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**ASSISTANCE IN POLLUTION CONTROL AND TREATMENT OF TANNERY
WASTES IN SELECTED AREAS OF CHINA**

US/CPR/92/120

PEOPLE'S REPUBLIC OF CHINA

Report of the evaluation mission*

Prepared in cooperation with
the Government of the Federal Republic of Germany and
the United Nations Industrial Development Organization

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EXPLANATORY NOTES

Unless otherwise indicated, the term "dollar" refers to the currency of the USA. The monetary unit of the People's Republic of China is the Yuan Renminbi (Y RMB). During the time of the mission, the United Nations operational rate of exchange was 1 US\$ = 8.28 Y RMB.

The following acronyms were used in this report:

BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (Ministry for Economic Cooperation and Development), Bonn, Germany
BOD	Biological Oxygen Demand
CLIA	China Light Industry Association
CLIC	China Light Industry Council
CLIRI	China Leather Industry Research Institute
COD	Chemical Oxygen Demand
CPC	Cleaner Production Centre
CTA	Chief Technical Adviser
EPA	Environment Protection Agency
ET	Effluent Treatment
ETP	Effluent Treatment Plant
NFLIR	National Fur and Leather Industry Research Institute
IRSI	Industrial Research and Service Institute
NPD	National Project Director
P.O.	Purchase Order
PR	Project Requisition
PPER	Project Performance Evaluation Report
R&D	Research and development
TOR	Terms of reference
TPR	Tripartite Review
UNDP	United Nations Development Programme
Y RMB	Yuan Renminbi

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The project was already relevant at the time of its approval and its relevance has increased with time. The approach taken by the project is correct as well as the choice and subsequent changes of project sites.

The project can be considered as reasonably efficient insofar as the effluent treatment plants in the three plants are working quite well and may be used for demonstration purposes. With regards to effluent dewatering, handling, final disposal and possible use of sludge, activities have started but the latter subject requires further attention.

The future of CLIRI is still pending. The plans for this Center drawn up by the project need revision. Deficits which influence the immediate and development objectives as well as the sustainability of the project refer to training of staff and dissemination of results to other plants, for which no concept is yet available. Both objectives as well as sustainability are within reach during the project's life.

The report further elaborates specific conclusions in respect of each of the four project sites.

The recommendations drawn up by the evaluation mission are addressed to the three project partners, that is the Chinese and German Governments and UNIDO. It is recommended to engage short-term expertise at the three plants to solve management problems with various aspects of waste minimization and ETP operation. A study is proposed to analyze the possibility for clean and cost-effective disposal of sludge.

Training and equipment for quality control laboratories in the three plants is recommended.

All ETP's do not meet the standards for ammonia nitrate. Either the legislation needs change or assistance to tanneries is needed in this respect.

Policy advice should be provided to the Government with respect to the legislation applicable to the disposal of tannery wastes.

A number of recommendations are made in respect of the dissemination of results achieved and yet to be achieved by the project.

Specific recommendations for each project site are made. The following should be particularly stressed:

- a) further major purchases for the Nanjing tannery should be conditional to the implementation of previous recommendations made under the project.
- b) activities in CLIRI should be centered on the planning and management of training, on information and on policy advice.

INTRODUCTION

1. The purpose of the mission is to undertake an in-depth evaluation of the project US/CPR/92/120, "Assistance in Pollution Control and Treatment of Tannery Wastes in Selected Areas of China"¹ as foreseen in the related project document. The field visit to all project sites, that is Beijing, Nanjing, Shanghai and Xian, took place between 2 and 14 November 1996.

The team was composed as follows:

- Mr. Georg von Koppenfels, Head of Division, Ministry of Economic Cooperation and Development, Federal Republic of Germany;
- Mr. O. Gonzalez-Hernandez, Head, Quality Assurance and Evaluation Branch, UNIDO;
- Mr. U. Frings, Technical Adviser

2. The mission had the opportunity to consult with the management and other staff of the three plants, particularly those concerned with effluent control and treatment, as well as with the authorities in Beijing involved in the management of the project. Thorough plant visits, particularly of the effluent treatment plants took place. The evaluation team was accompanied during the mission by:

Mrs. Zhang Shu Hua, National Project Director of the UNIDO project
Mr. Wang Zhenhe, Deputy National Project Director
Mrs. Song Xian Wen, Deputy National Project Director
Mr. Su Chaoying, Vice-Secretary General
China Leather Industry Association

3. The mission is especially grateful to the management of the three plants and of CLIRI for the information provided and the openness of the discussions which enabled the evaluation to be undertaken in the limited time available.

4. The list of key persons met by the mission is indicated in Annex 2.

¹ The terms of reference for the evaluation are contained in Annex 1.

L PROJECT CONCEPT AND DESIGN

A. Socio-economic and Institutional Context of the Project

The Economy

The economic reform process launched in 1979 has dramatically changed the economic and social landscape of China. Despite its incremental nature it has exceeded all initial expectations. There is widespread consensus among China's senior leaders about the necessity to deepen and broaden reforms to achieve the objective of creating a "Socialist Market Economy" by the turn of the century. This process has accelerated since 1992 to reach new areas, from banking and taxation to real estate and infrastructure. However, China still falls well short of having a full market economy, with adequate social protection including freedom of association for employees. Reform of state-owned industry, and the creation of a social security system to cope with its consequences, remain key challenges for the future. The establishment of an effective legal framework, properly enforced, is an essential element in the process.

Reform has changed the structure of China's economy beyond recognition. Collective, private and foreign-funded companies produce and sell well over half of China's industrial goods. Whilst over 80% of industrial output was subject to mandatory planning only ten years ago, the figure is now only 15%. The same is true for price controls, which affect less than 10% of retail sales at present. Public industry's share of total output has fallen from 77% to 44% over the same period and its share of retail sales to an even lower level. These figures clearly show a steady trend towards liberalization of the economy.

China's macroeconomic performance since the launching of reforms is remarkable. GNP growth rates reached around 9% during the 1980's, and 12-13% in the last three years, with industrial output and investment growing at over 20% for several years. China's total trade rose from \$US 20 billion to 237 billion between 1979 and 1994, growing twice as fast as output. Despite fluctuations, China's trade balance looks healthy and its foreign exchange reserves are big enough to cope with its substantial foreign debt.

But there is an accelerating inflation rate. The reasons for this are structural, due to an undeveloped monetary policy and expansive fiscal policy. Other important structural imbalances exist which could undermine future development. Traditional disparities between the coastal and inland areas are widening rapidly, leading to massive migrations, infrastructure bottlenecks and environmental degradation. The inevitable transfer of production from public industry to the private sector and the slowing down of the agriculture sector could lead to massive unemployment.

China has over the last years made enormous strides to liberalize its trade regime and open its economy to the world. Tariffs have come down, trading rights have been granted to firms on a wider basis, the dual exchange rate has been unified, foreign investment has been attracted on a large scale and the basic framework for an effective judicial structure to handle property rights has been established.

Although these measures represent important steps forward, they are clearly insufficient to make the Chinese trade system compatible with internationally accepted rules. The right to import and export goods in China remains largely a state monopoly. Customs duties are prohibitive, particularly for many consumer products (and are applied in an ad hoc manner). Non-tariff measures such as licences and quotas abound. Exports continue to enjoy numerous unfairly favourable conditions, foreign currency controls remain a major obstacle, and new technical barriers are introduced to frustrate imports. Transparency remains a big problem due to unpublished administrative rules and orders, and secret trade plans on some products.

China Leather Industry

The China Leather Industry is made of four main trades including leather-making, leather shoes, leather goods, furs and several matching trades consisting of leather chemical materials, mechanical equipment, shoe-making materials and hardware fittings. The industry commands 20,000 enterprises with 1.4 million workers.

China is very rich in leather resources, the annual output of pigskin occupies the first place in the world. Production in leather industry has expanded enormously in recent years. The annual output of leather is about 70 million pieces (converted into cattle hide). The annual output of leather shoes is 1 billion pairs. The quality and design of leather products has also gone up. Meanwhile, exports have been increasing rapidly. Nearly \$US 7 billion per year is being made from exports.

A full flourishing of the Chinese economy and a continuous enlargement of reform and opening up to the outside world provide a rather good environment to the further development of the Chinese leather industry. China is bound to enlarge international cooperation in this field and will make important contributions to the development of the world leather industry.

Pollution Problems Generated by Tanneries

Up to the present time, some 200 out of about 2,000 tanneries in China have already equipped or are equipping their factories with effluent treatment systems, but only very few of these operate in a satisfactory manner and meet national standards. Generally speaking, most of the effluents from the leather industry are discharged directly into rivers and lakes and municipal sewage systems without any treatment, resulting in serious pollution problems. Due to these problems, those tanneries which are located in densely populated urban areas are instructed by the Government to take appropriate action to move their factories to areas outside of cities, mainly to newly established industrial sites.

Besides the treatment of waste water, there is another major environmental problem which is still in need of a proper solution: the further handling, final disposal and possible utilisation of the tannery sludge resulting from the effluent treatment plants. The tanneries have adopted a wide range of temporary solutions, but none of them are really convincing. The Chinese Government is prevaricating on the development and introduction of binding standards, probably amongst other things because they know that a technically clean and

economically viable solution is not yet in sight and they do not know what conditions can reasonably be imposed on the tanning industry.

Relevance of UNIDO's involvement

UNIDO being the specialized agency of the United Nations system for industrial matters is particularly well poised to provide the assistance under evaluation. Pollution control and leather tanning are areas which have deserved particular attention from UNIDO. UNIDO being by definition a multilateral agency is able to tap on know-how from those countries that have it and is locked into one particular source. These facts add to the relevance of UNIDO providing the requested assistance. The technical solutions developed and still to be developed by the project (particularly for safe sludge disposal) will be of use not only in China but to other countries of the world where UNIDO is active in this field.

One of the factories assisted under the project (Xian) is owned by an industrial group which belongs to the Chinese People's Liberation Army. However, the factory produces overwhelmingly civilian final products and is operated according to normal corporate legislation and practice. The mission could not find use of military manpower and practices during the visit to the plant. It does not differ, apart from the ownership, from other public tanneries.

B. Project Document

The problem addressed by the project is obvious and is clearly defined in the project document.

The important question of legislation in China regarding effluents from the leather industry is dealt with in the project document but not in a comprehensive manner. The national standards indicated in the document are minimal standards but local authorities may issue stricter limits. There are no standards yet for the disposal of sludge - the main problem addressed by the project - but there are standards for chromium content in the use of sludge for agriculture.

There are also minor errors in the document, such as the indication of the Environmental Protection Research Institute (should be NEPA) which does not belong to the China National Council of Light Industry since it has ministerial ranking. The National Environmental Protection Agency (NEPA) is responsible for elaborating and finalizing the environmental legislation in China as well as for the supervision of the enforcement. At the provincial/municipal/prefectural and county levels, the Environmental Protection Bureaus (within NEPA) are responsible for the enforcement of the environmental legislation and its supervision.

The logic of the project is correct as well as the relation between the various elements. Quantified indicators are mentioned under "Expected end-of-project situation". Nevertheless, the way in which the immediate objective nr. 1 is expressed is rather modest since only the "identification of the priorities for a solution to the sludge..... problems" is mentioned, rather than the solution itself which remains the main objective of the project.

The national staff to be assigned to the project is mentioned in very general terms and no indication of national experts are mentioned although it was foreseen at the outset to employ them.

The project document was first prepared in 1991 and at the time of its approval - November 1993 - no major update was carried out, except to reduce the UNIDO budget to accommodate a lower availability of funds by the donor.

The function of the project was clearly institution (capacity) building, although this was not explicit in the document.

Although a work plan was to be prepared at the start of the project, this never took place. Lack of such a plan, as well as of a full or part-time CTA, influenced negatively the pursuing and maintaining of technical solutions advanced by the various international experts - all short-term.

Risks were mentioned in the project as small, which is an underestimation. In fact, some technical solutions need considerable research and trial and therefore failure or partial success - such as occurred with the solution for the disposal of sludge - should be possible and therefore foreseeable.

Although not explicitly stated, the project implies considerable dissemination of its results to the intended beneficiaries. The project document did not state a strategy and activities to this effect.

II PROJECT IMPLEMENTATION

A Delivery of inputs

The breakdown of the original budget and the latest situation (as of 31 October 1996) by main item of expenditure is provided below:

<i>Budget line</i>	<i>Description</i>	<i>in w/m and US\$</i>				<i>Uncommitted Balance</i>
		<u>Original budget</u>		<u>Later budget</u>		
11-01	CTA (Tannery pollution control)	8	96,000	1	17,473	-
11-02	Tannery effluent treatment	7	84,000	3.2	57,754	-
11-03	Tannery sludge handling	5	60,000	-	-	-
11-04	Effluent treatment equipment	4	48,000	1.5	15,251	-
11-05	Water treatment equipment	2	24,000	-	-	-
11-06	Laboratory control	5	60,000	-	-	-
11-07	Computer control systems	2	24,000	-	-	-
11-08	Hazardous waste technology	1	12,000	-	-	-
11-50	Short-term consultants	<u>5</u>	<u>60,000</u>	<u>13.5</u>	<u>191,063</u>	<u>74,394</u>
<u>11-98</u>	<u>International experts</u>	<u>39</u>	<u>468,000</u>	<u>18.2</u>	<u>281,541</u>	<u>74,394</u>
15-00	Project travel		10,000		21,792	6,757
16-00	Other personnel costs		12,000		40,735	9,450
17,99	National experts	-	-	99.0	120,400	36,891
21,99	Subcontracts	-	-	8.5*	137,750	0

31-00	<i>Individual fellowships</i>	216,444	152,608	0
32-00	<i>Study tours</i>	200,000	189,459	62,380
33-99	<i>In-service training</i>	-	40,250	22,786
41-99	<i>Expendable equipment</i>	30,000	40,000	38,340
42-99	<i>Non-expendable equipment</i>	1,078,739	1,059,004	405,945
59-99	<i>Miscellaneous</i>	<u>34,889</u>	<u>46,453</u>	<u>22,924</u>
	TOTAL	2,070,072	2,070,072	677,867

Difference in totals due to rounding.

* + 4.5 w/m at the home office

Expertise

There is a considerable change in the implementation of the expertise component in relation to the foreseen in the project document. The budget for individual expertise is reduced from \$US 468,000 to \$US 281,541. In work-months the reduction is even more considerable, from 39 to 18.2. Part of this reduction is attenuated by the inclusion of a new subcontracting component which covers the effluent treatment (ET) work which was to be originally undertaken by individual expertise. If we take the accumulated individual expertise and the consultancy work together, the drop is from \$468,000 to \$ 419,291 and from 39 w/m to 26.5 w/m for international field work.

The international expertise provided was in general of a high quality, particularly on ET under subcontract. One of the experts on low waste technology, although requested by the Chinese counterparts, was considered a bit too theoretical and did not offer enough practical solutions.

At the specific request of the Chinese project authorities, a considerable number of national experts were employed for long periods by the project to maximize the use of expertise existing in the country. Some of such experts and in the case of an international expert, double up as counterparts. The latter practice is normally not undertaken under UN or German bilateral assistance. However, in the project under review, this procedure had often a good cost/benefit ratio since the alternative would have been to recruit an international or national expert who would have needed more time to make himself/herself acquainted with local circumstances. This procedure can be continued provided the duties of such experts are clearly spelled out and involve the production of outputs which are clearly different from those expected from the same person as counterparts.

Training

A number of fellowships/study tours were undertaken to the U.S., Japan, U.K., Austria, Czech Republic and in China to Lhasa and Hong Kong.

The highest impact seems to have been the training course on "Low Waste Technology and Treatment of Tannery Wastes" at the Leather Technology Center in Northampton, U.K. The participants appreciated particularly the emphasis on cleaner technology, pre-treatment and separation of effluents as well as chemical recycling (to reduce BOD and COD). The materials provided were good and a translator into Chinese was provided by the Center which increased enormously the learning effect. The application of the know-how gained has been good but not complete since the course was based on fresh hides while in China mostly salted ones are used. Participants from various tanneries (not only from project sites) participated but technical personnel - for instance managers and other technical personnel of ETP's of project sites - could have participated in a larger number.

Another interesting study tour was to the site of a German bilateral leather project, in Lhasa, where the importance of good management - good housekeeping - was shown as the overriding principle to obtain less and cleaner effluents.

Other study tours, such as to the U.S., and Japan and Hong Kong, had less relevance to the project.

In order to ensure the maximum utilization of study tours and fellowships, the approach used by the German bilateral project in Lhasa to this effect is hereby noted. The project only finances the living expenses and course costs while the travel is covered by the counterpart organization. In this way the selection of participants done by the counterpart organization is more careful, since they have a financial stake in the course, and therefore then will naturally make the best use of the resources allocated to training.

A training course in Nanjing was organized in March 1996 and financed by the project under budget line 33 - In-service training. Participants from tanneries of 9 provinces were present. The course was conducted by national and international experts of the project. After the course a national consultant, Prof. Wu visited those tanneries to assist in the implementation of the measures explained at the course.

Equipment

The equipment provided and its status is listed in Annex 3. Part of the equipment is not yet delivered but already purchased or tendered. The project made every effort to convince the Chinese Counterparts to consider also national products in case it could meet the respective requirements. The utilisation of national products assures the availability

- of spare- and wear parts for local currency
- faster repair service
- less problems with guarantee and, last but not least, lowers the investment.

In **Da Chang tannery** most of the equipment is already installed and put into operation. Problems occurred with the installation and calibration of the WTW-Instruments (Oximeter and Air Flow Meters). The local WTW-service office in Shanghai was not used for the purchasing and therefore rejected to provide after-sales services. Not yet delivered is the equipment for the pilot plant which should be finalised as soon as possible.

In **Nanjing**, the equipment delivered is already installed except for the filter press and the sludge pumps not included in the production. This is particularly relevant for the sammying machine which was delivered already in August 95 but up to now has not been put to use. The sludge treatment facilities are installed but are not operated (because of less amount of production). Minor technical problems occurred with the sealing of one of the sludge pumps. Due to the actual situation of the tannery in terms of sales potential and financial means it seems doubtful whether the equipment will be fully used in production.

In **Xian** an automatic water supply system for the tannery was just delivered (October 96) but not yet installed. Water meters have been installed at all important points. The purchas-

ing and delivery of the remaining equipment is still under process and should be finalised as soon as possible.

In CLIRI Beijing a list of equipment was provided by the national office and tendering was already carried out by UNIDO. Due to the new governmental regulations prohibiting the operation of a pilot unit in the Area and due to the new Terms of References for the Center recommended by the mission, the list of equipment and chemicals has to be revised taking into consideration that:

- there is no need for any laboratory equipment for effluent treatment
- the requested computer may be purchased at the local market where license products of good quality are available
- the lists of chemicals should be revised due to the new tasks of CLIRI (execution of training courses only for laboratory staff)
- the list of laboratory equipment should be revised in order to avoid duplication of equipment in facilities elsewhere.

Anyhow, the purchasing of equipment should be postponed until the Terms of Reference of CLIRI are precisely formulated and finally agreed upon.

B. Implementation of activities

Some of the activities as listed in the project document were already finalised, some others require further attention.

The related activities to **output 1.1**, dealing with the handling of sludge and the operation of the ETP in Da Chang are almost completed as far as the "on-the-spot advice" and the "immediate assistance" are concerned. Still to be done is the final optimisation of the ETP, e.g. answering the question how the oversized ETP can operate on an economical level and the identification of a final solution for the chrome containing sludge.

The technical problems of the ETP have been analyzed and measures for improvement were undertaken as the reconstruction of the primary sedimentation tank, supply and installation of spare parts for the scraper, filter press and screening. In addition the whole system was revised and repaired, a monitoring system for the optimisation of operation (air flow meter, oxygen meter, continuously sampling devices) has been installed.

The activities related to the handling of the sludge problem are described under **output 2.2**.

The activities related to **output 1.2** deal with the setting-up of a pollution control laboratory, the training of counterpart in the laboratory and the installation of a small pilot unit for development and training work in the Da Chang tannery.

Because the new laboratory and pilot unit equipment is not yet delivered, neither the installation nor the operation of the pilot unit could be carried out. It seems difficult to do the latter within the limited time left. The reason why the training of staff which could have been done in other laboratories e.g. in CLIRI, was not carried out is unclear.

The actual laboratory work covers the daily waste water analyses which are filed but not used for monitoring or optimisation reasons. In addition, the results of the analysis do not inspire much confidence. There is almost no internal quality control in the laboratory. Standards and quality of chemicals and distilled water are not measured/checked regularly and sampling is not carried out exactly (e.g. sulphide oxidation ditches).

Output 2.1 deals with the setting of practical recommendations for the operation of ETPs. The activities concerned were almost completed. Still not been done is the elaboration of practical guidelines for the sampling and interpretation of the results. It must be pointed out that up to now no treatment plant achieves the standard for ammonia nitrate and there are also no recommendations made on how to achieve this standard in the future.

Pre-treatment measures as elimination of chromium and sulphide, reduction of organic matters and water are at least contributing if not essential for a proper functioning of a ETP. On the other hand they are also connected with waste minimisation. They are therefore compiled together with other activities in the field of waste minimisation under **output 3.1**.

Da Chang

The activities carried out are described under **output 1.1**

Nanjing

The whole ETP has been checked and necessary improvements were partly carried out (e.g. the construction of a new secondary sedimentation tank). Other recommendations related to proper collection of waste water, separation of sulphide containing flows, reconstruction of grid chamber and equalisation tank were not realised up to now. The laboratory is very poorly equipped, there is only one woman working on a time-contract base. Quality problems are at least in the same order as in Da Chang tannery.

Xian

The ETP in Xian works on a satisfactory basis. Problems occur in the solid waste removal and in the equalisation part. Although the laboratory results are, as in the other tanneries, not used for optimisation or controlling measures, the quality is obviously much better than there. Project's activities were concentrated on the redesign of the solid waste removal at the inlet, measures recommended to improve the equalisation tank, and specification of on-line monitoring equipment.

Output 2.2 includes the setting of practical recommendation for the handling of sludge. The activities concerned are carried out to some extent, but there is no compilation of results. It was difficult to determine the results of the expensive study tours carried out under activity 2.2.4 especially for dissemination purposes. Activities concerning the setting up of a legislation for the final disposal of toxic wastes and sludge resulting from tanning industry were not yet carried out.

Da Chang

In Da Chang, sludge dewatering was improved by improving the existing sludge filter presses. For the further utilisation two alternatives to the simple dumping were investigated and discussed with other factories as follows: incineration (too expensive, only transfer of the environmental problem from solid to gaseous states) and brick making (production of bad smell, large volumes of kiln required, finally rejected by the producer due to expected influences on product quality). As a temporary solution, layouts for a landfill site within the factory were prepared. Because the

current dumping on a municipal waste disposal site is not longer permitted by the local authorities and due to the absence of any other dumping site, the tannery is in urgent need for a final solution.

Nanjing

Sludge treatment, dewatering and storage were improved by the construction of a new sludge treatment building including a storage site and the supply and installation of new filter presses and sludge treatment facilities. The sludge is currently mixed with ash from the boiler house and sold to a tile factory which seems not to be a long lasting solution.

Xian

The existing sludge filter presses are under way to be replaced by stronger ones in order to improve the dewatering. The sludge was taken by farmers as fertiliser and for soil improvement. Due to a new regulation which prohibits tractors within town limits, the tannery is in need of a dumping side or any other solution.

Due to the unclear situation of CLIRI (former NIFLR) the activities carried out under **output 2.3** concentrated on the specification of equipment and chemicals and the support of one training course (training in cleaner technologies and effluent treatment plant in tannery) in Nanjing, March 1996. It is recommended to start project activities in CLIRI only after its institutional responsibilities and tasks are clearly defined.

Activities related to **output 3.1** include a set of different practical measures for waste minimisation carried out in the selected tanneries. It seems necessary to start with the compilation and interpretation of the results achieved so far. Otherwise the remaining time will be too short for the elaboration of recommendations and dissemination of results.

Da Chang

The whole waste water collection system has been reconstructed. Waste water is now separated into normal, chrome containing and sulphide flow. The sulphide oxidation system is on the way to be improved by the installation of a mechanised screen.

The chrome is recovered by precipitation with NaOH and dissolving with sulphuric acid. The project assisted in the re-design and implementation of the system and supplied some local equipment and spare parts.

Water consumption was reduced from 120 l per kg of hide down to 36 l per kg. Additionally reduction will be achieved when the installation of the aqua-mix system is completed.

Chrome utilisation is reduced by 1 % with better process and quality control. No additional savings exist on the use of the chrome recovered from the tannery liquor because it is sold to other tanneries. In case the chrome is recovered from the liquor (and the management of the plant plans to make it in the near future), then additional 40% of chrome will be recovered.

Spraying chemicals are reduced using new spraying cabins with controlled spraying area. At the same time the spray dust is filtered which reduces the discharge of spray chemicals into the atmosphere.

Chrome shavings have been reduced by 75%. This has been achieved by reducing the splitting tolerance from previously 2 mm down to 0.8 - 1 mm.

Nanjing

In Nanjing tannery main emphasis has been laid on the chrome recovery, the replacement of salted skins by fresh ones, and the mechanical dehairing of pig skins. However, the process is not running well and in case of debristeling it is not clear whether the damages created on the hides are more expensive than the reduction of sodium sulphide and the additional income generated.

Chrome recovery has been carried out by using NaOH. UNIDO experts introduced the use of MgO₂ due to the better quality of the chrome cake and the possibility of saving the filter press. Actually precipitation of chrome is done by using NaOH again. The cake is even after dewatering not very stiff but the quality is poor, impurities as hairs, lime, mud, flashing and other solids could be observed. It can't be reused in the tannery.

Dehairing of pigskins is done by using a bristle pulling process, thus saving chemicals for dehairing, reducing the COD and the concentration of sulphide in the waste water and generating an additional source of income by selling the bristles.

Processing of fresh skins was tested and introduced in order to save salt and to reduce chloride content in the effluent. However, the amount of fresh skins processed is small and varies with the output of the slaughterhouse. There is no reliable source of daily supply for certain amounts of fresh skins.

Xian

In Xian a chrome recycling system already existed prior to the project. Emphasis by the project was laid on recycling of lime water and reduction of process water.

The chrome recycling system installed in Xian works successfully with regard to the required quality of finished leather. Against the methods used in Da Chang and Nanjing, chrome containing waste water is directly reused after mechanical filtration, thus saving chemicals, energy and equipment. Currently about 70% of the chrome liquor is collected and some 85 to 95% is finally reused.

Water conservation was one major topic in Xian. The factory used around 130 l/kg of raw buff hide which is well above all standards (30 - 50 l/kg). In order to reduce water consumption water meters were installed and staff was trained. In addition a fine/bonus system was introduced. Part of the water is reused in other processes; recycling of treated effluent water is planned, storage and treatment tanks are already constructed.

A lot of efforts were undertaken to develop a process for direct recycling of lime/sulphide liquor. Tests on a trial scale have been successfully carried out. The introduction into a full-scale process is planned for the spring of 1997.

II C. Monitoring and Backstopping

Formal review meetings - in the model of UNDP's tripartite review meetings - were not conducted. Only one PPER was prepared. However, monitoring and backstopping of the project was faultless in terms of technical support and response. Frequent visits by the BSO to all project sites were undertaken. The project benefitted as well from an associate expert stationed in Vienna, paid under the project US/RAS/92/120, which provided administrative support to the project under evaluation.

II D. Other Related Technical Cooperation Projects

The following UNIDO projects have overlapping objectives with the project under evaluation:

US/RAS/92/120 - Assistance in Pollution Control in the Tannery Industry in South-East Asia
\$US 4,136,000 excluding support costs. As of 31 October 1996, \$827,651 had been spent, obligated or committed mostly for experts costs.

The programme addresses the issue of containment of environmental degradation emanating from the tanning industry in the Asian region. Under this "umbrella project", appropriate cleaner production methods, including recycling of chemicals and chrome recovery will be demonstrated, tested, selected and adopted. A relevant database network will be established, information widely disseminated and environmentally sound technologies introduced.

Full-fledged, industrial pilot effluent treatment plant (ETP), laboratory and demonstration facilities for safe sludge disposal will be installed. A comprehensive training programme including workshops, seminars, etc., with particular emphasis on technology transfer to small and medium-scale family units envisaged.

Additional expanded objectives, outputs and activities in respect of social aspects, i.e. occupational health, safety at work and ECO-labelling have been included, based on the interest of recipient countries as well as of donor countries for strengthening the efforts to improve these aspects. The ultimate aim is to improve work conditions and standards in the tanning industry in the countries participating in the regional programme, as well as to promote a voluntary scheme of process and product-based labelling for leather and leather products.

Participating countries: China, India, Indonesia, Nepal, Thailand.

Of particular interest to China are two components:

- Strategy for improvement of occupational safety and health standards at work in the tanning industry
- Women in development

In the other components Chinese authorities consider to be more developed than the other participating countries.

National experts to cover these components in China have been recruited but activities except for Da Chang have barely started. It is important to clearly delineate the relationship of the project with the one under evaluation and clarify this issue with the Chinese authorities who do seem to fully understand the links between the two projects.

National Cleaner Production Center

The purpose of the project is to achieve a critical mass of awareness, expertise and experience in the application of cleaner production in the industry, so that the dissemination and application of the concept can proceed on a sustainable basis. To achieve the purpose, the project will support the establishment and functioning of a Cleaner Production Centre in China through which the cleaner production concept and methodology will be disseminated in the industrial enterprises, focusing primarily on medium- and small-scale industry. Cleaner production case studies will be prepared, and at least partly implemented in a number of industrial enterprises and the findings and lessons learned will be exhibited in a manual. Managers, plant personnel, consulting engineers and Government officials will be trained in cleaner production practices and application. The project will also advise the Government on suitable tools for overcoming the constraints on the implementation of cleaner production and for stimulating its application.

Counterpart is the Institute of Environment Management of the Chinese Research Academy of Environmental Sciences.

Financing is provided under the interregional project US/INT/92/044 - **Project for National Cleaner Production Centers in Developing Countries** for 3 years, amounting to an external contribution of \$US 502,000 for the China Center.

The project is based on the so-called Prisma method, developed in the Netherlands, following US EPA pollution prevention approaches.

Cleaner production (or its equivalents: waste minimization or pollution prevention) is the avoidance or minimization of waste generation, waste-water and emissions into the air, in terms of volume and/or toxicity, through reduction at source or recycling on-site. The source reduction options are grouped into five prevention techniques: good housekeeping, the use of alternative raw and input material, alterations to production processes and on-site recycling and changes in product.

In the PRISMA method, the following four aims are central. First, to show that in industry prevention of waste and emission is possible in the short term and that it offers benefits both to companies and to the environment. Second, to test the usefulness and efficiency of a systematic approach in order to discover and implement possibilities for prevention in companies. Third, to take stock of obstacles to the introduction of prevention in companies and suggest ways to overcome those obstacles. Fourth, to formulate recommendations for an effective prevention policy.

The central part of the method is an experiment with 10 companies. Before starting the experiment, a method of analysing the flow of substances in and from a company is identified and

codified as a "Manual for Prevention of Waste and Emissions". Then, each company follows four-stage plan along the following lines:

* **planning and organization** - get management commitment, establish an assessment team, set overall assessment goals, overcome barriers and start a preliminary study;

* **assessment** - collect data and analyze substance flows, generate options to prevent pollution;

* **feasibility analysis** - conduct technical and financial analysis of the options and select solutions to be implemented;

* **implementation** - get commitment from decision-makers for the necessary adaptations and investments, application of preventive measures, evaluation of results and establish a continuous prevention programme.

In China the same methodology was followed. Of the 10 plants audited by the CPC two are in the leather sub-sector:

Beijing Tannery, Beijing
Yantai Leather Factory, Yantai, Shandong

It should be noted that the Beijing Tannery was abandoned as a site by the project under evaluation since its future was in doubt.

The evaluation could not ascertain any linkage between the CPC and the project under evaluation, although such a cooperation is desirable. In particular, the role of the CPC in the dissemination of the good practices established by the project being evaluated should be ascertained.

III PROJECT RESULTS AND ACHIEVEMENTS OF OBJECTIVES

A. Outputs

All in all six outputs (2 referring to immediate objective 1, two to immediate objective 2 and one to immediate objective 3) are described in the project document. Some of the outputs (2.1, 2.2 and 3.1) are formulated as “a set of practical recommendations for...”. It seems doubtful whether the existence of only a set of recommendations is sufficient to contribute to a sustainable project or development objective. For this, the demonstration of technical and economical feasible technologies and processes in order to transfer knowledge to other tanneries is essential. It seems that the project’s interpretation of the outputs should be and was more practical oriented, because otherwise no equipment would be needed.

1.1 Immediate and practical on-the-spot advice on urgent problems related to the operation and sludge handling at the Da Chang Tannery Common Effluent Treatment Plant. An action plan on measures that can be taken immediately will be prepared. The urgent fielding of a high level consultant with specific experience with common effluent treatment plants in 1993 is needed to evaluate the situation.

The output has been satisfactorily achieved. The ETP was rehabilitated and improved according to the technical advise provided. Daily operation is carried out up to the required standards without major difficulties. Regarding the sludge handling an provisional solution was introduced which includes the preparation of a temporary site within the factory. Further remarks to this subject are made in chapter III/D “Sustainability”.

1.2 A well equipped and fully operational specialised pollution control laboratory to perform all necessary analyses to control operation of the waste water treatment plant established at the Da Chang tannery complex near Shanghai, with a small pilot unit for carrying out practical development work in the field of tannery effluent treatment. Regular and strict control of key parameters in the effluent treatment plant will be carried out. The laboratory analysis and tests from the pilot plant will be utilised for full optimisation of the effluent treatment plant.

At the tannery there exists a fair equipped laboratory for wastewater analyses which carries out daily monitoring of the major key parameters of the ETP. Supply of additional equipment is under process (PR 95/008). No pilot unit equipment is ordered up to now. Currently the laboratory carries out monitoring only. The results are not used for optimisation of the plant (e.g. with regard to minimisation of chemical inputs and electric power consumption). Reasons for are to be seen in:

- the on-line monitoring instruments are installed but not operated
- lack of some equipment and the pilot unit
- lack of know-how and experience of the laboratory staff
- lack of management concern.

2.1 A set of practical recommendations for the technical and operational measures required to ensure the efficient operation of already existing, but not optimally functioning, tannery effluent treatment plants at selected industrial tanneries in different areas of China. Top priority will be given to the Da Chang Tannery common effluent treatment plant, and the expertise gained in the optimisation of the Da Chang plant will be utilised elsewhere in the country.

As far as the elaboration of recommendations at each selected site is concerned, the expected output has been met. What lacks is a compilation of those methods, recommendations and practical "what to do when" advice necessary for the dissemination of the experience gained. The output in this field is still limited to the translation of the laboratory manual which is also not complete (laboratory quality control, sampling, interpretation of results, standards and permitted variations are missing).

Talking in terms of practical measures carried out the project faces problems in Nanjing where only a part of the recommendations have been utilised and in Xian where a faster progress is hampered by the time consuming purchase procedure for equipment.

2.2 A set of practical recommendations for the efficient dewatering, further handling, final disposal and possible utilisation of the tannery sludge resulting from the tannery effluent treatment plants established at the selected tanneries involved with this project.

This output is only partly met. Currently the introduction of a sufficient dewatering technology is either completed or on the way to be completed. Any further handling is discussed and to some extent solved on a primarily basis for Da Chang only. Possible utilisation was checked during several visits abroad (during training) and to some extent in China too. For the final disposal and/or further utilisation no recommendations or solutions can still be offered.

One important part contributing to this output is the support of governmental authorities in setting up regulations for waste and sludge disposal. Without these regulations any recommendation requiring investment or expenses will not be seriously considered by the factories.

Da Chang

No recommendations for a possible further utilisation of the sludge exists. The same is valid for a final disposal. The dumping site used currently will be closed for tannery waste and other dumping sites do not exist. The dumping at the factory's site is possible for the next three years only. The cost for dumping (around 15 US\$/m³) seem high taking into account that no regulations exist regarding sludge disposal.

Nanjing

The current way of disposal will be possible as long as no environmental standards for tile factories exist. However, during uncontrolled heating of chrome sludge, three-valent chrome will be converted into high toxic six-valent chrome and released into the air. Consequently it cannot be considered as an acceptable solution.

Xian

The former way of selling the sludge and the solid waste from the grid to the farmers will be ruled out in future because of different reasons. Dumping sites do not exist at all.

2.3 An upgraded environmental protection section at the National Institute of Fur and Leather Industrial Research, NIFLR, in Beijing, well equipped to carry out applied research and experimental tests in the field of tannery effluent treatment technology and sludge handling and

further treatment, as well as in the monitoring of the environmental protection measures established for the leather industry in China.

No result could be achieved. Main reasons are:

- the output did not consider the actual and planned role of the NILFR which is not very clear at this time;
- the role of the NILFR (now CLIRI) in assisting the leather industry is not clear;
- The capability of CLIRI to assist the leather industry is assessed as weak. Know-how and practical experience seem sometimes to be higher in the factories themselves than in CLIRI;
- The planned pilot unit cannot be installed due to new governmental regulations. A Research Institute without research facilities is, on the other hand, senseless.

3.1 Specific recommendations on leather processing technology resulting in a significantly lower pollution load, actually adopted by the selected tanneries.

A set of different proposals dealing with a wide range of suitable measures for waste minimisation and reduction of inputs has been introduced and also partly practically demonstrated. The results are to some extent compiled and assessed with regard to their technical and economical feasibility. What is missing is the elaboration of reports and practical guidelines for the dissemination.

B. Achievements of the immediate objectives

In general the project performance can be divided into three levels, each containing a number of activities:

1. the practical introduction of technical and economic feasible solutions including the setting-up of monitoring facilities and the training of internal (project related) staff
2. the compilation and interpretation of results leading to a set of recommendations and guidelines
3. the dissemination of the results.

Level 3 is contributing to the development objective, whereas levels 1 and 2 are at the immediate objective level.

The overall status of the project is

level 1: a couple of possible technical solutions for the optimisation of ETPs and for waste minimisation were introduced and tested. The results achieved are in general positive, although some of the trials are suffering on delayed supply of materials and equipment. Monitoring equipment has been installed to a limited extend only. The activities carried out in training of internal staff to enable them to carry out proper operation, maintenance, monitoring and supervision are insufficient. Training was concentrated on the national administrative or management level if taking the study tours into account, and on one training course in Nanjing (March 1996) on which only middle and higher management

staff participated. In all of the tanneries visited, the ETPs are operated without firm monitoring. Analyses are carried out and filed because there is staff and there are orders to be followed. Typical answers of staff (even middle technical management) were “we don’t measure because we do not have problems with”, “water is clean because we buy it”, “we don’t need to measure because it can be calculated”. In case abnormal values appear they “inform the management”, or “the management will take it from the files”.

step 2: Compilation and interpretation of results have been done for some technical trials only. Missing are the critical review of those trials and the analysis of frame conditions (for which production, kind of leather, quality of leather, space of factory, etc.) these solutions can be applied to and what are the advantages and disadvantages.

step 3: will be discussed in chapter III/C: Contribution to the achievement of the development objectives.

1. Identification of the priorities for an immediate solution to the operational and sludge handling problem at the Da Chang Tannery Common Effluent Treatment Plant.

The priorities for an immediate solution to the operational problems of Da Chang ETP are identified and the ETP in terms of physical implementation also rehabilitated. For the sludge handling problem a temporarily solution was proposed, the implementation is not yet done.

2. Containment of environmental degradation emanating from three large tanneries in the selected areas of China, with particular emphasis on the efficient operation of waste water treatment plants to meet national standards for tannery waste water disposal

The effluent treatment plants meet, with the exception of Ammonia-Nitrate, the national and regional standards for waste water effluents from tanneries. They also provide technic and economic feasible examples for the use of tanneries of different sizes and production. The handling and disposal of sludge and other toxic waste is not yet solved. Part of the environmental degradation by waste water will be transferred to environmental degradation by improper disposal practice if this problem remains unsolved.

One bottleneck is the lack of governmental regulations for the disposal of sludge and other toxic waste derived from tanneries which hampers the application of proper disposal technologies by the factories.

Reduction of Environmental Pollution by Waste Water Treatment Plant (selected examples)

Item/Tannery	Da Chang	Nanjing	Xian	Total
COD (t/year))	10,700	1,100	1,800	13,600
SO ₂ (t/year)	95	34	8	137
Cr total (t/year)	24	13	17	54
Settleable Solids (t/year)	5,900	750	2,500	9,150
Sludge produced at the same time	6,000	600	600	7,200

3. Introduction of cleaner and environmental friendly technologies and a significant reduction in the amount of pollutants generated in the process of leather manufacture in the selected tanneries. The primary target will be the Da Chang Tannery Complex.

The environmental degradation caused by the three selected tanneries has been reduced not only by the improved effluent plants but also by the introduction of at least some possibilities of environment-friendly technologies. This is all the more important, as no transfer of waste (e.g. from water to sludge) with accompanying problems takes place.

Reduction of Environmental Pollution by adoption of Methods for Waste minimisation (selected examples)

Item/Tannery	Da Chang	Nanjing	Xian
Chrome recovery (t/year)	27	18	28
mechanical unhairing (t/year)	not executed	26 t COD per year	not executed
water reduction (t/year)	1,200,000	126,000	360,000
salt reduction (t/year)	not executed	500	not executed

C. Contribution to the achievement of the development objective

The development objective of the project is to assist the leather industry in China to expand without causing unnecessary degradation of the environment.

Since the start of the project pilot, systems for the treatment of tannery effluents, the reduction of toxic waste materials, the handling of chromium containing waste water, and the handling of tannery sludge have been established within the tanneries selected. All measures are suitable to be applied to other tanneries and except for the values of ammonia-nitrate they meet the national standards. They therefore can act as demonstration models. Apart from necessary minor adjustments and optimisation to be carried out during the remaining project time, the degree to which the development objective can be achieved will depend on how the results are disseminated and whether those pilot plants will be open for other tanneries (visiting, execution of training courses) in future too. For a successful transfer of technologies a dissemination concept, training documents, and professional expertise have to be first prepared.

D. Sustainability

The picture is differentiated on the question of sustainability of the direct project measures. The operation of the improved ETPs will continue providing a contribution to the environmental protection. The degree of contribution to the immediate objectives may be stable or even increase in factories like Da Chang and Xian where the management of the factory is

sensible towards these aspects and where sufficient financial means are available. In respect of the Nanjing tannery it is questionable whether this factory will survive the next five years. In case they will continue production the problems faced by the management of the factory make any sustained operation of the project measures (which today is not being done) questionable. The sustained operation of all measures is diminished by a poor or even non-existing monitoring and control and by insufficient trained staff. For the handling of sludge no sustained solution was developed till now.

From the external point of view, which means the compilation and dissemination of results in order to achieve contributions to the development objective, little has been done. Up to now there is no strategy that is: a concept for how to elaborate recommendations and training courses, how to spread information, where and by whom the training will be carried out and finally who has to pay for it in order to cover at least part of the expenditures and determine the subsidy needed.

IV. CONCLUSIONS

Relevance of the Project

The problems addressed the project at the time of its original design (1991) not only have remained actual but also increased in importance. These problems are:

- Effluents of tanneries discharged directly to rivers or municipality sewers;
- Low number of tanneries with ETPs;
- Low efficiency of the majority of such ETPs.

A particular and acute problem is the safe and long-term handling of sludge, as identified by the in-depth evaluation of the project - US/CPR/85/130, Assistance to the leather technology centre, Shanghai - in 1993 which became the "raison d'être" of the funding for the project under evaluation.

The above problems have increased in importance because the national legislation being developed is most likely to stiffen the limits of effluents. It is also likely that enforcement of such legislation will increase. Therefore, massive closure of tanneries may occur if these do not take measures at two levels:

- Waste minimization in the tanning processes;
- Installation of ETP's to ensure the meeting of standards.

The lack of training programmes to ensure a wide dissemination of principles and practices in waste minimization and ET has also increased in importance.

The government has therefore three options:

- The continuation of a liberal and lax policy in the setting and application of national legislation on effluents which would result in an increase of already high pollution levels;
- Enforce strict standards which would most probably result in massive closure of tanneries with huge social consequences;
- Enforce strict standards with accompanying demonstration facilities and training.

The obvious choice is the last one.

We understand that there are in China soft loans for the retrofitting of tanneries to meet stricter effluent standards. It seems the availability and conditions of financing is not the main problem but rather the applicable know-how and enforceable legislation.

The relevance of the project, in conclusion, remains indisputable.

Approach (strategy adopted by the project - institutional setting)

The original idea to choose three tanneries as pilot and demonstration centers to develop and disseminate good and applicable practices to solve the problems faced by the project is correct. The tanneries selected are, in principle, adequate. The need to substitute the Beijing with the Xian tannery is evident. The choosing of the Nanjing tannery may constitute in the medium-term a problem because of the financial situation of the company but we guess that this could not be ascertained at the time of the project design. The evaluation will say more on this point in the recommendations. It made sense to use the then Institute of Fur and Leather Research to have some kind of central pilot facilities for tanning and ET which meant the need to upgrade the then existing facilities. However, since the new local regulations prevent the operation of such facilities in the Beijing area and the fact that the basic tannery and ET pilot plant does not exist there any more, we feel that this approach has to be re-assessed. In the recommendations the evaluation will make propositions on future CLIRIs activities.

Production of Outputs - Efficiency

The effluent treatment plants work quite well and may function as demonstration plants for different scales of tannery. Monitoring laboratories are available and operated with varying accuracy at each project site. The laboratory work with respect to quality control needs further improvement and training. In addition guidelines for interpretation and consequences are necessary. The production of outputs is limited due to delayed purchasing of equipment (laboratory equipment for Da Chang, ETP-equipment for Xian).

Activities with regard to the efficient dewatering, further handling, final disposal and possible utilisation of the tannery sludge have been started. The problem of efficient dewatering is successfully shown in each factoryside. Although some activities, research and study tours have been carried out, the questions of further handling, final disposal and possible utilisation of sludge requires further attention.

Possibilities for the handling of toxic solid wastes from the tannery process have been investigated and to some extent also implemented. Emphasis was laid on the recovery of chrome, the reduction of water consumption, and sulphide.

The establishing of a training centre in Beijing is still pending. Due to the new governmental regulations and the fact that the former pilot plant no longer exists, some of the activities foreseen by the project (upgrading and further equipping of the pilot unit) are no longer possible.

Deficits which influence the achievement of immediate and development objectives as well as the question of sustainability refer to the dissemination of results and training of counterpart staff. Training and study tours were concentrated on high level counterparts including the upper management level of the factories involved. Special training courses for the staff related to the laboratory, ETP and waste minimisation processes did not take place. No concept for the dissemination of results to other tanneries was elaborated.

Achievement of Project Objective - Effectiveness

The technical solutions introduced in the field of ETP and waste minimisation contribute to the reduction of environmental degradation by the selected tanneries, although national standards are not completely met. The sludge problem is yet not solved. The proper disposal of sludge and other toxic waste is hampered by the non-existence of government regulations.

Achievement of Development Objective - Impact

The impact on the national leather industry is still very limited. Main reasons are:

- there is no concept for a dissemination strategy of the results obtained;
- the results achieved so far are not compiled and prepared in such a way that they might be useful for other tanneries too;
- participation of other tanneries in the courses organized under the project was limited.

Sustainability

Sustainability of the direct project measures within the tanneries depends to a high degree on the awareness and willingness of the management concerned and enforcement of legislation. In Da Chang and to some extent in Xian too, there is a great chance that the implemented measures will sustain, whereas in Nanjing it seems doubtful because of management reasons but also because of the financial and market potential situation of the factory.

The lack of training for the operational counterpart staff makes it difficult to keep the achieved high standards which will not be balanced by the extensive knowledge of high level national administration personal gained during international study tours.

There is no concept for the dissemination of experiences and know-how to other factories in China.

Specific conclusions for each project site

Shanghai

The ETP is well established and functioning, but oversized. An economical operation seems therefore difficult. The current cost are estimated at being around 1.17 US \$ per m³. From the point of investments and impacts on environmental protection partial utilisation of the plant is not economic. The leasing fee paid by the joint venture to the owner (170,000 US\$ per year) is not

sufficient to cover the depreciation (4,800,000 US\$ of investment). A sustainable operation seems difficult.

Measures for waste minimisation have been carried out successfully. Water utilisation was reduced from about 80 m³ to 36 m³ per ton of raw hide. Shavings were drastically reduced by optimisation of splitting.

In order to reduce sludge quantity, filter presses have been introduced. Because no final solution could be found a temporary solution planned to be implemented. The cost for dumping of sludge will be about 15 US\$/m³ which seems high compared with the non-existence of any legislative pressure.

The chrome recycling system works successful. The chrome sludge produced is not used within the factory yet, but sold to other tanneries.

Nanjing

The effluent treatment plant works successful with some limitations. The chrome recycling system is working. The sludge is mixed with ashes from the boiler house and sold to a brick factory (for colouring purposes). Its quality is poor.

The management of the factory seems to be unable to introduce and enforce the staff to new methods. Most of the suggestions made in 1994 by the experts are not be established yet. This is not only valid for cost intensive works but also for measures which could be introduced immediately on a low or even non-cost basis, but which require respective management power (e.g. vacuum dryer, operation of sammying machine, improvements in collection of chrome liquor, installation of screens). Due to the actual financial situation of the factory, its frustrated management, the location of the plant near the centre of the Nanjing city, a long term production seems doubtful. The more it seems that local authorities want to guarantee the existence only for the next five years.

Xian

The Xian factory is a good example of a strict and powerful management with long-term planning horizon and sufficient financial means for timely implementation.

The effluent treatment plant is a good example for factories with limited space. At the present stage of production and the present water consumption, it works quite effectively in terms of cost and water treatment.

The sludge handling is not clear. According to the local standards sludge may not sold as fertiliser; especially the waste removed from the grid can never meet any standard. The actual disposal (utilisation as fertilizer in rice production) is harmful and should be stopped immediately.

There are some doubts regarding the legality of this type of sludge disposal.

First positive results have been achieved in water saving. Remarkable is the fine/bonus system for water consumption in the production. The chromium recycling system functions satisfactory with regard to the required quality of finished leather. The efforts in finding their own way in waste minimisation are remarkable. This includes also efforts and investments for dust collection (buffing), filtering of boiler house exhausts and reduction of noise.

CLIRI

CLIRI carried out some training measures and inspections during 1995 and 1996. The Institute still suffers under a unclear formulation of its tasks, objectives and target groups.

V. RECOMMENDATIONS

General recommendations

The following recommendations apply to all the project partners, namely:

- the Chinese Government
 - UNIDO
 - and also, should the available/existing resources be insufficient, to the German Government
- The additional financial resources required for the implementation of some of the recommendations drawn up by the evaluation mission might be obtained from the following sources:

- utilization of the resources of the regional project
- exploration of Chinese cost-sharing arrangements for equipment and training
- additional German funds (multi- or bilateral).

We believe that the project still needs to engage short-term consultants/experts at the project sites: Da Chang, Xian and Nanjing to solve the management problems which concern waste minimization and the operation of the ETPs (specially its cost efficiency). An example of such activities is the good utilization of available labs, strong control within the individual production stages in the treatment of effluents, particularly under the objective - to avoid wastes and maximum recycling of tannery water and chemicals.

For the above tasks, we recommend engaging short-term consultants/experts who are already acquainted with the individual project sites and their local problems.

The New Zealand expert Mr. Kay Harre could take up the assignment in Da Chang, and the Sub-contractor Mr. Clonfero in Xian and in Nanjing. Mr. Clonfero should at any rate begin his assignment in Nanjing after the implementation of internal measures as recommended by the evaluation (which since 1994, were demanded/requested by the Performance Reports and particularly by the experts) have been completed.

The objective II of UNIDO-project foresees not only efficient sewage clearing up (which seems to have been achieved), but also the solution of the sludge problem. Until now this objective has not been achieved. With exception of the ETP in Nanjing, there is no answer/solution to clean disposal of chrome containing sludge. Even in Nanjing, the solution found is problematic and is only legal provided no standards for the sludge disposal are available.

With regard to the sludge handling it seems like that the "at the factory gate" solution is preferred. That means no responsibility is taken for the further handling of sludge outside the factory. In case any standard will be applied for solid waste disposal, the entire way of the present sludge handling will be obsolete. The aim of the project should be to offer clean and environmental acceptable solutions. Therefor further activities on a more general level should be considered.

We propose a study to achieve this objective by all means within the left over project period. The study should analyze in China the possibility for clean and cost-effective disposal of sludge. It should base itself on tests in Da Chang, Xian and Nanjing, derive three possible solutions and

clarify the costs for each solution. The study should finally give recommendations to the Chinese Government on legislative and administrative measures so that all 2,000 tanneries in the medium plan derive a solution for the safe disposal of sludge. The mission is of the firm opinion that a lasting solution to the sludge problems is vital to China, one of the largest leather manufacturing countries in the world.

For all laboratories, Quality Control (clean laboratory technology) is almost not existing. Training measures, laboratory inspection with recommendations for changing and further equipment is recommended.

All effluent treatment plants do not meet the standards for ammonia-nitrate. It should be checked whether either the legislation has to be changed in case the standards can not be achieved or whether the tanneries have to be supported to meet the standards.

Policy advice should be provided to the Government via CLIRI (or CLIA) with respect to the legislation applicable to the disposal of tannery wastes.

The document "Pollutants in tannery effluents; definitions and environmental impact" prepared by M. Bosnic, J. Buljan, and R.P. Daniels should be translated in Chinese and distributed. It provides an excellent overview on harmful contents, definitions and impacts and on methods of analysing. In addition a couple of national standards are attached.

National suppliers should be included in tendering in case the products meet the requirements. When purchasing foreign equipment the local after-sales services has to be assured.

Dissemination of results

Training courses should be developed for participants of other tanneries with different functions and levels:

Manager: waste minimisation, clean technologies, national standards and regulations, cost/benefit

Engineer: planning, design, operation criteria, chrome recycling, deliming, other technologies for waste minimisation

Laboratory staff: quality control, analysis, monitoring, evaluation

Operational staff: operation of plant, sampling, standards, immediate actions.

All training courses related to technologies and processes developed should be carried out at the tanneries site.

For the training of operational staff, special training courses should be elaborated and executed as soon as possible. Beside the practical operation, execution of analyses and sampling, main emphasis should be laid on "proper laboratory work" for which an international expert is required. The training courses should be carried out in one of the selected tanneries in order to

include practical exercises. The same course contents can be used for training of staff from other tanneries too.

All technological measures for waste minimisation and effluent treatment should be critically revised to assess their respective relevance for other tanneries and to identify the frame-conditions for functioning.

For the dissemination of the results to other tanneries a concept should be elaborated in which:

- the ways of dissemination (regular publishing of important results, training seminars on specific topics, dissemination via congresses, advice by national experts),
- the means (newspaper, pamphlets, videos),
- the organisation of work (establishing of a dissemination unit with clear tasks, budget, and objectives and expected outputs)
- the financing means (who will pay for what)

are described.

The tanneries taking part on those training courses should contribute to their cost.

Specific recommendations for each project site

Da Chang

The ETP should be analyzed due to possibilities for cost reduction taking into consideration that also in future only 50% of the ETP will be used.

Despite of the fact that currently no ideas about a final sludge handling exists, the temporary solution for the sludge disposal seems very costly. The system should be rediscussed in order to reduce cost and to create ideas for the long-term run. The system proposed makes only sense if the time won is used for the elaboration and establishment of a final solution.

With regard to the unused capacity of the Da Chang ETP the parties concerned should discuss the possibility of sharing the ETP with other factories in the surrounding areas.

The optimisation of the chrome recycling system with regard to power consumption (operation of the first filter press) should be checked.

Nanjing

The damaged sealing in the sludge pump provided under the project should be replaced.

Apart from the supply of minor items for the ETP (worth 10 - 15,000 US\$) any further activity in Nanjing should be bound to the following pre-conditions:

- the equipment delivered has to be installed, connected and included in the production process
- the recommendations elaborated by the different international experts in 1994 and 1995 should be transferred into action, especially the separation of waste water streams, the connection of all machinery to the respective drain, and the optimisation of the process flow.
- improvement of the chrome sludge
- introduction of a comprehensive monitoring system for the ETP on a regularly basis.

Xian

Additional expertise should be provided to discuss further activities and support to the factory in order to meet future standards. This can be taken as a good example how to adopt existing treatment plants to new regulations.

The factory should be used as model factory not only with respect to the physical measures implemented but also for the management awareness and the way how to put those measures in force.

CLIRI

As mentioned in the conclusions, the role of CLIRI in the context of the project, namely in the research and training in waste minimization and ET should be re-assessed. The evaluators feel that CLIRI should concentrate on a reduced number of activities where it should be the center of excellence in China. A too wide spread of activities will reduce its impact.

One of such activities is **Training**. CLIRI is uniquely poised to develop and manage the concepts for training needed by the Chinese leather industry, particularly in what concerns waste minimization and ET. For this, it should be attentive to the problems faced by the industry, their possible solutions, and identify the type and level and training materials. The latter should be developed in cooperation with those tanneries which have the necessary facilities in good working order where the actual training should take place. This would also facilitate the dissemination of the know-how acquired. The reason behind this recommendation is that any training of tannery staff in specialised fields of ET, the elaboration and adjustment of training processes and last but not least the adoption of process technologies aimed at waste minimization requires fully operational demonstration tanning and effluent treatment facilities which cannot be installed in Beijing because of cost and local regulations. One and only possible field of training activities in CLIRI's premises might be the training of laboratory staff in analyses methods.

Training organized by or in CLIRI should be paid, even if partially by the recipients. We feel that the increased enforcement of stiffened effluent limits will make recipients more interested in such courses. As a consequence, any related procurement of equipment for CLIRI under the project should be delayed until the targets of the Institution are clear and fixed.

The second group of activities for CLIRI is **Information**. The practice by CLIRI of collection, analysis and dissemination of information on technologies, trends, new experiences and any type of information of interest to tanners, should be continued and even strengthened. The activities and results achieved in the three project sites should be publicized using the periodicals of CLIRI. This should assist in the dissemination of the know-how developed under the project. The sending

and analysis of questionnaires to the intended users of such information should assist in better meeting their needs.

A good data-base would facilitate the third group of activities, namely **advise to the Government** on global trends of the sector and of legislative and standardization developments in the world (e.g., eco-labelling). In this way the Government will be better informed to take necessary supportive measures to the sector, incentives, needs for imports of inputs, education curricula and, in particular, because it concerns the project under evaluation, on national legislation on effluents from tanneries.

Policy advice

Policy advice should concentrate on the setting up of achievable standards which reflect the actual achievable technical level in China.

In order not to influence the free competition of industries on the market, standards should be the same nation-wide.

Beside the standards for tannery effluents, standards for disposal of solid waste from tanneries should be issued. They should include the technical conditions of landfill sites, the operation of landfills, the final preparation, and the maximum allowable contents for the toxic matters. It should also be decided on who has to operate these landfill sites.

CLIRI can collect all available data on the matters below, as means of disseminating information.

Wastewater

- existing standards (national and international)
- existing technical solutions in China including an evaluation of the equipment constructed in China
- elaboration of examples for wastewater treatment plants for different sizes of factories, various climatic conditions and different production.

Solid wastes

- existing standards (national and international)
- existing technical solutions in China including an evaluation of the equipment constructed in China
- existing international technical solutions
- elaboration of proposals for the construction, and operation of dumping sites including technical standards to be applied
- elaboration of a step-wise introduction of standards
- preparation of guidelines for the government

VI LESSONS LEARNED

Any re-utilisation of chemicals, liquids and other materials require a strict process and quality control to prevent negative impact on the final product. Success criteria is not whether it is explainable in terms of physical and chemical process reactions but whether the final product meets the requirements of the customer and the applicable legislation.

Process quality control process will be more essential when using used materials and when reducing the use of materials, water and chemicals.

Analyses in the laboratory are instruments for decision making. So the decisions to be undertaken should be clarified in this sense. Manuals with clear instructions on "what has to be done when what happens" are essential.

Waste minimisation and optimal operation of effluent treatment plants require a sound and consciousness management with the power to enforce even unpopular measures.

Effluent treatment requires the existence of standards, otherwise plants have no legal incentive to implement costly measures.

Optimisation of effluent plants as well as any measure to reduce waste production in tanneries requires an entire understanding of the processes concerned which may vary from tannery to tannery. Provision of on the spot advises requires therefore a comprehensive practical knowledge of the tannery process rather than academical knowledge.

New experts need time to become acquainted to the Chinese situation, the mentality and habits of people. In addition there is at least one opinion more than the number of experts you ask. However, a minimum presence of outside experts is needed to ensure application and maintaining of technical solutions. Counterparts may not have the incentives to do so.

Financial participation of the counterpart institutions and targeted end users in training (local and abroad) improves the selection of the participants and the application of the know-how gained. Training should be imparted in languages which are mastered by the participants.

The concept of "model factory" is often mentioned by UNIDO. This concept has to be clearly stated in the project document: the standards, laws, patterns etc. according to which the model is followed should be clearly spelled out.

ANNEX 1

TERMS OF REFERENCE

In-depth evaluation

US/CPR/92/120 -Assistance in pollution control and treatment of tannery wastes in selected areas of China

A. BACKGROUND

1. General

The main targets of this project are the optimization of the operations of several existing large-scale effluent treatment plants, introduction of selected cleaner processing methods and strengthening of the national R & D establishments dealing with pollution control. Specific, urgent attention will be given to the operation of the effluent treatment plant at the Da Chang Tannery Complex near Shanghai. Under the regional project US/RAS/92/120 "Assistance in Pollution Control in the Tanning Industry in South-East Asia", China will act as focal point for pig skin leather and, possibly, manufacture of by-products.

B. THE PROJECT

The subject project is financed through a trust-fund contribution from the Government of the Federal Republic of Germany at a total amount of US \$ 2,339,181.- , including 13 % support costs.

1. Problem Addressed:

Among the 200 effluent treatment plants, only 3% operate in a satisfactory manner meeting national discharge standards. The main problems are:

- i) Lack of technical information;
- ii) Shortage of technically qualified personal for design, operation and monitoring; and
- iii) Absence of the facilities for tannery effluent treatment and laboratory testing.

2. Immediate Objectives

The project immediate objectives are:

Immediate Objective 1

Identification of the priorities for an immediate solution to the operational and sludge handling problems at the Da Chang Tannery Common Effluent Treatment Plant

Immediate Objective 2

Containment of environmental degradation emanating from three large tanneries in the selected areas of China, with particular emphasis on the efficient operation of waste water treatment plants to meet national standards for tannery waste water disposal.

Immediate Objective 3

Introduction of cleaner and environment-friendly technologies and a significant reduction in the amount of pollutants generated in the process of leather manufacture in the selected tanneries. The primary target will be the Da-Chang Tannery complex.

3. OUTPUTS

Outputs as formulated in the project document:

1.1. Output 1

Immediate and practical on-the-spot advice on urgent problems related to the operation and sludge handling at the Da Chang Tannery Common Effluent Treatment Plant. An action plan on measures that can be taken immediately will be prepared. The urgent fielding of a high-level consultant with specific experience with common effluent treatment plants in 1993 is needed to evaluate the situation.

1.2. Output 2

A well equipped and fully operational specialized pollution control laboratory to perform all necessary analysis to control the operation of the waste water treatment plant established at the Da Chang tannery complex near Shanghai, with a small pilot unit for carrying out practical development work in the field of tannery effluent treatment. Regular and strict control of key parameters in the effluent treatment plant will be carried out. The laboratory analysis and tests from the pilot plant will be utilized for full optimization of the effluent treatment plant.

2.1. Output 1

A set of practical recommendations for the technical and operational measures required to ensure the efficient operation of already existing, but not optimally functioning, tannery effluent treatment plants at selected industrial tanneries in different areas of China. Top priority will be given to the Da Chang Tannery common effluent treatment plant, and the expertise gained in the optimization of the Da Chang plant will be utilized elsewhere in the country.

2.2. Output 2

A set of practical recommendations for the efficient dewatering, further handling, final disposal and possible utilization of the tannery sludge resulting from the tannery effluent treatment plants established at the selected tanneries involved with this project.

2.3. Output 3

An upgraded environmental protection section at the National Institute of Fur and Leather Industrial Research, NIFLR, in Beijing, well equipped to carry out applied research and experimental tests in the field of tannery effluent treatment technology and sludge handling and further treatment, as well as in the monitoring of the environmental protection measures established for the leather industry in China.

3.1. Output 1

Specific recommendations on leather processing technology resulting in a significantly lower pollution load, actually adopted by the selected tanneries.

4. New developments in the field since project approval

Liberalization of the Chinese economy has directly affected implementation of this project. When the project was designed about five years ago, the government authorities insisted that state owned tanneries were the main targets of technical assistance. In the meantime, some of these state owned tanneries find it very difficult to compete with tanneries in the private sector and will be closed rather soon. To ensure sustainability the project had to look for alternative sites and eventually the government authorities, somewhat reluctantly, have accepted that only those able to sustain project achievements upon project completion can be assisted.

5. Project sites selected:

1. Da Chang Tannery Complex, Shanghai
2. Nanjing Tannery, Nanjing
3. Xian Tannery (instead of the Beijing Tannery)
4. China Leather Industry Research Institute, CLIRI, Beijing

6. Project implementation:

- The project was approved in May 1992 and project operations commenced in January 1994;
- Provision of national and international experts;
- Provision of subcontractor component;
- Provision of training to local Chinese through fellowships and study tours;
- Provision of equipment; and
- Financial statement of project budget as of 31 December 1995 is attached as Annex II.

C. The in-depth evaluation mission

Scope, purpose and methods of the evaluation:

In accordance with the provisions of the policies and procedures for in-depth evaluations, the primary purpose of this in-depth evaluation are as follows:

Project concept, design and implementation

1. To assess the validity of the project concept and strategy.
 - 1.1. To assess:
 - Whether the problem the project is supposed to solve is clear and the approach used is sound;
 - Whether the beneficiaries and users of the project results are identified;
 - The objectives and outputs are explicitly stated, precisely and in terms that are verifiable; and
 - Whether the objectives, outputs, activities and inputs are clear, logical and commensurate, given the time and resources available.
2. The performance of project activities in order to determine whether the project objectives are being obtained or likely to be obtained.
3. To assess whether the outputs are being produced and how well they are being produced as well as their relevance and significance for the country.
4. To check on the results of the activities that have thus far been implemented comparing them to the work plan.
5. To check on the effectiveness of the technical approach used in producing those results and the main constraints which have affected the production of the results.
6. To check on the cost effectiveness of the project strategy.
7. To check on the performance of inputs.

As part of the above-mentioned tasks the evaluation team should especially:

- (i) Review the extent to which the equipment provided meets the needs of the project and whether they are being properly utilized;
- (ii) Review the arrangements for sub-contracts and the possible extent to which they are likely to provide the expected outputs and their cost effectiveness;

- (iii) Review the possibilities for better integration of the private sector into the project and examine the relevance of that approach;
- (iv) Assess to what degree achievements have been made to ensure that the selected enterprises can serve as a model demonstration plant;
- (v) Assess to what degree achievements have been made in the establishment of a Training Center for Tannery Environmental Protection which will be engaged in studies and training;
- (vi) Assess to what degree the pollution control laboratory is able to carry out proper control of tannery environmental pollution to develop improved treatment methods; and
- (vii) Assess the capacities and capabilities strengthened of the personnel in the Center and its linkages to the industry at large to ensure sustainability of the results produced under the project.

To identify internal factors which may or have influenced the projects' objective achievement or non-achievement. For example, factors could include project design, quality of expertise provided, adequacy of training, etc.

To identify external factors which may or have influenced the projects' objective achievement or non-achievement. For example, factors could include unexpected changes in government priorities, changed economic conditions, or new developments in technology.

The evaluation team should record any significant lessons that can be drawn from the experience of the project and its results, in particular anything that worked well and that can be applied to other projects and anything that worked badly and should be avoided in the future.

Composition of the mission

The evaluation team will be composed of the following:

- One representative of the Government of the Federal Republic of Germany (to be appointed by the German authorities);
- One representative from the Government of the Republic of China;
- One expert in effluent treatment; and
- One representative from UNIDO Evaluation Section.

These representatives should not have been directly involved in designing, appraisal and implementation of the project.

Timetable and report of the mission

The evaluation exercise will commence on -----.
The total duration duration will be three weeks. Mission itinerary is attached as Annex II.

In so far as required, the team will receive briefings at UNIDO Headquarters. Upon arrival in China for the evaluation exercise, the mission will be briefed by the Resident Representative of UNDP and /or UNIDO Country Director (UCD) who will provide the necessary substantive and administrative support. At the end of the mission there will be a meeting for discussion of the initial findings. A summary report containing the substance of their findings and recommendations will be presented by the mission at this meeting, as well as at their debriefing session at UNIDO HQ in Vienna.

The mission will conclude its findings with an evaluation report based on the guidelines indicated in UNIDO/DG/B.106.

Mission Itinerary**Timetable and reporting**

- | | | | |
|----|--|---|--|
| 1. | Pre-mission briefing
(UNIDO HQ) | - | Review of content of the TOR |
| | | - | Review of available documentation (project documents, PPERs, etc.) |
| | | - | Review of status of administrative matters |
| 2. | Field office briefings | - | Meeting at UNDP office with RR and concerned staff |
| | | - | Obtain all relevant documentation, including national plans, etc. |
| | | - | Discuss preliminary interview schedule with project staff, government officials and other relevant parties |
| 3. | Information gathering and compilation analysis | - | Review of project and related records etc. |
| | | - | Visit project sites |
| | | - | Interviews with selected people |
| | | - | Review project implementation experience |
| 4. | Preparation of summary sheet | - | Draft summary sheet |
| | | - | Review with UNDP |
| 5. | Debriefing in the field | - | Debriefing at UNDP followed by government officials |
| 6. | Debriefing at UNIDO | - | Debriefing at UNIDO Headquarters |
| 7. | Finalization of report - 3 days | - | Finalize report |
| | | - | Provide final evaluation report in 10 copies to UNIDO Headquarters |

LIST OF PERSONS MET

Staff accompanying the evaluation mission:

Mrs. Zhang Shu Hua, Vice-Director
Leather and Industrial Articles Office
China Council of Light Industry
Standing Deputy Chairman and Secretary General
China Leather Industry Association.
National Project Director of UNIDO project.

Mr. Wang Zhenhe, Deputy National Project Director.
Programme Officer, China National Council of Light Industry.

Mrs. Song Xian Wen, Deputy National Project Director.
Senior Engineer , Shanghai Leather Company.

Mr. Su Chaoying, Vice-Secretary General
China Leather Industry Association.

Shanghai

**Mr. Huo Jian Guo, General Manager
Shanghai Leather Corporation**

**Mr. Nigel W. Dobson, Director, General Manager
Shanghai Richina Leather Co. Ltd.**

**Mr. Lan You Min, Deputy General Manager
Shanghai Leather Corporation**

**Mr. Wen Zumou, Director, Deputy General Manager
Shanghai Richina Leather Co., Ltd.**

**Mr. Zhou Guo Hua, Director
Common Effluent Treatment Plant,
Shanghai Leather Corporation**

**Mr. Li Caigen, Manager, Effluent Treatment Department
Shanghai Richina Leather Co., Ltd.**

**Miss Li Qing, Technical Director
Effluent Treatment Section,
Shanghai Richina Leather Co., Ltd.**

**Miss Song Xian Wen, Vice- National Project Director
Shanghai Leather Corporation**

**Mr. Kay Harre, Manager of Production Department
Shanghai Richina Leather Co., Ltd.**

Nanjing

Mr. Yin Gong Guang, Director
Jiangsu Nanjing Tannery

Mr. Diao Li Qun, Vice-Head
Nanjing Municipal Second Light Industry Bureau

Mr. Zhou Chuan Hua, Director,
Nanjing Municipal Second Light Industry Bureau

Mr. Wu Hao Ding, Professor
East-South University

Mr. Zhang Jie, Chief of Effluent Treatment Plant
Nanjing Tannery

Mr. Xie Shiwei, Engineer
Effluent Treatment Plant
Nanjing Tannery

Mr. He Zhanzhu, Deputy Director
Nanjing Municipal Second Light Industry Bureau

Mr. Han Ren Chao, Secretary, Director,
Nanjing Municipal Second Light Industry Bureau
CPC Committee

Xian

**Mr. Hao Fengqi, Director, Xian Leather and Shoes Factory
China Xin Xing Corporation (Group)**

**Mr. Cao Huiquan, Engineer
China Xin Xing Corporation (Group)**

**Mr. Hui Shijie, Division Chief,
Xian Environment Protection Department**

**Mr. Gao Xiaozhong, General Engineer
Xian Leather and Shoes Factory
China Xin Xing Corporation (Group)**

**Mrs. Wang Xiaoli, Deputy Chief Engineer,
Xian Leather and Shoes Factory
China Xin Xing Corporation (Group)**

**Mr. Yang Jianjun, Section Chief
Effluent Treatment Plant
Xian Leather and Shoes Factory**

**Mrs. Sun Jing, Engineer
Xian Leather and Shoes Factory**

Beijing

Mrs. Shu Xiao Chun, Vice-President of the Leather Research Institute

Mr. Shong Xin, Vice-President of the Leather Research Institute

Mr. Gao Zhong Bai, Vice-Manager of the Training Centre

**Mrs. Qi Shu Xiang, Director, Foreign Liaison Department
China Leather Industry Information Centre**

UNIDO Office

Mr. N. Nygard, Programme Officer

Mr. L. Aumann, Junior Professional Officer

ANNEX 3

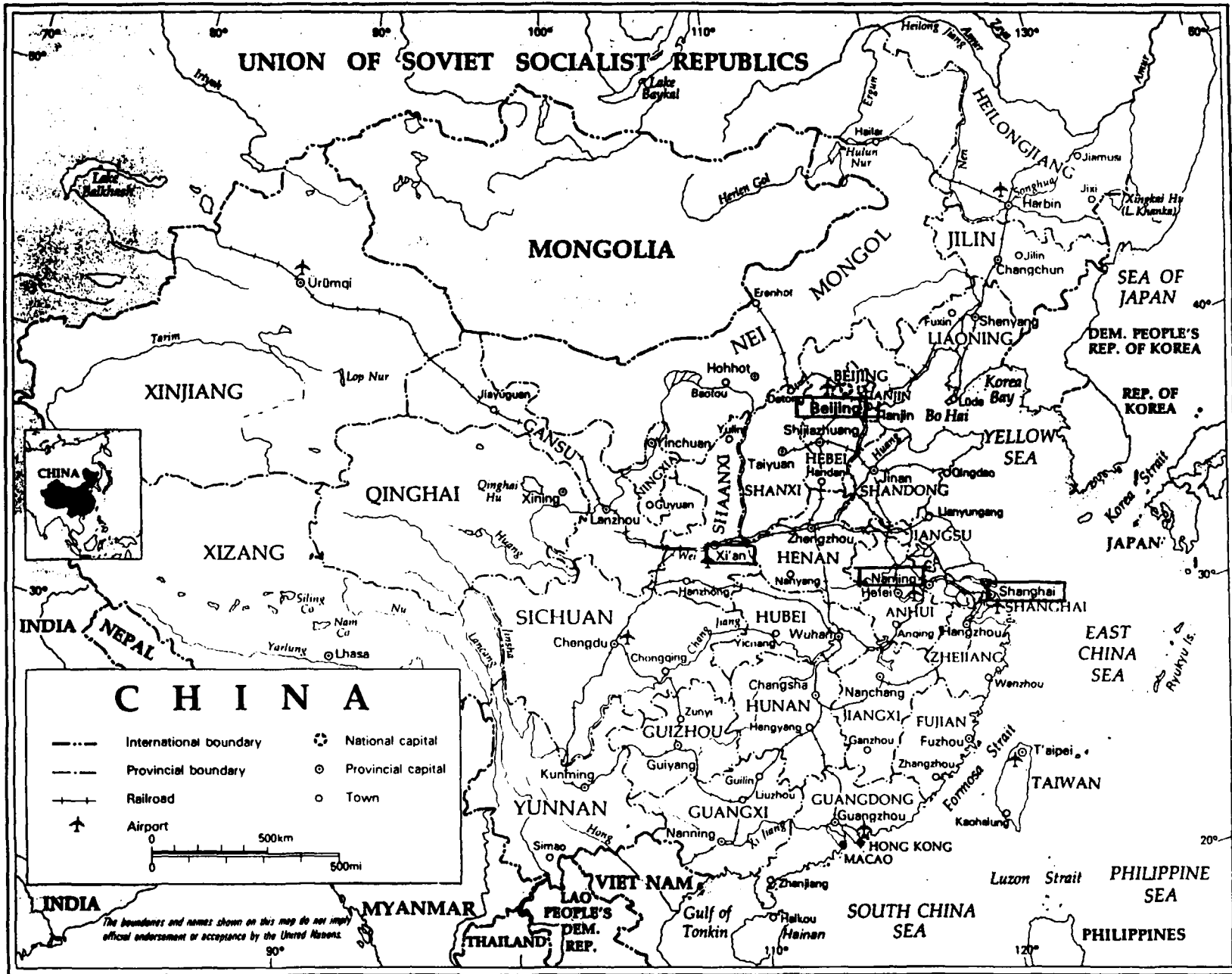
Equipment delivered

Location and condition of non-expendable equipment

Description	SUS equivalent	Received			Present condition	Present location
		Quantity	Month	Year		
Mixer for sludge, filter press	176,177	1 filter press 2 sludge pumps 1 mixing system	12	94	filter press operating, one sludge pump leaking, mixer system out of operation	Nanjing Tannery
Sammying machine	47,528	1	08	94	installed but not operational	Nanjing Tannery
Small equipment (laboratory material)	660	set	05	95	good	Nanjing Tannery
Monitoring and control equipment (oximeter, air flow meter, automatic sampler)	52,597	2 oximeter, 1 air flow meter, 2 sampler, auxiliary equipment	12	95	oximeter and air flow meter installed but not calibrated and operational	Da Chang Tannery
Wastewater equipment (submersible pumps, pressure pumps, finescreen, scraper, minor items)	158,838	div.	11	95	installed and operational, good	Da Chang Tannery
Spare parts for Hycor equipment	10,677	div.	11	95	installed, good	Da Chang Tannery
Spare parts for waste water treatment (spare parts for pumps, installations)	20,769	div.	11	95	all spare parts were installed, equipment is fully in operation, good	Da Chang Tannery
Spare parts for Netzch equipment (filter press)	13,154	div.	11	95	installed and operational, good	Da Chang Tannery
Spare parts for chrome recovery (sludge pumps, valves, membranes for filter press)	9,300	div.			installed, operational, good	Da Chang Tannery
Stand by pumps (pressure pumps)	23,000	2	12	95	good	Da Chang Tannery
Computer (1 desk, 1 portable)	8,680	2	12	95	working	Project Office
Automatic water supply (Aqua Mix)	52,000	set	10	96	not installed yet	Xian Leather and Shoe Factory

Equipment not yet delivered

PR#	Tannery	Description	Status	Estimated Cost \$US	Price \$US	Date of requisition	Mod/ P.O
95/008	Da Chang	laboratory equipment	under process	56,000			
96/003	Nanjing	process equipment for ETP	under process	90,000		July 1996	
96/004	Nanjing	on-line instrumentation for ETP	under process	11,000		July 1996	
96/005	Nanjing	portable instrumentation for ETP	under process	3,000		July 1996	
96/006	Nanjing	laboratory equipment for ETP	under process	2,000		July 1996	
96/007	Xian	automatic water supply	finalized		52,000	Oct. 1996	15-5-4365Z
96/008	Xian	process equipment for chrome recovery	under process	20,000			
96/009	Xian	process equipment for ETP	under process	200,000			
96/010	Xian	on-line instrumentation for ETP	under process	5,000			



ANNEX 4