramount importance that the maximum economies pipe selection are achieved. The installation costs associated with large diameter pipes are still significant and should not be over-looked. A schemmatic indication of the influence of pipe material and installation cost is given in Figure 10. This is meant to illustrate the typical range of material - installation costs for pipes laid in open country in good ground. In rocky ground conditions, the installation cost will increase. Similarly, for pipes being laid in roads, the cost of installation increase. In all cases there are many unknowns and unforeseeable factors and it is only by careful site supervision that the correct decision can be taken.

Operational Requirements

Life Expectancy

All installed pipelines should be considered as national assets and therefore it is in the interest of the community to protect this investment. Thus, initial installed cost of a pipeline should not always be taken as the overall cost, particularly if one pipeline material has a predicted life of 50 years whilst another has a life expectancy of 100 years. Obviously the case for increasing life expectancy by providing a corrosion protection system can be made, and the appropriate decision taken.

Clearly, simple cheap corrosion protection measures such as polyethylene sleeving for iron pipe systems or the use of sulphate resistant cement for prestressed concrete or asbestos cement pipes can be decided upon without recourse to financial advisers whereas extremely sophisticated corosion protection

systems may need comprehensive technical and economic analysis.

Often traditional materials such as grey iron offer exceptionally good value for money because the wide experience has established all the limitations and identified methods of design, installation and operation to guarantee a high probability of long life. Newer materials such as plastics do not have this experience and therefore it is wise to be conservative when anticipating the life expectancy of any pipeline system. (Bromell reported to the International Water Supply Association in Kyoto 1977 an increasing failure rate of PVC pipes with age of service.

Resistance to Surge

Unfortunately, most distribution systems are unable to operate at constant pressure and variations will occur as pumps and valves operate to meet demand conditions. Some materials are more sensitive to cyclic pressure and surges than others. It is now common practice to reduce the design stress of PVC pipes where cyclic pressures are significant. This usually results in selection of the next class of pipe.

If surge is a significant factor in the operating cycle of a pipeline, consideration has to be given both to the maximum pressure and the associated vacuum condition. Thus for complete operational safety it is necessary to select a material such as ductile iron or grey cast iron (which have sufficient reserves of strength and resistance to collapse and leakage), or introduce surge suppression equipment. Value analysis identifies the cheapest solution.

Resistance to Changing Soil Loading Conditions

Earlier sections highlighted the need for examining the top loading conditions and selecting the correct pipe and trench conditions to meet the foreseen demand on a pipeline. In rapidly developing countries new construction sites and roads place additional demands on established pipelines. In these circumtances selection can prove to be a wise investment.

It has now been established that each excavation in close proximity to an established pipeline can result in additional bending stresses. Excavations on adjacent services or the preparation of foundation for new buildings all cause earth movement which produce additional stresses in the pipeline. If pipes are imperfectly laid (or subsequently distrubed) then the bending stresses can become significant. Pipes behave in a different manner in these circumstances. Grey iron and asbestos cement have a reasonably high resistance to bending stresses provided there are no stress concentration factors resulting

from imperfect bedding. Certain plastics and steel pipes are capable of large deflections but they can bukle or collapse. GRP has limited resistance in bending and it is essential to correctly install it. Ductile iron pipe has a high resistance to bending stresses and is capable of withstanding significant strains giving a good all round performance.

Minimum Maintenance

Most pipeline systems operate with the minimum of maintenance provided the pipe is of good quality and correctly installed. Over half the operation failures in a correctly installed pipeline will probably be attributed to external interference. Thus it is recommended that only pipes and fittings manufactured to approved standards and backed up by a full quality control and inspection scheme are selected. Training of operative to correctly intall pipes is also important. Selection of a pipeline material which is resitant to installation imperfections and external damage will also ensure a good maintenance record.

Availability of repair systems should also be studied since a limited number of failures is inevitable.

Ability to insert branches or make Connections

Finally, consideration should be given to the cost of installing service or branch connections. Only on ductile or grey iron systems can simple cheap ferrules be screwed directly into the pipe wall. On steel systems welded connections are available whilst on asbestos cement and plastics, wrap round saddles are required. In congested areas with many services in close proximity, the cost of service connections can be a significant factor in the overall economic evaluation of alternative pipeline systems.

Concluding Remarks

Analysing the technical performance and evaluating it against cost is a powerful tool for engineers and accountants alike. Although this paper attempts to quantify pipe performance, this will vary for each diameter, class and type of pipe. One factor which is not built into the analysis is the question of source of supply. Some developing nations give preference to pipeline systems with a local manufacturing content, whilst others prefer to buy at lowest cost on the world market. One compromise alternative which is frequently adopted is in grey iron flanged pipework. Grey iron pipe is purchased from overseas, flanges attached locally and the system supplied with locally manufactured

grey iron flanged fittings.

Provided all aspects are considered at all stages and long life is considered as a prime requirement, then the extra cost of selecting the best available material and avoiding the subsequent expense of excessive repairs or replacements will be shown to be a bargain. Taking note of materials limitations rather than their strength is a good approach to avoid the long term cost of short term savings. A value analysis appraisal will lead to maximum cost effectiveness which will benefit the community as a whole.

Question and Answer:

Mr. Rahman — When you export these pipes to developing countries, are there some problems to compatibility between local products and imported materials? I had a great deal of problems in my research to see if there are locally available products to fit imported materials.

Dr. Smith — Compatibility is one of the difficulties, that is why I think international standardization is moving in the right direction. It is widely used in the Far East simply because local manufacturers have the fittings to go with it.

There are problems of compatibility because people supply parts from the Western World before standardization is even thought of. PVC systems are again a classic one between the imperial and metric systems in operation. My company has adopted the metric system and has spent very large sums of money to go metric. Having done so we still have the problem of the US operating in a different dimension.

It is difficult; I sat on many committees arguing about international standardization and we agree that we have got to have some degree of compatibility, otherwise when we get into technological breakthroughs there will be loss of benefits, sometimes some headaches.

RECOVERY OF ENERGY, FERTILIZER AND WATER FROM STRONG ORGANIC WASTES BY THE ANOX PROCESS

by D. Evers, B.Sc., M. Inst., W.P. C (Dip); M.R.S.H., Managing Director, D. Evers & Associates Limited, United Kingdom

General

D. Evers and Associates Limited offer Turnkey systems for continuous and automatic effluent treatment and provide and experienced team of systems engineers working in the effluent process environment.

The principals of the Company have a background in effluent process engineering and are experienced in managing capital projects with a focus on pollution control.

D. Evers and Associates Limited is a young company with a new formula for improving process economics through an integrated systems approach to process engineering.

D. Evers and Associates Limited is a specialist in process plant and, in particular, effluent treatment, and in conjuction with Mechanical & Combustion Engineering Co. Pte. Ltd. 10/12 Jalan Kilang, Singapore (MECOMB), has the resources and expertise to cover engineering projects from the design of specific articles of equipment to the total systems analysis, design, fabrication and construction of an entire effluent treatment system.

Many organisations may possess the necessary skills to design and select specific items of equipment. Few, however, have the experience, the integrated team approach or the top management time which are essential for the successful creation and future profitable operation of total systems.

The Evers/MECOMB team has been structured to provide multi-disciplinary expertise in finance, systems analysis, engineering equipment selection and procurement as well as contract management, training of client's staff and plant maintenance.

D. Evers and Associates Limited and Mecomb Co. Pte. Ltd. offer this total service.

D. Evers and Associates limited has developed a number of processes, and can confidently handle almost any pollution problem.

The Companies specialise in advanced waste treatment techniques such as:

a) Biological treatment with oxygen
b) Anaerobic digestion
c) Physico-chemical treatment
d) Electroflotation
e) Catalytic oxidation
f) Ion-exchange
g) Reverse osmosis and desalination
h) Carbon filtration
i) Solidification of toxic and intractable wastes

and through their associated companies produce package treatment systems in all these categories and many more.

Applications include effluent process control in the following areas:

Agriculture: Breweries and distilleries: Carpet Manufacture: Ceramics: Domestic sewage: Food prepearation and canning: Galvanising: General chemicals: Leather and tanning: Marine wastes: Metal finishing: Non-ferrous metal processing: Oil treatment and sludge solidification: Paint technology: Paper pulp and carboard: Pharmaceuticals: Phenols and cyanide: Plastic manufacture: Slaughter-houses: Steel manufacture and processing: Synthetic fibres: Textiles and dyeing: Wine industry.

Additional areas include:

Closed loop fish farm systems: Drinking water supply: Fume scrubbing and odour control: Swimming pool recirculation and treatment.

Our approach is extremely flexible and consequently the best solution, both technically and economically, can be found for any problem.

One of the processes developed and patented by D. Evers and Associates Limited which has attracted a great of interest worldwide because of the energy recovery aspect and its significance in this present energy cirsis is the ANOX process.

The ANOX Process is a system developed by D. Evers and Associates Limited of Worcester for the treatment of strong organic wastes to produce a clear, sterile and re-usable liquid, and a solid suitable for conversion to a fertilizer or high protein food, whilst being completely self-supporting energy wise.

This is achieved by using a highly efficient anaerobic digestion first stage which reduces the BOD by approximately 90% and gives off methane in a Bio-

gas. The surplus gas is burnt in a specially adapted engine coupled to a generator which gives sufficient power to run the second and third stages of chemical treatment and catalytic oxidation respectively, and there is also an abundance of surplus gas which can be used direct, as a heating source or converted to electrical energy to supplement, or even totally satisfy, the power requirement of the entire establishment.

Anaerobic Digestion

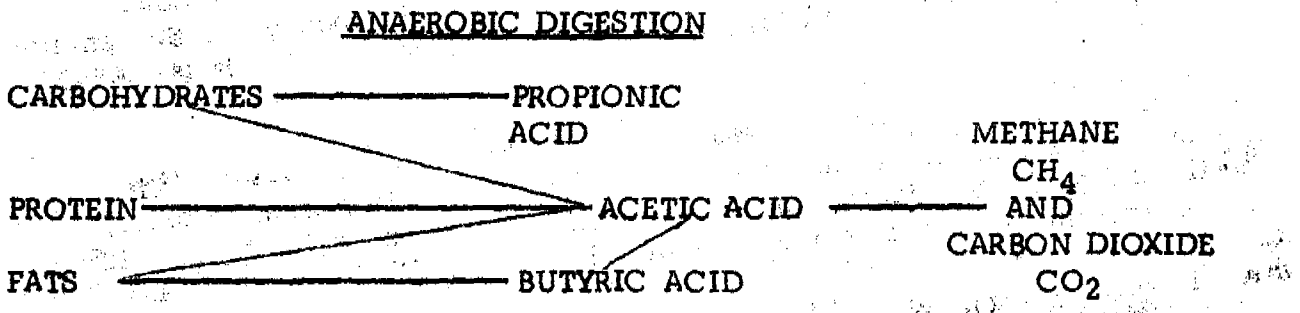
The anaerobic digestion process involves a complex series of reactions brought about by a mixed culture of bacteria. Two phases of decomposition occur in the digestion of organic matter: the liquefaction and gasification stages. The end products of the liquefaction stage are utilized in the gasification stage.

Bacteria are the essential ingredients of the process. Their reactive potency is partly explained by their tiny size and consequent massive external surface area. Man has a surface area of 0.16 sq.m./kg. whereas bacterial have a surface area of around 62,500 sq.m./kg. The bacteria needed occur naturally and will increase in numbers as the process continues.

The liquefaction of organic matter occurs when enzymes catalyse the hydrolysis of complex carbohydrates to simple sugars and alcohols; lipids to glycerol; Protein to peptides and amino acids and fats to fatty acids. These hydrolysed organics are further broken down to organic acids by anaerobic bacteria.

The gasification stage consists of the conversion of simple organic compounds to the final end-products of carbon dioxide and methane, plus an inert organic residue known as digested sludge.

Liquefaction and gasification occur simultaneously in a well balanced system. The two phase nature of the anaerobic digestion process is brought about by the presence of at least two large and physiologically different bacterial populations. The composition of the input and the environmental conditions applying are major factors in determining which species predominate at given times in the digestion process.



Active bacteria are present in anaerobic digesters in concentrations of 1 - 10 million per ml. Comparing these figures to those found for non-methanogenic populations suggests that nearly equal proportions of methanogenic and non-methanogenic bacteria are present in the average anaerobic digestion process.

The number, types and species of micro-organisms initiating fermentative events are undoubtedly selected by the environmental conditions imposed. Methanogenic bacteria are now known to be widespread in nature, having been isolated from garden soil; black mud; the rumen of herbivorous animals; marshes, ponds, lakes; sewage and sewage treatment processes.

Bio-Gas

The composition of the gas depends on the kinds of material being digested, and the length of time the sludge undergoes digestion. Not all sludges contain the same amount of gas, and not all bacteria form the same quantities of methane and carbon dioxide when they decompose organic matter. Most sludge gas produced from digesters is approximately 70% methane, 30% carbon dioxide and has traces of nitrogen, ammonia, hydrogen, mercaptans and amines, hydrogen sulphide and water vapour. The 70/30 methane to carbon dioxide ratio may vary by as much as 10% either way.

The calorific value of bio-gas varies from about 580 to 750 BTU per cubic foot. It is about 16,000 BTU per lb. The ignition temperature of methane in mixtures with air is the temperature to which the mixture must be raised to cause spontaneous combustion. This varies of course, with the purity of the gas, but for pure methane in air at atmosphere pressure, the ignition temperature is 300 - 350^{o}C.

Methane has a higher calorific value than petrol (23,000 BTU/lb. compared to 18 - 19,000 BTU/lb.) Due to its higher hydrogen content. Engines running on natural gas or methane have the advantage that they can go as much as five times further between oil changes. They also have 50% lower CO and HC emissions than engines running on petrol or diesel.

Bio-gas, either scrubbed or straight from the digester, can be used as fuel in a wide range of internal and external combustion engines. With a combustion range of 6 - 11% in air, and a slightly higher calorific value than petrol, methane is highly suitable for internal combustion engines.

Flotation System

The flotation system is unique in that it combines the use of chemical coagula-

tion and flocculation together with electrolytic flotation techniques to minimise space requirements, and produces an effluent quality superior to other systems.

Considerable development of lectrode material has taken place and from earlier work on the electrolysis of sea water to provide hypochlorous acid for sewage treatment in coastal areas.

Electroflotation is successfully used on the waste water from pig farms and found to be effective in minimising the COD and BOD content of the main liquor body. Depending upon the actual suspended solids level and also the soluble COD content, the treatment time varies from 30 to 90 minutes.

The applied power to the electrodes is 600 watts per sq. metre and using a power cost of 2.0p. per k.w.h. the operating cost is established at 1.2 p. per cu. metre.

Catalytic Oxidation

Catalytic oxidation is corrosive attack by oxygen predominantly as a result of the radical or ionic bursting of C-H and C-C bonds or by addition at double bonds. The reaction is brought about rapidly by initiators which supply first of all the desired or necessary initial concentration of radicals, to start the chain reaction or oxidative breakdown. Once initiated, the chain reaction is under normal circumstances brought to a halt by break-off reactions.

Radical formation is achieved by excited dissociated or at least in part ionized gases or gas quantities, preferably atmospheric air. The excitation and dissociation of ionization of the gaseous reaction partner is effected by radiation or electrical energy, e.g. in a field with a Townsend or corona discharge. The excited, dissociated or ionized gas particles thus formed react in water and to some extent inorganic impurities, then also with the water itself, with radical formation subsequently leading to hydroperoxide.

As the next stage in the breakdown process, the resulting and hydroperoxide compounds thus produced have to be decomposed in order to initiate a chain reaction, a process which is catalytically accelerated.

Glossary of Terms

DETENTION (retention or residence) TIME - the time which any portion of the input remains in the digester: digester volume - daily input colume, units days.

BOD - a measure of the amount of material in the waste which can be easily degraded by microbes, in terms of the oxygen used by microbes in the degradation of the waste; units mg/l or ppm. BOD causes rapid pollution in rivers and is mostly soluble or very fine particulate material.

COD - a measure of the total organic material in the waste which might eventually be degraded by microbes. It includes the BOD. Determination is by chemical oxidation and units are as COD; mg/l or ppm. COD also contains the larger solid material only slowly degraded by microbes and tending to cause long-term pollution.

TOTAL SOLID (TS) - the total amount of organic and inorganic material in suspension and solution in a slurry or sludge, determined by evaporating off the water, units% weight per volume, (i.e. g/100 ml) or sometimes mg/l).

VOLATILE SOLID (VS) - the organic material in the Total Solids, determined from the residue left after burning off the organic material; units % of TS or % weight per volume or mg/l in original waste.

VOLATILE FATTY ACIDS (VFA) - organic acids, mainly acetic, formed by microbial action on foodresidues in the animal intestines or while excreta stands in tanks or during anaerobic digestion; units mg (as acetic acid)/l.

AMMONIA NITROGEN (NH_3N) - ammonia formed by microbial action on proteins either in the animal intestines or as the excreta stands in tanks or during digestion; units mg/l.

SLURRY - usually refers to the raw mixture of faeces, urine and water, while sludge or digested sludge is the slurry after anaerobic digestion.

Analysis A

	BOD mg/l
Raw slurry feed	20,000
Out of digester	3,000
From clarifier after flocculation	800
From chemical coagulation/flocculation electroflotation	200
From catalytic oxidation	30
Final effluent after filtration	10

Analysis B

Analysis of Final Effluent (Laboratory Results)

pH Value	7.5
Suspended Solids	NIL
BOD	5.0 mg/l
COD	30.0
Ammonia	0.1
Nitrate	0.05
Coliform bacteria	0 in 100 ml.
Total bacteria	0 in 100 ml.

Digester Sludge

1) Solids content reduced by 40 - 50% i.e. 7% - 4.22 - 3.5%
2) After settlement sludge reduced by 30% ∴ solids conc increase to 7.2 - 6.0%.
3) Fertilizer values

	Nitrogen	P_2O5	K_2O
a) Cattle	0.59%	0.2 - 0.4%	0.5 - 0.6%) %
Pigs	0.6%	0.2 - 0.6%	0.2 - 0.4%) wet
Poultry	1.2 - 1.8	1.4 - 1.8%	0.7 - 1.2%) weight
Human (Sewage Sludge)	2.05%	4.46% dry weight	

b) Anaerobic digestion does not decrease dertilizer value. If supernatant is not seperated after digestion, at least 50% of N present is as dissolved NH_3 thus increasing the availability of N.
c) Phosphate - unchanged.
d) Potash - available at 75 - 100%
e) Nutrients from 1 tonne of undiluted waste

	Total nutrient units			available nutrient units.		
	N	P	K	N	P	K
Cattle	10	4	10	6	6	10
Pigs	13	4	4	6	2	4
Poultry	35	30	15	21	15	15

f) Digested pig slurry fertilizer value N,P,K = 6.8%, 6%, 1.5%
g) Digestion prevents "scorching" by removing organics and organic acids.

In general digestion does not remove nutrients but makes the nutrients more available, it also removes undesirable organics and pathogens.

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Quantities of Gas Produced From Some Typical Wastes

Waste	m^3/kg volatile solids	% CH_4	Priority
Slaughterhouse	0.71	78	(1)
Sewage Sludge	0.7	68	(2)
Maize Starch	0.67	68	(3)
Distillery Grain	0.68	65	(4)
Poultry Manure	0.6	60	(5)
Pig Slurry	0.5	70	(6)
Yeast Waste	0.5	68	(7)
Cattle Slurry	0.3	65	(8)

BTU equivalent of 1 m^3 Biogas = 21000
or 22.2 Mega Joules

Other materials that can be economically digested are:
Domestic refuse, crop residues, wood waste, rendering condensates, industrial effluents, etc.

In effect, any effluent with BOD over approximately 5000 mg/l and with recycling of solids wastes, down to BOD's of less than 1000 mg/l.

Only pre-requisite is that C:N ratio should be less than 30: 1, ideally about 20/25:1.

Mr. Rossi: Are you working with any Asian bodies on this?

Mr. Gilbeck: Yes, we are dealing with the Sime Darby group as well as Mecomb. We are also investigating big farming in Singapore.

Mr. Rossi: I am wondering - we are living in the centre of an area in which biogas and alcogas are being rapidly developed. I think it is a 2-way thing and Asia has a lot to teach Europe. There is not a great deal you can teach Asia about gasohol. . .

Mr. Gilbeck: I think I agree with you. The point I am trying to make is that a lot of our systems work and also the knowledge for a secondary and tertiary treatments are important.

Mr. Rossi: I would like to add another point; it sounded like a package which you can buy but you actually tailor it to individual needs, don't you?

Mr. Gilbeck: Yes, indeed .

Mr. Rahman: How does the cost of these energy fertilizers which you described compare with the conventional source?

Mr. Gilbeck: The cost is much the same. It is the recovery which makes the difference. As far as cost goes it is what you are getting back which is important. But cost obviously is difficult to generalise; it depends on the size of the plant and what level of discharge you wish to achieve.

Mr. Komdirit: The Anox process - what is special about it?

Mr. Gilbeck: It is a registered trade name.

Mr. Komdirit: What is its difference from other conventional designs?

Mr. Gilbeck: It is the design of reactors. A great deal of time and money has been spent to design these.

Dr. Suhaimi: Your analysis seems very interesting. Is that process employed on palm oil waste?

Mr. Gilbeck: Yes, we are doing it for the Sime Darby Group and Mecomb.

DENVER, COLORADO: CASE HISTORY OF THE DEVELOPMENT OF A WATER SYSTEM IN A SEMI-ARID AREA

by W.H. Miller, Manager, Denver Water Department, U.S.A.

Water, either too much of it or not enough, is interwoven in the history of Denver, Colorado. Early settlers found this out to their chagrin when they built thier houses and businesses on the banks of the innocent-looking Platte River and Cherry Creek only to have them wiped out by a massive flood that occurred in May of 1964. These pioneers dipped water by the bucklet from the South Platte and carried it to tent or cabin for drinking and cooking. Bathing usually took place in warm weather and downstream from areas where drinking water was obtained.

Water in this semi arid area of the United States (annual precipitation 12.5 inches) has always been a news maker. The first issue of the Rocky Mountain News, published by William Byers on April 23, 1859, carried a local news item on the front page concerning the possible formation of a ditch company. A few months later, the News carried a story about the formation of the Capitol Hydraulic Company. This ditch company was incorporated in November of 1859 under the laws of the territory of Kansas, 17 years before Colorado attained statehood.

History

The kansas Territorial Legislature, in 1966, granted Denver City (Incorporated in 1861) the power "to provide for and regulate the manner of introducing water into the City for irrigation and other purposes."

By 1870, Denver's population was 4,759, and water was a critical problem. The Denver City Water Company was formed in November of 1870 to build a pumping station at 15th Street and Platte River. Owners dug a large well and four miles of ditches to supply the growing city with water - at a profit. This company was the first in a series of eleven private water companies that were formed over the years.

In the early 1890's, two of the last surviving private water companies engaged in acompetitive battle that resulted in one actually giving away free water for a period of time. The Denver Union Water Company, incorporated in 1894, won the battle with the American Water Works Company of New Jersey. Denver Union was well financed and began to acquire meaningful water rights and to build storage and treatment facilities.

Large storage reservoirs were needed because 50 per cent of the annual water supply in Colorado is provided by melting snow, during a period of about two months. Balanced distribution through the year requires saving and storing that runoff. The company began construction of a large storage facility on the upper reaches of the South Platte, the first dam and reservoir of an extensive mountain water system. A May flood in 1900 washed out the first partially constructed dam, but work continued later that same year.

In 1905, Cheesman Dam was completed and named for the president of the Denver Union Water Company, Walter D. Cheesman, It was the major accomplishment of the company, and for many years was the world's highest dam -- its granite blocks, some weighing five tons, rising 231 feet above the st stream bed. In 1902, the company completed Marston Lake, about three miles northwest of present Littleton, the first large-scale water storage area for Denver. The dam impounds more than 17 thousand acre feet of water.

Public Ownership

The Denver Union Water Company made many other contributions to improve water service for the City, but citizens decided they should own their own water supply.

After prolonged and extensive court battles that ranged all the way to the United States Supreme Court, Denver voters on August 6, 1918, passed a bond issue to buy the private water company for $ 14 million. The same election also provided that the first five-man board be elected but that from time forth, succeeding commissioners be appointed by the Mayor. This basically was a reaction to the partisan politics of the time which was described by one historian as follows: "The Denver Union Water Company deeply interested itself in every election since the adoption of the Charter and leading city officials, the Mayor and the majority of City Council, were officials fully acceptable to the water company. These are facts that cannot be questioned."

Denver created Board of Water Commissioners as a non-profit, non-political commission, and it remains so today. The Department entrusted to it is financed entirely by the sale of water. It receives no tax monies, and revenue from the sale of water cannot be used for any other city service. Major capital improvements require bond issues approved by the voters. Bond are repaid by Department earnings.

The City Charter provides that rates will be fixed by the Water Department "as low as good service will permit" but will be sufficient to pay for operation, maintenance, reserves, debt services, additions and extensions, including those needed for anticipated growth of the Denver metropolitan area.

Good service to the community has been the responsibility of the Denver Water Department since it became publicly owned. Unfortunately, "good service" is not a simple commodity to render. For example, early Denverites weren't the only ones looking to the mountains for water supply sources.

Colorado Water Goes to Other States

The two-mile-high Colorado Rockies are the headwaters of four major river systems: the South Platte, the Arkansas, the Rio Grande and the Colorado -- systems that are important to at least nine other states. (Map 1)

It seemed the whole western half of the nation began appropriating Colorado water as settlers moved to the frontier. The claims have been upheld, for the most part, by the U.S. Supreme Court, and more than half of the state's annual supply remains allotted to other states and Mexico.

Through the years, Colorado agriculture has established rights to 95 per cent of the water left for state use -- for irrigation. To the present time, Colorado cities and towns have claimed and used only 2.7% of the state's retained water supply. Denver, with 40% of the state's population, uses only 1.3% of the municipal supply.

Under the appropriation doctrine, on which Colorado and the other western state's water rights are based, Colorado water belongs to all the people, and those who first put it to a beneficial use receive the first rights. Even so, the large majority of the state's water is used for agriculture.

Another 2.3% of the state's water is used by industry other than agriculture. Presently, the corporate limits of the City and County of Denver contain about 115 square miles, of which 17% or 20 square miles is still undeveloped. Potable water service is supplied to approximately 510,000 people within the City.

Service Outside Denver

The Department's water service to the suburbs is provided by contact through 138 distributors (municipal or quasi-municipal corporations). The distributor contracts are of three types:

1) Master Meter - distributor is totally responsible for operation and maintenance, and individual meter reading and billing;

2) Read and Bill - Department reads and bills individual meters and distri-

butor is responsible for operating and maintenance;

3) Total Service - Department is responsible for all aspects of the water system. In addition, Denver sells raw water to the City of Arvada, the North Table Mountain Water and Sanitation District, and to various industrial users.

The present outside Denver service area contains 181 square miles, of which 105 square miles or 58% is undeveloped. In the outside area, approximately 315,000 people receive treated water and approximately 84,000 people obtain a raw water supply from the Department.

In addition to furnishing water to meet the domestic, industrial, commercial, recreation and irrigation demands, the Department presently supplies water to approximately 9,000 fire hydrants within the metro area. The supply and associated water pressure is the major reason why Denver is rated by the National Bureau of Fire Underwriters as a Class 2 City, one of only a very few cities in the nation with this excellent rating. As a result, the area residents enjoy the lowest fire insurance rates available.

The Board's service policy is to provide a water supply adequate to meet the fluctuating demand at all times. A lesser service commitment would seriously jeopardize such essential needs as fire protection, hospital and sanitary service, and would adversely affect the health, general welfare and quality of life of all people receiving Denver water service.

The Denver metro area's treated water needs are predominantly influenced by the region's arid climate and short growing season. The present total annual raw water demand of 267,000 acre feet (which includes treated and raw water deliveries) increases steadily as additional people require service. A "dry" versus "wet" year may cause the annual raw water demand to fluctuate as mu much as 10%. The present "Average Day" treated water demand (total quantity used during a year divided by 365) is approximately 210 million gallons per day (MGD). The daily demands during the winter months of November through March average approximately 108 MGD. During the summer months, max day demands are sometimes in excess of 500 MGD. The hourly treated water demands presently range from a 60 MGD flow rate during winter nights to a high of 820 MGD flow rate during peak summer periods.

Raw Water

The Department's raw water supply is almost entirely derived from surface diversion of snowmelt runoff through three major collecttion systems: the South Platte Collection System, the Roberts Tunnel Collection System, and

the Moffat Collection System.

The South Platte Collection consists of direct diversion and storage facilities located on the main stem and the South Fork of the South Platte River and Bear Creek. In the upper reaches of the South Platte, Antero, Eleven Mile Canyon and Cheesman Reservoirs are used to store a portion of the high stream flows for susequent use later in the year and during years of low run-off. The South Platte Canyon Intake Dam, the Department's "primary" diversion facility on the South Platte River, is located just above Waterton, Colorado. It is used to divert the Department's direct stream flow rights and upstream storage releases directly out of the South Platte River. The Department's water rights in Soda Lakes and Bear Creek are conveyed by the Harriman Canal to Marston Lake. (Illustration A)

The Roberts Tunnel Collection System presently consists of Dillon Reservoir and Roberts Tunnel. Dillon is located on the main stem of the Blue River, a tributary of the Colorado River. Roberts Tunnel extends from Dillon to the North Fork of the South Platte River on the Eastern Slope near the town of Grant, Colorado.

The Department's water rights on the Blue River permit the storage of water in Dillon, or diversion directly through Roberts Tunnel. In order to meet the water demand within the metropolitan area, water is delivered through Roberts Tunnel to the Eastern Slope where it enters the North Fork of the South Platte River for subsequent diversion a South Platte Canyon Intake Dam. (Illustration B)

The Moffat Collection System consists of diversion structures, canals, conduits, tunnels and storage reservoirs which are used to collect and deliver raw water to the Moffat Treatment Plant. At the upper end of the Moffat Collection System, water is diverted from the Upper Williams Fork River Basin and transported by the Gumlick Tunnel to the Eastern Slope and back Basin. Combined with Fraser River Basin diversion, the water is transported back again to the Eastern Slope through the Moffat Tunnel which discharges into South Boulder Creek for temporary storage in Gross Reservoir. In addition, a portion of the natural stream flow in South Boulder Creek is stored in Gross when in priority. Releases from Gross are made into South Boulder Creek. The water is then diverted out of South Boulder Creek near Eldorado Springs and conveyed by a series of tunnels and canals to Ralston Reservoir.

Ralston Reservoir and Upper Long Lake also derive a small quantity of water from Ralston Creek when their storage decrees are in priority.

The Department's water in Ralston Reservoir is then conveyed to Moffat Treatment plant. (See Illustration C)

The total annual supply varies yearly, depending upon the snow pack. For exmaple, the unregulated runoff available for diversion by the Departments existing collection system is estimated at a maximum of 680,000 acre-feet during a wet year and a minimum of 130,000 acre-feet during a dry year. By careful management of the runoff and utilizing storage facilities for carry-over storage during dry years, the existing raw water system can deliver a firm annual supply of 298,000 acre-feet based upon historic runoff and weather patterns.

Treated Water

The Department has there treatment plants with rated capacities as follows: Kassler Treatment Plant -- 50 MGD, Marston Treatment Plant -- 260 MGD, and Moffat Treatment Plant -- 210 MGD, or a total of 520 million gallons of finished water per day provided the incoming raw water quality remains high. (Illustration D)

The Department's three treatment plants are interconnected by a large conduit system forming a complete loop around the perimeter areas of metropolitan Denver. This loop is formed by four conducts ranging from 60 to 84 inches in diameter. With the assistance of connecting pump stations and clear water storage reservoirs, water can be distributed throughout this loop; and, in most sections, flow in either direction can be accomplished. In general, a portion or all of the water filtered at any one of the three treatment plants can be conveyed to any part of the Department's service area. The pump stations are used to maintain adequate water pressure and convey water to lands located at high elevations. Withdrawals from the clear water storage reservoirs are made during the maximum demand hours of the day. The reservoirs are then refilled during the late evening hours.

Operation Plan

In order to assure that the constantly fluctuating water demand can always be met with an even greater fluctuating supply, the Department's system is operated in accordance with a comprehensive plan. The Department's operation plan provides an adequate water supply to the metropolitan area at all times, even during drought years, and maximizes the total water supply with appropriate consideration for economic and environmental impacts.

The treatment capabilities discussed can be achieved only when all conditions are ideal. Mechanical breakdowns, raw water quality affecting the interval of filter backwashing, and other factors affect the amount of water that can be treated at each facility. Because of the complete integration of the Depart-

ment's treated water system, water can, in general, be supplied to all parts of the Denver metropolitan area from any one of the three treatment plants or any combination thereof.

Economics, particularly within the filtration and treated water transmission and distribution system, play an important role in the Department's operating plan. Pumping creates the biggest economic impact. The water output from the Moffat Treatment Plant can be supplied to much of the metropolitan area by gravity, while most of the water from Marston and all of the water from Kassler must be pumped. As a result, a substantial savings in pumping costs can be realized by utilizing the Moffat Treatment Plant to the fullest extent conseistent with raw water availability.

The quality of raw water supplied to the treatment plants constantly changes throughout the year. As a result, it is sometimes more desirable to take advantage of better raw water quality from one source, particularly when taste and odor problems arise. In any event, the finished water from the treatment plants must meet the minimum water quality standards as set forth by the Federal Safe Drinking Water Act and Colorado State regulations.

In fact, drinking water delivered to Denver water customers is of higher quality than required by the Act. Purity and quality guidelines set by the Denver

Department not only pre-date the congressional actionm they are considerably stronger than the federal "Maximum Contaminant Levels," (MCLs).

More than 19,000 chemical tests, nearly 16,000 microbiological tests, more than 1,000 biological examinations and 17,000 field tests are conducted annually be chemists, microbiologists and technicians at Denver's Marston laboratory. Mineral and salts found naturally in water, and traces of heavy metals such as silver, lead and zinc, are identified through chemical tests. Various algae found in reservoirs are typed from microbiological tests. Biological tests determine the presence of any of the coliform group of microscopic organisms.

Both raw and treated or "finished" water also is constantly monitored at Denver's three treatment plants.

Extensive checking begins on Denver's watersheds on both sides of the Rocky Mountains which devides Colorado. Numerous streams and rivers flowing into Denver's reservoirs are sampled. Any nearby mountain construction is checked. Regular visits are made to point sources of pollution, such as a wastewater treatment plant on a stream flowing into a Denver reservoir. Denver's mountain reservoirs and rivers transporting water to Denver are analyzed regularly. Even after the "finished" water is on its way to customers,

the microbiological staff analyzes some 90 samples from various points throughout the metro area once or twice a week.

All new commercial installations and residential installations such as automatic lawn irrigation systems are inspected to insure that already used water will not back up into the distribution system. Mortuaries, chemistry laboratories, dry cleaning plants, and photo processing plants receive careful inspections.

Coordination of the operation of the raw water system, the treatment plants, and the transmission and distribution system is maintained on a continual basis. The operation is continually evaluated, reviewed and changed to meet the constantly changing supply and demand conditions. In this regard, a computerized operation is presently being developed which will continually analyze the total system and make operating decisions expediently in an effort to maximize the total raw water supply, minimize the operation costs, and avoe all, assure that the customers will be supplied with an adequate water supply 24 hours a day, 365 days a year.

The future treated water requirements discussed in Section I of this report clearly substantiate the need for additonal treatment capacity. Without it, some of the people within the metro area will surely be without water and others will be on severely restricted service. The additional of the Strontia Springs Diversion Dam, water tunnel, and Foothills Treatment Plant will enable the Department to increase its treatment capability beyond the present level of 520 MGD. (Illustration E)

The raw water supply to the Foothills Treatment Plant will initially come from the existing South Platte and Roberts Tunnel Collection Systems. The water will be delivered to the Foothills Strontia Springs Diversion Dam in exactly the same way as it is being delivered to the existing South Platte Canyon Intake Dam. In this regard, the Department presently has the capability to delivery over 1,200 MGD of raw water from existing storage, diversion and transmission systems. Since the combined treatment capacity of Marston and Kassler is 310 MGD, there is sufficient existing raw water delivery capability for an additional 890 MGD of treatment capacity. This delivery capability should not be confused with annual raw water supply.

The South Platte River channel will continue to be the conduit for conveying raw water to the Strontia Springs Diversion Dam from either Cheesman, Eleven Mile or Antero Reservoirs. The channel of the North Fork of the South Platte River will continue to be the conduit for conveying water from the Roberts Tunnel collection system. No changes in the existing collection facilities within the South Platte and Roberts Tunnel collection systems will be required as a result of the Foothills Project.

The delivery of treated water from the Foothills Treatment Plant to the Denver metropolitan area will be made initially by a 108-inch diameter transmission conduit. This conduit will connect to the existing major transmission loop, as shown on the diagram of the treated water system in Section II. The elevation of Foothills is such that water service to most of the metro area can be supplied by gravity. As a result, the maximum advantage of Foothills will be made by operating it to the fullest possible extent. For example, with the completion of the first 125 MGD stage, the plant will be operated at or near capacity on a year-round basis. During the winter time, this output will be sufficient to satisfy the present demand level of the entire metropolitan service area. As additional treatment capacity is needed, Marston, Kassler or Moffat will be put into operation. The energy conserved throughout the existing system by this operation is estimated to be approximately 21,000,000 KWH annually for the first 125 MGD Foothills addition.

The power generation feature planned for the Foothills Project is also an important aspect. It is estimated that 11,000,000 KWH of electrical energy will be generated on an average annual basis by the first 125 MGD unit. It is also estimated that the average annual power requirements to operate the 125MGD treatment plant are 8,000,000 KWH, thereby providing an average annual surplus available for use by others of 3,000,000 KWH. The power saved by locating the Foothills Treatment Plant at the proposed site plus the associated power generation features are certainly positive factors in view of the present national energy situation. Additionally, the treatment plant will be self-sufficient from an electrical energy standpoint which will be particularly significant in the event of power outages.

The Foothills Porject has been in the active planning and review stage for the past 25 years. It is the most cost effective plan for adding treatment capacity to the Department's existing system. It was also presented and approved by the citizens of Denver in the 1973 election which authorized the Department to issue bonds in the amount of $ 160,000,000 for donstruction of additional raw water supply and treatment projects.

Good service, at the lowest possible cost, is still expensive. The Water Department's budget for 1979 was 7.4 million.

Denver supplies water for more than 900 thousand person -- 40% of the state's population, yet uses only 1.3% of the water available for public supply.

The problems which face the Water Department in the future are myriad, but they are not insurmountable. Just as men of the past faced and conquered formidable mountain barriers to claim water of the highcountry, men of today must face the complexities of the future. Thoughtful protection, advance planning and careful management are essential for continuing good water and good service.

WATER POLLUTION CONTROL IN ENGLAND

by The Water Directorate, Department of the Environment, London, England

Introduction

England has a long history of concern for the protection of the environment generally, and the control of water pollution is no exception -- the first statute designed for that purpose being passed over 100 years ago.* Since then the legal and administrative machinery for control has been revised and expanded several times to reflect changes in social conditions and the advance of technology. Generally the process has been one of evolution, building upon and improving the previous arrangements, rather than establishing completely new ones. The purpose of this article is to summarize this development and to explain the current position.

Administration

Overall responsibility for all matters relating to the maintenance and improvement of the habitat lies with the Secretary of State for the Environment. So far as water is concerned he is responsible for the national policy on all matters of conservation and supply, sewerage and sewage disposal the control of pollution in both inland and coastal waters, and the use of inland waters for recreation and navigation. Althcugh the overall responsibility for coordinating environmental policy is his, other Ministers are involved with certain aspects of some of these matters. For example, the Secretary of State for Trade has particular responsibility for controlling marine pollution by oil, and the Minister of Agriculture, Fisheries and Food is responsible for land drainage, the protection of freshwater and marine fisheries, the dumping of waste at sea, and the safe use of agricultural pesticides, etc.

Because the effects of individual acts of pollution are usually most noticeable within the locality where they take place and can best be controlled by authorities with a detailed knowledge of the area, it has always been the practice in this country for the central government to lay down the statutory framework for controlling water pollution but, whenevr possible, to delegate the actual control to authorities operating at a regional or local level. Thus the Act of 1976 gave the responsibility for enforcement to local government

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* The Rivers Pollution Prevention Act 1976.

bodies, such as town and district councils.

In the following years, as the population became more and more urbanised, the use of waterborne sanitation became increasingly common: simultaneously there was a corresponding rise in the demand for water for abstraction purpose both for domestic and industrial use. Consequently it became necessary to create bodies responsible for the management of the water resources along the whole length (or at least considerable stretches) of the major rivers. Only in this way was it possible to approtion the capacity of the river fairly between the various towns and districts which relied upon it. Initially these river authorities were created piecemeal, starting with the rivers serving the major urban and industrial areas, but by the 1930's they existed for most of the more important rivers, and after the 1939-45 War a statute* was passed establishing them over the whole of the country.

The river authorities remained in existence until 1973 when the Water Act of that year replaced them with 9 regional water authorities, each one which is responsible for one or more of the major river systems (e.g. Thames, Severn/ Trent etc). The water authorities have responsibility for the management of the entire hydrological cycle within their area, including water conservation and supply, pollution control, sewerage, sewage treatment the development and control of aquifers, land drainage, flood prevention, freshwater fisheries, and the use of the water for amenity and recreation.

The water authorities are autonomous bodies. Just over half of their members are nominated by the local authorities within their areas, and the remainder are appointed by Ministers from people whose background and experience make them suitable candidates. Each authority has a permanent professional staff to carry out the day-to-day tasks. They are financially self-supporting, deriving their revenue mainly from charges for services such as water supply and sewage disposal. However, the Government has retained overall control of public expenditure, and each water authority is limited in the amount of capital expenditure that it can incur in any one year. Each authority has to submit annually a 5-year rolling programme of proposed capital works, together with a published report giving details of the work done during the year and an outline of its future policy and programme. In addition to the controls over capital expenditure, the Secretary of State for the Environment has power to compel a water authority to carry out its duties if it should be held to have neglected them -- though it has never been necessary to use this power. The

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* The River Boards Act 1948.

Secretary of State also has power to make Orders governing the way water authorities carry out some of their functions, powers for confirming byelaws made by the authorities, and semi-judiciary powers in connection with appeals against certain decisions of the authorities (see below).

However, central control over water authorities is exercised mainly through close liaison and the issuing of general guidelines. The principal vehicle for this liaison is the National Water Council which was set up by the same statute which established the water authorities and which consists of a chairman appointed by the Secretary of State, the chairman of the water authorities, and other members appointed by the Secretary of State and the Minister for Agriculture, Fisheries and Food. In addition to acting as the liaison link between the water authorities themselves and between the Government and the water authorities the NWC has advisory functions vis-a-vis both the Govenment and the authorities, and responsibilities for co-ordination in areas such as research and training.

The Law In Relation to Water Pollution*

As already mentioned, the first statute designed to control water pollution was the Rivers Pollution Prevention Act of 1876. Under this it was made an offence to discharge sewage or polluting matter into a watercourse. The Act provided for local authorities to take legal proceedings against offenders after having obtained permission in each case from central government. The court could require the offender to obtained from committing the offence or order him to treat the discharge in a specified manner in future. Before making an order the court might obtain information on "the best practical and available means" of treatment, and the nature and cost of the necessary plant. A certificate from a Government inspector certifying that a particular method of treatment was "the best practical and available means" was to be regarded as conclusive.

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*Quite apart from the statute law on water pollution described herein there is a body of law, known as common law, founded on traditional rights, which has been built up over the years by decisions of the courts. The common law maintains the rights of those with a proprietorial interest in a river, stream or lake etc, whether as owners of the bank, the bed, or any fisheries, and it provides civil remedies for the violation of these rights. Modern statute law has made only limited inroads into these common law rights, which are still exercised from time to time and which offer a civil law alternative to prosecution for statutory offences.

This procedure continued in use until 1951 when the foundation of the present control system was laid down by the Rivers (Prevention of Pollution) Act of that year. This repealed virtually the whole of the 1876 Act and substituted a procedure whereby anyone wishing to make a new discharge of sewage or trade effluent to a stream* is required to seek the consent of the river authority (now the regional water authority -- see above) which can include conditions in any consent as to the nature, composition, temperature, volume or rate of the discharge.

Although the 1951 Act did not apply to tidal waters generally it contained a power for the Secretary of State to make Orders applying its provisions to specific tidal waters, estuaries and adjoining parts of the sea. A few minor estuaries were controlled under such Orders, but in 1960 the Clean Rivers (Estuaries and Tidal Waters) Act extended the control system to all discharges commenced or altered after that date to most major estuaries.

In 1961 a new Rivers (Prevention of Pollution) Act strengthened the control system by bringing within it the pre-1951 discharges for which specific consent had not been required by the earlier Act. Such discharges became unlawful on 1 June 1963 if no application for consent had been made by then. The 1961 Act did not, however, bring under control pre-1960 discharges to tidal waters except in areas covered by an Order made under the 1951 Act. The Water Resources Act 1963 extended the control system to cover discharges to underground strata via wells, pipes or boreholes.

Discharges applying for consent under the above legislation have the right of appeal to the Secretary of State against the unreasonable refusal of consent or the imposition of unreasonable conditions. Samples of any discharge may be taken by the water authority and penalties are provided in the legislation for any contravention of the consent conditions. Consents for water authorities' own discharge (e.g. from sewage disposal works) are given by the Secreaty of State: in general the conditions included are similar to those imposed by the water authority on other dischargers.

The legislation also empowers water authorities to make by-laws to prevent refuse being put into streams, to control the washing or cleaning of certain things in the stream, and to prohibit or regulate the use of vessels fitted with

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*Defined as any river, stream, watercourse or inland water (whether natural or aritificial) but not including any sewer or any lake or pond not discharging into a stream.

sanitary appliances from which polluting matter could pass into a stream.

Water authorities also have powers to control the discharge of effluent to public sewers. These powers are mostly conferred by the Public Health Acts 1936 and 1961 and the Public Health (Drainage of Trade Premises) Act 1937. Under this legislation it is an offence to discharge into public sewers any matter which by its nature or its temperature is likely to damage the sewer or the treatment process; and in order to safeguard the condition of the water to which the treated mixed effluents will ultimately discharge authorities are empowered to impose conditions upon dischargers of trade effluent.

A major new extension of pollution control legislation -- the Control of Pollution Act -- was passed in 1974, but the majority of Part II of it, which deals with water pollution, has not yet been implemented. When it is brought into force it will extend to the consent system to include nearly all discharges to inland and coastal waters (including underground waters that may be specified by the Secretary of State, and land-locked lakes etc.) and also to land, since substances discharged to land frequently find their way into water. Controls which previously covered only non-tidal waters and designated estuaries will be extended to cover discharges through pipelines to tidal waters or the sea and discharges from working mines (which were previously exempt).

Virtually all forms of water pollution are covered by the Act. In addition to widening control of discharges, as described above, the Act strengthens the legal provisions designed to prevent casual or spontaneous acts of pollution-- such as the dumping of rubbish into water or the uncontrolled spraying of pesticides etc. In addition there are powers for the Secretary of State to make regulations so that anyone in control of a polluting substance must take precautions to prevent it getting into water, and to prevent the carrying out of certain activities in defined areas if there is a likelyhood that they could result in water pollution. Water authorities' powers to control boats fitted with sanitary appliances which discharge into the water will become generally available instead of having to be applied selectively through byelaws.

A feature of the 1974 Act is the scope it affords for public participation in the controlling of water pollution. In general, applications for consent to discharge will have to be advetised, and members of the public will be able to make representations about them to the water authority. The water authority. The water authority will be obliged to take account of any representations before giving consent, and anyone who made representations has the right to appeal to the Secretary of State against the water authority's eventual decision. Details of consents and information derived from analysis of samples of effluent, etc. will have to be entered in registers available for public inspection and the Act removes the previous prohibition on private prosecutions for pollution offences.

Standard of Control

There are no mandatory standards laid down by central government, either for water quality generally or for discharges. Decisions on standards for particular rivers or stretches of water and for individual discharges are taken at the local level by the water authorities. Water authorities have set river quality objectives (RQOs) for all sections of the watercourses under their control. (When Part II of the Control of Pollution Act is emplemented and coatal water are also brought under full control it is the intention that quality objectives will be set for those waters, too). A water authority decides on the quality requirements for a stretch of water in the light of its overall plan for the management of water resources in the area.

In amny cases they have set both current and long-term RQOs, the former reflecting present requirement and the latter being a target to be achieved over the period of time as resources permit. Consent conditions for individual discharges are determined according to the particular circumstances so as to enable the quality requirements to be maintained or achieved. We believed that this system of setting the requirements at the local rather than the national level makes it possible for each stretch of water to be given the appropriate degree of protection necessary in the particular circumstances, thus avoiding either over or under-protection, and ensures that the resources available for pollution control are directed where they are most needed.

Question and Answer

Dr. Grombach: With the introduction of these 9 water boards, which are big bodies, did the water supply improve compared to the small water companies or did you have some difficulties?

Dr. Smith: Well, the answer is, there was improvement. In 1976, in Europe, England and Wales, there was a severe drought for about 4 to 5 months' duration. Because of the formation of the large water authorities we were able to control and switch water from one source to another. We survived and without that management team we would have had serious trouble.

The other part of the question is one of cost- the cost of water and treating sewage has gone up significantly but sometimes we as consumers look to big buildings doing lots of experiments where we get value for money. I think we do. Perhaps in the past we got water too cheap. Now we have to pay and now we know the true cost.

Dr. Grombach: Are there any mandatory standards set up by the central government or water authorities and if not who looks after these?

Dr. Smith: There are some mandatory and voluntary factors. I would dodge that question because I can't tell you who is responsible for that. It may be the authority who says he will not have that level of pollution coming into the water source. It might be a tradition which has been set and followed. But I can't say it as a definite fact.

Mr. Gilbeck: I was on the working committee of the Certain recommendations were made by this committee which were supposed to be implemented, but never were . There is much inconsistency on what is acceptable in the UK. Certain authorities are extremely severe on some industries, whilst others are far more lenient.

WASTEWATER REUSE IN THE UNITED STATES

By

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Planned wastewater reuse in the United States has increased dramatically during the 1970's,particularly in the semi-arid southwest region. Impetus has come from a combination of increasing demand upon existing fresh water resources, better wastewater treatment which provides high quality effluents "too good to throw away", government legislation encouraging reuse of resources , and greater awareness of reuse potentials by the public and environmental professionals. Other countries are experiencing similar incentives toward wastewater reuse.

It is the purpose of this paper to provide a broad overview of wastewater reuse practices in the United States with emphasis upon how the wastewater is being reused. It is hoped that this information will encourage the reader to consider wastewater reuse as a water resource wherever technically and economically feasible, and to investigate United States experience as part of his decision making process.

Informal Reuse

Most wastewater reuse is informal and goes largely unrecognized by the public and many professionals.

Virtually every major surface water body in the United States contains domestic sewage effluent, industrial wastes, urban and agricultural run off. These waters are the drinking water supply of much of the nation's population. It is self-deception to fail to recognize this situation as de facto reuse of wastewater for potable purposes.

A similar situation exists for groundwater resources. Hundreds of municipal and industrial wastewater treatment plants dispose of their effluents to the land. Thousands of wastewater lagoons percolate effluents into the ground. Millions of septic tank systems leach their wastewater into the ground. Most of these wastewaters travel through the soil and eventually reach groundwater aquifers. Thus, as with surface water, informal groundwater recharge with wastewaters is occuring on a large scale.

The present interest in formal, regulated wastewater reuse projects is simply bringing focus upon an informal practice which has existed "in the closet" for a long time. The question is not whether wastewater reuse is acceptable,

but rather how best to control what is an existing and often long standing practice.

Informal wastewater reuse poses many technical, political and social problems to water suppliers. It is often difficult ot impossible to do an adequate system design because the wastewater sources (dischargers) are numerous and outside the control of the water supply agency. Since the wastewater is conveyed to streams and rivers with uncontrolled characteristics, the wastewater will be modified in a manner which is difficult to estimate from the existing state of knowledge. This is particularly true for many substances now suspected of being a health risk. These include certain heavy metal, pesticides/insecticides, aromatics, aliphatic solvents, phenols and several others, where data on their fate in the environment is limited, even more basic is the fact that it has been difficult to simply determine the identities and characteristics of wastewater dischargers upstream from water supply points. SCS Engineers is presently under contract to the US EPA to develop a large computerized data base system which will make upstream discharger information readily accessible to downstream users.

The conclusion is that formal, well monitored wastewater reuse is preferable to the relatively uncontrolled informal reuse described above.

Current Practices

The volume of wastewater available for potential reuse is significant; however, the quantity presently formally reused is small. The U.S. Water Resources estimated that in 1970 municipalities used 37.28×10^9 m^3 (9850 bil gal) of water, of which 20.03×10^9 m^3 (7670 bil gal), or about 78 percent, was returned as wastewater. In 1971, only 510×10^6 m^3 (135 bil gal) of municipal wastewater treatment plant effluents were being directly reused formally as shown in Table 1. The author estimates that this quantity of formal reuse has increased to approximately 750×10^6 m^3 (200 bil gal) in 1979 due to new projects.

TABLE I
Municipal Wastewater Reuse Practices, 1979

Type	Annual Volume 10^6 m^3	Annual Volume bil gal	Number of plants
Irrigation and agriculture	291	77	338
Industrial (process, cooling, and boiler feed water)	204	54	14
Recreational	11	3	5

Nonpotable Domestic	less than 4	less than 1	1
Directly groundwater recharge	less than 8	less than 2	8

Of the types noted in Table 1, the majority of plants practice reuse for irrigation. In terms of volume, however, irrigation accounts for slightly more than half the reuse reported, with industrial reuse a close second.

Geographically, the reuse operations are concentrated in the semi-arid southwestern United States. As shown in Table 2, the number in Texas and California far exceed those of other states.

Table
Geographical Distribution of Reported Municipal Reuse.

	Number of Municipalities Practicing Reuse					
States	Irrigation	Industrial	Recreational	Domestic	Ground H_2O Recharge	Total
Texas	144	5	0	0	0	149
California	134	1	3	0	0	144
Arizona	28	2	0	1	1	32
New Mexico	10	0	0	0	0	10
Colorado	5	1	1	0	0	7
Nevada	4	2	0	0	0	6
Others	13	3	1	0	1	18
Totals	338	14	5	1	8	366

Irrigation Reuse

Wastewater effluent is used for irrigation at over 300 sites in the United States, and accounts for approximately half the volume reused. Most of the crops grown are not for human consumption. However, a suprising variability is reported in the types of crops being irrigated with municipal wastewater. Successful irrigation of 39 different crops was reported, ranging from turf (grass) for recreation (i. e., golf courses, parks, etc.) at 40 locations, down to sugar beets at 3 locations. Other crops included truck vegetables, tree fruits and all types of grains.

Approximately 90 percent of the treatment plants provide the equivalent of secondary treatment. Interestingly, virtually all categories of crops are

also irrigated by primary treatment effluent at some locations.

A wide range of effluent quality is being applied to crops at various locations (e.g., BOD of 15 to 370 mg/l for cotton), showing that the effluent quality ranges from poor primary to excellent secondary. Of particular interest are the high average TDS (over 800 mg/l) and Na (over 300 mg/l) levels of reclaimed waters used for irrigation. These average values indicate that relatively poor waters in terms of dissolved salts are being successfully used on a wide variety of crops. Table 3 shows results of a 1972 survey. When one compares the water quality with recommended quality ranges for crop irrigation, it can be seen that "violations"of the recommended ranges are commonplace. Proper irrigation management is the key. Consideration must be given to the interrelationships between soil type, crop tolerance, drainage water application rate, climate, and other factors. Proper monitoring is necessary to protect public health against pollution of wayer, food, and/or air.

Table 3
Quality of Effluent Applied to Crops

Crop	No. Plants irrigating*	BOD (mg/l) Low	BOD (mg/l) High	BOD (mg/l) Avg	SS (mg/l) Low	SS (mg/l) High	SS (mg/l) Avg	TDS (mg/l) Low	TDS (mg/l) High	TDS (mg/l) Avg
Grain	17	10	1100	180	10	173	71	324	1400	837
Corn	11	10	370	76	10	135	69	8	1114	601
Vegetables	6	6	1100	193	6	127	31	5	1114	700
Fruit	12	10	160	32	9	135	58	14	1400	798
Cotton	26	15	370	84	12	259	94	324	2250	854
Fodder	51	1	370	54	0	259	66	8	1450	641
Pasture	34	7	370	50	2	118	40	6	2250	839
Turf & Landscape	47	1	80	19	0	200	26	43	2000	658

*Certain plants supply water to more than one crop.

Industrial Reuse

Industrial reuse of municipal wastewater effluents equals about 300 bil l/yr. (80 bil gal/yr.); most of it is used for cooling purposes. In addition, industry internally recycles great quantities of wastewater for conservation purposes. The major types of industries reusing wastewater are as follows:

* Basic metal manufacture.

* Power generation

* Petro-chemical.

* Mining and ore processing

In addition there are reports of some reuse by:

* Military installations.

* Electronic manufacturers.

* Electro-platers.

As previously stated, the great bulk of reuse is for cooling purposes. Other uses include the following:

* Ore processing.

* Air pollution scrubbers.

* Vehicle washing.

* Boiler feed water.

* Initial process washing.

* Product conveyance.

The technology for using wastewater for cooling purposes is well developed. Table 4 shows typical additional treatment provided to the reclaimed water for use as cooling tower make-up.

Table 4
EFFLUENT QUALITY VERSUS USER TREATMENT
REQUIRED FOR COOLING TOWER MAKE-UP WATER

Selected Users	Effluent quality mg/l BOD	SS	TDS	User Treatment Processes
City of Burbank, CA	2	2	500	Shock chlorination, pH adjustment, corrosion inhibitor
Nevada Power Co.	20	20	1,000-1,500	Shock chlorination, lime clarification, pH adjustment, corrosion inhibitor.
Southwestern Public Service Company Amarillo, TX	10	15	1,400	Lime clarification, pH adjustment, shock chlorination, corrosion inhibitor.

Economics is the prime motivating force of industry, and the use of reclaimed wastewater is governed by the cost of alternate water supply procurement and treatment. In locations where public water supplies of good quality and quantity are available at low cost, treatment and reuse of renovated water by industry has not been economically attractive. Thus, it is not surprising that most industrial users of treated municipal effluent are in the semi-arid southwestern states where water costs are relatively high and water quality tends to be poorer in terms of TDS and hardness.

Groundwater Recharge

Formal, planned groundwater recharge by percolation or well injection is being practiced at approximately 15 locations in the United States.

As groundwater supplies continue to be overdrafted, the problems of salt water intrusions and depleted supplies are causing authorities to look toward wastewater reuse with groundwater recharge, as a viable, expedient, and financially feasible alternative. Groundwater rehcarge with treated effluent has been shown to be an effective method of repelling salt water intrusion and in providing exceptional tertiary treatment for reuse. The use of effluent for these purposes will increase greatly in coastal areas threatened by intrusion and in the arid south western U.S.

Recharge by percolation has several advantages over recharge by well injection: standard quality secondary effluent can be used successfully,

capital costs and operation and maintainance requirements are minimal, and the soil provides exceptional tertiary treatment under proper operating conditions. Recharge by percolating is most successful when: SS concentration in effluent is low (less than 2 mg/l); infiltration rates are high (greater than 2 ft/day); and operation follows a cyclic flooding-draining-drying schedule to reduce surface clogging. Where percolation is not feasible (i. e., land not available, infiltration rates too low, etc.), well injection of effluent promises to be effective in repelling salt water intrusion and replenishing groundwater basins. The Palo Alto, CA., Orange County, CA., and Long Island, NY, programs are all in various stages of design and construction. Successful well injection recharge requires high quality tertiary effluent (e. g., BOD less than 5, SS less than 1, FE less than 0.5, JTU less than 0.3 units) usually achieved with chemical coagulation/settling, ammonia stripping or nitrification-denitrification, filtration, and carbon absorption. Full scale recharge by well injection should be preceded by extensive pilot studies to determine the hydraulic characteristics of the receiving aquifer. This is necessary to quantify the flow volume the aquifer can handle, the directions and velocities of underground flow, and the quality of effluent necessary to prevent clogging. Although well injection recharge is very expensive, involving extensive tertiary treatment and a deep well network, it is still economically attractive if it successfully repels salt water intrusion and/or supplements domestic supplies to eliminate or delay the need to develop costly alternate fresh water sources.

Both percolation and injection recharge systems can be operated in conjunction with extraction facilities to ensure that none of the effluent mixes with native groundwater. The high quality extracted water having received further treatment by migration through the soil can be reused for irrigation, recreation, or industrial purposes.

Other Applications

Other wastewater reuse applications in the United States include: recycling for toilet flushing (grey water recycling) and recreational lakes.

Recycling for toilet flushing is being successfully practiced at several highway rest stations and at least one large industrial manufacturing plant.

There are three major recreational lake reuse projects in the Unites States; i. e., Santee, Tahoe, and Lancaster, California. Each of these three recreational projects is unique but they share much in common. All have found it technically feasible to consistently produce effluent meeting drinking water coliform standards. All practice phosphate removal for algae control and filter the effluent to reduce turbidity . Many species of fish have been grown successfully, including trout.

Acknowledgement

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Minutes of the Inaugural Meeting of the Water Associations of Asia and the Pacific

The final morning of the conference was devoted to the formation of what will be known as the WATER ASSOCIATION ASIA PACIFIC.

It was agreed by all present to form the above association and for those present to act as a protem committee with Dr. Suhaimi as Protem President.

The aims will be:

1. "To provide an Asian organization for all industries through which to encourage, assist and promote the practice of Management of Water Resources, Water Supply, Waste Water Removal and Water Protection for the benefit of members and the national economy."

2. "To provide an advisory service and register of facilities covering recovery problems on Water Resources, Water Supply, Waste Water removal and Water Protection."

3. "To publish a Journal and other literature or material relating to Water Resources, Water Supply, Waste Water Removal and Water Protection for the benefit of its member."

Its constitution will be modelled on that of the Asian Recycling Association. It will be registered in Malaysia.

Membership fees will be:

Individual Members	$40 per annum
Corporate Members	100 per annum
Associate Members	10 per annum

Associates will not have voting rights.

Enquiris should be addressed to:

Dr. Ariffin Suhaimi
Faculty of Science & Environmental Studies
Universiti Pertanian Malaysia
Serdang, Selangor
Malaysia

Minutes of meeting held on 7th February 1980 at PSA Conference Room in reg rd to the setting of up a Water Association.

PART ONE

Dr. Suhaimi — I think the idea of having an Association for Water is already accepted and if that is so then we should be thinking of how we can set one up. Perhaps the working committe can look at the problems of starting an Association thinking in terms of the proper means to officially form an Association. It will have to look into the details.

Mr. Rossi: — We can assist you but it would begin with at least 16 members. I think we now have an up-to-date information on where to go with membership. From the government point of view and the private point of view we can give you a good point of setting up an Association.

Dr. Suhaimi: — If we do have the Association, rather the function of the Association, are there going to be conflicts?

Mr. Rossi: — No, there will be no conflicts but instead they will probably be complimentary.

Dr. Suhaimi: — I would like to offer my services. Being at the University, perhaps we are a bit more free and more neutral so we can serve as a link. We have the Environmental Science Department and there are the people who can help in this mission. We are trying to establish an environmental information with the cooperation of the WHO. If that is going to be of some help then the problem is the secretarial work. Maybe I can use my own secretary.

Mr. Rossi: — This aim is very valid. The Association is the best center from which to run conferences much better than trying to promote differently. I think we should have a Japanese in this field and we have one in Manila, a Mr. Fujica.

We also have an affiliate in Japan. We have one man in Singapore but when we were starting here, we had no Singaporeans to contact. You will have great difficulty because you are in Kuala Lumpur, unless you have active personnel in Manila, Bangkok or Singapore. The main point is to direct a two-way exchange from all over. The Association will help you as much as possible. We only have about 40% of active help from overseas. That is the stage that you got to reach.

Dr. Suhaimi: If we offer our services I think I can bring back this message to my University Chancellor for his approval; I think that there will not be much problem provided that the gathering here gives a protem committee.

Mr. Rossi: I think we should set up a protem commitee as we have a number of country representatives here from overseas. It is a good nucleus if we can look to Dr. Suhaimi to act as prime mover and supporters to aid in his prime moving.

Dr. Suhaimi: My fear is, of course, what is going to happen if I cannot get the approval and support from the University in Malaysia.?

Mr. Rossi: You will be the protem chairman. The executive committee has got to be legally constituted.

Dr. Ben Liu: I suggest that he serve immediately as committee chairman so that he can contact a number of government offic 'ls. We have a lot of representation from all over the countries and in this case if you do include the consultants, academicians, and government employees, then you will have good representation. Try to communicate with them and set up a constitution. Then send it to them and see if any correction is needed. The agreement should be by circulation. It is better to contact Associations in the United States and other countries and try to see if we can get some kind of support from them.

Dr. Ben Liu: Maybe, among us who are here today, we can decide whether we want to have any Associations and if there are any objections to Dr. Suhaimi being Chairman.

Mr. Rossi: Yes, recruitment is essential in the beginning. We could compile the various informations that we will get and send them in Magazine form to the members periodically. I do not know of any better way of promoting than through this type of magazine. The cost is negligible. It is very difficult to get press releases out like this. The minute you start the Association you will need money but if we could get the concept together today it would be simpler.

What is the position of International Water Association?

Mr. Rossi: I have no idea. I have just said that we will give every

assistance. We have the same problem at the headquarters with recycling in Europe.

Evelyn Tan: The head office is in London and we can try to get ourselves affiliated with them and work as a member in the Asian Pacific region.

Mr. Rossi: I think that we would be at an advantage in this.

Evelyn Tan: There are also countries who have their own Water Association. I happen to have the address of the Water Equipment Association here but I do not know how active it is here. In Japan they have a membership of 200 people.

Dr. Suhaimi: There is another thing of which I am not clear. This Asia Aquatech conference; is it a commercial job?

Mr. Rossi: Yes, a commercial job.

Dr. Suhaimi: Is it not a group of companies concern with water equipment and is it an informal grouping?

Mr. Rossi: Yes.

Evelyn Tan: We have a mailing list in Europe of 13,000 and in Asia we have only 10,000.

Mr. Rossi: It is the industry which is exclusive and the corporation.

Dr. Grombach: We should do something about water supply. I know many Associations that have a section especially for Water supply and if we start the Asian group of a water supplier association, nobody can forbid us to do so. I would be rather interested to know who are members of water suppliers' associations. I would like to know what happens in Singapore.

Mr. Rossi: In Singapore, there is a Singapore Water Suppliers' Association and a group of eastern Singapore members of the Singapore Water Suppliers' Association. They are not officially set up but they are in existence. The point to decide is how much should it cost to become member?

Dr. Grombach: As little as possible. How many of us are members of the International Water Supplier Association?

Dr. Ben Liu: Are we thinking of this association as some sort of Academic Association or commercial association? Who has attended the Water Resource Association meeting in Bangkok a couple of years ago? The Asian Institute of knowledge sponsored the Water Resource Conference jointly with the International Water Suppliers Association. It was very successful. I do not know if it is possible at this stage to define it.

Mr. Rossi: We can get members in the Phillipines provided the government can sponsor it. The people have to have a practical mind to know what the object would be. What would be the aim of the association if we go for one? One of them is to get water standards set. It would require a lot of assistance from every one.

Dr. Grombach: We should lower the object. I think the association would actually in the first place be a transfer of knowledge in both directions and a chance to talk together. You should more or less gear to that aim.

Mr. Harvey: It all means the promotion of management of water resources.

Mr. Suhaimi: In terms of the existing associations or committees, whether national or international, most of these might have objectives which might be overlapping. What would be our position in terms of the associations that already exist?

Mr. Rossi: There are 2 members here of an international a ssociation. What do they do in the association?

Mr. Grombach: They promoted the last conference. The IWSA had its meeting in Kyoto, Japan and one received a small leaflet stating that there will be a regional conference of the IWSA in Singapore.

Mr. Suhaimi: Why do they not expand their activities in Asia?

Mr. Rossi: Because they are not interested; otherwise they would have done so before. The help that they have given us has been nil. I object to living here and having to affiliate with someone overseas who is not interested in it. It does not make sense that there are any groupings in the association.. All of you should be part of a communication. They have no standards to set themselves against and they are trying to create their own standards,

Mr. Grombach: There should be no problem in setting up an IWSA. Once the association exists, it will be possible to get themselves as members and make a nucleus of Asian International Corporation and I think I understand it is possible to make on the inside of IWSA. We have raised a number of Associations in RI and it has 700 members.

Mr. Harvey: In America, isn't this the same problem? What has been done about it?

Mr. Rossi: They have not really done anything about it. You would not have this problem in Britain. You have working groups and people related by membership to one another.

Mr. Suhaimi: The problem is, of course, money.

Mr. Rossi: The first problem is for people to put enough to get the first stage done, and nobody is going to help us that way.

Mr. Harvey: How many more members would each of us have to attract?

Mr. Rossi: Say, five.

Mr. Harvey: That would be possible. I was thinking in terms of 50 or 100 more.

Mr. Grombach: There is no problem for Westerners here to get 10 or 15; and I would like to ask our Asian friends whether they could ask their University management to become members, too.

Mr. Rossi: Government departments eventually join in but they are not the first one to do so because they cannot afford it.

Mr. Grombach: It is quite normal to even know of a national association where the membership of officials of any kind of government is about a tenth of the individual members and one-third of commercial members.

Mr. Rossi: It is a little bit of a problem to support this. We are through with being an Association now. We took an intolerable loss and we had to make it up. We do not make money out of conferences and might get it back from proceedings which may take 2 or 3 years.

Mr. Komolrit: The idea of an Association is good and acceptable everywhere even in Bangkok. We have so many associations: Water Suppliers' Association, Water Pollution Control, etc. There is a need for these but the problem is that they become inactive. Once there is no direct interest, people become inactive. We would still need money to run the association and it is very difficult to get only from the membership dues.

Mr. Rossi: I think in a year or 2 the association has to have a look on the prime action that will get members interested. If the association is able to have a piece of land and develop it, that would help. The association must be aware that it can provide a full-time service. We can gather all the publications and form the cost of photo-copying and people get them without subscription. The reason for being is to make sure that it does not drop dead. We have a lot of interest in the centre. We went all over to find an area not politically committed.

Mr. Harvey: The people who have the interest are the manufacturers. The demanders are mainly government bodies.

Mr. Suhaimi: What we can offer is the facilities of the Environmental Information system that can be included inour annual budget. We are going to have a conference in 1981 in conjunction with the University. It organises agricultural weed with focus on a number of types. We are going with projects to offer commercial companies to exhibit but that is after 2 years with the mass media.

Mr. Rossi: If you organise an association you have to be PR- minded in many ways and to look for avenues to build on. But you need a home and certain things to promote your aim and the simplest thing would be land. Affiliated association with universities is simple to achieve.

Mr. Rossi: So with the home, our actual cost of putting up a center is nil. As an association, we have to work on a circle to build it. I do not know a number of associations that do not benefit from it directly because most of them have a need for the results or information coming out more than in magazines. To be successful, you have to hit their desk every week for something. Other magazines go out because of their advertising value. If you can multiply only this, you cannot die.

Dr. Suhaimi: How many individuals and organisations within this country are really interested to support an association? If it is only a few individuals, then I do not think it would survive.

Dr. Grombach: There has to be a nucleus first. I am sure that with the association existing, the main part of the bigger cities will be interested since we have something to send. I agree it is very difficult to make such a thing on a certain way but I realise what it has cost me to make my speech yesterday. It was easier, to prepare it than the cost of my journey here. It is only a question of the paper and print. We could go without the colour and have offset printing instead of book printing. The water suppliers and the sewage organisations of the bigger cities in Asia are surely interested.

Mr. Rossi: It is a reasonable way to get started. One way is to get them interested in a directory. We have 80% re ponse to the directory and in 10 joined them from that effect. That is natural because everybody wants to have their names printed in the directory.

Evelyn Tan: What we should do is to set our aims and I will ensure that that the association gets on without any problems.

Mr. Rossi: Are you going to be the Honorary Secretary?

Your rewards would be long coming. Do you accept it?

Evelyn Tan: Yes. Do not worry about money, as I am willing to bear full responsibility for it.

------ INTERVAL ----------

END OF PART ONE

MINUTES OF MEETING

(SECOND PART)

Mr. Rossi — We do not have a name for the Association.

Mr. Pariset — I think the Water alone is too general. We can name it as Water management or water quality.

Dr. Grombach — It is alright if it is general. As title, water quality will be too complicated. I think water covers everything.

But do people not classify water and waste water?

Mr. Suhaimi — Perhaps we can clarify that by putting it in our objectives.

Mr, Rossi — Yes. So, shall we call it Water Association Asian Pacific? Why Pacific?

Because we want to include the Pacific people.

Is this name acceptable?

Dr. Suhaimi — Yes. Is the Pacific likely to accept us?

Mr. Rossi — Yes, they have no way. You will notice there is something wrong in the constitution from pages 2 and 3 onwards. That would not apply here.

Mr. Grombach — I do not quite see the responsibility of the Executive Councellor and the Chairman.

We have to write that the executive Councellor can vote by correspondence so that it would not be necessary to travel over thousands of kilometers.

Dr. Suhaimi — I think that is possible.

Dr. Grombach — I was thinking of the Asian people too. It is still some distance from Bangkok to K.L., and we should not enforce strictly the quorum of 5.

Mr. Rossi — For example, when Bangkok wants to get the thing moving but they do not have the time to come, we can clearly vote by proxy.

Dr. Suhaimi — We have to consult the registrar of Societies. We have a set of provisions in our country but I am not sure of functions outside.

Mr. Rossi — The Association should have enough money to get together for a conference annually. The problem is your objectives. We have it in 10 parts in Clause 1. There is a sort of specification so that they spell out that we are not political which is the worry to the country. I think it would be very simple for you to replace them and have at least 6. You better have your Protem committee listed.

Dr. Suhaimi — There are at the moment only 2 of us who are willing to volunteer. Are there going to be more?

Mr. Rossi — We cannot act unless we get officially formed and constituted publicly. You have to start a scale of fees but all are in a corresponding position. Is it agreeable to everybody that all be members of the Protem Committee?

(All Agreed)

We have to have at least 15 members to be a protem committee and can be replaced when the protem committee becomes a committee by vote. Do we need to have a quorum?

Dr. Suhaimi — Yes.

Mr. Rossi — As usual we have to start a membership in order that you can have funds to work with. If you look back at the previous list you will see some corporate members and some likely to be individual members.

If we decide to arrange courses with the University, which we plan to do so in the future, then we have to look again at the separate student membership.

Dr. Grombach — We should separate a bit more, like stating US$ 40 for individual membership, US$ 100 for Corporate membership and US$10 for Associate membership. If an office wants to become a member, is it possible for a Government office to do so?

Mr. Rossi — No. Only Corporate membership and they can well afford it because they are the ones who want information and particularly for fee.

Dr. Ben Liu — Can we have the US$10 associate membership with voting rights?

Mr. Rossi — No, because of the value of the association. A foreign person who wants to locate agents can use it, so why stagnate a association fee?

Dr. Grombach — I think government employees should be employees of the Universities too.

Mr. Rossi — Yes, I agree and we will amend it.

Dr. Suhaimi — What about the accounts?

Mr. Rossi — We have one of the members doing it on a rotary basis. It is an outgoing which is pretty easy to access.

Dr. Suhaimi — Is there any difficulty about foreign exchange?

Mr. Rossi — Yes, we have to get the dollar separately.

Dr. Grombach — Will we be able to pay the fees?

Mr. Rossi — Yes.

Dr. Grombach — And for example, if the members in Manila have to pay in Kuala Lumpur.

Mr. Rossi — He can get the foreign exchange to do that.

Dr. Suhaimi — And they can pay bank draft?

Mr. Rossi — Yes. Your accounts have to be in your own currency and then can be converted later on.

Dr. Grombach — I should like to have someone to promote the awareness of water quality. Perhaps Dr. Suhaimi can define that. Just put it in as " Awareness of Water Quality".

Dr. Suhaimi — What is the term of reference to protem committee?

Mr. Harvey — It has to be registered in Malaysia.

Dr. Suhaimi — We will send the draft to the members.

Dr. Grombach — I suggest that you send the draft to everyone when it would take at least one week for one way to reach and one week for suggestions and another week for sending it back which takes in all three weeks for it to come back.

Mr. Rossi — In fact, you have to send them for signature.

Mr. Harvey — What would be the liability here?

Mr. Rossi — None

Dr. Ben Liu — If there are no suggestions or comments on the job, that is fine; but if one or 2 more objects then what will happen?

Mr. Rossi — We trust Dr. Suhaimi, who is the chairman, to decide whether a suggestion is good or not. We should have the possibility of making some suggestions after seeing the draft. It has to circulate twice but you can bill at the same time.

Evelyn Tan — I suggest that should you want anything done, you can just send everything over here and I will do it for you, cutting down your cost. I will do a form and get them to pay for it.

Mr. Rossi — I propose that Mr. Ragman of India be included. Also Mr. Trevor Smith and the gentlemen from Singapore because Mr. Smith has contacts in the United Kingdom. So bill them right away.

- — I notice that there is a 6 months period. Is there any reason for this urgency?

Mr. Rossi — No, but the sooner we get this thing started the less strain there will be for the Chairman. Dr. Suhaimi and Evelyn can sign for the bank statement and the cheques but you will have to send out the bank statements for the signatories.

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ASIA AQUATECH '80

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