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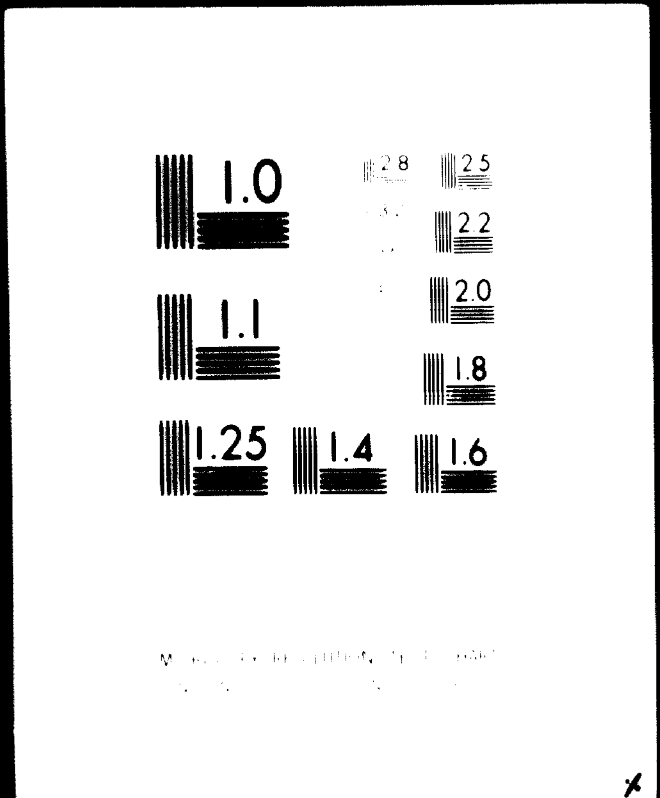

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As for an overall impression, however, the situation on water pollution and environmental health in Thailand is predominantly characterized by the problems of domestic wastes disposal. This has been described in detail in the country report on Thailand presented at the W.H.O. Seminar on Water Pollution Control in November, 1970 (5). Also the team found some extraordinary examples of heavily polluted environments, such as river waters, klongs, streets, which will be commented further in this report.

With respect to industries, factories and places of commercial activity it was found that many of the representatives concerned feel a responsibility for wastes disposal requirements. A good deal of factories visited by the team during their short stay have their own treatment or disposal facilities, even though some of them do not completely correspond to the local demands of pollutional prevention or show a lack of technological experience. Still a basic response to the public demand is evident, and should deserve any possible support in future.

(b) Approach to the Local Problems

The water pollution problems in Thailand, and in particular in the Bangkok-Thonburi region, are at present caused by the fact that people have been deprived of their natural use of river and canal water. Only a few percent of the total country's population are being served by water supply systems, while the vast majority depend on natural water resources. Many factories have gained access to rivers in the past years in order to utilize great quantities of river water for their manufacture process, and discharge the effluents back to the river without proper purification or treatment. Factories favouring the use of river water are, among others, sugar mills and paper mills, but also other industries depend on economic fresh water resources and wastewater disposal. So the list of "water-based" industries in Thailand is nearly alike that from other countries: -

sugar cane production
textile factories
paper mills
distilleries and breweries
tanneries
milk-powder processing
soap factories
rice mills
tapioca mills
flour (noodle) production
fishmeal factories
food canning factories
fermentation industry
steel and metal finishing

Some of the more specific Thai branches of production seem to face temporary difficulties caused by export and world market conditions, such as the tapioca feed and the sugar cane production. Other industries receiving government promotion will in the near future require utmost attention regarding their wastes disposal and wastewater problems, such as oil refineries, plastics and chemicals production.

A wide variety of light consumers' goods factories are within and around the capital city. Food and agricultural product factories are found in remote parts of the country, but are located in areas fairly close to provincial towns. Effluents are usually discharged to nearby waters such as canals and rivers.

In recent years a number of industries have been removed from the capital to other places in the country, such as tanneries, textile factories and paper mills. It is therefore necessary not to limit the industrial wastes studies to the Bangkok-Thonburi area but rather to cover the whole of the country or, as to the sugar mills, to investigate at least the region of natural growth of the raw product, where the majority of the mills are established.

2. Spot Investigations, Coordination with other Activities, and Findings

(a) Present Industrial and Municipal Pollution Problems

The problem of environmental pollution and its prevention is well familiar to the authorities and government agencies in Thailand. Hence it is not surprising that the Team found a number of institutions seriously engaged with research and control work on this field. For the purpose of reference the following record is given listing the places of such activity, -

Ministry of Industry, with the Departments concerned, including laboratory facilities,

Ministry of Public Health, with the Sanitary Engineering Division and its laboratory,

Asian Institute of Technology, with broad-scale research and teaching facilities,

Applied Science & Research Corporation of Thailand,

W.H.O. Representative, Thailand, who organized a seminar on water pollution control for the South-East Asian region,

Municipality of Bangkok, jointly with the

Bangkok Drainage & Sewerage Committee, which is attached to the National Economic Development Board and has responsibility for executing the Bangkok Drainage & Sewerage Master Plan.

In the course of the local studies and investigations the Team obtained various valuable information from these agencies and their representatives. Thus a more comprehensive view of the whole problem could be composed. Also a number of publications, papers, analysis sheets, graphs, have been received, some among them of considerable volume and scope so that more detailed study seems necessary. Still it is hoped that the main results of these documents have been evaluated as far as required within this Report.

The problem of industrial, municipal and possibly other kinds of pollution in a developing country like Thailand must be considered under economic aspects. In fact the promotion of industries, housing, agriculture, traffic and other basic elements of national life has received preference to the requirements of public hygiene, infrastructure and environmental health. However, the public opinion now becomes aware of such misrelation and newspapers frequently publish reports of nuisances caused by water pollution, garbage dumping or air pollution.

In order to reconstruct a realistic picture of industrial pollution in Thailand and the Bangkok-Thonburi area, the Team at first tried to obtain data from the Ministry's registration or factory statistics. This, however, proved not effective as up to now only small portions of the country's industries are on record. Mainly it is just a list with the total number of factories existing giving no further details. Therefore after discussions with the Ministry officials the Team decided to start an immediate ad hoc action in order to collect at least informative data. A questionnaire form has been drafted and duplicated, and a number of industry branches have been selected for this purpose. The list of industries includes the following:

1. Milk-powder processing factories (condensed milk, ice-cream, babyfood)
2. Sugar cane factories
3. Soft drink factories (Coca Cola, Pepsi Cola and other drinks, made from concentrates)
4. Metal pickling and plating factories (pickling, electroplating, processes with nonferrous metals and cyanide baths, aluminium coating)
5. Tanneries
6. Soap factories
7. Food canning factories (fruit-products, vegetables)
8. Abattoirs (slaughterhouses)
9. Paper factories
10. Distilleries (from corn, molasses, fruits)
11. Breweries
12. Textile factories (bleaching, washing, dying etc.)
13. Flour mills products (from tapioca, grain, rice)

From each of these industries a limited number of typical factories have been selected and thereupon enquired through the Ministry by Questionnaire, see Annex 1 (formate reduced). This questionnaire had of course to be restricted to the most characteristic items relating to wastewater quality, output, kind and process of production, water consumption etc. because the Team wanted to obtain answers as early as possible during their very short period of stay at Bangkok. For more detailed investigations the questionnaire would have to be drafted at a broader scope and for more specific comments. The data eventually received by the Team have been utilized with satisfactory results.

The selection of industries reflects a typical picture of the problem of industrial pollution in Thailand, insofar as almost all of the works have waste water effluents of an organic nature. Only metal pickling and plating would differ. In this respect it would be possible to pre-treat these effluents only in special cases and otherwise to release them into a public municipal sewerage network and treatment plant. However, no regular systems of such kind do exist in Thailand, and special solutions of wastewater treatment are therefore required.

(b) River and Water Pollution and Control Practise

The main stream of the Bangkok-Thonburi area is the Chao Phya, with 365 km in length, draining the vast alluvial plain of central Thailand of about 100,000 sq. km. where over one-third of the country's population live.

An intensive survey of the Chao Phya River has been performed during the years 1969 and 1970 to study the pollution effects in the river. The numerous canals in Bangkok and Thonburi behave like large sewers to carry waste water from various parts of the two cities into the river. It was discovered that the river water was potentially polluted before getting into the Bangkok and Thonburi area having average dissolved oxygen concentration only of 4.5 milligram per litre at 29^{o} C which is below 60 % of the saturation value. After receiving the discharges from the canals and a considerable amount of other wastes such as market drainage and garbage dumping the dissolved oxygen concentration becomes very low. The concentration at a station within the city area was below 2 milligram per litre 50 % of the time. There was time during the low flow period in June that the river was devoid of dissolved oxygen.

The prevailing situation has caused much anxiety among the engineers who are planning a drainage system for the city. It is feared that the pollution load to the river may be increased because waste water discharged will concentrate to the points of outfall and quicker methods of drainage will not allow decomposition prior to discharging at the outfalls.

This overall picture becomes more illustrative in a fundamental study of the Asian Institute of Technology, published by Pescod and Ratasuk (3). In the study the oxygen balance of the river's estuary has been investigated with respect to pollutional effects. As a summary, the following findings may be quoted.

From the field surveys it is estimated that about 145,000 kilograms of the 5-day biochemical oxygen demand (BOD_5) at 20^{o} C gain access to the estuary per day. This would be equal to organic wastes from a population of about 2.7 millions inhabitants - very close to the actual population of about 3 millions. Various aspects of the estuarine hydraulics have also been studied and the concept of "Equivalent half-tide distance" has been developed for use in plotting oxygen sag curves for the river estuary. A broad conclusion is that the water conditions in the estuary are worsening each year and that anaerobic conditions are likely to occur in the near future in the river section around Kilometre 41 at low river discharge. However, at high river discharge, the estuary can tolerate the likely pollutional load in the foreseeable future without causing problems near Bangkok and Thonburi.

The Project team had the opportunity of discussing the aforementioned results with the author, together with the other data, and for further studies will contact scientists in Europe with respect to the concept of equivalent half-tide distance. This theory has been deduced to overcome difficulties caused by the tidal effects on analysis values gained from samples of estuarine waters.

Regular river surveys are being conducted by the Sanitary Engineering Division of the Ministry of Public Health, as well as the Department of Science Laboratories of the Ministry of Industry.

The Team attended a boat-trip along the Chao Phya to the regular sample spots within the Bangkok area, altogether 7 spots reaching from the mouth to 80 km upstream. The map, Annex 2, shows sampling spots which the Ministry of Industry usually collect samples from, with particular attention to the freshwater intake of the Bangkok Municipal Waterworks.

On the day of the samples-taking demonstration, see photograph No. 1, the river flow was near the winter mean value, The fluctuations are very heavy ranging between a mean of 1,000 m^3/sec during August to December, and 25 to 50 m^3/sec in April. The maximum occurs in October at 3,000 to 4,000 m^3/sec.

The graph, Annex 3, shows oxygen values at low river flow, with considerable oxygen losses between the sample spot upstream and the other spot downstream the city. The analyses were made by the Ministry laboratory. Our evaluation of these and other results has clearly indicated the decrease of oxygen below the limits of fishlife. Oxygen values of less than 2 mg/l seriously call for effective measures. This would also apply to preventing the disposal of solid wastes, garbage, refuse etc. into the river.

A more detailed report on the river inspection, as well as a report on a klong inspection in the urban area, is included in the Team's note, Annex 4.

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The chemical and biological determinations from river water samples normally include -

(I) on the spot:
temperature
conductivity
dissolved oxygen (after Winkler's method)

(II) in the laboratory:
chemical oxygen demand (C.O.D.) by the chromate method (in other countries the permanganate value is in use)
chlorides
ammonia
organic nitrogen
settleable solids
turbidity

It can therefore be confirmed by the Team that the laboratory analysis practise meets the requirements. The determination of phosphates, nitrites, nitrates and ammonia is done by photometer, and the U.S. standard methods are applied in analysing, which agree to the German standard methods in those examinations mentioned. The laboratory is equipped sufficiently with apparatus and chemicals, and the staff seems to be adequate in professional skill and in number.

A rather specialized question was raised to the Team concerning the way of determining the biochemical oxygen demand. According to international practise the B.O.D. is determined in 5 days of incubation at 20° C of the sample. In tropical zones the temperature of open waters is normally higher, such as 30° C, and hence it has been suggested to determine a 3-day-B.O.D. at 30° C which, it is said, nearly

equals the 5-day-B.O.D. at 20° C. The Team have considered this but would recommend still to adhere to the 5-day-B.O.D. practise at 20° C because this would facilitate the comparison of figures found from different regions and countries.
According to the project outline, recommendations on adequate equipment for industrial effluent control and disposal should be made, combined with chemical testing facilities, both for fixed laboratory and field testing. The equipment at the laboratories of the Ministry of Industry and of the Ministry of Public Health has been found adequate and sufficient, see paragraphs above in this section, and Annex 4. These laboratories have all necessary instruments for full-scale water and wastewater analyses and no additional equipment is necessary.

As to field examinations the boat mentioned in Annex 4 is sufficiently equipped for the measurement of temperature, conductivity and dissolved oxygen. The other examination values are obtained from the samples taken to the laboratory. The basic checks of industry treatment plants, however, should be made regularly with a minimum equipment, as described on page 31.

At the laboratory of the Ministry of Public Health the analysing work is carried out without indicating to the laborants the origin of the samples (blind system), and the work is organized on routine.

At the Ministry of Industry laboratory it seemed to the team that there is a certain lack of skill in analysing practice (page 19). Therefore it has been recommended (page 37 and 38) to improve this by fellowships and by training on the job in a future phase of the project.

(c) Industrial Effluent Treatment and Control

Industrial effluents have in recent years become problematical in some parts of Thailand. The degree of public health hazard caused by industrial wastes ranges from obnoxious odour to pollution of public water resources. The types of industry considered in this respect have been mentioned before. Here a brief characteristic of these industries is given, also by quoting the findings in the Thailand water pollution report (5), however, with amendments and completions from the team's own investigations. For detailed information, reference is made to the technological reports in Annex 5(a) to 5(k).

Sugar mills

The factories in general are located on the banks of rivers, because a great amount of water is required for washing the sugar canes and for cooling processes. A factory may discharge waste which contains sugar, sugar cane fibre and dirt at a rate as high as 10 cubic metres per second. The waste is also thermally polluting having a temperature of about 50° C. The BOD_5 is from 100 to 200 milligrams per litre. Many factories are operating along the Mae Klong River alone within the distance of 30 kilometres. During the dry season, the river flow drops to about 30 cubic metres per second and the river turns anaerobic.

The kind of production and of wastes discharge, of B.O.D. load and of treatment of a typical factory are presented in Annex 5(a).

Paper mills

Some factories produce black liquor from pulping process. The effluents are very polluting. Treatment facilities provided in paper factories are very marginal. One factory attempts to treat the waste by lagooning but there has been very little improvement on the characteristics of the effluent. The other two factories also discharge effluents into rivers.

However, from the Team's visit to a kraft paper mill it was encouraging to find some effective treatment facilities and arrangements to recover chemicals used in the production process. It is also worth to be noted that this mill carries out regular control analyses of the wastewater. For details, see Annex 5(b).

Fishmeal factories

Fishmeal factories are generally of small scale but there are many of such factories in the coastal provinvial towns in the southern part of Thailand. Such factories produce fishmeals from practically everything caught in the fishing net. The mass of raw material usually comprises small fish, crabs, cattle fish, squids, lobsters etc. The process involves steam cooking, pressing and drying. The pressing in particular produces a very strong polluting liquor with total solids of almost 100 grams per litre and 14 grams per litre of grease. This pressing liquor should obviously be recovered as by-product, but most factories dispose of it as waste water. Fishmeal factories are small and most of their owners are reluctant to adopt new or additional processes. Damages caused by fishmeal factories are mostly local such as a nearby paddy field and irrigation canals.

A special case of pollution and bad smell was brought to the Team's knowledge and suggestions for immediate measures have been made thereupon; see Annex 5(c).

Food-canning factories

Both fruit and vegetable canning factories have been already in operation. In view that there is yet a great amount of surplus fresh fruit and vegetable, many more factories will be established in the near future. The existing canning factories are small and the production is seasonal. There are but two large pineapple canning factories, each discharges about 60 cubic metres of waste water per hour. One factory has built a lagoon and oxidation ditch system to treat the waste, but another factory directly discharges it into a river.

Milk-powder processing factories

Milk factories are milk reconstitution plants where imported milk solids and butter fat are processed with sugar and water to produce sweetened condensed milk and evaporated milk. Waste from these factories are very strong with BOD_5 concentration from 1,500 - 4,000 milligrams per litre, and deficient in both nitrogen and phosphorus. Aeration method has been adopted by some factories to treat the waste.

The Team had the opportunity to visit one factory where the liquid wastes are treated in an oxidation pond, with relatively good purification effect, see Annex 5(d).

Slaughterhouses (Abattoirs)

Abattoirs are run by local municipalities and each provincial town will have one abattoir where cattle and hogs are killed and eviscerated. Small quantity of water is used in the particular procedure of slaughtering used in this country, but the waste is very strong.

Most abattoirs do not have waste water treatment facilities. Effluents are discharged into roadside ditches or canals.

Additional information has been obtained from a special report on the wastewater conditions of the slaughterhouse at Chiengmai, the city second in size to Bangkok-Thonburi. Extract see Annex 5(e).

Textile industries

There are many textile factories producing cloth from cotton. Processes employed in typical factories are threading, bleaching, dying and weaving. Some larger factories also mercerise the cloth. Waste discharged from these factories are contaminated with starch, cottonfibre bleaching agents and dye.

An example of factory-owned and -operated treatment facility was visited and data collected, see report, Annex 5(f).

Further investigations on the spot and visits to factories with wastewater treatment have been made by the Team to -

- tanneries (see Annex 5,g)
- a chemical factory (see Annex 5,h)
- rice mills (see Annex 5,i)

- tapioca mills (see Annex 5,j)
- a soap factory (see Annex 5,k)
- a paper mill in Kanjanaburi
- a milk products factory in Bangkok,
- a soft-drink factory
- a sugar cane factory.

Further from the questionnaire action (Annex 1), as explained above, the team eventually received data on wastewater treatment facilities erected and operated by factories up country.

The list with analysis results, Annex 6, is an extract of data from the Ministry of Industry, Division of Physics & Engineering laboratory. As the figures just reflect single values and no systematic series of examinations, the team has abstained from interpreting this list, - except for the urgent advice to make any more efforts in intensifying such surveys on the side of the Ministry.

With only a few examples of systematic treatment of industrial effluent at present, any means of developing and enlarging such measures should be welcomed by official agencies. An appreciable approach has been found in the field of research work. Under the sponsorship of the Asian Institute of Technology, Government and international bodies, one subject studied by scientists and graduates deals with methods of wastewater treatment by cultivation of algae crop from stabilization ponds as a source of protein. A field laboratory run by the "Applied Scientific Research Corporation of Thailand" is used in these tests to recover the waterborne nutrients in the form of algae having potential as a livestock feed. The treated wastewater may be used as a reliable irrigation water supply. The algae plants cultivated in the tanks are Scenedesmus and Chlorella. By flocculation with aluminium salts the algae are removed from the water and dried. It is expected, under the prevailing climate of Thailand, that 150 pounds per acre (equal to 16,8 grams per sq.m.) of dried algae can be achieved. The theory dates back to 1947, when Howard at first suggested aquatic plantation to remove mineral nutrients from biological treatment-plant effluent. Bucksteeg in 1955 has initiated open-air tests (13) which resulted in the demand for a possibly full-scale utilization of natural resources. However, this is not viable under the changing climate conditions in the temperate zones. In Thailand this obstacle does not exist, and a systematic run of these tests is advisable. The team still found doubts about the economy of the method, viz a reasonable benefit from the sale of algae substances for protein feed or pharmaceutical utilization. As the team's own experience has shown, microscopic species of algae like Scenedesmus obliquus only can be removed from the water by rather costly procedure.

(d) Pollution from Industrial Solid Wastes and Air Pollution

With a rising standard of living the amount of domestic refuse and garbage increases - a fact to all developed countries. The same applies to the increase in industrial solid waste that might appear as a result of new or intensified production methods, different raw material used, etc. There is obviously not much difference in this respect between developed or underdeveloped / developing countries. So it is but natural that in Thailand the solid wastes problem both in the residential areas and in the industrial regions increasingly gives rise to nuisance by pollution of streets and open waters. Innumerable places of dumping, dipping or incineration of wastes have been found and it is considered reasonable for the time being to notice such occurences in connexion with the liquid wastes problem. This would reveal mainly those cases possibly causing poisonous, deleterious or hazardous dangers to the public, to the environment and to the surface and groundwater resources. Therefore an item has been included in the team's questionnaire plainly asking for solid wastes problems experienced by the industry firms. Out of 13 questionnaires received after completion by the firms, the team found not more than

- one distillery,
- the Bangkok slaughterhouse,
- one milk-powder processing works,

whose management reported difficulties with solid wastes disposal. Although not considered significant, this result indicates a distinct lack of "environment feeling". Further studies will certainly lead to more conclusive data.

The question of air pollution in Thailand is basically concentrated on the cities and centres of industry. As to the conditions in the cities, mainly in Bangkok, the most aggravating nuisance of air pollution is caused by the traffic which particularly in times of rush hours frequently reaches breakdown conditions and suffers from innumerable bottlenecks and deadlocks. Thus the accumulation of gases from motor-vehicles leads to hazardous air conditions. In the first line the mini-taxis, motor-tricycles, contribute to air poisoning, emanating from the incomplete combustion of petrol and lube-oil mixture used by these two-stroke engines. Only recently a deadline has been set by the Government to ban these vehicles within the next few years. An article entitled "Creeping Pollution", printed in "Business in Thailand", October 1970, well deserves being quoted as follows, -

"The fact is that vehicle fumes do more harm to the Bangkok environment than any other source of pollution, including industrial wastes and the discharge from airliners. Evidence for this assertion comes from a governmental committee which, since 1963, has acted as public watchdog on environmental pollution.

"Its findings are startling: the degree of pollution throughout many parts of the city far exceeds the "safe" level prescribed by international standards. The air samples take into account such factors as wind velocity, atmospheric conditions and traffic density, variables which influence the amount of carbon monoxide, lead particles and noxious gases spewed into the air.

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"Even after a police campaign against offending vehicles, the level of carbon monoxide reached 60 parts per million recently - still 10 p.p.m. above the internationally accepted limit."

The article further advocates the siting of factories in industrial zones, and control of wastes disposal, in order to put the air-pollution menace under terms of easier supervision and control. As to the siting of industrial zones this will be a future task of top priority to all authorities concerned. A mere ban of industrial establishments within urban districts cannot act effectively because industrial locating and residential zoning are of mutual effect.

Finally reference is made to the World Health Organization Report on urban air pollution (10) with particular reference to motor vehicles. For the time being, this report containing the collective views of an international group of experts is evidently the most recent presentation in this field and might give valuable advise also on the problems in Bangkok.

3. Effluent Standards and Codes

(a) Standards of the Receiving Waters and Disposal Systems

The Chao Phya River is the principal recipient stream of the Bangkok-Thonburi region. The pollution load of this river is caused by discharges of liquid wastes, effluents and stormwater from residential areas as well as commercial areas along the river banks, and also of solid wastes disposal into the river. Floating contaminants, refuse and garbage are visible along the river stretch within the urban district.

Another detrimental effect is the tidal movement of the river waters upstream from the mouth. As mentioned before, research on this item is under way, leaving open still a number of detailed questions concerning the river pollution and its degradation. Thus it is rather difficult to display a sort of river quality picture as practised with other rivers where surveys and long-range data have been collated and checked. Such kind of river quality chart normally serves to identify the possible or acceptable utilization of water in the different sections of the river course. At the same time the minimum requirements of river-water quality can therefrom be derived and fixed in the form of standards to be applied within the respective locations or river sections. In other words, - certain well-defined substances must completely be withheld from any discharge into the river, and certain substances which may be discharged must be within the minimum limit values of concentration.

Such river water survey is normally based on the following criteria:

(I) physical properties (smell, taste, temperature etc.);

(II) biological properties (biochemical values);

(III) chemical properties, i.e. both minimum content of necessary substances (e.g. oxygen) and maximum allowable concentration of pollutants;

(IV) special characteristics, as for example bacterial counts, radioactivity etc.

Surveys of this kind always must be related to a critical low river flow, which may be expressed by a defined number of days per year when this flow is not being reached, - for instance 20 days. This practise is not adoptable with the Chao Phya due to lack of sufficient data. Therefore it is considered more useful to follow more simplified principles of standards, and in the first line to state -

- that no discharge into a river must cause a negative effect to the present river water quality,

- that discharges into a river which might lead to such effect must be subject to treatment, however, within the scope of technological and economical feasibility.

Effluents carrying organic pollution should in general be treated by biological purification; anorganic effluents should mainly be treated by chemical and/or mechanical process; sometimes the way of recirculation or, in extreme cases, transportation of contaminants to the open sea might be necessary.

As far as the discharge of effluent into public, municipal sewers and treatment plants is concerned, well-experienced patterns of standards for such discharge are in use in many countries. The Bangkok sewerage system is at present at the beginning of its implementation, with a large diversion tunnel and a pumping station. Further contracts for construction work will follow. With respect to the discharge of industrial effluent into the future network the master plan provides for the following procedure (quoted from (4) Supplementary Report):

"Industrial wastes presently existing in the Master Plan area do not require pretreatment. Page 199 of the Master Plan report suggests the establishment of Waste-Water Ordinances, including one which would establish the terms under which the facilities are to be used. It is anticipated that each potential user of the sewerage system would be evaluated with regard to need for pretreatment of his wastes."

More detailed information may also be quoted from the same source which can be considered adequate and in the line of international practise: -

"Pretreatment of Industrial Wastes

In most large municipalities it is the practice to accept industrial wastes into the municipal sewerage system. Whether or not such wastes should be subjected to pretreatment before they are discharged to the sewer is dependent upon the type of waste and its relative volume in comparison to the flow in the sewer.

Some types of wastes which may require pretreatment are those with an unusually low or high pH, those containing toxic or radioactive wastes, or those containing unusually large amounts of fibres, grease or heavy solids. Tannery wastes often contain a large quantity of lime which could result in encrustation of the sewers into which they discharge. Additional problems are also associated with other industrial wastes, particularly when those wastes constitute a substantial proportion of the total flow of waste water in the sewer.

"Pretreatment of problem wastes may consist of adding chemicals to adjust the pH of the wastes to acceptable levels or to neutralize metallic plating wastes or other toxic wastes. Plain sedimentation is often an adequate pretreatment measure. Only rarely is it necessary to require an industry to provide complete treatment before discharging its wastes into the municipal sewer."

(b) Industrial Effluent Standards and Codes

The Ministry of Industry have established "Working standards for effluent discharging to inland streams". These standards, given in this report as Annex 7, form a useful basis to initiate the control over industrial discharges. The values are maximum values for various effluent contents, without regarding any difference between the types of industrial effluent. This, however, is a matter of necessity as the particular effluent might often require very specific treatment methods, depending on the flow and conditions of the receiving river water. Therefore standards must necessarily take in account the most recent level of treatment methods and efficiencies. The values set as standards are supposed to testify the accordance both of maximum acceptable contamination and of technologically justified treatment processes. In the light of this fundamental, and internationally accepted, proposition, some of the Ministry's figures seem to be too sharp, e.g. zinc, chromium, nickel, which values can practically by no technical means be maintained in many industrial effluents. In Germany, for an example, the limit had to be adjusted for effluents from electroplating factories, namely

total chromium	2 mg/l
nickel	3 mg/l
zinc	3 mg/l

The list of the Ministry also gives a limit for silver which will always be recovered from a factory prior to being discharged, whereas copper is not listed.

The low limits set by the Ministry can practically be reached only by applying the ion-exchange process. This process is generally being used if there is lack of fresh water or the water price high, and water then can be re-used.

As shown above, it is not quite realistic to establish and impose discharge standards for overall oberservance at a relatively high level of values hardly attainable. Even standards set particularly for the branches of industry may easily cause misinterpretation because of different methods of production. In these cases expert advise will be necessary to support the authority responsible for imposing standards.

The Team have discussed with the Ministry standards for a limited number of industry branches, also taking into account the type and degree of effluent treatment applied. The draft standards of effluents have been included in Annex 8 to this report.

Annex 8(a) contains the general aspects of setting effluent standards in Thailand.

Annex 8(b) represents standard values, established in Germany, applicable only for industrial effluents discharging into public sewerage networks and treatment plants. This list may be considered a pattern for future regulations in Thailand once public sewerage facilities will be existent at a broader scale.

Annexes 8(c) to 8(j) then give the draft standards on industrial effluent discharge as suggested and motivated by the UNIDO team.

4. Effluent Control Measures and Equipment

An industrial wastewater treatment plant will always call for a good and effective operation so as to justify the considerable cost and expenditure spent on the plant. Therefore it is of necessity to observe a regular control and checks of its effluent characteristics. In all developed countries it has become a matter of practise to let the owners or administrators of factories carry out these checks and analyses by their own staff with their own laboratory equipment on a routine basis. Special attention must be given to the maintaining of the specific effluent standards set for the respective factory by the Ministry of Industry.

These standards in general require the determination of the following effluent values: -

settleable solids
pH value
floating matter
chemical oxygen demand (C.O.D.)
B.O.D.

Under special conditions the concentration of chemicals used by the process must be examined, e.g. in particular -

organic solvents
free chlorine
sulfide.

The metal-finishing industry, electroplating works, will require the determination of -

copper	cadmium
nickel	iron
zinc	cyanides

The team had the opportunity of introducinq the staff of the Ministry's laboratory into the analysing methods by examining samples taken by the team on visits to various factories.

Control analyses must of course be conducted by the Ministry according to the "standard methods" under accurate laboratory conditions, whereas the simplified check shall be up to the individual producer releasina this effluent. The following basic checks should be made regularly by the producer with the following minimum equipment -

temperature	-	by thermometer
pH value	-	by indicator paper
settleable solids	-	by Imhoff cone glass

As to more detailed checks reference is made to the U.S. manual on simplified wastewater examination (11) which gives sufficient instruction. An essential point is careful recording of all figures and values found by the tests.

In close connexion with the analysinq practise the calculation of population equivalents is applicable which relates the pollutional load of an industrial outflow to a domestic effluent. International literature even qives the opportunity to valuate the quantity of polluted matter carried in an effluent accordina to the quantities of production of such factory, as for instance the annual or monthly or daily output of a product. From such fiqures it would be possible to express the total industrial pollution in the Bangkok-Thonburi in population equivalents. At present the industrial statistics run by the Ministry of Industry are not yet at such a level as they merely contain the number of industries without data, and the registration chart, Annex 9, is as yet only available from a few factories. Nevertheless a consequent pollution statistics would necessarily contain data permitting the calculation of population equivalents.

For a logical follow-up of control measures, it is important to bring the whole action under a system, which is based on the river regime or a major section of it. Also the temporary change of conditions must be considered in this plan which therefore might be divided in stages of execution. In other words, it would be unwise simply to impose standards on the individual producers of effluent without taking in account the river conditions, the regional or local development and possible changes of pollution in future.

In this connexion it seems usefull to envisage regulations to be drafted which at a future stage of development will serve as models or, more effectively, be incorporated in an official Act, Ordinance or Bye-law. Although the team is in some doubt about the present efficiency of this approach for Thailand, in Annex 9 draft regulations have been established. They should be considered to form a first step until the deficiencies of data and of control facilities will be overcome.

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5. Conclusions

The effects of free discharge of municipal and industrial wastes are becoming most extreme in the Bangkok-Thonburi area. With a population of about 3 million discharging wastes untreated into the open canals and with many thousand industrial installations contributing their portion of raw wastes, there is no doubt that the present conditions call for remedies. At times of low flow in the Chao Phya river the organic pollution discharged would seriously deplete the dissolved oxygen level in the river.

Also the other regions in Thailand show similar, worsening conditions of environmental protection. As for the industrial part of pollution, even more serious effects may occur in future. Only a few industrial works avail of wastes treatment facilities. An overall requirement is therefore an intensified care for advance planning. At an early stage of development of new industrial undertakings surveys will be necessary to secure full consideration of planning elements and infrastructure. General recommendations as to industrial infra-structure have been compiled in the UNIDO Monograph on Industrial Planning (1). The chapter on regional and locational aspects of industrial planning refers to the mutual relationship of urbanization and availability of infrastructure. Both economic advantage of urban locations and disadvantage are compared and discussed. Eventually the availability of urban water supply, sewerage, drainage and waste disposal for most of the water-based industries would plead for locations within urban reach.

Therefore in order to tackle future problems, industrial promotion and city planning should involve more consideration on the ecology. Industrial zoning should make unevitable problems of waste effluent much easier and more economical to deal with. City planning will do the same kind of good when problems of water supply and sewerage need to be coped with.

An essential basis of any development policy is the collection, evaluation and continuous keeping up to date of data. This the Team has found a point which in future needs much more attention, as has also been stated in the industrial report on Thailand (6). From several discussions it appeared that a more specific type of data would be required in the field of industrial polution control than an administrative statistic presently available, see form, Annex 10. The Ministry of Industry should therefore start such data collection by questionnaire similar to Annex 11, however, with a number of more detailed items to be included. The form entitled "Factory Inspection Report", see Annex 11, has since recently been used by the Ministry's engineers when on inspection travel to firms applying for new establishment, expansion or putting into operation of their factory installations. Unfortunately only very few forms showing entries have been handed over to the Team as the pattern has just come in use. The basis of the factories inspections is laid in the "Rules and Regulations for factory establishment and extension dealing with wastewater", Annex 12, which seems self-explanatory and does not give rise to objections.

Once the Ministry will have such basic data in hand, it will be much easier to pursue the Ministry's policy of pollution control. This policy will directly lead to concrete engineering studies and design of treatment plants. In the scope of such engineering activity also particular studies will be carried out as to combined collection of wastewaters together with domestic sewage and, consequently combined treatment, or drafting of cooperative systems between different industrial factories of a distinct region. A special demand is also raised in connexion with the environmental hygiene and protection, thus in the same course calling for measures of solid wastes disposal and prevention of air pollution.

Regarding the present position of urban sewerage and drainage in Thailand, the team found in several discussions a view of promoting drainage and flood protection measures of the large cities, but not of sewerage measures. The difficulties in financing have been given the pretext to this.

As far as the Team has been given to understand, the great Bangkok project which in 1968 has been described (8) and subsequently been followed up in planning phases, has since recently been handled under this aspect with the first stages of implementation only dealing with drainage and flood protection facilities.

The Team can for the time being hardly see that the postponing of sewerage measures will in reality meet the health requirements of the next future. Not only will this policy obstruct in many cases an economic way of industrial effluents disposal; rather will the hazard to hygiene deteriorate much more the public life in the big cities. A serious examination of the whole position is considered urgent, this to be conducted in conjunction with, and with the full engagement of, the top ministerial officials in Thailand.

This picture which is in conflict to international opinion and practise, will of course not give relief to industrialists towards their wastes disposal problems. Water pollution controlling is a costly and complex matter. The problem arising from pollution in Thailand at present is, almost as a general rule, a menace to the public who cannot directly counteract and defend themselves. Pollution arises from extensive usage of water which is the consequence of the rapid development of the country. It is possible that as the pollution problems are looked upon together with other subjects, a developing nation may have to set them aside as problems of second priority. In case of Thailand were industrial promotion has been so successful in a short period of time, control and administration may have been behind.

New problems caused by large industries and advance in technology have overtaken the controlling authorities. The latter are often faced with problems which are hard, if possible at all, to solve.

For all these reasons new efforts are necessary with the aim to enable the Ministry of Industry, on the side of the administrative competence, as well as the various industrial establishments, to achieve full control over their pollution problems and to realise practical measures by appropriate technical means.

6. Recommendations

In the course of the local studies, the team found that the problem of industrial effluents and wastes disposal requires more detailed investigation. So it is not only the Bangkok/Thonburi area which represents the problems but also other districts in the country, as for instance the sugar cane and the textile factories, the tanneries, certain metal-processing, food canning and flour production works. A number of these and other branches of industries have in recent years been removed from the capital to places in the country.

The Factory Act (2) and the effluent codes and control standards drafted with the assistance of the team, requires for its enforcement additional facilities, both laboratory and administrative, as well as intensified training of professional staff. The developing of new industries, e.g. of oil refineries, also calls for urgent measures in order to strengthen the position of the Ministry of Industry and their full technological competence and know-how.

In the first line provisions are necessary for the setting up of a registration scheme on "Industrial Pollution Control" which should be achieved in addition to the administrative registration cards already in use. Consequent follow-up of this register will be needed.

For the improvement of engineering skill and practise high priority must be placed upon receiving special advice in performing full-scale engineering studies and design of wastewater treatment plants. Preference will be given to selected industries requiring immediate action. Factories in urgent need for such technical assistance are -

the sugar cane factories
the paper and pulp factories
the textile factories
the distilleries
the flour mills.

Possible combination of treatment from close-by situated factories or communities will deserve special attention for technical and economic reason.

Allocation of fellowships with appropriate institutions abroad and of training on the job to improve engineering practice will be included in the programme.

This programme should be supported by posting of experts and will have to include the following subjects:

(a) to establish a registration system of industrial pollution control which will be set up, completed and subsequently kept up to date under the Ministry of Industry. This system will compile and forthwith evaluate the technical data on water consumption, wastewater disposal, solid and liquid wastes disposal, industrial air pollution and other details possibly affecting the environmental conditions;

(b) to carry out engineering studies and design of industrial treatment plants based on modern and economic practices, taking in consideration the special country's conditions and limited capital resources for constructing such facilities. Special attention should be given to treatment systems successfully practised with effluent from sugar cane processing, paper and pulp production, textile manufacture, distilleries and flour mills. The studies should also include laboratory analyses of effluents and other preliminary work necessary for optimum solutions;

(c) to recommend economical and organizational measures to industrialists to introduce and possibly adopt the system of cooperative treatment measures, similar to schemes well established in European countries and the U.S.A. since many years, in order to reduce the cost of construction and operation of waste water treatment plants. Also other possible means of financing and budgeting will be examined with a view to suggest the most feasible way to implementation.

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Annex 1

Questionnaire on Industrial Pollution Control

(drafted and used by UNIDO team, November 1970)

Kind of Industry: ______________________________

Please insert data of plant suggested for visit or of plant with effluent analyses available. If neither is applicable, please select factory/factories typical of respective industry branch (not more than 2)

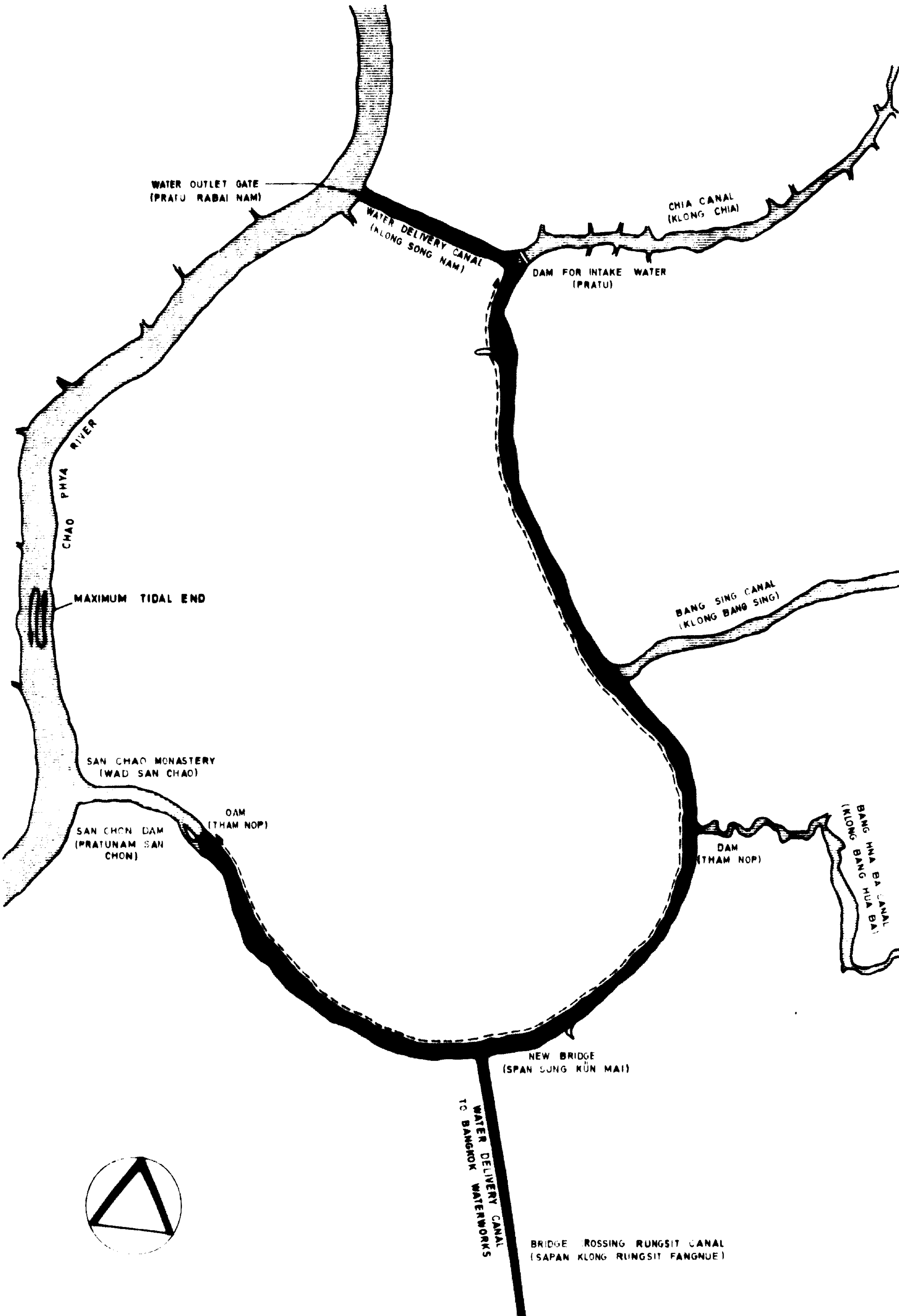
	(1)	(2)
Name of factory		
Analyses sheets and/or graphs available? (Please attach)		
Number of employees, total		
Kind of products		
Quantity of products (unit)		
Kind of raw materials		
Quantity of raw materials (unit)		
Chemicals and additives (kind & quantity		
By-products (kind & quantity)		
Water consumption (quantity & unit)		
Wastewater (quantity & unit)		
Including cooling water?		
Treatment plant existing?		
Receiving water		
Solid wastes problems?		
Air pollution problems?		

Remarks: ______________________________

Findings from visit: ______________________________

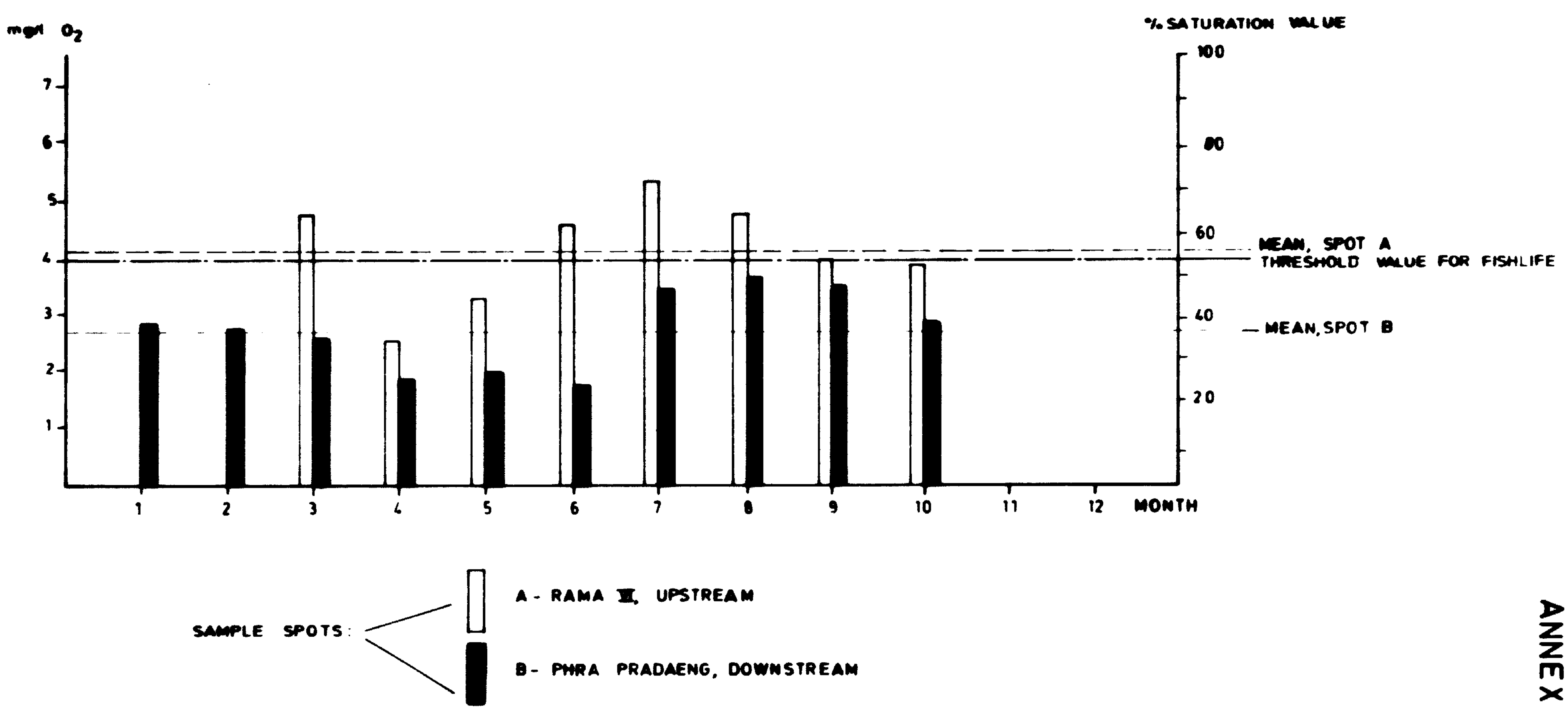
List of Annexes

ANNEX 2



WATER OUTLET GATE
(PRATU RABAI NAM)
WATER DELIVERY CANAL
(KLONG SONG NAM)
CHIA CANAL
(KLONG CHIA)
DAM FOR INTAKE WATER
(PRATU)
CHAO PHYA RIVER
MAXIMUM TIDAL END
BANG SING CANAL
(KLONG BANG SING)
SAN CHAO MONASTERY
(WAD SAN CHAO)
DAM
(THAM NOP)
SAN CHON DAM
(PRATUNAM SAN CHON)
BANG HNA BA CANAL
(KLONG BANG HUA BA)
DAM
(THAM NOP)
NEW BRIDGE
(SPAN SUNG KUN MAI)
WATER DELIVERY CANAL
TO BANGKOK WATERWORKS
BRIDGE CROSSING RUNGSIT CANAL
(SAPAN KLONG RUNGSIT FANGNUE)

OXYGEN VALUES, CHAO PHYA RIVER, AT BANGKOK, JAN.-OCT. 1970



Annex 4

Report on River and Klong Inspection

The Chao Phya River has been inspected by a boat which is specifically equipped for the taking and spot-analysing of river water samples, see photograph No. 1. The collection of samples is being practiced regularly from seven fixed points along a river stretch over 80 km upstream from the municipal area, through the Bangkok-Thonburi area and downstream from this area to the river mouth.

The taking of samples could be demonstrated only from two different points near two bridges connecting Bangkok and Thonburi.

The following values are measured on board:

temperature
conductivity
dissolved oxygen, D.O.

Another two samples are being collected for laboratory examination of:

nitrites
nitrates
phosphates
COD
chloride
ammonia
organic nitrogen
settleable solids
turbidity

The general hygienic status of the Chao Phya River over the section inspected is not very satisfactory. Large sections of the river banks are free to access and the consequence is that there can be found residential quarters, huts on piles, small commercial settlements of various kinds, trade and shipping yards as well as industrial establishments, many of them extending their premises and factories down to the river line. Hence it is not surprising that all kinds of domestic refuse, garbage and other liquid and solid wastes are usually being disposed or dumped into the river water. There is but little of control, prevention or prohibition of this practise. The visitor will therefore find many places with wastes or garbage (see photograph No. 2) floating down the river.

A multiple source of environmental pollution is implied by the numerous open canals (klongs). One place visited close by the Bangkok railway station showed floating sludge with formation of gas, indicating the digestion of organic pollutants settling on the bottom of the canal. Heaps of rubbish and refuse lie along the banks and concentrated effluents from the market-halls pour directly into the canal.

Annex 5(a)

<u>Sugar Mill</u>

The annual season for sugar production begins in December and ends in May. For this reason, as the visit took place prior to the season, the inspection of the sugar factory was mainly for information.

The factory visited, entitled Thai Roong Ruang Industry Co. Ltd. is situated on a river where over a section of 10 km the effluents of nine sugar factories are being discharged. The river seems to run on low water level during the sugar campagne.

The factory's wastewaters are diverted into so-called non-polluted effluents (mainly cooling waters) and polluting effluents. For the latter a wastewater treatment plant exists as follows (see paragraph No. 3) -

oil separator
collection basin of 810 m^3 capacity
2 aeration basins of 520 m^3 capacity for the biological treatment using air-diffusion
sludge-drying basin.

The effluents are led from the collection basin into the aeration basin and aerated for 12 hours.

The "non-polluted" cooling waters still carry a considerable amount of BOD. Therefore the following approximate figures given to the team seem to reflect the relation of the two components.

		non-polluted discharge	polluted discharge
quantity	m^3/day	100 000	150
additionally each 21st day			700
BOD_5	mg/l	100	2 000
BOD total discharge	kg/day	10 000	300
additionally each 21st day			1 700

This table of figures indicates that during a period of twenty days only 3 % of the total pollution are subjected to treatment, whereas on the twenty first day 15.5 % of pollution are treated. Further the efficiency of the system is affected as the biologically activated sludge looses its activity during cease of aeration, or otherwise is then passing over the outlet of the aeration basin. In this case the subsequent incoming charge will not find sufficient sludge concentration.

For an improvement of the system it would be helpful to reach a continuous biological treatment of the polluted discharge quantities. For an example, at an increase of daily polluted discharge up to 500 m^3 and at 2000 mg/l of BOD concentration the BOD load would count as follows:

$$\frac{2{,}000 \times 500}{520} = 1.9 \ \frac{\text{kg BOD}_5}{\text{m}^3 \text{ day}}$$

This would promise an 80 % degree of treatment efficiency.

Also some improvement of the structural arrangement seems advisable. The activated sludge should be collected in a special basin so to allow a proper circulation. The sanitary effluents of the employees could also be taken into the system.

Annex 5(b)

Paper Industry

The works visited, the Siam Kraft Paper Co. Ltd., employs 540 workers and produces 170 tons per day of wrapping paper from bagasse of sugar cane, wastepaper and unsorted chemical pulp. The bagasse is dissolved the same way as by using straw chemical pulp. The raw material is treated by sodium hydroxide and the boiler waste liquor used for recovery of the sodium hydroxide. Thus only 50 % of organic pollution are being discharged into the effluent.

The polluted effluents are collected first in a sedimentation basin which is equipped with sludge conveyors, and second in a lagoon. The lagoon gives rise to unaerobic digestion, and for the future it is intended to install aeration cones floating on the water surface.

The total discharge of 18 000 m^3 per day and 750 m^3 per hour is rather high. Unfortunately the analysis results from the effluent were not available. Therefore only a tentative picture was obtainable which seems to show that a considerable part of pollutants has been eliminated. The lagoon aeration planned will give even better results.

As to the solid wastes problem it is recommended to investigate whether the sludge can be retained and recovered for production.

Annex 5(c)

Treatment of Fishmeal Factory Effluent

During the stay of the UNIDO expert team a case of nuisance by wastes disposal of a fishmeal factory occurred. A report given to the team stated that the fishmeal factory in question produced a heavily polluted effluent and also that obnoxious odour arose. Although there was no opportunity of visiting the place, the urgency called for immediate action on behalf of the Ministry of Industry. So the team gave recommendations upon their experience, as follows.

For the purpose of the treatment, especially for the abatement of odour, the following procedure seems advisable, provided the local conditions would not be adverse.

(1) Sedimentation tank, allowing about 1 hour detention time, providing for sludge removal, scum and grease removal by a small draw-off. The brines should not enter this tank, but bypass it, with respect to their higher temperature (smell!).
The sludge collected in the hopper is drawn off regularly and dried on beds, possibly by adding calcium chlorine to prevent bad smell, and/or used as fertilizer.

(2) Chlorination contact basin, providing for a 1/2 hour contact time, containing also inside walls so as to lengthen the way of flow.

(3) Chlorine dosage store to provide the regular delivery of chlorine led into the contact basin inflow below the surface to achieve a full mixture and to avoid escape of chlorine into the atmosphere. The mixing ratio should be 80 to 100 g of chlorine per 1 m^3 of discharge.

An improvement of the effect can be reached by adding $FeCl_3$ combined with $Ca(OH)_2$, as per example

$$\begin{array}{llll} & 100\ g/m^3 & of & FeCl_3 \\ + & 2.5\ kg & of & Ca(OH)_2\ per\ m^3. \end{array}$$

Large quantities of sludge will have to be removed requiring filtration or incineration.

Milk-Powder Processing Factory

The factory visited produces different types of condensed milk from milk-powder, butterfat and sugar. The kind of wastewater originates mostly from the cleaning of containers and the workshops. The quantity of wastewater has been given at rather different rates; so in one case with a production of 150 000 tins per day a water consumption of 110 000 m^3 per 24 hours was given, with a rate of 25 m^3 per hour of polluted waste equaling 4 000 litres per 1 000 tins. In a second case the water consumption, at 130 000 tins per day has been given at 120 m^3 per 15 hours and polluted wastewater of 45 m^3 per 15 hours equaling 350 litres per 1 000 tins. The Pranakorn Milk Factory at Samrong District of Bangkok which was visited by the team, was established in 1966 and is scheduled to produce

sweetened condensed skimmed milk with butterfat and without butterfat,

non-sweetened evaporated milk.

The raw materials in the process are dry skimmed milk solids, butterfat, refined cane sugar and water. The milk solids and butterfat are imported.

The milk products are reconstituted from various proportions of the basic constituents. The process includes mainly the following steps:

(1) Dissolving and mixing
Two cylindrical tanks are used. Each has six cubic meter capacity with a propeller type mixer and a hoppered charging door on top of the tank.

(2) Regulation

A tank similar to the dissolving is used as buffer tank to regulate flow to the following stages. A mixing propeller keeps the fluid uniform.

(3) Pasteurizing

A standard pasteurizing unit is used to eliminate harmful bacteria micro organisms in the milk.

(4) Homogenizer

Piston type homogenizer breaks down butterfat globules to prevent subsequent oil separation.

(5) Holding tube

Steam-heated holding tube gradually increases the temperature of the milk mixture prior to evaporation in the vacuum pan to prevent thermal shock.

(6) Vacuum pan

Excess water in the mixture is removed by vacuum until the optimum moisture content is reached.

(7) Cooling plates

Water cooled radiator plates reduce the temperature of milk mixture down to room temperature.

(8) Holding tanks

Four holding tanks, each 30 m^3, keeps the product under a controlled condition ready for canning.

(9) Canning

An automatic canning machine is used for all types of product. The capacity is 250 cans/minute.

(10) Sterilizing

For evaporated milk which is not sweetened, additional sterilizing at 155^{o} C is applied to the canned milk to ensure sterility; the unit can sterilize 250 cans per minute.

(11) Cooling
Sterilized milk cans are cooled down to room temperature, ready for packing and storage. The capacity of the cooler is integral with the sterilizer.

The sources and characteristics of the wastewater are the floor cleansing, the periodic washing of the filters and occasional leakage from the canning machine. The main part of the wastewater is discharged by gravity to an oxidation ditch. According to a recent inspection by the Government laboratory, the effluent reaching the oxydation ditch showed the following values:

pH	6.7 to 7.0
temperature	35.9 to 38.1° C
BOD	132 to 542 mg/1; mean 250 mg/1

Nutrient Balance:
Ratio of BOD : N : P = 100 : 5.3 : 2.8

The ratio is suitable for treatment of this waste by the activated sludge process which generally requires a ratio of 100 : 5 : 1.

The oxydation ditch is constructed in the usual shape with half circle ends, holding 378 m^3 capacity. The oxygenation is achieved by a brush-type rotor which floats on a pair of pontoons close to the wastewater inflow. The rotor length is 4 m, with 10 cm immersion depth.

The ditch should be operated on a fill-and-draw basis, however, leakages did not allow this operation to be followed exactly. Consequently the rotor is in operation all the time.

As to the results of the wastewater treatment and its efficiency, the analysis of raw water and the corresponding waste samples are given below.

Production & Date	Samples	BOD	PO_4	NH_3 N	Org. N	ml/l Sett. Sol.	Susp. Solids
Sweetened milk April 15, 1970	Raw waste	542	6.30	0.46	29.20	nil	77
	Effl.	91	1.75	0.58	12.06	6.00	24
Unsweetened milk April, 1970	Raw waste	250	7.10	0.46	29.2	nil	55.3
	Effl.	29.5	60.3	9.95	2.10	3.50	28.0

Although the team did not have the opportunity to examine the efficiency of the plant, the quality of the outgoing effluent was not as convincing as should be expected. The report mentioned above also states that the quality of the effluent was inconsistent and unsatisfactory, despite the figure of 83 % of BOD removal. Also the production of active biological sludge in the ditch did not seem to be sufficient. This overall result about the efficiency of the system would call for a thorough investigation. Therefore only brief comments can be given for an improvement, such as -

- an additional sedimentation tank to collect the activated sludge for recirculation into the ditch,
- a sludge return facility, i.e. a sump with a sludge pump.

This system would then allow a continuous operation of the existing plant.

Another milk powder processing factory was visited where a full biological treatment plant of the effluent is in operation, This plant consists of

1 storage basin
1 aeration basin
1 secondary sedimentation tank with sludge
recirculation
sprinkler irrigation equipment.

No analyses results could be made available of the effluent. Only one grab sample indicated a rather high $KMnO_4$ value of 215 mg/l and a BOD of 200 mg/l, both of the secondary sedimentation tank. This of course would mean a rather high organic pollution carried by the effluent leaving the plant. Also here a careful investigation is necessary in order to improve the operation system.

Slaughterhouse (Abattoir)

The slaughterhouse of the city of Chiengmai has been examined on its industrial wastes disposal by a special investigation of the Ministry of Public Health laboratory. The slaughterhouse normally supplies the demand of pork and beaf of the city's population of 40 000.

According to the report the procedure is that all the slaughtering can be carried out by persons or groups of persons owning animals for slaughtering. The municipality is responsible only to keep the abattoir in a hygienic stage and provide the necessary facilities, such as water and electricity. A veterinarian is in charge of the slaughtering process and the inspection of the meat prior to distribution to the markets. Fresh meat sale is allowed only within each individual municipality area and it is against the law to carry meat over the town frontier for sale in the other districts, consequently, practically all of the provincial towns in Thailnd have their own abattoir. Most of the abattoirs situate within or just outside the municipality area, which is fairly close to the residential and commercial district.

Wastewater discharged from these abattoirs often create nuisance due to inadequate disposal measure. As for the abattoir at Chiengmai, the waste is discharged into small canals and fouls it up with solids deposition and obnoxious smell due to anaerobic decomposition.

During the examination period the number of kills were approx. 150 hogs per day and 20 cattles per day. The waste discharge was 0.37 m^3 per cattle and 0.28 m^3 per hog.

The wastewater discharge was measured separately from the hog and cattle slaughtering compartments. The recording was done hourly during a 12-hour operation period from either discharge. At the same time, i.e. at hourly intervals, a composite sample was taken from either outflow. The samples were transported to the Bangkok laboratory and analysed.

The analysis results are given in the following table together with the daily discharge.

Date of observation	animal killed hogs	cattle	total waste m^3	susp.sol. mg/1	BOD_{20}^{5} mg/1	COD mg/1	NH_3-N mg/1	Org-N mg/1	Population equivalents*
27/2/1970	149	-	29.94	767.0	1,540	2,580	61.00	110.31	6 + 1 = 7
	-	18	6.14	1,006.7	1,340	2,216	20.25	107.93	8.5 + 3 = 11.5
1/3/1970	112	-	19.45	1,608.0	1,000	1,991	76.43	125.00	3.3 + 2.5 = 7.8
	-	16	6.00	1,152.0	3,275	1,811	14.43	61.55	23 + 4 = 27
2/3/1970	111	-	15.15	1,542.0	1,830	2,743	64.38	115.31	16 + 19 = 35
	-	17	6.05	720.0	808	1,823	16.69	84.12	6 + 2.4 = 8.4

* These values have been calculated from basic equivalents of BOD and suspended solids internationally applied for comparison.

The discussion of the above figures, as given by the analysts's report can only be quoted without detailed comments because in comparing the investigation with slaughterhouse effluent from numerous examples elsewhere, the team found considerable discrepancies.

It seems that the survey shows rather small water consumption but a stronger concentration of wastewater. The average BOD_5 values of the discharges have been found at 1,415 mg/l for cattle and 1,042 mg/l for hogs. The total N concentration of the wastes was 195 mg/l for cattle and 88 mg/l for hogs.

The team have made the attempt to derive figures of population equivalents of the Chiengmai slaughterhouse effluent, with the results in the last column of the table above.

Annex 5(f)

Textile Industries

The firm of Petchasem Weaving Ltd. was visited by the team. Cloth is produced there from artificial fibre, and the main production processes are weaving, bleaching and dyeing. The daily production is 10 000 yards equal to 2.8 tons per day, with 24 hours production time and 30 working days per month.

The wastewater discharge has been 22 m^3/hour showing a significant alkaline reaction due to the consumption of chemicals.

The wastewater treatment is composed of

- a device for dosage of $Al_2(SO_4)_3$
- one storage and mixing basin with air diffusion
- one sedimentation basin.

Photograph No. 4 gives a view over this treatment plant.

The treatment is operated intermittently and mutually between the storage and the sedimentation basins. The chemical dosage is without an effective control, and the high alcalinity of the wastewater stored in the storage and mixing basin prevents a regular chemical treatment. The two basins operated mutually do not have devices for separate discharge of treated effluent and of sludge after sedimentation. The outlets are not properly watertight and therefore untreated wastewater continuously leaves the plant.

The sludge is being removed from the sedimentation basin and deposited in the fields nearby. It is intended to incinerate the sludge when sufficiently dewatered.

As a result it should be noted that the firm has endavoured to get the wastes problem under control. However, the treatment plant is not fully efficient to reduce the pollution of the effluent. Specifically spoken, the correct use of the method applied here would just result in reducing the alcalinity and not or only at a little extent reduce the organic pollution and the dye substances.

This should be considered as soon as the firm will have to comply with the effluent standards applicable for textile industry effluents. It is recommended to determine any standard values from representative daily samples by laboratory tests.

To summarize the findings of the visit, the following points should be noted for the improvement of the present wastewater treatment:

(a) To store and to equalize the factory effluents in a storage basin.

(b) To carry out laboratory tests with flocculants, preferrably iron salts, and with neutralizing agents for dosage into the outlet of the storage basin.

(c) To install a small flocculation basin which provides the oxydation of Fe-II-salts to Fe-III-salts at a detention time of 1/2 to 1 hour to allow the necessary formation of flocs; possibly the adding of coagulants may be advisable.

(d) To construct the sedimentation basin with sufficient capacity, equipped with facilities for daily sludge removal.

A further improvement of the purification effect would be possible by using biological treatment process. In this case the sanitary wastes from the factory would have to be included in the treatment system.

Abstract

The economic development in Thailand has caused problems of industrial effluents and trade waste disposal. The Government has therefore requested the United Nations Industrial Development Organization for assistance in order to study the problem and to give advice on improvement measures. Accordingly a programme has been made and a team of experts posted in the Bangkok area for a study period of one month.

In the first stage the local problems have been investigated by evaluating data existing at the Ministry of Industry and other authorities. The second stage has been the collection of information by visits of factories, laboratories and by other spot investigations. Also discussions with Ministry and other representatives have been held and chemical analyses of wastewater samples were carried out by the team.

The findings of the study have materialized in the drafting of standards for industrial effluents discharge relating to the most problematical branches of industry, and in recommendations on analysis practice. Regulations on industrial effluent discharge and its control have been designed emanating from the survey in conjunction with the team's own experience.

This report has been prepared in pursuance of the local and home studies by -

Dr. Günter Bachmann, Sanitary Engineer (Team Leader),
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The team wishes to acknowledge with thanks the manifold support received by the Thai authorities, the UN and UNIDO staff members.

Tanneries

The tanneries in Thailand are almost completely concentrated in Baingpoo Village, a place near the coast of the Gulf of Siam, altogether about 30 firms of various size but rather similar kind of production. The largest tannery, Chunwang Brothers Tannery R.O.P. has been visited.

The tanning agent mainly in use is chromium salt, however, some vegetable-synthetic tannings are also used. The wastewater discharges of all tanneries of the region are collected in an open canal and led over about 300 m into the Gulf. The discharges are heavily polluted both with mineral and organic as well as with dissolved and undissolved solids. The canal was carrying a discharge of approx. 100 m^3/hour. No further figures could be obtained concerning water consumption, production quantity, number of employees, etc.

The voluminous sludge and solid wastes usually arising from the tanning process is being dumped without control creating heavy nuisance. An impression of this may be seen from photograph No. 5.

The findings of the visit can be summarized as follows:

(a) The method of concentrating the tanneries and collecting their wastes is a simple means to solve the problem. However, due to the presence of chromium salts and other chemicals used in the tanning process, the biological degradation of organic matter is affected, leaving unchanged the organic substances which in themselves are difficult to be decomposed biologically anyhow. Therefore nuisance and damage in the environments of wastes discharge must be encountered, as for instance to fishery and with respect to spreading of anthrax.

(b) Chemical treatment of liquid wastes is therefore strongly recommended even with subsequent discharge into the open sea. This would result in the removal of substances detrimental to the natural self-purification process, and would reduce the organic pollution down to 70 % of C.O.D.

(c) The precondition for a reasonable purification effect is a well-working equalization of waste effluents that are fluctuating heavily in their contents.

(d) The best dosage by using neutralization and flocculation agents must be identified by tests.

(e) The discharge pipe should be extended into the open sea and not end at the strand.

(f) The sludge should be collected together with the solid wastes dipped elsewhere and both kinds of wastes should be disposed of without causing hygienic hazards, the best solution being by incineration.

Annex 5(h)

Chemical Industries

The chemical factory of Messrs. Hoechst at Thonburi was visited. This plant may at the same time stand for an increasing number of factories established by foreign countries with certain support and assistance by the Thai authorities. It is a policy to attract foreign capital for investment in the country.

At the Hoechst works there are two different factories, viz a pharmaceutical factory and a polyvynil chloride factory (PVC).

The one producing pharmaceuticals is being operated by processing and composing the basic products supplied from outside. Products supposed for the Thai market are tablets, pills, capsules, drops, syrup, toilet powder, spray and injection solutions. Some of the products are containing antibiotics.

The annual output is 8 million packing units. The production of injection solutions requires a very well treated water supply which is secured by an ion-exchange plant. The water consumption is 1 500 m^3 per month, the greater part of it being recirculated, desalinated and led over a cooling tower.

There is no treatment required of the effluent produced from this part of the work. The other part of the factory producing PVC is operating on one daily shift at a capacity of 100 tons per month, with a changeover to two-shift production in future. The final product is polyvynil-acetate dispersion which serves as a basic material for latex being a componente of glue and textile processing industries.

This part of the factory has a water consumption of 750 m^3 per month and the daily wastewater discharge is 5 to 8 m^3. The remainder is cooling water. The wastewater quality does not involve treatment problems because the main pollution components are particles from polymeres in a fine dispersion, and can be retained in a small sedimentation tank. The sanitary sewage of the factory from about 100 to 120 employees is collected in a septic tank which discharges its effluent through a sanitary sewer into a klong outside the factory area.

Annex 5(i)

Rice Mills

The factory of Messrs. Kamol Kijco Ltd. has been visited. It employs 160 people and is in operation for 24 hours per day. The rice delivered from the farmers is processed by milling and polishing.

The daily production of 110 tons is at 60% by use of water and the remainder by dry process. Under the watering process the rice is soaked for 24 hours and then after dewatering treated by steam and finally dried in the air. Subsequently the milling and polishing is done on dry conditions. The peels are used as boiler fuel for steam production.

The water consumption has been at around 450 m^3 per day equal to 4 m^3 per ton of rice.

The wastewater contains a great quantity of floating solids which should better be removed prior to disposal of the effluent. As to the dissolved solids, these are caused by the organic pollution. No BOD figures were available, however, with a relatively large open stream nearby it might be possible to discharge such effluent without substantial treatment. The place visited was near the Chao Phya River.

Much better discharge conditions would be at hand if a public sewerage system with a treatment plant was existing. In this case the only condition would be to avoid shock loads of the treatment plant.

Tapioca Mills

The tapioca mill visited by the team produces 43 tons per day of starch from 200 tons of tapioca root (manioc). The production is not dependent from seasonal growth. The mill works 24 hours per day and employs 200 people.

The roots are washed at first, producing about 30 m^3 per hour of wastewater which is directly discharged into the klong. After grinding the starch liquid is being extracted, leaving wastewaters with considerable quantities of undissolved matter, the latter being sieved, pressed and sold for fodder. The wastewater coming from the starch-liquid processing, about 30 m^3 per hour, is led into a series of sedimentation basins with a total capacity of 950 m^3. Thus the wastewater stays within the area for about 30 hours until it flows to the klong. It could be seen that the colouring in the basins was changing from white to red to black.

The sludge is removed from the basins from time to time for drying.

From the different kinds of wastewater no analysis results were available. However, it is a known fact that at least the discharge from the extraction of the fruit pulp and from the starch-liquid processing are heavily polluted by organic substances. With respect to the rather long detention period and the rapid decomposition tendency nuisance by bad smell is inevitable. Therefore a secondary treatment by irrigation or sprinkler distribution of the effluent is advisable.

Soap Factory

The firm visited was Nguan Huat Industry Co. Ltd. which produces soap, glycerin, margarine and tallow from coconut oil and animal fats.

The following data have been given to the team.

Employees	200	
Raw and auxiliary materials:		
coconut oil	20	tons per month
animal fats	80	tons per month
caustic soda	15	tons per month
sodium chloride	2	tons per month
hydrochloric acid	0.5	tons per month
activated carbon		
clay		
Production:		
soap	100	tons per month
glycerin (80%)	10	tons per month
margarine, tallow	50	tons per month

The wastewater produced of about 5 m^3/day mainly comes from the purification of oil and fat and from the soap production. The wastewater is treated by aluminium sulphate and lime. After passing a filter and after sedimentation the treated effluent is discharged to the klong.

The production of glycerin has the effect of eliminating organic and mineral pollutants from the wastewater. The first step is a chemical treatment by $FeCl_3$ of the lye. After separation of the glycerin the salt solution is being recirculated for the soap separation.

The treatment of the effluent is by gravel filter. The filters and their containers are clogged and the effluent is septic. Our provisional effluent analysis produced the following values:

pH	8.3
$KMnO_4$ consumption	540 mg/l
BOD_5	400 mg/l
conductivity	4.0 mS/cm 20° C

This would mean a heavily polluted effluent. However, due to the fact that chemical treatment would promise only a limited purification effect it is advisable to release the effluent in small doses after fat removal and neutralization, or to irrigate it in the ground.

Annex 6

Division of Physics & Engineering

November 12, 1970

Data of Analysis of Waste Water

Effluent from: -	pH	Alkalinity as $CaCO_3$ mg/1	B.O.D. mg/1	C.O.D. mg/1	T.S. mg/1	S = as H_2S mg/1
1. United Milk, Bangkok	7.2	-	190	-	992	-
2. Sugar Cane Factory	4.8	-	1,169	2,060	-	-
3. Coca-Cola	7.7	-	185	-	1,756	-
4. Pepsi-Cola	7.2	-	707	-	1,561	-
5. Union Industry Company	12.5	-	6,250	-	432	-
6. Tannery	7.5	-	850	-	1,380	-
7. Golden Cup Soap	6.0	-	3,400	-	9,656	-
8. Food Canning Factory	5.2	-	6,730	-	14,711	-
9. Paper Factory	7.1	350	552	-	796	1.6
10. Distillery	6.1	-	1,100	-	-	-
11. Textile Factory	8.65	-	2,970	-	8,372	-
12. Flour Mill Products	5.5	350 (acidity)	5,200	6,500	2,800 (SS)	-

Annex 7

Ministry of Industry

Working standards for effluent discharging to inland streams

B O D (5 days 20° C)	max	20 ppm
Suspended solids	max	30 ppm
Dissolved solids	max	2000 ppm
pH value	between 5 and 9	
Permanganate value	max	60 ppm
Sulphide (as H_2S)	max	1 ppm
Cyanide (as HCN)	max	0.2 ppm
Oils and grease	none	
Tar	none	
Formaldehyde	max	1 ppm
Phenols and creates	max	1 ppm
Free chlorine	max	1 ppm
Zinc, Chromium, Arsenic, Silver, Selenium, Lead, Nickel	individually or in total, max 1 pp	
Insecticides	none	
Radioactive materials	none	
Temperature	max	40° C
No disagreeable taste and odour		

Standard for sewage effluents discharging to inland streams of high dilution ratio

Volumes of dilution	Max. permitted suspendes solids
8 - 150	30
150 - 300	60
300 - 500	150

1. Purpose of Study

(a) Background and Description of Project

Following contacts between the Ministry of Industry of the Kingdom of Thailand, and the United Nations/UNDP Resident Representative in Bangkok, the United Nations Industrial Development Organization has approved of a project on industrial effluent and trade waste disposal in the Bangkok/Thonburi area.

The problem of industrial effluents and trade waste disposal in the Bangkok area is considered a most urgent one to be combatted under the requirements of public and environmental health. For this reason the Ministry of Industry has established a Working Committee on Treatment of Industrial Waste. This Committee has endeavoured to identify the extent and type of waste discharged by industry and to recommend remedial measures against increasing numbers and types of wastes disposal problems in a rapidly growing industrial economy.

The problem has been, and still is, so critical, that outside assistance was requested. A group of experts from UNIDO has therefore been posted to the Bangkok area and attached to the Ministry of Industry in order to -

(a) examine the problem caused by industrial effluent and trade waste disposal including the problems of water and air pollution;

(b) suggest technical standards for such effluents and trade discharges and draft effluent codes and control regulations;

Draft Standards on Industrial Effluents Discharge

With reference to paragraph 3(b), "Industrial Effluent Standards and Codes", the team have during their local studies and discussions with Ministry Agencies made the attempt to collect and evaluate data available in order to set standards on effluent quality. The guide-line of this part of their studies was to select those branches of industry causing difficulties with the treatment of their discharges. On the other hand those industries have been considered explicitly being of importance of the national economy of Thailand at present and in the near future. The sugar cane industry could not be studied in practise as the campaign was not on during the team's studies.

As already explained in paragraph 3(b) it would not seem wise to suggest standards and codes just and only by transferring standards and codes from developed countries with a well advanced status of environmental pollution control and ordinance acts.

Even though in most of the European countries there are standards in use in a flexible way over the regions of the country, because the local circumstances, the kind and quantity of production and the nature of the receiving water, or public sewerage network, would make it impossible to establish values not subject to correction and variation. As for a most recent example, Annex 8(b) shows the regulations introduced in the Federal Republic of Germany since 1970. The brochure containing these regulations together with a full-scale catalogue of industrial wastewater characteristics, has been prepared and edited jointly by representatives of the industries and of the pollution control authorities, and published by "Abwassertechnische Vereinigung", the German Association on Water Pollution Control. Annex 8(b) gives an extract of those industrial wastewater properties supposed for being collected and treated by public sewerage facilites.

Based on this fundamental condition, the following draft standards have been designed for future application in Thailand. The different nature of wastewaters therefore requires a different classification of standards according to the kind of treatment:

(1) primary treatment

(2) partly biological (secondary) treatment
The values apply only in case if a partly biological treatment would suffice.

(3) full biological treatment

In most cases special remarks are given on particulars of the respective wastewater.

Beschaffenheit und Inhaltsstoffe gewerblichen Abwassers vor der Einleitung in öffentliche Abwasseranlagen.

(Stand 1970) (Quality and contents of industrial effluents prior to discharge into public sewerage facilities.)

In der Regel sind als unbedenklich anzusehen

1. **Temperatur**	bis 35° C
2. **pH-Wert**	6,5—9,5
3. **Absetzbare Stoffe**	a) biologisch abbaubar: begrenzt durch 1.3 der Hinweise und Nr. 11 dieser Anlage. b) biologisch nicht abbaubar: 1,0 ml/l (Ausnahme s. Nr. 10 dieser Anlage). Dieser Wert bezieht sich auf eine Absetzzeit von 0,5 Std.
4. **Petrolätherextrahierbare Öle und Fette**	a) verseifbar: 100 mg/l b) nicht verseifbar: 20 mg/l
5. **Organische Lösungsmittel**	a) mit Wasser mischbar: nur nach spezieller Festlegung. b) mit Wasser nicht mischbar: maximal entsprechend ihrer Wasserlöslichkeit. c) halogeniert: dürfen nicht eingeleitet werden (in Sonderfällen ggf. nach Einschaltung von Sachverständigen möglich).
6. **Phenole** (berechnet als C_6H_5OH)	100 mg/l
7. **Sulfat** (SO_4)	400 mg/l In Einzelfällen können je nach Baustoff höhere Werte zugelassen werden.
8. **Cyanid** (CN) durch Chlor zerstörbar gemäß Deutsche Einheitsverfahren zur Wasser-, Abwasser- und Schlammuntersuchung)	1 mg/l
9. **Metalle** (gelöst und ungelöst)	a) Ges. Chrom (Cr) 4,0 mg/l b) Chromat (Cr) 0,5 mg/l c) Kupfer (Cu) 3,0 mg/l d) Nickel (Ni) 5,0 mg/l e) Zink (Zn) 5,0 mg/l Eine Überprüfung der Gesamt-Metallfracht im Zulauf zum Klärwerk nach 2.2 und 2.3 der Hinweise kann u. U. erforderlich sein.
10. **Eisen (Fe) und Aluminium (Al)**	keine Begrenzung, soweit klärtechnische Schwierigkeiten nicht zu erwarten sind.
11. **Feststoffe** (siehe Nr. 3)	Das Einleiten und Einbringen von Feststoffen, die durch Ablagerung in den Kanälen den Abfluß behindern können, ist nicht erlaubt. Hierzu gehören z. B. auch Schutt, Asche, Glas, Schlacke, Sand, Müll, Kunststoffe; ferner flüssige Abfälle und Stoffe, die im Kanalnetz erhärten, und Carbid, das zur Entwicklung von Acetylen führen kann.
12. **Gase**	Die Ableitung von Abwässern, die z. B. Kohlensäure, Schwefelwasserstoff, Schwefeldioxyd usw. in schädlichen Konzentrationen enthalten, ist verboten. Entsprechendes gilt z. B. bei Reaktionen von Säuren mit Sulfiden und Hypochloriten.
13. **Geruch**	Durch das Ableiten von gewerblichen Abwässern sollen an den Kanalschächten und in den Klärwerken keine belästigenden Gerüche auftreten.

Soap Factory Effluent

(1) Primary Treatment

(a)	settleable solids	0.3 ml/1
(b)	floating matter	not perceptible
(c)	pH value	6.0 - 8.5

(2) Partly Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	undissolved matter	20 mg/1
(c)	permanganate value (C.O.D.)	120 mg/1
(d)	BOD_5	80 mg/1

(3) Full Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	undissolved matter	20 mg/1
(c)	permanganate value (C.O.D.)	80 mg/1
(d)	BOD_5	25 mg/1

(4) Special Notice

(a) oils and grease might affect treatment process, removal necessary

(b) waste liquor must not be released in bulk

(c) mind high salinity

Breweries Effluent

(1) Primary Treatment

(a)	settleable solids	0.3 ml/1
(b)	floating matter	not perseptible

(2) Partly Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	undissolved matter	20 mg/1
(c)	permanganate value (C.O.D.)	150 mg/1
(d)	BOD_5	80 mg/1

(3) Full Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	undissolved matter	20 mg/1
(c)	permanganate value (C.O.D.)	80 mg/1
(d)	BOD_5	25 mg/1

(4) Special Notice

No discharge of yeast liquid.
Lye from bottle and barrel cleaning should be discharged continuously in small quantities.

Annex 8(e)

Textile Industries Effluent

With respect to wastewater discharge it is the practise to divide the textile industry into two groups. The first group comprehends those factories producing semi-products from raw material. The second group is factories processing woven goods for the final product, as for instance bleaching plants, dressing establishments, fabric print works etc. These kind of production process are producing numerous wastewaters of most different types, varying not only between factory and factory, but also within one factory, depending on kind and number of production processes. One characteristic of wastewater discharge at textile factories are shock concentrations occuring usually with worn out dye discharges or other wastes liquids. Therefore any standards applicable for textile industry effluents must be applied with flexibility.

For typical examples from the first group as above, the effluent quality standards of rayon and viscose factories are shown below.

(I) Basic Textile Industries, Rayon and Viscose Factories

(a)	settleable solids (higher values can be permitted if the value for undissolved solids is maintained)	0.3 ml/l
(b)	undissolved matter	30 mg/l
(c)	pH value (provided the acid combination capacity of the receiving water permits, pH values below 6.0 may be allowed in order to avoid additional salination)	6.0 to 8.0
(d)	permanganate value (C.O.D.)	100 mg/l

(e)	BOD_5 (as to (d) and (e) variations may be permitted in particular cases according to the requirements)	30	mg/1
(f)	sulphates: this standard of SO_4 content must be fixed after specific requirements of the factory and of the recipient water.		
(g)	hydrogen sulphide	2	mg/1
(h)	sulphides: This standard can only be fixed after the specific requirements of the factory and of the recipient water.		

(II) Textile Industries, Processing Factories

(1) Primary Treatment

(a)	settleable solids	0.3	ml/1
(b)	undissolved matter	30	mg/1
(c)	pH value	6.0 to 9.0	

(2) Chemical Treatment

(a)	settleable solids	0.3	ml/1
(b)	undissolved matter	30	mg/1
(c)	pH value	6.0 to 9.0	
(d)	permanganate value (C.O.D.)	200	mg/1
(e)	BOD_5	100	mg/1

(3) Biological Treatment

(a)	settleable solids	0.3	ml/1
(b)	undissloved matter	30	mg/1
(c)	permanganate value (C.O.D.)	100	mg/1
(d)	BOD_5	30	mg/1

(4) Special Notice

In practically all cases a neutralization will be required. Bleaching plants will deserve special attention for chlorine content in the discharge.

Annex 8(f)

Paper and Pulp Factories Effluent

With respect to the wastewater the production from the following raw materials must be distinguished:

(A) Paper and cardboard from chemical pulp

(B) Paper and cardboard from chemical pulp and wood pulp

(C) Paper and cardboard including mineral pigments

(D) Paper and cardboard with wastewater additives

(E) Paper and cardboard from chemically processed ragged clothes, wood, straw and synthetic materials (bagasses from sugar cane production would fall under this grouping)

Standards of effluent quality must be based on the respective type of raw material used, see corresponding letters A, B, C, D, E as above.

		A	B	C	D	E
(1) Primary Treatment						
(a) settleable solids	ml/l	(not practicable due to fibres)				
(b) undissolved matter	mg/l	30	40	40	50	100
(c) pH value		——— 5,5 to 9.0 ———				
(d) bleaching agent		not detectible				
(2) Chemical Treatment						
(a) settleable solids (higher values permitted if value of undissolved matter maintained)	ml/l	0.3	0.3	0.3	0.3	0.3
(b) undissolved matter	mg/l	20	25	30	40	50
(c) pH value		——— 6.5 to 9.0 ———				
(d) permanganate value (C.O.D.)	mg/l	150	300	400	400	400

(e)	BOD_5	mg/l	150	200	200	200	200
(f)	bleaching agent		not detectible				

(3) **Biological Treatment**

(a)	settleable solids (higher values permitted if value of undissolved matter maintained)	ml/l	0.3	0.3	0.3	0.3	0.3
(b)	undissolved matter	mg/l	20	20	20	-	30
(c)	permanganate value (C.O.D.)	mg/l	100	100	150	-	200
(d)	BOD_5	mg/l	25	25	25	-	40

(c) recommend adequate equipment for such effluent control and disposal combined with chemical testing facilities both for fixed laboratory and field testing;

(d) recommend measures for further action.

In the course of their local studies and inquiries the team found that the problems described before indeed call for urgent measures, both technical and administrative. Moreover they found, though in a rather quick review, the rapid industrial development even complicating the position of industrial wastes disposal at present and in the near future. The report prepared earlier this year by the UNIDO Field Adviser gives details and facts on these observations (quoted as (6) in the list of bibliography attached to this report). Also an article by Dr. Amnuay Virawan, Secretary-General of the Board of Investment, in an economic magazine (9) indicates more problems of environmental protection in the course of industrial promotion. Establishments of new industries as well as extension of existing works will require precautions and early action to avoid dangers and damages from environmental pollution.

It can also be shown that the total quantity of industrial pollution increases more rapidly compared with pollution by domestic wastes disposal. Furthermore the agglomeration of certain industries, due to the locality of their raw-material sources, aggravates the problem of wastes disposal - in particular of those industries situated along rivers and streams.

Tannerie<ins>s</ins> and Leather Factories Effluent

These wastewaters should be only separately treated if joint treatment with domestic effluent is not feasible.

This type of wastewater is characterized by frequent change of composition and quantity fluctuation. A fully effective purification is in many cases practically not possible.

Prior to chemical or biological treatment the equalization of quantities and concentrations is necessary. To obtain this several methods can be applied, depending on the particular case.

The first step will be to retain, by screens and sieves, solids of skin scraps and other residues which might affect the operation of pumps and other processes at the treatment plant. The solids retained may be treated by lime and used for fertilizer after composting.

(1) Primary Treatment

(a)	settleable solids	0.3 ml/l
(b)	undissolved matter (floating matter)	not perceptible

(2) Chemical Treatment

(a)	settleable solids	0.3 ml/l
(b)	pH value	7.0 - 8.5
(c)	permanganate value (C.O.D.)	
(d)	BOD_5	

Standards of (c) and (d) must be fixed upon the concentration of the wastewater after primary treatment. For a rough orientation a permanganate value (C.O.D.) of 400 mg/l and a BOD_5 of 200 mg/l may be quoted. These standards may be exceeded if a decrease of both values of 70 % has been achieved in comparison to the primary-treated effluent.

(e)	sulphides	below	2	mg/l
(f)	total chromium	below	2	mg/l
(g)	total iron	below	2	mg/l

(3) Biological Treatment

(a) settleable solids 0.3 ml/l

(b) permanganate value (C.O.D.)

(c) BOD_5

Standards for (b) and (c) must be fixed upon the concentration of the wastewater after primary treatment. For a rough orientation a permanganate value (C.O.D.) of 150 mg/l and a BOD_5 of 50 mg/l may be quoted. These standards may be exceeded if a decrease of both values of 95 % has been achieved in comparison to the primary-treated effluent.

Milk-Powder Processing Effluent

This kind of wastewater should be treated separately only if joint treatment with domestic effluents is not feasible. There are fluctuations in water consumption and consequently in concentration and quantity of wastewater effluent, depending on different and variable operation of the process.

A very suitable solution of the effluent problem can be reached by reuse of effluent in irrigation or sprinkling of agricultural parcels. This technique depends mainly on climatic and pedologic conditions, and special investigations should then be performed in advance. The standards given below are based on usual purification and disposal methods.

(1) Primary Treatment

(a)	settleable solids	0.3 ml/l
(b)	floating matter	none
(c)	pH value	6.0 to 8.5

(2) Partial Biological Treatment

(a)	settleable solids	0.3 ml/l
(b)	undissolved matter	20 mg/l
(c)	floating matter	none
(d)	permanganate value (C.O.D.)	120 mg/l
(e)	BOD_5	80 mg/l

(3) Full Biological Treatment

(a)	settleable solids	0.3 ml/l
(b)	undissolved matter	20 mg/l
(c)	floating matter	none
(d)	permanganate value (C.O.D.)	80 mg/l
(e)	BOD_5	25 mg/l

Slaughterhouses Effluent

This kind of effluent should be treated separately only if joint treatment with domestic effluents is not feasible.

(1) Primary Treatment

(a)	settleable solids	0.3 ml/1
(b)	floating matter	not perceptible

(2) Partly Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	floating matter	none
(c)	permanganate value (C.O.D.)	150 mg/1
(d)	BOD_5	80 mg/1

(3) Full Biological Treatment

(a)	settleable solids	0.3 ml/1
(b)	floating matter	none
(c)	permanganate value (C.O.D.)	100 mg/1
(d)	BOD_5	25 mg/1

Plating Industry Effluent

The properties of these effluents are changing according to the electro-plating process applied, and so do the methods for decontamination. From this point of view, three groups of plating technique have to be distinguished -

(1) cyanidic effluents
(2) acid metallic effluents
(3) chromic acid effluents

The treatment process mainly extends on the oxidation of cyanides, the reduction of chromates and eventually on the separation of the metal salts precipitated.

(a)	settleable solids	0.3	ml/l
(b)	pH value	6.5	to 9.0
(c)	metals, dissolved and undissolved		
	total chromium (Cr)	2	mg/l
	copper (Cu)	1	mg/l
	nickel (Ni)	3	mg/l
	zinc (Zn)	3	mg/l
	cadmium (Cd)	2	mg/l
	iron (Fe)	2	mg/l
(d)	cyanides (degradable by chlorine)	0.1	mg/l
(e)	free chlorine	0.5	mg/l
(f)	oil and fat (by aether-extraction)	10	mg/l

Draft Regulations on Industrial Effluent Discharge and Control

(I) Procedure

The control authority concerned issues the legal permission for the discharge of effluents with a validity of up to 20 years, however, revocable at any time. The application must be submitted formally, containing descriptions of the plant and its facilities, of the method of treatment proposed, and plans of the sewerage and wastewater network pertaining to the system. The permission shall distinguish the discharge of

- storm water
- cooling water
- sanitary wastewater
- industrial wastewater

The permission relates to a well-defined point of effluent discharge along an open water stream and imposes the items in the following paragraphs for observance. The values and regulations given below are drafted for the Bangkok-Thonburi region in general but may be subject to variations under specific local conditions.

(II) Quality Regulations

The discharge must not cause any nuisance in the river which might lead to damage on animals or plants living in water, or might affect the common use of the river water, the fishery and the use for water supply. The following values and quantities must be maintained

(a)	temperature	not exceeding	40° C
(b)	pH value	between	6.0 and 9.0
(c)	settleable solids in 2 hours	not exceeding	0.3 ml/l
(d)	floating solids		not visible

Further limiting values may be imposed according to the type of industry and its effluents. One of the normal values to be maintained with organic polluted effluent is -

(e)	biological oxygen demand in 5 days ($B.O.D._5$)	not exceeding	25 mg/l

For anorganic pollution the values are imposed according to the degree and the feasibility of appropriate treatment processes. As per example, the metal-processing industries effluents must not exceed the following values:

(f)	copper	1 mg/l
(g)	iron, chromium	2 mg/l
(h)	nickel, zinc, cadmium	3 mg/l

In case of pollutants fluctuating in concentration, their permissible total loads (per day, per month etc.) will be imposed.

Under special and difficult circumstances the possibility of adjusting the standard values should always be observed from the authorities concerned, viz both to increase and to decrease the figures according to the local conditions.

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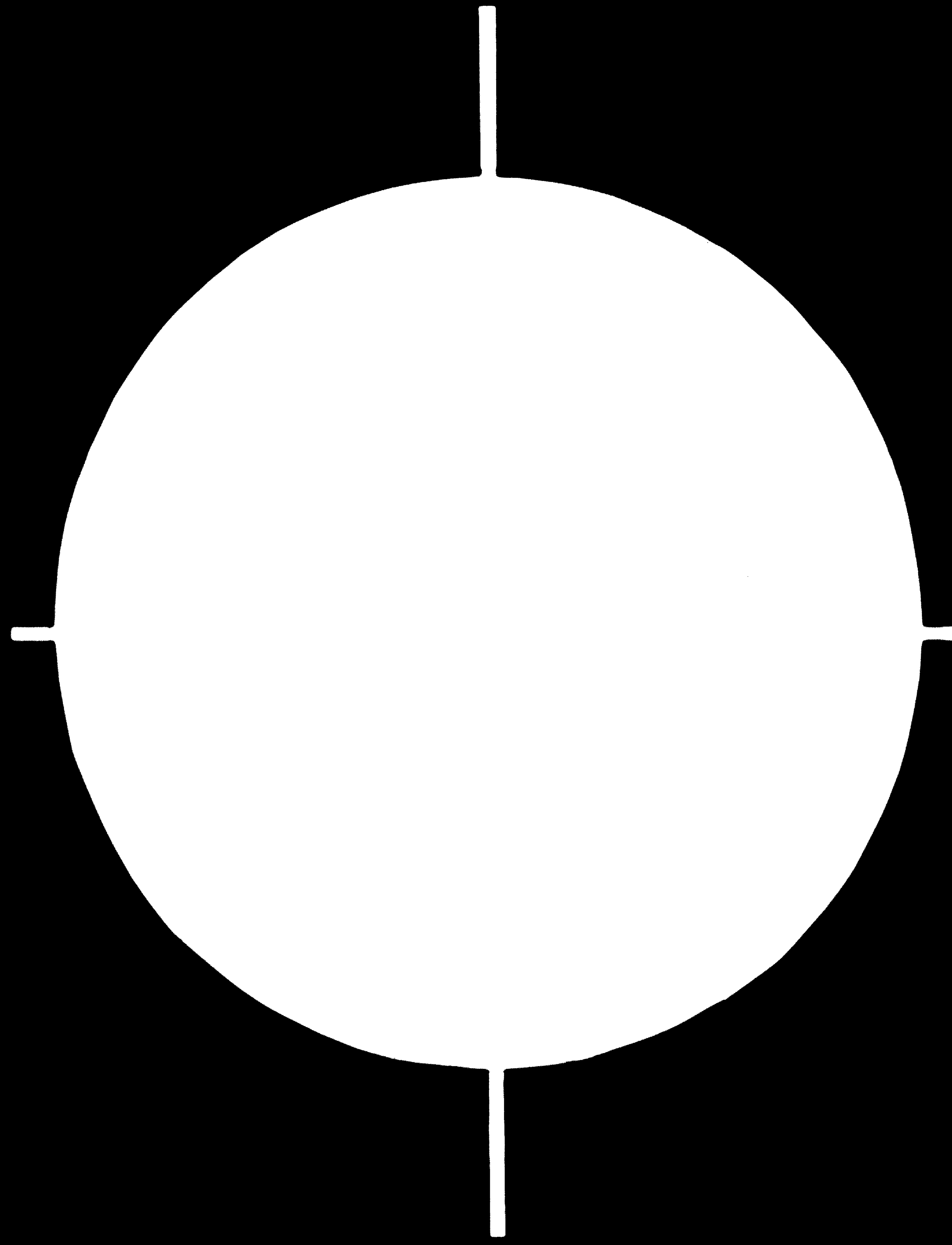

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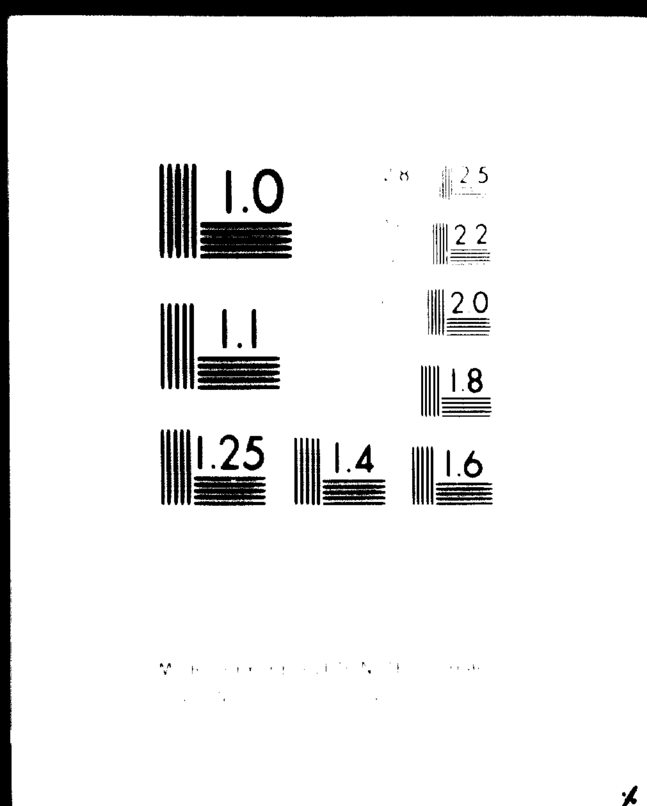

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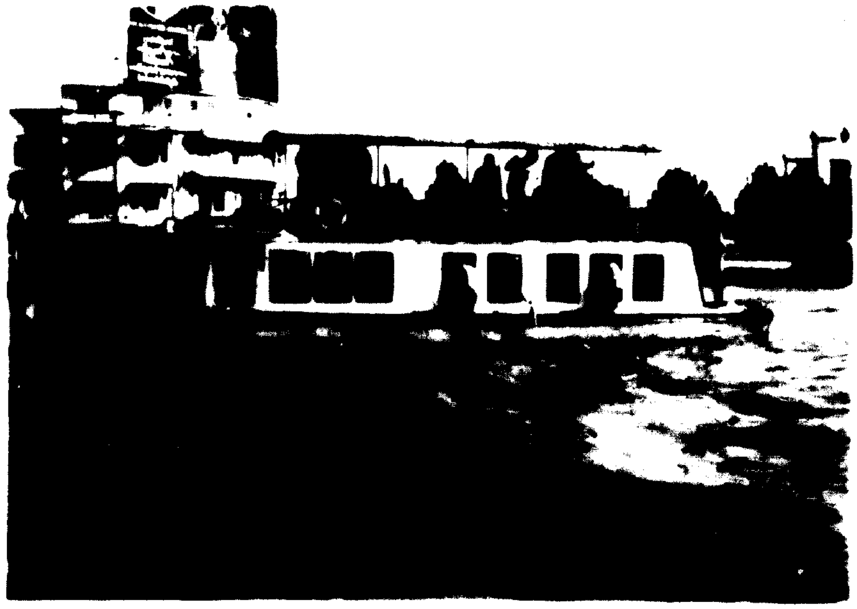
Annex 12

Rules and Regulations
for factory establishment and extension dealing
with waste water

For the purpose of the prevention of nuisance caused by water pollution discharged by industrial factories, the factories are obligated to perform the following duties.

1. Location and area of factory must be: -
   1) In suitable places for discharge of waste water or in the places allocated by the government.
   2) Enough area for waste water treatment or reservation.

2. Treatment process
   1) Suspended solids must be separated from waste.
   2) Sludge separated from waste water must be treated properly in order to avoid further nuisance.
   3) pH value and alkalinity must not be too high or too low.
   4) Any poisonous matter which may be dangerous to public health must not be discharged from the factory without proper treatment.
   5) Waste water treatment process must be shown by drawing together with the plant layout.
   6) Waste water must be treated properly, the method of treatment should be approved by government official.



Photograph No. 1:

Collection of Samples, Chao Phya River,
Bangkok 1970

Photograph No. 2:

Garbage and Wastes floating on the
Chao Phya River

Photograph No. 3:

Sugar Mill - aeration basin
(empty as no season)

Photograph No. 4:

Textile Industries -
storage and aeration basin

Photograph No. 5:

Tannery Wastes - sludge and solid wastes dumping

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(III) General Regulations

(1) The applicant planning to erect and to operate a plant must observe the general rules and standards of technology. The regulations on accident prevention and safety must also be followed.

(2) The applicant must comply with all remarks or corrigenda shown on the application documents after their examination by the authority concerned.

(3) Storm water, non-polluted cooling water and sanitary sewage must be collected separately from the industrial wastewaters, and discharged only after proper treatment.

(4) All changes within the factory involving changes of the wastewater conditions must be given on record to the authority concerned.

(5) Liquids on storage dangerous to the quality of open waters or groundwater must be stored in such a way that they can be collected in tanks or pools for reuse, or otherwise be discharged without causing damage or danger. They must by no means enter the public sewerage network.

(6) In case of wastewaters that may affect the purification of the other wastewaters in a factory, those liquids must be subject to pre-treatment on the spot in so far that the normal wastewater treatment measures will not be affected.

(7) For the period of time during which the above conditions have not been fulfilled, an annual contribution will be levied supposed for public pollution control purposes. Permanent efforts must be made to reduce the wastewater effluent quantities of the applicant's factory.

(8) Once the permission has expired the outlet facility must be abandoned.

(IV) Self Control by the Applicant

(9) All drainage and sewerage facilities must be controlled, maintained in proper conditions and operated permanently.

(10) The applicant has to nominate a representative of his staff who will be responsible for the correct operation of all facilities concerning the collection, treatment and orderly discharge of all wastewaters.

(11) The applicant has to conduct the following measurements continuously, e.g. by use of self-recording control device:

(a) wastewater quantity
(b) temperature
(c) pH value
(d) settleable solids
(e) turbidity
(f) odour threshold value
(g) any other simplyfied examinations typical of the respective effluent.
The measurements must be made daily/weekly from grab-samples/average samples and the

results taken on record. Also any other occurrences, breakdowns etc. must be noticed in the records book. An annual report on all measurements conducted will be submitted to the authority concerned.

(12) The effluent outlet must be placed at a point suitable, well accessible and always open to representatives of the authority concerned.

(v) Control by the Authority

(13) The effluent discharged from the applicant's factory must be analysed at least once per year, at his expense, by an expert or an institution authorized by the authority.

(VI) Solid Wastes

(14) Solid wastes must be disposed or discharged without causing damage or danger to open waters nor otherwise to the public.

(VII) Effects to other River-Water Users

(15) The effluent outlet and its maintenance must not affect the maintenance works along the open water, the river bed, the river banks nor the operations of naval traffic. Damages occurring from the effluent outlet must be repaired at the applicant's expenses.

(16) The outlet pipe or conduit must have a minimum

covering of 2.50 m at the point reaching the river banks.

(17) The applicant shall tolerate, without claim of indemnity, all measures of the authority concerned, caused by changes of the water course, the embankment, the water level or the water quality.

(18) As to the extraction and use of river water for water supply purposes, in particular for drinking water, any protective measures considered necessary by the authority concerned will be exerted by special procedure.

ANNEX 10

International Standards of Industrial Classification
I.S.I.C. No. ....

Type Industry
ประเภทอุตสาหกรรม ....

Lic. No.
ทะเบียนเลขที่ ....

รายการทั่วไป General Information

ชื่อโรงงาน Name of the Factory .... ชื่อเจ้าของ Name of the Owners .... ชื่อผู้จัดการ Name of the Director or Manager

จดทะเบียนเมื่อ Date of the License Issued .... เลิกกิจการเมื่อ Date of Termination of the Business ....

โรงงานตั้งอยู่ที่ Loc. of the Factory ซอย .... ถนน St./Rd. .... หมู่ที่ .... ตำบล Tambon .... อำเภอ Amper .... จังหวัด Province .... โทร Tel. ....

สำนักงานตั้งอยู่ที่ Loc. of Busin. Office ซอย .... ถนน St./Rd. .... หมู่ที่ .... ตำบล Tambon .... อำเภอ Amper .... จังหวัด Province .... โทร Tel. ....

เงินทุนจดทะเบียน Amount of Registered Investment .... เงินทุนดำเนินงานทั้งหมด Total Investment of the Business ....

ที่มาของทุน: Source of the Investment ....

....

หมายเหตุ: Note ....

คนงานและผู้ควบคุมการผลิต Workers and Production Controllers

ประเภทคนงาน Type of workers / ปี Year	2508	2509	2510	2511	2512	2513	2514	2515	2516	2517
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
จำนวนคนงานทั้งหมด Total Workers										
จำนวนคนงานชายทั้งหมด Males (Total)										
- ที่เป็นช่างฝีมือ Skilled Labors										
- ไม่ใช่ช่างฝีมือ Unskilled Labors										
จำนวนคนงานหญิงทั้งหมด Females (Total)										
- ที่เป็นช่างฝีมือ Skilled Labors										
- ไม่ใช่ช่างฝีมือ Unskilled Labors										
จำนวนคนงานเด็กทั้งหมด (อายุต่ำกว่า 18 ปี) Youngsters (under 18 years old)										
ผู้ชำนาญการจากต่างประเทศ Specialists from Foreign Countries										
ช่างเทคนิค และช่างฝีมือจากต่างประเทศ Technicians and Skilled Labors from Foreign Countries										

เครื่องจักร ต่างๆ ตาม ร.ง.5 Machinery According to the Application Form

ปี Year	ปี Year	ปี Year ....

ANNEX 10a

Raw Materials and Products

วัสดุดิบที่ใช้และวัสดุ

ปี Year	ชนิดและปริมาณของวัสดุดิบที่ใช้/ปี Name and Volume of Raw Materials used per Year	ชนิดและปริมาณของวัสดุสำเร็จ ที่ผลิตได้/ปี Name and Volume of Products per Year

Information of Change

วัน เดือน ปี Date	การเปลี่ยนแปลง Elements of Change	ชื่อโรงงาน Name of the Factory	เจ้าของ Name of Owner	ผู้จัดการ Name of Director or Manager	ที่ตั้งสำนักงาน Location of the Factory	เงินทุน Amount of Investment	อื่น ๆ Others (if any)

Factory Inspection Report on waste water discharge for factory applying for establishment, expansion and operation

1. Name of Factory ....

   Location: No ..... Soi (Lane) .... Street ....

   Precinct (Tambon) .... District(Amphur) ....

   Province(Changwat) .... Phone number ....

   Kind of Factory and its Product ....

2. Name of Licensee for operating the factory ....

   Residence: No ..... Soi(Lane) .... Street ....

   Tambon .... Amphur ....

   Changwat .... Phone number ....

3. Indicate existence in the surroundings of the factory:

   O Residential Buildings O Factories O Commercial Buildings

   O River O Canal O Public Sewer

   O Others ....

4. Raw Materials used:

   1) ....

   2) ....

   3) ....

5. Description of Production Process (briefly) ....

   ....

6. Volumes of waste water discharged:

   O Process water .... m^3/d .... m^3/hr

   O Wash Water .... m^3/d .... m^3/hr

   O Waste Waters from worker's quarters ......m^3/d .... m^3/hr

   O Other Waste Waters .... m^3/d .... m^3/hr

7. Nature of Waste Water:

O Acidity O Alkalinity

O Color O Odor

8. Draining of Waste Water:

8.1 Draining period

O ..... hr/d O ...... times/d

O 24 hours O ...... days of retention per period

8.2 Discharges into:

O Ditch O Canal

O River O Public Sewer

O No Discharges O Others

8.3 Distance from Factory site to

O Ditch O Canal

O River O Public Sewer (......... m)

8.4 Neighbouring Factories:

O Discharging Waste Water

O No Discharge

9. Process of Waste Treatment ....

....

....

O With sedimentation tanks capacity .... m^3.
number of tanks ....

O Without sedimentation tank

10. Availability of Space in the Factory Compound

O Available Area .... m^2

O Not available