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ASSISTANCE IN THE ESTABLISHMENT AND OPERATION OF A PILOT AND DEMONSTRATION PLANT FOR TANNERY EFFLUENTS TREATMENT, AT ESTANCIA VELHA, R.S.

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BRAZIL

Interim Report

Prepared for the Federal Government of Brazil and

Funding Donors - Republic of Italy by

The United Nations Industrial Development Organisation

Based on the work of David Winters,
Expert in the treatment of Tannery Effluents, C.T.A.

United Nations Industrial Development Organisation
Vienna

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ASSISTANCE IN THE ESTABLISHMENT AND OPERATION OF A PILOT AND DEMONSTRATION PLANT FOR TANNERY EFFLUENTS TREATMENT, AT ESTANCIA VELHA, R.S.

I. SUMMARY

This interim report briefly surveys the project's implementation and activities from its conception in November 1979 through the formal signature of the Project Document in October 1981 which paved the way for activities until March 1985, when the original funding was completely utilised. The donors, the Republic of Italy, have indicated their willingness to fund a further one year second phase of project activity, which is expected to commence May/June 1985.

The catalyst for this project was the publication of "norms", regarding tannery effluent discharges, promulgated by the Secretary of Health and Environment (DMA), State of Rio Grande do Sul (R.S.) dated March 14 1979. Such norms stipulated that all tanneries in the State should have primary effluent treatment plant operational by March 1981 and secondary (biological) treatment by March 1984. The tanners of the State felt uncertain as to which technologies would be suitable, accordingly the Government of Brazil requested assistance in this area from UNIDO. A UNIDO adviser felt the lack of knowledge in this field to be most marked and, in association with specialists at the Brazilian Tannery School (ETC), Estancia Velha, prepared a detailed project proposal for the pilot demonstration plant.

Following the generous agreement of the Government of the Republic of Italy to provide the necessary funding, the project proposal was able to be implemented by UNIDO with the Servico Nacional de Aprendizagem Industrial (SENAI), R.S. as counterparts.

For operational efficiency the day to day external expertise was effected via a team of Italian technicians, retained by UNIDO on a sub-contract basis, whose input was 18·5 man months (m/m) in the field. Overall co-ordination of the project was undertaken by the UNIDO Chief Technical Adviser (CTA). (The adviser who prepared the project

proposal), who was fielded for short periods every three months as well as providing continuous backstopping.

Four major outputs of the project have been :-

(i) The installation of the pilot demonstration plant, which includes a primary treatment system and four alternative biologic treatment units.

(ii) The expansion of the ETC's laboratories and equipment so that all relevant effluent and solid waste analysis and pilot plant control may be effected.

(iii) A national and regional centre of knowledge and expertise created to offer demonstration and extension services to both industry and governmental authorities.

(iv) A centre capable of training personnel at all levels in the introduction of better environmental processing, and the treatment of solid and liquid tannery wastes and the control of such processes.

The project has been able to achieve much progress towards the attainment of its immediate objectives :-

(i) The pilot demonstration plant, which handles 100 m^3/day from the ETC tannery, augmented by supplies drawn from a nearby commercial tannery (Messrs Leuck Mattes) has been well proven.

The primary treatment unit (physico-chemical) has operated well, obtaining reductions of 96 - 99·8% of Settled Solids in the effluent and 40 - 60% reduction of organic pollution ($B.O.D._5$) (dependent on the levels of chemical dosage).

Subsequent treatments in the Secondary Units has shown BOD_5 reductions of from 77 - 91%, far higher than original expectations. Recycling of chrome and lime liquors in the tannery have been regularly demonstrated.

(ii) The laboratories are fully operational, having carried out several thousand determinations of effluent characteristics. The facilities also are being employed carrying out analysis for commercial tanneries, as well as monitoring the multiple activities of the pilot plant.

(iii) A full time counterpart team of 8 (6 graduates) has now been created, trained by the external assistance team. Extension services are now available from the project team, and a large number of tanneries, in most states, have been visited and advice offered; to date, project proposals or modifications have been prepared for some 27 tanneries. The project has successfully tackled the information and technological needs of the industry, holding an "Open Week", "Semana de Debates Sobre Tratamento de Effluentes da Industria de Peles e Couros" March 1984, which was attended by some 200 participants from the industry, Government Agencies and specialists in this field.

(iv) In addition to training the counterpart team, several courses have been held for DMA officials, specialised short courses for projectistas and others on "Dimensioning of Projects" and "Control of Biological Systems", and regional activities were initiated with a training course for 27 participants (13 from other Latin American countries).

In general the project's immediate objectives have been attained, however, due to a variety of external factors, the ultimate development objective is not yet reached. It had been assumed in the original project proposal and workplan that most tanneries would have had their primary treatment systems operational when project activities commenced, and that a major component of project activity would be in the area of secondary treatment, however, the reality was that tanners delayed implementation of their primary treatment projects, or due to lack of "know-how" installed poorly designed and dimensioned, inoperative projects, so that at the moment a majority of tanneries still do not have efficient primary treatment plants. (Secondary units cannot be installed or operated without a reasonably efficient primary unit).

This has been recognised by the DMA in R.S. who effectively re-scheduled their regulatory time-table. Consequently, project extension activity is only now, somewhat belatedly, being directed towards biological treatment systems. It is to further extension work in this field that the second phase of project activity was proposed and will be generously funded by the Republic of Italy.

II INTRODUCTION AND HISTORIAL BACKGROUND

A. Background

The Brazilian Tanning Industry discharges some 10 - 20 million M^3 of effluent annually, such effluent with characteristically high pollutant levels e.g. Biochemical Oxygen Demand ($B.O.D._5$) > 2,500 mg/l and Suspended Solids (S.S.) > 4,000 mg/l, was traditionally discharged, untreated, into adjacent watercourses, with consequential environmental degradation.

On 17 January 1976 the Federal Government published a "Ministerial Order Establishing Quality of Water". This order classified watercourses into four categories and outlined the characteristics of allowable discharges into these recipients. The implementation of this order was assigned to competent local authorities. Consequently each state has promulgated its own proposed regulations for effluent discharges.

Consequently, in R.S., where some 50% of the tanning industry is located, the DMA in 1979 instituted a two phase programme to compel tanners to reduce the pollutant level of their discharges :-

By March 1981 - Primary Treatment to be operational

By March 1984 - Secondary Treatment to be operational.

The tanners in the state expressed some degree of disquiet regarding the choice of technology to be installed, feeling also that there was little expertise available in the country to advise them. To evaluate the situation SENAI, through the Federal Government, sought assistance from UNIDO, who fielded an adviser (D. Winters, U.K.). His findings during a three week visit to Brazil in November 1979 under project SI/BRA/79/801, with brief survey of ten large tanneries (capacity 15 - 20% of Brazilian industry), together with visits to the Tannery School at Estancia Velha (ETC), Secretary of Health, State of Rio Grande do Sul and other Government departments and institutions suggested that there did not seem to be available, within the country, sufficient expertise to formulate the large number of individual projects required to allow tanners to install plants to meet

the norms proposed. To overcome this deficiency the adviser recommended that the Tanning School at Estancia Velha install a pilot demonstration plant for tannery effluent treatment. It was considered that such pilot plant would allow evaluation of many of the conventional treatment systems under local conditions. Dissemination of such findings by extension and other services would assist tanners to institute the most realistic recycling and effluent treatment systems, with regard to both cost and technical efficiency. A detailed draft project proposal for this pilot demonstration plant for tannery effluent treatment was prepared.

The Government of Brazil requested external assistance in the operation of the pilot demonstration plant, initiation of the first phase of which had actually been started up by the authorities concerned in the State of Rio Grande do Sul in August 1980.

UNIDO, who approved the pilot plant project proposal, had no immediate funds available, therefore sought funding from possible donors, and were fortunate that the Italian Government was prepared to provide the necessary U.S.$ 414,500. The Brazilian Government (SENAI) initial contribution to the project was estimated at 15·9 million Cruzeiros. Thus the Project Document was able to be signed on 19th October 1981, and implementation commenced.

B. Project's Objectives

The project design matrix may be seen at Annex I.

1. Development Objectives were :-

- To minimize the environmental degradation caused by the pollutants contained in the tanning industry's large volume effluents ensuring that during the introduction of mitigating measures adequate utilization of the most applicable systems, (from technical and economic standpoints) will not impede the sector's development.

2. Immediate Objectives were :-

To establish in Brazil a pilot demonstration plant for tannery effluent treatment capable of:

- Assisting the tanning and allied industries to obtain reduction in the levels of pollutants of their effluent; to achieve the "norms" promulgated by the competent local authorities; assisting both the local authorities and the tanning industry in the preparation and evaluation of the technically feasible projects necessary to achieve such lessened pollution at minimal economic cost.
- Evaluating, under local conditions, the cost effectiveness of a variety of effluent treatment techniques;
- Conducting a systematic programme of training to develop a cadre of qualified personnel in this field;
- Carrying out a programme of applied research in the treatment of tannery wastes and the economic recovery of materials from such wastes;
- Initiating a programme of demonstration, extension services and dissemination to ensure that all sectors of the leather industry in Brazil (and the entire Latin American region) are able to obtain up-dated technical and economic information relating to the introduction of better environmental processes (recycling and other means) and the treatment of tannery wastes (aqueous and solid);
- Liaising between local authorities and tanners to ensure that the Government's ultimate objectives are understood by the industry.

C. Implementation

The project was planned to be installed on the site of the Tannery School (ETC) at Estancia Velha, R.S., although expected to work

closely with the school, the project was to be independent, and directly responsible to the counterpart agency, SENAI, Regional Headquarters, R.S. The counterpart personnel available to the project may be seen at Annex II.

Note: The SENAI cruzeiro contribution has had to be greatly increased to offset the effects of devaluation, and would appear to have exceeded the planned equivalent of US $ 97,000.

Four Brazilians (2 project staff, 1 representing R.S. tanners and 1 representing the Brazilian Association of Leather Technologists (ABQTIC)), undertook a two week study tour in Europe visiting Effluent Treatment Plants and Research Associations, accompanied by the UNIDO CTA and were thus familiarized with this subsectors activities and were able to assist with the detailed project planning.

For technical efficiency UNIDO decided that rather than field a series of individual experts a "consultant team" should carry out the majority of technical input. Following international tender, the contract was awarded to Studio Tecnico Dr Clonfero of Florence, Italy. The subcontractors team joined the project after the civil works had been completed and carried out 18·5 man months (m/m) in the field. (See details at Annex III).

G. Clonfero	4·5 m/m	Chemist (Team Leader)
E Rietti	8·0 m/m	Chemist
P. Nini	6·0 m/m	Chemist

In addition a further 3·5 m/m were expended at their home base, preparing reports and backstopping services.

The UNIDO adviser who prepared the project proposal (D. Winters) was appointed Chief Technical Adviser (CTA) and made short visits to the project at 3 - 4 monthly intervals, to ensure the project's activities conformed with the original work programme, was carried out in accord with the UNIDO mode and assist in overcoming any hindrances. The mode of implementation, with numerous short visits, exceeded the budgeted cost of personnel and accordingly the Italian authorities increased their donation to U.S.$ 459,125.

III PROJECT OUTPUTS

A. Pilot Demonstration Plant Installed

The original plan for the project called for the pilot plant to have a daily capacity of some 50 m^3/day (M^3/d), commensurate with the 50 hides/day processed by ETC. However, to maximise utilization of the four parallel secondary units, it was ultimately decided to raise the capacity to 100 M^3/d, this was effected by installing a pumped pipeline of some 3/400 metres from the equalization tank of an adjacent commercial tannery. Such supply augmentation overcame problems due to discontinuous production by ETC and facilitated 7 day a week, 24 hour operation. The project is grateful for the kind co-operation of Cortume Leuck Matter in this matter. The installation work proceeded more slowly than originally envisaged mainly due to problems associated with the near impossibility of excavating and concreting the necessary pits and lagoons in the period June - December 1982, when the region was inundated due to persistent heavy rains.

The pilot plant consists of the following units. (See layout of pilot plant at Annex IV*).

1. Primary Treatment

a) - Two tanks each of some 50 m^3
- Screening (brushed and self-clean types)
- Homogenization (diffused air and/or surface aerators)
- pH monitor and adjustment (meter and dosing pumps)
- Coagulation and flocculation (dosing pumps,
- Primary sedimentation (vertical tank 3·7 m^3)

b) Catalytic oxidation of sulphides (separate lime liquors and/or complete homogenization of liquors).

c) Protein precipitation tank (2·5 m^3)

d) Facilities for chrome recovery and recycle.

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* More detailed data is available in the Final Report prepared by Studio Tecnico Dr Clonfero

2. Secondary Treatment Units :-

Five systems capable of being operated in parallel or series were implanted :-

a) Oxidation Ditch - Volume of 60 m^3, 0·75 m rotor length with 3 H.P motor. Capacity 25 - 50 m^3/d.

b) Extended Aeration - employing primary equalization tank with floating aerator of 2 H.P. 25 m^3/d.

c) Aerated Lagoon - 22 m x 12 m surface, 1·5 m deep with 1 or 2 floating aerators of 2 H.P.

d) Trickling Filter of total volume 19 m^3, half filled with crushed stone, half filled plastic pall rings. (One section able to be operated at a time).

e) High Load Activated Sludge. (Air by diffusion, 12 hour retention).

f) Secondary Sedimentation Units - 2. (Able to operate at 1 and 2 m^3/hr respectively).

3. Sludge Treatment

a) Thickener - gravity, cylinder, 4·2 m^3 volume

b) Filter Press, 12 plate 0·5 x 0·5 m x 23 mm.

c) Drying Beds. 12 beds each 5 m x 2 m.

The above pilot plant was mostly installed by January 1983, when the Italian team commenced their contract, the plant was fully commissioned and operational by the end of 1983.

The plant is flexible in nature, thus it is possible to run units in series or parallel. Sufficient equipment is available so that trials may be conducted of nominally similar processes employing differing equipment, i.e. homogenization may be effected with a variety of air diffusion systems or by mechanical aerators, or slow speed stirrer.

It may be pertinent to note that the concept of a pilot effluent plant, at such scale, is unique globally in the leather sector and thus the project concept may be considered as a pioneer, with no possibility to learn from examples elsewhere.

Major plant supplied by UNIDO may be seen at Annex V.

The pilot plants day to day activities are controlled and monitored by all members of the counterpart team (rotating responsibilities).

B. Laboratory

An important output of the project was the installation of a laboratory capable of analysing and testing all tannery effluent and solid wastes. To achieve this aim it was decided to augment the equipment of the existing ETC Laboratories rather than equip an independent unit, which would have entailed some measure of equipment duplication. UNIDO supplied some US $ 30,000 equipment and reagents in order to attain the desired level of operational capability.

The project laboratory currently has one small room for its sole specialized use and shares the facilities in two other laboratories. The permanent laboratory staff is one graduate chemist and 1 technician. However, when necessary, ETC personnel are co-opted and other team members may undertake specific laboratory activities.

C. Centre of Knowledge and Expertise

A major result of the project was to establish a national/regional centre of knowledge and expertise, able to offer demonstration and extension service to industry and governmental authorities to allow implementation of realistic/economic projects by all tanneries, to minimise the environmental degradation caused by the industry and conform to governmental norms.

The concept was that to complement the pilot plant and laboratory, human resources would need marshalling and moulding to ensure maximum benefit from the installed plant and equipment.

To this end the project built up a cadre of qualified personnel (see Annex II) so that there is currently a team of eight persons (six graduates). In addition to their formal educational qualifications the counterpart team have received in-plant training from the Italian team, covering all aspects of design, operation and control of tannery effluent treatment, and currently the project and team is recognised as a local fount of knowledge in this area of activity.

D. Training Capability

Given the dearth of knowledge in the region on the subject, a major output of the project was to create a centre capable of training personnel at all levels in the introduction of better environmental processing and the treatment of solid and liquid tannery wastes and the control of such processes.

Given the pilot plant, laboratory and cadre of specialists built up, complemented by the facilities of the school (ETC) such capability has been attained.

IV PROJECT ACTIVITIES

This section briefly reviews the operational activities from early 1982 until the present time. More detailed technical data is available in Studio Clonfero's Final Report of July 1984. The activities are treated separately under the four areas established for the outputs (see earlier Chapters), although it must be emphasized that the four facets are closely interwoven.

A. Pilot Plant

The pilot plant commenced operation at the close of 1982, with only the secondary unit initially, gradually as further equipment was installed and more counterpart personnel made available, all units have been commissioned and operated, some continuously, some on a discontinuous basis.

A major problem encountered by the project has been a wide variation in the characteristics of the effluent being processed. Partly due to the noncontinuity of the school's leather production and subsequent effluent, but even more to changes in production at Cortume Leuck Mattes who supply the bulk of the effluent processed by the pilot plant. This problem is one faced by many tannery effluent treatment plants. To offset these day by day fluctuations, most trials in the pilot plant were run for at least two months and results averaged.

Typical characteristics of the raw effluent (after screening) may be seen from the average of the period November/December 1984 :-

COD	3838	mg/l
BOD	2137	mg/l
SS	2053	mg/l

1. Primary Treatment

a) General

Given the high cost of chemical reagents in Brazil (especially polyelectrolytes) there was a strong feeling among tanners that primary treatment should be based on minimal chemical dosing. The pilot plant was therefore operated under four different conditions of dosage

(several months each condition) :-

	Alum		Polyelectrolytes
High dosage	800 mg/l	+	1 mg/l
Medium dosage	400 mg/l	+	1 mg/l
Low dosage	200 mg/l	+	0·5 mg/l
Nil dosage	NIL		NIL

The results showed a consistent pattern :-

	Reduction of Pollutants		
	Settled Solids	COD	BOD_5
High Dosage	99·8%	76·9%	61·5%
Medium Dosage	99·0%	73·7%	62·1%
Low Dosage	99·3%	66·8%	58·7%
Nil Dosage	96·7%	49·0%	39·3%

(N.B. Minor reservations must be attached to the above reductions as there was some variation in the characteristics of the influent).

The above reductions in pollutants obtained by physico-chemical sedimentation show the high level efficiency of the plant. The "low dosage" showed the most cost effective system. It underlines the need for a balance to be drawn taking into account the size and cost of subsequent biologic treatment if NIL dosing systems are employed (cf BOD_5). It is also necessary to confirm that the physico-chemical operation is relatively simple to control, whereas biological secondary treatment, which must remove the residual organic load (BOD_5), is much more complex.

b) Catalytic Oxidation of Sulphides

Removal of residual sulphide ($S^{=}$) from tannery effluent may be effected by precipitation or oxidation. However, it was felt that precipitation had many inherent disadvantages, (colour, cost and large volume of sludge), accordingly the project concentrated on oxidation techniques (air in the presence of Mn^{++} catalysts). These were carried out in two ways :- (i) On total volume of homogenized liquors
(ii) On lime and wash floats in a special tank.

(The liquors from Messrs Leuck Mattes were not capable of separate treatment as (ii) above).

(i) $S^{=}$ Oxidation in Homogenisation Tank

The wastes were agitated and aerated by blowing air through sintered Alundum Candles (5 - 6 m^3/air/hr per m^3 of tank), with average retention times of 7 hrs and 20 mg/l Mn^{++} catalyst. The final concentration was brought generally well below 10 mg/l $S^{=}$, an acceptable level.

(ii) $S^{=}$ Oxidation of Lime/Wash Floats

The advantage of this technique is that the volume to be treated is very small - only 10% or so of total daily volume. Similar techniques were employed in a tower (3 m tall). Employing higher catalyst and air input levels (100 mg/l Mn^{++} and 15 m^3/air/hr per M^3 tower), Sulphide levels were reduced from 410 mg/l $S^{=}$ in about 4½ hrs, (average of 11 tests), to circa 20 mg/l $S^{=}$.

When one considers that this liquor will subsequently be diluted almost 10 fold by other non $S^{=}$ bearing liquors, one may calculate a combined liquor $S^{=}$ content of well below 10 mg/l.

The economic and technical advantages of this selective treatment are self-evident, and suggest that when tanneries are able to "stream" their flows, such methods should be adopted.

c) Protein Precipitation

Where "streaming" is carried out, one has in a small volume (10%) of lime/wash floats a high percentage of the total effluent organic pollutants, possibly > 50% of COD and possibly 70 - 80% of total BOD_5. A series of trials were carried out to precipitate proteins out of this small volume float.

The liquor was acidified to circa pH 3·8 and the protein precipitated. (10 kg of 96% sulphuric acid per M^3 of liquor when unclarified. 6·5 kg of 96% sulphuric acid per M^3 when the liquor was presettled to remove majority of hair and lime). Such technique produced on average (10 trials) reductions of 80% of COD and 75% of total Kjeldahl Nitrogen (TKN) (a measure of protein or organic matter present.)

When evaluating such trials the cost of the acid utilized must be set against possible savings in size and operating costs of up to 50% in subsequent secondary treatment.

d) Chrome Recovery

The school (ETC) had for some time practised direct recycling of chrome liquors (regeneration following screening and analysis), project activities therefore concentrated on an alternative technique involving screening, (self-clean), alkaline precipitation (pH 8·0), passing through filter press, redissolving the cake with acid, analysis and reuse.

From a residual tan bath of 4 gm/l Cr_2O_3 one was able to produce a filter press cake of 10 - 12% Cr O which when redissolved gave a chrome liquor of 10% Cr_2O_3 (by weight).

To recover 1 Kg of Cr_2O_3 value circa	US $ 3·80
it was necessary to utilize 0·5 - 1·0 Kg Alkali at	US $ 0·50
and 0·7 - 1·0 Kg Acid at	US $ 0·15
Value of necessary chemical utilized	US $ 0·65

In addition to the economic saving there was a reduction of some 99% in the Cr_2O_3 in the discharged tan float.

N.B. Employing the recovered chrome by itself in tanning trials (normal procedure would be to blend it with new chrome), little difference was found after physical and chemical analysis from leathers tanned with normal "new" chrome. (10 - 20% lowering of tensile strength and cracking load).

2. Secondary Treatment

The variety and scope of the pilot plants secondary treatment units is too great to successfully summarize, it may however be noted that the project has had outstandingly good results from its "extended aeration" trials. Possibly the most efficient and reliable has been the oxidation ditch mode of extended aeration.

Of the secondary units only the oxidation ditch and the aerated/facultative lagoon have operated continuously over the two year operational period.

N.B. The results from differing trials may not be directly comparable as the primary treatment (as outlined earlier) was varied over the period.

a) Oxidation Ditch

This has operated from late 1982 until the present time with no serious problems encountered, it has shown itself most resilient to variations in influent character. For most of the period it operated with a 2½ day retention, although even when operated at 1.1/4 days retention it proved quite efficient. Over a three month trial (with high chemical dosage primary treatment) the oxidation ditch reduced BOD_5 by some 85% and COD by 68%, to yield final effluent of 29 mg/l BOD_5, much lower than any discharge standard in Brazil.

During a six month period with "nil chemical" primary treatment it reduced BOD_5 and COD by 8% and 76% respectively, with final effluent having a BOD_5 of 83 mg/l - acceptable in most situations.

Average Mixed Liquor Suspended Solids (MLSS) circa 2,100 mg/l.

b) Extended Aeration

This was carried out employing an unutilized equalization tank and a floating aerator, operating conditions very similar to the oxidation ditch with an MLSS of 2,300 mg/l. Over a five month trial period this form of extended aeration was compared with the "oxidation ditch" system with almost identical results. During this period high and medium dosage primaries were practised, final effluents from extended aeration averaged 23·5 mg/l BOD_5, (oxidation ditch 24·0 mg/l). However, the extended aeration - floating aerator - yielded final effluents of 335 mg/l COD compared with 220 mg/l COD from the oxidation ditch.

c) Aerated Lagoon

Following primary treatment with a 9 day retention and a specific power input of 3·5 w/m^3 reductions of 90% BOD_5 and 79% COD were obtained, with the final effluent having 54 mg/l BOD_5.

Given reasonable primary treatment such a system may be cost effective in areas where sufficient land is available.

N.B. The lagoon has only operated for 2½ years, experience elsewhere suggests if no provision for sludge removal is included in the scheme, they may need closing down and desludging every 5/10 years.

d) Trickling Filter

The filter, with a water jet rotary distributor, is divided with a perpendicular wall, one half plastic packed, the other crushed stone, a plastic cover diverting water from the section not in use.

With an inflow of 1 m^3/hr to the 9·5 m^3 of filter medium, pollution reductions were obtained :-

	Reductions Obtained		Final Discharge
	BOD_5	COD	BOD_5 mg/l
Plastic Media	75%	47%	119
Stones	66%	51%	175

Considering the bulk of such filter, and the relatively high residual BOD_5 concentration, such process is unlikely to be widely employed.

e) High Load - Activated Sludge

This system, although widely employed in Europe, has only recently (July 1984) been operated at the pilot plant. With a retention time of 8 - 12 hours, at an MLSS of 3-4,000 mg/l only mediocre results have been obtained, with the best performance being in January 1985 when a final effluent with a BOD_5 of 64 was attained, (cf BOD_5 14 mg/l from oxidation ditch during same period).

3. Sludge Treatment

a) Thickener

Trials with primary sludges showed that the pilot plant thickening tank raised the solids content of sludge from 2·3% to 3·5% i.e. a reduction in volume of 38%. (Employing 4 Kg lime per M^3 sludge).

b) Filter Press

Yielded cake of 25% and 29% solids (primary and thickened respectively) with no operational problems encountered.

c) Sludge Dry Beds

Filling the sludge beds to 40 - 50 cms with a drying time of 25 - 35 days a sludge of 25 - 30% solids was obtained. (Effective

load 60 - 80 Kg dry sludge/M^2 bed/year).

With the high rainfall in Estancia Velha experiments were also carried out with covered beds. It was concluded that during the first two weeks bulk dewatering is by filtration via the sand bed, later drying is by evaporation.

4. Conclusion

It was universally felt that the project's operations over the last two years showed that, given the correct design and operating paramenters, all of the conventional treatment systems can yield effective effluent treatment, and as such may be recommended to tanners. The project's results in both extended aeration modes were far superior to those obtained elsewhere, whether such efficiency is due to the higher ambient temperature or due to the good monitoring and control by the project team is uncertain.

B. Laboratory

The laboratory has been fully operational since mid-1983 and has carried out many thousands of determinations on effluent and other wastes. Until recently the major activity was the monitoring of the pilot plant.

Currently however the situation is changing, as R.S. and other States impose their discharge standards on tannery effluent, they couple this with an obligation for regular effluent analysis to be carried out, e.g. in R.S :-

Small Tanneries (less than 100 m^3/d) must have full analysis every 3 months

Medium Tanneries (100 -500 m^3/d) must have full analysis every month

Large Tanneries (over 500 m^3/d) must have full analysis every 2 weeks

As a consequence of these regulations large numbers of tanneries are requesting the project laboratories to undertake such analysis, for a moderate fee. Such analysis includes oil and grease, Cr^{+++}, $S^{=}$, BOD_5, COD, Settleable Solids.

Today the laboratory is directing the majority of its endeavours towards satisfying the demand from commercial tanneries, without doubt the laboratory facilities are over-extended and discussions are being held regarding the possibility of erecting a new building, which, with further equipment, would allow the project to undertake an increasing role satisfying tannery demand for analysis.

C. Centre of Knowledge and Expertise

The dual roles of demonstration and extension service in this sector have received top priority from all project personnel.

1. Demonstration

The pilot plant facilities, operating over the last two years, have had many hundreds of interested parties visiting and examining all aspects of the project's activities. The majority of viewers of the demonstration plant have been tanners, government environmental officers and "projectistas" (engineers who prepare treatment projects for tanneries).

The role of the project in this field was firmly cemented when it held an "Open Week", in March 1984, this was most successful with between 1 - 200 people attending for the presentation of over 20 talks, papers and reports, covering all facets of tannery effluent treatment. The presentations were by project staff and consultants (Brazilian and foreign). All participants familiarized themselves with the pilot plant demonstration facilities and the "Open Week" received appreciable publicity in the media, which greatly aided its major objective of dissemination of "know-how".

The full proceedings of the "Open Week" have been published by SENAI: "Coletanea das Palestras e Debates. Semana de Debates Sobre Tratamento de Efluentes da Industria de Peles e Couros. 19 - 23 March 1984". Published August 1984.

2. Extension Services

Following the publicity received by the "Open Week" there was a massive increase in demands for assistance with individual tannery

pro[illegible]. This demand for extension service activity has been further expanded by the action of State authorities who are at this time increasing their pressure to make tanneries comply with discharge regulations. In R.S. several tanneries have been threatened with closure if they do not rapidly install effluent treatment plant, in other States the discharge standards have not in all cases been fixed, but tanneries are being forced to take mitigating measures to reduce their discharge of pollutants.

Given this climate, the requests for assistance have almost outstripped the availability of personnel. The project has to date accepted requests from 27 tanneries for extension services - see list of tanneries at Annex VI. The assignments at these tanneries variously covered complete preparation of treatment schemes, as well as modification of existing or proposed projects. (Currently this service is offered free subject to the tannery covering direct expenses of the Brazilian personnel (travel and accommodation), and the travel costs of UNIDO personnel.

One major area of extension service activity proved abortive. The project personnel expended much energy in attempting to realize a project in Estancia Velha R.S. whereby a common effluent treatment plant would have treated effluents from 12 or so tanneries and allied industries (glue plants etc.), in addition to the municipal domestic sewage. Initially all parties recognized the economic advantages such communal plant offered. The project gave technical inputs towards a major preliminary study prepared by a parastatal and private sector consortium. The concept however died when the DMA issued its most recent regulations.

Discussions with the tanners of Estancia Velha clearly showed that the effects of the law, and further regulations due to be promulgated in the near future, eroded the foundation of the proposed joint scheme, as some five or six tanners under the new regulations will not need to install secondary treatment units for at least three years (maybe not even then) and consequently were not prepared to invest in a joint secondary treatment scheme at this time.

Four Estancia Velha tanners who must submit to DMA their secondary treatment plans by March 1985 (Bender/Mattes/Remus/Schuck) expressed interest in a smaller joint treatment project. However, even this

smaller scheme was unable to proceed as one tannery acted too slowly to allow attainment of the DMA timetable.

Note: Although most of the 1983/4 requests for assistance were from the State of R.S. it is pleasing to know that in the last few months (early 1985) demands from the North and North East States have been in the majority, reflecting the Centre's acceptance by all sectors of the industry.

D. Training Centre

The project has undertaken trairing at both formal and inf rmal levels.

Initially the Italian team concentrated on in-plant training of the counterpart staff, which was continuous. Once the pilot plant was fully functional the project was able to offer training to external personnel, among the earliest participants, in early 1984, were the DMA who sent four batches (total thirteen officers) of their technical staff, for 3 - 4 week courses in tannery effluent treatment. (Theoretical and practical courses).

In June 1984 two specialized courses of three days each were held :-

a) Primary Treatment of Tannery Effluents - Dimensioning and Operation. (13 participants - DMA - Parastatal bodies - "Projectistas").

b) Secondary Treatment of Tannery Effluents - Dimensioning and Operation. (20 participants).

In October/November a one week Regional Training Course was held in association with ETC and the Organisation of American States. Some 27 participants undertook the course. (14 Brazilians and 13 from other Latin American States). The academic/industrial background of the participants may be recognized from the fact that the group included 22 University Graduates, 21 of the participants being employed in tanneries. The project staff, aided by three UNIDO consultants, were available for this course.

The "Open Week" outlined earlier, was a major activity also in the area of training.

V. CONCLUSIONS

The project would appear to have been well designed and has sufficient resilience to adjust its programme and activities to conform to the everchanging needs of the sector.

From the technical viewpoint the project has confirmed that most of the systems of treatment proven elsewhere are applicable to Brazil, and the tanners may install them with confidence, provided the correct design and operating parameters are observed.

The high level of requests for extension services confirm the project's acceptance by industry and environmental authorities.

It is hoped that during the Second Phase of Project activity, anticipated to commence in June 1985, the major activities will be:-

a) Further uplifting the technical expertise of the counterpart cadre, so that they be fully self-sufficient to allow :-

b) The expansion of extension service activities, so that all tanneries in the region may receive the benefits available from the project's experience and accumulated knowledge.

c) To expand the regional activities of the project.

COUNTRY : BRAZIL TITLE : US/BRA/80/166

PROJECT DESIGN MATRIX

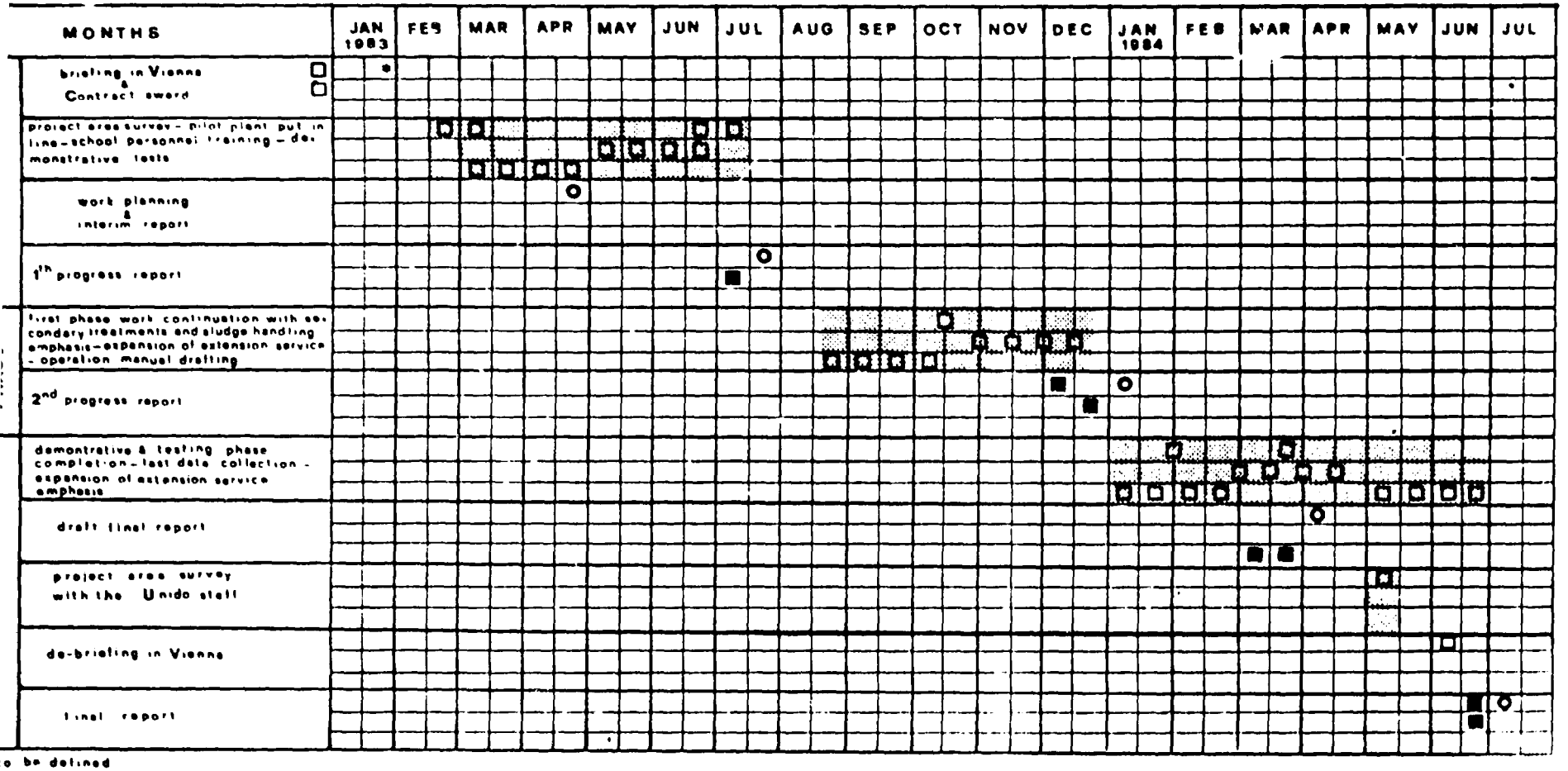
PROJECT LOGIC	ACHIEVEMENT INDICATORS	CRITICAL ASSUMPTIONS AND PREREQUISITES
ELOPMENT/PROGRAMME OR HIGHER-LEVEL JECTIVE(s): inimize the environmental degradation caused by pollutants contained in the tanning industry's e volume of effluents, ensuring that the oduction of mitigating measures and adequate ization of the most applicable systems, from nical and economic standpoints, will not impede ector's development.	**IMPACT MEASURES:** Implementation of efficient secondary treatment units at all tanneries. Significant reduction in sectors' pollutant discharge. Monitor:Department of Environment.	**PROJECT OBJECTIVE TO HIGHER-LEVEL OBJECTIVE(s):** Ability (willingness) of commercial tanneries to accept transfer of technology from pilot plant. Monitor: (i) analysis of tannery effluents:State norms (ii) economic impact - installation and operation of units. Monitor by Project and Department of Environment.
JECT (IMMEDIATE) OBJECTIVE AND FUNCTION: t/Demonstration effluent treatment Plant condary) - fully operational allowing :- nstration - Extension activities - emination - Training.	**STATUS AT END-OF-PROJECT OPERATIONS:** Base - Lack of real knowledge in this field Objective - Knowledge disseminated leading to tannery effluent treatment schemes implanted. Monitor - Industry:Department of Environment after March 1984	**OUTPUTS TO PROJECT OBJECTIVES:** That the four proposed biological systems will operate efficiently given prevailing climatic conditions at project and effluent characteristics found.
JECT OUTPUTS/RESULTS: . Demonstration Plant Installed. rol Laboratory Installed. ional/Regional Centre for Knowledge/expertise anted.	**OUTPUT TARGETS AND MAGNITUDE:** Recognised by operational efficiency of pilot plant as reflected in analytical data ref. final effluent.	**WORK PROGRAMME TO OUTPUTS** Expeditious procurement of equipment. Efficient customs clearance/transportation. Timely completion of civil works. Provision of suitable counterpart personnel.
JECT ACTIVITIES/WORK PROGRAMME: ign, procure equipment and initiate civil works pilot/demonstration plant. Harness and rdinate counterpart, sub-contract and UNIDO sonnel inputs	**MILESTONES AND EVENTS** Civil Engineering contract completed. Plant and equipment procured on site. Expertise/Personnel contracted.	**INPUTS TO WORK PROGRAMME** Budgetary adjustment necessitated to allow programme inputs. (Donors to be approached).
JECT INPUTS DO Funds - Equipment (sub + pilot plant) Expertise - Sub-contract Management - CTA T. Funds - Civil Engineering Counterpart and support personnel	**BUDGET AND SCHEDULES** All now O.K. in line with revised schedule. Due implementation delay/inflation/method of implementation need further funding of 5 - 10% of UNIDO/Donor contribution.	

ANNEX II

LIST OF COUNTERPART PERSONNEL

Luiz RUPPENTHAL	Chemical Engineer - National Co-Ordinator	1981 - 3/83
Paulo T JOST	Chemical Engineer - National Co-Ordinator	12/83 - Continuing
Frederico WEBER	Chemist	12/83 - Continuing
Jair Joao RUARO	Chemist	12/83 - 1/85
Antonion LEITÃO	Chemical Engineer	12/83 - 5/84
Vera REBEIRO	Chemical Engineer	8/84 - Continuing
Jose Luiz ROSENBACK	Chemical Engineer	8/84 - Continuing
Luiz Carlos MERIGO	Chemical Engineer	3/85 - Continuing
Sidney BRUSCHI	Chemical Engineer	3/85 - Continuing
Isabel GREGORY	Laboratory Technician	1981 - Continuing
Carlos BOHNE	Mechanic	1981 - Continuing

WORK PLAN



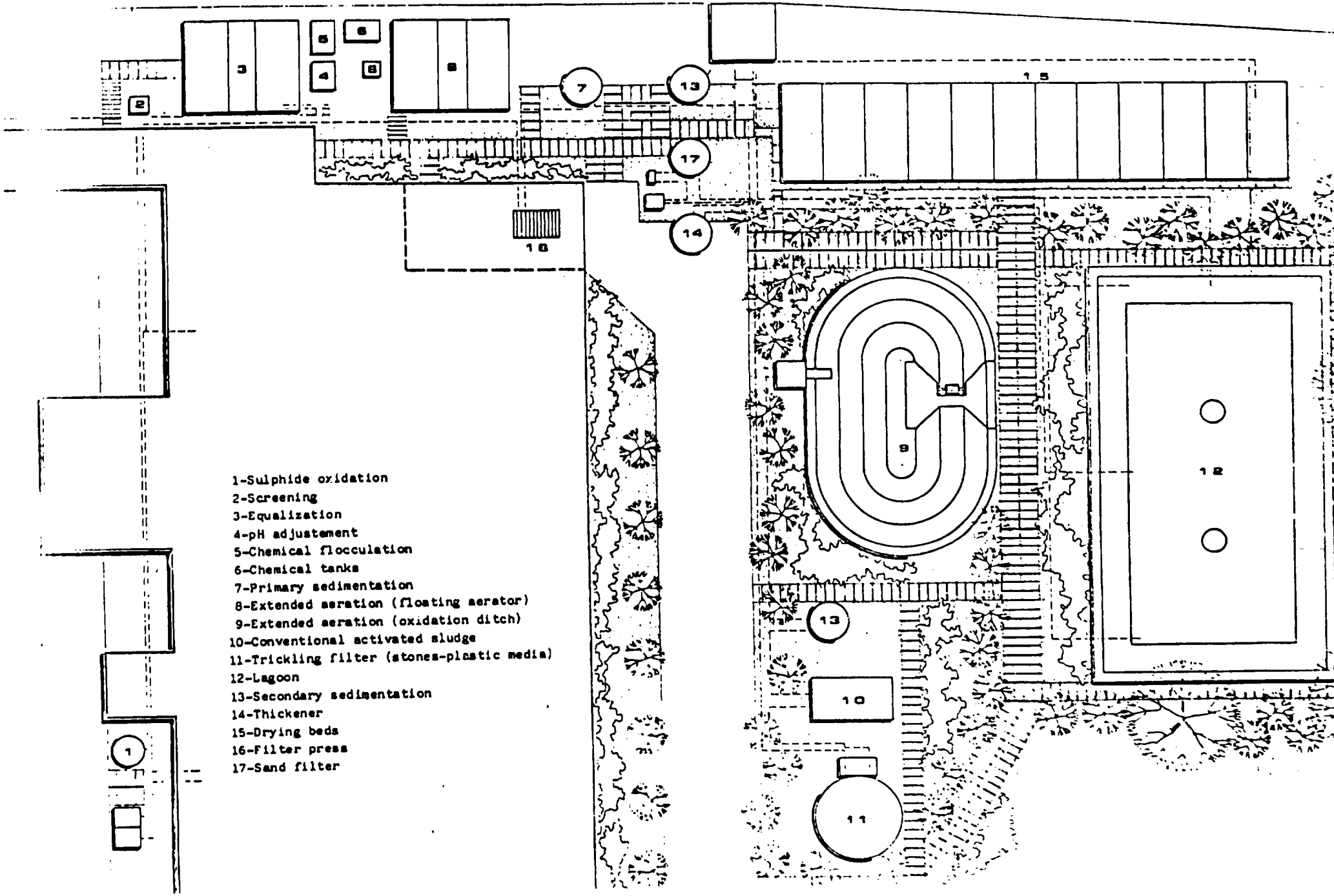
SUB-CONTRACTORS INPUT

to be defined

- team leader
- technician A
- technician B
- project area service
- report
- home office service

UNIDO-VIENNA

CONTRACT N°82/105/MK


1-Sulphide oxidation
2-Screening
3-Equalization
4-pH adjustement
5-Chemical flocculation
6-Chemical tanks
7-Primary sedimentation
8-Extended aeration (floating aerator)
9-Extended aeration (oxidation ditch)
10-Conventional activated sludge
11-Trickling filter (stones-plastic media)
12-Lagoon
13-Secondary sedimentation
14-Thickener
15-Drying beds
16-Filter press
17-Sand filter

ANNEX V

MAJOR PILOT PLANT EQUIPMENT SUPPLIED BY UNIDO

Item	No.	Source	US $
Brushed Screen	1	U.K.	4,043
Flygt Ejectors and Pump	Set	Italy	948
Air Blower	1	"	1,054
Floating Aerators 1 H.P.	2	"	4,055
Filter Press and Pump	1	"	7,405
Oxidation Ditch Rotor	1	U.K.	9,483
Venturators	Set	"	955
Catalytic Oxidation Tank	1	Brazil	4,366
Vertical Sedimentation Tank	1	"	6,328
Agitators and Tanks 1700 R.P.M	3	"	3,427
Agitator and Tank 300 R.P.M.	1	"	1,230
Submersible Aerator 3 H.P.	1	"	3,834
Protein Preciptiation Tank	1	"	3,200
Rotating Distributor	1	"	580
Sand Filter	1	"	1,100
Dosing Pumps	2	"	2,350
pH Control Unit	1	"	2,472
Aeration Diffusers	2 Sets	F.R.G.	1,410
Air Blower	1	Italy	1,480
Vertical Sedimentation Tank	1	Brazil	3,500
pH Controller	1	"	2,000

ANNEX V.

TANNERIES WHICH HAVE REQUESTED EXTENSION SERVICES

Tannery	State	Output
Aluorada	S.P	Modification to Primary Project
Augustin	R.S.	Modification to Primary Project
Bender Schuck	R.S.	Modification to Primary + Secondary Project
Bier Scharlau	R.S	Modification to Primary Project
Buffalo	R.S	Primary Project
Buhler	R.S	Modification to Primary Project
Campello	B.A	Primary Project
Campo Grande	M.S	Primary Project
Cantusio	S.P	Modification to Primary Project
Carioca	R.J	Primary Project
Co-Brasil	S.C	Modification to Primary Project
Costa	S.P	Modification to Primary Project
Eldorado	R.S	Outline Primary Project
Fassolo	R.S	Modification to Primary + Secondary Project
Fassolo	S.P	Outline Primary Project
Frizzo	R.S	Primary + Secondary Project
Heeman	R.S.	Modification of Primary Project
Kern Weinads	R.S	Modification of Primary Project
Leiner	R.S.	Modification of Primary Project
Leuck Mattes	R.S.	Primary + Secondary Project
Momburger	R.S	Modification of Primary Project
Motta	R.N	Primary Project
Muller	R.S.	Modification of Primary Project
Perdigao	S.C	Modification of Primary Project
Remus	R.S	Primary + Secondary Project
Sander	R.S	Primary Operational Assistance
Sarandi	R.S	Modification of Primary Project
Yurgel	R.S	Primary + Secondary Project