REPORT

ENVIRONMENTAL IMPACT ASSESSMENT OF KASUR TANNERIES EFFLUENT TREATMENT PLANT

FEBRUARY 1993

IUCN
The World Conservation Union

ENVIRONMENTAL IMPACT ASSESSMENT

OF THE

PROPOSED TANNERY WASTE TREATMENT WORKS

AT KASUR, PUNJAB

BY

IUCN - PAKISTAN

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On Behalf of

NORAD, THE ROYAL DUTCH EMBASSY AND UNIDO

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EXECUTIVE SUMMARY

1. Project History

The town of Kasur, located near the Indian border in the province of Punjab, Pakistan, has become well-known for the pollution problems caused by the discharge of large volumes of untreated tannery wastes. For the past two years a UNIDO project has been considering solutions to the problem, whilst a parallel collaborative project funded by NORAD, the Dutch Government and UNDP has been considering the impact of these discharges on public health, air and water quality, agriculture, livestock and the institutional framework needed to address these problems.

The proposed solution for the tannery wastes treatment plant and its infrastructure is estimated to cost approximately US$ 8 million. Such a plant is self-evidently beneficial to the general environment and socioeconomic conditions in the area. However it is recognised that the end of pipe solution is only one component in a complex series of interlinked problems and so an overall strategic approach is being taken.

2. Background

The leather sector in Pakistan is one of the largest foreign exchange earners generating some Rs. 11,500 million in FY 1989/90. The tanning industry is concentrated in Karachi Kasur, Lahore, Sahiwal, Multan, Gujranwala and Sialkot. No attempt been made to treat tannery wastes in any of these locations, and the Kasur project where the problems are arguably the most acute is seen as a model for other locations to emulate.

In Kasur there are some 160 tanneries processing 8,000 hides and 15,000 skins each day to the wet-blue stage. These tanneries are located in three clusters in the centre of a town of over 250,000 inhabitants. Domestic sewage is freely discharged and allowing for an increase in the number of tanneries, the total volume of waste being considered for treatment is 12,700 cu.m per day.

The wastes from one cluster (Dingarh) discharge into an abandoned water course which also carries domestic sewage and other industrial waste. This water is used by farmers for irrigation. The discharges from the other clusters are collected in an open, earthen channel along the main road and collect in three stagnant pools of highly coloured waste water of several hectares in area. During rains these ponds spillover onto adjacent lands.

The municipal sewerage system is incomplete, and owing to organisational and financial problems is not functioning. Estimates of the future volume of sewage are 30,000 cu.m. per day as the water supply to the town is improved, although at present it is only one third of this figure.

Solid wastes arise both from the tanneries and from residential areas. They are disposed of by casual dumping in various locations. Some of the waste solids from the tanneries are reused for by-products, but it is estimated that the total daily quantities to be disposed include 100-150 tonnes tannery wastes and 150-200 tonnes domestic solids.

3. Description of Proposed Treatment Plant

The proposed treatment plant will accommodate an eventual flow rate of 13,000 cu.m/day. The steps proposed by the UNIDO consultants include:

- Evacuation of the stagnant ponds of tannery effluent.
- Setting up the tannery effluent drainage and collection system.
- Construction of the tannery effluent treatment system
- A solid waste disposal system.
- Rehabilitation of municipal drainage and disposal works.
- Establishment of a common municipal waste treatment plant.

The sludge treatment and solids disposal is intended to take place in a site 5 km from the town.

4. Mobilisation

IUCN were commissioned to undertake the Environmental Impact Assessment of the project. The team mobilised and commenced field activities on November 23 1992.

The team comprised :

- Project Director
- Team Leader, Project Manager and Public Health Engineer
- Community Health Specialist
- Agriculturalist
- Fisheries Specialist
- Hydrologist

5. Information and Data Reliability

During the preparation of this report a major concern has been establishing the reliability and veracity of the information and data provided to the Consultants. Record keeping is not always thorough and the rapid turnover of Government officers often means that their personal recollections are limited. Also, records are often kept for reasons different to what one might expect. For example, death certificates are filed to establish claims to inheritance, and drawing any conclusions from the medical data contained within them could be very misleading. Equally, during the field investigation into the fishing rights of the area, a senior government official stated categorically that there were no fishing rights. Another official produced documentary records of

financial transactions relating to these rights. Such occurrences were commonplace and strenuous efforts were made to check and double check information. Certain data contained within this report conflicts with that stated in previous reports. In no way is this intended to criticise the diligence of the authors of previous reports. Rather it serves to illustrate the difficulties involved in studies of this nature.

6. Review of Baseline Data

A considerable amount of data exists in a series of reports prepared by NMC Ltd under a separate commission. These relate inter alia to : health and welfare, baseline air and water quality, agriculture, livestock, and socioeconomics. This data has been reviewed for relevance and validity. The original authors of the reports have been contacted and interviewed, and where possible reference made to the source data.

With respect to health aspects the methodology of data capture, the interviewing techniques, and statistical methods employed are not consistent with generally accepted practice and subsequently the results include a bias which renders the justification of the conclusions invalid.

As regards the baseline water quality and air pollution data, no methodology has been given, the sampling points have not been specified and subsequent results have not been subject to quality assurance or quality control cross checks. Therefore the conclusions are invalid.

7. Experimental Data

One of the original design parameters of the treatment plant is based on results obtained by the Punjab EPA. Field measurements were carried out and samples taken which were then subjected to standard tests in the Punjab EPA laboratory. No quality control or quality assurance procedures existed within the laboratory at the time of the analysis. Without prejudice to the EPA Laboratory, it is considered prudent to verify the data from an independent source.

In the design consultants initial sampling, a cross check was carried out by preparing duplicate samples and having both sets analyzed by EPA Laboratory and PCSIR. The results obtained vary beyond the limits of experimental error. Serious doubt must exist about the validity of these results.

8. Hydrological Aspects

The design report states that the Pandoki Outfall carries 2,000 cusecs at full flow. The design capacity of Pandoki Outfall is 624 cusecs. The design report states that the River Sutlej carries a minimum flow of 30,000 cusecs. Examination of daily records for the

last ten years indicates that at times there is almost no flow (although there is water) in this branch of the Sutlej river.

9. Health Aspects

Reference to medical records and a "walk through" examination reveals that there is a high incidence of respiratory disorders and skin infection related diseases. It is thought that these are due to the conditions under which the tannery workers operate rather than secondary effects of tannery effluent. The sanitary conditions in Kasur are similar to those found in many rural townships but are exacerbated by the close proximity of residential dwellings and industry.

Within the available data the impact from environmental pollution on health can not be quantified and there is no scientific basis to conclude that a statistically significant increase in illness attributed to pollution has occurred (as stated in previous reports). Through observation, consultations and by examining obvious trends in the available information, environmental pollution seems to have caused an increase in the incidence of acute and chronic systemic ill health effects and in all probability a sound epidemiological study will reveal an increase in morbidity caused by environmental pollution.

In order to establish the true severity of the health situation in Kasur and determine the degree of improvement from the implementation of the treatment plant, a long term epidemiological study is recommended with a carefully selected control group. This should include :

- "Receiving both occupational and environmental exposures"
- "exposed only during occupation"
- "exposed only through ambient environment"
- "unexposed in the non-polluted areas"

This will help in identifying any morbidity and mortality differences between these sub-populations.

Drinking water in Kasur is obtained by tubewells and residents complain about the quality of the water deteriorating due to organoleptic effects. The water from the tubewells was analyzed and found to be outside the standards for drinking water.

There is no doubt that conditions in Kasur are detrimental to the health and well being of the population. It is not possible at this juncture to state whether health problems of the population are due primarily to the tanneries or whether the tanneries add to generally insanitary conditions. It must be emphasised that curing the tanneries effluent problem will not redeem the situation for the total population of Kasur. There are other industries discharging to the municipal sewerage system and domestic sewage is a major concern. An overall masterplan is needed of which the tanneries effluent treatment plant is the first stage of implementation.

10. Agricultural Aspects

A comprehensive survey has been carried out on the effects of the tanneries effluent on the crops and livestock of the farmers in the area. The farmers have taken steps to prevent the effluent spilling onto their land by building earth bunds but despite this certain areas of their land are now infertile and are not producing crops. Farmers report that their crop yield has dropped by up to 50% over the last 10 years and they now resort to buying feed from elsewhere for their animals. Cases of sickness in their animals have required watering from tubewells remote from the stagnant pools and these animals have subsequently recovered.

Reclamation of the inundated areas and reversion to cropping would generate a financial benefit of some Rs 1.3 million per annum but this would not be realised until the lands are fully recovered.

Deposition of the waste plant sludge to a selected landfill site has raised fears of groundwater contamination by chromium. The chromium to be tipped (trivalent) is the subject of much debate throughout the world as to its toxicity, preferential absorption into the food chain and subsequent biomagnification. The consensus of opinion is now that previous anxieties were unwarranted and so standards are being relaxed. In view of the absence of tubewells in the area of the proposed landfill site this is not considered a crucial issue. However it is recommended to implement an ongoing well sampling program to monitor the situation. This should be initiated before the tip becomes operational. Also it is recommended that the tipping site be adjacent to the treatment plant to avoid disturbance to Kesargarh village and to save on transport costs

The landfill site proposed for dumping of the tannery sludge should not receive other industrial wastes, particularly acidic wastes.

The farmers having land/tubewells along the nullah may have to bear the loss due to pollution for several years, as the contamination already affecting the underground aquifer due to tanneries effluent will not cease immediately. The condition of livestock will be improved, but again it will depend upon the quality of ground water. It may take several years to restore the quality of underground water due to the slow mobility velocity of the aquifer. In case of failure of the plant the tanneries effluent will flow in a brick channel to the Pandoki drain. This will significantly reduce the chances of groundwater pollution. In Pandoki drain the dilution factor of 1:4 of tannery effluent and drain water will not be sufficient to avoid creating problems for animals.

11. Fisheries

There is a scarcity of data on water quality, discharges, and beneficial uses and what data does exist should be used with caution. However, fisheries within the Sutlej do form an important part of the local economy and are sold by auction each year. Last

year Sutlej fishing rights fetched 20-30 lakh for the whole river and approximately 6 lakh downstream of the proposed discharge point.

Fisheries is perhaps the only area where construction and operation of the treatment plant will have a detrimental effect. The extent of the damage to fisheries is primarily dependent upon the frequency of plant breakdown and the season it occurs.

Although final effluent quality is poor by most standards, normal operation of the plant is considered likely to have minimal impact on fisheries during high flows. During low flows fish are likely to show an avoidance reaction. It is however the teams view that breakdowns are almost certain to occur. Three separate scenarios of operation and their effect on water quality and fisheries are considered in more detail in sections 12, 13, 14 and 15.

A further point that should be made is that the natural oxidation assumed in the proposed Green channel has not been quantified and there is little evidence to support this.

12. Treatment Plant Design

The treatment plant design incorporates two factors which are control of sulphides generation by aeration and BOD removal by lagooning. Comparison with experience elsewhere and published references suggests that odours are likely to be generated when the plant is operational. The intended location of the treatment plant is adjacent to Stagnant Pool 2. Upon draining of the stagnant pools a considerable area of land will be available. The odour generation should be considered in any land use planning and a buffer zone of 1 km from any residential development maintained.

The plant performance specification refers to "natural purification" as evidenced by Rohi Nullah based on experimental results. Natural oxidation is possible as Rohi Nullah is slow moving, shallow, and heavily overgrown with algae and aquatic weeds. However such naturally occurring reaeration is related to photosynthesis and may vary diurnally. The experimental exercise was repeated and no evidence of significant reaeration was found. In addition as the final outfall will be a concrete channel with little likelihood of aquatic life, reaeration in the outfall is considered unlikely.

The acceptability of discharging the treated effluent to Pandoki Outfall and then to the River Sutlej relies heavily on large dilution, and assumes there are no beneficial uses of these water courses. Pandoki outfall is used for washing of clothes and livestock watering but this is an informal and perhaps illegal activity and so detrimental effects to Pandoki are not considered an issue.

The quality of the treated effluent will not be such that discharge to Sutlej can proceed without some adverse effects at times of low

flow unless the treatment plant is upgraded to produce higher quality effluent. At time of high flow the discharge will be acceptable under normal operating conditions.

13. Effects Due to Normal Operation of the Plant

This would involve 13,000 m3/day of treated tannery effluent entering the Pandoki and then the Sutlej.

The effluent is not treated to a high standard and at periods of low flow dilution within the Pandoki is only 6:1. Further salinization and high levels of chromium and sulphides may exclude aquatic life from the Pandoki and any fish remaining should not be used for human consumption. The status of the Pandoki however is as a drain, and adverse ecological effects are of little consequence.

Under normal operating conditions the major concern from a fisheries aspect is the concentration of chromium and sulphides generated within the Sutlej. To meet the standards that avoid bioaccumulation within fish flesh a minimum flow of 1500 cusecs is required. During the dry season these standards will not be met for several months. This could result in fish being unfit for human consumption if taken from the short stretch of the river below the connection with Pandoki drain, before complete mixing occurs with the main branch of the river. Since many fish will show an avoidance reaction to the discharge this would be of limited effect.

14. Effects due to Failure of Dingarh Pumping Station

If the proposed Dingarh pumping station fails then Rohi Nullah will receive its current untreated effluent load and the Sutlej, via the Pandoki will receive 9,500 m3/day of treated effluent. Given the current high assimilative capacity of Rohi Nullah, it is unlikely to result in a significantly worse situation than discharge under normal operation as described above.

However the quality of the Rohi Nullah will have been improved under normal operations, and if breakdown occurs after some time, the Rohi Nullah is expected to revert to its previous state.

15. Effects Due to Total Failure of Treatment Plant

This situation would result in 13,500 m3/day of untreated effluent entering the Pandoki outfall and then the Sutlej.

With a B.O.D. of over 1200 mg/l it is likely to have a severe deoxygenating effect on firstly the Pandoki and quite possibly the Sutlej. A fish kill in the Pandoki is almost certain, assuming normal discharges have not already excluded aquatic life.

The effect of a plug of deoxygenated water, of high B.O.D. entering the Sutlej will almost certainly result in a fish kill. Its extent will depend on the time the discharge continues for, and the

dilution flow available within the Sutlej. The high temperatures and nutrient levels within the Pandoki may mean that the B.O.D. is quickly exerted and the effect on the Sutlej will be lessened. However this occurrence cannot be relied upon.

The long term break down of the plant is likely to result in fish from the Sutlej being unsuitable for human consumption due to high sulphide and chromium levels.

To meet the standards for receiving water quality to avoid contamination of fish intended for human consumption, requires a minimum flows of 40,000 cusecs in the case of sulphides, and 3,000 cusecs for chromium.

These conditions will be met for chromium for only 20% of the low flow period between October and March. The situation for sulphides is worse, and required dilution will never be achieved during this period, and for only 50% of the remainder of the year.

It must be stressed that this assumes total failure of the plant and permanent discharge to the river. This will lead to steady state conditions whereby the fish life are exposed for a sufficient time for ingestion of chromium and tainting by sulphides to occur. This is not an instantaneous process and should be viewed in the context of the life cycle or maturity period of the fish which could be months or seasons.

Should steady state conditions prevail, that is a permanent discharge occur,then sulphides in particular, and possibly chromium may reach toxic levels. Fish kills could occur and the fish would not be fit for human consumption. With the limited data available it is difficult to quantify the effects.

16. Mitigation Measures Against Total Failure of the Plant

The scenario described above assumes total failure of the plant and necessary discharge of the collected effluent ultimately to the Sutlej. In the event of this happening a mitigation measure is proposed of discharge of untreated effluent to the Rohi Nullah. This could be achieved at the point where it crosses the Depalpur road by means of mechanical weirs or gates.

The long residence time within the Rohi Nullah, its low velocity and large surface area should effectively reduce the pollution load entering the Sutlej. This mitigation measure would provide an effective buffer whilst the plant became operational again. A fish kill would probably occur but the effects of this would be limited and controllable.

The blocking of the Sutlej river to form a lagoon at times of low flow has been considered. This would be an effective technique as it would effectively create another maturation lagoon but the practicalities of this are in doubt as a permanent measure. It could be a useful temporary measure whereby manual labour was

employed to erect earth bunds across the river to contain any unplanned discharges. This should be a normal contingency plan response on the part of the plant manager.

The prevention of such a situation arising is a management and administration matter. Often too much emphasis is placed on capital and recurrent costs such as electricity which are easy to quantify. Routine maintenance is usually included in budgets but non routine maintenance in response to a breakdown is often overlooked. Although the design will include standby systems as a matter of course, unless adequate monies are allowed then breakdowns may become permanent. Also such funds should be under the direct control of the plant manager so that he may immediately commission contractors and not be subject to decision by committee or a lengthy administrative procedure.

17. Institutional Aspects

A major conflict exists between the Kasur Municipality and PHED. The Municipality claim that the sewerage system installed was improperly designed and does not function correctly. PHED state that this is not the case and have considerable documentary evidence to support this. Whatever the reality, such a situation offers little by way of reassurance for the effective functioning of a joint management authority, which is crucial to the successful operation of the plant, unless a privatised scheme with financial incentives is implemented.

18. Conclusions

There is no doubt that the environmental conditions in Kasur are detrimental to the health and well being of the inhabitants, the tanneries workers, and the farmers. Some form of overall environmental improvement scheme is required and this proposed treatment plant could form the first step in such a program. The treatment plant as proposed will effect a significant improvement by removal of the stagnant ponds, permit farmers to recover contaminated land and allow for the future development of Kasur. These benefits do have an associated penalty which is that the treatment plant will produce solid and liquid wastes which must themselves be disposed of.

All of the environmental aspects of the scheme have been examined and two key issues identified. Solid wastes quantities will be considerable but not problematical as chromium contamination of groundwater is not considered to be an issue, although a recommendation on a revised site location has been made.

Discharge of the treated effluent is a major issue and it has been recognised since the very inception of the project that a convenient and adequate receiving water body does not exist. All the options for disposal of the effluent (and sludge) have been reviewed and are included in Table 1.

After due consideration of all the options it is agreed that discharge to Pandoki drain and the Sutlej river is the only viable option. At times of low flow severe environmental degradation to Pandoki can be expected. However this is a drain under the control of the Irrigation Department, any other uses are carried out without approval and so any deterioration of the water quality is not an obstacle.

Sutlej River does support significant fisheries activity and at times of low flow there may be some limited adverse effects.

The discharge of the waters from Kasur treatment plant will be of acceptable quality for the dilution afforded for the nine months of the year. Under normal conditions there is unlikely to be any deoxygenation and toxic effects on the Sutlej River. However for three months of the year dilution will be insufficient to prevent localised effects and some bioaccumulation in fish of chromium and sulphides may occur.

If the plant were to fail and not be repaired then the current pollution load in Kasur would be transferred to the waters of the river Sutlej. Whereas at the moment the situation in Kasur is undesirable, it is containable. On the contrary, discharge of the untreated effluent to the river would exceed allowable concentrations for fisheries for protection of human health and could lead to long term chronic health effects.

Management, institutional, and technical measures have been identified in the report to mitigate against this on a temporary basis but continuous discharge of the untreated effluent into the river system on a permanent basis is unacceptable. Satisfactory assurances must be obtained that this will not occur. If these are forthcoming then on balance the scheme will effect a significant improvement in the general conditions in Kasur and the adverse effects are of an acceptable level. If these are not obtained then the scheme will transfer a problem area from one location to another.

19. Recommendations

a) The decision to go ahead with this scheme must be taken in the knowledge that there will be localised adverse effects during times of low flow.

b) The proposed treatment plant should be modular and be upgraded once the plant has been operated successfully for a time.

c) The scheme must be seen as the first part of an integrated project to improve the environment in Kasur.

d) A contingency plan should be drawn up to be taken in the event of plant breakdown.

e) The land under stagnant pools should be reclaimed scientifically with adequate monitoring.

f) The landfill site should not present a hazard, but should be kept separate from other forms of solid waste. It could be sited nearer the plant.

g) A baseline monitoring survey is suggested involving; health; ground water quality; fisheries; water quality of receiving waters; and plant growth in the sludges.

TABLE 1

REVIEW OF TANNERY EFFLUENT PRETREATMENT AND DISCHARGE OPTIONS

Possible alternative tannery effluent pretreatment options are reviewed below

ALTERNATIVE	BENEFITS	DISBENEFITS
EFFLUENT AND SLUDGE TREATMENT		
Evaporation lagoons	No effluent discharge	Large area (ca 400 ha) and long transport of the raw effluent required (ca 20 km).
Treatment by naturally aerated lagoons	No primary treatment	Big area required (ca 30 ha) and still effluent has to be discharged.
Aerated lagoons	less area required	High power (O/M costs) requirement.
Chemical treatment*	Improved quality effluent	High O/M costs and permanent foreign exchange contribution.
Sludge treatment by mechanical treatment** presses or centrifuges	Less transport costs	High investment and O/U costs, purchase of polyelectrolyte requires high foreign exchange contribution

* NOTE: Artificial aeration and chemical treatment are considered as possibilities to upgrade the treatment efficiency of the CEPTP, if and when necessary.

** NOTE: Mechanical treatment should be considered in the final stage of the full scale system implementation.

ALTERNATIVE	BENEFITS	DISBENEFITS
EFFLUENT DISCHARGE		
BRBD Link Canal	Short outfall distance	No guaranteed dry weather flow, high pumping, private property must be crossed.
Rohi Nullah	Short Outfall distance few beneficial uses	Pumping required private property, must be crossed, discharge into neighboring country surface waters.
CEPTP location at the site recommended for solid waste disposal and discharge into the BRB or R. Nullah flows	No land use conflicts as town expends, short outfall distance	High pumping costs of raw domestic sewage as plant must be designed for peak Discharge to Rohi Nullah or BRBD link suffers from low flows.
Direct into the Sutlej river	No effects on Pandoki outfall long transport	Transport over 8 km of private owned land.
Prolongation of the final Outfall alongside Pandoki Outfall	No effects on Pandoki Outfall	Transport over 10 km of private land.
Deep Well injection	No water course required for effluent disposal	Not technically feasible.
Spray evaporation	No water course required for effluent disposal	Very expensive and health hazards.

ALTERNATIVE	BENEFITS	DISBENEFITS
Discharge into Pandoki and BRBD Canal at BRBD Siphon	No discharge into Sutlej river	No guaranteed flow in BRBD Canal
Install gate at BRBD Siphon to flush Pandoki drain	Technically simple and would improve quality of Pandoki. Could meet requirements of Fisheries Department.	Needs approval of Imigation Dept, no guaranteed flows in BRBD canal. 10:1 dilution ration required.
Construction of low flow veir and extension of Pandoki Outfall into centre of Sutlej rather then branch	No odours adjacent to river bark at times of low flow	Flow in centre of Sutlej no better than in branch. No major improvement Necessary to cross 1.5 km of river bed.
Fiscal Measures. Provide tube wells to villages affected by Pandoki deterioration and compensate fishermen	There are only 15 village and most have tube wells already so cost should low. Little fishing activity can take place in dry season 64 fishermen identified	Excessive claims for lost fishing rights will be made. Baseline data collection program is essential Fishing right Rs. 330,000
Build Phase 2 Treatment Plant	No detrimental effects to Pandoki or Sutlej. Fisheries Dept. requirements met. Large scale improvement in Kasur twon	Capital costs of US $ 25 million

CONTENTS

1.0 BACKGROUND

1.1 Project Title

The project is Preparatory Assistance in the Treatment of Tannery Wastes in Kasur, the Islamic Republic of Pakistan, DP/PAK/89/05.

1.2 Project Initiator

The town of Kasur is located in Punjab Province near the border with India where the River Sutlej enters Pakistan. Kasur has been known since antiquity as a centre of trade, commerce, and culture yet little evidence of this survives today (Figure 1.1). Industry represents a major activity in the area, and tanneries have existed in Kasur for several decades. They now number over 160 individual factories varying in size from large to small. The tanning industry is generally regarded worldwide as a "noxious" industry, and the situation in Kasur is no different. No special provisions were made at the time of developing the tannery industry to treat the liquid and solid wastes and this has led to serious environmental degradation of the general conditions both in and around Kasur.

In response to this situation the Tanneries Association Dingarh approached the Government of Pakistan and requested assistance. They in turn approached international aid agencies and a Preparatory Assistance Project was agreed. This has been funded under UNDP/UNIDO (PA) PAK/89/025, Treatment of Tannery Waste, assisted by support from Netherlands Bilateral Aid and the Norwegian Development Agency (NORAD).

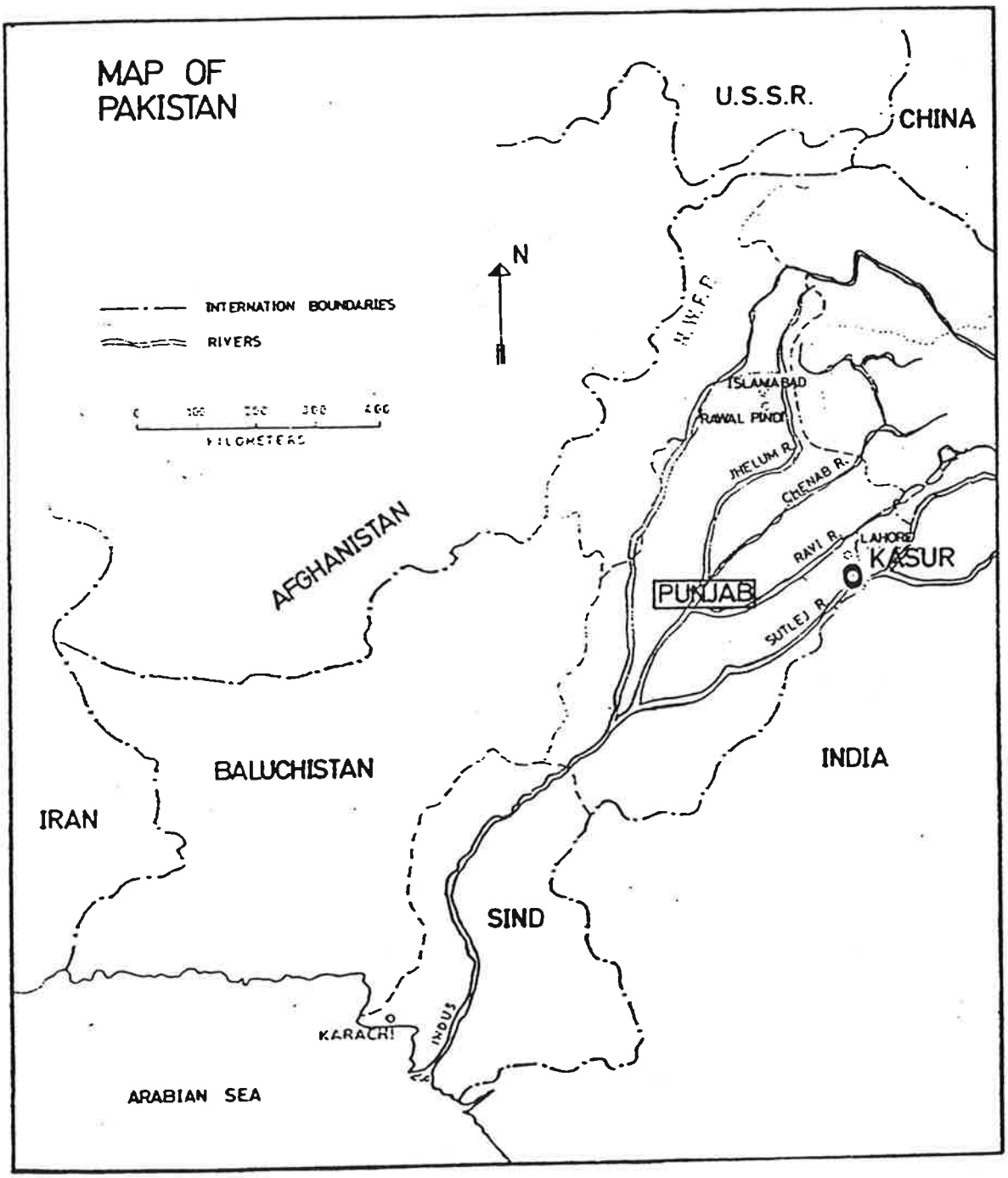
1.3 Preceding Studies

Over the previous three years various studies have been conducted as components of the preparatory assistance. These have included: a Techno-economic Study which examined technical alternatives and proposed a preferred design solution; a series of socio-economic studies which examined social, economic, public health indicators, community health and welfare, quality of drinking water and air, irrigation, agriculture, livestock, and institutional framework. In addition, various independent reviews of the project were carried out by a UNIDO consultant, a NORAD consultant, and a Netherlands Bilateral Aid Agency Consultant.

1.4 Need for Environmental Impact Assessment

The proposed solutions for the treatment of the tannery wastes are estimated to cost in the order of $8 million for which US$ 3,748,000 are for civil construction works, US$ 3,295,000 for equipment and US$ 934,000 for technical assistance inputs. Before an investment of this order is made, it was felt prudent to carry

FIGURE 1.1



LOCATION OF KASUR

out an environmental impact assessment (EIA) of the proposed treatment works. Whilst such a treatment system is designed to treat pollution, and so is self-evidently environmentally beneficial to the situation in Kasur, the treated effluent must ultimately be discharged into a receiving water body.

Due to the constraints of local technical ability, finance and timing, it is not viable to treat the effluents and wastes to a level whereby discharge to the environment will be totally benign. Therefore an EIA was commissioned to examine the consequences of improving an existing situation at one location, but with potentially significant effects elsewhere.

1.5 EIA Team

In order to perform the EIA, NORAD in conjunction with Netherlands Aid and UNIDO commissioned IUCN to undertake the study. They compiled a team consisting of:

- Project Director and IUCN Coordinator
- Team Leader, Project Manager and EIA Specialist
- Hydrologist
- Agriculturalist
- Community Health Specialist
- Fisheries Specialist

In addition the Director General Punjab EPA requested that members of his staff be assigned to the project. Consequently the Deputy Director (Technology Transfer) joined the team. He is the officer within the EPA responsible for EIA evaluation. Also the Punjab EPA laboratory staff were utilized with a Research Assistant and laboratory technician assisting with field work and analysis. Full details of the team are given in Annex 1.

The EIA commenced on November 22 1992 with the arrival of the team leader in country. One month's field work was conducted by the various team members, including data gathering and consultations. The report was then produced in the home office.

1.6 Scope of Work of the EIA

Many of the issues to be addressed in the EIA have already been examined in the course of separate studies over the last three years. Therefore the requirements for the EIA were:

- Review all previous documents produced during the Project including details of the proposed treatment plant.

- Assessment and detailed discussions with authors of the various reports to clarify the reliability of the social and agricultural baseline data already collected.

- Meetings with the Tanners Association in Kasur, and the Kasur Municipality to discuss local concerns.

- Collection of hydrological data relating to the recorded flows in the Sutlej River and its tributaries and data on groundwater around Kasur.

- Collection of information concerning the beneficial uses of water bodies, including irrigation, water supply, fisheries, wildlife and industry both upstream and downstream of the Sutlej River.

- Assessment of efficiency of proposed treatment plant, the quality of effluent under different conditions, dilutions afforded at different times of year and likely impacts upon receiving water quality and the users of this water. The various zones of influence of the effluents would be outlined.

- Should any of these assessments prove unfavourable, proposal of mitigating measures to protect water users in the event of different scenarios.

- Assessment of the hazards involved in the final use of any reclaimed areas which are currently unusable due to unacceptable levels of pollution.

- Assessment of the hazards resulting from tannery solid waste management and disposal, particularly leachate and contamination of ground water. This should include information on the hydrology and groundwater use.

- Recommendations for monitoring environmental quality and health.

- Whilst it was not anticipated that detailed sampling and analysis would be possible during the EIA, spot sampling and site measurements would be made as necessary.

Full details of the Terms of Reference are given in Annex 2.

2.0 STATEMENT OF NEED

2.1 Introduction

The leather sector in Pakistan is one of the fastest growing foreign exchange earners, contributing some Rs. 11,500 million in 1989/90. The tanning industry is concentrated in Karachi (where over 50% of the leather is produced), Kasur (which produces 30% of the total), Lahore, Sahiwal, Multan, Gujranwala and Sialkot. In none of these locations has any attempt been made to treat the tannery wastes and the project at Kasur, where the problems are arguably the most acute, is seen as a prospective model for other concentrations of the industry.

In Kasur there 159 tanneries processing some 8,000 hides and 12-15,000 skins each day to the wet-blue stage. These tanneries are located in three clusters in the centre of a town of over 250,000 inhabitants (Figure 2.1). The volumes of waste water being discharged from these three clusters is estimated to be as follows:

Dingarh	48 tanneries	3,560cu.m per day
A.Qadir/ N.Nagar	95 tanneries	4,690cu.m per day
Y.Nagar	16 tanneries	550cu.m per day
TOTAL	159 tanneries	8,800cu.m per day

In addition there are discharges of domestic sewage. Allowing for the predicted growth in the number of tanneries, the total volume of waste being considered for treatment is 12,700 cu.m per day.

The wastes from Dingarh discharge into the Rohi Nullah, an abandoned water course which now carries only domestic sewage and tannery waste. This water is used by farmers with lands adjacent to the Rohi Nullah for irrigation.

The discharges from the other clusters are collected in an open, earthen channel along the main road and flow under gravity to stagnant pools of highly coloured waste water, each of several hectares in area. During periods of rainfall these ponds spillover into adjacent lands and there is a potential risk that the groundwater could be contaminated.

The municipal sewerage system was constructed in 1978 to cover 50% of the township. Some sewage is collected by subsurface drains and is discharged into a pumping station which lifts it into the Rohi Nullah. Owing to organisational and financial problems the system is not operational. It has become silted, the sewers may be damaged and the sewage backs-up. Estimates of the future volume of sewage are about 30,000 cu.m. per day as the piped water supply to the town is extended. At present it is approximately 10,000 cu.m. per day.

FIGURE 2.1 - LOCATION OF TANNERIES

Solid wastes arise from the tanneries and from residential areas. They are disposed of by casual dumping in various places including the Rohi Nullah. Some of the solids from the tanneries are used for by-products, but is estimated that the total quantities to be disposed of are 100-150 tonnes/day tannery wastes and 150-200 tonnes/day domestic waste.

The previous surveys on public health, livestock and agriculture appear to indicate that water supplies from handpumps and tube wells, and foodstuffs produced in the area are contaminated with dissolved solids, especially sodium chloride and sulphides. However, this needs to be verified.

The general standard of hygiene existing in Kasur is very poor and gives serious cause for concern. Examination of medical records reveals that there is a high incidence of respiratory disorders and skin infection related diseases although it is thought that these are due to the conditions under which the tannery workers operate rather than secondary effects of tannery effluent. The sanitary conditions in Kasur are similar to those found in many rural townships but are exacerbated by the close proximity of residential dwellings and industry.

Drinking water in Kasur is obtained by tubewells. Residents complain about the quality of the water deteriorating due to organoleptic effects which commenced some 5-7 years ago. Analysis of the water from the tubewells shows that it is outside the W.H.O. standard for dissolved solids and is brackish to the taste.

There is no doubt that conditions in Kasur are detrimental to the health and well being of the population although it is not possible at this juncture to state that the health problems of the population are due primarily to the tanneries, rather than the tanneries adding to generally insanitary conditions. It must be emphasised that there are other industries discharging to the municipal sewerage system, domestic sewage is a major concern, and resolving the tanneries effluent problem will not redress the situation for the total population of Kasur. An overall masterplan is needed of which the tanneries effluent treatment plant should be the first stage in implementation.

There is no doubt that this treatment plant must proceed. However, the treatment plant must be part of an overall strategy to improve the total conditions in Kasur. If the commitment to undertake the implementation of an overall strategy is not secured from all parties, then resolving the tanneries related issues will not necessarily benefit all the residents of Kasur, but it would still represent a major improvement.

3.0 PROJECT DESCRIPTION

As part of the Preparatory Assistance Project a Techno-Economic Study has been carried out by UNIDO Consultants. (Preparatory Assistance in the Treatment of Tannery Wastes in Kasur, DP/PAK/89/025; TEH-PROJECT HIDRO, July 1992).

This was a very comprehensive study and produced many involved and detailed reports. Field surveys were carried out to establish by measurement volume flows of liquid wastes from individual tanneries. Solid waste arisings were both measured and calculated, and future growth patterns predicted.

It has been identified that the environmental problems in Kasur derive from the following three sources:

- Tanneries
- Domestic sewage
- Other industries

Each of these three sources is responsible for generation of liquid effluents. At the moment there is no overall collection, treatment and disposal system and any effluents produced find their way by gravity to existing water courses or into low lying areas, forming the "stagnant pools". To tackle the problems causing this situation a two phase approach has been proposed:

- **Phase 1** is the installation of a collection, treatment, and disposal system aimed primarily at tanneries effluents.

- **Phase 2** is extension of the tanneries effluent collection system to receive domestic and other industrial wastes, extension of the treatment plant to accommodate all effluents, and final disposal.

The major objective of the project is implementation of Phase 1 in such a manner as to facilitate subsequent implementation of Phase 2.

The present flow rate is estimated to 8,800 cu.m/day with an eventual flow rate of 13,000 cu.m/day. UNIDO proposes that the first phase for immediate implementation will include:

- Introduction/construction of in-house arrangements
- Construction of the tannery effluent collection system
- Installation of the Common Tannery Effluent Pre-treatment Plant (CEPTP) with laboratory
- Construction of the Final Outfall
- Installation of the Cr-recovery and by-products processing pilot plant(s)

- Installation of and arrangements for the CEPTP's sludge processing, transport and disposal facilities.

In addition some technical assistance will be provided.

The proposed treatment works for the effluents will consist of:

- Screening
- Equalisation of the wastes
- Two settling tanks with sludge and scum collection of 18 m diameter and 2.5 hrs detention time
- Sludge drying, consisting of drying lagoons operated on a 6 week rotational basis capable of handling sludge volumes of 680 cu.m per day
- A system of aerobic lagoons for biological treatment of effluent

After treatment the tannery effluents are to be carried by a newly constructed drainage channel known as the Final Outfall to an irrigation drain, the Pandoki outfall, and from there into the Sutlej river, a distance of 17 km. It is postulated that since considerable natural oxidation of the tannery wastes presently being discharged into the Rohi Nullah has been found to occur, such natural oxidation will continue in the drainage channels before it reaches the Sutlej river. The conditions in the Rohi Nullah itself should be improved as the tannery effluents currently discharged there will be diverted to the Common Effluent Pretreatment Plant.

The sludge treatment and solids disposal will take place at a site in a disused railway cutting, within 5 km of the town.

Space to locate the CEPTP and the solid waste disposal site is very limited and the procurement of a site is further complicated by land ownership rights. The sites selected are located on the old disused railway line, as this land is still under government authority and so purchase should be less problematical.

4.0 IDENTIFICATION OF ENVIRONMENTAL ISSUES

4.1 Situations Arising From Normal And Breakdown Conditions In The Treatment Plant

At present, the tanneries operation results in discharge of large quantities of untreated liquid effluent and solid waste. Solid waste has primary and secondary adverse environmental effects in that the wastes themselves are a problem, and their casual tipping can cause blockages of drainage channels and sewer systems causing flooding of stormwater, sewage and industrial effluents. It is intended that the construction of the treatment plant and its associated collector system will alleviate this situation as the first stage of an overall environmental improvement and waste management strategy. It is possible that the treatment plant may not operate at full efficiency at all times, and so for the purposes of the EIA the following scenarios have been examined:

Scenario 1
The treatment plant operating as specified at a constant daily rate of 13,000 cu.m/day after primary treatment and "self purification" in the drainage channels. This, along with the disposal of solids, can be called normal operation and would give the effluent characteristics, as shown in Figure 4.1 below which would be ultimately discharged into the Sutlej River.

Figure 4.1 : Treated Effluent Standard

	BOD	COD	SS	CL	S-2	Cr+3
Treated Tannery Effluent mg/l	<450	<1600	<150	<3200	2-4	1-2

Scenario 2
If the proposed Dingarh pumping station were to fail the 3,500 cu.m/day currently being discharged into the Rohi Nullah will revert back to it and be mixed with the sewage from Kasur township. Under this scenario 9,500 cu.m/day will be discharged as treated effluent into the Sutlej river.

Scenario 3
If the treatment plant fails completely, the waste may have to be diverted directly into the new drainage canal and will eventually be discharged into the Sutlej River. Although untreated, some BOD reduction may take place during its passage to the river. This worst case scenario would mean discharge of wastes with characteristics shown in Figure 4.1 into the River.

It is necessary to compare these situations with the present baseline conditions which exist. The main cause for concern is therefore the Sutlej River and the dilution afforded by its waters. The most critical time will undoubtedly occur if breakdown occurs during the dry season, when very little water flows particularly as the waters of the Sutlej are under Indian control.

4.2 Discharge To Pandoki Outfall And Sutlej River

Based on unconfirmed information given by the resident authorities in Kasur, during the project preparation it was estimated that the winter flows in the Pandoki Outfall were around 1 cu.m/sec (35 cusecs) rising to about 55 cu.m/sec
(2000 cusecs) during the monsoon when the channel is completely filled with water. In the Sutlej river, the low winter flow was given as 1,000 cu.m/sec. As a result, the dilution ratio between the discharge of the treated effluent at 0.15 cu.m/sec (13,000 cu.m/day) and the water flow in the Sutlej River during winter was taken as 1:6,000. [These figures were later discussed with the appropriate authorities e.g. WAPDA and significant variance found.]

Environmental concerns include the flows of the river throughout the year, and the subsequent uses to which the waters are put: irrigation, water supply for humans and livestock, and fisheries. Apart from the Sutlej River, some uses are made both of the Rohi Nullah and the Pandoki Outfall particularly for irrigation. The impacts upon these uses should any components of the plant fail were considered.

In particular, if natural oxidation and settlement occurs as predicted, the main cause for concern could be the additional salinity introduced by the tannery effluents into the water bodies, as the high salt content of the tannery effluents will pass through the treatment plant without reduction. Chromium concentrations in the wastes at Kasur are generally lower than normal for tannery wastes due to the reuse of spent tanning solutions by smaller tanneries. Also a major proportion of the chromium will settle out in the sludges and so will not be discharged in the final effluent. However, it will remain in the sludge.

4.3 Sludge Treatment And Disposal

In addition to comparing the above scenarios to the existing situation, it is also necessary to consider the impacts of dumping of solid wastes in the sites identified, particularly since most of the chromium will be deposited there. Issues to be considered here include the stability of the chromium and the possibilities of contamination of ground water particularly during the rainy season. Whilst much research has been done on the stability of chromium sludges in other situations, this information must be considered in

relation to the particular sites selected and the groundwater conditions.

4.4 Drainage Of The Stagnant Ponds

It is being proposed that the existing stagnant ponds be drained and reclaimed. In view of the fact that they have developed over a long period of time and will contain contaminants, it is necessary to consider the hazards associated with reclaiming and reusing the land.

5.0 HYDROLOGICAL ASPECTS

5.1 Hydrological Description

Kasur is subject to pollution problems arising from:

- Tannery waste water from the three tannery clusters on the left bank of the old course of Rohi Nullah
- Sanitary effluent of the 250,000 inhabitants of Kasur town finding its way through a number of routes into the Rohi Nullah
- Percolation of sanitary effluent into the soil during the dry season

The following quantities of waste water are discharge :

Dingarh	3,560 cu.m per day
A. Qadir/N. Nagar	4,690 cu.m per day
Y. Nagar	550 cu.m per day
Total from tanneries	8,800 cu.m per day
Domestic sanitary waste	3,900 cu.m per day
Total volume	12,700 cu.m per day

Dingarh tanneries waste falls into Rohi Nullah in addition to sanitary waste from Kasur Town. The waste water from the other clusters is collecting in three stagnant pools along Kasur-Dipalpur Road. During the rainy season Rohi Nullah and the stagnant ponds overflow having a further deleterious effect on the situation in and around Kasur Town.

The Pandoki Drain which is about 8 km. from the stagnant pools is a nearby drainage channel which could carry the waste water to the River Sutlej. It is proposed that the waste water from the treatment plant may be dropped into Pandoki Drain which then flows 10 km. further on to River Sutlej as emission into Rohi Nullah is not considered viable.

5.2. Rainfall Runoff Relationship

The runoff from a drainage basin may be considered as a part of the hydrologic cycle which is influenced by two major groups of factors: climatic factors and physiographic factors. Climatic factors include mainly the effects of rainfall interception, evaporation and evapotranspiration, all of which exhibit seasonal variations. Physiographic factors may be further classified into two kinds: basin characteristics and channel characteristics. They can cause two neighbouring basins of similar size to behave entirely differently with respect to runoff phenomena. Flow data was available for Sutlej River but not for Pandoki Outfall.

Therefore flows in Pandoki Outfall were calculated from known rainfall data.

5.3 Sutlej River Flows

Ganda Singhwala is the entry point of the River Sutlej into Pakistan, and the area on the right side of the River Sutlej from Ganda Singhwala to Sulemanki lies within Pakistan. Ideally one needs the discharge data of the river at this point, and a gauge is maintained at this site by the Dipalpur Canal Circle of the Irrigation and Power Department Punjab. This is intended to act as an early warning indicator but there is no discharge measurement site.

There is also a gauge/discharge site on the River Sutlej near Baherke Canal Rest House about 40 km. downstream of Ganda Singhwala. However, the river follows an uncontrolled and meandering passage at this point and so the discharge site was discontinued. Now only a gauge site is maintained.

Sutlej River discharge data is available upstream of Sulemanki which is about 60 km. downstream of Kasur. The data for Sulemanki includes the discharge flowing through the Balloki Sulemanki Link-I and II and so in order to determine the discharge figures near Kasur the discharge from the link canals was deducted. Consequently the base discharge data used is that obtained from upstream of Sulemanki. Daily River Sutlej discharge data for the period 1922 to 1991 was collected from the Discharge Division of the Irrigation and Power Department, Punjab. (Figure 5.1)

5.4 Frequency Analysis of Sutlej River Flows

5.4.1 Frequency Analysis of Minimum Flows

Minimum flows in the river near Kasur are the most relevant for the purposes of an environmental assessment as this will allow evaluation of the worst case condition.

Frequency analysis of flows for the months of January, February, March, October, November and December are shown in Figure 5.2 and 5.3. In the analysis Weibull's Plotting Position have been used. As a result of this analysis, exceedence levels of minimum discharges have been determined and are given in Figure 5.4 indicating at 40% exceedence level the mean value of minimum discharges occurs. One can expect the discharge at 40% exceedence level to occur after every two years. The 50% exceedence level indicates minimum flows through the period October - March of 150-260 cusecs. At times zero flow is recorded.

5.4.2 Frequency Analysis of Maximum Flows

The analysis was also performed for the maximum flows during the same months i.e. January, February, March, October, November and December and are shown in Figure 5.5, 5.6 and 5.7. The exceedence level of maximum discharged during the low flow months are given in Figure 5.8. The table shows that the mean maximum discharge during the low flow period varies between 600 to 1,800 cfs which would be sufficient to assimilate the treated waste water without affecting the quality of water assuming a reasonable value of mixing ratio.

5.4.3 Frequency Analysis of Maximum Peak River Flows

The analysis of Annual Peak Discharges was carried out. The peak discharge values are given in Figure 5.9 and the analysis is shown in Figure 5.10. The analysis of exceedence level indicates that a peak of discharge of 145,000 cfs can be expected after every two years and 460,000 cfs on a 20 years return period.

5.5 Pandoki Drain

Pandoki Drain was initially constructed by WAPDA and subsequently handed over to the Irrigation and Power Department as a collector for the seepage of the area. There is no gauge or discharge measurement station on the drain as is usually maintained on other water courses. Data is limited but full use has been made of available information for determining the runoff depths and flows in Pandoki Drain by calculation.

Kasur area receives about 400 mm annual rainfall with very low precipitation during January, February, October, November and December months. The rainfall runoff relationship was examined for Kasur, especially for the area including Pandoki Drain. The climatological and the rainfall data utilised in the computation is given Figure 5.11, Figure 5.12 and the computation is given in Figure 5.13.

For the purposes of the EIA minimum daily rainfall data of Kasur was used. It will be seen that during January-May, October-December there is no runoff. The runoff is only during June-September for 4 months only. This gives an average annual runoff coefficient of 16.75% with Standard Deviation equal to 22.5 and coefficient of variance = 1.34.

The Hydraulic Profile of Pandoki Outfall, which shows the original design, was obtained from the drainage division of the Irrigation and Power Department. The minimum catchment area was taken from the longitudinal section of the drain.

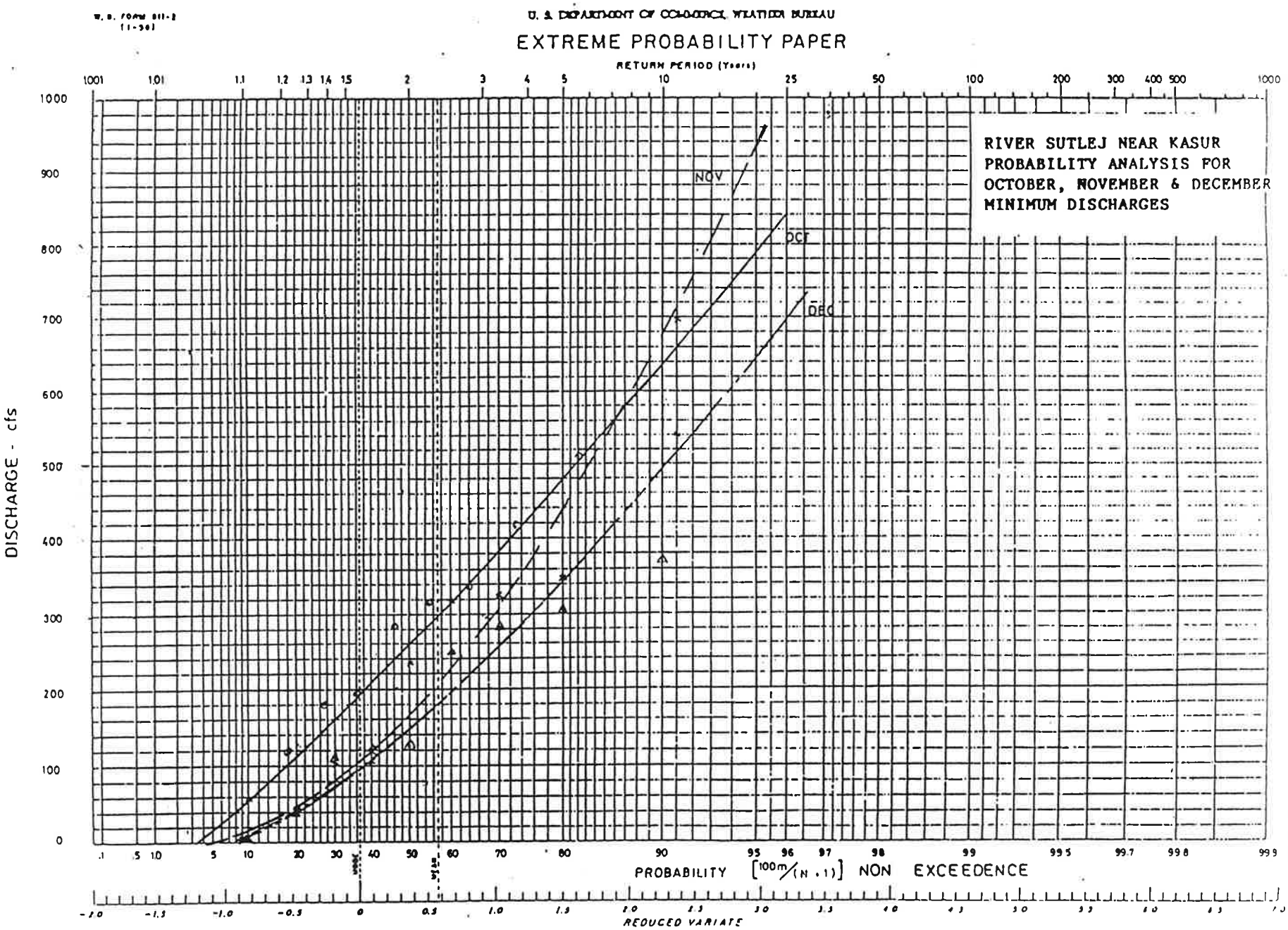
The computation of minimum flow in Pandoki Drain is given in Figure 5.14 and plotted in Figure 5.15. A copy of the longitudinal section of the drain was obtained from WAPDA which gives complete hydraulic data of the drain, but not the minimum flow. Figure 5.14 shows that the minimum flow is of the order of 10 cfs during October and November and during December January the minimum flow rises up to 20 cfs. The highest minimum flow of 150 cfs occurs during July. The design flow of the Pandoki drain is 624 cusecs. Allowing a 25% freeboard factor this would give a maximum flow of 780 cusecs at which point overtopping would occur.

It should be noted that in the Design Review document (Technic-Economic Comparison Between Different Treatment Alternatives, Part 6, Working Document based on the work of Dr G. Soderlund, April 1992, Revised May 1992, Annex I P. 4) the assumption is made that the maximum flows are 2,000 cubic feet per second. This statement contradicts the information made available to the EIA consultants.

FIGURE 5.1

RIVER SUTLEJ
PEAK DISCHARGES
SULEMANKI HEAD WORKS UPSTREAM

Year	Dicharge 1000 cfs	Date	Year	Discharge 1000 cfs	Date
1922	-		1957	210	9/9/57
1923	-		1958	244	10/8/58
1924	-		1959	152	24/9/59
1925	190	27/7/25	1960	267	6/9/60
1926	207	3/8/26	1961	265	10/8/61
1927	176	4/8/27	1962	226	26/9/62
1928	133	5/9/28	1963	152	16/6/63
1929	267	21/8/29	1964	185	21/8/64
1930	270	31/7/30	1965	91	30/8/65
1931	141	24/8/31	1966	202	10/9/66
1932	239	29/8/32	1967	189	31/8/67
1933	202	18/8/33	1968	100	1/8/68
1934	174	20/7/34	1969	150	23/8/69
1935	194	14/8/35	1970	106	18/8/70
1936	207	30/7/36	1971	227	15/8/71
1937	154	10/8/37	1972	93	15/7/72
1938	214	4/8/38	1973	177	15/8/73
1939	124	31/7/39	1974	281	27/7/74
1940	116	6/8/40	1975	49	21/9/75
1941	172	22/8/41	1976	118	6/9/76
1942	325	24/8/42	1977	53	25/9/77
1943	309	18/8/43	1978	182	25/8/78
1944	205	9/8/44	1979	29	28/7/79
1945	246	30/9/45	1980	91	18/7/80
1946	209	29/7/46	1981	23	1/8/81
1947	360	30/9/47	1982	27	10/8/82
1948	170	23/8/48	1983	68	15/9/83
1949	129	19/9/49	1984	42	6/9/84
1950	332	22/9/50	1985	36	26/7/85
1951	286	27/8/51	1986	29	7/3/86
1952	262	24/8/52	1987	04	16/6/87
1953	274	7/8/53	1988	399	30/9/88
1954	234	1/10/54	1989	13	5/8/89
1955	596	8/10/55	1990	162	12/9/90
1956	175	15/8/56	1991	21	19/9/91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RIVER SUTLEJ NEAR KASUR
PROBABILITY ANALYSIS FOR
OCTOBER, NOVEMBER & DECEMBER
MINIMUM DISCHARGES
NOV
OCT
DEC
DISCHARGE - cfs
0 100 200 300 400 500 600 700 800 900 1000
.1 .5 1.0 5 10 20 30 40 50 60 70 80 90 95 96 97 98 99 99.5 99.7 99.8 99.9
PROBABILITY [100m/(N+1)] NON EXCEEDENCE
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REDUCED VARIATE

FIGURE 5.3

FIGURE 5.4

RIVER SUTLEJ NEAR KASUR
EXCEEDENCE LEVEL OF MINIMUM DISCHARGES - CFS

Return Period Years	Exceedence Level %	Jan	Feb	Mar	Oct	Nov	Dec
1.04	96	-	-	-	-	-	-
1.11	90	10	20	80	55	15	5
1.18	85	25	25	100	85	30	25
1.25	80	50	45	110	115	45	40
1.43	70	90	75	150	160	80	72
1.67	60	160	110	200	205	120	110
2	50	240	160	260	260	165	150
2.5	40	370	220	360	315	230	200
5	20	970	440	750	480	440	345
10	10	2100	700	1220	660	680	490
20	5	-	960	1800	790	915	640
50	2	-	-	-	-	-	-
100	1	-	-	-	-	-	-

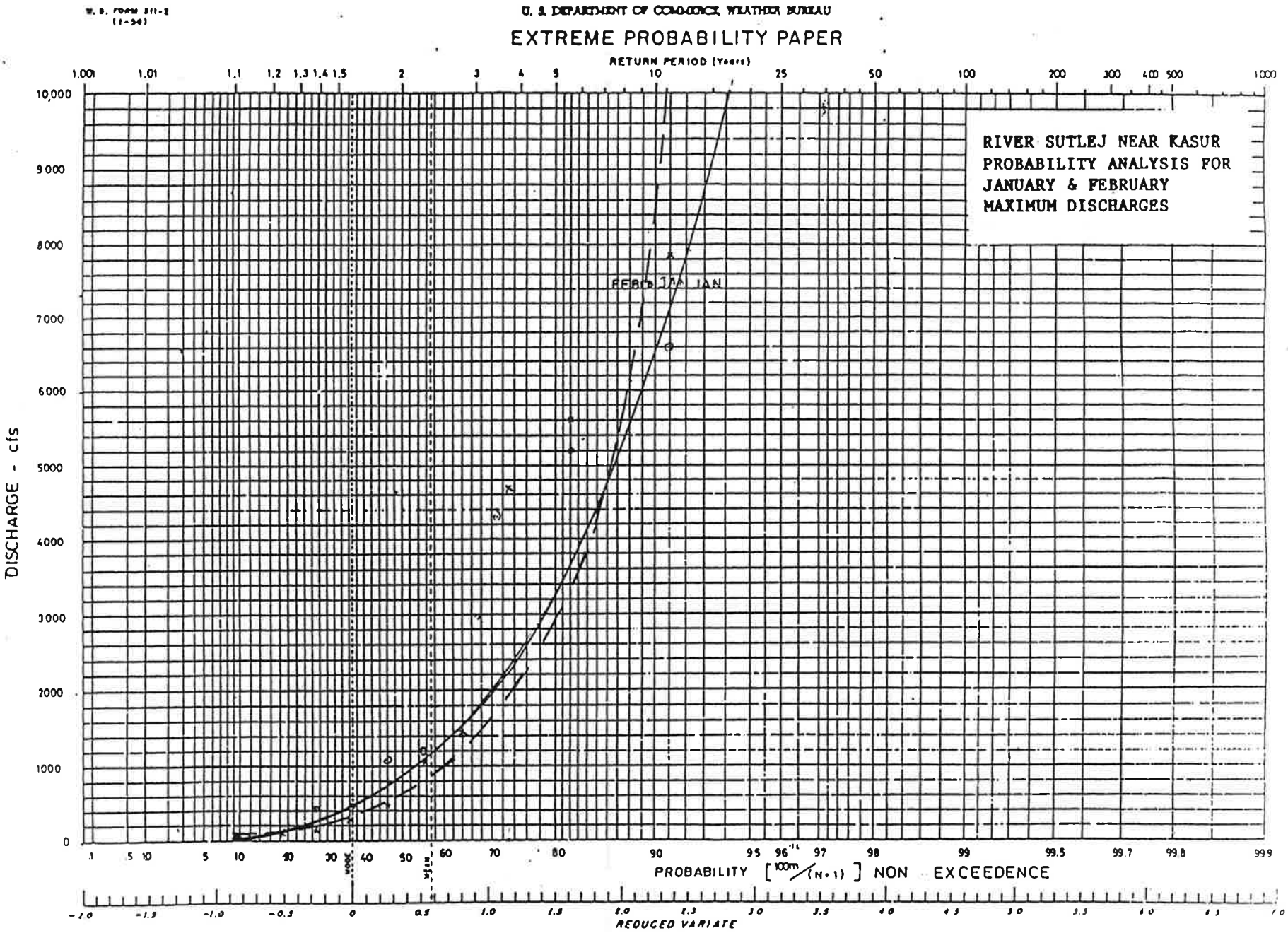

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
EXTREME PROBABILITY PAPER
RETURN PERIOD (Years)
1.001 1.01 1.1 1.2 1.3 1.4 1.5 2 3 4 5 10 25 50 100 200 300 400 500 1000
RIVER SUTLEJ NEAR KASUR
PROBABILITY ANALYSIS FOR
JANUARY & FEBRUARY
MAXIMUM DISCHARGES
FEB'b
JAN
DISCHARGE - cfs
10,000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
.1 .5 1 2 5 10 20 30 40 50 60 70 80 90 95 96 97 98 99 99.5 99.7 99.8 99.9
PROBABILITY [100m/(N+1)] NON EXCEEDENCE
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0
REDUCED VARIATE

FIGURE 5.5

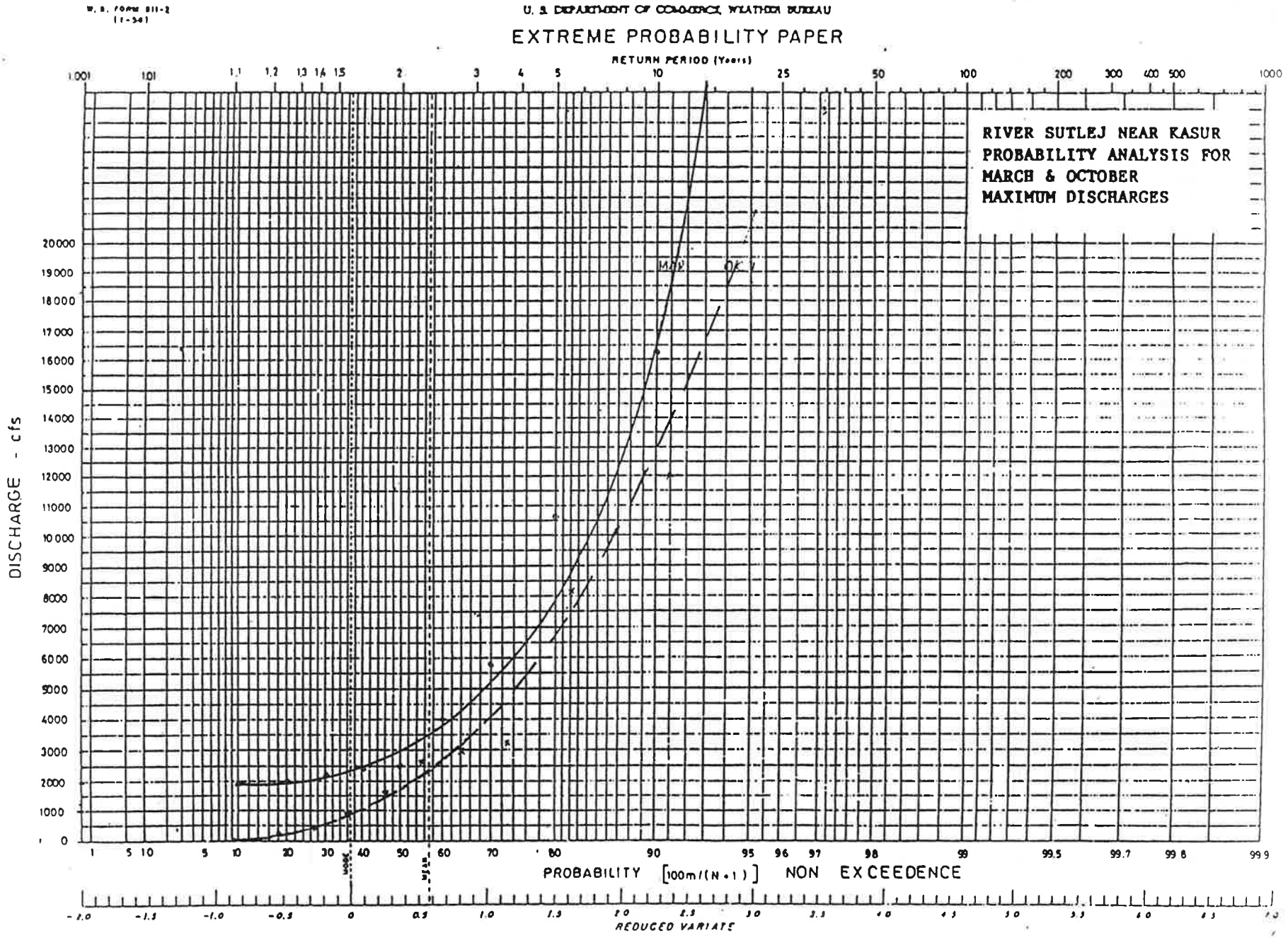
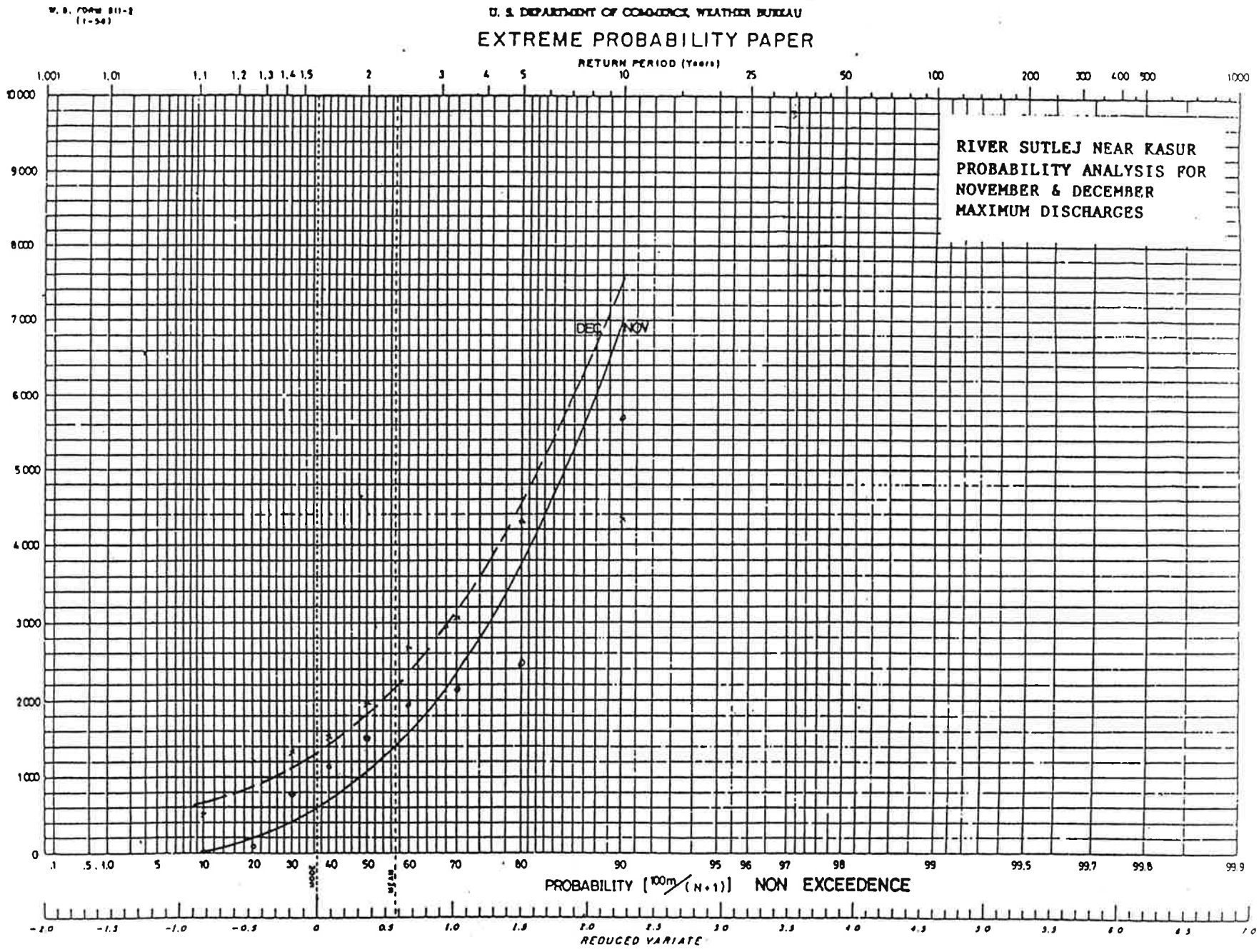

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
EXTREME PROBABILITY PAPER
RETURN PERIOD (Years)
1.001 1.01 1.1 1.2 1.3 1.4 1.5 2 3 4 5 10 25 50 100 200 300 400 500 1000
RIVER SUTLEJ NEAR KASUR
PROBABILITY ANALYSIS FOR
MARCH & OCTOBER
MAXIMUM DISCHARGES
MAR
OCT
DISCHARGE - cfs
20000 19000 18000 17000 16000 15000 14000 13000 12000 11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
1 5 10 5 10 20 30 40 50 60 70 80 90 95 96 97 98 99 99.5 99.7 99.8 99.9
PROBABILITY [100m/(N+1)] NON EXCEEDENCE
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0
REDUCED VARIATE

FIGURE 5.6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EXTREME PROBABILITY PAPER
RETURN PERIOD (Years)
1.001 1.01 1.1 1.2 1.3 1.4 1.5 2 3 4 5 10 25 50 100 200 300 400 500 1000
10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
RIVER SUTLEJ NEAR KASUR
PROBABILITY ANALYSIS FOR
NOVEMBER & DECEMBER
MAXIMUM DISCHARGES
DEC
NOV
.1 .5 1.0 5 10 20 30 40 50 60 70 80 90 95 96 97 98 99 99.5 99.7 99.8 99.9
PROBABILITY [100m/(N+1)] NON EXCEEDENCE
MODE
MEAN
-2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0 6.5 7.0
REDUCED VARIATE

FIGURE 5.7

FIGURE 5.8

RIVER SUTLEJ NEAR KASUR
EXCEEDENCE LEVEL OF MAXIMUM DISCHARGES - CFS

Return Period Years	Exceedence Level %	Jan	Feb	Mar	Oct	Nov	Dec
1	96	-	-	-	-	-	-
	90	50	80	1800	60	50	600
	85	70	100	1900	150	100	750
	80	125	140	2000	200	200	850
	70	300	220	2150	500	400	1100
	60	550	400	2500	1000	700	1400
2	50	850	600	3000	1500	1000	1800
2.5	40	1300	1000	3800	2700	1600	2400
5	20	3300	3000	8000	6700	3800	4600
10	10	6600	8500	16700	12800	7000	7500
20	5	9800	-	-	20600	-	-
50	2	-	-	-	-	-	-
100	1	-	-	-	-	-	-

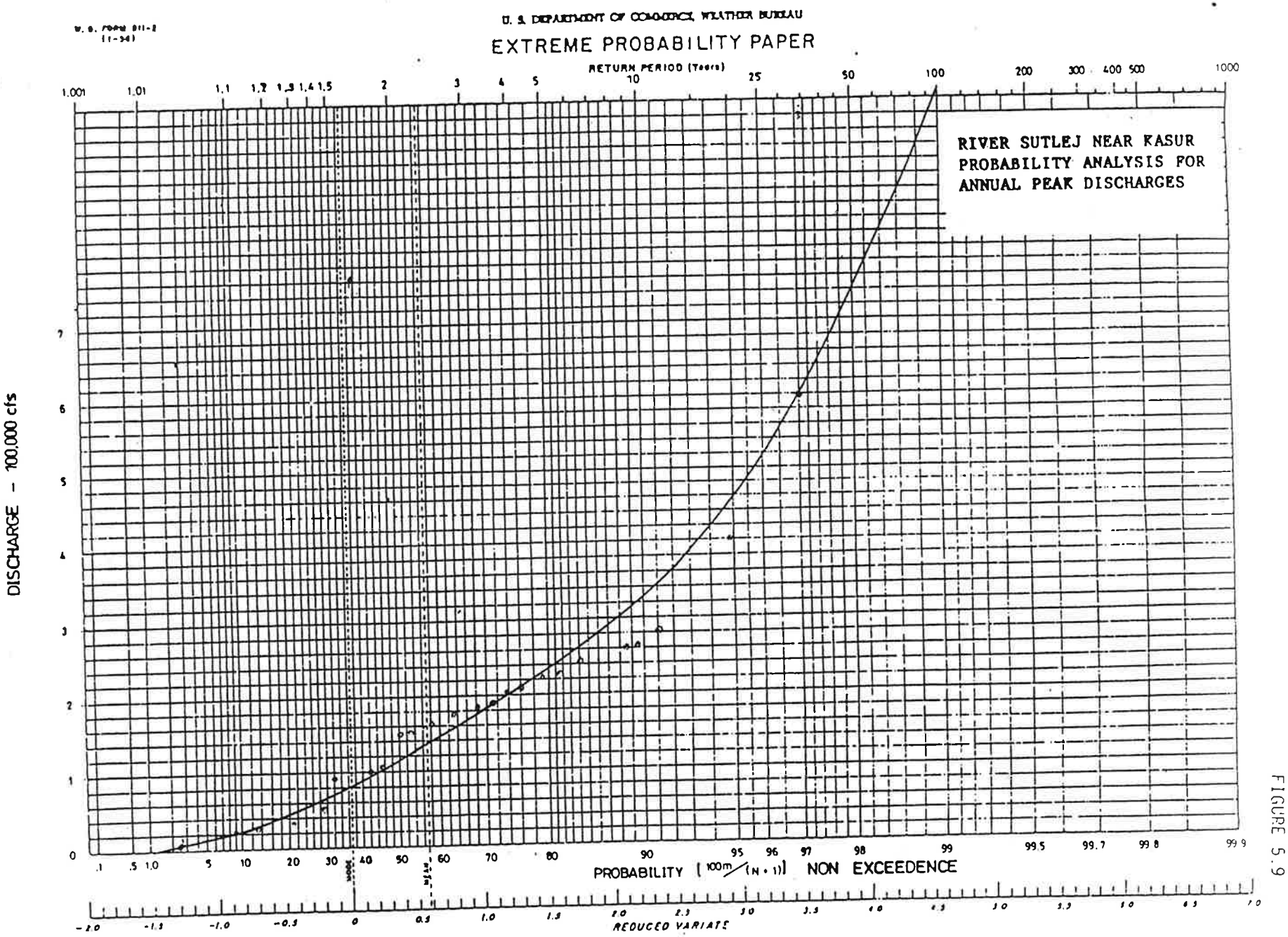

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU
EXTREME PROBABILITY PAPER
RETURN PERIOD (Years)
1.001
1.01
1.1
1.2
1.3
1.4
1.5
2
3
4
5
10
25
50
100
200
300
400
500
1000
RIVER SUTLEJ NEAR KASUR
PROBABILITY ANALYSIS FOR
ANNUAL PEAK DISCHARGES
DISCHARGE - 100,000 cfs
0
1
2
3
4
5
6
7
.1
.5
1.0
5
10
20
30
40
50
60
70
80
90
95
96
97
98
99
99.5
99.7
99.8
99.9
PROBABILITY [100m/(N+1)] NON EXCEEDENCE
-2.0
-1.5
-1.0
-0.5
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
REDUCED VARIATE

FIGURE 5.9

FIGURE 5.10

RIVER SUTLEJ NEAR KASUR
EXCEEDENCE LEVEL OF ANNUAL PEAK DISCHARGES - CFS

Return Period	Exceedence Level %	Annual Peak Discharges (1955-1991)
1	97.8	4,000
	96	12,000
	90	22,000
	85	35,000
	80	45,000
	70	65,000
	60	90,000
2	50	115,000
2.5	40	145,000
5	20	235,000
10	10	330,000
20	5	460,000
50	2	740,000
100	1	-

FIGURE 5.11

CLIMATOLOGICAL DATA
KASUR

	Rainfall-mm	Evaporation-mm	Temperature C
January	9.8	40	11
February	8.7	65	16
March	24.7	100	21
April	9.0	150	26
May	4.5	175	31
June	32.6	200	33
July	131.8	175	31
August	76.5	185	32
September	86.5	170	30
October	4.2	150	26
November	2.5	75	17
December	5.0	45	12

KASUR RAINFALL

Average (until):	1977	1988	1989	1990	1991	(until) 1991
January	25.9	4	19	-	-	9.8
February	21.1	-	-	-	22.5	8.7
March	19.8	51.0	28	15	9.5	24.7
April	8.9	-	8	-	28	9.0
May	8.4	-	-	-	14	7.5
June	36.1	30.0	-	-	9.7	32.6
July	108.2	237	185	108	21	131.8
August	105.4	72	55	75	75	76.5
September	56.4	220	125	25	6	86.5
October	10.7	10	-	-	-	4.2
November	2.5	10	-	-	-	2.5
December	10.2	-	-	15	-	5.0
Annual						395.8

FIGURE 5.12

RAINFALL RUNOFF RELATIONSHIP
KASUR AREA

	Rainfall - mm	Runoff - mm	Runoff Coefficient - %
January	9.8	0.0	RECESSION
February	8.7	0.0	RECESSION
March	24.7	0.0	RECESSION
April	9.0	0.0	RECESSION
May	4.5	0.0	RECESSION
June	32.6	3.56 (0.14")	10.92
July	131.8	96.5 (3.8")	73.2
August	76.5	43.2 (1.7")	56.47
September	86.5	52.3 (2.06")	60.46
October	4.2	0.0	RECESSION
November	2.5	0.0	RECESSION
December	5.0	0.0	RECESSION
Annual	395.8	48.89	

Average Annual Runoff Coefficient = 16.75%
Standard Deviation = 22.50
Coefficient of Variance CV = 1.34

FIGURE 5.13

PANDOKI DRAIN
MINIMUM DISCHARGE

Month	Minimum Daily mm	6-Hours Rainfall (P6) mm	6-Hours Effective Rainfall (P6xRC) mm	Intensity of Effective Rainfall 'p' mm/hour	Minimum Catchment ARBA 'A' Km2	Minimum Discharge Px0.2778xA m3/s	cfs
January	4	2.4	0.386	0.064	31.73	0.564	19.92
February	3	1.8	0.288	0.048	31.73	0.42	14.83
March	9	5.4	0.864	0.144	31.73	1.269	44.81
April	8	4.8	0.768	0.128	31.73	1.13	39.90
May	4	2.4	0.386	0.064	31.73	0.564	19.92
June	13	7.8	1.248	0.208	31.73	1.83	64.62
July	30	18	2.88	0.48	31.73	4.23	149.38
August	15	9.0	1.44	0.24	31.73	2.11	74.51
September	25	15.0	2.4	0.4	31.73	3.52	124.30
October	2	1.2	0.192	0.032	31.73	0.282	9.96
November	2	1.2	0.192	0.032	31.73	0.282	9.96
December	4	2.4	0.386	0.064	31.73	0.564	19.92

Runoff Coefficient (RC) = 0.16
Minimum Catchment Area (A) = 12.25 sq km = 31.73 km2

FIGURE 5.14

PANDOKI DRAIN

MINIMUM MONTHLY DISCHARGE

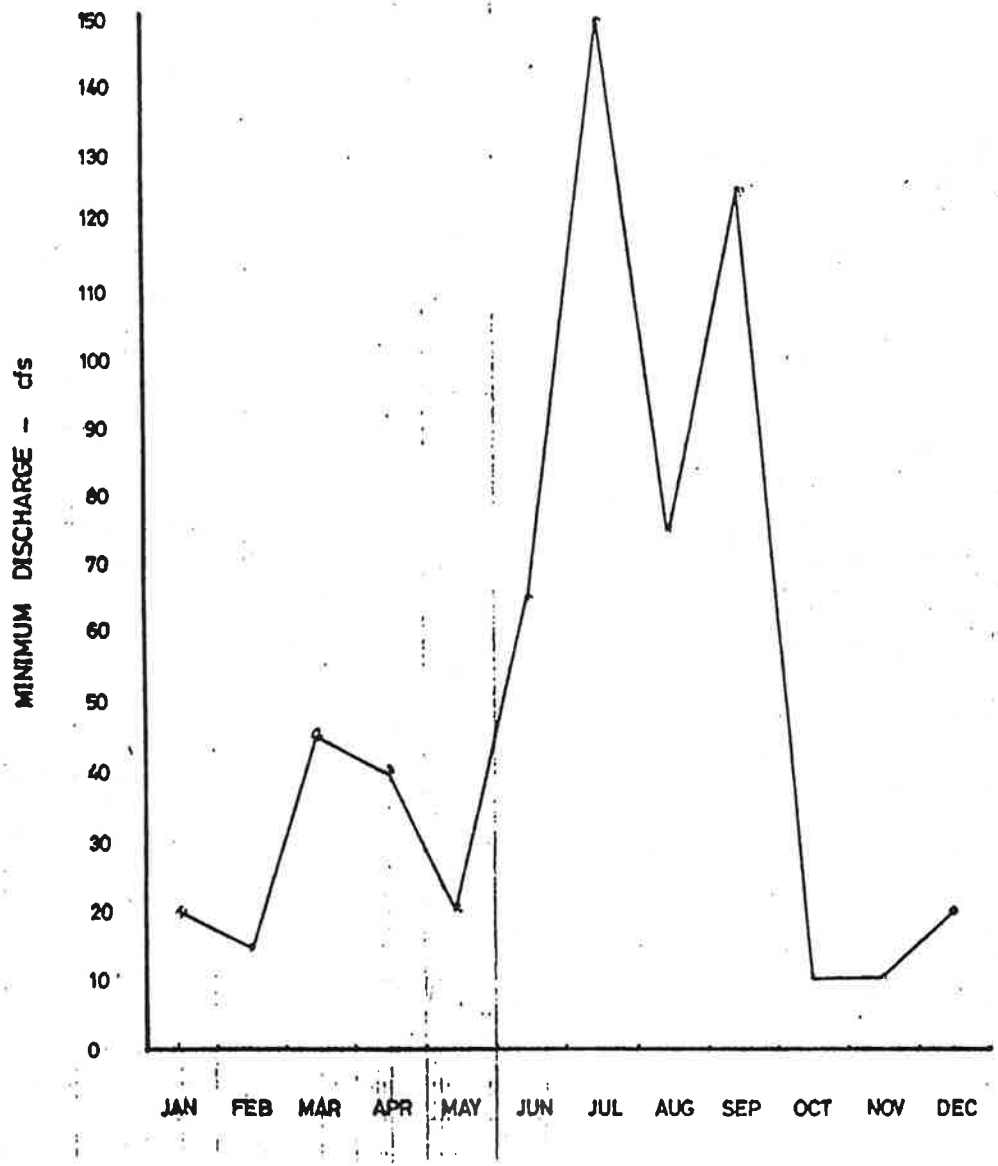


FIGURE 5.15

6.0 COMMUNITY HEALTH ASPECTS

6.1 Assessment Of Baseline Data

The report on base-line health survey conducted by the National Management Consultants (NMC), was the only health data provided to be utilized in the preparation of the EIA. The following observations are based on a critical review of the report, a meeting with Dr. Junaid Ahmed of NMC (November 26, 1992, PIDC House, Karachi) and a meeting with Mr. Mohammad Afzal Malik of NMC (December 3, 1992, 77K Defence Phase-I, Lahore).

This report is an extensive and detailed investigation to determine if there is a higher prevalence of disease in Kasur compared with elsewhere and to correlate this high prevalence to the environmental pollution caused by the tanning industry. With respect to questions and the methodology of the health survey at Kasur, Dr. Junaid responded that NMC mainly deals with the management, economics and administrative issues of institutes and organizations. Working on the health survey in and around Kasur was the first time for NMC to be involved in such an issue. He stated that Mr. Mohammad Afzal Malik of NMC Lahore office was the project coordinator for the survey and referred queries to him regarding the methodology of the survey. He also stated that because of the sensitive nature of that survey, the data and laboratory reports for the different tests are kept in the Karachi office. He suggested that if the EIA team wished to go considers going through the data, they could do so at NMC's Karachi office.

Mr. Afzal Malik responded that the methodology, questionnaire and laboratory test were based on suggestions given by two professors of Medicine and Dr. S.M. Zubair of Institute of Hygiene and Preventive Medicine, Allama Iqbal Medical College. Experts were responsible for the quality assurance of data collected (NMC Health Report 2.6 page 2-8). However there are many indications in the report which leads to the conclusion that guidance from experts was not sought at least at the time of data analysis. Table 3.23 on page 3-17 shows that 85% people in polluted, non-polluted and less polluted areas have an abnormal pulse. In Table 3.26 the laboratory test results of 13 people from nonpolluted area are missing. Table 3.27 shows very high rates of abnormal random blood sugar tests, 65%, 50% and 22.5% in polluted, less-polluted and non-polluted areas respectively. Not only is this suspicious in itself but these results are inconsistent with the urine sugar results presented in Table 3.29 where only 8%, 1.75% and 7.5% urine samples are abnormal for sugar. Table 3.17 reveals that the general population from polluted or clean areas were suffering from on an average eight symptoms per person at the time of interviews. 51 people at that time responded that they are suffering from pain in right hypochondrium. According to survey findings 28% referrals to hospital were for renal failure. According to Table 6.2, 213

patients were being referred to hospital everyday. In this way 60 patients of renal failure were being referred every day by the medical practitioners.

According to the response of Mr. Afzal Malik sampling can be termed as "haphazard" and not "random" as it was not drawn randomly from any lists. Where there were many households or shops they picked every third and at times fifth. If that person refused to be interviewed the person next door was contacted. In areas where there were very few shops or households the interviewers consulted everybody. In addition samples were too small to prove any differences statistically.

At time NMC teams asked Numberdar of villages to provide space for examinations and asked them to help get people who wanted to be interviewed. This methodology introduces bias.

Mostly leading questions were made to the interviewees.

Doctors went to polluted, less polluted and non-polluted areas and were not "blind" in epidemiological terms. The same was the case with the interviewers.

For the patients survey the patients coming to the Kasur District Headquarters hospital were interviewed. There may be a difference in the patterns of seeking medical help from different sources between people of lower socio-economic status living in the most polluted areas and people of higher socio-economic status living in non-polluted areas.

One may be able to recall diseases like Pneumonia and Fits for the last two years but two-year recall for "diseases" (at many places the NMC report confuses symptoms with diseases which reflects not only the lack of technical input at the time of designing the study but also a poor quality data analysis) such as diarrhoea, sputum, nasal discharge, cough is not good enough for any study to be valid. Generally fifteen day recall is considered valid.

It is difficult to determine from where the percentages were calculated which appear in "Horizontal Analysis" Tabulation. The frequency given along with these percentages do not produce these percentages. NMC were unable to help in this regard.

Criteria for defining polluted, less polluted and non-polluted areas are not given.

For the "worker's survey" the data lacks the information on the duration of job and the information about the actual job description of workers. There are tremendous difference in exposures to person involved with buffing and to person who do only soaking.

No previous incidence or prevalence studies' results from Kasur have been reported/quoted in order to compare and note any decrease or increase. Increase in the number may be due only to increase in the population, better diagnostic facilities and/or better awareness of people and changes in treatment seeking patterns.

In the general health survey section of this report, one does not find any information on who and how many of these 200 people work in the tanning industry.

The NMC report makes no reference to these severe limitations of the survey design, methodology and analysis.

The term "significant increase" is misleading. (e.g. Page 3-3 last para). It may be stated as "significant difference" if the responses of people regarding disease in the last two years are considered valid, but it should be recognised that people may exaggerate when they see a team of doctors in the area.

In the document "CTA's First Mission to Pakistan" the statistical exercise on page 28-29 calculates a strong significant difference in the incidence of disease in the last two years on the basis of Table 3-5, 3-6 of NMC report. On the contrary in Table 3-17 which shows the symptoms suffered at present, incidence is higher for many symptoms in non-polluted areas. Responses of people regarding current symptoms/diseases may be considered more valid as compared to a 2 year recall. One needs to note this contradiction when interpreting the data.

Demographic, work, socio-economic and housing data for polluted, less polluted and non-polluted areas is not available. This data is necessary as these are the variables which also determine morbidity and mortality.

It is considered likely that a well designed and better executed epidemiological study might arrive at the same conclusions that gastrointestinal, respiratory tract and skin problems are significantly higher in the polluted area, as is stated in this report. But because of the above mentioned limitations one is unable to draw such conclusions from this report.

6.2 Morbidity And Mortality Patterns:

A survey by Unicef and Directorate of Katchi Abadis Punjab of 15 katchi abadis which include the "polluted area" such as Kot Haleem Khan, Kot Molvi Abdul Qadir and Tibba Shiekh Amin, show that cold flu/fever, diarrhoea, and skin problems/rashes were the three most prevalent diseases in infants and children under 5 year of age. At the time of survey 56.5% 10.1% and 13.9% of children 0-14 years of age were suffering from cold/flue, diarrhoea and skin problems respectively. The survey was conducted in February when diarrhoea

and skin problems are less as compared to their prevalence in summer and rainy months. 30% of infant deaths and 18% deaths among children 1-5 years of age were due to diarrhoea. Pneumonia and Fever were the other frequent causes of death.

NMC Health Survey also reports diarrhoea, cough, skin irritation/urticaria as the most frequent diseases reported by general people, patients and as perceived by medical practitioners in the area.

Meetings were held with Assistant District Health Officer, Dr. Ishfaq Ahmed, Medical Officer of Municipal Committee, Dr. Parvaiz Khalid and an eminent general medical practitioner, Dr. Safdar in order to obtain their perceptions on the morbidity and mortality patterns and to collect any information/data available with them which reflects upon the environmental problems. Although no data on morbidity is kept, all three were of the opinion that diarrhoea/dysentery, cough, scabies, dermatitis, chronic obstructive pulmonary diseases, gastrointestinal problems and malaria are the most frequent diseases suffered by the residents of Kasur. Although according to these three health personnel diarrhoea and dysentery are more common in children there no unique or high risk group in the area. Other than an epidemic of chicken pox in the last two years, no other epidemic was mentioned by them. Similarly neither a syndrome like problem nor a cluster of a particular problem was described by them.

Dr. Safdar attributed a phenomenal increase in skin diseases to environmental pollution. No increase in Cancer or renal disease was reported by them.

Death records are maintained at the Municipal Committee not for public health reasons but for decisions on cases of heir and property. A mere 1-2% people who report deaths present a death certificate prepared by a doctor. Otherwise whatever a relative of the deceased reports as cause of death is written in the death register. As no better information on mortality is available, a comparison of 1980 and 1992 mortality from this record is presented below (Figure 6.1). Limitations in interpreting this information include unverified death reporting, changes in denominator population; change in treatment seeking pattern & changes (increase) in diagnoses of certain diseases

REPORTED CAUSE OF DEATH	1980 JAN-NOV (11 MONTHS)		1992 JAN-NOV (11 MONTHS)	
CANCER	7	0.9%	25	3.3%
RESPIRATORY INCLUDING PNEUMONIA	34	4.6%	41	5.4%
DIARRHOEA (OTHER GIT)	11	1.5%	41	5.4%
HEART ATTACK	50	6.8%	137	18.1%
FEVER	480	64.9 %	277	36.5%
RENAL	8	1.1%	11	1.5%
DIABETES	9	1.2%	22	2.9%
TB	21	2.8%	24	3.2%
LIVER/HEPATITIS	6	0.8%	8	1.1%
OTHER	114	15.4 %	172	22.6%
TOTAL	740	100%	758	100%

Figure 6.1 Comparison of Mortality 1980-1992

6.3 Identification of Environmental Problems Based on Site Visit.

6.3.1 Stagnant pools

Three stagnant pools alongside Kasur - Depalpur road are at a lower level than the tanneries and residential areas of Yunas Nagar, Niaz Nagar, Tibbi, Basti Shahdarah and village Banglah Kamboh. A rough estimate of population living near the edges of these pools is 5000 - 7000 people. People living in these areas do not utilize water from these stagnant pools for drinking, washing or irrigation purposes. A pungent odor is a direct cause of nuisance to people living in the nearby areas. Contamination of groundwater may have caused the hand pump and shallow well water to become odorous and unpalatable as complained of by the community.

Analysis by PCSIR as reported in the NMC survey shows higher than permissible values for BOD, COD, TDS, sulphides, ammonia and chloride, in hand pump waters both from polluted and non-polluted areas. The values are higher in polluted as compared to other areas.

The seepage of effluent to ground water from the stagnant pools is not the only source but also from the open rills and washed out tannery effluent in the streets and open areas in and around these tanneries. Draining of the stagnant pools will not stop the whole seepage until all tannery effluent is carried to CEPTP by paved channels and there is no seepage of this water en-route.

6.3.2 Use of reclaimed land

On the issue of the use of reclaimed land from the stagnant pools, the Tanners Association stated that 30% of the land of the largest pool (No. 1) has already been sold before this land was submerged by effluent. It was not possible to ascertain for what purpose this land was purchased and by whom. The rest of the 70% of the land is on sale but at a very high price which according to tanners is beyond their means so tanneries will not develop on that reclaimed land. On the contrary when discussed with community members, they were of the opinion that this land will most probably be used for tanneries and as people live adjacent to tanneries in Niaz Nagar and Younas Nagar, people will also start settling among new tanneries.

Although the Stagnant Pool No. 3 is at a lower level than the existing tanneries, with the treatment plant installed tanneries will also be built here and a further 3,000-5,000 people may reside in these new localities according to the community. Reclaimed land from stagnant pool # 2 will be used for agricultural and residential purposes by the villagers.

In order to avoid exposure to people who will reside on the reclaimed land, it is necessary to evaluate the contamination of

soil of reclaimed land and to dispose of the soil in a proper fashion

6.3.3 Extent of Environmental pollution

Nobody from communities in the above mentioned polluted areas considered living at those localities a "healthy living". A very bad smell from the tanning processes, effluent in and around households and in stagnant pools, lack of a proper sewerage system and sewage disposal, lack of hygienic water supply to a majority of people, fumes and dust emission, stationary ponds of sewage in Rohi Nullah emitting bad smells, and acting as breeding places for mosquitoes were the main pathology mentioned for this socially unhealthy living. Many people stated that if they could afford to do so, they would like to move to another place.

As told by community members diarrhoea/dysentery, respiratory problems, malaria, skin diseases and typhoid are the illnesses they suffer most. Over the last few years the incidence of these disease has been said to be increasing at a phenomenal rate.

A majority of people from these polluted areas work in the tanning industry where they are exposed to different highly hazardous processes. At home and in the streets these workers are exposed to environmental problems caused again by the tanneries emissions and effluent. This doubly exposed population is at very high risk of getting diseases caused by occupational and environmental pollutants. There is a huge overlap of community exposed to both occupational and environmental pollution.

According to Tanners Association about 15,000 people are working in tanneries. But as revealed by different community members 40-50% Tanners are not members of the Tanner's Association. Large number of people are involved in one or other tanning process within their houses. A large number of people particularly women are involved with a potentially hazardous process of sheep hair handling. In addition to this it is very difficult to estimate the number of employees as most of the laborers are contract labor. According to a rough estimate 50,000 people are directly involved with one or the other process within tanning industry. A large number of these people live in the polluted area.

According to observation, communities are exposed to bad odor, contaminated/odorous/unpalatable ground water, dust from the buffing processes, dust and hairs (and most probably many allergens), and fumes from different hazardous processes such as "chrome formation". There are 50,000 - 60,000 people environmentally exposed, a number which is increasing with increasing population density and which might further increase if reclaimed land is used to build more tanneries. This estimate is based on population figures for some localities available with Population Welfare Office, Kasur.

6.4 Specific environmental issues

Rohi Nullah, which carries sewage and the tanneries effluent from Dingarh, can be considered as one of the major cause of environmental problems for the community living around. Rohi Nullah receives hardly any rain water and it is neither channelized nor covered where it passes through different settlements. At places it has taken the form of lakes and mosquitoes are breeding along its length. A foul smell is causing nuisance to nearby residents. Water from the hand pumps in houses along the course of the nullah has a typical sewer smell.

Spill-overs from open rills in streets which carry tanneries effluent has caused formation of small, shallow pools at many places within these communities. People particularly children who do not take care to avoid playing in and around these stagnant waters are exposed to chemicals. The pools also create bad odours.

Sheep hairs are scattered in open areas purposely in order to dry them so that they can later be processed to make brushes. Everybody in these localities is exposed to these hairs which cause respiratory tract problems.

Small pieces of treated and untreated leather and animal fats are scattered in open places all around the polluted localities. After drying animal fats are processed to send to the chicken feed industry. All of these may be a source of air pollution emitting allergens and chemicals in addition to smell. (NMC's report on air quality suggests a significantly high concentration of hydrogen sulphide only. However this report does not provide information on the exact sites where air samples were collected.

Different tanneries are emitting vapors, fumes and dust in the streets to which the passerby is exposed and those people who live in the area.

6.5 Hazardous Occupational Health Processes

As the community which suffers exposure to adverse environmental effects is mostly the same which works in the tanning industry, it is of value to describe the most hazardous job practices.

A local tanning chemist stated that powdered chromium is becoming more and more costly, so many tanneries are making a liquid chromium (he named it "chromosole") through a highly hazardous procedure whereby in a cement tank outside the tannery they add H_2SO_4 to a mixture of potassium bichromate and Brown sugar. This process emits fumes which cause choking to whoever passes near that tank. Workers are exposed heavily.

Small scale tanneries which make poor quality leather purchase used chromium (collecting tanning solution from tanning drums) from

larger tanneries. Those who collect this tanning water rarely observe any occupational safety standards.

Workers involved with buffing are exposed to very high levels of dust. Again the dust is emitted into the streets through vents causing environmental problems for residents.

Boiling of fat is another process which causes obnoxious odour and fumes and leads to occupational and environmental problems.

Dusting of hairs, mainly done by women, is another hazardous process and more so when people sitting close to each other are involved in this processes. No woman was seen to be provided with a mask. A few of them were using a chaddar or Duppata as a mask.

The tanning process uses a mixture of chemicals and it is difficult to pinpoint particular toxins that may impinge on the local community. Entry of chemical wastes into surface water and ground water is a potential health hazard.

A list of chemicals used at the local industry was requested from Tanner's Association which they promised to provide. Later on the following list of most commonly used chemicals was provided by a local doctor who himself owns two tanneries.

Sodium Bisulfide, Sulfuric Acid
Lime, Chrome (Sodium Bichromate) Trivalent Chromium Sulphate.
Formic Acid, Dyes (mostly non Benzidine)
Pigments, Acrylic Binders, Poly Urethane
Silicon based feel modifiers, Sodium Formate
Fate liquors
Preservatives, mostly PCP (Pentachlorophenol) free but a few of these contain PCP.

Another key informant revealed that although many tanneries now use Non-Benzidine dyes as the leather is periodically examined in International market, the use of Benzidine dyes is still prevalent at a smaller scale.

Neither an up-to-date inventory of chemicals ordered and used is kept nor is there any mechanism for periodic waste audits. At the same time chemicals with adverse effects such as Benzidine and PCPs are still in use.

According to local tannery workers about 8-10 years ago almost 90% tanning in Kasur was vegetable tanning. Over the last decade due to the developing leather garment and fashion industry which needs fine quality tanned leather in larger quantities, chemical tanning has replaced vegetable tanning. This has caused a higher concentration of chemicals to be discharged into the environment and has increased effluent problems as chemical tanning requires large volumes of water for the different process.

Leather dust has been listed by the European Commission as a potential carcinogen. Benzidine is known to be carcinogenic. However, as the cancers usually have long latency periods and as the exposure period of the local community to these toxins is only a few years it may take several more years before the present level of toxic exposure causes a higher incidence (or an epidemic) of cancers, renal pathology or other systemic diseases.

Figure 6.2 gives health effects of some chemicals used in the tanning industry..

Chemical	Acute	Chronic Effects	Long term effects
Benzidine			Bladder Tumors
Chromium (Trivalent) to little extent may be converted to hexavalent in intestines	Skin lesion irritation	Chronic Bronchitis, chronic rhinitis, conjunctivitis, pneumoconiosis	Risk of lung cancer (Hexavalent)
Leather Dust	Respt. tract irritation, cough	Bronchitis	Potential Carcinogenic
Hydrogen Sulphide	Pulmonary Oedema, Bronchitis, Pneumonia	Irritation of cornea, keratitis	Neurological problems
Poly Urethane	Wheezing, Chest tightness Airway constriction	Decreased pulmonary function	Potential carcinogenic
Acrylic Binders	Eye irritation diarrhoea, weakness, headaches, vomiting	Hepatotoxicity	
PCP (Pentachlorophenol)	Skin irritation, painful irritation of eyes, nose and throat	Nephrotoxic Hepatotoxic Bronchitis Dermatitis	Polyneuritis aplastic anemia hodgkin disease

Figure 6.2 Health Effects of Chemicals Used in the Tanning Industry

Available data, consultation with the community and doctors suggest that acute and some chronic ill effects of environmental pollution due to tanning toxins are increasing. It may take some time to note any increase in the long term effects.

6.6 Assessment of Environmental Conditions

Following a "walk-through" examination of the tanneries, the tanning process and visits to the residential areas around tanneries, the following observations have been made.

Groundwater pollution is occurring due to effluent, waste waters and stagnant pools. Open drains and Rohi nullah which are being used as sewers are also burdened with tannery effluent. At places this has caused water to spill over and contaminate soil within the residential areas and tanneries.

Toxic fumes and dust are emitted in the streets causing air pollution. Generally there is an odor and nuisance which is at times intolerable.

The transport of new chemicals and used chemical (for recycling) is mainly by donkey carts with high risks of exposures to workers and a risk of soil and air pollution.

Certain hazardous processes such as "Chrome formation" are done in open cemented tanks placed outside the tanneries in the streets. This process emits toxic fumes.

All affected areas are liberally littered with animal fat, small pieces of leather, and hairs causing severe nuisance and air pollution.

This situation is unhygienic and can be defined as detrimental to the health of the residents.

6.7 Community Opinion on Treatment Plant

Citizen participation has been considered as one of the two central principles to a healthier environment. The other is the equitable access to resources. Participation by communities has been considered as a means to develop policies and projects to meet their priorities. According to the UNICEF study people from fifteen katchi abadies in Kasur prioritized water, sewerage/drainage system, and garbage as their main problems. No single community came forward with nuisance from stagnant pools and tanneries. These katchi abadi's included Kot Haleem Khan, Tibba Shiekh Amin and Kot Molvi Abdul Qadir. Again the community members consulted during the EIA prioritized water, general sanitation in and around their homes, drainage system and chemical dust and fume emissions from tanneries as the main problems. Treatment of

effluent was lower in the list. Although people in Kasur do not know the terminology such as "End-of-Pipe" treatment, they do understand that the treatment plant is but one of the solutions which will help them in avoiding long term effects. They understand very well what other actions will improve their living conditions. The community takes the treatment plant option as valid on the philosophical grounds that "something is better than nothing". The community understands that effluent in stagnant pools is causing ground water to become unpalatable and deleterious to their health and that the treatment plant will do at least two things; decreasing nuisance and odor to a large extent and prevention of further seepage from the pools. Similarly health professionals in Kasur see treating effluent as a move in a positive direction, although they consider it only a part of the solution to the health problems of people in Kasur.

On the other hand, the community fears that if reclaimed land is used to establish more new tanneries, and the situation of uncontrolled discharge persists then not only will the people who live near to the new tanneries suffer but also the general environmental situation in Kasur will further deteriorate.

6.8 Projected Health Improvements After Installation of Treatment Plant

Scenario 1 : Treatment Plant Operating To Specification

For risk assessment reliable data on exposures, dose-response relationship and factors causing variability in dose-response relationship are necessary. In the case of Kasur Tanneries with the available information to date it is difficult to estimate what fraction of morbidity and mortality can be attributed to the environmental pollution caused by tanneries and in particular to the pollution caused by tanneries effluent. Only a qualitative judgment can be made about the present health impact and future projections regarding improvements. This judgement is based upon observation, community consultation, consultations with key informants on health and health risks in the area, available information, and from the existing scientific knowledge about the problem caused by tanneries effluent and waste.

At least 50,000-60,000 people are exposed to pollution and on the basis of existing morbidity patterns and changes, it can be said that the pollution has started causing short term acute, localized and systemic health effects. But the environmental diseases related to tanning chemicals, which have longer latency period have not yet started appearing. Ground water pollution with tannery effluent is one of the major routes of exposure of the community in the affected areas as large numbers of people use upper table water for drinking/cooking/washing purposes. The treatment plant with an efficient drainage system which will preclude seepage will

eliminate to a great extent the exposure at least through this route. Exposure to an estimated 30,000 population which in the affected area use ground water will be reduced to a large extent.

In the case of proper drainage of Dingarh tannery effluent direct to the treatment plant, Rohi Nullah will then only be receiving sewage. This will help in improving the situation as the spill-over from the banks will be reduced and there will be less stagnation and lakes formation which at this time generate the problem of more seepage, nuisance and mosquito breeding. This will help in improving the general sanitation along the course of the Nullah but channelization of the nullah and covering it at least in the residential area is necessary if its use as sewage carrier is to continue.

People in the affected areas are suffering more from odor from the tanning processes, tannery waste and effluent in and around tanneries as compared to odor from effluent in the stagnant pools. At present there are no households in the vicinity of the proposed treatment plant. If people start living on the reclaimed lands (3-4 years in future) and if the plant is not properly managed, then it will cause pollution and nuisance problem for the community living around.

The community at Banglah Kamboh village is exposed mainly through ground water polluted by stagnant pools, as they are not exposed to other tannery wastes directly or indirectly. A clean up of the pools, particularly of pool number 2, will eliminate further pollution of ground water. There will be improvement in terms of nuisance, odor and chemical exposure reductions at least to this community. On a negative note the land of stagnant pool number 2 is owned by villagers and after its reclamation it will be used mainly for agricultural and housing purposes. This community may become exposed to potentially highly contaminated soil.

Land around the proposed Final Outfall is mainly used for agricultural purposes. As the treated effluent in the final outfall is not to be used for agricultural and domestic purposes up to Pandoki Outfall there may will not be any effects on human health either directly or indirectly. Similarly, as water from Pandoki Outfall is not being used for irrigation purposes and there are no communities along its course using its water up to Sutlej river, there will be very little, if any deleterious effects on human health. Use of Sutlej River water containing treated effluent for irrigation purposes does not involve potentially dangerous exposures to people using Sutlej water.

Scenario 2 : Failure of Dingarh Pumping Station

In this case most of the health improvements and/or potential hazards will resemble those presented in Scenario 1 but with the exception of the situation at Dingarh. At present tanneries

effluent from Dingarh enters into the Nullah at several (at least six) places. Along the course of Nullah it mixes with sewage and becomes fairly homogenized. Effluent is to be diverted to the proposed Dingarh pumping station site and if that pumping station fails then all this effluent will revert back to the nullah at one point. Under this situation the community downstream from the point of this bulk effluent entry into the Nullah may be exposed to higher concentrations of chemical as they use the Nullah water for irrigation. Seepage of higher concentration of chemicals will further deteriorate the groundwater and a community of about 3000 - 5000 may be exposed to a higher degree of pollution as compared to the current situation.

Scenario 3 : Treatment Plant Fails To Operate

Effluent will be carried away from Kasur so that potential improvement in living condition of the affected areas of Kasur will be the same as projected in Scenario 1. No data is available on the extent of use of Sutlej River water for irrigation and domestic purposes. Similarly no data is available on the number of people living (and using Sutlej water for domestic purposes) beyond the point where Pandoki outfall enters the Sutlej. It is difficult to estimate hectares of land or numbers of people who will be exposed to contaminated water along the Sutlej. With a typical dilution ratio of 1:1000, the river water concentration of pollutants at the point of entry of Pandoki outfall into Sutlej will be as follows:

	Effluent after dilution	Drinking water limit (USA) (6)
SS	3.0 mg/l	-
BOD5	1.5 mg/l	0.75 - 1.5 mg/l (as excellent source needing disinfection only)
COD	4.0 mg/l	
Sulphates	1.00 mg/l	250 mg/l
Chromium III	0.03 mg/l	0.05 mg/l (federal mandatory limit)

(This calculation does not takes into consideration the amount of pollutants and salts in Sutlej from other sources.) This dilution situation should occur for the major part of the year but may not be attained in the dry weather period.

The effluent if properly mixed with Sutlej water, should not result in potentially hazardous exposures particularly if used for agricultural purposes only.

6.9 Conclusion

Through observation, consultations and by looking into trends obvious in the available information the environmental pollution seems to have caused an increase in incidence in acute and some chronic systemic ill health effect. With the help of available data the present status of health impacts of environmental pollution can not be quantified and there is no scientific basis to conclude that a statistically significant increase in illness attributed to pollution has occurred. But it is most probable that a sound epidemiological study will reveal the increase in morbidity caused by environmental pollution.

The treatment plant will be able to eliminate a part of exposure to people living in the affected area.

The treatment plant will be able to eliminate a large source of nuisance and odor from the stagnant pool and overflows of effluent in and around households in industrial areas. This will partially improve living conditions but may slow down the process of community sensitization, awareness and community action.

Fumes, dust, vapors, hairs, and fat are major sources of pollution in the area. In addition to being exposed to these hazardous materials through the general environment, the same community is heavily exposed at work where occupational safety standards are poor. The treatment plant is an end-of-pipeline solution able to eliminate only a part of problem.

6.10 Recommendations

- The treatment plant needs to be considered as a part of the solution.

- Contaminated soil of reclaimed land should be disposed of before the land is used for residential, agricultural or industrial purpose.

- A comprehensive environmental control strategy at the level of tanning industry needs to be envisaged. This should include in addition to the treatment plant: use of chemicals with lowest toxicity, processes with lowest possible exposures to workers, water conservation techniques, and proper disposal of tanneries wastes.

- This comprehensive occupational/environmental strategy at industry level needs to be the part of an integrated environmental health action plan at the level of all parties involved. Industry, Community, Municipal Committee, local health authorities, Central Govt. agencies (as Rohi Nullah, as advised by Municipal Committee Medical Officer is under the domain of Provincial Government) need to chart out an integrated action for safe water supply, better sanitation

standards and sewerage system, and reduction of exposure of community to chemicals.

- o There is a need to incorporate an environmental monitoring program in the integrated approach. Environmental monitoring needs to fulfill two basic objectives: estimating exposures to people and determining whether these exposures comply with the international standards (7).

- o There is a need to determine the current health status and any increase in mortality incidence. This may be done through a well executed case-control study. This will not only help to identify any ill health affects in polluted area but also will act as a baseline for future monitoring.

- o Similarly there is a need to conduct a study based on biological monitoring and exposure levels for workers involved in different tanning and other hazardous processes in the industry. This will determine whether exposure to workers are within permissible limits and will help in establishing safety measures.

- o An epidemiological follow up study should be implemented. This should address the following target groups :

  - "Receiving both occupational and environmental exposures"
  - "exposed only during occupation"
  - "exposed only through ambient environment"
  - "unexposed in the non-polluted areas"

  This will help in identifying any morbidity and mortality differences between these sub-populations.

7.0 AGRICULTURAL ASPECTS

7.1 Introduction

Kasur district relies predominantly on an agricultural based economy. Both crop and livestock sectors play an important role in the economy of the district. In the crop sector, wheat and rice crops are the most important. These are cultivated over an area of 483,000 and 149,000 acres respectively out of the total cultivable area of 705,000 acres of the district. In the livestock sector, buffalos and cattle represent 40% of the total number of livestock but contribute 92% to the total estimated values of this sector.

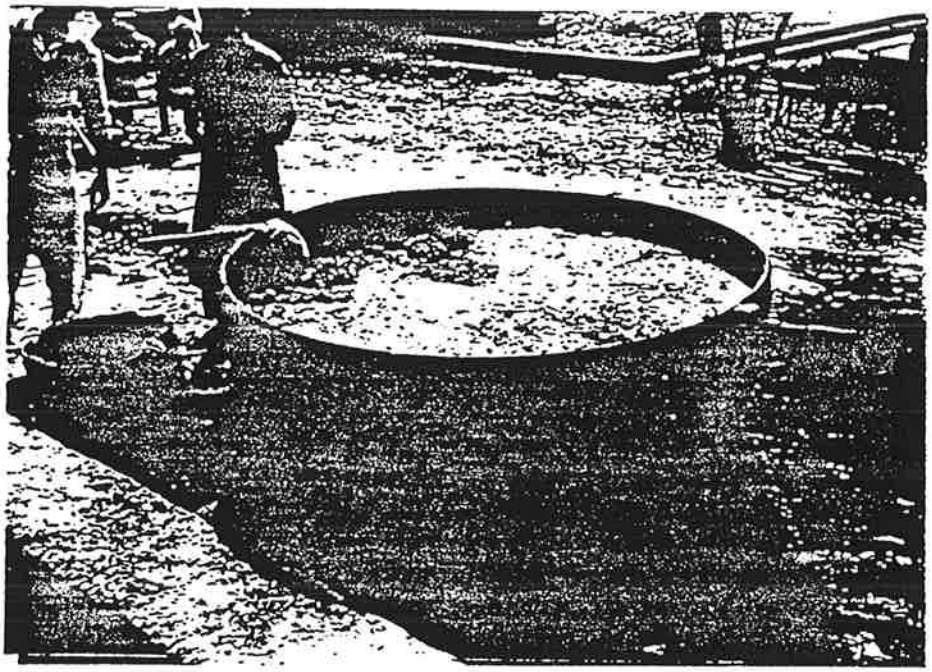
Although limited in scale, the crops and livestock in the villages namely: Bangla Kambo, Doley Wala, Kasir Garh, Bahamni Wala, Mann, Nazam Pura and Faqiria Wala have been badly affected by the chemical effluents coming from hundreds of tanneries established in Kasur city. The tanneries water has formed a number of scattered stagnant pools over an area of more than 200 acres. In addition the effluents from some of the tanneries installed in Dingarh are entering the Rohi Nullah. These effluents are polluting the ground water around the nullah and create problems for the crops through irrigation water.

For the last 4 to 5 years this polluted water is posing a serious threat to the crops, livestock and inhabitants of the area due to increase in tannery effluents and probably more use of chemicals in the tanneries. The local people occupying land surrounding the stagnant pools have appealed to the concerned authorities and the Tannery Association has also approached the Government for help.

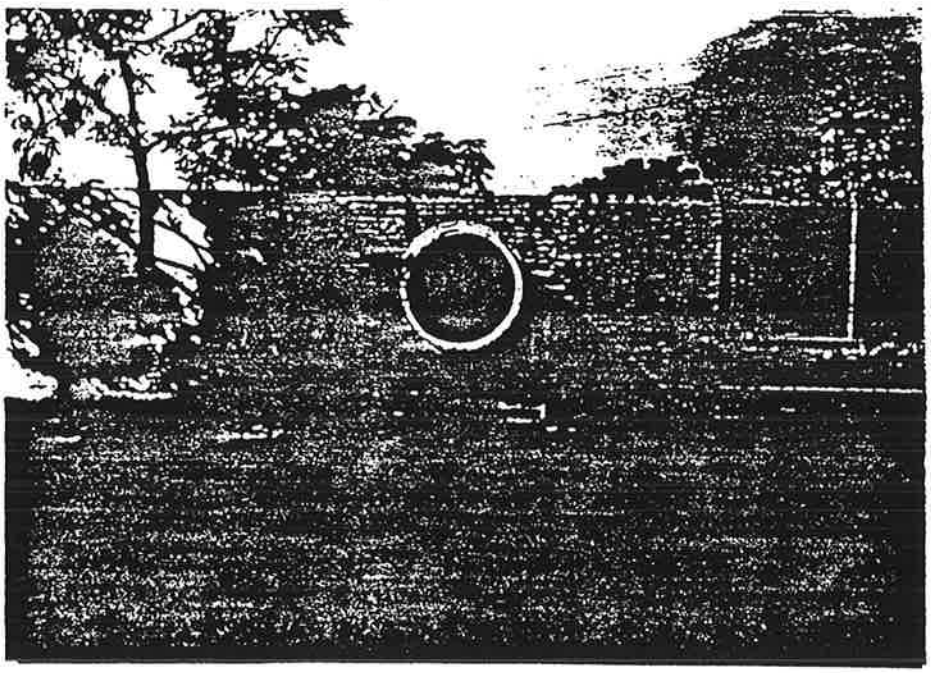
7.2 Objectives

The objectives of this sector were :

- Assess the effect of tanneries effluents on the crops and livestock under the existing situation.
- Assess the possible improvement in agriculture sector after the installation of treatment plant.
- Assess the effect of tannery effluents on agricultural production if the treatment plant does not operate effectively.
- Assess the hazards to agriculture occurring from the dumping of solid wastes arisings from operations of the treatment plant.
- Propose appropriate use of land after drainage of water from the stagnant pools.



Kasur Tanneries : Reuse of Waste Materials



Kasur Disposal Works, Nonfunctioning for 18 months

7.3 Methodology

Since the time at the disposal of Environmental Impact Assessment Team was short formal sampling of the populations affected by the effluents was not possible. However, best efforts were made to contact all the concerned agencies for collection of information related to the problems in the agriculture and livestock sectors. The agencies contacted are listed below:

- Farmers
- Agricultural Extension Workers and other related Government Agencies
- Livestock Development officers
- Revenue Department officials.
- Pharmacies shops in the city.

The detail of the persons contacted during the study is given in Annex 3.

In order to gain a general knowledge of the infrastructure of villages, roads, drains/nullahs and the Sutlej River a comprehensive survey was carried out in the area. It was followed by a number of visits to the polluted and non-polluted areas to assess the extent of damage by the tanneries effluents to the crops and livestock. During the visits sufficient time was spent with the farmers to have first hand information of the issues.

Before conducting the survey and visits to the area, National Management Consultants Reports on Air and Water Survey (Vol-2), Livestock Survey (Vol-3) and Agriculture Survey (Vol-4) were examined. Also during the survey and writing of the Environmental Impact Assessment these reports were frequently consulted.

7.4 Comments On the NMC Reports

7.4.1 NMC Report on Air & Water Survey

In the table of contents of this report a few subheadings are given, namely :

- 1.2 International and Pakistani standards for drinking water
- 1.3 International and Pakistani standard for irrigation water
- 1.4 Pakistani air pollution limits.

These headings indicate that some standard data has been incorporated in the report. No such data are given at all in the report for comparison of results obtained during the NMC studies.

In last line of para 3.1.3 it is mentioned that "for detail results see Annexure 1". No such results are given in this annexure.

In Annexure-2 the quality of piped drinking water in control and affected areas is almost the same. This water must be coming from the Municipal tube wells probably installed in control area. That is why there is no difference in quality analysis of water obtained from polluted and non polluted area. The details of water sampling sites is not indicated in the report. This is essential in understanding and interpreting water quality data of polluted and non polluted areas.

The concentrations of all the parameters except ammonia tested under water quality are almost the same throughout the year. However, three times more quantity of ammonia has been reported in the water in January than in November and December. No reasons for this anomaly have been given in the report.

Referring to page 7, Table 2.2 shows that 7 samples have been taken from a canal, whereas no canal exists in the area or nearby polluted area.

In this report a number of parameters are a duplication of the data given in:

- NMC Report on Agriculture Survey
- NMC Report on Livestock Survey

The details are given below:-

Annexure	Parameters in Air & Water Survey	Same as in Report on
4	Analysis of drinking water for cattle	L.Stock Survey page 6-7 to 6-13
5	Analysis of milk	" " " 7-14 to 7-20
6	" " meat	" " " 7-2 to 7-13
7	" " fodder	" " " 6-1 to 6-7
8	" " crops	Agric. Survey page 1-1 to 1-12
9	" " vegetables	" " " " "
10	" " irrigation	" " " 2-1 to 2-12

It is not understood how the parameters of milk, meat, fodder, crops, vegetables etc. fall under Air and Water when these parameters are being discussed in detail in other reports.

7.4.2 NMC Report on Livestock Survey.

It is observed that the contents table of this report has been put in Agriculture Survey Report and vice versa.

With reference to Para 1.1.3. The contribution of livestock sector to GDP of 7% and to GNP 9% should be reversed as GNP of a country is higher than GDP. Thus contribution of livestock to GNP should be lesser than the contribution to GDP.

With reference Para 3.4. The area under study has no canal system for irrigation. It is not clear how they have concluded that canal water is one of the sources of drinking water in their report.

With reference to Table 3-5. The data show that out of the total 14 diseases discussed with the farmers, occurrence of 4 serious diseases namely, hemorrhagic septicemia, foot and mouth disease, abortion and dermatitis (skin irritation) was higher in non-polluted area than in polluted area. Due to the short time at the disposal of the EIA team it was not possible to get a response from a sizeable (and hence statistically significant) number of farmers about the occurrence of disease. However, in discussion with the farmers in polluted and non-polluted areas it was observed that disease problems to animals in polluted areas are higher, and especially skin irritation must be higher due to chemically polluted water emanating from the tanneries. The reason for reporting higher cases of skin diseases in non-polluted areas might be some misunderstanding during questioning of the farmers or some mistake in tabulation or processing of the data.

With reference to Table 3-12. The title of the table is incorrect. Moreover the data also are incorrect as it indicate that 91.43% of the respondents of the polluted area gave no response to the questions as to whether a proper drainage system for tannery effluents should be made, or whether tanneries should be shifted away from the city. It should be the other way around as every inhabitant of the polluted area objects strenuously to the adverse situation created by the tanneries wastes.

With reference to Table 4-3. In this table the data on the increase in occurrence of various diseases during the last 2-3 years have been reported without any indication of the locality, or whether the results are from polluted or non-polluted areas. While interpreting this data it is stated that "the increase in gastro-intestinal problems in animals may be associated with tannery pollution in the area". This statement can be justified only if it was supported by data from the polluted as well as non-polluted areas.

With reference to Table 4-4. The data on change in the status of production performance of animals is reported without any indication of the polluted and non polluted area. Thus this does not fulfil the requirement of the goals for which this survey was conducted.

With reference to Table 4-5. The title of the table states "Trend of medicines used by patients from polluted and non-polluted areas", but no separate data are given in this table.

With reference to Table 5-1. The data given in this table show that 58.33% of persons attending pharmacies shops present more than 15 prescriptions per day for the treatment of animals. To confirm the trend of this aspect a rapid survey was conducted in the city of Kasur. The results of this survey shows that on an average only 8 prescriptions per day are being filed for taking medicines for animals (Figure 7.1).

Figure 7.1 Number of prescriptions received by pharmacies shops

Sample Number	Number received per day
1	5
2	8
3	5
4	20
5	5
6	10
7	5
8	6
Average	8

Source. EIA Survey in Kasur City.

With reference to Table 5-2. As indicated by the supervisors of the pharmacy shops, they have no knowledge of whether the persons are coming from polluted or non polluted areas. The pharmacy owners stated that they neither asked the persons from which area they belong nor do the persons tell them about their area. Thus it is not understood how the NMC report could identify this segregation of animal medicine buyers in to polluted and non polluted area.

With reference to Table 6-1. For showing sulfides/chromium levels in fodder the unit of mg/l has been used. In fact for plant material or soil analysis the unit of percent or ppm are used. The use of mg/l in NMC report is incorrect. Moreover various fodder have been tested in the survey but data is combined for all the crops. This renders it invalid to compare this data from polluted areas with the standard level of each crops as the concentration of nutrients in plants differ at various stages of the plants growth and life cycle (Figure 7.2).

Figure 7.2 : Relationship of plant age to the N & P concentrations in spring wheat plants.

No.	Age of plants (Days after seeding)	Percent	
		N	P
1	21	4.3	0.30
2	36	2.5	0.24
3	49	1.7	0.15
4	62	1.3	0.13

* Soil Testing and Plant Analysis. 1973. Revised Edition. Edited by Leon Walsh & James D. Beaton. Page 336.

7.4.3 NMC Report on Agricultural Survey.

The observations in respect of this report are :

- The most important parameter of total area under stagnant pool has not been incorporated. Accordingly total losses to crops have not been calculated.
- The crop yield losses due to tannery effluents have been reported only for polluted area thus one cannot compare the yield obtained in non-polluted area.
- The concentration of elements in crops and vegetable is in mg/litre. The correct unit for such kind of analysis is PPM or mg/gm of dry weight of the plant material.

7.5 Extent of Tannery Effluents Problems Based on the Discussions with the Farmers

The tannery effluents problems have been categorized as financial, health, social and others.

7.5.1 Financial problems.

Land under water.

Figure 7.3 shows the acreage under tannery effluents. The data show that village Bangla Kumbo is in the worst condition as 70 acres of land of this village has been affected by the tannery effluents. It was pointed out by the farmers of village Bangla Kumbo that out of this area about 15 acres of land was barren whereas the rest of

the land was under cultivation. During "Monsoon" the area under stagnant pools expands and the situation becomes worse. The water enters into the standing crops, it badly affects the growth of crops and causes substantial yield loss. Since no crop can be grown under this chemically polluted water, farmers are facing financial problems. A few of the farmers stated that they had now started selling their animals for feeding their families.

Low yield of crops.

Reviewing the data given in the NMC Report on Agriculture Survey and by the facts collected from the farmers during the EIA survey it was ascertained that the crop yields have been very badly affected by chemically polluted water seepage from Rohi Nullah, and from the stagnant pools. As reported by the farmers, the crop yields have decreased by almost 50 % (Figure 7.4). The situation around the Rohi Nullah is comparatively better although significant reduction in crop yields was reported.

Figure 7.3 : Area under stagnant pools formed by tannery effluents

No.	Village	Area (Acres)
1.	Bangla Kumbo	70
2.	Kaser Garh	40
3.	Mann	20
4.	Bahamni Wala	40
5.	Doley Wala	30*
6.	Nazam Pura	10*
	Total:	210

* Water of Rohi Nullah containing sewage and tannery effluent.

Figure 7.4 Decrease in crop yield due to seepage of tannery effluents

No.	Crop	Yield (kg/acre)		Decrease in Yield(%)
		Before pollution	Present	
1.	Potato	10000	5500	45
2.	Wheat	1400	640	54
3.	Rice	1600	900	44
4.	Berseem	3200	1520	52

Source: Information collected from farmers during EIA study.

Damage to Orchards.

During the Environmental Impact Assessment it was noted that a number of guava trees in a garden in village Bangla Kumbo were dried out whereas the rest of the trees were looking healthy. This was possibly due to the seepage of polluted water from the stagnant pool.

Low output from animals.

Farmers also confirmed the findings of NMC survey. They categorically stated that the buffalo lactation period is now about six months as compared to 12 months prior to the inundation by tannery effluents. It was noted that the general condition of the animals was weak. Farmers further added that milk production per animal has also reduced by about 50%. It was probably more due to the chemically polluted water and less due to poor fodder supply because of termination of the second source i.e., agricultural land.

Payment of unused electricity bills.

Farmers whose land is under water naturally do not use electricity for running their tubewells. However WAPDA is regularly billing for the electricity charges as it is based on a fixed fee. The farmers have complained frequently to the concerned authorities about the factual position but could not obtain exemptions from the authority. They are now paying bills for electricity which they never use.

7.5.2 Health problems

Human and Animals health.

Human as well as animal health is deteriorating. Particularly the children are very prone to such conditions. Frequent diarrhoea disease in children and stomach disorders in animals were reported by most of the farmers.

Skin diseases.

In an emergency, farmers have to walk through the tannery effluents which causes skin diseases to their legs. Unless they immediately wash their legs with clean water they feel uncomfortable and experience skin irritation.

7.5.3 Social problems

Quarrels and fighting.

As the tannery effluents flow from the land of one farmer to the other, the farmers erect "bunds" to protect their land, which

floods their neighbours land. A number of quarrels were said to have taken place leading to serious social problems and physical violence.

Working on substandard jobs.

The farmers whose land has become barren due to stagnant water now go to the city to earn their livelihood. Respectable farmers are forced to go for substandard jobs which normally are not acceptable in their social system. While returning home they collect weeds from wherever they can to use as fodder for their animals.

7.5.4 Other problems

Wastage of time and energy/inconvenience.

Tannery effluents have taken the form of stagnant pools in the vicinities of neighbouring villages. The farmers, in addition to wastage of their land due to polluted water, cannot go straight to their farms to bring fodder and other produce from the farm to their homes. They are forced to walk around the pools and have to cover at least 2 to 3 times more distance to reach their farms.

Drinking water pollution.

As the hand pump water is polluted due to seepage from stagnant pools the farmers have to bring drinking water from Kasur or from hand pumps installed deeper by financially sound families.

Discolouration of metallic utensils.

Sulphur present in the polluted water from hand pumps is affecting metallic utensils. The utensils rapidly become blackish and have a very ugly appearance.

Tubewell Water Pollution.

The water of tubewells installed near the Rohi Nullah is being contaminated with chemicals from the tanneries. Instances were mentioned by the farmers that tubewell water given at first irrigation immediately percolates into the soil, while in subsequent irrigations it leaches after 1 or 2 days. In this way the crops become light green in colour and growth is badly affected. This is probably due to increase of sodium content in the water which when applied to soil reduces the permeability of soil and downward movement of water.

7.6 Results Based on Revenue Department

7.6.1 Inundation of Agricultural Land

Affected village and land use.

Nine villages namely: Bangla Kumbo, Kaser Garh, Doley Wala, Faqirea Wala, Bahamni Wala, Harihar, Kotli Hathar, Tolu Wala and Nazam Pura are affected due to collection of tanneries effluents in the form of stagnant pools, and seepage of polluted water from these pools as well as from the Rohi Nullah. About 92% of the total area of these villages (11,930 acres) is cultivable, whereas the actual cultivated area is 76%. Unproductive land is 16% of the total area. The land use statistics of these villages is presented in Figure 7.5.

Figure 7.5 : Land use statistics

Land Category	Area in acres	Percent of G.A
1. Gross area	11,930	100.00
2. Uncultivable area	916	7.7
3. Cultivable area (CA)	11,014	92.3
4. Cultivated Area	9,080	76.1
5. Unproductive land	1,934	16.2

Source:- Revenue Department, Tehsil Office, Kasur.

Polluted area.

There is no managed disposal of tanneries waste and Rohi Nullah water. Water stands in more than 300 acres of land at different spots in the above mentioned villages. Details of stagnant water and land affected by seepage of polluted water are shown in Figure 7.6.

Figure 7.6 Land affected due to polluted water from tanneries and Rohi Nullah

Village	Acre
Tolu Wala	43.78
Kaser Garh	11.07
Maan	7.48
Harihar	22.24
Bahamni Wala	87.93
Doley Wala	26.54
Kotli Hathar	40.83
Nazam Pura	16.50
Bangla Kumbo	75.37
Total:	331.37

Source: Revenue Department Tehsil office, Kasur.

Cultivation in the pond area cannot be made. Thus there is a great loss to the farmers as they can not obtain any crop whatsoever from this area.

7.6.2 Present Cropping Pattern.

The area is uncommanded and the main source of irrigation is tubewells. Ground water quality seems to be satisfactory as it has not created salinity problems in the area where people have been using it for long periods. The cropping patterns of these villages for the year 1991-92 i.e. Kharif 1991 and Rabi 1992 presented in Figure 7.7 were collected from Revenue Department, Tehsil Office, Kasur.

Figure 7.7 : Present Cropping pattern and intensities in polluted villages

Crops	Total area cultivated (Acre)	Cropping intensity* (%)
Rice	892.1	9.8
Kh. Grains	88.1	1.0
Cotton	11.1	0.1
S. Cane	275.3	3.0
Orchard	528.7	5.8
Kh. Fodder	2731.5	30.0
Kh vegetables	1837.3	20.0
Bamboo	99.1	1.1
Misc.	308.4	3.4
Kharif Total:	**6751.5**	**74.4**
Wheat	3006.8	33.0
Pulses	165.2	1.8
R. Fodder	2037.6	22.4
R. vegetables	2632.3	29.0
S. Cane	275.3	3.0
Orchard	528.7	5.8
Bamboo	99.1	1.1
Misc.	363.5	4.0
Rabi Total:	9108.5	100.3
All Total:	15860.0	174.7

Kh. = Kharif (Summer Crops)
R. = Rabi. (Winter Crops)
* Percent of total cultivated area.

Most of the inhabitants are directly and indirectly involved in agricultural farming. The annual cropping intensity comes to 174.7 percent with kharif/Rabi ratio of 1:2.35. Major crops sown during Kharif season are rice, fodder and vegetables which occupy 9.8, 30.1, and 20.0 percent of cultivated area respectively. Major Rabi crops are wheat, vegetables, fodder, and potato which cover 33.0, 29.0 and 22.4 percent of cultivated area respectively.

7.6.3 Crop Benefits

The 331 acres of land which at present is under water would also produce the same crops as in the normal area after disposal of stagnant waters. However, reclamation of this land would be required after drainage of chemically polluted water. This will be primarily done through flushing of salts in deeper layers of soil by successive and heavy irrigations. There is a possibility to reclaim soil within a few months where tanneries water has occupied the soil for the last 1 to 2 years. However, longer periods would be required where the polluted water has been standing for 5 to 10 years. After reclamation this land could be very productive and substantial crop yields could be obtained with the prevailing crop production technology.

After reclamation of the affected land, benefits of Rs. 1.34 million per annum are estimated, which can further be increased with the application of judicious use of improved production technology (Figure 7.8).

Figure 7.8 : Crop benefits to be achieved from 331 acres after disposal of stagnant water in Pandoki Drain.

Crop	Cropping pattern (%)	Acreage* (acs)	Yields mds/ac Rs./ac.	Total Prod. (mds)	Price Rs/md.	Total Benefits (Rs)
Rice	9.8	32.0	25	800.0	105	84000
K. Grains.	1.0	3.0	23	69.0	160	11040
Cotton.	0.1	0.331	12	4.0	512	2048
K. Fodder.	30.1	100.0	1800	-		8000
K.Vegetable.	20.0	66.0	4500	-	-	297000
K.Misc.	3.4	11.0	2400	-	-	26400
Wheat.	33.0	109.0	30	3270.0	185	604950
Pulses.	1.8	6.0	10	60.0	700	42000
R.Fodder.	22.4	74.0	5200	-	-	384800
R.Vegetable.	29.0	96.0	6400	-	-	614400
R. Misc.	4.0	13.0	2300	-	-	29900
Orchards.	5.8	19.0	4000	-	-	76000
S.Cane.	3.0	10.0	550	5500.0	17	93500
Gross benefit						2446038
Less cost of production @ 45% of gross benefit.						1100717
Net benefit.						1345321
						= 1.34 million

* Out of total area of 331 acres.

7.7 Conclusions

7.7.1 Present situation

The tannery effluents polluted water in the stagnant pools and Rohi Nullah is badly affecting the agricultural production and general health of the community. The total loss to agricultural crops is estimated to be Rs 1.3 million per annum. Although it was not possible to ascertain the losses in the animal sector, it was observed that considerable difficulties with respect to animal health and milk production are being faced due to polluted water. The pollution of under ground water due to seepage of tanneries effluents is also posing a serious problem both for drinking as well as irrigation water. The pungent odour emanating from the stagnant pools poses a nuisance to the surrounding communities and other people passing daily through the area.

7.7.2 Improvement in agricultural production with the installation of Treatment Plant.

i) The implementation of the treatment plant will confer significant benefits on the community, in particular the farmers who will be able to reclaim their land and earn their livelihood. However, the loss of Rs 1.34 million per year would not be restored immediately on the installation on the treatment plant. The land currently submerged by polluted water for the last one or two years may be reclaimed immediately, whereas it may take more than one or two years to reclaim the land where water has been standing for 5 to 10 years. Monitoring of the situation by Government agencies would help the farmers to reclaim their land on scientific lines and probably in the shortest possible time. For this purpose a detail comprehensive analysis of soil of each field is required immediately after the drying out of the land.

ii) With the establishment of the treatment plant the tanneries effluent flow in Rohi Nullah will cease. Thus the source of pollution of the area on the sides of Rohi Nulla will also stop, and farmers will be able to use sewage water for irrigation without adverse effects. However, the ponds formed alongside the path of the Nullah will remain unless arrangements for narrowing the nullah, and permanent brick channelling is carried out.

iii) The farmers having land/tubewells along the nullah may have to bear the loss due to pollution for several years, as the contamination already affecting the underground aquifer due to tanneries effluent will not be restored immediately. The farmers may have to live with this for several years.

iv) The condition of livestock would also be improved, but again it will depend upon the quality of ground water. It may take

several years to restore the quality of polluted underground water due to the slow mobility velocity of the aquifer. The inhabitants also will have to live with the situation in the hope that the water quality will gradually improve.

7.7.3 Effect of Tannery effluents on agriculture if the Treatment Plant fails

i) In case of failure of the plant the tanneries effluents will be flowing in a 8 kilometer pucca channel before entering into Pandoki drain. There will be no danger of pollution to ground water, and this will be one of the most important achievements in removing tannery effluents from the existing area. In Pandoki drain the dilution factor of 1:4 of tannery effluent and drain water will not help, and it will create problems for animals.

Pandoki drain is deep enough so that the danger of polluting ground water due to seepage of tannery effluent will be several times less than seepage occurring from the stagnant pools and Rohi Nulla.

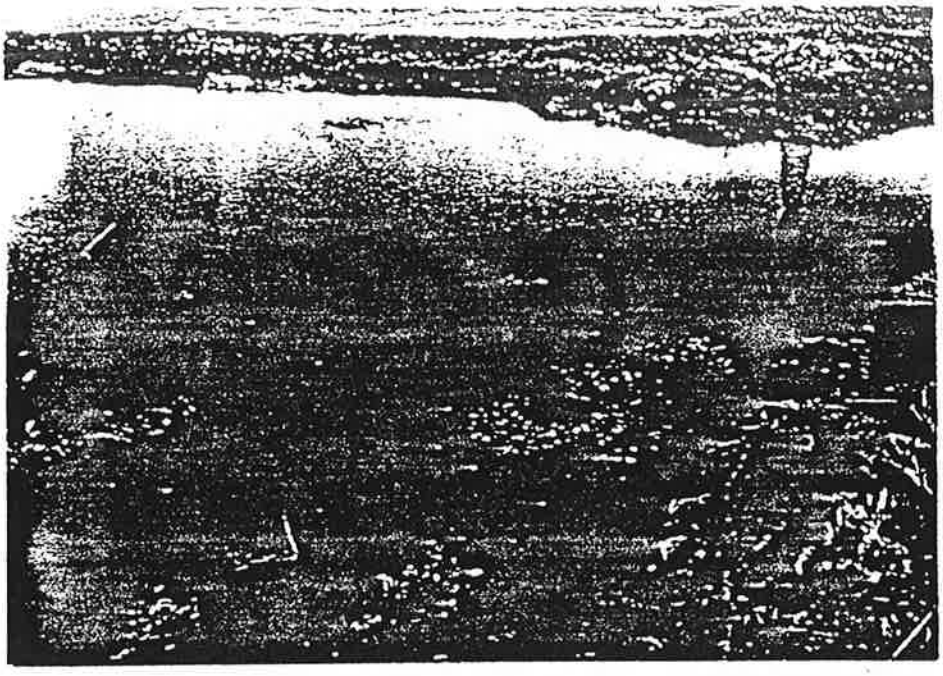
ii) Pandoki drain will carry the effluent to the Sutlej River where the dilution factor at peak flow of the Sutlej would render it benign to the aquatic life. However, at times of low flow in the river it may cause problems to fishes. In case of zero flow of water in Sutlej river during winter possibility could be explored to obtain water from BRBD canal for mixing with tannery effluent polluted water in the Pandoki drain. With this added dilution there would probably be no adverse effects to the crops and livestock alongside the Pandoki drain & Sutlej River.

7.8 Recommendations

In view of the serious problems being faced by the community due to tannery effluents, the following recommendations are made for immediate relief.

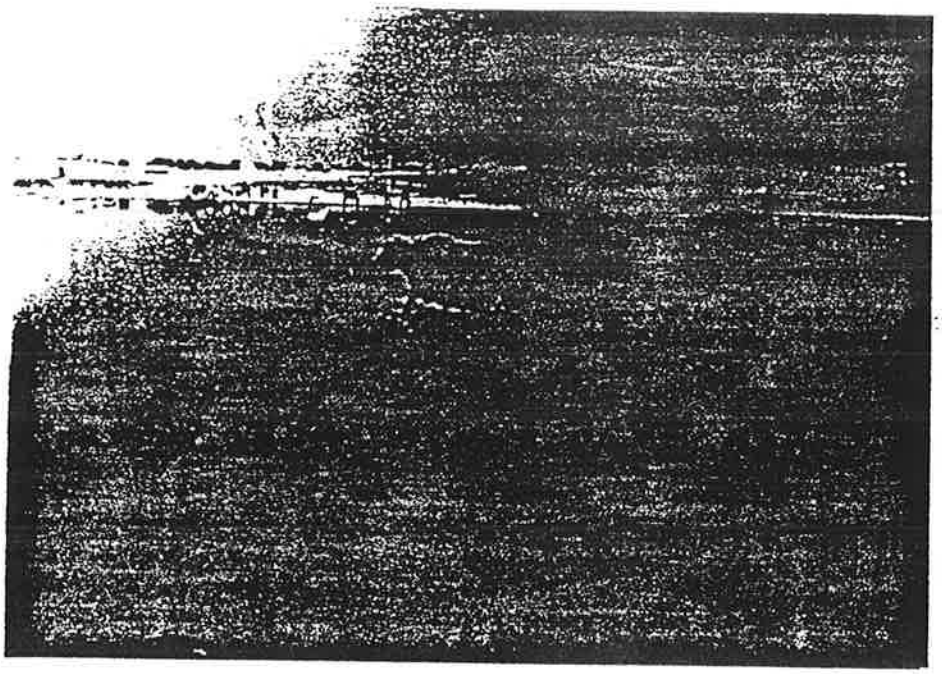
- The treatment plant for tannery effluents should be immediately installed.
- Sludge should be covered with soil to avoid the generation of pungent odour from the sludge or percolation of chromium in the under ground water by rainfall.
- Monitoring of the sludge dump site should be carried out periodically to monitor potential pollution.
- The land vacated by draining the stagnant pools should be reclaimed on scientific lines. For this purpose a government

agency e.g. Soil Fertility Department, Punjab should help the farmers to analyze soil samples and suggest appropriate measures to reclaim the land.

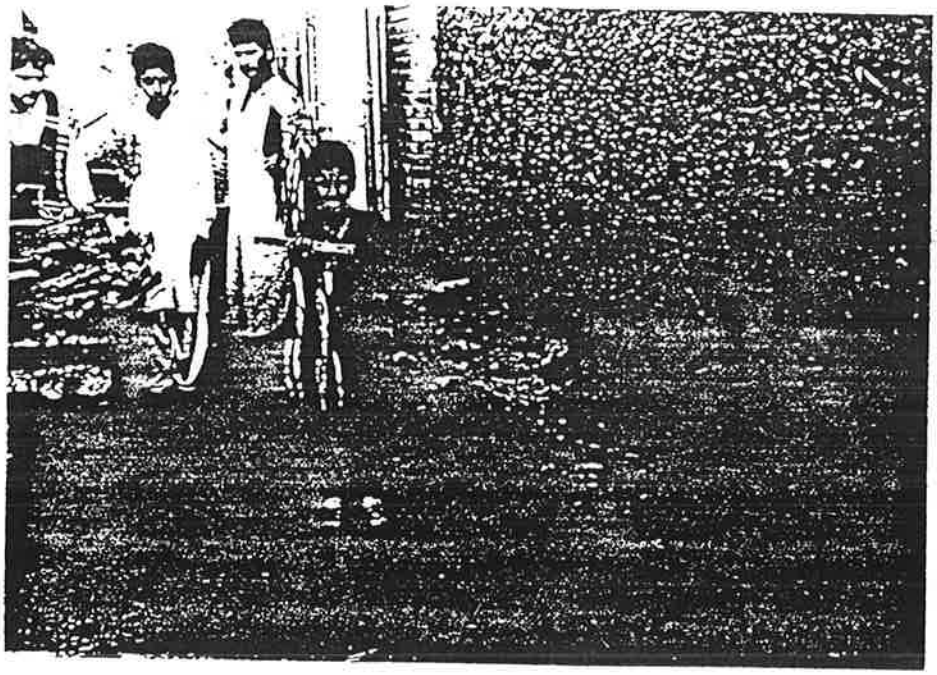


Sulphuric Acid and Oil Discharge from Batch Treatment Process into Rohi Nullah, Kasur

Rohi Nullah, Kasur. Note Irrigated fields to left of Nullah. Object in lower left hand corner is remains of dead animal



Stagnant Pools, Kasur next to Dipalpur Road. Note animals grazing in distance



Sutlej River fish on sale in Kasur Market

8.0 ASSESSMENT OF AQUATIC ENVIRONMENT

8.1. The Baseline Situation

8.1.1 Rohi Nullah

The Rohi Nullah is a disused river bed which currently receives 3500 cum/day raw tannery waste and some 10,000 cum/day untreated sewerage effluent.

Considering that these are the only effluents into the system Rohi Nullah is in surprisingly reasonable ecological state. This may be due to its physical characteristics which aid the assimilative capacity.

At the point where the Rohi Nullah crosses the Dipalpur road it has opened out into a large settlement pool. No unpleasant odour was noticed although water clarity was poor. One fisherman was using a cast net and locals reported that small fish called "dumbra" were abundant. These are rohu carp (Labeo rohiat) and feed predominantly on algae. As members of the Cyprinid family they are unlikely to have particularly demanding water quality requirements.

The Fisheries Department of Punjab (Lahore) reported that Rohi Nullah contained a mix of species but was not a particularly important fishery. The commercial fishing rights to it are auctioned together with that of the river Sutlej (see below).

On 8/12/92 four D.O. readings were taken from the road bridge across Rohi Nullah between 07.23, and 17.46. All readings recorded a zero D.O. level although parts of the settlement pool must obviously contain oxygen as fish were present. Local people reported no instances of large scale fish kills.

The dissolved oxygen levels of zero differ markedly from high levels quoted in previous reports. This illustrates the scarcity of long term reliable water quality data. At the point where the Rohi Nullah enters the Pandoki Outfall its character changes completely and becomes a reasonable fast flowing narrow channel of 1m width.

A D.O. level of 3.2 mg/l was measured at 16.29 hrs and the discharge was roughly estimated at 3-5 cusecs. This is in broad agreement with earlier reports.

Given the flourishing fish life in the Rohi Nullah and the reasonable D.O. levels on entering the Pandoki, it seems fair to agree with earlier studies that there is considerable self purification within the system, although this may have been overestimated. This is most likely due to the long residence time

within the settlement pool of Rohi Nullah and the abundance of aquatic plants.

There may be some concerns on health grounds of fish caught in the Rohi Nullah. For example the Australian E.P.A. recommends a maximum level of chromium in water of 0.05 mg/l which is likely to be exceeded in this case.

The Rohi Nullah is obviously an ecosystem under some stress and biological sampling may be an important component in long term monitoring of environmental quality.

8.1.2 Pandoki Outfall

The Pandoki Outfall is a drainage channel designed to carry saline water to the river Sutlej, some 10km away. For this reason it has been assumed to be of low amenity value and that "nobody is using the water for irrigation or other types of activities" (U.N.I.D.O. report DP/PAK/89/025).

Unfortunately this is not entirely correct and a small amount of fishing occurs in the drain. The fishing rights for the current season were sold for only 6000 Rupees, indicating that fishing is poor and of nominal value. However, at the time of the site visit people were using the drain for washing clothes and watering animals.

The drain itself is quite shallow and some 15-20 m wide as viewed on 8/12/92. Discharge on 8.12.92 was crudely estimated at 40 cusecs which is in agreement with the low flow figure of 80,000 m3/day (32 cusecs) given in earlier reports (UNIDO report DP/PAK/89/025). Dissolved oxygen levels taken on 8.12.92 recorded 13.5 mg/l at 17.10 hrs above the point where Rohi Nullah enters Pandoki Drain, 3.9 mg/l at 12.45 pm at the road bridge, approximately 1km below where Rohi Nullah enters, and > 12 mg/l just before the Pandoki joins the Sutlej. These figures may well be due to the deoxygenating effect of Rohi Nullah (high B.O.D) entering Pandoki Drain and the natural oxidation of the Pandoki as it enters the Sutlej.

The Pandoki was thick with filamentous algae possibly due to excess phosphate and nitrate leached from the soil. The algae would also account for the supersaturated oxygen levels observed above Rohi Nullah and at the Sutlej junction. No thermometer was available at the time of the sampling but as water temperature was clearly above 6 degrees Centigrade saturation was > 100%. Excessive oxygen levels are often an indication of extreme diurnal D.O. fluctuations which may at times be stressful to aquatic life.

Some invertebrates were found although the salinity of the water may inhibit diversity. Where the drain entered the Sutlej the water was fairly clear and sweet smelling.

8.1.3 Sutlej River

Two trips were made to Kasur with the intention of meeting the Director of Fisheries. On each occasion this proved impossible.

Some information was however obtained from the Department of Fisheries Punjab (Lahore), Mr. Ashraf Ali, Principal Chemist, Fisheries Research and Training Institute, (Manawan) and discussions with local villagers and fish sellers.

The river is divided into 6 reaches thought to be yielding a total rent of 20-30 lakh, and the Upper Sutlej would appear to be one of the more valuable. Fishing rights also include those of the Rohi Nullah.

Fishing rights are auctioned each year and in the concerned area two stretches of the Sutlej river are under fishing concessions:

a) From the first entry of the Sutlej river from India into Pakistan till the exit point into India (Figure 8.1) the existing contract is for Rs. 540,000 per year.

b) From the re-entry of the river into Pakistan until a point called Hanif Post the present contract is for Rs. 330,000 per year. This stretch of the river includes the point where the Pandoki drain flows into the Sutlej.

c) Further downstream outside the area of interest another contract exists for Rs. 296,000 per year.

Commercial fishing rights are usually purchased by an individual who then employs fishermen to catch as much fish as possible. The leasing of the fishing rights is known to be extremely profitable and a multiplier of perhaps five could be used in estimating the value of the fishery. The main species caught are rohu carp (Labeo rohiat), thaila (Catla catla), mori (Cirrhinus marigala) and malli (Wallago attu). The fishing season is September through to May and the fish are mainly caught through beach seines and drift nets.

The price of fish given by the Fisheries Department was rohu 75 Rs/kg, and thaila 60 Rs/kg, while a fish seller in Kasur was selling large rohu at 60 Rs/kg and small at 40 Rs/kg.

Taking an average fish price of 60 Rs/kg it is clear that at least 9,000 kg of fish must be caught to recover the fishing rights rental. Of course in reality allowing for profits and multiplier effects several times this amount must be caught.

One fish seller in Kasur stated that he buys 30 kg of Sutlej fish each day and estimates the total sold in the city to be 200 kg each day. Allowing 200 days at 300 kg/day would give a figure of 60,000 kg/year. Fish production for the Kasur region is estimated at 1,475 tonnes for 1990-91, although this includes farmed fish. In the whole of the Punjab, fish production in 1989 was estimated at 45,239 tonnes. (Source: Handbook of Fisheries Statistics, Pakistan, 1986-89).

Fisheries data for the Kasur district supplied by the Punjab Fisheries Department are given in Figure 8.2. All figures should be viewed with extreme caution. For example fulltime fishermen are considered to earn their entire income from fishing. On this assumption the quoted total income figure gives each fisherman an annual income of only 270 Rs/year.

Figure 8.2 : Fisheries Statistics as Supplied by Punjab Fisheries Department for Kasur District

YEAR	1988/89	1989/90	1990/91	1991/92
Fish Production (metric tonnes)	1767	1856	1475	N/A
Total Income (lakh rupees)	12.94	9.99	14.52	N/A
Fishing Boats				
< 1 ton	25	30	32	35
1 - 2 tons	7	8	10	10
> 2 tons	0	0	0	0
No of Fishermen				
Full time	4320	5000	5370	5550
Part time	1950	7005	8000	8102
Occasional	500	4199	5300	5000

A more methodical fisheries sampling program is currently underway in Punjab and this should more clearly determine the productivity of the fisheries and their importance to the region. Further site visits and interviews with fishermen indicated that these figures are high. The number of fishermen working the reach of the Sutlej where Pandoki enters is 64 and their annual earnings are about Rs 5,000. It can be said that commercial and recorded fisheries are of not insignificant consequence to the economy of the region.

The point where Pandoki outfall enters the Sutlej was visited on 8.12.92. It was observed that the 1:1000 low flow dilution assumed

to occur as the Pandoki enters the Sutlej (UNIDO Report DP/PAK/89/025) was over estimated by a highly significant amount as minimal to zero flow was observed. Also it was noted that the Pandoki discharges into a minor channel of the Sutlej, with the main flow passing to the east. It is an estimated 12 km before the full flow and dilution is realised.

The dilution figure given in the treatment plant design specification assumes a minimum winter flow of 30,000 cusecs which is clearly incorrect. In fact as stated in Chapter 5 the hydrological data indicates that from 1976 to 1991 the peak discharge in 7 of these years failed to reach this figure.

Indeed it is not an unusual occurrence during the low flow period from October to March, to have a month with no discharge at all. Sections of the river in this case are likely to become completely dry with the fish moving into the remaining pools. In fact a more normal median discharge for low flow months is 200 cusecs giving a dilution between the Pandoki and Sutlej of perhaps 1:6.

On the day the Sutlej was visited it appeared almost stagnant upstream of the Pandoki. Small fish were in evidence and the water had a green, eutrophic appearance. Rivers of this type are however likely to be extremely variable in nature and productivity.

Due to control of the upstream flows by the Indian authorities the flows in the Sutlej are extremely variable. During one site inspection (1.2.93) the flow in the river was estimated to be 5 cusecs, that is less than the proposed effluent flow.

Fishing does not usually occur at times of low flow but pollution during this period may mean that fish avoid the area. More sedentary organisms do not have this option which will have long term consequences for the ecology of this section of the river. This will certainly delay and possibly prevent return of fish to the stretch. If fish do remain they may become contaminated beyond acceptable standards.

8.2 Effluent Standards and Dilution Ratios

Any effluent treatment plant should be designed to treat effluent to a required standard with some allowance for the dilution and amenity value of the recipient water body. The tannery treatment plant has set itself on effluent standard as laid down by the Punjab Environmental Protection Agency. These standards are not enforceable under current legislation and can only be advisory.

By the standards of developed countries the E.P.A. effluent standards are low, they are however a move in the right direction. Unfortunately there is no mention of the minimum dilution ratios and quality of the recipient water. In many cases discharging effluent to E.P.A. standards would be grossly polluting.

The theoretical standard of the treated effluent does not however reach even these minimal effluent standards (Figure 8.3).

Figure 8.3 : Comparison of E.P.A. and Treated Effluent Standard

	B. O. D.	COD	SS	CL	S-2	Cr+3
Treated Tannery Effluent	<450	<1600	<150	<3200	2-4	1-2
E.P.A. Standard	80	150	200	1000	<1	<1

Exceedance of E.P.A. standards is not minimal but by several fold in the case of B.O.D., C.O.D., chlorides and sulphides.

It may be asked why such poor standards for final effluent were accepted. This would appear to be based on 3 assumptions.

- The natural oxidation that currently occurs in the Rohi Nullah is assumed to also occur in the newly constructed drainage canal (Green channel).
- The Pandoki Outfall is considered of no amenity value so any environmental degradation is assumed of no consequence.
- The dilution factor of the R. Sutlej is considered so enormous (1: 3000 under low flow conditions) that even poor quality effluent would have little impact.

It would appear that all three of these assumptions may be invalid.

Firstly as previously discussed the Rohi Nullah does appear to have considerable natural self purifying capacity. However much of this benefit is derived from the extremely long residence time of the effluent before entering the Pandoki. The newly constructed drainage channel is unlikely to share this characteristic and so the assumption of similar natural oxidation is unlikely.

As already mentioned the Pandoki Outfall has some informal amenity value in terms of fisheries, watering of livestock and clothes washing. Assuming a minimum dilution ratio in the Pandoki of 6:1 (UNIDO Report DP/PAK/89/025), even satisfactory plant operation is likely to cause some environmental degradation. A discharge of untreated effluent is likely to cause fish mortality. As Pandoki is classified as a drain and persons utilising the water do so without permission then degradation of its water quality is not a major concern.

The further salinization of the Pandoki is also likely although no water quality data was available on its current state. The Australian E.P.A. recommend that salinity should not increase by more than 5% from background levels. Variation greater than this is likely even perhaps in the Sutlej, although once again there is a scarcity of reliable data.

The third assumption based on the minimum flows in the Sutlej is apparently incorrect. Indeed under some circumstances the discharge would be to a stagnant pool. The large dilution ratios on which the plant appears to have been designed do not apply at all times.

During discussions with Mr. Ashraf Ali, Principal Chemist Fisheries Research and Training Institute, Manawan, standards for effluent quality and a final standard of recipient river water were presented. He believes these would ensure the maintenance of the current fisheries and ecology of the river (Figure 8.4 and see Annex 5 for comments in detail)

The proposed effluent standards are broadly in line with U.K. Royal Commission recommendations of 20:30, BOD to SS. assuming a dilution of 8:1. The River Quality Objectives fall somewhere around class 1b under the U. K. classification scheme. This applies to rivers supporting high class fisheries and of high amenity value.

The figures are most useful in that they specify dilution ratios and recipient river water quality. It could however be argued that the effluent and water quality objectives are too rigorous, given the current likely condition of the Sutlej. If high dilution ratios could be proved to occur then some reduction of standards could be allowed.

Figure 8.4 Effluent Quality Guidelines as Presented by the Punjab Fisheries Research and Training Institute.

If more than 8 times of dilution of clean river water is available, working standards to be applied to the effluents discharging to rivers should be :

The B.O.D. (5 days, 20C) of effluents < 20 ppm
Suspended solids (plus dissolved iron) < 30 ppm.
pH should < 9 or > 6.5.
Cyanides (as HcN) < than 0.1 ppm.
Sulfides (as H2S) < than 0.1 ppm.
Chromium and other toxic metals either single or in combination < than 0.5 ppm.
Oil and grease : nil.

Further details of the Proposal can be found in Annex 5

8.3 Situations Arising from Normal and Breakdown Conditions of the Treatment Plant.

The EIA has been asked to address three separate scenarios of operation of the treatment plants and in particular to assess the impact of operation on the aquatic ecosystem. To do this with any certainty requires a reasonable source of reliable data. The basic data for this assessment does either not exist, or is considered unreliable.

Specifically :

- Dilution ratios of discharge to the Sutlej are clearly unreliable. Reasonable discharge data for the Sutlej has now been collected and indicate that the river has no discharge for perhaps several months during the dry season.
- No information is available on water quality within the river Sutlej itself. This will obviously be extremely variable given that the river may at times assume a series of pools.
- No adequate data on either water quality or discharges within the Pandoki are available.
- The limited hydrometric and water quality data already collected has been proved to be unreliable.
- The laboratories used for sampling have unreliable quality control. Two identical samples analysed by the EPA and PCSIR laboratories yielded completely different results. These were not errors 10-20% but of the order of several 100%. One laboratory returned results showing identical B.O.D. and C.O.D. results which is impossible.
- Evidence for the self purification and oxidation occurring in the newly constructed green channel is lacking. This would be a concrete channel of small cross section and bears little relation to the Rohi Nullah with which it is compared.
- A definitive map of water courses within the proposed area does not appear to have been consulted. For example it was only recently highlighted that the Pandoki discharges into a minor channel of the Sutlej and it is some 12km before the water mixes with the full volume of the river.

Given these severe limitations in available data it is difficult to predict with any certainty the potential environmental impact on the three operating scenarios.

Under low flow conditions no dilution may be available within the Sutlej, so total dilution may be as little as 6:1 due entirely to the Pandoki after attainment of steady state conditions. The specific effects within the mixing zone with the Sutlej are difficult to predict, but sedentary benthic organisms are likely to suffer. At periods of prolonged low flow it is even possible that anoxic conditions may occur in the Sutlej.

However, some observations may be made under the three operating scenarios.

8.3.1. Normal Operation of Plant

This would involve 13,000 m3/day of treated tannery effluent entering the Pandoki. As previously mentioned the effluent is not treated to a very high standard. At periods of low flow, dilution within the Pandoki is only 6:1. The argument for considerable natural oxidation of the effluent on its way to the Pandoki is not accepted.

Given these conditions it is likely that even treated effluent will have adverse ecological consequences on the Pandoki, and possibly the Sutlej. However the Pandoki has limited amenity value.

The treated effluent is itself highly saline and would contribute to the already saline Pandoki, increasing the loading on the Sutlej.

The concentration of chromium and sulphides may also give cause for concern. Acceptable levels from a fisheries aspect given by the Australian EPA are 0.05mg/l for chromium and 0.01 mg/l for sulphides. These are maximum levels in the water body that avoid bioaccumulation within fish flesh.

To meet these standards for chromium and sulphides requires dilution ratios of 40 and 300 respectively in the ultimate receiving body, that is a minimum flow of 1500 cusecs. Under normal operation these standards will not be met for several months during the dry season. During the wet season they will be met. This could result in fish being unfit for human consumption if taken from the short stretch of the river below the connection with Pandoki drain, before complete mixing occurs with the main branch of the river.

Sulphides and chromium are themselves directly toxic to fish. The toxicity can depend on several factors including synergistic effects with other pollutants, p.H., temperature and oxygen levels within the recipient water body. Toxic effects are generally experienced at approximately ten times the concerntration at which

bioaccumulation can occur. The standards are then taken at 0.5 mg/l for chromium and 0.1 mg/l for sulphides final receiving water quality.

Sulphides themselves are particularly toxic and their concentration depends on the oxygen available within the receiving water. Where sufficient oxygen is available they are easily oxidised to sulphates which are barely toxic.

Although insufficient data is available on water quality within the Sutlej when all factors are considered it is most unlikely that sulphides will exist in toxic concerntrations during normal operation of the treatment plant. Levels of chromium are unlikely to present a toxicity problem either.

8.3.2 Failure of Dingarh Pumping Station

If the proposed Dingarh pumping station fails then Rohi Nullah will receive its current untreated effluent load and the Sutlej, via the Pandoki will receive 9,500 m3/day of treated effluent.

Given the current high assimilative capacity of Rohi Nullah, it is unlikely to result in a significantly worse situation than discharge under normal operation. However the quality of the Rohi Nullah will have been improved under normal operations, and if breakdown occurs after some time it is expected to revert to similar conditions as at present.

The highly toxic sulphides are not responsible for fish kills within the Rohi Nulah at present and reversion to this situation should not cause problems in the future.

8.3.3. Total Failure of Treatment Plant

This scenario would result in 13,500 m3/day of untreated effluent entering the Pandoki outfall and then the Sutlej.

With a B.O.D. of over 1200 mg/l it is likely to have a severe deoxygenating effect on firstly the Pandoki and quite possibly the Sutlej. A fish kill in the Pandoki is almost certain, assuming normal discharges have not already excluded aquatic life. The effect of a plug of deoxygenated water of high BOD entering the Sutlej will depend on the time the discharge continues for and the dilution available within the Sutlej.

If anoxic or near anoxic conditions prevail then the sulphides will not be converted to sulphates and the water will become toxic to fish. A precise prediction of the consequences of this are impossible and depend on the current river dilution, extent of the mixing zone, degree of deoxygenation occurring and reaction of the fish.

To achieve an acceptable concentration of sulphides within the water body at 0.1 mg/l from an original level at 80 mg/l requires an overall dilution ratio of 800. This requires a flow of 4000 cusecs which is rarely achieved during the dry season. A fish kill under these circumstances is then a high possibility but depends ultimately upon other factors on which there is no information.

It is possible that the deoxygenating effect on the Pandoki will be quickly exerted due to high temperatures and high nutrient levels. This will cause the Pandoki to become anaerobic and fully depleted of oxygen. If the Pandoki provides sufficient reoxygenation the effect on the Sutlej may not be catastrophic.

Chromium is considerably less toxic than sulphides and to achieve an acceptable standard of 0.5 mg/l from an effluent of 20-30 mg/l requires a dilution ratio of only 60. Consequently chromium is unlikely to present toxicity problems even in the case of total plant breakdown.

To meet the standards for receiving water quality to avoid contamination of fish intended for human consumption requires minimum flows of 40,000 cusecs in the case of chromium and 3,000 cusecs for sulphides. The respective standards are 0.05 mg/l for chromium and 0.01 mg/l for sulphides.

These conditions will be met for chromium for only 20% of the low flow period between October and March. The situation for sulphides is worse, and required dilution will never be achieved during this period, and for only 50% of the remainder of the year.

It must be stressed that this assumes total failure of the plant and permanent discharge to the river. This will lead to steady state conditions whereby the fish life are exposed for a sufficient time for ingestion and tainting by chromium and sulphides to occur. This is not an instantaneous process and should be viewed in the context of the life cycle or maturity period of the fish which could be months or seasons.

Should steady state conditions prevail, that is a permanent discharge occur, then sulphides in particular, and possibly chromium may reach toxic levels.Fish kills could occur and the fish would not be fit for human consumption. With the limited data available it is difficult to quantify the effects.

Economically the fishing rights downstream of the discharge are worth some Rs 626,000 and provide a source of income to several hundred fishermen.

The opinion of the Deputy Commissioner Kasur was that this is a free market economy in which the fishing rights are auctioned and if their value is reduced then this will be reflected in the realised auction price. However this view does not reflect a

reduction in income, fish availability and employment within the local economy and is therfore rather short sighted.

With regards to health aspects, with the limited data available it is not possible to quantify exact figures, but there is an unacceptable risk of long term detrimental health effects if the scenario of total discharge of untreated waste was allowed to occur.

8.3.4 Mitigation Measures Against Total Failure Of Plant

The scenario described above assumes total failure of the plant and necessary discharge of the collected effluent ultimately to the Sutlej. In the event of this happening a mitigation measure is proposed. Investigations of Rohi Nullah indicate a high capacity to assimilate oxygen demanding pollutants due to the abundant aquatic life. Also the flow into Rohi Nullah is low and the surface area very large as the nullah at one point spreads out into large ponds near Depalpur road. Due to the low flow the retention time of the ponds will be very high and any flows entering the ponds will become virtually stationary. The previous sedimentation tests on tanneries effluent indicated that 85% removal of chromium took place after a 2 hour detention period.

As the detention period of the ponds is of the order of days they would act as an efficient removal mechanism. Also the BOD load exerted on Pandoki drain will be enhanced by the high nutrient levels. Although this will have a catastrophic effect on Pandoki this will reduce the effects on the Sutlej. Therefore in the event of temporary failure of the plant it is recommended to discharge to Rohi Nullah at the point where it crosses Depalpur road. This could easily be accomplished with mechanical weirs or gates. This would have a severe effect on Rohi Nullah but in effect would cause it to revert to the condition it is in now. This mitigation measure would provide an effective buffer whilst the plant became operational again.

The blocking of the Sutlej river to form a lagoon at times of low flow has been considered. This would be an effective technique as it would effectively create another maturation lagoon but the practicalities of this are in doubt as a permanent measure. It could be a useful temporary measure whereby manual labour was employed to erect earth bunds across the river to contain any unplanned discharges. This should be a normal contingency plan response on the part of the plant manager.

8.4 Conclusions

The tannery effluent treatment plant will produce effluent of poor quality. Natural oxidation assumed in the proposed Green channel has not been quantified and little evidence to support its occurrence provided.

The Pandoki has greater fisheries and amenity value than previously recognised. However this is an informal presumption on the part of the local people. It has been publically stated by government officials that preservation of water quality within Pandoki is not an issue as it is classified a drain.

The dilution ratios available within the Sutlej have been overestimated. There is a scarcity of data on water quality, discharges and beneficial uses. What data does exist should be interpreted with caution.

Although it has proved difficult to quantify, fisheries within the Sutlej form an important part of the local economy, and represents approximately Rs 600,000 income (minimum) downstream of the discharge point.

Under normal operation the effluent treatment plant as proposed will have adverse and possibly severe ecological consequences on the recipient water bodies at periods of low flow. Limited fish kills may occur over a small length of the river due to deoxygenation. Also standards to avoid bioaccumulation for sulphides and chromium will be exceeded for most of the year for sulphides and for one to two months in the case of chromium. The effect is likely to be local but benthic organisms and through them fish are likely to accumulate elevated levels of chromium and sulphides.

If the plant becomes nonoperational then 13,500 m3/day of untreated effluent will enter the Pandoki outfall and Sutlej.

A fish kill in the Pandoki is almost certain. Pandoki will quickly become anaerobic and fully depleted of oxygen, but the effect on the Sutlej may not be catastrophic if reoxygenation occurs before discharge to the river.

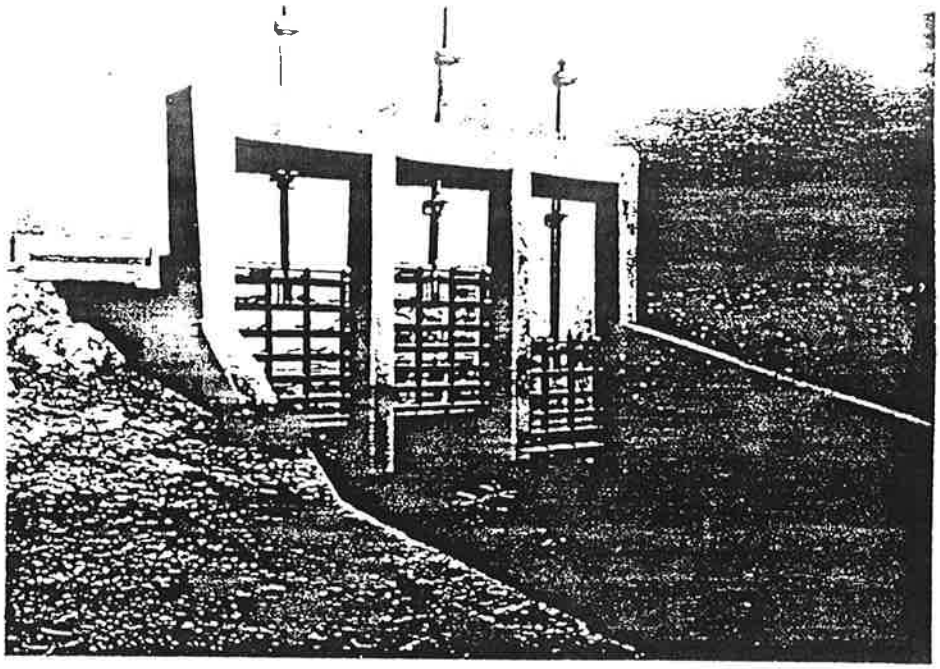
Sulphides will also enter the river in high concerntrations and depending on the degree of oxygenation may become toxic. Precise effects are difficult to predict but deoxygenation combined with high sulphides may well result in a fish kill.

From a bioaccumulation point of view both sulphides and chromium may present a problem if discharge continues for a long time. This could result in fish being unfit for human consumption.

During the period October to March, for 80% of the time the standard for chromium will not be met. For 20% of the time and for the rest of the year the standard will be met. For the period October to March the standard for sulphides will never be met. During the remainder of the year for 50% of the time the standard may be met.

Economically the fishing rights downstream of the discharge are worth some Rs 626,000 and provide a source of income to several hundred fishermen.

With regards to health aspects there is an unacceptable risk of long term detrimental health effects if the scenario of total discharge of untreated waste is allowed to occur. An effective mitigation measure against this would be diverting the discharge to the Rohi Nullah at the Depalpur road crossing and exploiting the natural assimilative capacity of the ponds formed by the nullah at a point slightly further downstream.



Entry of Rohi Nullah into Pandoki Outfall

Pandoki Outfall

Livestock Watering in Pandoki Outfall

Entry Point of Pandoki Outfall into Sutlej River. Rip-rap protection indicates height of wet weather flows and differential flow rates.

9.0 TREATMENT PLANT

9.1 Tanneries Effluent Management Plan

The improvement of the liquid wastes collection and disposal operation in Kasur is to take place in two stages. These are:

- Construction of the tanneries waste Common Effluent Pretreatment Plant, and its ancillary infrastructure (CEPTP)
- Extension of the works to provide a Common Municipal Treatment Plant

The overall system of the CEPTP will include the following:

i) A collector system serving the Dingarh area
ii) A pumping station at Dingarh to lift the effluents into the drain feed to the treatment plant, so avoiding discharge into the Rohi Nullah
iii) Construction of the drain feed channel by extending the existing "pucca" drain
iv) A collector system serving the Younus Nagar area and a pumping station
v) The treatment plant itself
vi) The treated effluent "Final Outfall" which will discharge to the Pandoki Outfall and be 8.4 km. in length
vii) An analytical laboratory
viii) A pilot chrome recovery plant
ix) A solid waste tip, site compacting vehicles, and road transport vehicles.

It is estimated that the total construction costs, allowing 20-30% contingency, will be of the order US$8 million, with maintenance costs of approximately 10% of this per annum.

9.2 Selection of Generic Type of Treatment Plant

During the Project Preparation Technical Assistance, various alternatives were examined by the UNIDO consultants to determine the most cost effective and appropriate type of plant. Alternatives examined included:

- Activated sludge
- Oxidation ditches
- Upward flow Anaerobic Sludge Blanket Process
- Naturally aerated lagoons

A detailed financial and technical evaluation was performed and the finally selected optimal solution was as follows:

- o In house screening bars and grit chambers plus water flow metering in each tannery
- o Coarse pretreating and mechanical removal of entrapped particles in treatment plant
- o Equalisation and homogenisation of the waste influent with surface agitation
- o Settling tanks with sludge and scum collection, each tank being 18 metres in diameter with 2.5 hours detention time
- o A series of interlinked naturally aerated lagoons of which the first 4 will be for sludge drying purposes
- o Sludge stabilisation by lime addition
- o Sludge removal by road transport
- o Discharge of treated effluent by final outfall, and bypass overflow channels

9.3 Review of Design Performance

The treatment plant is intended to accept 12,700 cubic metres per day of effluent with the characteristics given below:

Parameter	Unit	Value
Suspended Solids(SS)	mg/l	2,700-3,000
BOD(5)	mg/l	1,200-1,350
COD	mg/L	3,500-4,000
Sulphides(S--)	mg/l	70-80
Chromium (Trivalent)	mg/l	20-30
Chlorides	mg/l	3,000-3,200
pH	-	7-9

In order to minimise on complexity, energy requirements, and chemical additives, the proposed system dispenses with two stages that are commonly used in similar treatment plants elsewhere. Manganese catalysts may be added at the sulfide oxidation stage in the equalisation phase to assist in oxidation of sulphides to sulphates. The sulphate sludge may then be precipitated out and disposed. Whilst sulphate compounds are not malodorous, they may be reduced to hydrogen sulphide gas if anaerobic conditions and low pH occur. Therefore it is necessary to retain alkaline conditions and sufficient dissolved oxygen downstream to prevent hydrogen sulphide generation. If chrome recovery is a priority issue, the addition of lime together with chrome settling agents can take place in the chrome waste stream.

Secondly, to ensure effective BOD reduction, the lagooning process requires lagoons of sufficient depth to ensure facultative breakdown occurs, or additional oxygen demand is met by mechanical surface aeration. It is noted that the lagoons will rely on natural aeration with no mechanical assistance.

The design performance of the treatment plant is stipulated as being:

Parameter	Reduction Percentage (%)
Chromium	95-98%
Sulphide	95-98%
Suspended Solids	95%
BOD(5)	60%
Dissolved Salts	0%

In order to improve the BOD removal efficiency of the lagoons it would be necessary to allow for increased retention time (and hence greater area) or allow for provision of mechanical aeration which could necessitate increased depth (See M. Aloy's Report, April 1992).

In climatic condition such as relate in Pakistan, one must design for large temperature variations, from a high of 30-40 centigrade in summer to below 10 centigrade in winter. With regard to standard design equations (See World Bank Technical Paper No. 7 "Notes on the Design and Operation Of Waste Stabilisation Ponds in Warm Climates in Developing Countries", Urban Development Technical Paper Number 6) for temperatures below 12 degrees centigrade a loading of 180 kgm/hectare.day BOD is recommended. For temperatures above 12 degrees a loading of 250-300 kgm/hectare.day is recommended. The figures are based on empirical data. It is noted that the loading on the first lagoon will exceed this figure by a considerable margin and so anaerobic conditions can be expected to arise. This may result in the release of dissolved sulphides and give rise to the generation of odours. It is noted that this point is acknowledged in the TEH Design Statement. (Executive Summary, Conclusions and Recommendations, Book 2, Section 3.3.2 July 1992.) Their findings are concurred with, and odour generation should be taken into account in the future development of the surrounding area as will most likely be encouraged upon draining of the Stagnant Pools.

9.4 Review of Experimental Data

The original design of the treatment plant is based on previous experience and on results obtained by the Punjab EPA. Two sets of field measurements were carried out one week apart and samples of tanneries effluent taken. These samples were then subjected to standard tests in the Punjab EPA laboratory. The results of these

tests formed part of the design parameters of the treatment plant. The Punjab EPA Laboratory is staffed with competent officers who are well trained and conscientious. However, two recent reports, by the Asian Development Bank (Strengthening of Environmental Management in Pakistan, ADB TA 1266, 1991) and by the World Bank (Punjab Urban Environment Project, ongoing) both drew attention to the level of ability of the EPA laboratory. No quality control or quality assurance procedures exist within the laboratory, they are short of equipment, and reagents are in short supply. Without prejudice to the EPA Laboratory, it seems unwise to embark on a major project expenditure without verifying the data from an independent source.

In the design consultants initial sampling, a cross check was carried out by preparing duplicate samples and having both sets analysed by EPA Laboratory and PCSIR laboratories. The results are shown in the consultants report. (DP/PAK/89/025 Study on the environmental problems emanating from the tannery industry in Kasur, Part 2, CTA's mission to Trieste, August 1991, Annex I, P.47) The results show extensive variation far beyond the limits of experimental error, and often by an order of magnitude. The results do not differ in a consistent manner and at one point figures for BOD and COD are presented which are physically impossible to realise. Serious doubt must exist about the validity of these results.

9.5 Sampling

9.5.1 Objective of Sampling

In the design document (Teh Project Hidro, Book One, DP/PAK/89/025, August 1991) reference is made to the natural recreation abilities of the Rohi Nullah. This is based on field data collected by Punjab EPA on 17.6.91 and presented in their report "Study on Characteristics and Treatment of Tanneries Effluents at Kasur" (undated). In Annexure 12 of this report, data is given which has been derived by analysis of three samples. These samples were taken at the following locations:

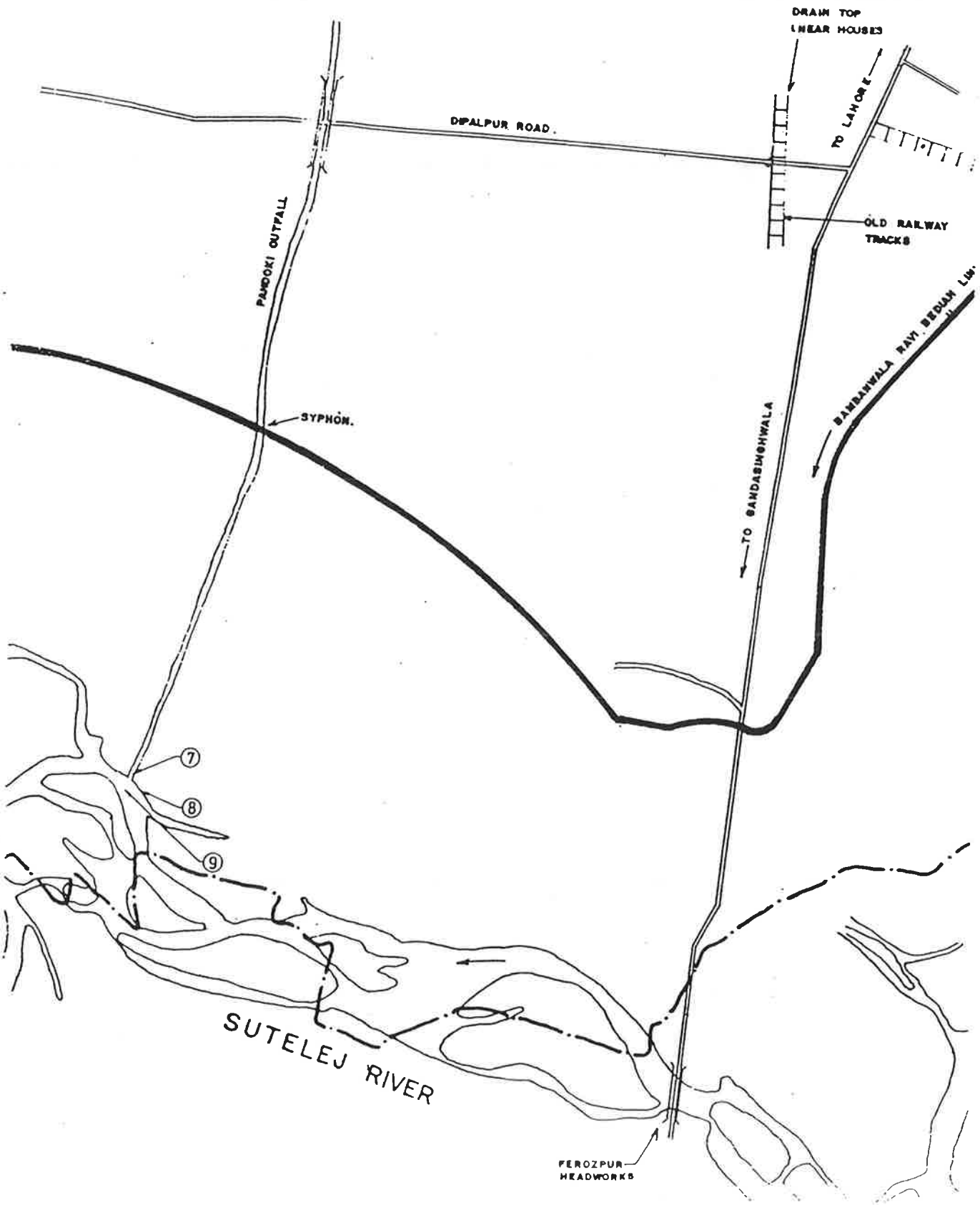
- 100 metres downstream from the Disposal Works
- At the first crossing of Rohi Nullah under the Dipalpur Road
- At the second crossing of Rohi Nullah under the Dipalpur Road, where the Nullah forms a large ponded area known as Tolwahwala accumulation

The results indicate high values of BOD(5) and correspondingly low values of D.O. at the first 2 locations, but low BOD(5) and high D.O. at the third location. The figures given show a complete absence of D.O. occurred at the first two sampling points and a value of 9.2 mg/l existed at the third. The conclusion drawn from

FIGURE 9.1(a) LOCATION OF SAMPLING POINTS

FIGURE 9.1(b)
LOCATION OF
SAMPLING POINTS.

KASUR



this was that Rohi Nullah exhibits "self purification" (Teh-Project Hidro report, "Summary Conclusions and Recommendations" July 1992, Paragraph 3.2.2.) The consultants do qualify this state by stating that they find this surprising.

All natural watercourses exhibit a degree of self regeneration due to the biological action of the aquatic organisms, and this biodegradation proceeds naturally in the presence of oxygen and suitable temperatures. In addition to this, photosynthetic action can take place due to the presence of algae and plants if certain requirements are met, namely adequate sunlight, carbon dioxide for energy fixation, oxygen for respiration and various major and trace elements. The oxygen generated by this action may lead to supersaturation and can be lost by exchange to the atmosphere in fast moving water bodies, or if an increase in temperature occurs. In slow moving, sluggish water courses such as Rohi Nullah this is unlikely to occur and supersaturation is likely. The supposition is supported by examination of the EPA data. This shows the colour and appearance of the water samples change from grey/turbid appearance to "greenish tinge" and the pH increased, which is indicative of algae presence. Such a mechanism would rationalise the high D.O. figure recorded, but the process is subject to diurnal variation. The timing of the sampling was not given and so no conclusions can be drawn with respect to this.

In order to establish the reliability of the data, the sampling exercise was repeated taking the Tolwahwala accumulation point as the most sensitive indicator location.

Samples were taken from predawn through the day to late afternoon to identify any diurnal variations.

9.5.2 Sampling Procedures and Analysis

The sampling exercise was carried out on 8.12.92. The sampling was not restricted to the Rohi Nullah but included Pandoki Outfall and Sutlej River. The sampling locations are shown in Figure 9.1. Direct readings were taken of dissolved oxygen using Wet Chemical Methods. In certain locations, bacteriological samples were taken in sterile bottles for subsequent analysis in the laboratory. Also two samples of drinking water were taken in sterile bottles from handpumps. These were subsequently analysed for compliance with drinking water quality standards. Both site analysis and subsequent laboratory analysis was carried out by the Punjab EPA laboratory staff under the supervision of the consultants. Tests for drinking water quality were performed by the Public Health Engineering Department, Punjab.

9.5.3 Quality Control

In addition to the sampling exercise above, which was primarily directed towards examining the regenerative capabilities of the various watercourses, a separate spot sampling exercise was carried out on 3.12.92. It had been noted in an earlier report (DP/PAK/89/625, Techno Economic comparison between different treatment alternatives, Part 2, Working Draft, August 1992, Annex 3 P.47) that analysis performed by Punjab EPA in early 1991 had been cross checked by reference to analysis of duplicate samples performed by PCSIR laboratories.

The comparative results given were significantly different beyond the limits of experimental error, analytical technique or statistical variance and so their validity is in doubt.

To cross check quality control, five samples were taken at various location around Kasur. The samples were obtained using standard techniques and each sample was divided into two. The samples were presented to the Punjab EPA laboratory and to the Punjab Soil Fertility Department, Lahore. Each laboratory was requested to perform analysis which contained common parameters. The results are shown in Figures 9.2 and 9.3. Neither laboratory knew of the others involvement. As can be seen by direct comparison of conductivity the two sets of results compare favourably and are within the limits of experimental error.

9.5.4 Discussion of Results

The results of the analysis are shown in Figure 9.4.

i) Drinking Water

The drinking water samples demonstrated bacteriological contamination and were classed as unfit for drinking water. Residents reported that they do not use water from that pump for drinking or irrigation but for washing clothes.

ii) Assimilative Capacity of Rohi Nullah and "Autopurification"

The location where Rohi Nullah becomes a large area pond was sampled at dawn, midday and dusk to identify any diurnal variation in dissolved oxygen levels. On each occasion dissolved oxygen was measured as zero, with high levels of COD and bacteriological contamination indicating gross industrial and domestic sewage pollution. At the point where Rohi Nullah enters Pandoki Outfall, D.O. figures had risen from zero to 3.2 mg/l indicating some regenerative capacity. This is less then indicated in previous reports. In interviews with local residents they voiced the opinion that the nullah had deteriorated over the last two years. Fish are caught in Rohi Nullah, and due to the low flows, pockets of deoxygenated water may exist.

RESULTS OF SAMPLES TAKEN IN KASUR 3.12.92
ANALYSED BY PUNJAB EPA LABORATORY

Sample No	Location	pH (site)	pH (Lab)	Cond	CR ppm	TDS mg/l	Time	Date
1.	Drain from steel workshop in Kasur	5-6	8.5	1700	Nil	1010	14.00	3.12.92
2.	Handpump of house near Rohi Nullah Kasur	7-8	7.9	3550	Nil	2990	14.15	3.12.92
3.	Rohi Nullah near "Disposal Works"	7-8	9.2	3600	Nil	2050	14.35	3.12.92
4.	Handpump on Dipalpur road near Rohi Nullah	6-7	9.3	3500	Nil	2590	14.57	3.12.92
5.	Pandoki Outfall near bridge for Dipalpur road	7	8.1	1700	Nil	1020	15.05	3.12.92

FIGURE 9.2

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رپورٹ برائے تجزیہ پانی

PARC اسلام آباد

نام زمیندار/پتہ ڈاکٹر تاسیم جوئیہ صاحب نمبر 1938/1-26 تاریخ 10-12-72

نمبر شمار	تفصیل	حل پذیر نمکیات (TSS) (ppm) یا برقی موصلیت (EC×10⁶)	کیلشیم + میگنیشیم (Ca + Mg)	سوڈیم سلفیٹ (SO4) Na	کاربونیٹ (Co3)	بائی کاربونیٹ (Hco3)	کلورائڈ Cl	سوڈیم کی جذب سطحی نسبت (SAR)	زائد سوڈیم کاربونیٹ (RSC)	کیفیت
			meq/l							
184	1	1620	5.9	10.3	NiL	10.6	3.0	6	4.7	unfit for Irrigation
185	2	3760	12.0	25.6	NiL	28.8	8.7	10	16.8	—do—
186	3	3740	6.1	31.3	NiL	15.4	19.8	18	9.3	—do—
187	4	3650	7.9	28.6	NiL	20.4	15.8	14	12.5	—do—
188	5	1652	5.2	11.32	Traces	10.8	4.7	7	5.6	—do—

Unsealed water samples received through frame is authenticity rests upon him

دستخط انچارج معائنہ

نظامت زرخیزی زمین و تجزیہ اراضی لاہور

محکمہ زراعت حکومت پنجاب

نمبر تجزیہ بستہ 1847 ©

سوکھا پانی

FIGURE 9.3

RESULTS OF SAMPLING TAKEN ON 8.12.92

NO.	LOCATION	TIME	OBSERVATIONS	D.O. mg/l	C.O.D mg/l	MPN/100 ml
1	Tolawalah Stagnation Pond. Upstream of Bridge.	07.23 (Dawn)	Litle flow, oil and scum on surface, some foaming.	0	-	-
2	As No. 1, Downstream side of Bridge	07.36	Slight flow, bacteriological sample for later analysis.	0	240	Infinite
3	Handpump water from pump next to Tolawalah road	07.45	Quality control test. Water tastes sulphurous and saline. Bacteriological test for later analysis	2	-	26
4	As 1.	12.06	Slight flow, bacteriological sample for later analysis	0	296	Infinite
5	As 1	17.46 (Dusk)	Little flow, sample dark gray	0	-	-
6	Pandoki Outfall	12.45	Downstream of junction with Rohi Nullah	3.9	48	Infinite
7	Pandoki Outfall	14.35	Upstream of Junction with River Sutlej, water clear, abundant filamentous algae, possibly eutrophic	9.7		
8	Sutlej River at junction with Pandoki Outfall	14.45	Near to bank, no flow	11.5	-	-

FIGURE 9.4

9	As 8	15.20	In centre of river, little flow, Water turbid, greenish tinge, evidence of phytoplankton	12.3	-	-
10	Rohi Nullah upstream of junction with Pandoki Outfall	16.29	Flow estimated at 5 cusecs	3.2	-	-
11	Pandoki Outfall, junction with Rohi Nullah.	16.50	In mixing zone of Rohi Nullah entering Pandoki Outfall. Bacteriological sample for later analysis	3.2	152	Infinite
12	Pandoki Outfall, upstream of junction with Rohi Nullah	17.10	Before mixing zone	13.5	-	-

FIGURE 9.4
(cont.)

CENTRAL RESEARCH LABORATORY

PUBLIC HEALTH ENGG: DEPARTMENT PUNJAB
2 - LAKE ROAD, LAHORE.

BACTERIOLOGICAL ANALYSIS REPORT

Source & Depth.....Hand. Pumps..... Tehsil & District.....KASUR.....

Place....DEPAL ROAD...KASUR..... Collected by..M.R. ASHRAF...(R.A.).....

Sl. No.	Laboratory No.	Date of Collection	Time of Collection	Description (Sampling Point)	Date of Analysis	Residul Chlorine	RESULT		Remarks
							MF/100 ml	MPN/100 ml	
1	2	8-12-92	7.26AM.	W/S taken from Hand. Pumps.	9-12-92	—	26	—	UNFIT
2	4	-do-	12.96 PM.	W/S taken from Hand-Pumps.	-do-	—	8	—	UNFIT

10-12-92

FIGURE 9.4 (cont.)

iii) Pandoki Outfall

Upstream of the junction with Rohi Nullah, Pandoki outfall is of clear appearance, high D.O. levels and sustains high aquatic life. It is high in dissolved solids and is classed as unfit for irrigation. Below Rohi Nullah confluence, the D.O. levels drop significantly. During the transit time to the entry point into the branch of the Sutlej river, D.O. levels have returned to high levels of approximately 9 mg/l. The Pandoki outfall is used along its length for clothes washing and livestock watering. Limited fish are reported to be caught.

iv) Branch of Sutlej River

The Pandoki Outfall enters a spur of the Sutlej River, rather than the river proper. The water flows were extremely slow moving, water clarity was murky with a greenish tinge indicative of the presence of phytoplankton. Very high flows do occur as evidenced by the scouring action visible on the banks. Dissolved oxygen levels were high which may be due to supersaturation, as the water was cold and slow moving.

9.5.5 Additional Sampling

During a site inspection of Kasur township and the drainage system associated with Rohi Nullah, it was observed that black, oily deposits were entering the nullah. These were traced to a small steel handling workshop some 2 km. away from Rohi Nullah. The process is a batch process with intermittent discharge of spent solvents and materials. In this case the spent materials include sulphuric acid and oil. These pass directly into the surface drainage system and hence into the nullah. This could have significant effect on sulphide generation. This case is typical of many in Kasur.

Five locations were used for "grab samples". These were:

- Drain from steelworks in Kasur
- Handpump of house near Rohi Nullah
- Rohi Nullah near disposal works
- Handpump on Dipalpur Road near Rohi Nullah
- Pandoki Outfall near Dipalpur Road

The results are shown in Figure 9.2. In all cases the waters were unfit for irrigation and potable water supplies.

9.6 Review of Previous Reports

During the course of the Preparatory Assistance Project there have been several reviews of the treatment plant design. Comments and suggestions have been made. These are reviewed below.

9.6.1 Assistance in the Treatment of Tannery Water, Kasur, DP/PAK/89/625/11-53; Mission Report, M. Aloy, UNIDO Consultant, June 1992

This report reviews the basic design and confirms the appropriateness of it as low cost, low technology, low maintenance.

The report compares the proposed design with the UASB system and concludes that the UASB system is not appropriate due to insufficient nutrient levels in the influent, potential corrosion problems, higher maintenance requirements and higher energy needs.

The report reviews the performance specifications claimed by the design team. The report concludes that "in the absence of surface aerators, and relying only on natural aeration due to wind, it seems impossible to have a BOD(5) elimination greater than 15-20% in the warmer conditions". The report then recommends additional mechanical surface aeration. This would require 300 Kw. of installed power.

Alternatively, if a higher quality of effluent is required a longer residence time of 6.8 days as opposed to 4.2 days is recommended. These findings are concurred with.

Under the present design, the specification for treatment will be:

Parameter	Reduction	Concentration in Effluent
Suspended Solids	95%	150mg/l
COD	55%	1,690mg/l
BOD(5)	65%	445mg/l
Sulphides	98%	2mg/l
Chromium	95%	1mg/l

If this quality of effluent is not acceptable then further treatment will be necessary.

9.6.2 Environmental Project for Kasur, Pakistan, Jordforsk, Project No. 1624, June 1992, prepared for NORAD, Islamabad, Pakistan

This report reviews the historical background to the project and reviews the baseline data. The report raises fundamental questions regarding the "control" group in the statistical evaluations. The report supports the choice of aerobic lagoons over more technical processes. The report stresses the need for an overall environmental management plan. The report is concurred with.

9.6.3 Mission Report on Kasur Tannery Project, J. Schaapman Haskoning, Royal Dutch Consulting Engineers and Architects, 6.7.92

This report reviews the historical basis of the proposed treatment plant. The report states that the self purification properties of Rohi Nullah are lower than assumed. This is concurred with. The report stresses water conservation and states that in order to meet the required standards the lagoons will require aeration. Sulphide generation from the first lagoons is predicted due to a shortage of available oxygen. The report stresses chrome recovery has been proven to be cost effective elsewhere and assists in the sludge disposal issue. The report discounts reverse osmosis as an option as hypersaline brine will result. The report recommends extended aeration. The findings of the report are concurred with. The report suggests the use of UASB system. This is not concurred with as its viability in Kasur is not yet established.

9.7 Acceptability of Standards

There are no emission standards or receiving water quality standards extant in Pakistan. However, provisional standards have been promulgated by Punjab EPA and these were informally accepted by the Pakistan Environmental Protection Council in July 1991.

These standards require the following parameters to be met. They are emission standards and so relate to end-of-pipe concentrations:

Parameter	Standard (mg/l)
BOD(5)	80
COD	150
SS	200
TDS	1,000
Chromium	1
Sulphides	1

By comparison with international standards (e.g. EC, USA, Australia) these would be regarded as very lax. For example figures of 20:30 BOD:SS are normally enforced. However, in the Pakistan context they are probably appropriate.

During discussions with the EPA it has been previously agreed that these standards need not apply and that higher figures (i.e. lower quality) effluent will be acceptable.

These are based on the available treatment efficiency of the proposed plant. This conceptual approach is acceptable, and

commonly used elsewhere in the world if one accepts the principle of "Best Practicable Means".

The tanneries untreated effluent, treated effluent, and EPA standard are shown below:

Parameter	Tannery Effluent	Treated Effluent	EPA Standard
BOD(5)	1,300	445	80
COD	3,000	1,690	150
SS	3,200	150	200
TDS	3,000	3,000	1,000
Chromium	30	1	1
Sulphides	80	2	1

Taking BOD(5) as an indicative parameter, it is evident that the standard will be exceeded by a factor of five. The EPA standards assume a minimum dilution ratio, outside the mixing zone of 10:1 (Reference EPA Punjab Emission Standards, first promulgated 1985).

If one assumes discharge into the Pandoki outfall then at full flow (650 cusecs) a dilution ratio of 120 would apply. At periods of low flow (20 cusecs) a dilution ratio of 4 will apply. This would indicate conditions arising outside the area intended to be protected by the standards by a considerable margin, and could generate anaerobic conditions.

If one presumes ultimate discharge into the Sutlej river, a further application factor will apply upon entering the river. Taking a mean minimum flow of 150 cusecs. (the L50 or 50th Percentile) then an overall dilution ratio of 30 would apply. This could exert a significant oxygen demand on the receiving water.

The current EC directive on surface water for fish recommends "not to be exceeded" figures of 3mg/l for high stressed target group, and 6mg/l for more resilient species such as carp, as are found in the locale. Both these figures would be exceeded. (Figure 9.5.)

In terms of receiving water quality, this may be directly translated into the river classification. No such system exists in Pakistan at the moment but as the Sutlej River is high in biodiversity, and supports several beneficial uses then a higher order Classification Index may be anticipated. With such BOD(5) levels the river would be classified as outside Class 2, and within Class 3 if reference is made to U.K. River Classification Systems. (Figure 9.6.) Class 2 is only expected to provide "moderate" amenity value. Class 3 assumes fish are sporadically absent.

At times of high flow, the flows in the River Sutlej would be of the order at least 1,000 cusecs. The anticipated dilution would be such that BOD(5) levels less than 1mg/l may be expected and the

Parameter	Unit	EC-Directive on Surface Water for the Production of Drinking Water						EC-Directive on Surface Water for Bathing		EC-Directive on Surface Water for Fish		General Medium-term Goal in the Netherlands	
		With Simple Treatment A_1		With more extensive Treatment A_2		With extensive Treatment A_3							
		Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Goal	Guide Value
GENERAL													
Temperature	°C	25	22	25	22	25	22			21.5(S) 28.0(C)		25	23
pH			6.5–8.5		5.5–9		5.5–9	6–9		6–9		6.5–8.5	6.5–8.5
Odour Threshold Number			3		10		20					35	10
Taste Number												35	10
Colour Number	mg/l Pt–Co	20	10	100	50	200	50		Natural Colour			35	15
Suspended Matter	mg/l		25								< 25	80	25
Glowing Rest	mg/l												
Turbidity	dm							10	20			5	10
Oxygen	mg/l. O_2									> 7(C)*) > 9(S)	***)		
Oxygen Saturation	%		> 70		> 50		> 30		80–120	50		> 50	80–120
$\alpha + \beta + \gamma$ – Activity – (excl. Tritium)	pCi/l											10	
α – Activity	pCi/l												
β – Activity	pCi/l												
β – Activity of K–40	pCi/l												
β – Activity of Sr–90	pCi/l												
α – Activity of Ra–226	pCi/l												
β – Activity of Tritium	pCi/l												
Coliforms (Mac. Conkey)	n/100 ml		50		5000		50 000	10 000	500			5000	< 200
Coliforms (Eykman)	n/100 ml		20		2000		20 000	2 000	100			2000	< 100
Streptoc. FAEC.	n/100 ml		20		1000		10 000		100			1000	
Colony Counts at 20 °C	n/ ml												
37 °C	n/ ml												
Salmonella	n/1000 ml		n/5000ml		0				0				0
Virl	n/10 l								0				0
Sulfite Reducing Clostridium	n/20 l												0
Discharge	m^3/sec												

S = Salmon C = Carp

***) 50% of Time > 8 (C) and 9 (S)
100% of Time > 5 (C) and 7 (S)

*) 50% of Time

FIGURE 9.5

Parameter	Unit	EC-Directive on Surface Water for the Production of Drinking Water						EC-Directive on Surface Water for Bathing		EC-Directive on Surface Water for Fish		General Medium-term Goal in the Netherlands	
		With Simple Treatment A_1		With more extensive Treatment A_2		With extensive Treatment A_3							
		Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Goal	Guide Value
Inorganic Substances													
Electrical Conductivity	mS/m (20 °C)		100		100		100					100	75
Chloride	mg/l.Cl		200		200		200					200	<150
Sulfate	mg/l.SO_4	250	150	250	150	250	150					150	<150
Sodium	mg/l.Na												
Potassium	mg/l.K												
Calcium	mg/l.Ca												
Magnesium	mg/l.Mg												
Total Hardness	m equiv./l											5	
Carbonate Hardness	mg/l.$CaCO_3$												
Hydrogen-Carbonate	mg/l.HCO_3												
Ammonia	mg/l.NH_4-N		0.04	1.2	0.8	3.1	1.6			<0.2	<0.04	2.0	0.5
Albuminoid Nitrogen	mg/l.NH_4-N									<0.8	<0.03 (S)		
											<0.016(C)		
N-Kjeldahl	mg/l.N		1		2		3.					3	1
Nitrite	mg/l.NO_3-N										<0.003(S)	1	
Nitrate	mg/l.NO_3-N	11	5.5	11		11					<0.01 (C)	4	2
Total Phosphate	mg/l.PO_4-P		0.17		0.31		0.31					0.3	0.05
Ortho-Phosphate	mg/l.PO_4-P												
Total Silicon	mg/l.SiO_3												
Fluoride	mg/l.F	1.5	0.7/1		0.7/1.7		0.7/1.7					1.2	0.7
Iron (Dissolved)	mg/l.Fe	0.3	0.1	2	1		1					1	0.1
Copper	mg/l.Cu	0.05	0.02		0.05		1				0.04	<0.05	<0.01
Nickel	mg/l.Ni											<0.05	<0.01
Zinc	mg/l.Zn	3	.0.5	5	1	5	1			<1.0(C)		<0.2	<0.01
										<0.3(S)			
Lead	mg/l.Pb	0.05		0.05		0.05						<0.05	<0.02
Cadmium	mg/l.Cd	0.005	0.001	0.005	0.001	0.005	0.001					<0.005	<0.001
Chromium	mg/l.Cr	0.05		0.05		0.05						0.05	
Cobalt	mg/l.Co												
Mercury	mg/l.Hg	0.001	0.0005	0.001	0.0005	0.001	0.0005					0.001	0.0002
Arsenic	mg/l.As	0.05	0.01	0.05		0.1	0.05					<0.05	0.01
Manganese	mg/l.Mn		0.05		0.1		1					0.1	
Selenium	mg/l.Se	0.01		0.01		0.01						0.01	
Beryllium	mg/l.Be											0.001	
Lithium	mg/l.Li												
Vanadium	mg/l.V											0.01	
Antimony	mg/l.Sb											<0.05	
Cyanide	mg/l.CN	0.05		0.05		0.05						0.05	0.01
Barium	mg/l.Ba	0.1		1		1						<0.1	
Boron	mg/l.B		1		1		1					1	
Titanium	mg/l. Ti												
Tin	mg/l.Sn												
Molybdenum	mg/l.Mo												
Uranium	mg/l.U												
Thallium	mg/l, Tl.												
Tellurium	mg/l, Te												
Silver	mg/l.Ag												

*Petr. Ether Extr. **) IR – Method.

FIGURE 9.5 (cont.)

Parameter	Unit	EC-Directive on Surface Water for the Production of Drinking Water						EC-Directive on Surface Water for Bathing		EC-Directive on Surface Water for Fish		General Medium-term Goal in the Netherlands	
		With Simple Treatment A_1		With more extensive Treatment A_2		With extensive Treatment A_3							
		Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Mandatory STD.	Guide STD.	Goal	Guide Value
Organic Substances													
BOD_5*	$mg/l.O_2$		<3		5		<7				<3(S) <6(C)	<5	<3
COD	$mg/l.O_2$						30						
$KMnO_4$ Consumption	mg/l.O2												
TOC	mg/l.C												
DOC	mg/l.C												
Total Detergents	µg/l												
Anionic Detergents	µg/l(manoxol)		200		200		500					500	<200
Total Organo Sulfides	µg/l							No Foam	<300			200	<200
Total Organo Chlorine Compounds	µg/l												
Total " " Pesticides	µg/l	1		2.5		5						10	
Indiv. " " "	µg/l											1	
PCB's	µg/l											0.1	
HCB's	µg/l											0.1	
HCH's	µg/l												
Cholinesterase Inhibitors (Para-Oxon Equiv)	µg/l												
Aromatic Amines	µg/l											1	
Polycyclic Aromatic Hydrocarbons	µg/l	0.2		0.2		1						5	
Phenols	µg/l	1		5	1	100	10	<50	< 5	No taste		0.2	
Oil	µg/l	50*		200*		1000*	500*	No visible Film	<300*	in Fish No visible Film		5 200**)	1 20**)

*Petr. Ether Extr.

**) IR – Method.

FIGURE 9.5 (cont.)

Suggested classification of river quality

River Class	*Quality criteria*	*Remarks*	*Current potential uses*
	Class limiting criteria (95 percentile)		
1A	(i) Dissolved oxygen saturation greater than 80%. (ii) Biochemical oxygen demand not greater than 3 mg/l. (iii) Ammonia not greater than 0.4 mg/l (iv) Where the water is abstracted for drinking water, it complies with requirements for A2** water. (v) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 1.5 mg/l. (ii) Visible evidence of pollution should be absent.	(i) Water of high quality suitable for potable supply abstractions and for all other abstractions. (ii) Game or other high class fisheries. (iii) High amenity value.
1B	(i) DO greater than 60% saturation. (ii) BOD not greater than 5 mg/l. (iii) Ammonia not greater than 0.9 mg/l. (iv) Where water is abstracted for drinking water, it complies with the requirements for A2** water. (v) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 2 mg/l. (ii) Average ammonia probably not greater then 0.5 mg/l. (iii) Visible evidence of pollution should be absent. (iv) Waters of high quality which cannot be placed in Class 1A because of high proportion of high quality effluent present or because of the effect of physical factors such as canalisation, low gradient or eutrophication. (v) Class 1A and Class 1B together are essentially the Class 1 of the River Pollution Survey.	Water or less high quality than Class 1A but usable for substantially the same purposes.
2	(i) DO greater than 40% saturation. (ii) BOD not greater than 9 mg/l. (iii) Where water is abstracted for drinking water, it complies with the requirements for A3** water. (iv) Non-toxic to fish in EIFAC terms (or best estimates if EIFAC figures not available).	(i) Average BOD probably not greater than 5 mg/l. (ii) Similar to Class 2 of RPS. (iii) Water not showing physical signs of pollution other than humic colouration and a little foaming below weirs.	(i) Waters suitable for potable supply after advanced treatment. (ii) Supporting reasonably good coarse fisheries. (iii) Moderate amenity value.
3	(i) DO greater than 10% saturation. (ii) Not likely to be anaerobic. (iii) BOD not greater than 17 mg/l*.	Similar to Class 3 of RPS.	Waters which are polluted to an extent that fish are absent or only sporadically present. May be used for low grade industrial abstraction purposes. Considerable potential for further use if cleaned up.
4	Waters which are inferior to Class 3 in terms of dissolved oxygen and likely to be anaerobic at times.	Similar to Class 4 of RPS.	Waters which are grossly polluted and are likely to cause nuisance.
X	DO greater than 10% saturation.		Insignificant watercourses and ditches not usable, where objective is simply to prevent nuisance developing.

Note

(a) Under extreme weather conditions (e.g. flood, drought, freeze-up), or when dominated by plant growth, or by aquatic plant decay, rivers usually in Classes 1, 2 and 3 may have BODs and dissolved oxygen levels, or ammonia content outside the stated levels for those Classes. When this occurs the cause should be stated along with analytical results.

(b) The BOD determinations refer to 5 day carbonaceous BOD (ATU). Ammonia figures are expressed as NH_4.

(c) In most instances the chemical classification given above will be suitable. However the basis of the classification is restricted to a finite number of chemical determinands and there may be a few cases where the presence of a chemical substance other than those used in the classification markedly reduces the quality of the water. In such cases, the quality classification of the water should be downgraded on the basis of the biota actually present, and the reasons stated.

(d) EIFAC (European Inland Fisheries Advisory Commission) limits should be expressed as 95% percentile limits.

*This may not apply if there is a high degree of re-aeration.

**EEC category A2 and A3 requirements are those specified in the EEC Council Directive of 16 June 1975 concerning the Quality of Surface Water intended for Abstraction of Drinking Water in the Member States.

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river would have a Classification Index 1, that is be of high amenity value.

9.8 Evaluation of Alternative Discharge Points

i) Pandoki Outfall

The minimum flows in the Pandoki have been calculated based on rainfall and size of the catchment area. These calculated minimum flows are conservative as they do not take into account regeneration, that is seepage from adjacent areas and flow from numerous drains and tubewells. However they do concur with observed flows of 15 to 20 cusec at the bridge on the Dipalpur Road during the driest month. From this point the Pandoki drain runs 10 km till it outfalls into a right bank creek of the Sutlej river.

ii) Sutlej River

There is no discharge observation site on the Sutlej river downstream of the Ferozpur H.W. within Pakistani territory as far as the Suleimanki H.W. which is located about 85 km downstream of the Pandoki outfall point. The calculated minimum flow of water in this stretch of the river based on 20 years records at the Suleimanki barrage shows that during the driest month of December, in 9 out of 10 years (90% exceedence level) the river discharges more than 5 cusec, and in 1 out of 10 years less than 5 cusec. These figures are conservative and do not take into account regeneration. During a site visit the estimated flow in this branch of the river was 250 cusec. However, this does not take into account the flow through the other, wider branch at the left side of the river. At the Suleimanki H.W. large flows are always recorded due to the outfall of the B.S. Link canals. The consultant's assumption of a minimum flow of 30,000 cusec is not correct.

Direct discharge to the Sutlej river would preclude adverse effects on the Pandoki outfall but would increase construction costs by approximately U.S. 1 million dollars. Therefore this alternative is discounted.

iii) BRBD Link Canal

The BRBD Link Canal is a major water course providing irrigation water from a link to the River Chenab. It is a wide fast flowing canal and contains considerable civil works for energy dissipation. It has a strategic value and is classed as a "defense canal". Its location and flow are such that gravity flow from the treatment plant location should be possible. The flows observed during the site inspection would be sufficient to ensure adequate dilution.

The Irrigation Department absolutely refused to consider any discharge to the BRBD link, on the grounds that the effluent (treated or untreated) may have adverse effects on the crops irrigated by the canal.

Although their point of view is respected, it is felt that this is somewhat extreme and an opportunity to discuss this should be afforded. The waters of the canal remain within Pakistani control; dilution appears to be acceptable and cost savings may be made on the outfall. Validation of dry and wet weather flows is essential.

iv) Rohi Nullah

Above Kasur the Rohi Nullah divides into two streams. One flows through Kasur and into Pandoki Outfall. The other stream passes to the east of Kasur and enters the Sutlej upstream of the Ferozepur Barrage. It is feasible for the final outfall to flow east from the treatment plant and into the Rohi Nullah. According to Irrigation Department the Rohi Nullah contains a minimum of 10 cusecs flow. The Rohi Nullah flows into the headwaters of the Ferozepur Headworks which is stated to have a minimum flow of 10,000 cusecs. The Rohi Nullah is bounded on one side by a 4 metre flood protection bund which effectively precludes animals from drinking the water or people using it for other purposes. (Although isolated cases of livestock watering were seen.) On the other side the Rohi Nullah is bounded by the international border with India which prevents any access. Therefore the beneficial uses of the Rohi Nullah are considered to be minimal. Upon entry into the River Sutlej further dilution will occur. A realigned outfall would have to transect the main road and the BRBD Link Canal. The road already contains a culvert which could accommodate an outfall. The BRBD Link includes a siphon which passes under an existing stream. Therefore BRBD Link does not pose an obstruction to the construction of a new outfall. Irrigation Department state that an NOC would be required from the Secretary, Irrigation. In principle, their engineers can see no objection.

In view of the above, further site visits were made to the Rohi Nullah, and discussion continued with the authorities. It is understood that Rohi Nullah is a seasonal drainage channel entering Pakistan from India and that India has constructed some control across the nullah to utilize the water. Consequently, the minimum flow can not be guaranteed.

The Rohi Nullah outfalls into the right-most creek of the Sutlej river. Pakistani authorities have recently constructed an earthen embankment across the creek known as the Saflian river diversion bund to protect the intensively cultivated area within the Pakistani enclave against floods. During the site visit there was a wide expanse of water but this was the result of the Saflian bund being breached and partly washed away during the recent heavy

floods. When the bund is repaired, this river branch will be again a standing pool and not a flowing river.

The flows from the Rohi Nullah enter India upstream of the Ferozpur Head Works and it is possible that the Indian authorities would raise serious objections to the presence of contaminated water entering the large pool directly upstream of the Ferozpur Headworks as fishery is an important activity.

Discharge to the Rohi Nullah could represent a cost saving and would have less effect on beneficial uses. However, there may be transboundary pollution problems, and definitive data on flows is very hard to establish. Also there may be objections on military and strategic grounds. Any such objections would need discussion at the Federal level and could be very lengthy. Therefore this does not seem to be a realistic option.

9.9 Institutional Aspects

A major conflict exists between the Kasur Municipality and PHED. The Kasur sewerage scheme was initiated in 1978-79 and became operational in August 1985. It provided a sewerage system to approximately 50% of the town of Kasur.

The sewerage was piped to 3 wet wells from where it was pumped into the Rohi Nullah. This was done by 10 pumping machines each with a capacity of 6 cusecs.

The total cost of construction and works was 19,800,000 Rs. To date only 400,000 Rs has been paid to PHED and 3,800,000 Rs is still owing. The responsibility for maintaining and running the system rests with Kasur Municipality and this was to be done on a contract basis by PHED. Running costs for the period from 1986 to May 1991 were 485,000 Rs and these are still owed by Kasur Municipality to PHED. Despite receiving no payment throughout this period PHED felt a public obligation to keep the system operational. A shut down would in any case cause blockage and deterioration of the sewers.

In May 1991 the system shut as a result of non payment of an electricity bill for the pumps of 1 million Rs owing to WAPDA. PHED attempted to mediate between Kasur Municipality and WAPDA over payment of the bill and it was agreed that the electricity would be turned back on with the understanding that 100,000 Rs would be paid within 5 days. No money was forthcoming from the Municipality and it was subsequently turned off.

PHED maintain that up until this time at least 70% of the sewerage system was fully operational. They accept that over a year and a half of disuse may have caused blockages and further deterioration of the system. There is currently a contingency fund of 5,50,000 Rs for rehabilitating the system to 100% efficiency. Of this, 400,000

would be spent on the sewers and 150,000 for maintenance of machinery. A small part of the system is still operational by gravity but sewerage does back up. The main sewer is also likely to be silting. However were an electricity supply resumed to the pumps and using the contingency fund, the system could soon be fully operational.

Whatever the reality of the situation, such an impasse offers little by way of reassurance for the effective functioning of a joint management authority, which is crucial to the successful operation of the plant.

In informal discussions with the technical staff of the Irrigation Department, they expressed concern over the prospect of a treatment plant involving any degree of sophisticated technology (defined by them as "moving parts") and insisted that a self functioning treatment system was the only one likely to operate successfully.

9.10 Conclusions and Recommendations

Conclusions

There is no doubt that conditions in Kasur are detrimental to the health and well being of the population. It is not possible at this juncture to state whether health problems of the population are due primarily to the tanneries or whether they add to generally insanitary conditions. Therefore it must be emphasised that curing the tanneries effluent problem will not redeem the situation for the total population of Kasur. There are other industries discharging to the municipal sewerage system and domestic sewage is a major concern. An overall masterplan is needed of which the tanneries effluent treatment plant is the first stage of implementation.

The basic experimental data on which the treatment plant is in part designed may be optimistic. It would be prudent to cross check the data.

The quality of the treated effluent will not be such that discharge to a water course having significant beneficial uses can proceed without adverse environmental effects. The planned discharge to the Pandoki Outfall and then to the Sutlej river will have significant adverse effects on beneficial uses at times of low flow. Discharge of the treated effluent at the concentrations of BOD, COD, suspended solids and dissolved salts will affect the beneficial uses of the Pandoki Outfall and the Sutlej River. However examination of alternative discharge points is recommended has been carried out and this route is the only viable option.

The intended location of the treatment plant is adjacent to Stagnant Pool 2. Upon draining of the stagnant pools a considerable

area of land will be released. Odours will arise from the treatment plant and this may preclude development of the land to its full potential. This may not occur until some time in the future but the implications should be considered now.

Any institutional arrangement that is set up to manage the plant must include financial incentives for the operators. Otherwise there will be no motivation associated with the operation and breakdowns may be anticipated.

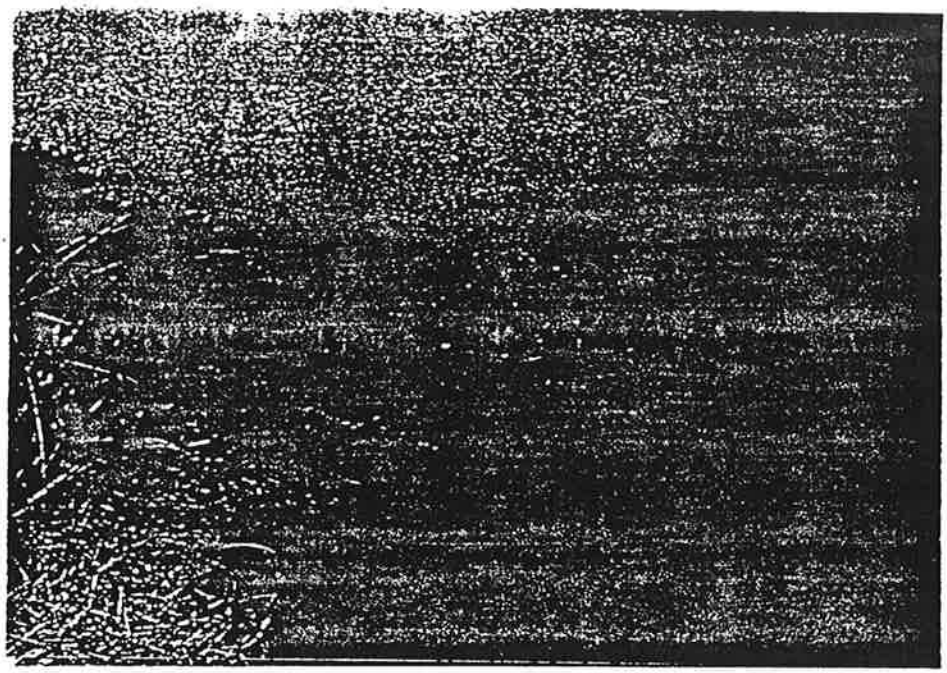
Recommendations:

- **If discharge is to Pandoki Outfall and Sutlej River then it must be accepted that this may cause adverse effects in winter. In summer it will be acceptable.**

- **Baseline monitoring should be commissioned on Pandoki Outfall and Sutlej river so as to be able to quantify any changes to water quality in periods of low flow. The EPA should be requested to undertake this.**

- **The plant should be upgraded and the quality effluent improved as soon as possible. The initial design must be modular and so allow provision for improved performance at a later date. If financially possible, deeper lagoons and/or mechanical aeration should be considered now.**

- It is essential to have a strong and effective plant management. Failure of the plant and lack of rapid repairs would lead to discharge of the total effluent ultimately to the Sutlej river which is not an acceptable practice.



Rohi Nullah to east of Kasur. Grazing and use of water is restricted by topography.

Rohi Nullah upstream of entry point into Sutlej and then India. On left Indian border can be seen. Elevated flood protection bund is shown in centre of picture.

10.0 SLUDGE DISPOSAL

The operation of the treatment plant will lead to considerable quantities of sludge which require ultimate disposal and which will by design contain large quantities of chromium.

Destruction by incineration can be an effective disposal method. It can be attractive due to the potential recovery of heat from the process and yields minimal final residues. However, environmental problems can arise from chromium in the flue gases and in the ashes, when the presence of lime might lead to the production of carcinogenic calcium chromate. Incineration is unlikely to be economical for small tanneries.

The physical and chemical characteristics of solid wastes do not render them unsuitable for disposal to landfill sites as long as good practices are observed. A UK Code of Practice governing landfill use has been drawn up by the Department of the Environment after general consultation. They have recommended that sites accepting domestic refuse could be used for tannery waste providing no acidic waste was present.

Much concern has been exhibited in the past over the dumping of hexavalent chromium containing sludges, as hexavalent chromium entering the water table can ultimately cause lung tumours and kidney inflammation to users of the water. The available literature on sludges containing chromium indicates that moderate quantities of trivalent chromium are unlikely to cause problems in normal landfills.

Alternative sites were evaluated during the design procedure and the site selected is that located on the old railway line near the village of Kasagarh. The landfill site proposed for dumping of the tannery sludge should not receive other industrial wastes, particularly acidic wastes as these can react with the tannery wastes liberating toxic hydrogen sulfide gas. Similarly the dumping of domestic refuse in landfills is not advisable as its decomposition can lead to acidic conditions in the fill.

The sludge will consist of a mixture of fine to very fine material of different chemical and biochemical components. Dumping this sludge at the selected site should not pose any major pollution hazard for the ground water as the material is a clay-like substance which will act as an impermeable layer to rainwater. At the dumping site the sludge will dry out due to natural evapotranspiration and adhere to the bottom and sides of the landfill site. This will result in an element of "self-sealing".

However, as a precaution during the life of the dump, shallow water wells in the immediate surroundings should be regularly checked (for example twice a year) for possible contamination. Before

starting the dumping operations a ground water quality baseline survey should be carried out. Ground water levels occur at roughly 5 metres below ground level. Generally the soils in the area consist of fine sand which are permeable (report on "Kasur, 10 Shallow Ground Borings", November 1991).

If necessary in the future to prevent leachate to the underground water, sludge could be placed in slightly sloped heaps. This arrangement will decrease interface/surface contact area of the sludge and water particles. Thus there will be less seepage of polluted water to the groundwater table.

In order to avoid any hazardous situation over a long period, it is suggested to periodically monitor the landfill site. It should cover the analysis of leachate in the underground water and odour generation during different months of the year. The management should also control any run off water from the landfill following rainfall as this could affect agricultural land and create a leachate problem to ground water remote from the site. For comparative purposes it is advisable to carry out chemical analysis of both ground water and soil before using the site for landfill.

According to the considerable evidence available, trivalent chromium, as found in tannery wastes, is neither phytotoxic nor absorbed to an unacceptable degree by most growing vegetation. In many countries consideration is now being given to the application of tannery wastes, before or after composting, to agricultural land as a source of nitrogen and other trace elements.

Efforts should be made to establish if any vegetation will grow on the dumped material, which could be mixed with some soil. Soils having a pH value below 7 and chrome levels of 1,000 mg/kg of soil show a noticeable effect on crop yields. It is noted that chrome recovery is to be an integral part of the final project strategy. This should be emphasised. If sludge is ultimately low enough in chrome content to be suitable for reuse as soil conditioner then this would reduce the total quantity of sludge requiring disposal. This would extend the life of the landfill site which could represent a considerable cost saving. Standards for chrome concentrations in land applications are given in Figure 10.1. These should be observed during trial applications.

From a planning point of view the location of the treatment plant at the site intended for the landfill would be preferable as it is remote from all habitation. To examine the feasibility of this a topographical survey was carried out. (Figure 10.2). Use of this site would require additional pumping and a 0.5 m. diameter pipeline. This option was rejected as not viable as discharge to the BRBD Canal is not permitted.

There does not appear to be any specific reason for the landfill site be located near the village of Kesargarh. Also there is no

technical objection to the landfill area being adjacent to the proposed treatment plant on an extension of the railway land and this could represent a considerable cost saving on road vehicles. It would also prevent heavy vehicles passing through Kesargarh which is to be avoided. Therefore relocation of the solid waste tip to a position adjacent to the treatment plant is recommended.

COMPARISON OF SLUDGE RE-USE STANDARDS IN SEVERAL COUNTRIES (SOURCE-WILLIAMS)

Parameter	Belgium	Denmark	England & Wales	France	Germany	Holland	Norway	Sweden	Switzerland	U.S.A.
Maximum permissible soil concentration (mg/Kg)	150	100	600	150	100	100*				
Maximum permissible sludge concentration (mg/kh DS)	500	100		2000	1200	500	200	150	1000	1000
Suggested annual loading limit for Cr (kg/ha/yr)	2.0			6.0	2.0	1.0	0.4	1.0	2.5	20-120
Maximum recommmended metal loading (t/ha)			1000	360	210	100	4			100-600
Maximum sludge solids loading (t/ha)					167	200		5 in 20	5 yrs	

FIGURE 10.1

Sugggested maximum annual sludge solids application		1.5		3.0	1.7 (arable) 1(grass)	2	2	1	2.5 (t/ha)
Minimal application period (yrs)	20	30		100	100		10	5	
Minimal soil (pH)		6.5**	6.0						6.0

* Varies according to clay content, eg 50 + (2 x % clay) = max. permissible soil Cr concentration

** The pH quoted is for arable land; for grassland, minimal pH is 6.0

FIGURE 10.1 (cont.)

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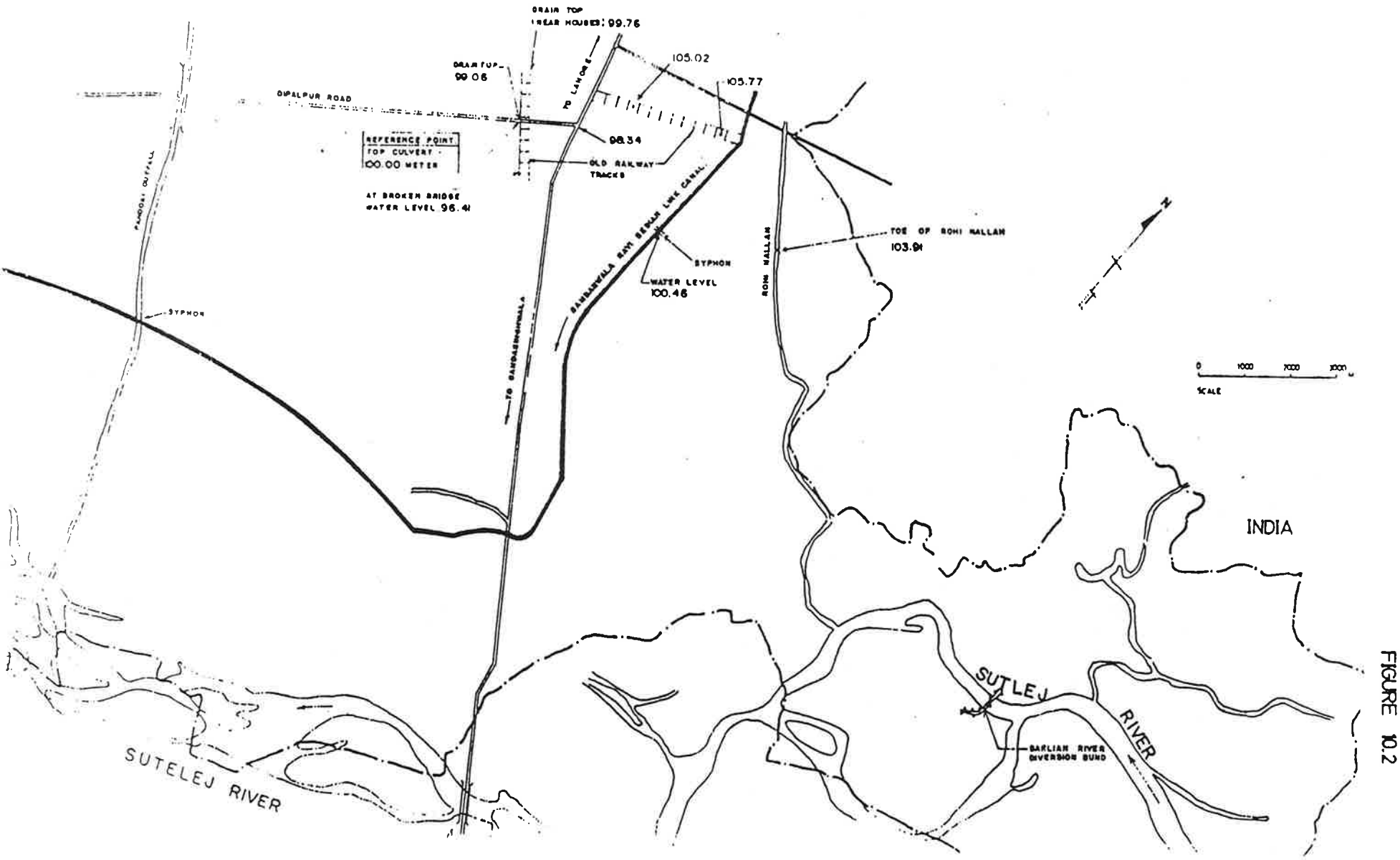


FIGURE 10.2

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Review of the Proposed Design and Previous Studies

The EIA team has found that there are a number of methodological inconsistencies, biases and errors in the previous baseline studies, experimental data and assumptions. In particular, it is considered that:

a) The conclusions of the health study are invalid because the methodology, statistical analysis and interpretation are inconsistent.

b) The conclusions of the water quality and air pollution study are suspect because of uncertain methodology and inadequate quality control.

c) The conclusions of the agricultural and livestock surveys suffer from similar types of inconsistencies.

d) The experimental data upon which the plant design parameters were based requires verification because the Punjab EPA laboratories were not subject to quality control tests at the time, and cross checking carried out by the design consultants between two different laboratories showed results outside normal limits of experimental error.

e) The design proposed relies upon natural purification within the Green Channel similar to that observed in the Rohi Nullah. Checks of the natural purification in the Rohi Nullah have shown that the significance of this may have been overestimated, especially in a concrete channel with no vegetation.

f) The design proposed relies upon dilution factors of 1:6 in the Pandoki outfall and 1:3000 in the Sutlej River during winter. These figures are completely erroneous and the real maximum flow in the Pandoki outfall is 3 times lower than originally assumed. At certain times of year there is no flow at all in the Sutlej River owing to control of the waters by India.

11.2 Choice of Alternative Designs and Discharge Points

With these errors in design assumptions, a review of the alternative designs and discharge points was undertaken by the EIA team.

a) The choices for design included evaporation lagoons, naturally aerated lagoons, aerated lagoons, chemical

treatment and sludge treatment. Land availability for the simpler lagooning systems was a major constraint, whilst increasing costs and complexity of operation were constraints for the aerated and chemical systems.

b) The conclusion was that the proposed system offered the most effective treatment (albeit very poor) which could be expected within the land and complexity constraints - the decision being taken not to include chemical treatment and aeration (which are often standard procedures for treating tannery wastes) because the supply of chemicals, equipment and electricity could not be relied upon.

c) However, the team concluded that it was highly likely that without these additional treatment refinements the plant would tend to smell and become unpleasant for residents moving into the neighbouring areas. As such it is suggested that a buffer zone of 1 km between the treatment plant and any incoming residential zones be respected. The plant will only achieve a very low standard of partially treated effluent which is still high in BOD, Chromium and Sulphides. It will be reliant upon adequate dilution to reach normally acceptable standards.

d) The choices for alternative discharge points included the Rohi Nullah, the BRBD Link Canal, direct discharge into the Sutlej River, Deep well injection and Spray evaporation. All of the alternatives were discounted for various reasons, including piping and pumping costs, lack of dilution and lack of technical feasibility. The team came to the conclusion that discharge to the Pandoki outfall for onward discharge into the Sutlej River was the only viable alternative.

e) The acceptability of a decision to go with the proposed design and outfall depends upon the receiving waters and their uses (see below).

f) The disposal of the high chromate sludges from the plant at a site on the disused railway line was considered not to pose a hazard due to the absence of tube wells in the area, and recent findings in other parts of the world that the trivalent chromium is not leached out. There is no reason why the sludges could not be disposed of on the railway track extension adjacent to the plant, and this would save some operational costs.

g) There are indications of institutional problems between two of the possible operators of the plant. It is critical that satisfactory institutional arrangements are

agreed prior to implementation of the project, if the plant is not to fail due to institutional malfunction.

11.3 Impact of Normal Operations of the Plant

The EIA team considered the impact of the treatment plant from three major viewpoints: Health, Agriculture and Aquatic Resources.

Health.

a) The existing conditions in Kasur have probably given rise to an increase in the morbidity of the population and incidence of respiratory diseases and skin infections. It is, however, difficult to attribute these effects to the pollution from the tanneries specifically when hygienic conditions in Kasur are so poor, and when there are other pollutants discharged into the area.

b) Drinking water quality from tube wells in the underlying free aquifer is reported as having deteriorated organoleptically. Tests show that it is outside normal drinking water standards.

c) Under normal operations the treatment plant will provide the basis for more hygienic conditions since the tannery effluents will be excluded and removed from Kasur. The discharge through a concrete lined channel will preclude infiltration into groundwater.

d) However, the provision of a treatment plant is only a partial solution to the generally unhygienic conditions. This will require an integrated waste management scheme for Kasur, involving sewerage, sewage treatment, solid waste disposal and community health education, in addition to the tannery waste water treatment. The proposed treatment plant is only a partial solution.

Agriculture:

a) Farmers around the existing stagnant ponds have built bunds to prevent the tannery waste from spilling over on to their lands, but certain areas are now infertile due to seepage of the tannery waste. Crop yields have dropped by 50% over the last 10 years, and similar effects have been noticed by farmers in livestock production.

b) The total loss to the local economy is estimated at about Rs. 1.3 million per annum. The installation of the treatment plant will enable these losses to be recovered, through reclamation of the land under the stagnant ponds, and improved irrigation water quality (from shallow tube wells and from the Rohi Nullah).

c) Reclamation of the land under the stagnant ponds for agriculture may take several years depending on the length of time inundated. This will depend upon flushing the salts and chemicals from the soil and this should be monitored by government agencies.

d) Under normal operations of the plant, all the wastes will be removed from the Kasur area and the Rohi Nullah and ground waters will no longer be contaminated. There will be considerable improvement in agriculture and livestock production.

Fisheries:

a) The effects on the aquatic environment and the fisheries is potentially the most damaging. The treatment and discharge points proposed will have the effect of shifting the pollution from the town of Kasur to the Pandoki outfall and the Sutlej River.

b) The quality of the Rohi Nullah will be improved under normal operation since it will only receive domestic sewage. The fisheries are of little significance in this nullah.

c) The quality of the Pandoki outfall will be considerably worse than at present, both in terms of the organic content, sulphides, chromium and salt. The low flow dilution will only be 6:1, which will not give adequate dilution of these contaminants. However, whilst there are currently incidental uses of the Pandoki Outfall, these are considered informal/illegal since the Pandoki is officially a drain. Once the treatment plant comes on stream, local users should be advised not to continue these uses.

d) In the Sutlej River, fisheries is a significant local occupation worth over Rs. 600,000 in fishing rights. However at certain times of year, the flows in the Sutlej are minimal, affording very little dilution. The discharge under normal operation will not cause significant deoxygenation. However, the acceptable levels of chromium and sulphides considered necessary to minimise the risks of bioaccumulation in fish flesh will require a dilution of 40 and 300 times respectively. This would be a minimum flow of 1500 cusecs in the Sutlej. During the wet season, this dilution will be afforded, but at times during the dry season, when there is minimal flow it will not. The significance of this is that the fish which remain in the affected branch of the river may be subject to bioaccumulation. The concentrations of chromium and sulphides in fish flesh from the Sutlej

River should be monitored.

11.4. Impact of Failure of the Dingarh Pumping Station

If the Dingarh pumping station breaks down, the effect will be to discharge the wastes from the tanneries in Dingarh back into the Rohi Nullah. This is similar to the present situation. However the conditions in the Rohi Nullah may have improved during normal operation of the plant, and uses of the waters may have increased. The water may become unsuitable for irrigation and livestock for as long as the failure continues. Such users should be advised of failures. The impact on health and fisheries is not considered significant.

11.5. Impact of Total Failure of the Treatment Plant

In the event of total failure of the treatment plant, the raw wastes will be discharged directly into the lined Green Channel, discharging into the Pandoki Outfall and Sutlej River. The wastes will be removed completely from Kasur and cause pollution in the Sutlej River.

a) The health of the people of Kasur will not be affected and ground water will not be contaminated. The agriculture will not be affected, unless the Rohi Nullah is used as an emergency treatment lagoon (see later). In this case irrigation and animal watering should be stopped.

b) The conditions within the Pandoki Outfall will inevitably deteriorate as a result of the discharge of 13,500 m3/day of untreated wastes. This will result in immediate and total deoxygenation in the Pandoki Outfall. A fish kill within the Pandoki is almost certain, assuming that normal discharges have not already excluded most aquatic life. The status of the Pandoki Outfall as a drain will not be affected. However, in the event of total failure, the people around the drain should be informed.

c) It is possible that given the high temperatures and high nutrient levels in the Pandoki, that this deoxygenating effect will have been reduced by the time the Pandoki discharges into the Sutlej. In this case the immediate effect of deoxygenating the Sutlej waters may not be catastrophic, especially if this occurs at times of high flow. A plug of deoxygenated water entering the Sutlej would cause fish kills in the immediate mixing zone. This zone would be larger at times of lower flow and might extend for several kilometres.

11.7. Recommendations

Ultimately the decision to go ahead with a scheme such as this is a political one, taken in the knowledge of the risks and benefits which can occur. This EIA is only able to indicate these risks and benefits, it is not able to quantify them or to predict when they will occur. It is foreseen, however, that there will be times, whether for mechanical, financial or institutional reasons, when the plant breaks down and the wastes are discharged into the Sutlej River untreated. These recommendations are therefore made with this in mind.

a) The proposed treatment plant will improve the general environmental conditions within and around the town of Kasur, and, under normal operating conditions not give rise to adverse effects within the Sutlej River during nine months of the year. The overall benefits and disbenefits of the scheme is shown diagrammatically in an Environmental Impact Matrix.

It is therefore recommended that the scheme goes ahead knowing that there may be localised adverse effects in the Sutlej River during low flows in three winter months, and that these may decrease the fisheries productivity of the area and cause some bioaccumulation of sulphides in fish.

b) However, the scheme is by no means ideal, providing limited treatment and operating with a tendency to smell. The design should be such that it is modular and can be modified to allow for use of chemicals and aeration/ deeper lagoons to increase treatment efficiencies at some stage in the medium term once the plant has been operating successfully.

c) The scheme should be viewed as the first part of an integrated process to improve the environmental conditions in Kasur. This process should include in-tannery use of less hazardous chemicals and processes, pretreatment and recycling of tannery wastes, domestic and other industrial waste treatment, solid waste disposal and public health education.

d) The scheme should develop a contingency plan for action to be taken in the event of different forms of breakdown. In the event of total plant failure, this should include diversion to the Rohi Nullah, for which provision must be made by the construction of weirs and gates. It should also include the warning of possible users of different water bodies (official and unofficial users) of the action being taken.

d) For chromium a flow of 3000 cusecs will be needed to reduce the concentration in the total untreated wastes below acceptable limits to minimise bioaccumulation. For chromium, during the five months of the dry season this condition will not be met for 80% of the time. During the wet season the standard will be met.

e) For sulphides, a flow in the river of 40,000 cusecs is required to dilute the wastes to below acceptable limits. During the dry season there will never be sufficient flow in the Sutlej, and for the wet season, there will be sufficient flow for 50% of the time. However, Sulphides are oxidised fairly rapidly in the presence of oxygen, and so this effect may not be that dangerous if the levels of dissolved oxygen in the Sutlej River are not depleted by the discharge.

f) Whilst the fishing activities in the Sutlej River are reduced during the dry season, and fish may avoid areas of severe pollution, the effects of discharge of untreated wastes into the Sutlej River may be localised fish kills, and, over the long term, depletion of the ecology of the river, thus reducing its fisheries productivity. In addition continued discharge of untreated wastes would increase the risks of fish becoming unacceptably contaminated with chromium and sulphide.

11.6. Mitigation Measures in the Event of Total Failure.

In the event of total failure of the plant occurring at times of low flow in the Sutlej River, a contingency plan should be agreed upon to implement the following mitigating measures immediately.

a) The total flow from the tanneries should be diverted by means of mechanical weirs or gates into the Rohi Nullah near the Depalpur road. The Rohi Nullah has been shown to have considerable assimilative capacity and eventually discharges into the Pandoki. This would have the effect of allowing additional natural treatment to occur as a buffer for the Sutlej River. It would of course have a detrimental effect upon the Rohi Nullah, similar to the present situation.

b) The temporary blocking of the branch of Sutlej River below the Pandoki Outfall, by means of earth bunds, at times of low flow, to provide additional lagooning for the wastes, may also be considered. This would prevent much of the pollution from reaching the rest of the Sutlej until it is either more purified or can be diluted adequately.

concentration of chromium in land applications should be worked out. This will also indicate the recovery of the land under the stagnant pools.

e) The land under the existing stagnant ponds should be reclaimed on scientific lines. It is recommended that an agency such as Soil Fertility Department, Punjab should assist farmers by carrying out detailed soil analysis and suggest suitable measures for reclaiming the land for agricultural, domestic and industrial uses. If for agricultural use, continued analysis of samples may be required until the soil is considered fit for crops.

f) The landfill site and operations are not considered to represent an undue environmental hazard. However, domestic and other industrial wastes should be excluded from the site. It is possible that the site could be placed closer to the treatment plant. In the event of cleaner technologies within the tanneries being used and less chromium being deposited in the waste, the sludges could be used as soil conditioner rather than being thrown away.

g) A baseline survey and monitoring programme should be set up with the following components:-

i) Current Health Status and incidence of mortality through a well-designed case-control study. This will identify any ill effects within the polluted area. This should be followed by an epidemiological study addressing the target groups receiving:-
- both occupational and environmental exposures.
- occupational exposures only
- ambient environment exposure only
- unexposed in non-polluted areas.

ii) Ground water quality, both around the present stagnant ponds, the Rohi Nullah and the landfill site. Shallow water wells in the vicinity of the landfill site should be regularly checked twice per year.

iii) Fisheries production in the affected areas of the Sutlej River below the Pandoki outfall, and the content of chromium and sulphide in fish flesh from this area.

iv) Once the plant has come on stream, the effluents and water quality of the receiving waters should be monitored on a regular basis.

v) Trials on plant growth in the deposited sludges, in different mixtures with soil. Guidelines on the maximum permissible

KEY

D Potentially significant adverse environmental impact for which a design solution has been identified

U Potential environmental impact that is potentially significant but about which insufficient information has been obtained to make a reliable prediction

● Residual and significant adverse environmental impact

E Significant environmental enhancement

MATRIX

PROJECT ACTIVITIES

PROJECT : PROJECT PREPARATION ASSISTANCE TO KASUR TANNERIES

Environmental Components		Identification of Activities	CEPTP: Drainage of Stagnant Pools	Solid Waste Collection System	Sludge Disposal	Discharge to: Pandoki Outfall	Sutlej River	Rohi Nullah	BRBD Link	Phase II: CMETP	Full Sewerage Scheme	Solid Waste Collection and Disposal Master Plan
Physico-Chemical	Land	Land										E
		Soil Profiles	D									
		Soil Composition			D							
		Slope Stability										
		Subsidence and Compaction										
		Seismicity										
		Flood Plains / Swamps	E	E							E	E
		Land Use			D					D		E
		Engineering and Mineral Resources										
		Buffer Zones	D							D	D	D
	Surface Water	Shoreline										
		Bottom Interface										
		Flow Variation	E								E	
		Water Quality	D			U	U	D	D	U	E	
		Drainage Pattern	E								E	E
		Water Balance										
		Flooding	E	E							E	E
		Existing Use	E								E	
	Groundwater	Water Table	E									
		Flow Regime										E
		Water Quality	E		D						E	E
		Recharge										
		Aquifer Characteristics										
		Existing Use	E		D						E	
	Atmosphere	Air Quality	E	E						D	D	E
		Air Flow										
		Climatic Changes										
		Visibility										
	Noise	Intensity										
		Duration										
		Frequency										
Biological	Species and Populations	Terrestrial Vegetation	E									
		Terrestrial Wildlife	E								E	
		Other Terrestrial Fauna	E								E	
		Aquatic / Marine Flora								U		
		Fish	U								U	
		Other Aquatic / Marine Fauna	U									
	Habitats and Communities	Terrestrial Habitats	E								E	
		Terrestrial Communities	E								E	
		Aquatic Habitats										
		Aquatic Communities										
		Estuarine Habitats										
		Estuarine Communities										
		Marine Habitats										
		Marine Communities										
Human	Health and Safety	Physical Safety										
		Psychological Well-Being	E							E	E	E
		Parasitic Disease	E	E						E	E	E
		Communicable Disease	E	E						E	E	E
		Physiological Disease	E		D					E	E	E
	Social and Economic	Employment										
		Housing										
		Education										
		Utilities	E	E						E	E	E
		Amenities	E	E						E	E	E
	Aesthetic and Cultural	Landforms										
		Biota										
		Wilderness										
		Water Quality	U	E						E	E	E
		Atmospheric Quality	U	E						E	E	E
		Climate										
		Tranquility										
		Sense of Community								E	E	
		Community Structures										
		Man-Made Objects										

MATRIX

Potentially significant adverse environmental impact for which a design solution has been identified

Adverse environmental impact that is potentially significant but about which insufficient information has been obtained to make a reliable prediction

Residual and significant adverse environmental impact

Significant environmental enhancement

PROJECT ACTIVITIES

PROJECT : PROJECT PREPARATION ASSISTANCE TO KASUR TANNERIES

Category	Sub-category	Identification of Activities	SOLID WASTE COLLECTION AND DISPOSAL MASTER PLAN	FULL SEWERAGE SCHEME	PHASE II CMETP	DISCHARGE TO: BRBD LINK	DISCHARGE TO: ROHI NULLAH	DISCHARGE TO: SUTLEJ RIVER	DISCHARGE TO: PANDOKI OUTFALL	SLUDGE DISPOSAL	SOLID WASTE COLLECTION SYSTEM	DRAINAGE OF STAGNANT POOLS	CEPTP	DRAINAGE SYSTEM
PHYSICO-CHEMICAL	LAND	Land	E										D	D
		Soil Profiles												
		Soil Composition								D				
		Slope Stability												
		Subsidence and Compaction												
		Seismicity												
		Flood Plains / Swamps	E	E							E		E	E
		Land Use	E		D					D				E
		Engineering and Mineral Resources												
		Buffer Zones	D	D	D								D	D
	SURFACE WATER	Shoreline												
		Bottom Interface												
		Flow Variation		E									E	E
		Water Quality		E	U	U	U	D	D				D	E
		Drainage Pattern	E	E									E	E
		Water Balance												
		Flooding	E	E							E		E	E
		Existing Use		E									E	E
	GROUNDWATER	Water Table											E	E
		Flow Regime	E											
		Water Quality	E	E						D			E	E
		Recharge												
		Aquifer Characteristics												
		Existing Use		E						D			E	E
	ATMOSPHERE	Air Quality	E	D	D						E		E	E
		Air Flow												
		Climatic Changes												
		Visibility												
	NOISE	Intensity												
		Duration												
		Frequency												
ENVIRONMENTAL BIOLOGICAL	SPECIES AND POPULATIONS	Terrestrial Vegetation											E	E
		Terrestrial Wildlife		E									E	E
		Other Terrestrial Fauna		E									E	E
		Aquatic / Marine Flora			U									E
		Fish		U									U	U
		Other Aquatic / Marine Fauna											U	U
	HABITATS AND SITES	Terrestrial Habitats		E									E	E
		Terrestrial Communities		E									E	E
		Aquatic Habitats												
		Aquatic Communities												
		Estuarine Habitats												
		Estuarine Communities												
		Marine Habitats												
		Marine Communities												
HUMAN	HEALTH AND SAFETY	Physical Safety												
		Psychological Well-Being	E	E	E								E	E
		Parasitic Disease	E	E	E						E		E	E
		Communicable Disease	E	E	E						E		E	E
		Physiological Disease	E	E	E					D			E	E
	SOCIAL AND ECONOMIC	Employment												
		Housing												
		Education												
		Utilities	E	E	E						E		E	E
		Amenities	E	E	E						E		E	E
	AESTHETIC AND CULTURAL	Landforms												
		Biota												
		Wilderness												
		Water Quality	E	E	E						E		U	E
		Atmospheric Quality	E	E	E						E		U	E
		Climate												
		Tranquility												
		Sense of Community		E	E									
		Community Structures												
		Man-Made Objects												
		Historic Places or Structures												
		Religious Places or Structures												
		Landscape												
		Composition												

ANNEX 1 Terms of Reference

PROPOSAL TO NORAD

TO CARRY OUT AN ENVIRONMENTAL IMPACT ASSESSMENT

ON THE PROPOSED TANNERY WASTE TREATMENT WORKS AT KASUR

NOVEMBER 1992

1. INTRODUCTION

The town of Kasur, located near the Indian border in the province of Punjab, Pakistan, has become well-known for the pollution problems caused by the discharge of large volumes of untreated tannery wastes into the environment. At the request of GOP initiated by the Kasur Tanneries Association, a series of preliminary activities such as socio-economnic and techno-economic studies required for the formulation of a large-scale Treatment of Tannery Waste Project in Kasur have been carried out over the past three years. This has been funded under UNDP/UNIDO Preparatory Assistance (PA) PAK/89/025: Treatment of Tannery Waste, aided by the support of the Netherlands Bilateral Aid and the Norwegian Development Agency (NORAD). The terms of reference of the socio-economic study included the various social, economic and environmental indicators on public health, quality of drinking water, quality of air, agriculture, irrigation, livestock, ecology and institutional set-up etc.

The proposed solutions for the treatment of the tannery wastes are estimated to cost in the order of $8 million for which US$ 3,748,000 are for civil construction works, US$ 3,295,000 for equipment and US$ 934,000 for technical assistance inputs. Before an investment of this order is made, it has been felt important to carry out an environmental impact assessment (EIA) of the proposed treatment works. Whilst such a treatment system is self-evidently designed to deal with a pollution problem, and so should improve the environmental situation in Kasur, the treated efluent will be discharged into the Sutlej river via existing the Green Channel and the Pandoki Outfall Drain. Thus the situation will be changed from the unsatisfactory way it is presently discharged and its environmental impact should be assessed to ensure that the changes will not also be damaging to the environment.

2. BACKGROUND INFORMATION

The leather sector in Pakistan is one of the fastest growing foreign exchange earners, amounting to some Rs. 11,500 million in 1989/90. The tanning industry is concentrated in several towns of the country -- Karachi where over half of the leather is produced, Kasur, Lahore, Sahiwal, Multan, Gujranwala and Sialkot. In none of these towns has any attempt been made to treat the tannery wastes, and the project at Kasur, where the problems are arguably the most acute, was seen as a model for other concentrations of the industry.

In Kasur there are 159 tanneries processing some 8,000 hides and 12 - 15,000 skins each day to the wet-blue stage. These tanneries are located in three clusters in the centre of a town of over 250,000 inhabitants. The volumes of waste water being discharged from these three clusters are as follows:

Dingarh	48 tanneries	3,560 cu.m per day
A.Qadir/N.Nagar	95 tanneries	4,690 cu.m per day
Y.Nagar	16 tanneries	550 cu.m per day
TOTAL	159 tanneries	8,800 cu.m per day

In addition there is some domestic sewage discharged and allowing for an increase in the number of tanneries, the total volume of waste being considered for treatment is 12,700 cu.m per day. The wastes from Dingarh discharge into the Rohi Nullah, an abandoned water course which now carries only domestic sewage and tannery waste. This water is used by farmers with lands adjacent to the Rohi Nullah for irrigation. The discharges from the other clusters are collected in an open, earthen channel along the main road and end up in three stagnant pools of highly coloured waste water of several acres in area. As a result there is also a risk that the groundwater could be contaminated. During the rains these ponds spillover into adjacent lands. This possible contamination has to be monitored on a regular basis.

The municipal sewerage system is still incomplete, but some sewage is discharged into a pumping station which lifts it into the Rohi Nullah. Owing to organisational and financial problems the system is not working. It has become clogged, the sewers are damaged and the sewage backs-up. Estimates of the future volume of sewage are about 30,000 cu.m. per day as the water supply situation in the town is improved, although at present it is only one third of this figure.

Solid wastes come from both the tanneries and from residential areas. They are disposed of by casual dumping in various places including the Rohi Nullah. Some of the solids from the tanneries are used for by-products, but it is estimated that the total quantities to be disposed of include 100-150 t/day tannery wastes and 150-200 t/day domestic solids.

The surveys of public health, livestock and agriculture appear to show that water supplies from hand-pumps and tube wells, and that foodstuffs produced in the area are contaminated

particularly with dissolved solids, especially sodium chloride and sulphides. The health of both tannery workers and the people living in the area appears to have been affected significantly. There is some controversy over these findings, which need to be checked during the EIA.

3. DESCRIPTION OF PROPOSED TREATMENT PLANT

The proposed treatment plant will be designed to take an eventual flow rate of 13,000 cu.m./day. The present flow rate is considered to be 8,800 cu.m/day. UNIDO proposes the first phase for immediate implementation which includes:-

1. Construction of the tannery effluent collection system,
2. Construction of the Final outfall,
3. Introduction/construction of in-house arrangements,
4. Installation of the Cr-recovery and by-products processing pilot plant(s)
5. Installation of the Common tannery effluent pre-treatment plant (CEPTP) with laboratory
6. Installation of and arrangements for the CEPTP's sludge processing, transport and disposal facilities.

In adition various technical assistance will be provided.

The treatment works for the tannery effluents proposed consist of:

1. Screening
2. Equalisation of the wastes
3. 2 x Settling tanks with sludge and scum collection of 18 m diameter and 2.5 hrs detention time
4. Sludge drying, consisting of 6 drying lagoons operated on a 6 week rotational basis capable of handling sludge volumes of 680 cu.m per day.
5. A system of facultative lagoons for biological treatment of effluent.

After primary treatment the tannery effluents are to be discharged into a newly constructed drainage canal which will then discharge into an irrigation drain, the Pandoki outfall, and from there into the Sutlej river, some 17 km away. It is considered that since considerable natural oxidation of the present tannery wastes being discharged into the Rohi Nullah has been found to occur, such natural oxidation will continue in the drainage ditches before it reaches the Sutlej river. The conditions in the Rohi Nullah itself will be improved because the tannery effluents currently discharged there will be diverted to the Common Effluent Pretreatment system.

The characteristics of the raw tannery wastes as measured by the UNIDO consultants, and the estimated characteristics after lagooning and after screening, equalisation and settlement are shown in tables 1,2,3.

The sludge treatment and solids disposal will take place in sites in a disused railway cutting, within 5 km of the town.

4. ENVIRONMENTAL ISSUES TO BE ADDRESSED

4.1. Situations arising from normal and breakdown conditions in the treatment plant.

It has been requested that the EIA addresses various situations:-

1. The treatment plant operating as specified at a constant daily rate of 13,000 cum/day with characteristics as shown in Table 2, i.e. after primary treatment and "self-purification" in the drainage canals. This, along with the disposal of solids, can be called normal operation.

2. If the proposed Dingarh pumping station fails, the 3,500 cu.m./day currently being discharged into the Rohi Nullah will revert back to it and be mixed with the sewage from Kasur township. Here it will receive the oxidation already noted to be occurring at present. Under this scenario 9,500 cu.m./day will be discharged as treated effluent into the Sutlej river as in Scenario 1.

3. If the treatment plant fails completely, the waste may have to be diverted directly into the new drainage canal and will eventually be discharged into the Sutlej River. Although untreated, some BOD reduction may take place during its passage to the river. This worst case scenario would mean discharge of wastes with characteristics shown in table 1 into the River.

The EIA would thus have to compare these situations to the present situation which will pertain until something is done. The main cause for concern is therefore the Sutlej River and the dilution afforded by its waters. The most critical time will undoubtedly occur if breakdown occurs during the dry season, when very little water flows; the waters of the Sutlej are under Indian control.

According to unconfirmed information given by the resident authorities in Kasur, it is estimated that in the Pandoki Outfall, the winter flow is around 1 cu.m./sec, rising to about 2 cu.m/sec during the monsoon when the channel is completely filled with water. In the Sutlej river, the low winter flow is 567 cu.m/sec. As a result, the dilution ratio between the discharge of the treated effluent (13,000 cu.m/day) and the water flow in the Sutlej River during Winter is 1: 3000. These figures will have to be confirmed through consultation with the appropriate authorities, e.g. WAPDA.

The EIA would have to consider the flows of the river throughout the year, and the subsequent uses to which the waters are put - possibly irrigation, water supply for humans and livestock, and fisheries. Apart from the Sutlej River, some uses are made both of the Rohi Nullah and the Pandoki Outfall particularly for irrigation. The impacts upon these uses should any parts of the plant fail have to be considered.

In particular it would seem that if natural oxidation and settlement occurs as predicted, the main causes for concern are the additional salinity brought by the tannery effluents. Chromium concentrations in the wastes at Kasur are generally lower than normal for tannery wastes which may be a bonus as far as the treatment system is concerned. However, this may perhaps be a temporary phenomenon as the present re-use of spent tanning sollutions by smaller tanneries improve their production methods with the result that more chromium is discharged.

Much of the Chromium will settle out in the sludges and so will not be discharged in the final effluent. The oxygen demand of the effluent should be naturally reduced as it passes down the drains. One of the main areas of concern is the high salt content of the tannery effluents which the treatment system can do nothing about.

4.2. Sludge treatment and disposal

In addition to comparing these scenarios to the existing situation, the EIA will also consider the impacts of dumping of solid wastes in the sites identified, particularly since most of the chromium will be deposited there. Issues to be considered here include the stability of the chromium and the possibilities of contamination of ground water, particularly during the rainy season. Whilst much research work has been done on the stability of chromium sludges in other situations, the EIA should consider such information in relation to the particular sites selected and their groundwater conditions.

4.3. Drainage of the stagnant lagoons

It is being proposed that the existing stagnant lagoons be drained and reclaimed. In view of the fact that they have developed over a long period of time and will contain contaminants from the tanning industry, the EIA will consider the hazards associated with reclaiming and reusing the land. Suggestions will be made for suitable uses and any mitigating measures which need to be taken.

5. METHODOLOGY

Since much of the scope of the EIA has already been carried out in the course of separate studies over the last three years, the requirements for the EIA are fairly closely defined as indicated by the issues above. However the following steps will have to be taken.

1) Study of the documents produced by the Projects and the details of the

treatment plant.

2) Assessment and detailed discussions with NMC staff to clarify the reliability of the social and agricultural baseline data already collected.

3) Meetings with Dingarh Tanners Association and Pakistan Tanners Association in Kasur, and the Kasur Municipality to assess local concerns about the treatment plant, the landfill site and reclamation of the land covered by stagnant ponds.

4) Collection of Hydrological data relating to the annual (monthly) flows in the Sutlej River, in the Pandoki Outfall drain and in the groundwater around Kasur and water quality.

5) Collection of information concerning the uses of different water bodies, for irrigation, water supply, fisheries and wildlife, industry (upstream and downstream of the Sutlej River). This should include quantity of water used and quality of water required.

6) Assessment of efficiency of proposed treatment plant, the quality of effluent under different conditions, dilutions afforded at different times of year and likely impacts upon receiving water quality and the users of this water. The various zones of influence of the effluents would be outlined.

7) If any of these assessments should prove unfavourable, mitigating measures to protect water users in the event of the different scenarios.

8) Assessment of the hazards involved in different uses for the reclaimed stagnant ponds. Uses to be considered should be, domestic housing, agriculture/forestry, industrial development. Recommendations for the safest use and precautionary measures to be given.

9) Assessment of the hazards resulting from tannery solid waste management and disposal, particularly leachate and contamination of ground water. This should include information on the hydrology and groundwater use.

10) Recommendations for monitoring environmental quality and health.

Whilst it is not anticipated that detailed sampling and analysis will be required during this EIA, some spot sampling and site measurements may be necessary.

6. EIA TEAM AND SPECIALISTS REQUIRED

It is proposed that EIA team be made up of the following specialists:-

1) Team Leader/EIA specialist (1 month)
2) Hydrologist (2 weeks)

3) Agriculturalist (2 weeks)
4) Public Health Engineer (1 week)
5) Community Health Specialist (2 weeks)
6) Fisheries specialist (1 week)

In addition to this team it has been suggested by the Director General of the Punjab EPA that a counterpart team from his agency be assigned to work with the EIA team. This team would include
Assistant Director from the EPA, an EPA Inspector as Research Assistant. In particular the Punjab EPA would be asked to provide back-up waste water engineering expertise. In addition laboratory facilities from the EPA would be made available for any analysis required.

The coordination and supervision of progress and quality of the EIA would be carried out by IUCN in Karachi, in particular by P.J.Meynell, Programme Coordinator, Coastal Ecosystem Unit.

The Terms of Reference of these specialists would be:

1) Team Leader/EIA specialist

The team leader would be responsible for defining in detail the tasks of the specialists in the light of available documents and consultations with local people. S/He would detail the process of the EIA, and be responsible for the production of the final document. S/He would be responsible for assessing the influence upon downstream industrial water users. (In addition the Team Leader would put together the Terms of Reference for the Dutch funded project formulation mission after due consideration of the various documents.)

2) Hydrologist

The Hydrologist would collect information on the ground and surface water flows and quality from appropriate sources. S/He would detail the various water uses and future requirements and together with the Public Health Engineer assess the future quality of the receiving waters. S/He would establish what zones of influence the effluents will have in these waters. In addition s/he would assess hydrological hazards emanating from the landfill site.

3) Agriculturalist

The Agriculturalist would check the agricultural and livestock baseline data and collect information relating to agricultural crops and livestock adjacent to the drains and Sutlej River. S/He would assess the risks to these crops and livestock as a result of being irrigated or drinking water contaminated with effluent from the treatment plant. S/He would compare the improvements in the agricultural production and quality of produce as a result

of the proposed treatment plant.

4) Public Health Engineer

The Public Health Engineer would assess the proposals for the treatment plant and the natural oxidation received by the effluent during the passage down the drains. In consultation with the Hydrologist s/he should assess the dilution of effluents under different conditions and the resulting water quality.
S/He should assess the public health risks resulting from the landfill site and reclamation of the stagnant pond sites. It is important that the Public Health Engineer should have had professional experience in tannery waste treatment.

5) Community Health Specialist

The Community Health Specialist would assess the social and public health baseline data, and collect any other available data from municipal and health authorities in the area. S/He would consult with local people on their concerns about the proposed treatment plant, and with farmers and riparian water users. S/He would assess the total populations likely to be affected in the different zones of influence. S/He would assess the improvements to public health and standards of living as a result of the treatment plant (i.e. compared to the present situation).

6) Fisheries and Wildlife Specialist (optional)

The Fisheries and Wildlife Specialist will collect available data on fish populations and production in the downstream receiving waters, together with information on other wildlife which might be at risk. In consultation with the Hydrologist and the Engineer s/he will assess the risks to these populations, both in the event of short term untreated discharges and chronic low-level toxic materials (e.g. chromium).

7. TIMING

It is proposed to start this work around the middle of November 1992. Apart from visits to Islamabad, and field visits to Kasur, the team will be based in Lahore.

The first week would involve meetings with UNIDO, the Dutch Embassy, NORAD and LIDO in Islamabad to collect and study relevant documents. This work would be the concern of the Team Leader and the Assistant Director Punjab EPA. During the first week the Team Leader would assimilate the various documents and prepare for the team briefing. <He would also prepare the first draft for the TOR for the project formulation mission sponsored by the Dutch (see attached brief) during the first week.>

At the beginning of the second week, the whole team would meet for an initial briefing in Lahore, followed by a visit to Kasur to meet with representatives of the Kasur Municipality, and the tanners associations.

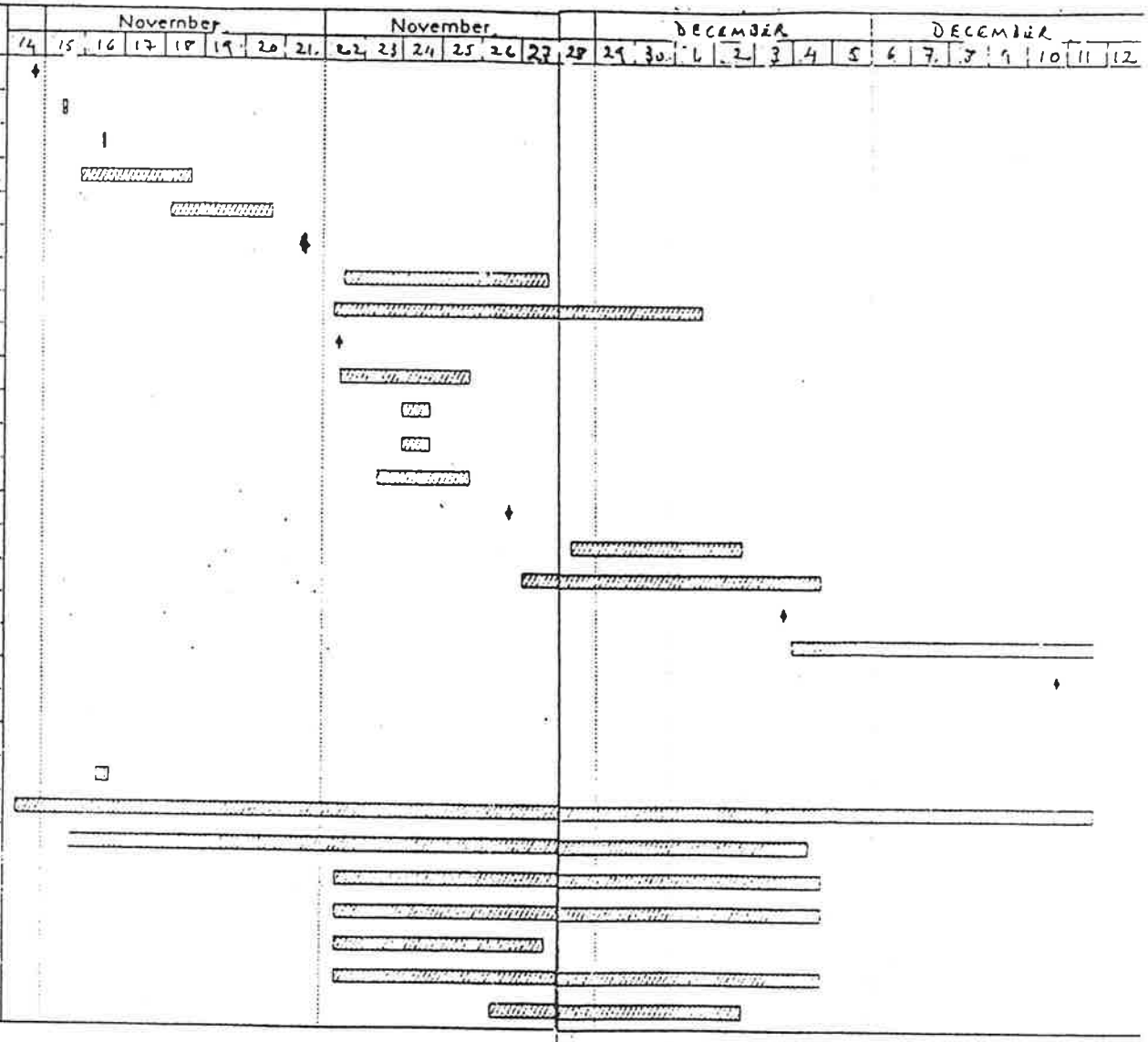
The rest of the second week would involve field visits to Kasur, consultations with local people and farmers, and collection of information from organisations such as WAPDA, agriculture and fisheries departments etc.

The third week will involve further information collection and preparation of the specialist reports. At the end of the third week the team would make a presentation to representatives of the people in Kasur about their findings.

The final week would involve the team leader writing the final report based on the findings of specialist reports and making a presentation to the donors.

The detailed work plan is shown below:-

ID	Name
1	Team Leader arrives Islamabad
2	Briefing meeting with donors
3	Meeting with LIDO + other Islamabad agencies
4	TL assimilates info. Prepares for team briefing
5	TL prepares draft TOR for project formulation mission
6	Team briefing in Lahore
7	Team Visits to Kasur
8	Collection of information
9	Meetings with Tanners + Kasur Municipality
10	Site visits, initial surveys
11	Meetings with WAPDA, Lahore
12	Meetings with Health/Agric surveyors from NMC
13	Other meetings (Lahore)
14	Team Progress meeting (Lahore)
15	Further visits to Kasur
16	Preparation of Specialist reports
17	Presentation of findings at Kasur
18	Preparation of Final report/EIS (Islamabad)
19	TL debriefs donors (Islamabad)
20	
21	
22	INPUTS FROM TEAM MEMBERS
23	Team Leader
24	Punjab EPA counterpart
25	Hydrologist
26	Agriculturalist
27	Public Health Engineer
28	Community Health Specialist
29	Fisheries /Wildlife Specialist



ANNEX 2 Team Members

The I.U.C.N. team undertaking the E.I.A. for the proposed tannery waste treatment plant at Kasur, comprised the following people.

Mr Peter-John Meynell	I.U.C.N. Coordinator
Mr David Lees	Team Leader and Public Health Engineer
Dr Mohammed Qasim Chata	Agriculture Specialist
Dr Afzal Mahmood	Community Health Specialist
Mr Trevor Porter	Fisheries Specialist
Mr Saeed Ahmed Awan	Hydrologist

ANNEX 3 Meetings and Consultations

PERSONS CONTACTED DURING EIA SURVEY

1.	M. Shafique Passari	General Secretary, Tanneries Association, Kasur. Other executive members of Tanneries Association
2.	Sardar Muhammad Akbar	Extra Asstt. Director Agriculture, Kasur
3.	Razak Ahmad Malkana	Deputy Director Agriculture, Kasur
4.	Dr. Abdul Majid Niazi	Veterinary Doctor, Kasur
5.	Ch. Muhammad Rafique	Director, Farm Water Management, Lahore
6.	Iftikhar Ahmed Cheema	Director, Agriculture Extension Head Quarter, lahore
7.	Dr. Khalid Hussain Gill	Director, Soil Fertility Punjab, Lahore
8.	Mr. Sadiq Hussain	Technical Officer, Centre for Environmental Protection studies PCSIR, Lahore
9.	Sheikh Khalil-ur-Rehman	Agri. Officer, EADA Office, Kasur
10.	Sher Muhammad Sherawat	" " " "
11.	-	Qanoon Go, Tehsil Office, Kasur
12.	Muhammad Ummar,	Farmer Village Bangla Kumbo
13.	Amanit Ali	" " " "
14.	Muhammad Yunis	" " " "
15.	Rehmat Ali	" " " "
16.	Akram Khan	Farmer Village Doley Wala
17.	Mukhtar Khan	" " " "
18.	Haji Bashir Ahmed	Farner Village Nazam Pura
19.	Rehmat Ullah	Farmer Village Bangla Kumbo
20.	Muhammad Aslam	" Village Kaser Garh
21.	Abdul Khaliq	" " Bhala
22.	Muhammad Sharif	" " Nazam Pura
23.	M. Rafique	Farmer Village Bhala
24.	Muhammad Yaqoob	" " Nia Key, on Bank of Pando Key Drain
25.	Rehmat Ali	Farmer Village Tulo Wala
26.	Mehar Abdul Ghani	" " Nazam Pura
27.	Mr E.U. Sardar	Chief Engineer, Irrigation, Lahore, together with Executive Engineer, Kasur
28.	Secretary, Environment	and Urban Affairs Division, Islamabad
29.	Mr S Siddiqui	Director General LIDO, Islamabad
30.	Various senior engineersin WAPDA, Irrigation and Drainage Department	
31.	Director Fisheries, Lahore	

Other meetings and officers are referred in the text.

PHARMACIES SHOPS IN KASUR

1. Afzal Medical Hall
2. Rauf Medical Hall
3. Sajid Medical Hall
4. Amjid Medicine Company
5. Rehman Medical Hall
6. Al-Shaffa Medical Hall
7. Sheikh Medical Hall
8. Amin Medical Hall

ENVIRONMENTAL IMPACT ASSESSMENT - KASUR
MEETINGS AND VISITS DURING COMMUNITY HEALTH SURVEY

25/11/92	Karachi	Meeting with Dr. Junaid Ahmed of NMC
29/11/92	Lahore	Team Meeting with Public Heath Engineer, Team Leader, Agriculturalist, Community Health Specialist, Hydrologist.
30/12/92	Kasur	Site Visit to Stagnant Pool Sites Meeting with Tanner's Association - Mian Mohammad Shafiq, Mr. Shahzad, EIA Team. Visit to the site/Consultation with Community Members at Dingarh and around Rohi Nullah Visit to Pandoki Out-fall
01/12/92	Kasur	Visit to Tannery Meeting with a Knowledgeable Local Tanning "Chemist" Visit to the street of Niaz Nagar to identify Hazardous Processes causing Environmental Pollution. Meeting with Assistant District Health Officer Kasur, Dr. Ishfaq Akhtar Consultations with community members in Kot Molvi Abdul Qadir and Niaz Nagar.
02/12/92	Kasur	Community Consultation at various affected sites in Kasur Meeting with Municipal Medical Officer, Dr. Pervaiz Khalid Meeting with General Medical Practitioner, Dr. Safdar
03/12/92	Lahore	Meeting with NMC Project Coordinator for Kasur Survey. Mr. Mohammad Afzal Malik

ANNEX 4 References

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EFFLUENT LIMITATIONS GUIDELINES; NEW SOURCE PERFORMANCE STANDARDS AND PRETREATMENT STANDARDS FOR THE LEATHER TANNING AND FINISHING INDUSTRY, USEPA, 1982

GUIDANCE MANUAL FOR LEATHER TANNING AND FINISHING PRETREATMENT, USEPA, 1986

ANNEX 5 Comments of Fisheries Department on TOR

Comments by Fisheries Department, Lahore on the proposal for finalizing T.O.R. for waste treatment works at Kasur

1. Tables 1, 2, 3 as detailed in the report are not attached. However an official who was deputed to bring the same from the EPA office was procured with the tables attached as annexure.

2. If more than 8 times of dilution of clean river water is available, working standards to be applied to the effluents discharging to rivers should be as under:-

The B.O.D. of effluents should not be above

1. The B.O.D. of effluents should not be above 20ppm (5 days,20C).
2. Suspended solids (plus dissolved iron) should not be more than 30 ppm.
3. pH values not more than 9 or less than 6.5.
4. Cyanides (as HcN) = not more than 0.1 ppm.
5. Sulfides (as H2.S) = not more than 0.1 ppm.
6. Chromium and other toxic metals either single or in combination = Not more than 0.5 ppm.
7. Oil and grease = Nil.

3. Rivers of India and Pakistan are in spate during the monsoon and rainy season, but the water table becomes very low during dry season. The above referred standards will then have to be modified, keeping in view the volume of diluting water available in the river. As for example authorities in England producing or expeeding to produce sewerage effluents complying with standards stricter than those of the Royal Commission on sewerage disposal are under:-

Dilution available	B.O.D. (ppm)	Suspended solids (ppm)	Treatment
1:1	< 10	< 20	Sedimentation activated sludge and possible microstrainers
1:2	< 20	< 10	Sedimentation percolating filters humid tanks or microstrainers
Low or	~ 5-6	~ 5	Sedimentation activated sludge, percolating filters, humid tanks and sand filters or microstrainers

4. The overall requirement of standards available in the river water after mixing with the effluents should be as under:-

1. pH 6.5-8.5
2. Dissolved oxygen < 5mg/l
3. B.O.D. 1.5 - 4
4. Toxic substances, oils, tars, free acid, floating solids or debris should not be present.
5. Disovled salts (as Cl) may convert the stream from fresh to saline water and may affect the entire biology and ecology. It should be ensured that fresh water entity of the river is not affected.

The data regarding dilution water available in the Sutlej river during different seasons has not been provided. In its absence, EPA may be stressed upon to ensure that on and after mixing of the effluents, Sutlej river water must conform to the standard of quality as outlined in para 4 of this report and the effluents before discharge must confirm to the standards outlined in para 2 if more than 8 times dilution of clean river water is available, and these outlined in the table of para 3 if lesser dilution volume is available. If these standards are not maintained then the biology and ecology of the entire river may be changed and Fisheries may also get eradicated from the river Sutlej.

One Fisheries specialist (one week) may be nominated in the EPA team to collect the available data on fish population and production in the down stream receiving waters as required.