JAJMAU TANNERY INDUSTRY

ROAD MAP TO SUSTAINABLE WASTE MANAGEMENT

A Model for the Ganga Basin

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Executive Summary

Background

In the industrial suburb of Jajmau, Kanpur, over 400 tanneries discharge high levels of chromium, sulphide, organic matter and salt into the sewer system. It is estimated that 80% of the 28 to 50 million litres of tannery effluent makes its way to the Ganga River each day due to failing treatment infrastructure and lack of capacity.

Tanneries in the Jajmau cluster are distinguished by differences in size and in the tanning processes that are performed. There are approximately 55 medium/large tanning companies, each processing over 100 hides per day into finished leather. The majority of tanners, however, are small operations typically processing less than 100 hides per day. Many of these small facilities focus on the initial process of converting raw hides to the 'wet blue' stage. Wet blue hides are mostly sold to the larger tanneries. Many of these smaller businesses are considered to be operating on narrow economic margins and are extremely vulnerable to external changes.

In recent years, government has taken strong action to address pollution concerns, including significant regulatory interventions such as tannery closures, prosecutions and arrests of tannery operators. Despite these actions, systemic failures have allowed the discharge of effluents to the Ganga to continue, with little or no consequence.

As a result of the unsustainable practices in Jajmau and the significant environmental and human health implications, on 30 September 2011 the Allahabad High Court directed that all chromium-based tanneries in Kanpur be closed. A subsequent court decision requested a *Zero Discharge* solution be studied which, if proved viable, would allow the tannery industry to continue to operate in Jajmau.

Since 2011 a number of detailed project reports (DPRs) have been proposed or completed for the development of a new Common Effluent Treatment Plant for the Jajmau tanneries. The Indian Institute of Technology Kanpur (IITK) has been working on solutions to address the environmental issues associated with Jajmau's tannery industry. IITK is currently developing the conceptual basis for the completion of another DPR.

Developing the Road Map

Despite all stakeholders clearly working towards the same objectives, there is currently a lack of trust and collaboration between tanneries, government and regulators.

In May 2013 a team of experts from Victoria, Australia formed a partnership with IITK to study the situation and produce a Roadmap for improving the situation of Kanpur. Support was provided by the Australian Government.

A consultative approach was adopted for this exercise. This included:

- *Consultations* - with IITK, representatives of the tanneries in Jajmau, and State and Central Government departments, including the Uttar Pradesh Jal Nigam; Uttar Pradesh Pollution Control Board (UPPCP); Uttar Pradesh Urban Development, Urban Employment & Poverty Alleviation Department; Central Pollution Control Board (CPCB); and the National Mission for Clean Ganga (NMCG). The team also consulted with the World Bank (WB) and the International Finance Corporation (IFC).
- *Site-based engagements* - with tanneries in Jajmau; the existing Common Effluent Treatment Plant (CETP); and with other tannery clusters in India, including Tamil Nadu, Kolkata and Unnao.
- *Expert dialogue* - with Indian tannery support organisations including the Indian Leather Industry Foundation (ILIFO) and the Council for Leather Exports.

To assess the best options for implementation in the Jajmau context, a number of further analyses were undertaken to evaluate current and possible options.

Analyses undertaken included:

1. Cleaner Production Study;
2. Wastewater Treatment Options Analysis;
3. Waste Management Review;
4. Regulatory Review;
5. Value Chain Analysis;
6. Health and Safety Analysis; and
7. Best Practice Governance Review.

Key Findings

Through the Road Map development process the following findings were identified:

1. The leather industry is a significant contributor to employment and the economy of Kanpur, consisting of a diverse mixture of operations of different sizes and assorted tanning operations.
2. Tanneries in Jajmau recognise that tackling environmental concerns is key to the future growth of the cluster, however, lenient enforcement of environmental regulations in the past has provided a competitive advantage for the Jajmau tanning industry.
3. Small tannery operators are likely to experience the most significant impact of the imposition of additional costs related to waste management. As a result the smaller tanneries will require a great deal of support (both financial and technical) from outside sources to implement proposed changes to the tannery industry.
4. Significant opportunities are present for the improvement of both workplace and community health and safety. These improvements will incur upfront costs to tannery operators for training and optimisation of equipment, especially for small scale industries.
5. Relocating the tannery industry away from Jajmau is not the preferred option to solve current environmental issues. This option would leave a contaminated site legacy and numerous social and economic issues.
6. The focus of the solution to date has been on building a new treatment plant to resolve the issue. This approach fails to adequately address pollution at source or possible contaminated land, contaminated groundwater and human health issues. Large infrastructure solutions are also expensive and have the potential to place unnecessary financial burden on the Tannery industry.
7. Complementary upstream opportunities such as cleaner production and water efficiency programs, which can deliver short-term gains by reducing wastewater treatment capital and operational expenditure, have not been adequately considered in existing proposals. These have been unsuccessful in the past as a result of little financial incentive to reduce water usage or the amount of salt or chemicals in effluent. A 20–40 % reduction in pollutants is possible – as demonstrated in industrial sectors in other parts of the country and internationally.
8. The most cost effective solution to the Jajmau waste issue will be one that considers upstream pollution control opportunities, ensures flexibility in new infrastructure planning and works in conjunction with the existing sewage treatment plant. It is acknowledged that stakeholder relationships will need to be developed and improved in order for this potential option to be a reality.

The Road Map

The proposed Road Map is a holistic strategy for government, business and the community to ensure the leather industry in Jajmau is able to sustain growth, whilst not compromising the river and community health. It is a realistic and measured approach to address the social and environmental impacts and provides effective technical and regulatory solutions.

The Approach

It is recommended that an accepted and balanced regulatory and customer focused approach is adopted incorporating the following elements:

Set Standards – Define and agree on performance standards and set realistic timelines to achieve regulatory standards, against which improvements can be measured.

Inform and Educate – Publish and share performance standards and best practice advice with tanneries, regulators and the local community to establish realistic expectations.

Support to Comply – Provide practical help and expert advice to tanneries to improve environmental and safety performance, as well as assistance to strengthen governance of compliance through collaboration with Uttar Pradesh Pollution Control Board (UPPCB) inspectors.

Encourage Performance – Encourage industry and operators to exceed standards and strive for more efficient practice via incentives, promotions and awards.

Monitor Compliance – Monitor and report openly on performance and achievements against standards and regulations.

Enforce the Law – Actively address poor performance and publically report when standards are consistently not met.

The Priority Areas

Five priority areas have been identified to address issues and present both relatively inexpensive actions that can be introduced in the short term, and more capital intensive items that will require a longer time frame to implement.

An emphasis has been placed on waste minimisation and cleaner production, which is anticipated to complement the establishment of large infrastructure already flagged by State agencies.

1. Support the Tannery Industry

The strong support of the tannery industry is critical to the success of the Road Map. By strengthening the industry and associations, collaborative efforts to improve the industry will be easier to roll out across small and large tanneries.

Strategies to strengthen the tannery industry include a number of activities to promote collaboration between tanneries. These include but are not limited to:

- Establishment of a formal, single Tannery Association able to provide administrative resources and capacity-building;
- Establishment of formal trade waste agreements, beginning with agreements to focus on support to comply and cleaner production, and establishing expectations for ongoing improvement;
- Establishment of resources to implement a 'support to comply' service, including establishment of compliance officers and knowledge management systems; and
- Establishment of strategic relationships with regulatory bodies to ensure priority issues are agreed upon and collaborated upon where possible.

2. Promote Cleaner Production and Water Efficiency

This strategy is presented as a lower cost and immediate means of reducing pollution with the objective of load and flow reductions in the order of 20-40 per cent prior to any infrastructure upgrades. Cleaner Production addresses many of the earlier inputs to the tanning process and provides alternative strategies for leather production that reduces volumes of waste produced throughout the process.

3. Optimise Wastewater Treatment

The optimisation of wastewater treatment is designed to improve the performance of the existing conveyance system and Common Effluent Treatment Plant (CETP) and enhance utilisation of the domestic sewerage treatment plants.

At present, the treatment plant has not been effective due to:

- Insufficient capacity of the CETP to cope with current wastewater volumes;
- Inadequate level of treatment; and
- Inappropriate water sources reaching the CETP (i.e. stormwater).

Alongside technical improvements for the optimisation of wastewater treatment in Jajmau, the establishment of processes for the effective governance of trade effluent management, including pricing mechanisms to incentivise good performance will also be required.

The implementation of ISO accreditation is recommended to ensure the system designed is subject to ongoing maintenance. This has been proven to be a successful approach for the Ranipet CETP in Tamil Nadu.

4. Plan for Operational Model and Modular Infrastructure

Appropriate institutional, regulatory, financial and managerial mechanisms are required to continually improve the long-term sustainable operation of wastewater treatment infrastructure. These are outlined in the Road Map and include:

- Water treatment and reuse option appraisal;
- Refinement of an operation and management model for upgraded Jajmau treatment system;
- New / Upgraded CETP pre-feasibility study, tendering and construction; and
- Continuous improvement during operation.

5. Improve Community Health, Liveability and Development

Improvements to health, liveability and social development in the Jajmau area are critical to the success of the Road Map. This includes evaluations of both positive and negative environmental and social impacts of the tanneries on the Jajmau community

including elements of health and safety, as well as the development of a community led monitoring program.

A community led monitoring program will engage the community in understanding the impacts of tannery effluent on water quality in the Ganga, and promotes empowered decision making in the community to drive development.

The community development priority action is anticipated to inform and empower the Jajmau community to develop sustainable businesses and improve overall health, safety and liveability in the region.

Road Map Implementation

It is envisaged that the Road Map will be implemented under the broader National Ganga River Basin Project.

Institutional Arrangements

During detailed design of the initiative, a series of workshops will be conducted to develop the appropriate institutional arrangements for the Road Map.

Institutional arrangements are likely to include:

- Policy support and guidance provided by the Ministry of Environment and Forests and State Ganga River Conservation Authorities;
- Program Management provided by the National Mission for Clean Ganga (NMCG) and State Program Management Groups (SPMGs);
- Executing Agency(s) (EA) - to be determined at a later date – consisting of technical agencies with the mandate of industrial pollution control at either or both the state and national level (e.g. Pollution Control Board);
- Industry implementing body consisting of a single Tannery Association responsible for ensuring improved performance and compliance with regulations.
- Project and Technical Consultancy consisting of local and international experts to support the implementation of the Road Map.
- Partner agencies which will provide additional specialised expertise and capacity to the main implementing agencies.

Work Program

An initial five (5) year program is envisaged. This program is expected to deliver significant short-term results through industry support programs, cleaner production initiatives and optimisation of existing infrastructure, while at the same time, informing planning and flexible design of longer term infrastructure and governance mechanisms. Table 0.1 summarises the key anticipated benefits and reductions to pollution / volumes associated with the implementation of each priority area in the roadmap by year.

Table 0.1 Anticipated Benefits and Pollution / Volume Reductions associated with Key Activities

Year	Key Activities	Anticipated benefits	Anticipated Pollution / Volume reduction (against current baseline)
1	Establish industry association	Enhanced relationships between all stakeholders, particularly regulators	5% reduction in wastewater volume to sewer
	Establish 'support to comply' program	Direct support to tanners will immediately raise profile and alter performance positively	5% reduction in Total Dissolved Solids (TDS)
	Baseline monitoring	Monitoring equipment installation will immediately modify behaviour positively	10% reduction in chromium (Cr)
	Develop case study / demonstration sites	Improved problem quantification via monitoring and assessment	
	Establish trade effluent governance	Monitoring installed in priority locations for long term management	
	Environmental and social assessment	Roles and responsibilities clearly understood by stakeholders	
2	Build 'support to comply' program	Tanners engaged and industry leaders driving peers towards improvement	10% reduction in wastewater volume to sewer

Year	Key Activities	Anticipated benefits	Anticipated Pollution / Volume reduction (against current baseline)
	Establish funding framework for improvements	Clear evidence of potential for improvement via demonstration sites	10% reduction in TDS
	Showcase improvements at demonstration sites	Monitoring and management systems affecting tanner behaviour positively	20% reduction in Cr
	Develop detailed cleaner production / water efficiency programs	Potential wastewater treatment improvements identified	
	Assess existing wastewater treatment		
	Implement trade effluent management systems	Underperforming tanners identified	
	Establish community environmental monitoring	Community engaged and actively supporting environmental improvement	
3	Cleaner production / water efficiency programs roll out	Significant reductions in trade effluent volume and qualities from support programs	25% reduction in wastewater volume to sewer
	Funding allocated for onsite infrastructure improvements	Trade effluent management identifying and actioning underperforming tanners	20% reduction in TDS
	Trade effluent management systems implemented	Trade effluent management identifying and actioning underperforming tanners	Cr effectively fully removed from wastewater
	Investigation of common treatment facilities		
4	Continue delivery of cleaner production / water efficiency programs	Continued reductions in trade effluent volume and qualities from support programs	30% reduction in wastewater volume to sewer
	Continue funding allocation for onsite improvements	Reduced additional inputs to sewers from illegal discharge / connections	15% reduction in additional inputs to sewer
	Undertake improvements to sewer and treatment infrastructure	Wastewater treatment improved resulting in improved discharge qualities	25% reduction in TDS
	Imbed trade effluent management	Underperforming tanners improving towards regulatory standards	
5	Continue delivery of cleaner production / water efficiency programs	Continued reductions in trade effluent volume and qualities from support programs	35% reduction in wastewater volume to sewer
	Undertake improvements to sewer and treatment infrastructure	Continued reduction in inputs to sewers from illegal discharge / connections	20% reduction in additional inputs to sewer
	Imbed trade effluent management to business as usual	Underperforming tanners achieving compliance with standards	30% reduction in TDS

Table of Contents

List of Acronyms

ACIAR	Australian Centre for International Agricultural Research
APPCB	Andhra Pradesh Pollution Control Board
AusAID	Australian Agency for International Development
BOD	Biological Oxygen Demand
CCRP	Common Chrome Recovery Plant
CDI	Cluster Development Initiative
CETP	Common Effluent Treatment Plant
CLE	Council for Leather Exports
CLRI	Central Leather Research Institute
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CPWE	Cleaner Production and Water Efficiency
CCRP	Common Chrome Recovery Plant
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSR	Corporate Social Responsibility
DCLR	Direct Chrome Liquor Recycling
DEPI	Department of Environment and Primary Industry
DPR	Detailed Project Reports
DTF	Department of Treasury and Finance
EBSO	Aegean Region Chamber of Industry
EPA	Environmental Protection Authority
ESC	Essential Services Commission
FAO	Food and Agriculture Organisation (UN)
HACCP	Hazard and Critical Control Point
ICEC	Institute for Quality Certification for the Tanning Industry
IFC	International Finance Corporation (World Bank Group)
IIT	Indian Institutes of Technology
IITK	Institute of Technology Kanpur
ILIFO	Indian Leather Industry Foundation
IL&FS	Infrastructure Leasing & Financial Services
INDECO	Industry Alliance for Reducing Energy Consumption and Carbon Dioxide Emissions
INR	Indian Rupee
ISO	International Standards Organisation
JTEPA	Jajmau Tanneries Environnemental Protection Association
MLD	Million Litres per Day
MNC	Multinational Corporations
MoU	Memorandum of Understanding
NF	Nanofiltration
NRGBA	National River Ganga Basin Authority
OH&S	Occupational Health & Safety
PCB	Pollution Control Board
PPE	Personal Protective Equipment
PPP	Public Private Partnership
PSLP	Public Sector Linkages Program
RO	Reverse Osmosis
ROI	Return on Investment

SA	Social Accountability
SLF	Secure Landfill Facility
SOO	Statement of Obligations
SPV	Special Purpose Vehicle
SS	Suspended Solids
STP	Sewage Treatment Plant
SWOT	Strengths, Weaknesses, Opportunities, Threats
TDS	Total Dissolved Solids
TKN	Total Kjehldahl Nitrogen
TTGV	Technology Development Foundation of Turkey
TUBITAK	Scientific and Technological Research Council of Turkey
UASB	Upflow Anaerobic Sludge Blanket
UNIDO	The United Nations Industrial Development Organisation
UPLIA	Uttar Pradesh Leather Industries Association
UPPCB	Uttar Pradesh Pollution Control Board
VOC	Volatile Organic Compound
ZLD	Zero Liquid Discharge

1.0 Road Map Introduction

This report provides a Road Map for action by government, business and the community to ensure that the leather industry in Jajmau is able to sustain growth whilst not compromising river and community health. It is a realistic and measured approach to address the social and environmental impacts of the industry, and provides both technical and regulatory solutions.

1.1 Project Objectives

The Road Map seeks to introduce a solution for environmentally and socially sustainable growth where the:

- Amount of water consumed by tanneries is minimised;
- Amount of waste generated by tanneries is minimised;
- Tannery effluent conveyance network can convey all wastewaters to the treatment plant and is protected from corrosion or failure for the full life of the assets;
- Treatment plant can sustainably treat all the wastewater that is generated by the tanneries;
- Discharge to the Ganga River is within environmental standards;
- Solid wastes produced by the tanneries and treatment systems are reused or disposed of in an environmentally appropriate manner;
- Waste management and treatment systems are operated sustainably; and
- Cost of waste treatment to tanneries and all stakeholders is minimised and fairly apportioned based on the relative contribution of pollution to the wastewater system.

The Road Map vision is for "*The Leather Industry in Jajmau to be able to sustain growth whilst not compromising the health of the River Ganga and the community.*"

Plate 1.1 The River Ganga

1.2 Origin of the Project

The Victorian Government, with the support of the Australian Government through AusAid's Public Sector Linkages Program (PSLP) collaborated with the Indian Institute of Technology Kanpur (IITK) to develop a Road Map for the sustainable management of wastes from the Jajmau Tannery Industry Cluster.

The purpose of the PSLP is to transfer skills and expertise from Australian government agencies to the public sector in partner countries, and to support bilateral and regional public sector partnerships.

1.3 The Project Partnership

Indian Institute of Technology Kanpur

IITK has been working on solutions to address the environmental issues associated with Jajmau's tannery industry. They are currently advising on the remodelling of the DPR being prepared by SPV for Jajmau Tanneries.

The work of the IITK is taking place under the umbrella of the Ganga River Basin Plan – being developed by a consortium of seven Indian Institutes of Technology (IIT) commissioned by the Government of India's National Mission for Clean Ganga (Ministry of Environment and Forests).

It is noted that while IITK facilitated the work completed by the Victorian Government team, recommendations made in this report are those of the Victorian team and are not necessarily agreed to by all stakeholders, including IITK.

The Victorian Team

The State of Victoria and the rest of Australia (like India), faces significant challenges in terms of water resource management and pollution control. Over the past 25 years, Victoria has implemented a comprehensive water reform agenda which has resulted in fundamental shifts in the way water resources are valued, managed and used. The Victorian Government has used a combination of measures to help protect the State's waterways.

The Victorian Government team includes representatives from:

- The Government of Victoria;
- The Environmental Protection Authority (EPA) (Victoria's environmental regulator);
- City West Water (a water retailer in Melbourne, responsible for managing trade waste from Australia's largest industrial zone); and
- Earth Systems, a multidisciplinary environmental and social consulting firm with twenty years of international experience.

Plate 1.2 The work completed by the Victorian Government team was facilitated by ITTK

1.4 The Ganga

The Ganga (Ganges) River represents significant economic, environmental, and cultural value to India. The Ganga River Basin accounts for 26% of India's landmass, 30% of India's water resources and is utilised by more than 40% of India's population. As a result of the growth of population and industry in the Basin, the Ganga River is facing severe pollution pressures. Untreated sewage and industrial wastewater are the main sources of pollution.

1.5 The Jajmau Tannery Industry

Jajmau, one of the oldest districts of Kanpur, is located on the southern bank of the River Ganga, in the south eastern region of the city. The Jajmau tannery cluster has been operating in the area for over 150 years. It has grown over time to become an integral part of the Jajmau area - the community and local economy. The Jajmau cluster is currently composed of a diverse mixture of over 400 tanneries on the southern bank of the Ganga, as illustrated in Plate 1.3.

These facilities are distinguished by variations in size and the tanning processes that are performed. There are approximately 55 medium/large tanning companies which individually process over 100 hides per day into finished leather. A significant proportion of the leather is used for the production of footwear and saddlery items for export. These operations are characterised by a large workforce, relatively up-to-date technology and management systems and strong producer to buyer relationships.

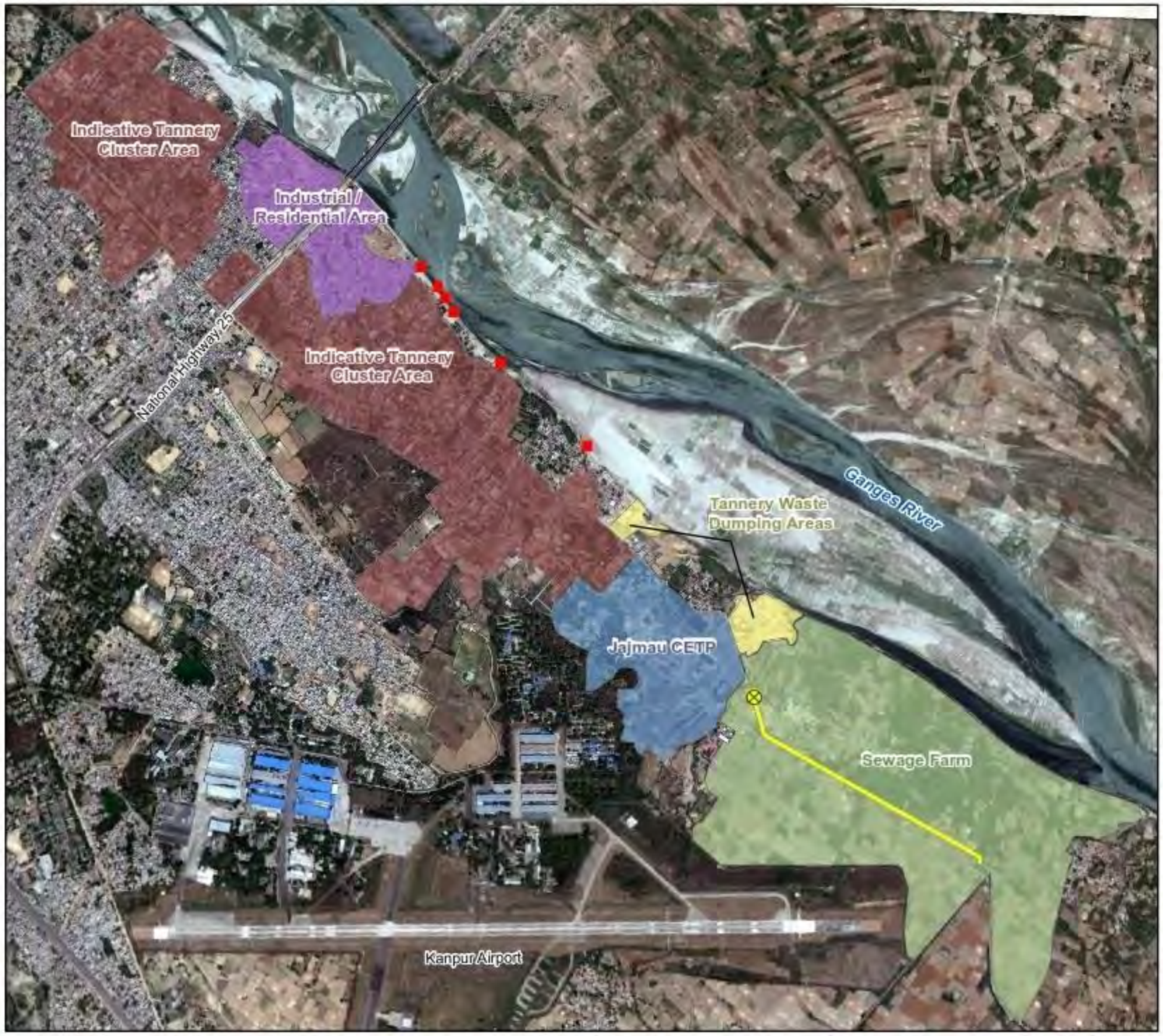
The majority of tanners however are small and micro 'backyard companies' which process less than 100 hides per day. Many of these facilities only convert raw hides to the 'wet blue' stage. Wet blue, or chrome-tanned, is a tanning process using chromium sulfate and other salts of chromium that results in a blue-coloured hide. These processed wet blue hides are mostly sold to the larger tanneries. Many of these operations are considered to be operating on narrow economic margins and are extremely vulnerable to external changes.

The Jajmau tanneries are a significant contributor to the economy of Kanpur. According to the Council for Leather Exports (CLE), leather and leather product exports from the Kanpur region totalled approximately $US 205 million for the April to July 2013 financial quarter, representing 19% growth in the industry from the previous year.

Section 3.1 describes the characteristics of the Jajmau Tannery Industry, in further detail.

Figure 1.1 illustrates significant landmarks associated with the Jajmau Tannery Industry.

Plate 1.3 Aerial View of the Jajmau Tannery Cluster



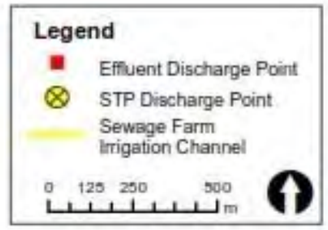


Figure 1.1 Jajmau Tannery Industry Landmarks

1.6 The Challenge

It is estimated that between 28 and 50 million litres of wastewater per day is discharged by the Jajmau Tannery Industry. Most of the wastewater ends up making its way untreated to the Ganga River due to failing infrastructure and the lack of capacity to treat the effluent. According to the Central Pollution Control Board (CPCB, 2009), the water quality of the Ganga River at Kanpur is classified as "Bad" or "Not satisfactory" with respect to biochemical oxygen demand (BOD).

Along with domestic and other industrial sources of pollution, tannery operations have the potential to cause significant environmental impacts. Tanning processes use a large volume of water, and a wide range of chemical compounds to preserve, remove hair and tan hides. Untreated tannery waste contains high concentrations of dissolved and suspended solids, chromium, nitrogen, ammonia and sulphur compounds and has a high BOD.

Some effluent from the Jajmau Tannery industry is directed to the Common Effluent Treatment Plant (CETP) for treatment. The CETP was constructed in 1995 in conjunction with an Indo-Dutch project as part of the Ganga Action Plan Phase 1. The CETP incorporates the Upflow Anaerobic Sludge Blanket (UASB) process. The CETP was designed to treat 9 million litres per day (MLD) of tannery effluent mixed with 27 MLD of municipal sewage. The ratio was determined using bench scale reactors. A 130 MLD sewage treatment plant (STP) is also located at the CETP site, with a 43 MLD expansion project currently being implemented for the STP.

There are various issues associated with the current system that have resulted in the Ganga River being polluted by tannery effluent including:

- Inadequate pre-treatment (i.e. chromium removal) being conducted by tanneries;
- Insufficient capacity of conveyance network;
- Illegal discharges of tannery effluents and domestic sewage in respective conveyance networks leading to inadequate treatment of pollutants; and
- Insufficient capacity of the CETP.

In 2006, *Public Interest Litigation no. 4003 versus the State of Uttar Pradesh and Others regarding Ganga Pollution* was filed by the Allahabad High Court. The Court has ordered that a Zero Liquid Discharge solution be designed to address pollution issues from Jajmau tanneries and that relocation options be considered. Court order transcripts related to the Jajmau tannery industry are included in Appendix A.

Various organisations have offered solutions to the problem, however, little has been achieved on the ground to solve the issue.

Plate 1.4 The Jajmau Common Effluent Treatment Plant

2.0 Road Map Methodology

The Victorian Team, supported by IITK, adopted a consultative based approach for research and development of the Road Map.

2.1 Review of Previous Work

A wide range of literature sources were consulted to gather a baseline of prior research for the study. Reports presenting waste treatment options for the Jajmau Tannery Industry that were examined included:

- IL&FS Clusters, Detailed Project Report, Up-gradation of Tanneries CETP at Jajmau (2010);
- Deloitte, Relocation of Tanneries in Kanpur, Interim Report (2010);
- IL&FS CDI & IL&FS Water Ltd, Draft Revised Detailed Project Report for Proposed Upgrade of Common Effluent Treatment Plant Facilities for Tannery Cluster at Jajmau, Kanpur (2011); and
- Central Leather Research Institute (CLRI), Chennai, Study Report on Relocation of Tanneries in Jajmau, Kanpur (2012).

Other pertinent reports related to the Jajmau Leather Industry included:

- IL&FS CDI, Diagnostic Study of Kanpur Leather Cluster (no date supplied); and
- Chakrabarti & Varman, Labour in Global Value Chains: A Study of the Leather and Footwear Manufacturing Cluster of Kanpur (2009).

A comprehensive list of the references used in the production of the Road Map is included in Section 7 of this report.

2.2 Stakeholder Consultation

The Road Map development process included a series of consultative activities including meetings, workshops and site visits.

Over four (4) missions, the Project team conducted a number of workshops with IITK to gain an understanding of the current situation and to conduct collaborative analysis of IITK proposed interventions.

The Project team met with representatives of the tanneries in Jajmau, to understand the challenges that are faced by tannery operators. A diverse variety of large and small tanners were represented at these meetings.

Representatives of State and National government departments were engaged including the Uttar Pradesh Jal Nigam, the Uttar Pradesh Pollution Control Board, the Central Pollution Control Board and the National Mission for Clean Ganga.

The Project team also met with representatives of the World Bank and International Finance Corporation.

Annex B summarises the key stakeholders associated with the project and Annex C presents a summary of the engagements by the team with the project stakeholders.

2.3 Assessment and Investigation

Representatives of the Project Team visited large, medium and small tanneries in Jajmau. Tannery businesses described the operations they performed and the pressures they faced when managing their facilities. Opportunities for cleaner production initiatives were also discussed with the tannery operators.

The Project Team visited the Jajmau CETP. The team met with the Uttar Pradesh Jal Nigam Plant Manager, who described how the plant operated and the challenges that were faced with regards to the effective treatment of tannery effluent under the current waste management framework in Jajmau.

2.4 Best Practice Comparative Analysis

2.4.1 Best Practice Literature Review

Literature reviewed related to best practices for the treatment of tannery waste included:

- UNIDO, Introduction to Treatment of Tannery Effluents 2011 (See Annex G); and
- ACIAR, Salinity Reduction in Tannery Effluents in Australia and New Zealand (2009).

2.4.2 Indian Tannery Clusters

Representatives of the project team visited tannery clusters at:

- Bather and Unnao, Uttar Pradesh;
- Ranipet, Tamil Nadu; and
- Kolkata, West Bengal.

The purpose of the visits was to investigate tannery clusters where different tannery waste management and treatment practices have been implemented.

The project team visited the CETP at Banther. A special purpose vehicle (SPV) had been set up to manage the treatment of effluent from the tanneries. The SPV was owned by the tanneries, shares in the SPV being allocated in proportion to the production capacity of each tannery.

In Ranipet, "Zero Liquid Discharge" (ZLD) principles are regulated by the Tamil Nadu Government. Consequently, the treatment plant at Ranipet is equipped with a reverse osmosis facility and treated effluent is recycled back to the tanneries for reuse.

The leather cluster at Kolkata provided an example of where the entire tannery industry has been relocated by the Government to a greenfield site in an attempt to manage pollution. The relocation of tanneries resulted in the closure of a significant proportion of the smaller tanneries at Kolkata.

2.4.3 Dialogue with Tannery Support Organisations

Representatives of the project team met with members of ILIFO in Chennai on two occasions to discuss the support ILIFO has provided to tanneries in Tamil Nadu and elsewhere in India. ILIFO support the tanners industry through the implementation of cleaner production initiatives amongst other services. They are also involved with the design of the ZLD plant in Ranipet. A meeting with a representative of the Council for Leather Exports was also held to discuss the economic importance of the tannery industry to Kanpur.

2.4.4 International Best Practice Case Studies

An investigation of international best practice of tannery operations was completed. Section 3.5 of this report presents case studies of best practice tannery operations in Italy and Turkey.

2.5 Value Chain Analysis

The Value Chain Analysis provides initial information on the Kanpur leather industry supply chain and value addition at the different stages of production. It draws on information from a number of existing studies on the leather supply chain in India including a *Diagnostic Study of Kanpur Leather Cluster (IL&FS undated);* CLRI's *All India Survey on Raw Hides and Skins* (2005); and *Global Value Chains: A Study of the Leather and Footwear Manufacturing Cluster of Kanpur* (Chakrabarti, M. & Varman, R. 2009).

Information was also obtained through site based meetings with 25 suppliers and five (5) producers in Kanpur. These engagements were conducted by the Project team and a number of IITK post graduate students. A summary of information obtained through these engagements is provided in Annex C.

2.6 Health and Safety Analysis

An analysis of opportunities for improvement of health and safety in the Jajmau Tannery Cluster was undertaken to highlight some of the indirect benefits of implementing cleaner production processes.

A detailed review of literature was conducted to establish best practice in occupational health and safety standards and common areas for improvement.

2.7 Regulatory Review

The review of regulatory and legislative processes was established through consultation with a number of sources, relevant literature and discussions with key stakeholders including the Uttar Pradesh Pollution Control Board, Jajmau tannery associations, and individual operators.

2.8 Waste Management Review

A rapid waste management review of the Jajmau tanneries sub-cluster was conducted to:

- Characterise current waste management and treatment practices taking place in Jajmau; and
- Assess previously proposed management options (i.e. CLRI and IL&FS) and add rigour to management solutions currently being developed by IITK and other stakeholders.

The review drew upon previous literature (e.g. High Court records, DPRs, concept papers), site based engagements with tanneries and pollution managers in Kanpur and Chennai, and meetings with other relevant stakeholders. A key aspect of this review was the conduct of a number of working sessions with IITK where process diagrams of current and proposed situations were developed to identify critical control points/areas of concern and inform discussions about current issues and possible solutions.

2.9 Cleaner Production Study

A study into the potential gains for the implementation of cleaner production initiatives was completed.

Sources of information included:

- Tannery cleaner production studies completed in India and internationally, including investigations completed by the Andhra Pradesh Pollution Control Board (APPCB, 2005) and the Australian Centre for International Agricultural Research (ACIAR, 2008);
- Discussions with ILIFO, regarding cleaner production initiatives they have been involved with throughout India;
- Discussions with tannery operators in Jajmau, Tamil Nadu and Kolkata.

2.10 Wastewater Treatment Options Analysis

2.10.1 Information Sources

Information sources used for the options analysis included:

- The research of potential methods and treatment technologies for the management of tannery waste;
- Discussions with tannery operators;
- Discussions with operators of treatment facilities in Jajmau, Unnao and Tamil Nadu; and
- Conversations with the Indian Leather Industry Foundation (ILIFO) regarding the implementation of the Zero Liquid Discharge philosophy in Tamil Nadu and the application of cleaner production initiatives in tanneries.

2.10.2 Approach to Wastewater Treatment Analysis

The scope of works that was completed for the options analysis is described in the following paragraphs.

Holistic Assessment of Treatment Alternatives

City West Water led a workshop at ITTK to qualitatively assess the economic, environmental, social, technical and political factors associated with each alternative (as well as the current situation). Staff and students from IITK and Earth Systems participated in the session. The results of the assessment are presented in the following section.

Preliminary Technical Analysis of Treatment Options

The technical issues associated with each of the proposed options were considered. Some factors included the requirements for:

- Percentage of tannery effluent requiring reverse osmosis treatment;
- Reverse osmosis facility size and treatment requirements; and
- Capacity and footprint for the storage of the reject from the reverse osmosis treatment.

Preliminary Financial Analysis of Treatment Options

A financial analysis of the various proposed treatment options was conducted. Financial data provided in the Ranipet Tannery Effluent Treatment Co Ltd Annual Report (Tamil Nadu) was used as the basis to estimate the capital and operating costs associated with the various scenarios.

2.11 Best Practice Governance Review

Best practice governance procedures for the management and treatment of industrial waste were researched. City West Water, which is responsible for managing trade waste from Australia's largest industrial zone, directed this study.

The long term sustainability of the sewerage system, treatment, environmental discharge and beneficial reuse resulting from the Jajmau tanneries is dependent upon robust trade effluent management and a transparent governance framework.

The information contained in Section 3.7 provides guidance for the development of a trade effluent management system, with clear roles and responsibilities for relevant agencies and organisations. It is proposed that the establishment of such a system / framework would draw largely on existing best practice, practitioner experience and real world examples. The Australian and Victorian jurisdictions offer a source of such examples and experience.

3.0 Findings: Review and Technical Analysis

This section of the Road Map Report presents information sourced from the review of previous studies (Sections 3.1 to 3.4) and additional work by the Victorian team (Sections 3.5 to 3.8) that builds upon the knowledge gained from previous studies.

3.1 Review of the Tannery Industry

3.1.1 Jajmau Tanneries

There are over 400 tanneries in Jajmau of varying size. Table 3.1 (IL&FS et al 2011) describes the distribution of the tanneries according to size.

Table 3.1 Jajmau Tannery Unit Sizes

Capacity (hides per day)	Number of Tanneries
<50	292
51-100	63
101-200	20
201-300	14
301-500	13
>500	8

Source: IL&FS et al 2011

There are also distinctions between the tanneries with regards to the tanning processes that are performed. While most of the larger tanneries complete all tanning processes at their site, a significant proportion of tanneries only process raw hides to the wet blue stage; some tanneries only process wet blue to finished leather, while other tanneries only perform finishing operations and job work. Figure 3.1 provides a breakdown of the different types of tanneries according to the processes they perform.

The greatest impacts to the environment from the tanning process are generally associated with the production of wet blue from raw hides.

As further discussed in Section 3.2, smaller tanneries, with low profit margins, often perform these works. Additional waste management requirements and costs are likely to cause significant financial stress upon these smaller operations. All these tanneries and the products they produce play an important role in the overall tannery 'ecosystem' in Jajmau. For example, tanneries producing finished leather products may rely on other tanneries to provide them with semi-processed leather products (e.g. blue hides). Other tannery associated businesses may rely on 'waste' produced from other tanneries (for example for the production of dog chews).

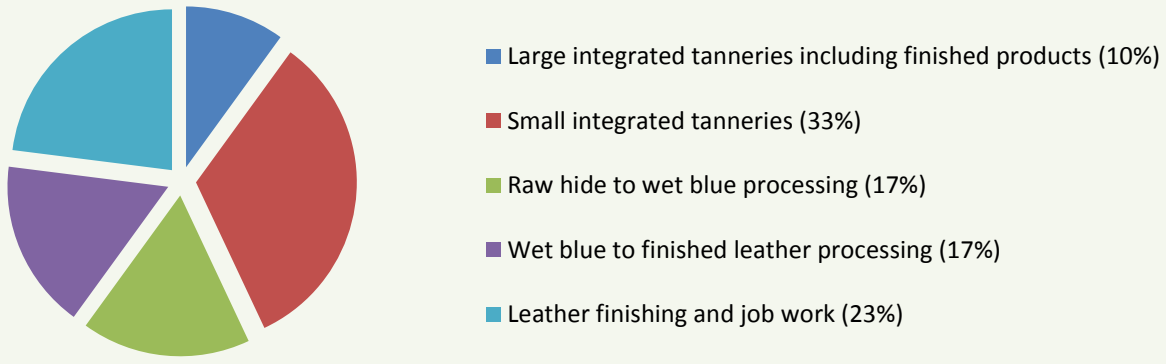


Figure 3.1 Production Processes Completed at Jajmau Tanneries

3.1.2 Tannery Industry Associations

Three industry associations represent the tanners in Jajmau including the:

- Uttar Pradesh Leather Industries Association (UPLIA);
- Small Tanners Association; and
- Jajmau Tanners Association.

These associations have endeavoured to represent the diverse collection of tanning operations in Jajmau with limited resources and support to assist their efforts. The associations are made up of influential leaders within the tannery industry who are looking for opportunities to partner with government to resolve environmental and regulatory concerns.

The Jajmau Tanneries Environmental Protection Association (JTEPA) was incorporated under the guidance of the three associations. The JTEPA commissioned the completion of Detailed Project Reports (DPR) in 2010 and 2011 for the upgrade of the common effluent treatment facilities for tanneries at Jajmau (see Section 3.4.2).

3.1.3 Kanpur Industry Products

The Kanpur Leather Industry Cluster is famous for the processing of buffalo leather. Approximately 50% of the finished leather that is produced is exported. The remainder is used for the production of leather products in Kanpur or other Indian leather production centres (IL&FS, 2010).

There are approximately 1,100 businesses in Kanpur that are involved in the footwear and component sub-sector (IL&FS, 2010). There are 50 businesses making safety and fashion footwear, primarily for the export market, with a further 50 businesses making shoe components mainly for the export market. Approximately 1,000 small business units produce chappals and sandals. Many of these units have switched to using synthetic materials due to increases in the price of leather (IL&FS, 2010).

Kanpur produces the vast majority of saddlery items in India. According to IL&FS there are 200 units producing saddlery items in Kanpur, 175 of which are household units. All of this production was for export. The major export markets included the USA, Germany, the United Kingdom and France.

The Kanpur leather industry has a competitive advantage in relation to the production of these items due to:

- The availability of tanned buffalo leather;
- Skilled man power; and
- Inexpensive man-power for the labour intensive process.

These advantages or 'strengths' were confirmed by outcomes of the SWOT analysis with large tannery operators in Jajmau (see Table 3.4). Additional strengths in Jajmau include:

- Experience gained through generations of families working in tanneries businesses;
- Community involvement in the tannery sector; and
- The adequate supply of water (at this time).

3.1.4 Competitors

Kanpur and three other major clusters produce 85% of the leather produced in India. These clusters are located in:

- Tamil Nadu
- Kolkata; and
- Jallandhar.

Globally, leather producers from China and Italy along with other countries compete with Indian leather manufacturers. The competitive advantage for Chinese suppliers is related to their ability to produce high quantities of items at relatively low cost. Italian suppliers compete in the high quality market space.

3.1.5 Customers

Approximately half of the finished leather that is produced in Kanpur is exported. Based upon data obtained from the Council for Leather Exports, leather and leather product exports from the Kanpur region totalled approximately $US 205 million for the April to July 2013 financial quarter, representing 19% growth in the industry from the previous year.

The major importers of Indian leather and leather products during the April to July 2013 financial quarter, as provided by the Council for Leather Exports, are listed in Table 3.2. The Kanpur Region accounted for approximately 11% of the total Indian export figures.

Table 3.2 Importers of Indian Leather (Quarter April – July 2013)

Country	Value ($US million)	Proportion of Total
Germany	227.15	12.7%
United Kingdom	207.74	11.2%
USA	195.76	10.6%
Italy	141.22	7.6%
France	109.27	5.9%

Source: Council for Leather Exports 2013

The categories of leather and leather products, as provided by the Council for Leather Exports, as detailed in Table 3.3 were exported from India.

Table 3.3 Categories of exported leather (Quarter April – July 2013)

Category	Value ($US million)	Proportion of Total
Leather Footwear	617.23	33.3%
Leather Goods	421.08	22.7%
Finished Leather	420.71	22.7%
Leather Garments	178.15	9.6%
Footwear Components	109.84	5.9%
Non-Leather Footwear	59.67	3.2%
Saddlery and Harness	45.36	2.4%

Source: Council for Leather Exports 2013

3.1.6 Kanpur Industry Contribution to the Local Economy

It is estimated that at least 250,000 people are directly or indirectly employed through the Kanpur leather industry (Chakrabarti & Varman 2009). Occupations contained within this figure include flayers, tannery workers, and employees of the saddlery and footwear sectors. The figure is based on an informed estimate as there is little documentation regarding employment in the cluster. Employment levels are very dynamic in the sector and fluctuate with the number of orders and seasons (Chakrabarti & Varman).

3.1.7 Kanpur Leather Industry Growth

According to official data, Kanpur leather production grew approximately 10% between 2011 and 2013 (CLE 2013). While finished leather exports from Kanpur have continued to grow, there has been neither a crystallised vision for the cluster nor a precise road map developed by government to support the industry (IL&FS).

It has been argued by leather producers in other areas of India that the growth of the leather industry in Kanpur has been a result of the lack of effective enforcement of environmental regulations in Jajmau, and at the expense of other Indian leather clusters. In Tamil Nadu, the leather industry has faced a steady decline. The enforcement of environmental regulations is stronger in Tamil Nadu where the policy of ZLD is enforced. The cost to treat one cubic metre of waste water is US$0.25 in Jajmau compared to US$4.00 in Tamil Nadu. The cost of wet blue is 10c per square foot in Tamil Nadu compared to 6-7c per square foot in Jajmau (ILIFO).

The Central Pollution Control Board has dictated that Jajmau tanneries are not allowed to expand their operations, nor are new tanneries allowed to commence operations in Jajmau.

During consultations with the Jajmau tannery cluster, representatives indicated that they considered 20% growth in their business per year to be an acceptable level.

Further growth of the industry will require the implementation of an effective waste management and treatment system for the tanneries. This was acknowledged by Jajmau tannery businesses during the conduct of the SWOT analysis (see Table 3.4). According to the results of this analysis, key factors affecting future growth in Jajmau include:

- The immediate need to address imminent threat of temporary or permanent closure;
- The ability of the industry to tackle environmental issues through better government / tannery cooperation and the development of more effective and affordable treatment solutions;
- Inadequate supply and additional cost of electricity; and
- Security of future water supply of adequate quality for high quality leather production.

Table 3.4 Jajmau Tannery SWOT Analysis

Strengths	Weaknesses

• Experience gained from generations working in the industry.
• Availability and skills of labour.
• High skills at management level - Management level has a high level of education, high skills in management and have had exposure to international markets.
• Raw hide availability - There are more hides than can be processed. This is due to the increase in national consumption of water buffalo.
• Established supply chain of hides - Both local (~90%) and imported (~10%).
• High demand for leather - This is due to a decline in tannery production in other countries. Tanneries in other countries have had many complications including issues with supply chain of hides.
• Will of the tanners to address waste. Management issues.
	• Hide preparation from the unorganized hide supply sector (30%) in remote villages.
	• Poor infrastructure (i.e. roads).
	• Power - Jajmau is not declared an Industrial Zone and so power supply is not assured.
	  ○ Cost of alternative diesel supply (Tanner provided an example that it costs 89,000 Rupees for 14 hours for diesel for generators, 3 times as much as grid power).
	  ○ Irregular power supply - damages machines.
	  ○ Often 6 to 8 hours of black out per day.
	• Paying for effluent treatment that is not effective.
	• Tanning process is environmentally damaging.

Opportunities	**Threats**
• Improvements to the power supply. • Proactive and supportive government. • Willingness of stakeholders to cooperate. • Improvements to Occupational Health and Safety (OHS).	• Government / political issues. • Temporary / permanent closure • High cost of treatment. • Discharge of wastewater, i.e. environmentally non-compliant discharge. • Future supply of water / future cost and metering of water use

Source: Vic & IITK 2013

3.1.8 Key Findings

1. The Leather Industry is a significant contributor to employment and the economy of Kanpur, with approximately 250,000 people directly or indirectly employed through the sector.
2. The 400 Jajmau tanneries are comprised of a diverse mixture of operations of different sizes conducting assorted tanning operations, ranging from hide preparation to wet blue stage, and preparation of finished leather and leather products such as saddler items for export.
3. Lenient enforcement of environmental regulations in the past provided a competitive advantage for the Jajmau tanning industry compared to other Indian tannery clusters. As a result, Jajmau has had favourable economic conditions for producing leather when competing with other areas of India.
4. Tanneries in Jajmau recognise that tackling environmental concerns is critical to the future growth of the cluster, however, under present circumstances there is little to no incentive for implementing changes to the tanning processes to improve environmental conditions.

3.2 Value Chain Review

As outlined in Section 3.1, the Jajmau cluster is built on a strong relationship between large and small tanneries, with small tanneries supplying semi-finished products to the larger operators. The initial stages of the tanning process are the most polluting yet the value and margins of the semi-finished products is relatively low compared to finished products such as footwear and saddlery.

One of the challenges for the development of a sustainable solution to the waste issues in Jajmau is to ensure that these interrelationships and value disparities are understood and the cost of environmental pollution is shared equitably by businesses across the cluster.

This review identifies key information gaps and presents an approach for completing a more detailed analysis of production costs and value addition.

3.2.1 The Value Chain

Figure 3.2 provides an overview of the global value chain for leather and foot-ware production. It depicts the general situation of leather production in developing countries (on the left) and consumption in developed countries (on the right). The figure also represents the on-going shift of finished leather production to developing countries and recent growth of domestic consumption in some developing markets. The figure highlights areas within the value chain which are the most polluting (e.g. production of cured and blue hides) and have highest value addition (i.e. finished leather).

The following sections provide a description of factors that impact upon the value chain for the Kanpur Leather Industry including:

- Suppliers;
- Cost of production;
- Value addition;
- Customers; and
- Corporate Social Responsibility.

3.2.2 Suppliers

Hide Suppliers

Figure 3.5 provides a summary of hide collection across India (CLRI 2005). According to this data, 75% of hides are obtained from slaughter houses with the remainder sourced from fallen animals. Approximately 70% of the slaughter houses are over 50 years old, the majority of which have inadequate water supply, poor flooring, inappropriate animal housing and unsuitable lighting. As a result, the quality of the hides is affected.

Table 3.5 Indian Hide Collection Statistics

Source of hides	Slaughter houses: 75% Fallen animals: 25%
Total buffalo hides tanned annually	28 million pieces (est.): 50% from Uttar Pradesh, Andra Pradesh and Kerala
Value of losses due to non-recovery of hides and skins	3.7 billion Rupees annually
Main reason for non-recovery of fallen carcasses	Social stigma attached to the activity

Source: CLRI 2005

Kanpur is home to a large hide market situated on Nayisadok Road. This market has approximately 500 wholesale hide traders. Various levels of hide pre-treatment are done on site including washing, sizing, salting and staking. Approximately 50% of the hides that move through Nayisadok are salted.

Hides are sourced from around India including Jabalpur, Maharashtra, and Madhya Pradesh, with hides originating from the vicinity of Kanpur representing only a small proportion of the total market. Imports from outside India are considered to represent approximately 15% of the hides used by the Jajmau tanners.

The supply of raw hides to the tanneries in Jajmau is variable. The import of blue hides is allowed, however, due to the lack of a bulk buying collective, small tanneries are unable to make use of this potential supply. Suppliers are the dominant force in the raw hide market, as the demand for hides has grown faster than supply. Larger tanners are able to guarantee supply by offering advance payment to suppliers. Due to a lack of capital, smaller tanneries find it difficult to guarantee supply.

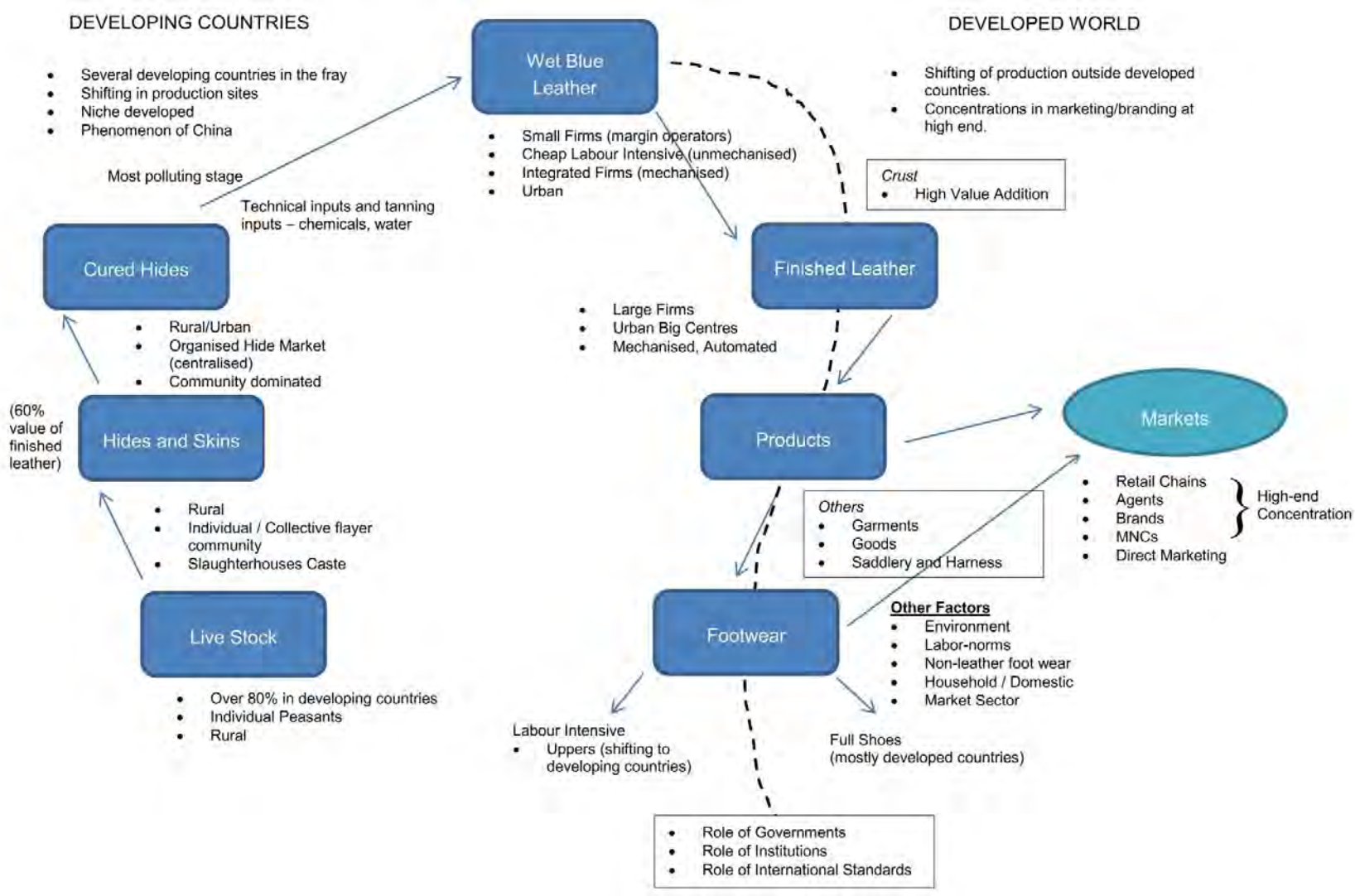


Figure 3.2 The Global Value Chain of Leather and Footwear Production

Adapted from: Chakrabarti, M. & Varman, R. 2009.

Chemical Suppliers

All of the major chemical suppliers have a presence in Kanpur, including Sigma Minerals Limited which supplies lime to the tanneries. Other raw materials used by the tanneries include:

- Chrome oxide;
- Organic tannins;
- Fat liquors;
- Dyestuffs;
- Acids;
- Salts;
- Tensides;
- Enzymes; and
- Finishing products.

3.2.3 Costs of Production

In addition to the cost of raw materials (i.e. hides) and chemicals as outlined above, other costs associated with production include labour, equipment (capital and maintenance) and other overheads (water, electricity, rent).

To date, information on costs of production across the various stages of the leather value chain have not been quantified in Jajmau.

The IL&FS study (undated) provides some indicative information on costs of production (i.e. raw hides, chemicals and labour) of the overall value of finished products. This information is presented in Table 3.6.

This table highlights the high percentage contribution of raw material and chemicals in the production of each product – with minor variations. It also highlights the relatively low cost of labour.

Further information is required for a detailed understanding of the costs of production for the different types of tanneries that are located in Jajmau. This includes disaggregated inputs quantities and input costs for semi-finished (raw hide, wet blue and crust) and finished products (finished leather, footwear, saddlery). Table 3.7 provides an outline of information required. Consequently, the impact of additional costs associated with improved waste management procedures upon the different types of tanneries at Jajmau could be calculated.

Table 3.6 Contributions of Raw Materials and Chemicals in Leather Production

Cluster Product	Average Unit Value (INR)	Value Distribution (Rs)							
		Raw Material		Chemicals		Labour		Overhead and Profits	
		%	INR	%	INR	%	INR	%	INR
Finished Leather	50*	60	30	25	12.5	5	2.5	10	5
Fashion Footwear	600	60	360	20	120	10	60	10	60
Safety Footwear	500	60	300	20	100	10	50	10	50
Saddlery**	-	50	-	30	-	10	-	10	-

IL&FS (undated)

* per square foot

** value of unit not calculated.

Table 3.7 Value Analysis – Information Framework

Processes	Production (Products per day)	Value (Price of Products)	Variable Costs					Fixed Costs	Other Costs
			Raw Material / Products	Chemicals	Direct Labour	Utilities	Other inputs		
Animal slaughter	Large Tanners	Factory door (Jajmau)	Raw hide	Chrome oxide	Skilled	Electricity	Packaging	Capital	Taxes and licencing
Hide preservation	Medium Tanners	Wholesalers (India)	Wet blue hide	Organic tannins	Un-skilled	Water	Storage	Equipment maintenance	Pollution control
Transport of Hides	Small Tanners	Wholesalers (Export)	Crust	Fat liquors		Diesel	Other inputs	Investment costs (depreciation)	R&D
Green Fleshing		Retailers (India)	Finished leather	Dye stuffs				Rental / Mortgage	Royalties and patents
Soaking		Retailers (Export)	Fashion footwear	Acids				Credit financing	Waste Disposal
Liming			Safety footwear	Salts				Management and administration	
De-liming			Saddlery	Tensides				Sales and distribution	
Pickling				Enzymes					
Tanning				Finishing products					
Wet finishing									

3.2.4 Value Addition

Indicative information on value addition from raw hide to finished leather production is presented in Table 3.8 and Table 3.9 – based on estimates from Tanneries operators (VIC 2013) and CLRI officials (Chakrabarti and Varman, 2009).

Table 3.8 Value of Intermediate Tannery Products

Product	Value (INR)	Value Addition	
		INR	%
Raw hide	2,000	-	-
Wet blue	2,500	500	25%
Crust	3,500	1000	50%
Finished leather	4,000	500	25%
Finished leather to customer*	-	-	-
Total		**2,000**	**100%**

Source: VIC (2013)

* Finished leather to customer not collected

Table 3.9 Value Addition through the Chrome Tanning Process

Product	Value (INR)	Value Addition	
		INR	%
Raw hide	2760	-	-
Wet blue	3220	460	25%
Crust	3680	460	25%
Finished leather	3956	276	15%
Finished leather to customer	4600	644	35%
Total		**1,840**	**100%**

Source: Chakrabarti and Varman, (2009)

* Value Rs based on % of final product value. Final product value estimated using information from consultation with tanneries (Vic 2013)

The information presented in both Tables suggests that relatively little value addition occurs in the production of wet blue from raw hide (approximately 500 Rupees per hide). For a small tannery only processing 50 hides per day to the wet blue stage, this equates to 25,000 Rupees ($US400 per day) not including input costs such as chemicals, labour, energy and other expenses. The raw hide to wet blue processing tanning stage also includes the most water consuming and polluting processes, such as soaking, liming and tanning.

The largest share of value addition is realised in the production of finished products (between 15% and 25%) and selling these products to market (35%). According to Table 3.8, businesses producing and selling finished leather products direct to customer may be obtaining up to 50% of total value addition.

Value addition for the production of crust leather differs substantially between the two sources and requires further investigation.

Further information is required for a detailed understanding of value addition for semi-finished and finished leather products in Jajmau - based on a more comprehensive survey of production (economies of scale) and product 'at tannery' and market prices. Finished products such as shoes and saddlery should be included in this future study. Value obtained by wholesalers and retailers should also be examined – see Table 3.7.

3.2.5 Profit Margins

Information on real costs of production across the various stages of leather production, coupled with a more detailed analysis of value addition is required to determine profit margins for tannery businesses producing various products in Jajmau.

This information will be important for understanding the ability of different operations (large and small) to absorb costs of pollution control and the development of models for equitable distribution of these costs.

3.2.6 Other Value Addition Opportunities

Eco-labelling

Eco-labelling schemes have the potential to add further value to the leather products being produced in Kanpur. An appropriately accredited and respected scheme could enable eco-labelled products to position themselves in a higher cost segment of the market. Eco-labelling opportunities are currently under discussion between the seven Indian Institutes of Technology (IIT's) for use within the tanning industry as well as for textiles, paper products and the like.

An official Indian eco-labelling scheme called Ecomark was introduced in 1991 and is run by the Ministry of Environment and Forests with the technical advice of the Central Pollution Control Board. In general, the scheme has not been successful, as there are relatively few companies that have been accredited. No leather manufacturers have been accredited.

The Institute for Quality Certification for the Tanning Industry (ICEC) is a global certification body for the leather sector, and was established in 1994. It offers a number of certification services including those related to management systems, as well as those related to particular products as per their method of production.

Accreditation

Leather exporters are often required to meet stringent environmental requirements of export markets. For example in a study conducted by UNIDO (2010) of footwear exporters from developing countries, 90% stated that they were required to comply with buyer codes of conduct while 44% stated that the SA8000 Social Accountability accreditation was requested of them.

The adoption of SA and/or ISO quality and environmental management systems (e.g. ISO 140001) will be an effective tool for individual tanneries and the Jajmau sub-cluster as a whole, to manage these 'access to market' risks.

3.2.7 Corporate Social Responsibility

Many multinational companies now have strong corporate social responsibility (CSR) policies driving their activities and in particular product purchasing. This offers an excellent opportunity to drive improvement through the supply chain, as these end-buyers will often have the greatest potential for additional contribution to environmental improvement.

An exploration of larger purchasers of finished products should be undertaken, including determining their CSR position and potential to influence for improved outcomes.

3.2.8 Key Findings

1. Small tannery operators are likely to be the most impacted by the imposition of additional cost related to waste management due to costs of production, production output (economies of scale) and value addition potential for semi-finished products. As a result the smaller tanneries will require a great deal of support (both financial and technical) from outside sources to implement proposed changes to the tannery industry.
2. Current information on costs of production and value addition throughout the leather production process in Jajmau is currently limited to aggregated, anecdotal estimates from key stakeholders (e.g. tannery operators and CLRI).
3. Other value addition opportunities include eco-labelling, accreditation and CSR of large wholesale and retail buyers of Jajmau leather products. These are currently being explored by a number of entities in India, however, they have not been successfully encouraged or implemented to date.

3.3 Health and Safety

3.3.1 Workplace

Working conditions and workplace safety are under increasing scrutiny, with products found to be made under unacceptable work conditions coming under strong global consumer pressure for improvement.

For the benefit of both workers in the tanning industry, and the reputation of the local leather industry, it is important that Kanpur's tanneries understand the health and safety risks of the industry, and how to deal with them in an appropriate way.

Improving workplace health and safety would ideally lead to an improvement in worker health and productivity. The UNIDO Report (2000) 'Occupational Health and Safety in the Tanning Industry in South East Asia' identified the following workplace risks in the tanning industry:

Chemicals

A number of particularly hazardous chemicals are utilised in the tanning process. It is anticipated that knowledge about appropriate storage and handling of chemicals is very low within the Kanpur Leather Industry.

It is likely that workplace risks associated with chemicals would be reduced as a result of the implementation of cleaner production techniques in leather processing.

Machinery

Machines that are manufactured on a small scale typically lack basic safety installations. While the machines may be cheap, they are likely based on out-dated designs that do not consider high standards of safety, and noise reduction. Noise from machines was noted in the study by UNIDO, stating that a significant proportion of tannery workers had a partial hearing impairment.

Other risks include poor electrical installation and maintenance, which could lead to electrocution.

Vapour, mist and dust

Inadequate extraction systems for vapours, mist and dust pose serious risks to the health and safety of workers.

It is recognised that a number of limitations are attributed to the current lack of health and safety measures in the workplace, including:

- Limited awareness of risks;
- Time required to conduct training;
- Economic barriers;
- Demand for low prices;
- Infrastructure limitations such as inconsistent electricity/water supply; and
- Space and layout limitations.

An emphasis on local achievements, incentives and rewards for improvement as well as linkages between health and safety and improved profit and productivity is recommended to encourage the adoption of improved workplace health and safety.

It is foreseeable that health and safety requirements within the tanning industry will become stricter to adapt to rising global standards.

3.3.2 Broader Community

This Project represents the opportunity to improve the health and safety of the broader community through the improvement of the environmental health of the Ganga River.

Many people within the local Kanpur community and downstream currently utilise the Ganga for bathing, washing and religious purposes, potentially exposing them to the pollutants present within the Ganga.

By improving the quality of the Ganga, health risks potentially associated with pollution have the potential to be reduced in both severity and frequency.

It is also possible that improvements to the Ganga will lead to positive recognition of the efforts of tanneries to reduce their environmental and health impacts upon the Ganga.

3.3.3 Key Findings

1. Significant opportunities are present for the improvement of both workplace and community health and safety. These improvements will incur upfront costs to tannery operators for training and optimisation of equipment, especially for small scale industries.

3.4 The Regulatory Setting

This section provides a brief outline of the environmental regulatory framework governing the Jajmau Tannery sub-cluster.

3.4.1 Legislative Framework

Key Legislation and Guidelines

Legislation and guidelines relevant to the Jajmau Tanneries sector include:

- Water (Prevention & Control Pollution) Act 1974;
- Environmental (Protection) Act 1986;
- Environmental (Protection) Rules 1986; and
- Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008.

Regulatory Limits

Regulatory limits for the discharge of treated tannery effluent into inland surface waters are presented in Table 3.10.

Table 3.10 Discharge Limits for the Disposal of Treated Wastewater

Parameter	Unit	Discharge Limit
pH	pH units	6.0 – 9.0
Chemical Oxygen Demand	mg/L	250
Biological Oxygen Demand (3 Days at 27°C)	mg/L	30
Suspended Solids	mg/L	100
Hexavalent Chromium	mg/L	0.1
Total Chromium	mg/L	2.0
Ammonia (as Nitrogen)	mg/L	50
Total Kjeldahl nitrogen	mg/L	100
Sulphide	mg/L	2
Sulphates	mg/L	1,000
Total Dissolved Solids	mg/L	2,100

3.4.2 Regulation of the Jajmau Tanneries

Pollution Control Boards

The Central Pollution Control Board (CPCB) is the statutory organisation constituted under the Water (Prevention & Control Pollution) Act 1974, providing technical services to the Ministry of Environment and Forests. The primary functions of the CPCB are to:

- Promote cleanliness of streams, by prevention, control and abatement of water pollution, and
- Improve the quality of air.

To operate, a tannery must obtain "Consent" under the Water (Prevention & Control Pollution) Act 1974, and "Authorization" under Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008.

The Uttar Pradesh Pollution Control Board (UPPCB) is the statutory authority responsible for the implementation of environmental laws and rules within Uttar Pradesh.

The CPCB, with a regional office located in Uttar Pradesh, also has an inspection role and can give directions to close facilities if they are not satisfied that the issue is being dealt with at the state level.

Specific to the Jajmau Tannery sub-cluster, the PCBs (Central and State) have the right to inspect individual tanneries and are responsible for monitoring the operation of the CETP and discharges into the environment.

PCB enforcement functions are more limited for publicly managed facilities like the Jajmau CETP. As a result, much of the PCB focus is directed to industry.

The CPCB and UPPCB set the standards for primary treatment. The UPPCB aim to inspect tanneries and conduct laboratory analysis every three months, however due to limited resources it is unlikely that the UPPCB are able to maintain this frequency. The UPPCB requires measurement of water use from boreholes and effluent discharge. A relatively small fee (e.g. 3-5 rupees per KL) is charged for water use.

According to the UPPCB the following enforcement actions have been carried out in Jajmau:

- Directions have been issued for better treatment/recovery of chromium.
- Directions have been issued to separate soaking waste and re-use in processes; and

- 45 tannery operations have been closed. When closure orders are issued the PCB arranges for power supply and water to be turned off (although water is hard to stop and diesel is often used by businesses as alternative power). Regulatory actions are implemented under Section 33 of the Water Act, and 49 cases for the prosecution of illegal operations are currently being pursued in court.

Indian Judiciary & Public Interest Litigation

A public interest litigation is a provision of the Indian Constitution and is increasingly being used by the Indian Judiciary to address perceived inaction by the Government on long standing environmental issues.

In 2006, Public Interest Litigation 4003 versus the State of UP and Others regarding Ganga Pollution was filed in the Allahabad High Court. Over this period the High Court has used the PIL process to convene key stakeholders and direct action in Jajmau.

The Court has ordered that a Zero Liquid Discharge (ZLD) solution be designed to address pollution issues and that relocation options be considered.

The High Court has directed that tanneries in Kanpur which continue to discharge untreated water with high levels of chromium be closed (see Annex A).

State Government agencies such as the UP Urban Development Urban Employment & Poverty Alleviation Department and UPPCB are responsible for implementing the Court's orders and directives.

3.4.3 Stakeholder Perceptions

There are a number of issues concerning the regulation of the Jajmau tanneries industry that were raised during consultation with key stakeholders:

- Focus on enforcement – The current approach focuses primarily on enforcement and less on incentive based measures to encourage change.
- Corruption - There have been allegations of corruption against government officials charged with enforcing pollution control regulations. Some tannery operators reported that they must make payments to government representatives regardless of whether or not they are performing their waste management responsibilities (Vic & IITK 2013).
- PCB enforcement functions are more limited for publicly managed facilities like the Jajmau CETP. As a result, much of the PCB focus is directed to industry.
- Weak monitoring – There are currently weak monitoring systems in place across the Jajmau sub-cluster. As a result, knowledge of effluent flows and pollutant loads entering or exiting the system is limited.
- Disconnect between tanneries and CETP – There is a lack of coordination between the Jal Nagam management of the CETP and tanneries. The Jal Nagam does not directly regulate or work with businesses using the CETP system to meet standards required for effective treatment.
- Zero Liquid Discharge (ZLD) – There is confusion and uncertainty about future regulations on industry. For example ZLD is considered an aspirational target by many stakeholders rather than a strict discharge limit. Long term ZLD ambitions to limit salt input to the Ganga may be at the expense of the promotion of adherence to national standards for other pollutants, including chromium and short-term recycle and reuse opportunities.

3.5 Waste Management Review

3.5.1 The Current Situation

The current Jajmau tannery industry waste management situation, is illustrated in Figure 3.3.

There are various issues associated with the current system that have resulted in the Ganga River being polluted by tannery effluent.

1. **Inadequate Pre-Treatment Being Conducted by Tanneries**

All tanneries are required to use pre-treatment facilities. However, large tanneries are also required to operate chromium recovery facilities, while small tanneries must segregate chrome-impacted waste streams to enable the chrome-impacted wastewater to be collected and trucked to the Common Chrome Recovery Plant (CCRP) for treatment. Pre-treatment and chromium recovery systems are not being utilised by the tanneries for economic reasons. The CCRP is not being utilised by the majority of the smaller tanneries due to fear that this may lead to accusations that they are processing more hides than they have approval for.

2. **Salt Content Present with Preserved Raw Hides**

Hides are transported to the Jajmau tanneries from throughout India. ILIFO has estimated that it can take up to seven months for a raw hide to travel from a slaughter house to a tannery. During this time salt is likely to be applied to the hide on three to four occasions. As the hides are sold to the tanners on a weight basis, it is also in the financial interest of the hide supplier to apply as much salt as possible in order to increase the weight of the hide.

There are methods to remove a significant proportion of the salt prior to the soaking of hides. However, there are no financial incentives for tanneries to do this. Consequently effluent from tanneries contains a high concentration of salt.

3. **Conveyance Network**

Open channels are used to transport tannery effluent to the CETP. The open channels allow access for illegal discharges and surface water drainage (i.e. during the monsoon season) to be added to the tannery effluent.

There are four (4) pumping stations in the network. These pumping stations are often offline. Key issues include gross pollution which clogs the system, problems with electricity supply, and the subsequent cost of operating the stations with generators.

The conveyance network was installed in 1995, when 175 tanneries operated in Jajmau, for a capacity of 9 MLD. It is now estimated that between 28 MLD (IL&FS) and 50 MLD (CLRI) is discharged by the 410 Jajmau tanneries. Due to the inadequate capacity, polluted water enters the Ganga River without treatment as well as impacting upon the surrounding community and land.

4. **Tannery Effluent Entering the Domestic Sewage Network**

It has been estimated by the Jal Nigam that 15 MLD per day of tannery effluent enters the domestic sewage network illegally. This has been calculated through the analysis of the domestic sewage stream before and after it passes Jajmau. The contaminants in the tannery effluent impact upon the operation of the sewage treatment plant (STP) and the beneficial uses for which the treated domestic sewage can be used for.

5. **Capacity and Operation of the CETP**

Like the conveyance network, the CETP was constructed in 1995 to handle a capacity of 9 MLD. The CETP was designed such that 9 MLD of tannery effluent would be mixed with 27 MLD of domestic sewage. The Upflow Anaerobic Sludge Blanket (UASB) technology that was implemented was designed to generate power as well as treat waste. However, due to the composition of the tannery effluent being received, which is high in sulphides, the anaerobic treatment process is being inhibited, and methane is not being produced for energy generation. Additionally, in order to treat as much tannery effluent as possible, 12 MLD of tannery effluent is processed by the CETP, rather than 9 MLD. Consequently, the CETP is not being operated in accordance with its design specifications and the performance of the plant has suffered.

5. **Health and Safety Issues**

Following treatment, water discharged from the CETP and the STP is combined and used to irrigate the nearby sewage farm. Prior to the installation of the CETP as part of the Ganga Action Plan, villages surrounding Jajmau were supplied with a mixture of untreated sewage and river water and were able to maintain vibrant dairy and floriculture industries. It is

alleged that the use of the treated sewage and tannery effluent for irrigation has destroyed agriculture, drastically reduced flower cultivation, polluted groundwater and increased the rate of disease in humans and cattle (Singh, 2006).

Impacts from the tannery industry upon the River Ganga result in bathers coming into direct contact with polluted water. Long term impacts upon the health of residents will also occur though land and groundwater contamination associated with poor waste management practices at the tanneries.

Sulphides are present in tannery effluent as a result of the use of sodium sulphide and sodium hydrosulphide and the breakdown of hair in the liming process (UNIDO, 2011). When the pH of tannery effluent falls below 9.5, hydrogen sulphide is produced, causing an odour characterised by a rotten egg smell. At low levels of exposure hydrogen sulphide can cause headaches and nausea and possible eye damage. At high concentrations death can occur rapidly. Numerous deaths in sewers around the world have been caused by the build-up of hydrogen sulphide in the sewer system.

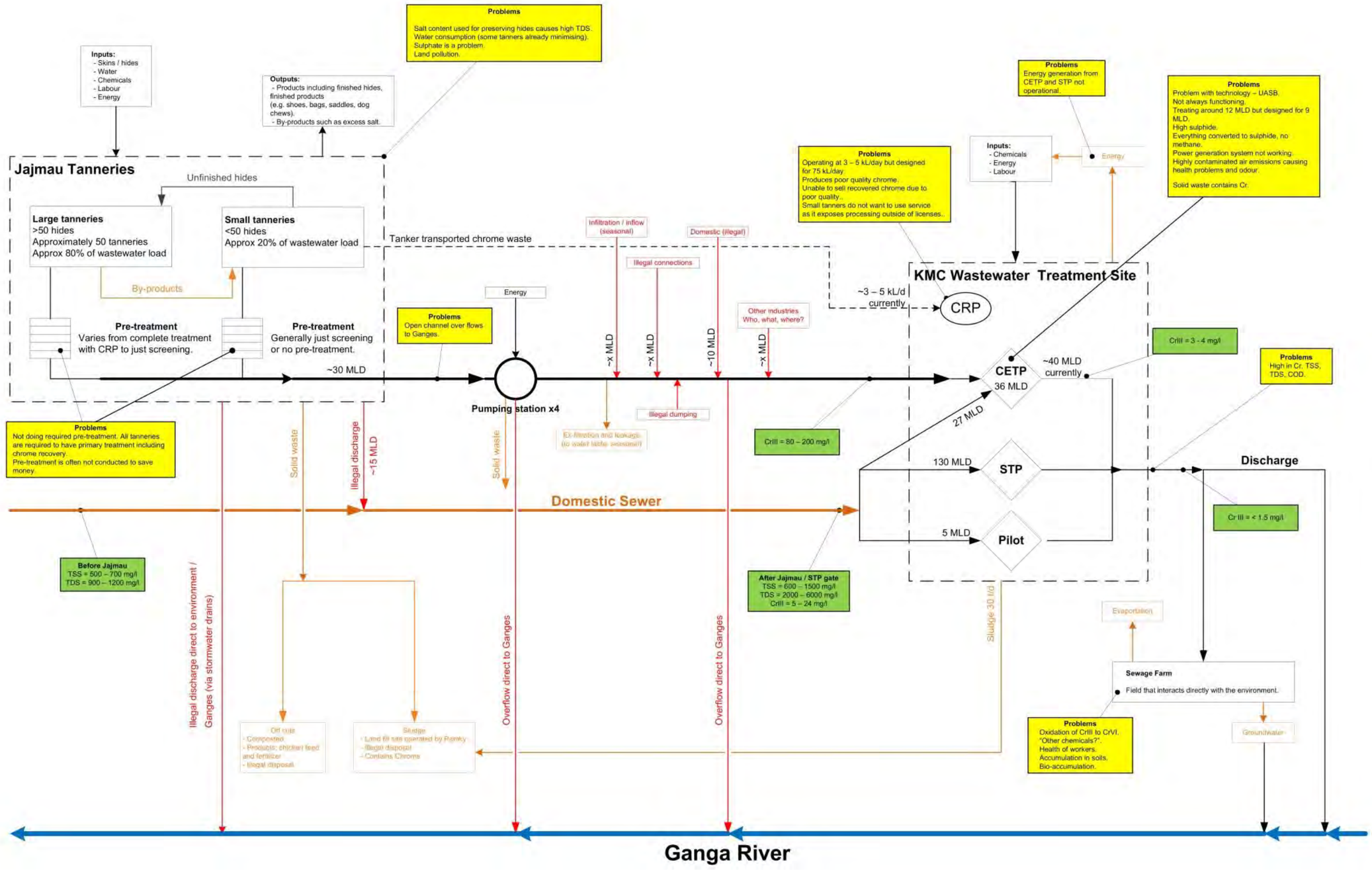


Figure 3.3 The current Jajmau tannery industry waste management situation

3.5.2 Solutions that have been Previously Proposed

1. **Deloitte – Relocation of Tanneries in Kanpur, Interim Report (2010)**

The December 2010 Deloitte Interim Report submitted to the Uttar Pradesh Jal Nigam presented the advantages and disadvantages of a range of options including the:

- Upgrade of the CETP at the existing location (as per the IL&FS DPR);
- Upgrade of the CETP at the existing location with reverse osmosis, in order to achieve zero liquid discharge (ZLD);
- Relocation of the tanneries to a nearby location (such as Unnao) without ZLD;
- Relocation of the tanneries to a nearby location (such as Unnao) with ZLD; and
- Relocation of the tanneries to a distant location without ZLD, such that the discharge could not reach the Ganga.

Table 3.11 summaries the advantages and disadvantages for each option as presented by Deloitte.

2. **IL&FS Cluster Development initiative & IL&FS Water Ltd – Proposed Upgrade of Common Effluent Treatment Plant Facilities for Tannery Cluster at Jajmau, Kanpur (2011)**

The October 2011 DPR prepared by IL&FS for the Jajmau Tanneries Environmental Protection Association was an update of the March 2010 DPR following review by the Indian Institute of Technology (IIT), Delhi.

The main findings of the report included that:

- The CETP should be upgraded to a capacity of 32MLD at the site of the existing CETP and STP in Jajmau.
- The capacity requirement of the CETP was based on the discharge of 28MLD of tannery effluent along with 4MLD of raw sewage from tannery toilets and surrounding habitations that cannot be separated from the tannery effluent.
- The design flow to the CETP was based upon a series of discussions with stakeholders and the Government of Uttar Pradesh during 2009-2010. As neither expansion of tanneries nor establishment of new tanneries is permitted in the area, the estimated flow was used as the final design flow to the CETP.
- Use of aerobic technology for the treatment of wastewater. (Aerobic treatment was included in the 2011 design following comments provided by IIT Delhi)
- The capacity of the combined chrome recovery system was proposed to be upgraded from 74 m^3/day to 274 m^3/day with the addition of two modules of treatment capacity 100 m^3/day.
- A new secure landfill project with a total storage capacity of 400,000 tons was proposed for the same premises as the CETP.
- The Jajmau Tanneries Environmental Protection Association would be responsible for the implementation and operation and maintenance of the CETP, CCRP and secure landfill.
- The Project cost was proposed to be financed under the following model:
    - 70% grant from the Government of India under the National River Ganga Basin Authority (NRGBA);
    - 20% grant from Government of Uttar Pradesh; and
    - 10% contribution by tanners in the form of equity/unsecured loans.
- The anticipated project implementation time was 24 months and the commissioning period was 6 months.
- The estimated capital cost of the CETP upgrade including CETP, CCRP and secure landfill was 2116.4 million Rupees ($US34.1 million).
- Operating costs were estimated at:
    - 24.55 Rupees/m^3 for the CETP;
    - 1.50 Rupees/m^3 for the pipeline infrastructure; and
    - 7.60 Rupees/m^3 for use of the secure landfill.

It is noted that this option did not include the treatment of effluent such that TDS levels would be reduced to concentrations below the regulatory limit. To achieve this outcome the treated tannery effluent would need to be mixed with treated effluent from the STP prior to disposal or reuse.

Table 3.11 Advantages and Disadvantages of Options Presented by Deloitte (2010)

Option	Advantages	Disadvantages
Upgrade of the CETP at the existing location.	Least disruption, and least operating and capital costs.	Concerns that inadequate operation and maintenance may lead to pollution
Upgrade of the CETP at the existing location with reverse osmosis, in order to achieve zero liquid discharge (ZLD).	Zero discharge, regulated water supply, effective operation and maintenance, and long term sustainability.	High capital and operating costs
Relocation of the tanneries to a nearby location (such as Unnao) without ZLD.	Regulated water supply, reduced operating and capital costs (compared to ZLD).	High relocation costs, long term process, disruption of supply chain, supporting infrastructure and labour related issues
Relocation of the tanneries to a nearby location (such as Unnao) with ZLD.	Zero discharge, regulated water supply, effective operation and maintenance, and long term sustainability.	High relocation costs, high capital and operating costs of ZLD, long term process, disruption of supply chain, supporting infrastructure, and labour related issues.
Relocation of the tanneries to a distant location without ZLD, such that the discharge could not reach the Ganga.	Regulated water supply/discharge Organised cluster operations Reduced operating and capital costs (compared to ZLD).	High relocation costs, long term process, disruption of supply chain, supporting infrastructure, and labour related issues.

3. CLRI – Study Report on Relocation of Tanneries in Jajmau, Kanpur (2012)

The Central Leather Research Institute (CLRI), Chennai, completed a report examining the relocation of the tanneries away from Jajmau. The 2012 CLRI report recommended that the tannery industry should not be moved from Jajmau. The report made the following arguments in support of its conclusion:

- Once the collection system and pumping stations are upgraded, overflow to the Ganga will be stopped;
- The Government of Uttar Pradesh has enough land area available for the construction of a CETP and Secure Landfill Facility (SLF) in the Jajmau area;
- Enough treated sewage is available in the Jajmau area to dilute the treated tannery wastewater; and
- The relocation of tanneries is time consuming and requires huge investment.

3.5.3 Treatment Options Advanced by IITK

A potential wastewater treatment option that has been proposed by IITK is presented as Figure **3.4**.

Key components of the proposed wastewater treatment system include:

- Segregation and storage of chrome-impacted wastewater streams at all of the tanneries to enable this waste stream to be collected and trucked to the CCRP.
- Tanneries would only be required to complete limited pre-treatment of effluent prior to disposal, such as the removal of coarse solids from wastewater.
- The combination of a reverse osmosis plant with the CETP to treat the wastewater to a level that would enable the treated effluent to be recycled back to the tanneries for use.
- Storage of the highly saline reverse osmosis reject at a contained storage facility for the nine dry months of the year. The treated salty water would be released to the Ganga during the three wettest months of the year, when the discharge of the water would have no significant impact upon the TDS concentration in the Ganga.
- IITK has also recognised that potential benefits could be associated with the segregation of saline water streams. Such benefits may relate to the reduction of capacity required for reverse osmosis treatment and associated savings with regards to capital and operating costs.

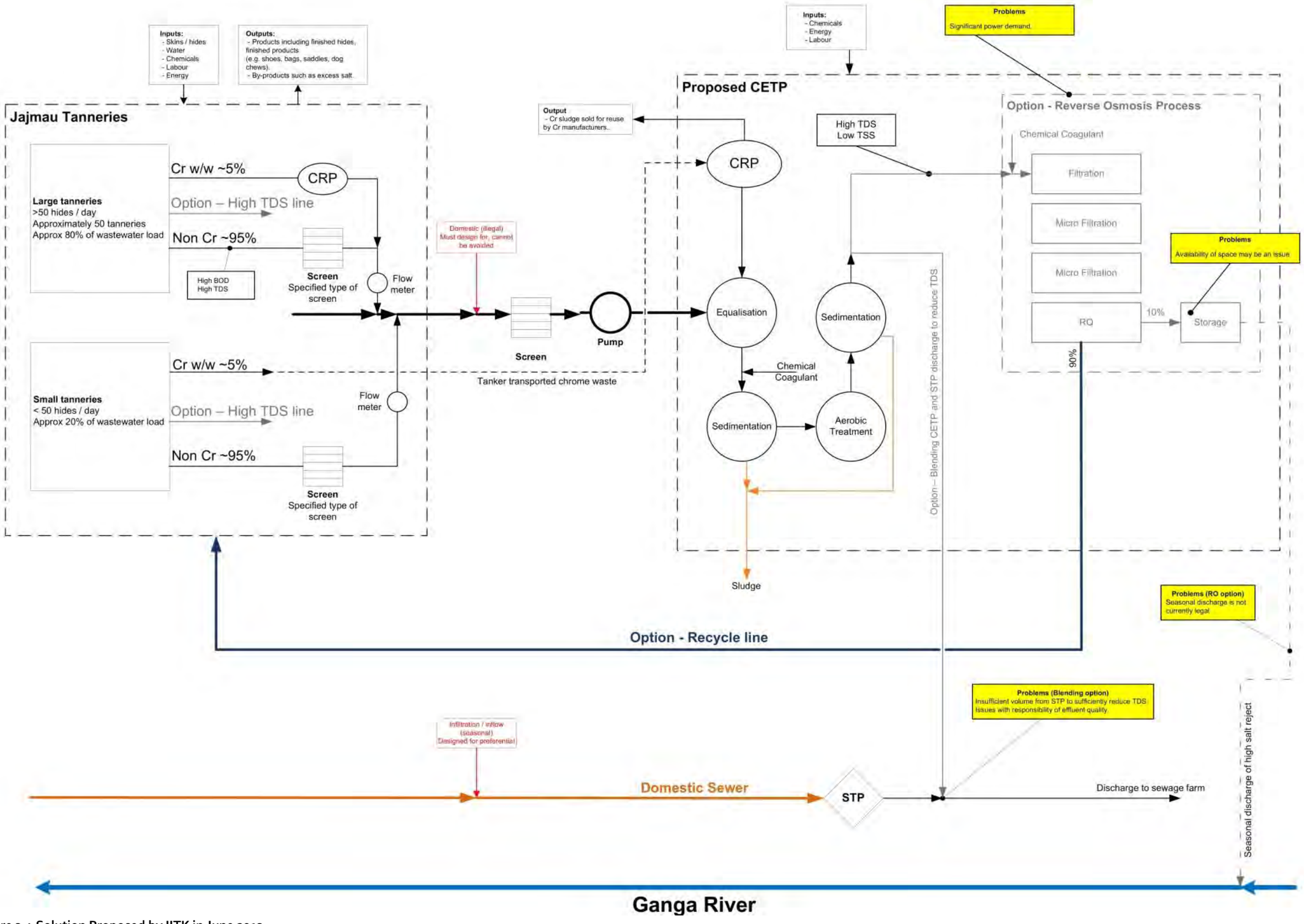


Figure 3.4 Solution Proposed by IITK in June 2013

Potential options for the segregation of process streams with high TDS concentrations include:

- **The implementation of a common wash facility**. The facility would function as a common resource for all of the tanneries in Jajmau. The soaking of raw hides is a relatively uncomplicated process. Tanneries could outsource this process to the common facility. The salty wastewater from this process would then be directed from this facility straight to the reverse osmosis plant. Cleaner production initiatives could also be used at the facility to remove salt from the hides prior to soaking. It is noted that a common washing facility may cause significant impacts to smaller tanneries where beam house operations may be a core component of their business.
- **Separate sewer line from the tanneries for segregated effluent with high TDS concentrations.** This option would require the installation of a dedicated sewer for salty water from the tanneries. Tanneries would need to modify their processes such that three types of process water are segregated and directed to the correct sewer or storage area. The three types include:
    - Effluent with elevated TDS concentrations;
    - Chrome impacted wastewater; and
    - Other wastewater steams.

  The salty water stream would be directed to the reverse osmosis unit (which would also include facilities for physical, chemical and biological treatment as required).

4. **Combination of Tannery Effluent with Domestic Sewage for Treatment**

This option was recommended in the CLRI (2012) report. Currently, treated domestic sewage from the STP is mixed with treated effluent from the CETP and disposed to the sewage farm near Jajmau. However, due to inadequate treatment of the effluent, as a result of the quality of the effluent being received by the CETP and STP, the productivity of the farm and the health of residents is being impacted by this water.

The combination of tannery effluent with domestic sewage for treatment would provide the most cost-effective means for the treatment of tannery effluent such that it can either:

- Meet regulatory limits for discharge to the Ganga;
- Be recycled back for the tanneries; or
- Be used for another beneficial use.

An effective governance system will be required to ensure that appropriate pre-treatment and/or segregation of process streams occurs at the tanneries to ensure that chromium-impacted wastewater does not enter the sewage network.

This option may also require the construction of reverse osmosis or other treatment facilities to supply water of an appropriate quality. However, the capital and operating costs associated with the infrastructure will be vastly reduced compared with the options where tannery effluent is segregated and treated in isolation from the domestic sewage stream.

3.5.4 Key Findings

1. The relocation of the tannery industry away form Jajmau is not the preferred option to solve current issues associated with tannery waste polluting the Ganga, especially due to the high economic value of the tanning industry to the region.
2. A number of reports have been produced with solutions primarily focussed on the upgrade of wastewater treatment infrastructure. Reverse osmosis systems have also been proposed to enable treated water to be recycled back to the tanneries for use.
3. The most cost effective solution will be one that works in conjunction with the existing sewage treatment plant. It is acknowledged that stakeholder relationships will need to be developed and improved in order for this potential option to be a reality.

3.6 Cleaner Production and Water Efficiency

3.6.1 Current Situation

Whilst cleaner production and water efficiency processes have previously been considered for implementation in Kanpur, they have not been successful largely due to a lack of incentives for investment.

At present, significant consequences do not necessarily result for companies in the tanning industry that pollute. Some regulations are in place, however they are not governed effectively to provide incentives to invest in cleaner technologies and reduce pollution.

Significant reductions in the capital and operating cost of the proposed solutions can be made through the implementation of cleaner production initiatives. It has been estimated that the implementation of cleaner production initiatives could result in up to a 40% reduction in the volume of water discharged by tanneries and the load of salt and other pollutants in the effluent (ILIFO). These reductions have been observed in Tamil Nadu, where cleaner production initiatives have been implemented by tanneries.

The Indian Leather Industry Foundation (ILIFO) has trialled approximately sixty cleaner production initiatives in Tamil Nadu. They have successfully implemented sixteen initiatives. One of their most successful interventions was the introduction of the "Dodeca Frame". This relatively simple piece of equipment resulted in a reduction of 15% of the TDS load being discharged by the tanneries.

Table 3.12, sourced from the Andhra Pradesh Pollution Control Board (APPCB, 2005) describes cleaner production processes that can be implemented during various stages of the tanning process.

Table 3.12 Cleaner Production Options for Tannery Processes

Process Stage	Issues	Contaminants	Cleaner Production Options
Soaking	Salts in skins are released	Cl &TDS	Desalting prior to soaking.
	Protein from skins are released	N, BOD & COD	Segregation and solar evaporation of wastewater
Liming	Use of lime and sodium sulfide	Ca, S^{2-}, TDS & COD	Recycling spent floats, optimisation of sulfide use, enzyme aided systems and lime splitting
	Protein matter from skins	N, BOD & COD	Hair saving processes
Deliming	Ammonium and calcium salts	Ca, N, TDS & COD	Ammonia free deliming, carbon dioxide deliming, reuse of deliming wastewater for liming or soaking
	Protein matter from skins	N, BOD & COD	
Pickling	Use of Salt	TDS	Pickle free process, reuse of pickling wastewater for a minimum of ten recycles
	Protein matter from skins	N, BOD & COD	
Tanning	Chrome tanning	Cr, SO_4^{2-}, $NaHCO_3$ & TDS	Optimise Chrome addition for least product use, high exhaustion tanning process, chrome recovery and reuse.
Wetfinishing	Use of phenolics, acrylics, oil, dyes,	SO_4^{2-}, TDS, COD, BOD & VOC	Optimise chemical use, Chrome fixing in neutralisation, chrome precipitation, buffing dust and leather fibre separation, replacing nitrogenous compounds, screening of chemical products for degradability and treatability.

Following the implementation of cleaner production processes, the APPCB estimated that the wastewater reduction displayed in Table 3.13 could be achieved for the processing of one tonne of raw hide.

Table 3.13 : Reduction in Wastewater Discharge that could be achieved from Cleaner Production

Operation	Discharge	
	Standard	Use of Cleaner Production
Soaking	7-9	2.0
Liming	9-15	4.5
Deliming	7-11	2.0
Tanning	3-5	0.5
Post-tanning	7-13	3.0
Finishing	1-3	0
Total	34-56	12

Table 3.14 summarises the reduction in pollution loads that the APPCB stated could be achieved through the implementation of cleaner production initiatives.

Table 3.14 Reduction in Pollution Loads that could be achieved from Cleaner Production.

Contaminant	Load Reduction
Suspended solids	58%
COD	38%
BOD	37%
Chromium	94%
Sulphides	90%
Ammonia	87%
TKN	57%
Chlorides	75%
Sulphates	70%

Discussions with tannery operators and ILIFO indicated that cleaner production initiatives that should produce significant benefits with regards to reductions of water and salt discharged include:

- Optimisation of water use in each process cycle;
- Optimisation of product / chemical application in each process stage;
- Methods to remove salt from raw hides prior to soaking;
- Recycling of liquor from the deliming process to the liming process;
- Recycling of pickling liquor; and
- Counter current soaking.

Some methods for cleaner production of leather include:

1. *Preservation of Fresh or Cooled Hides*

This has proven effective to reduce salt pollution at later stages of hide processing. Methods to reduce salt include chilling the hides, which has the potential to reduce the TDS load by 3,300 ppm.

Barriers to implementation of hide preservation are discussed in the ACIAR investigation report, and include obstacles such as:

- Absence of regulation of hide suppliers; and
- Lack of a reliable power source to allow constant refrigeration and refrigerated transport to tanneries.

2. *Direct Chrome Liquor Recycling*

If utilised correctly, direct chrome liquor recycling (DCLR) will allow indefinite re-use of the chrome liquor used by tanneries.

By doing so, the TDS load can be reduced by 20% (equivalent to 2,200ppm).

3. *Pickle Liquor Recycling for Vegetable Tanning*

Commercial trials suggested that recycling pickle liquors for more than around 12 cycles may compromise the quality of leather. Therefore, the pickle liquors cannot be recycled continuously, as is the case with DCLR. It is estimated that recycling pickle liquors for up to 12 cycles can reduce the TDS load in effluent by 22–27% (Mr P. Saravanan - pers. comm., 16 March 2009).

SALINITY REDUCTION IN TANNERY EFFLUENTS IN INDIA AND AUSTRALIA – ACIAR

In 2009, the Australian Centre for International Agricultural Research (ACIAR) in co-operation with the CSIRO, conducted a study to evaluate the success of different strategies to reduce salinity in the tannery industry, focusing on tanneries in Tamil Nadu.

The authors of the study established that the technologies developed under the ACIAR-funded project had potential to substantially reduce leather production costs, mainly by lowering the cost of effluent treatment and waste-salt disposal. They highlighted the value of developing technologies that reduce the level of pollutants rather than dealing with the pollution further down the line.

However, the study further highlighted some key obstacles in the adoption of the technologies and cleaner production strategies, citing a number of reasons including:

- Difficulties in training hide providers associated with the dispersed nature of hide providers;
- Lack of incentive for hide providers to utilise new techniques as they do not directly benefit;
- Perceived risks in changing a technique that is accepted universally; and
- Reluctance to change techniques without government assistance, or unless obliged to do so by regulation.

Review of Treatment and Management Processes

Table 3.15 provides a summary of the results of the review of the treatment and cleaner production processes that was completed by the project team for the management of contaminants associated with the tannery industry.

Table 3.15 Review of Tannery Pollution Treatment and Management Processes

Waste-Product	Standard Management Practices	Comments Regarding Process in Use at Jajmau	Obstacles / Opportunities
Chromium	Slow precipitation of wastewater with magnesium oxide, settling of the suspension, decantation of the supernatant (no need for a filter press) and subsequent acidification of the relatively dense precipitate.	Larger tanneries are required to have chrome recovery units. However these units are not being used by a significant proportion of the industry. Smaller tanneries are required to separate their chromium impacted wastewater which is collected by tanker for treatment at the CCRP. The CCRP is not being utilised by the majority of the smaller tanneries.	The recovery of chromium for reuse or sale should result in significant funds being generated for the operation of chromium recovery units. Due to poor operation and maintenance of these units at some tanneries, the process is viewed as a significant financial burden and chromium impacted wastewater is discharged direct to the sewer. The CCRP is not being utilised by the smaller tanners in part due to a fear that this may lead to accusations that they are processing more hides than they have approval for.
	Direct Chrome Liquor Recycling (DCLR): In contrast to the precipitation process using magnesium	It is understood that cleaner production methods involving DCLR are not being used by the	Implementation of the DCLR process at tanneries would require some modification to process units. Some financial savings

Waste-Product	Standard Management Practices	Comments Regarding Process in Use at Jajmau	Obstacles / Opportunities
	oxide, DCLR recycles the entire chrome liquor, also resulting in the reduction of the TDS concentration of the effluent (ACIAR, 2009). ACIAR developed a method that resulted in the production of good quality leather.	Jajmau tanneries.	would result from reducing expenditure on chrome powder.
	Nanofiltration (NF) and reverse osmosis (RO) in combination can provide better recovery of unreacted chromium from high concentrated spent tanning effluent.	Relatively advanced and expensive technology that is not being used by the Jajmau tanneries.	High capital costs are an obstacle to the use of this technology.
Dissolved Solids	Low-salt preservation (without drying) for up to 21 days. ACIAR found that preservation for 21 days could be achieved using 20% salt with an appropriate additive, such as soda ash.	Raw hides received by the tanneries in Jajmau are heavily salted.	Low salt preservation needs to be implemented at the hide suppliers' level for it to be effective. Hides are obtained from a multitude of suppliers from diverse areas. It can take up to seven months for a hide to reach the tanneries from the slaughter house. See Section 3.2.2.
	Chilling of hides and skins. This has been found to produce an acceptable quality of leather utilising no salt. An instruction manual for this process under Indian conditions has been produced as part of the ACIAR study to encourage adoption.	The chilling of hides for transport is not used for the transport of hides to Jajmau tanneries.	Requirement for reliable power source to power chillers, reliable insulated / refrigerated trucks, chilled storage areas at tanneries pre-processing.
	Direct Chrome Liquor Recovery (DCLR), including recovery and re-use of excess liquor to reduce TDS.	It is understood that cleaner production methods involving DCLR are not being used by the Jajmau tanneries.	Implementation of the DCLR process at tanneries would require some modification to process units. Financial savings would results from reducing expenditure on chrome powder which is relatively expensive.

Waste-Product	Standard Management Practices	Comments Regarding Process in Use at Jajmau	Obstacles / Opportunities
	Recycling of Process Waters	A limited number of tanneries have implemented or are planning to implement processes such as counter current soaking or recycling of pickle liquor. However no significant recycling procedures are understood to be used by the vast majority of tanners in Jajmau.	There has been no significant financial incentive in the past to save water or reduce salt loads in effluent.
	Reverse Osmosis	No reverse osmosis units are currently used in Jajmau. At least one tannery operator is considering the on-site use of reverse osmosis.	Reverse osmosis is expensive. Solid or liquid waste from the process will need to be managed.
Suspended Solids	Bar screening, removal of larger solids.	Tanneries are required to treat effluent prior to disposal to remove coarse suspended solids prior to discharge. However blockages in the conveyance system indicate ineffective use of these systems	Improved governance procedures are required to ensure that appropriate pre-treatment is conducted by the tanneries.
	Removal of grit and floating matter.		
	Self-cleaning screens.	The CETP performs a number of processes for the removal of suspended solids from tannery effluent.	The ability of the CETP to treat wastewater is inhibited by an unreliable source of electricity to power pumps. The capacity of the CETP is currently not large enough to treat all of the effluent being discharged by the tanneries.
	Pumping/lifting.		
	Chemical treatment (coagulation, flocculation).		
	Settling – primary sedimentation.		

Waste-Product	Standard Management Practices	Comments Regarding Process in Use at Jajmau	Obstacles / Opportunities
Solid Waste	Recycling of leather trimmings - units in Italy and Brazil convert leather trimmings into a nitrogen rich fertiliser source.	No units are currently present in India.	The dumping of leather trimming onto the roadside or directly into the river represents a significant source of pollution in Jajmau. The conversion of this waste to fertiliser could be a potential revenue source as well as being a solution to the pollution issue.
	Sludge drying beds (primarily in small tanneries) for disposal in landfill.	Sludge drying beds are present at the CETP.	There are plans to replace the sludge drying beds with mechanical sludge dewatering equipment in order to free up space at the CETP site for the upgrade of the plant.
	Establishment of Solid Waste treatment facility	Sludge is currently collected from the CETP by a registered contractor for disposal.	Plans have been established for the development of a Solid Waste Treatment Facility at the Jajmau CETP site.
Air Emissions	Hydrogen sulphide control, maintaining a pH level above 10 in relevant process streams.	The extent of the use of pH control to control odours at Jajmau tanneries is uncertain	A major obstacle to rigorous odour control is the recognition of odour issues as a source of impact to the standard of living to the community of Jajmau.
	Enclosure of activities causing odours		
	Addition of hydrogen peroxide or pure oxygen	Residential communities live in close proximity to the tanneries and are affected by the odours that result from the industry.	Implementation of these options will be relatively expensive if not already present at the tanneries. Smaller tanneries are often responsible for beam house processes that are odorous and may not have the area or the finances to adapt their operations.
	Biofilters / Stacks		

3.6.2 Case Studies

The Tannery of the Year is an awards programme for the global tanning industry, launched in 2009 to celebrate the production of leather and to help promote its use throughout the world in footwear, furniture, automotive and aeroplane interiors, handbags and other accessories.

Case Studies 3.1 and 3.2 outline the activities of the SEPICI Tannery in Turkey, and the Dani Gruppo Tannery in Italy who were the winner and runner up in 2013.

Case Study 3.1 SEPICI Tannery, Turkey.

SEPICI Tannery in Turkey was the recipient of the Tannery of the Year Award for Europe in 2013. SEPICI is located in Çaybaşı Village of Torbalı Province, and has been operating since 1974.

In 1989, SEPICI started the first permanent wastewater treatment plant in the Turkish Leather Industry, allowing the tannery to treat its wastewaters according to the country's environmental regulations. SEPICI also has a Discharge Permit License granted by the Ministry of Environment.

Ongoing improvements have been made to the wastewater treatment plant, including physical, chemical and biological treatment units, allowing the plant to reach a capacity of 1000 cubic meters per day and a higher treatment efficiency. The company which keeps the dust emissions under control with VOC filtered ecological chimneys and dust removal equipment has a Class B Emission Permit License which is given for compliance with air quality by the Ministry of Environment and a First Class License for Unhealthy Enterprises which certifies environmentally appropriate production.

In addition to these activities, SEPICI sought to end the fleshing waste problem, which was the biggest problem of the leather industry, by carrying out a Project funded by TTGV and TUBITAK in 2004. A recovery plant was established, which won an Environment Award. Now fleshing wastes are being processed, and valuable tallow oil which can be used in soap and tanning industries is produced.

SEPICI continues its environmental projects and improvements under constant surveillance. In 2010 the company worked on the composting of tannery sludge and executed lab scale studies onto industrial scales. Thanks to this 2010 EBSO Environment Award winning study, very high sludge disposal costs are prevented, the carbon footprint is reduced and a useful material is provided to the horticultural industry.

Case Study 3.2 Gruppo Dani Tannery, Italy.

Gruppo Dani Tannery in Italy was runner up in the Tannery of the Year Award for Europe in 2013. It brands itself as 'Sustainable Leather'. The key actions of Gruppo Dani are summarised in Figure 3.5 below:

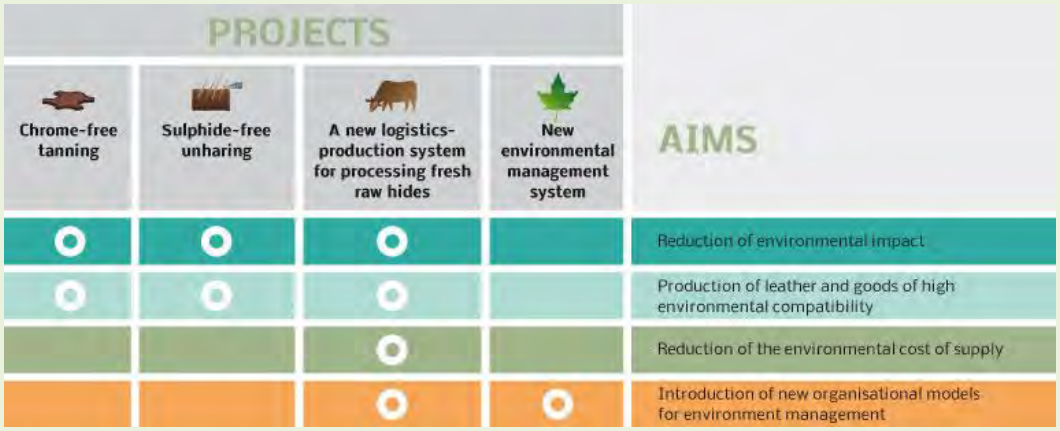


Figure 3.5 Summary of Projects and Goals in Gruppo Dani Tannery

Gruppo Dani joined a project called INDECO (Industry Alliance for Reducing Energy Consumption and CO_2 Emissions) initiated by the National Tanning Industry Union, led by an European partnership made up of 16 members. The project began in May 2012, and aims to promote investments and energy efficiency. Through the use of energy audits the tannery aims to identify key areas for improving energy efficiency in the tannery and in the production chain, and to locate the best technological solutions in the national and European scene.

Gruppo Dani's environmental commitments have been developed as a result of their involvement with INDECO, as well as through consultation with qualified experts and establishing a dense network of active relationships with universities, research institutes and laboratories.

Gruppo Dani is committed to internal training, having allocated 7000 working hours in 2012 to implementing internal courses aimed at improving communications, environmental awareness, business management, marketing and statistics.

In 2012, Dani attended the most important Italian event dedicated to Corporate Social Responsibility at Bocconi University, an opportunity to share the latest knowledge on industrial sustainability across the academic and the business world.

Case Study 3.3 Cleaner Production in the Textile Industry, Bangladesh

The DBL Group is one of the largest Bangladeshi textile and garment manufacturers, providing fabric and clothes for companies such as H&M, Puma and Esprit.

The textiles industry requires large amounts of water for dying and rinsing cloth, as well as large quantities of steam for printing and pressing fabric. Under baseline conditions, DBL used 3,400 cubic meters of water to produce 35 metric tons of cloth each day.

In 2011, DBL and 17 other Bangladeshi factories upgraded equipment as part of a program supported by the aid agencies of Britain and Norway, and the International Finance Corporation.

The 18 Bangladeshi textile makers together invested more than $1 million to upgrade their factories, while 10 apparel buyers, including the giant retailers H&M and Tesco, contributed a total of $35,000 to the program. Solidaridad, a Dutch non-governmental organization, provided technical advice and funding.

DBL invested $80,000 to make simple but powerful upgrades to equipment (i.e. boilers and dyeing and rinsing machines), as well as fixing existing implementations such as insulating steam pipes and pipe leaks. Before the upgrade, DBL used approximately 120 litres of water to produce one kilogram of cloth. After implementation of the upgrades, required water was only 60 litres.

DBL has also installed sensors on dyeing and rinsing machines to automatically stop the machines when cloth was adequately saturated or rinsed. DBL also added magnetic devices to its boilers to reduce mineral build-up, reducing the need to flush equipment with water and preserve the machinery.

Large rollers were adjusted to wring out rinsed fabric thoroughly, so less energy was needed for drying. Sensors on dryers were programmed to retain eight per cent moisture, which is the minimum needed for the next stage of production.

DBL is building a rainwater harvesting system to capture water during the monsoon and make use of groundwater unnecessary for four months. It is also trying to get European companies to make dyes that work at lower temperatures.

DBL has a multimillion-dollar effluent treatment plant, however many Bangladeshi textile factories — not to mention tanneries and other industries — do not. Wastewater contaminated by dyes and chemicals is often dumped directly into rivers, contaminating water and killing fish and other wildlife that millions of people depend on.

3.6.3 Key Findings

1. Impacts to the Ganga caused from the Tannery Industry can be significantly reduced prior to the introduction of new treatment infrastructure through installation of cleaner production processes.
2. The most significant reductions in pollution from the Tannery Industry can be achieved through implementing cleaner production initiatives at the initial stages of hide preservation and soaking.
3. Significant reductions in the capital and operating cost of the proposed solutions can be made through the implementation of cleaner production initiatives.
4. Cleaner production has been unsuccessful in the past as there has been little financial incentive for tanneries to reduce their water usage or the amount of salt or other chemicals in their effluent.
5. It has been estimated that the implementation of cleaner production initiatives could result in up to 40% reduction in the volume of water discharged by tanneries and the load of salt and other pollutants in the effluent. These reductions have been observed in Tamil Nadu, where cleaner production initiatives have been implemented by tanneries.

3.7 Wastewater Treatment Options Analysis

3.7.1 Aims and Objectives

The aim of the wastewater treatment options analysis was to assess the various alternative options proposed for the treatment of tannery effluent and to recommend a preferred approach based upon the analysis.

The following objectives formed the basis of the assessment:

- Holistic evaluation of various proposed options for the treatment of tannery wastewater with regards to economic, environmental, social, technological and political factors;
- Preliminary appraisal of the technical factors related to the alternative wastewater treatment options; and
- Preliminary assessment of the capital and operating costs associated with the various options.

3.7.2 The Alternatives

Various alternative treatment options were assessed. Further details and flow charts for each of the proposed options that were evaluated are presented in Section 3.6.6.

A common pre-wash facility has been proposed in conjunction with Options 1 and 4. The pre-wash facility would be a common facility available for all tanneries where the initial process of soaking rawhides would be conducted. The effluent from this process would be particularly high in salt content accounting for approximately 50% of the salt in tannery effluent (ACIAR 2009). Effluent from the common wash facility would be directed to the reverse osmosis facility for treatment.

Reverse osmosis treatment facilities are included in Options 1 to 4 to enable treated water with a TDS content of 900 mg/L to be recycled back to the tanneries. The reverse osmosis treatment facility would also include processes for the physical, chemical and biological treatment of wastewater prior to the reverse osmosis treatment.

Common chrome recovery plants are included in each of the proposed alternatives. Tannery effluent from chroming processes would be segregated at the tanneries and trucked to the common chrome recovery plant.

The options that were evaluated were:

Option 0

Option 0 reflects the current situation. The "do nothing" alternative was used as a baseline to compare the alternative options against.

Option 1

A common pre-wash facility with reverse osmosis to treat the pre-wash effluent stream and storage facility for the reverse osmosis reject. This option would include a dedicated CETP for effluent from the tanneries and a common chrome recovery plant. Treated tannery effluent would be recycled back to the tanneries.

Option 2

As per Option 1, tannery effluent from chroming processes would be segregated and tankered to the common chrome recovery plant. The remaining effluent from the tanneries would be sent to the CETP via a single sewer. A reverse osmosis facility would be used to treat the water from the CETP with the reject sent to a storage facility. Treated water would be recycled back to the tanneries.

Option 3

As per Options 1 and 2, tannery effluent from chroming processes would be segregated and trucked to the Common Chrome Recovery Plant. Option 3 will require two sewerage lines to transport effluent from the tanneries to the treatment plant. Process streams with high salt levels, including from the washing and pickling processes, will be segregated at the tannery and discharged to a dedicated sewer. This process stream would also be treated using reverse osmosis. The treated water from both treatment streams would be recycled back to the tanneries.

Option 4

As per the other alternatives, tannery effluent from chroming processes would be segregated and trucked to the common chrome recovery plant for treatment. Option 4 is similar to Option 1 in that a common pre-wash facility will be used by the tanneries. This stream will be treated by reverse osmosis, with a reject storage facility. However, wastewater from the tanneries (which does not include the high-salt wash streams) will be disposed

to domestic sewer and will be treated by the municipal sewage treatment plant. Water will be recycled back to the tanneries from both treatment streams.

Option 5

This option would involve transporting and treating tannery effluent with municipal sewage in a single sewerage system.

This alternative was not assessed as part of the options appraisal that was conducted with IITK. Nevertheless, this option should be presented for consideration.

This approach would be consistent with common international urban sewerage management.

Option 5 would be the most economical option to enable compliant discharge or treated water reuse and would involve:

- The requirement for every tannery to meet set trade waste limits (including TDS and Cr), which will mean that they will need to implement cleaner production and water efficiency processes plus pre-treatment.
- In some cases for the tanners, this may require a TDS variation above the standard where all reasonable measures have been implemented.
- In this instance tanneries may pay for the privilege of disposal of waste water with an elevated TDS concentration (noting the total load will still need to remain under a certain threshold).
- This waste would be discharged via the municipal sewer to the municipal STP and mix with domestic sewage. The municipal STP would need to be upgraded to treat greater volumes of domestic and industrial waste so that a suitable dilution would enable the mixed discharge to have a TDS concentration below discharge limits. This has the additional benefit of providing greater treatment capacity for domestic sewage, which is also a contributing factor to Ganga River pollution.
- A reverse osmosis unit could be used as needed at the back of the train for the most viable reuse requirement.

Plate 3.1 Open Drain at Jajmau

3.7.3 Holistic Evaluation of Proposed Options

The various options were evaluated with regards to financial, environmental, social, technical and political considerations. Each option was awarded a score of 1, 2 or 3 for each criterion. The options were compared relative to one another with a score of 3 allocated to the option with the most desirable outcome and a score of 1 allocated to the options with the least desirable outcome.

The following weightings were assigned to each group of criteria:

- Financial – 25%
- Environmental – 25%
- Social – 20%
- Technical – 20%
- Political – 10%.

Table **3.16** provides a description of the reasoning for the scores applied to each criterion.

Table 3.16 Holistic Options Analysis Ranking Rationale

Weighting	Criteria	Ranking		
		3	2	1
25%	**Financial**			
10%	Value for Money	Very good return	Modest return	Significant wastage
5%	Capital Expenditure	<US$20 million	US$20-40 million	>US$40 million
5%	Operational Expenditure	<50 Rupees/L	50-100 Rupees/L	>100 Rupees/L
5%	Conveyance Cost	Single sewer low load	Single sewer high load	Dual sewer
25%	**Environmental**			
8.3%	Effluent Quality	Suitable for recycle	Achieves compliance	Non-compliant
8.3%	Recycling Potential	Fit for all purposes	Fit for limited use	No recycle
8.3%	Energy Consumption	Low	High	Very high
20%	**Social**			
6.7%	Impact on Tannery Industry	No business closed or no jobs lost	<20 businesses closed or <1000 jobs lost	>20 businesses closed or > 1000 jobs lost
6.7%	Positive Community Impact	Large improvement	Small improvement	No change
6.7%	Provision of Water	All water needs met / good quality	Some water needs met / medium quality	No water needs met
20%	**Technical**			
6.7%	Time to Implement	<2 years	2-5 years	>5 years
6.7%	Physical Footprint	Very big	big	Small to medium
6.7%	Risk of Operational Down-Time	Simple process	Medium complexity	Complex
10%	**Political**			
10%	Stakeholder Acceptance	All stakeholder needs satisfied	Most stakeholder needs satisfied	Most stakeholders not satisfied

Table 3.17 provides a summary of results of the holistic options analysis.

Table 3.17 Holistic Options Analysis Summary of Ratings

Criteria	Option				
	0	1	2	3	4
Value for Money	1	2	2	3	3
Capital Expenditure	3	1	1	1	2
Operational Expenditure	3	2	1	1	2
Conveyance Cost	2	3	2	1	3
Financial Average	**2.00**	**2.00**	**1.60**	**1.80**	**2.60**
Effluent Quality	1	3	3	3	3
Recycling Potential	1	2	3	3	3
Energy Consumption	3	2	1	2	3
Environmental Average	**1.67**	**2.67**	**2.33**	**2.67**	**3.00**
Impact on Tannery Industry	2	1	3	3	1
Positive Community Impact	1	3	3	3	3
Provision of Water	2	3	3	3	3
Social Average	**1.67**	**2.33**	**3.00**	**3.00**	**2.33**
Time to Implement	NA	2	2	2	3
Physical Footprint	2	2	1	2	2
Risk of Operational Down-Time	1	2	1	1	3
Technical Average	**1.50**	**2.00**	**1.33**	**1.67**	**2.67**
Stakeholder Acceptance	1	2	2	2	1
Political Average	**1.00**	**2.00**	**2.00**	**2.00**	**1.00**
Overall Score	**1.65**	**2.23**	**2.05**	**2.25**	**2.50**

Based on the qualitative analysis, Option 4 was rated as the most appropriate option from a holistic point of view taking into account financial, environmental, social, technical and political factors. This approach takes advantage of infrastructure that exists for domestic sewage treatment.

An effective governance system will be required to ensure that appropriate pre-treatment and/or segregation of process streams occurs at the tanneries to ensure that chromium-impacted wastewater does not enter the sewerage network.

The following sections provide further details regarding the financial and technical aspects of each of the alternatives.

3.7.4 Technical Analysis of Alternatives - Assumptions

For each of the options that were analysed a number of assumptions were made which were common to each of the options.

Table 3.18 provides a summary of the values and reasoning for each assumption.

Table 3.18 Summary of Technical Assumptions Used to Assess Each Option

Assumption	Value	Source / Reasoning for Assumption
Quantity of water used by tanneries	40 MLD	Intermediate value between that provided in the IL&FS DPR (28 MLD) and that provided by CLRI (50 MLD)
Proportion of water used for soaking	15 %	Based on data presented by the Food and Agricultural Organisation of the United Nations (FAO).
Proportion of water used for tanning	5 %	Based on information provided by IITK.
TDS content of groundwater at Jajmau	650 mg/L	Information provided by IITK
TDS content of domestic sewage	650 mg/L	Information provided by IITK
TDS content of soak water	37,000 mg/L	Based on data from Central Pollution Control Board Report
TDS content of reverse osmosis reject	55,000 mg/L	Based on information provided from the Ranipet CETP in Tamil Nadu
TDS content of reverse osmosis treated water	350 mg/L	Based on operation of Ranipet plant in Tamil Nadu
TDS of content of combined tannery effluent	11,000 mg/L	Value provided in ACIAR Report.
TDS content of tannery effluent with soak water removed	6,500 mg/L	Calculated on basis that soak water comprises 50% of the salt load of the combined tannery effluent (ACIAR report) and 15% of the volume (FAO report).
Proportion of water returned as supernatant by CCRP	90 %	Assumption based on information provided by CETP operators.
Proportion of water returned by CETP following treatment	95 %	Assumption based on information provided by CETP operators
Proportion of water returned by STP following treatment	95 %	Assumption based on information provided by treatment plant operators
Evaporation each year excluding July, August and September (wet months)	150 cm	Annual rate of 200cm/year based on data from the National Institute of Hydrology, Roorkee.
Precipitation each year excluding July, August and September (wet months)	18.5 cm	Climate data for Kanpur
Difference between evaporation and precipitation in dry months	131.5 cm	Precipitation subtracted from evaporation

3.7.5 Technical Analysis of Proposed Alternatives

Two scenarios were considered for each option as follows:

1. Treatment of effluent to enable water with a TDS content of 900 ppm to be recycled back to the tanneries for use.
2. Treatment of effluent to a TDS level of 2,000 ppm to ensure compliant disposal of treated water to the Ganga.

Flow diagrams have been included in the following section that illustrate both of these scenarios. The flow diagrams illustrate points within the treatment system for which the TDS concentration and flow rate have been calculated on the basis of the assumptions presented in Table 3.18.

For all the calculations it was assumed that the reject from the reverse osmosis process would have a TDS concentration of 55,000 mg/L. For the recycle options, the flow rate of the streams entering the reverse osmosis treatment facility were adjusted such that the recycled water being used by the tanneries (Point 1) would have a TDS concentration of 900 mg/L. For example for Option1 – Recycle, the flow rate at Point 10 that would produce a TDS

concentration of 900 mg/L at Point 1 was calculated to be 29.0 MLD.

Similarly for the compliant disposal options, the flow rate of the streams entering the reverse osmosis facility were adjusted such that the treated water discharged to the Ganga would have a TDS concentration of 2,000 mg/L. For example for Option 1 – Compliant Discharge, the flow rate at Point 10 that would produce a TDS concentration of 2,000 mg/L at Point 15 was calculated to be 23.7 MLD.

For all of the options considered it has been assumed that appropriate processes, technologies and governance systems have been put in place to ensure that chromium, organic and other pollutants are at concentrations in treated water that are compliant with legislation.

It was assumed, as presented in Table 20 that 90% of the water that entered the CCRP would be returned as supernatant. For example for Option 1 – Recycle, the flow rate of Stream 7 is 90% of the flow rate of Stream 5. Similarly it was assumed that 95% of the water that entered the CETP or STP facilities would be discharged as treated water. For example for Option 1 – Recycle, the flow rate of Stream 9 is 95% of the combined flow rates of Streams 6 and 7.

The following points were considered key outputs of the technical assessment and will be key factors related to the capital and operating costs of the treatment system:

- required capacity for the CETP;
- requirements for reverse osmosis;
- requirements for the storage of the reverse osmosis reject.

It has been proposed that reject from the reverse osmosis facility will be stored in a containment facility and be discharged to the Ganga during the three wettest months of the year (July, August and October) when approximately 80% of the annual rainfall occurs. Discharge of the reject at this time will not result in significant impacts on TDS concentrations in the Ganga.

Based upon the estimated volume of reject that will be discharged from the reverse osmosis treatment facility, the volume and footprint of the required reject storage facility for each of the alternatives was calculated. The difference between evaporation and precipitation in the nine driest months of the year has been estimated at 131.5 cm each year. For July, August and September it has been assumed that reject produced from the reverse osmosis facility will be discharged directly into the Ganga.

Based upon the predicted volume of reject being discharged by the reverse osmosis facility and the net loss of water from the storage facility due to evaporation, the area of the storage facility required for the evaporation of all of the reject water was calculated. It is noted that for this scenario a suitable option for the disposal of the solid salt would be required. In Tamil Nadu, salt produced from evaporation units represents a significant waste management issue for Zero Liquid Discharge Plants.

For each scenario it was also calculated what area would be required for the storage facility if the depth of the storage was assumed to be 3m.

Option 1 - Recycle

An indicative flow chart for Option 1, including recycle, is displayed in Figure 3.6. Table 3.19 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

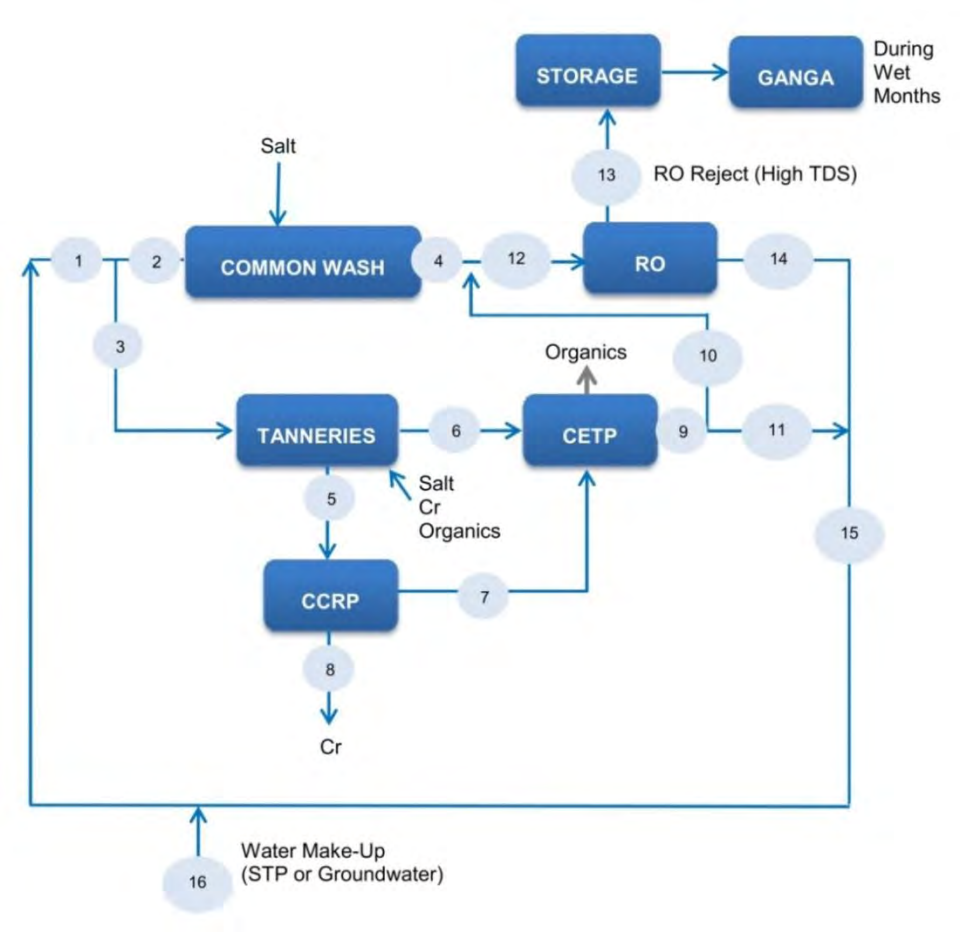


Figure 3.6 Option 1 (including Recycle) Flow Diagram

Table 3.19 Option 1 (including Recycle) Volume and Flow Data

Point	1	2	3	4	5	6	7	8
Flow (MLD)	40.0	6.0	34.0	6.0	2.0	32.0	1.8	0.2
TDS Concentration (mg/L)	900	9000	900	37,000	6,500	6,500	6,500	6,500

Point	9	10	11	12	13	14	15	16
Flow (MLD)	32.1	29.0	3.1	35.0	7.3	27.7	30.8	9.2
TDS Concentration (mg/L)	6,500	6,500	6,500	11,700	55,000	350	970	650

Based on the assumptions used for this preliminary analysis, 90% of the effluent from the CETP in addition to the effluent from the common wash facility would require reverse osmosis treatment in order to reduce TDS levels to 900 mg/L for recycling back to the tanneries.

The reverse osmosis facility would require a capacity of 35.0 MLD. Seventy-nine per cent (79%) of the water that enters the reverse osmosis treatment plant would need to be returned as water with a TDS concentration of 350 mg/L. The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,230m long by 1,230m wide (no discharge)
- 680 m long by 680m wide (3m depth).

Option 1a – Compliant Discharge to Ganga

An indicative flow chart for Option 1a, enabling compliant discharge to the Ganga, is displayed in Figure 3.7. Table 3.20 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

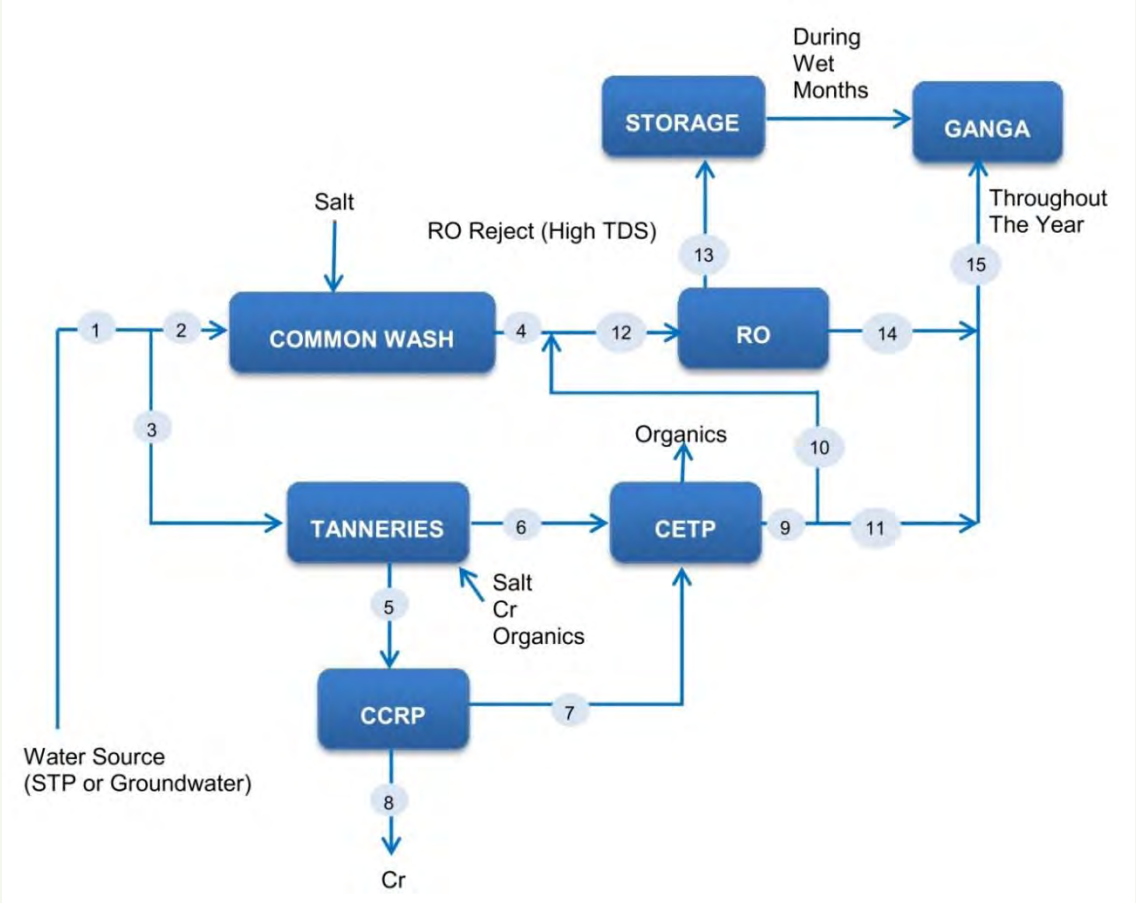


Figure 3.7 Option 1a (Compliant Discharge to Ganga) Flow Diagram

Table 3.20 Option 1a (Compliant Discharge to Ganga) Volume and Flow Data

Point	1	2	3	4	5	6	7	8
Flow (MLD)	40.0	6.0	34.0	6.0	2.0	32.0	1.8	0.2
TDS Concentration (mg/L)	650	650	650	37,000	6,500	6,500	6,500	6,500

Point	9	10	11	12	13	14	15
Flow (MLD)	32.1	23.7	8.4	29.7	6.7	23.0	31.4
TDS Concentration (mg/L)	6,500	6,500	6,500	12,660	55,000	350	2,000

Based on the assumptions used for this preliminary analysis, 74% of the effluent from the CETP in addition to the effluent from the common wash facility would require reverse osmosis treatment in order for TDS levels to be reduced to 2,000 mg/L.

The reverse osmosis facility would require a capacity of 29.7 MLD. 77% of the water that enters the reverse osmosis treatment plant would need to be returned as water with a TDS concentration of 350 mg/L.
The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,180m long by 1,180m wide (no discharge)
- 650 m long by 650m wide (3m depth).

Option 2 - Recycle

An indicative flow chart for Option 2, including recycle, is displayed in Figure 3.8. Table 3.21 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

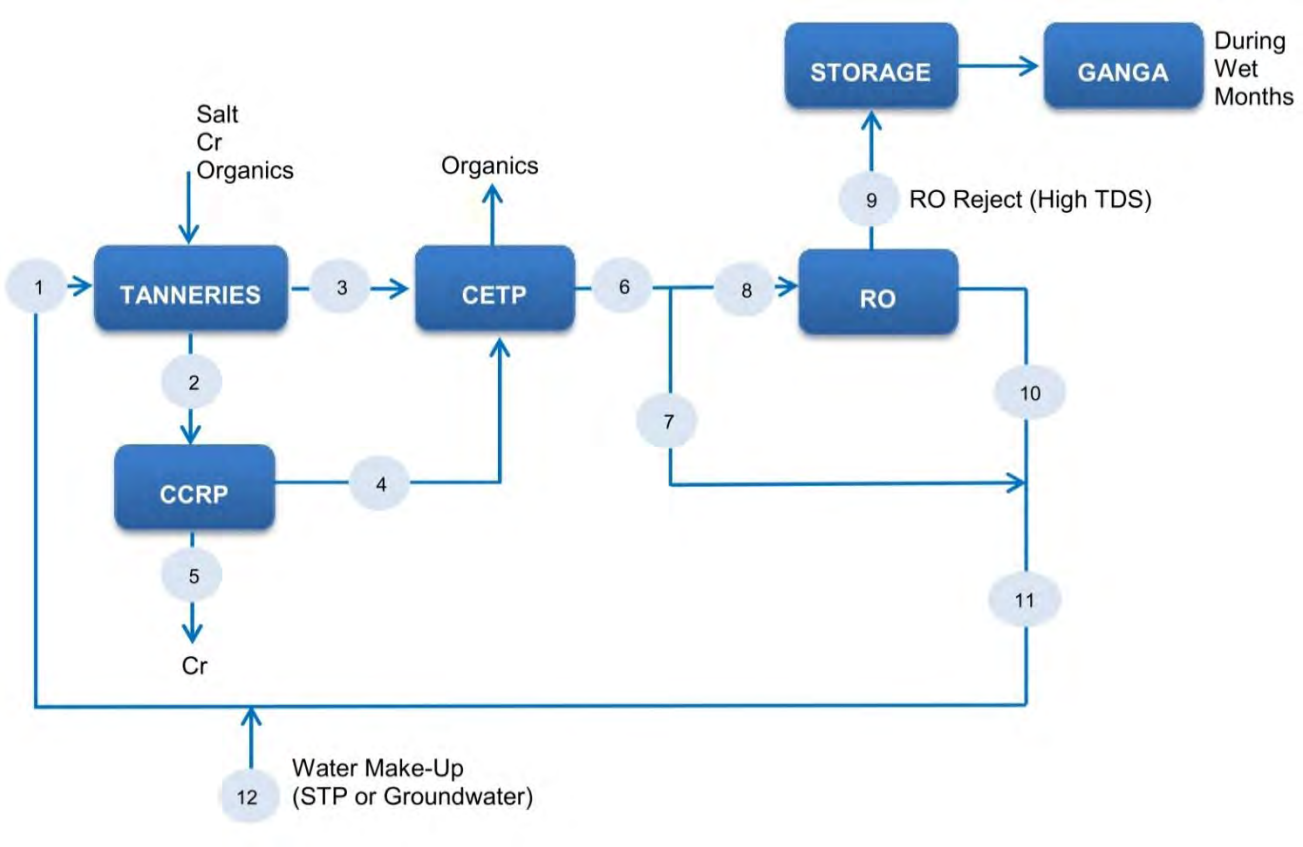


Figure 3.8 Option 2 (Including Recycle) Flow Diagram

Table 3.21 Option 2 (Including Recycle) Volume and Flow Data

Point	1	2	3	4	5	6
Flow (MLD)	40.0	2.0	38.0	1.8	0.2	37.8
TDS Concentration (mg/L)	900	11,000	11,000	11,000	11,000	11,000

Point	7	8	9	10	11	12
Flow (MLD)	1.8	36.0	7.0	29.0	30.8	9.2
TDS Concentration (mg/L)	11,000	11,000	55,000	350	900	650

Based on the assumptions used for this preliminary analysis, 95% of the effluent from the CETP would require reverse osmosis treatment in order to reduce TDS levels to 900 mg/L for recycling back to the tanneries.

The reverse osmosis facility would require a capacity of 36.0 MLD. Eighty-one per cent (81%) of the water that enters the reverse osmosis treatment facility would need to be returned as water with a TDS concentration of 350 mg/L

The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,210m long by 1,210m wide (no discharge)
- 670 m long by 670m wide (3m depth).

Option 2a – Compliant Discharge to Ganga

An indicative flow chart for Option 2a, enabling compliant discharge to the Ganga, is displayed in Figure 3.9. Table 3.22 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

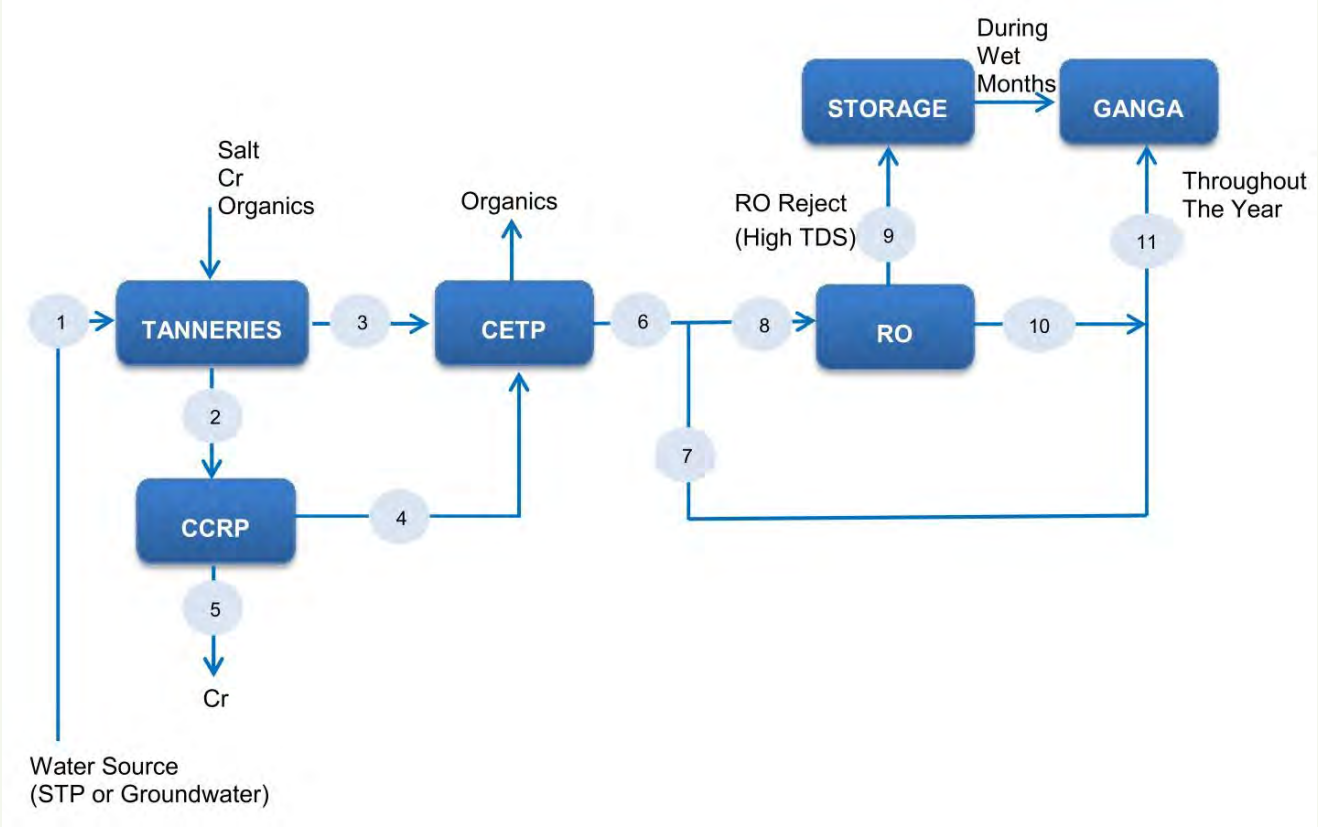


Figure 3.9 Option 2a (Compliant Discharge to Ganga) Flow Diagram

Table 3.22 Option 2a (Compliant Discharge to Ganga) Volume and Flow Data

Point	1	2	3	4	5	6
Flow (MLD)	40.0	2.0	38.0	1.8	0.2	35.8
TDS Concentration (mg/L)	650	11,000	11,000	11,000	11,000	11,000

Point	7	8	9	10	11
Flow (MLD)	4.6	31.2	6.1	25.1	29.7
TDS Concentration (mg/L)	11,000	11,000	55,000	350	2,000

Based on the assumptions used for this preliminary analysis, 87% of the effluent from the CETP would require reverse osmosis treatment in order for the reduction of TDS levels to 2,000 mg/L to be achieved.

The reverse osmosis facility would require a capacity of 31.2 MLD. Eighty-one per cent (81%) of the water that enters the reverse osmosis treatment facility would need to be returned as water with a TDS concentration of 350 mg/L.

The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,130m long by 1,130m wide (no discharge)
- 620 m long by 620m wide (3m depth).

Option 3 - Recycle

An indicative flow chart for Option 3, including recycle, is displayed in Figure 3.10. Table 3.23 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

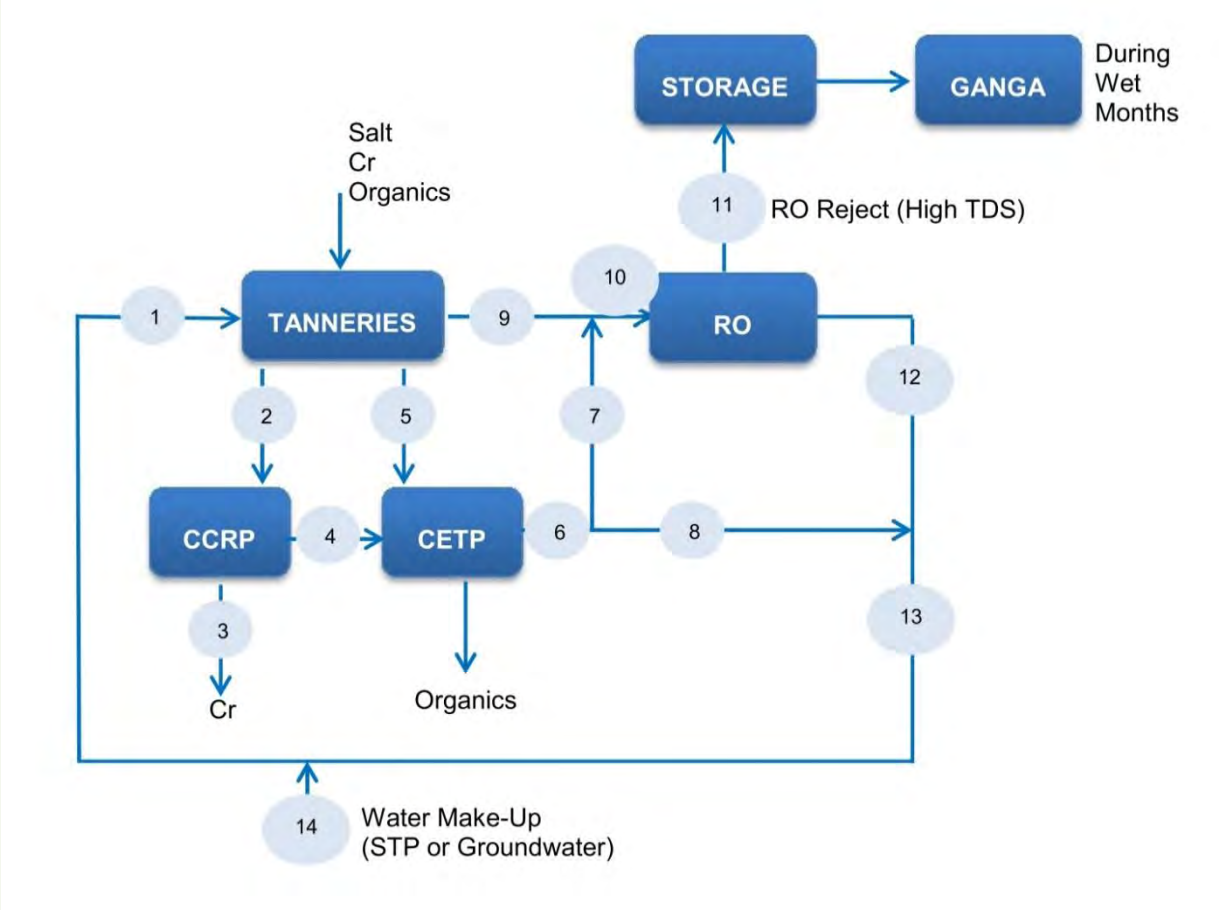


Figure 3.10 Option 3 (Including Recycle) Flow Diagram

Table 3.23 Option 3 (Including Recycle) Volume and Flow Data

Point	1	2	3	4	5	6	7
Flow (MLD)	40.0	2.0	0.2	1.8	32.0	32.1	29.0
TDS Concentration (mg/L)	900	6,500	6,500	6,500	6,500	6,500	6,500

Point	8	9	10	11	12	13	14
Flow (MLD)	3.1	6.0	35.0	7.3	27.7	30.6	9.2
TDS Concentration (mg/L)	6,500	37,000	11,700	55,000	350	970	650

Based on the assumptions used for this preliminary analysis, 90% of the effluent from the CETP would require reverse osmosis treatment in order to reduce TDS levels to 900 mg/L for recycling back to the tanneries.

The reverse osmosis facility would require a capacity of 35.0 MLD. Seventy-nine per cent (79%) of the water that enters the reverse osmosis treatment facility would need to be returned as water with a TDS concentration of 350 mg/L.

The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,230m long by 1,230m wide (no discharge)
- 680 m long by 680m wide (3m depth).

Option 3a – Compliant Discharge to Ganga

An indicative flow chart for Option 3a, enabling compliant discharge to the Ganga, is displayed in Figure 3.11. Table 3.24 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

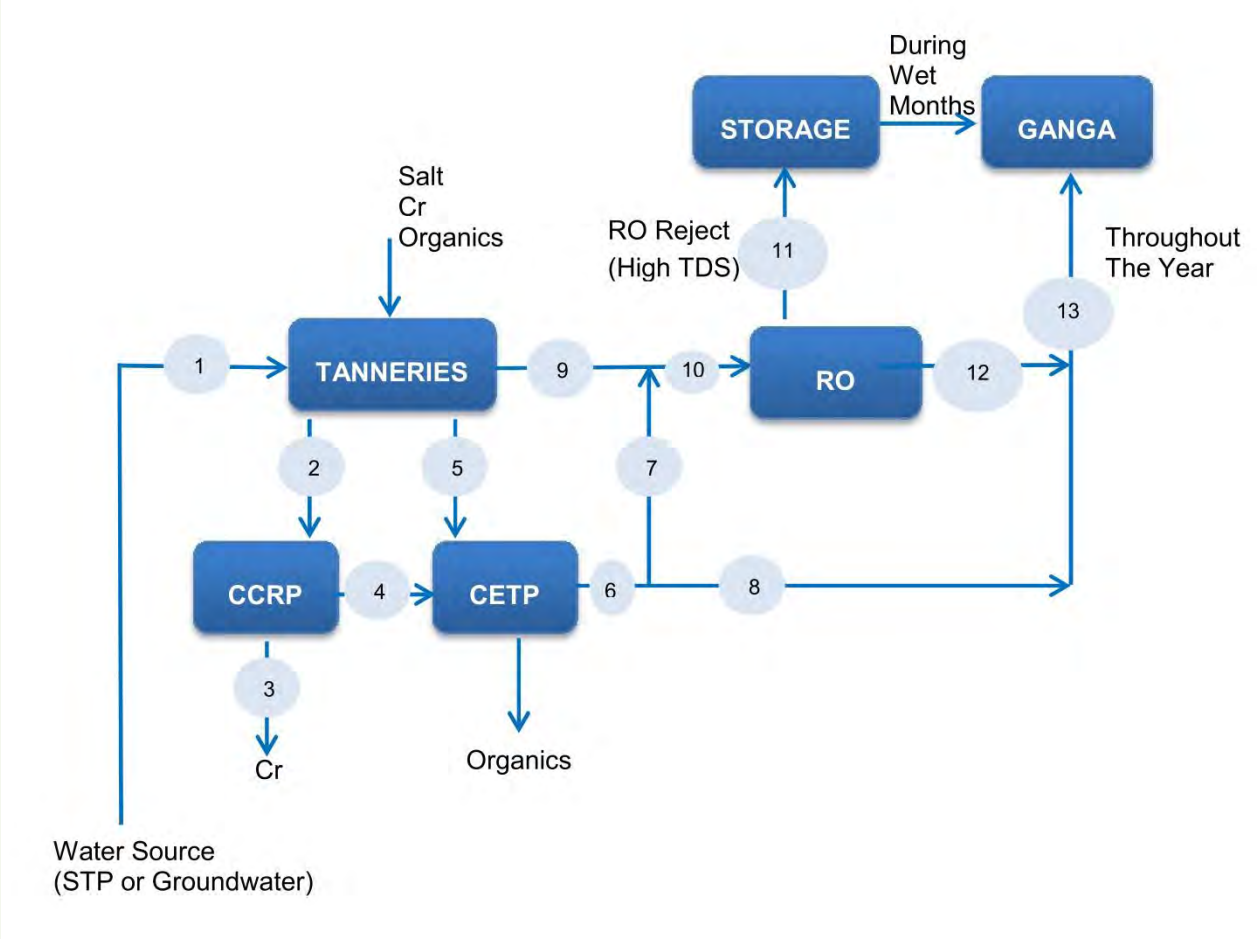


Figure 3.11 Option 3a (Compliant Discharge to Ganga) Flow Diagram

Table 3.24 Option 3a (Compliant Discharge to Ganga) Volume and Flow Data

Point	1	2	3	4	5	6	7
Flow (MLD)	40.0	2.0	0.2	1.8	32.0	32.1	23.7
TDS Concentration (mg/L)	650	6,500	6,500	6,500	6,500	6,500	6,500

Point	8	9	10	11	12	13
Flow (MLD)	8.4	6.0	29.7	6.7	23.0	31.4
TDS Concentration (mg/L)	6,500	37,000	12,700	55,000	350	2,000

Based on the assumptions used for this preliminary analysis, 74% of the effluent from the CETP would require reverse osmosis treatment in order to reduce TDS levels to 2,000 mg/L.

The reverse osmosis facility would require a capacity of 29.7 MLD. 77% of the water that enters the reverse osmosis treatment facility would need to be returned as water with a TDS concentration of 350 mg/L.

The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,180m long by 1,180m wide (no discharge)
- 650 m long by 650m wide (3m depth).

Option 4 - Recycle

An indicative flow chart for Option 4, including recycle, is displayed in Figure 3.12. Table 3.25 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

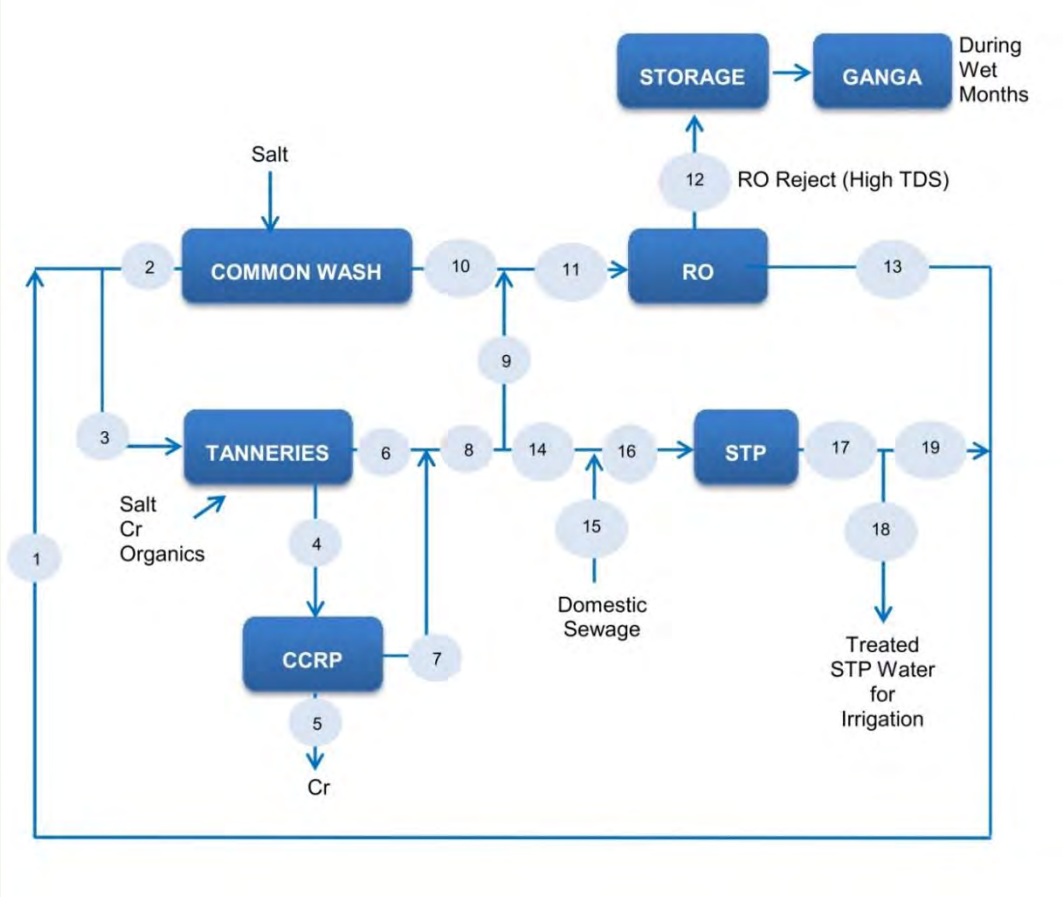


Figure 3.12 Option 4 (Including Recycle) Flow Diagram

Table 3.25 Option 4 (Including Recycle) Volume and Flow Data

Point	1	2	3	4	5	6	7	8	9	10
Flow (MLD)	40.0	6.0	34.0	2.0	0.2	32.0	1.8	33.8	13.7	6.0
TDS Concentration (mg/L)	900	900	900	6,500	6,500	6,500	6,500	6,500	6,500	37,000

Point	11	12	13	14	15	16	17	18	19
Flow (MLD)	19.7	5.6	14.1	20.1	194	214	203	177	25.8
TDS Concentration (mg/L)	15,800	55,000	350	6,500	650	1,200	1,200	1,200	1,200

Based on the assumptions used for this preliminary analysis, 41% of the effluent from the tanneries would require reverse osmosis treatment in order for the TDS levels to be reduced 900 mg/L for recycling back to the tanneries

The reverse osmosis facility would require a capacity of 19.7 MLD. Seventy-two per cent (72%) of the water that enters the reverse osmosis treatment would need to be returned as water with a TDS concentration of 350 mg/L. The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 1,080m long by 1,080m wide (no discharge)
- 590 m long by 590m wide (3m depth).

Option 4a – Compliant Discharge to Ganga

An indicative flow chart for Option 4a, enabling compliant discharge to the Ganga, is displayed in Figure 3.13. Table 3.26 details the flow rates and TDS concentrations for each of the indicated points on the flow diagram.

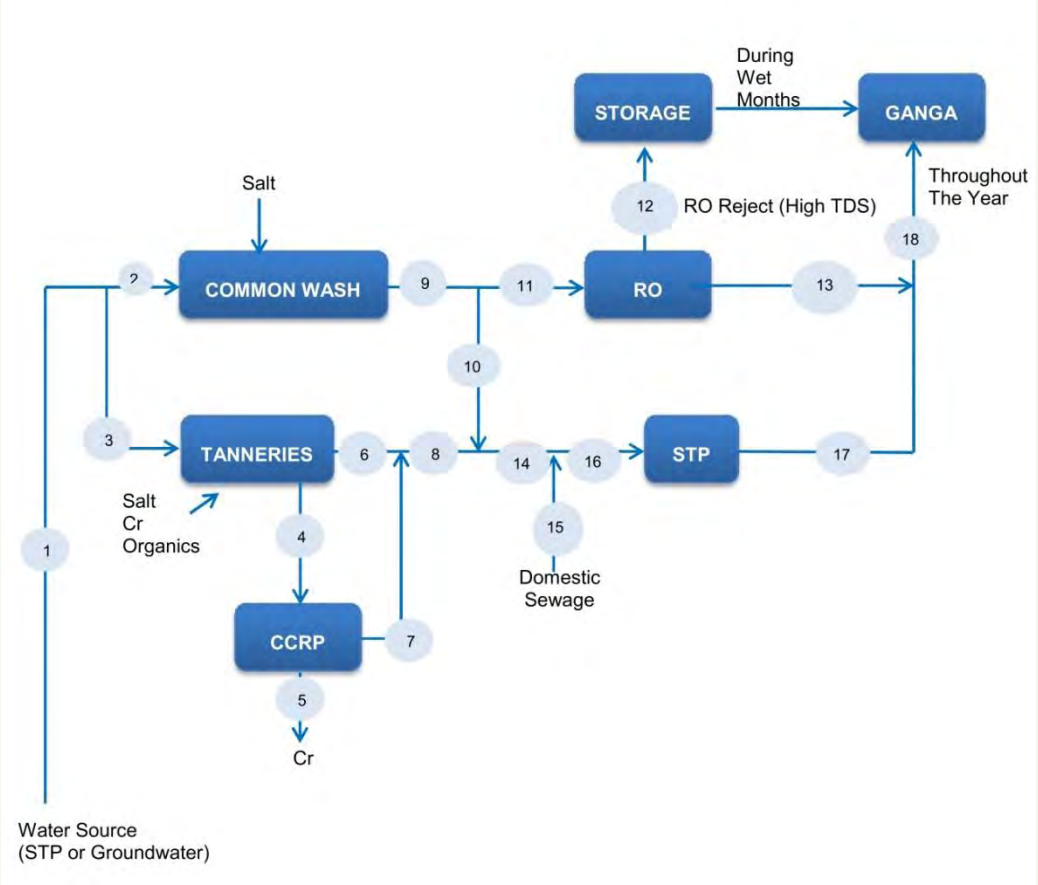


Figure 3.13 Option 4a (Compliant Discharge to Ganga) Flow Diagram

Table 3.26 Option 4a (Compliant Discharge to Ganga) Volume and Flow Data

Point	1	2	3	4	5	6	7	8	9
Flow (MLD)	40.0	6.0	34.0	2.0	0.2	32.0	1.8	33.8	6.0
TDS Concentration (mg/L)	650	650	650	6,500	6,500	6,500	6,500	6,500	37,000

Point	10	11	12	13	14	15	16	17	18
Flow (MLD)	2.6	3.4	2.3	1.1	36.4	178	214	203	204
TDS Concentration (mg/L)	37,000	37,000	55,000	350	8,650	650	2,010	2,010	2,000

Based on the assumptions used for this preliminary analysis, 57% of the effluent from the common wash unit would require reverse osmosis treatment in order to reduce TDS levels to 2,000 mg/L. The remainder of the pre-treated tannery effluent would be mixed with municipal domestic sewage for treatment.

The reverse osmosis facility would require a capacity of 3.4 MLD. 33% of the soak water that enters the reverse osmosis treatment facility would need to be returned as water with a TDS concentration of 350 mg/L.
The required footprint of the reverse osmosis reject storage facility would be the equivalent of:

- 690m long by 690m wide (no discharge)
- 380 m long by 380m wide (3m depth).

3.7.6 Financial Analysis of Alternatives - Assumptions

Table 3.27 provides a summary of the assumptions that were used for the financial analysis of the options and reasoning for each assumption.

Table 3.27 Summary of Financial Assumptions Used to Assess Each Option

Assumption	Value	Source / Reasoning for Assumption
Cost of effluent treatment (excluding reverse osmosis)	40 Rupees/kL (US$0.65/kL)	Ranipet CETP , Tamil Nadu
Cost of reverse osmosis	107 Rupees/kL (US$1.73/kL)	Ranipet CETP , Tamil Nadu
Capital cost of treatment plant including reverse osmosis (includes installation of recycling pipelines to tanneries)	98 million Rupees / MLD capacity (US$1.58 million / MLD capacity)	Ranipet CETP , Tamil Nadu
Total capital cost of recycle pipeline back to tanneries	336 million Rupees (US$5.4 million)	IL&FS 2011 DPR
Capital cost of reverse osmosis reject storage facility	620 Rupees/m^3 (US$10/$m^3$)	Based on cost estimate in IL&FS DPR for secure landfill at Jajmau

3.7.7 Comparison of Wastewater Treatment Costs

Table 3.28 provides a comparison of the wastewater treatment costs for each of the options based upon the assumptions used in this preliminary analysis.

Table 3.28 Comparison of Estimated Costs for the Alternative Options

Option	Wastewater Treatment Operating Cost (per kL of treated effluent)	Wastewater Treatment Capital Cost (Rupees/$US)	Reverse Osmosis 3m Deep Reject Storage Capital Cost (Rupees/$US)
1 – Recycle	138 Rupees US$2.23	3,420 million Rupees US$55.2 million	860 million Rupees US$13.9 million
1a – Compliant Discharge	119 Rupees US$1.92	2,560 million Rupees US$41.3 million	790 million Rupees US$12.7 million
2 – Recycle	142 Rupees US$2.29	3,520 million Rupees US$56.8 million	830 million Rupees US$13.4 million
2a – Compliant Discharge	134 Rupees US$2.15	2,710 million Rupees US$43.7 million	829 million Rupees US$11.6 million
3 – Recycle	140 Rupees US$2.25	3,760 million Rupees US$60.6 million	860 million Rupees US$13.9 million
3a – Compliant Discharge	124 Rupees US$1.99	2,900 million Rupees US$46.8 million	790 million Rupees US$12.7 million
4 – Recycle	83 Rupees US$1.34	1,930 million Rupees US$31.1 million	660 million Rupees US$10.6 million
4a – Compliant Discharge	49 Rupees US$0.76	<300 million Rupees <US$5 million	270 million Rupees US$4.4 million

The wastewater treatment operating cost was calculated by multiplying the proportion of the total flow that required reverse osmosis treatment by the rate presented in Table 3.27 and adding this to the cost of effluent treatment (excluding reverse osmosis). For example, for Option 2 – Recycle, 95% of the effluent from the CETP was sent to the reverse osmosis unit. The wastewater treatment operating cost was subsequently estimated as (0.95 x 107 Rupees/kL) + 40 Rupees/kL = 142 Rupees/kL.

The wastewater treatment cost is based on the Ranipet data and includes the replacement of conveyance lines and the installation of recycling pipelines to the tanneries.

For the compliant discharge options for Options 1 and 2, the cost to install a sewer line, as estimated in the IL&FS DPR has been subtracted from the total capital cost using the Ranipet data, as no recycle sewer is required. For Option 3 – Recycle, the cost for an additional sewer has been added to the total cost calculated from the Ranipet data due to the requirement for an additional sewer for the transport of salty wastewater from the tanneries.

3.7.8 Key Findings

1. The most significant cost savings are achieved if treated tannery effluent is mixed with domestic sewage for treatment.
2. Options 1-3 are very expensive and potentially cost prohibitive for many tanners to continue operation.
3. For all options, the cost of recycling compared to simple (environmentally compliant) discharge is greater, however not significantly so as to make recycling unrealistic.
4. Option 4 is considerably more cost effective.
5. Option 5 provides the least cost option to achieve environmental compliance with Ganga River water quality standards.

3.8 Best Practice Governance Procedures

3.8.1 Aim

The long term sustainability of the sewerage system, treatment, environmental discharge and beneficial reuse resulting from the Jajmau tanneries is dependent upon robust trade effluent management and a transparent governance framework.

It is proposed to develop such a robust trade effluent management system, with clear roles and responsibilities for relevant agencies and organisations.

3.8.2 The Solution

The establishment of a robust trade effluent management system and transparent regulatory framework will provide the basis for long term sustainable operation of the sewerage / treatment solution for the Jajmau tanneries.

It is proposed that the establishment of such a system / framework would draw largely on existing best practice, practitioner experience and real world examples. The Australian and Victorian jurisdictions offer such detail and experience.

In particular, the Australian Sewage Quality Management Guidelines 2012 provide an excellent basis for the development of an appropriate management system (see Annex F). Ultimately, it is desirable that any management system is certified under an International Standards Organisation (ISO) system, such as ISO 22000, which uses the Hazard and Critical Control Point (HACCP) approach for risk identification, management and control.

3.8.3 Sewage Quality Objectives

The trade effluent management system should operate to ensure the recognised five sewage quality objectives, being:

1. **Occupational Health and Safety** – Protecting both sewer workers and the general public who may have reason to come into contact with sewage. This objective seeks to ensure that at all times the safety of people is paramount, for both acute (for example being overcome by gas) or chronic health issues.
2. **Sewer transport system** – Protection of sewer assets, including pumping stations for issues such as corrosion management, blockages, illegal connections etc.
3. **Treatment system** – Ensuring treatment systems operate as designed, and that sewage volumes or qualities are not such that might cause a reduction in performance or failure of treatment.
4. **Environment** – Ensuring that any discharge to the environment (water or land) is compliant with the relevant environmental standards. This is particularly important for parameters that are not, or only partially, treatable, for example inorganic salts.
5. **Reuse** – Ensuring that reuse (both water and biosolids) is fit for purpose and within standards as set by the relevant authority, or World Health Organisation.

These objectives should be enshrined as the basis for all activity and be agreed and committed to by all stakeholders.

3.8.4 Roles and Responsibilities

It is imperative that a trade effluent governance system has clear roles and responsibilities for all stakeholders. This is currently not the case in the Jajmau precinct, and should be addressed as a matter of priority.

The Victorian example shows that the Environment Protection Authority (EPA), equivalent to the PCB, plays a clear regulatory role for licencing sewage treatment plant discharges and reuse. Further, water authorities (equivalent to Jal Nigam) regulate trade effluent discharged by each premises to meet the specifications for treatment and reuse. There is potential to use this, at least in part, as a future model for governance responsibilities.

3.8.5 Regulatory Approach

It is recommended that an accepted and balanced regulatory approach is adopted incorporating the following elements, as based on the EPA's Compliance Q Model (**Error! Reference source not ound.** below):

Set Standards – Define and agree on performance standards and set realistic timelines to achieve regulatory standards, against which improvements can be measured.

Inform and Educate – Publish and share performance standards and best practice advice with

tanneries, regulators and the local community to establish realistic expectations.

Support to Comply – Provide practical help and expert advice to tanneries to improve environmental and safety performance, as well as assistance to strengthen governance of compliance through collaboration with UPPCB inspectors.

Encourage Performance – Encourage industry and operators to exceed standards and strive for more efficient practice via incentives, promotions and awards.

Monitor Compliance – Monitor and report openly on performance and achievements against standards and regulations.

Enforce the Law – Actively address poor performance and publically report when standards are consistently not met.

3.8.6 Basic Elements of Wastewater Quality Management

The following details the basic elements for the development of a robust trade effluent management system:

- Collective commitment of all stakeholders
- Set wastewater quality specifications / standards (to ensure sewage quality objectives are being met)
- Assess the hazards (potential to harm any 1 or more of the sewage quality objectives)
- Assess the risks (will the hazard occur and how bad will it be)
- Determine controls to manage the risks (multiple barriers where possible)
- Monitor compliance with controls and correct as necessary
- Provide assistance / incentives for improvement to customers (tanneries)
- Verify sewage quality objectives are being met
- Support the process
  - Training
  - Stakeholder management
  - Research and Development
  - Document and reporting management
- Audit / Review / Improve

Examples of the above are outlined in the following documents.

City West Water's Trade Waste Customer Charter (Annex D)

The Purpose of the Trade Waste Customer Charter is to:

- Inform customers about the trade waste service and the respective rights and responsibilities of City West Water and its customers;
- Provide customers with consistent, transparent and timely decision making for trade waste applications and management; and
- Ensure City West Water's trade waste services comply with the regulator's requirement.

City West Water's Sewage Quality Policy (Annex E)

The objectives outlined in the Sewage Quality Policy include:

<u>Environment – Significantly more with significantly less</u>

- Protection of the environment, and minimization of the impact of services on the environment;
- Maximisation of the sustainable reuse of water; and
- Towards zero waste.

<u>Customer</u>

- Services matched to customer needs;
- Efficient water users; and
- Clean and efficient producers.

<u>Social</u>

- Absolute safety.

Australian Sewage Quality Management Guidelines (Annex F)

The Australian Sewage Quality Management Guidelines are a framework for effectively managing sewage to a sewerage system from its source, through collection, transfer and treatment, to disposal or reuse. By following the guidelines, utilities will better manage loads and concentrations of inputs to the sewage system and achieve other benefits.

3.8.7 Self-Identification of Issues and Stakeholder Engagement

The development of a sewage quality management system requires extensive engagement. A system that will ultimately be adhered to and improved only exists where there is widespread understanding, support and buy-in from stakeholders.

Ideally, stakeholders will self-identify their issues and opportunities, allowing the process of risk assessment and control to be a collective undertaking.

Staff engaging with stakeholders, particularly customers, need to be skilled relationship managers and negotiators.

3.8.8 Determining Appropriate Controls

Controls to manage risks can be varied and need to be tailored to best suit the local situation and issues. Controls can include:

- **Pricing** - this may be pricing for specific parameters based on concentration and / or load, volume of water consumed, or trade effluent discharged etc. Where possible, pricing should seek to cost recover based on treatment requirements, dis-incentivise the discharge of particularly problematic parameters and incentivise the adoption of cleaner production and water efficiency. The "Polluter Pays" principle should be used as a basis for all pricing determinations to ensure that pricing does not allow poor performing customers to have their pollution costs covered by other, better performing customers.
- **Issue trade waste agreements** – this defines the clear requirements of tanners including monitoring requirements, discharge volume limits and water quality parameters, pre-treatment requirements, business management systems etc.
- **Installation of pre-treatment** – this may be either commonly available technology (where the industry / customer does not pose a significant risk) or best available technology (where risks are significant).
- **Regulator visits / inspections** – to establish an ongoing relationship with the customer and actively address any issues as soon as they arise in a co-operative manner. The frequency of inspections would be based on the relative risk posed by the customer, that is, a larger site with higher discharge volumes / concentrations / loads would be inspected more frequently than a smaller customer.
- **Customer education** – providing sufficient information to customers so that they understand their responsibilities and how they can best achieve the desired outcomes.
- **Customer monitoring** – monitoring (by customers under strict direction by regulators) of sufficient frequency to provide confidence that discharge of trade effluent from a premises is within set standards.
- **Regulatory monitoring** – monitoring by regulators to confirm customer monitoring is valid.
- **Cleaner production / water efficiency** – to reduce pollutants in a planned manner.
- **Non-compliance management** – actively working with non-compliant customers to address issues. This may also involve:
    - **Issuing infringement notices and fines** – to provide an immediate incentive for improvement.
    - **Cost recovery of time spent by the regulator addressing the non-compliance** – to provide an immediate incentive for improvement.
    - **Short-term blocking of access to the sewer** – where the risk of discharge poses immediate risks.
    - **Long-term disconnection from the sewer** – where a customer fails to address issues in a timely manner.
    - **Prosecution of the customer** – to follow appropriate jurisdictional environmental law and also send a message to the broader industry that gross non-compliance will be appropriately actioned.

3.8.9 Training and Development of Regulatory Staff

A key requirement of a well-functioning trade effluent management system and regulatory framework is knowledgeable and engaging staff.

The recruitment and training of such staff would be a key initial task. In the case of the Jajmau tanneries, such staff may include representatives from the Industry Association, Jal Nigam and Uttar Pradesh Pollution Control Board.

The Gruppo Dani Tannery (See Case Study 3.2), a finalist in the 2013 Tannery of the Year awards, has a strong commitment to training, allocating up to 7000 hours per year for staff training programs.

3.8.10 The Victorian Example

Victorian Regulation of Services

One wholesale company, Melbourne Water and three retail companies operate in the Melbourne Metropolitan Area. The retail companies are state owned and are the holders of water and sewerage licences issued under the *Water Industry Act (Vic) 1994*. The retail water businesses function with independent skill based boards that are appointed by and report to the Minister for Water. The retail water companies operate the water distribution and sewerage systems for the Melbourne metropolitan area. The wholesale company, Melbourne Water, is the supplier for the three retail companies. Melbourne Water controls the major treatment plants and is responsible for drainage and waterways.

Corporate governance responsibility for the water sector is divided between the Department of Environment & Primary Industries (DEPI) and the Department of Treasury and Finance (DTF). Under the State's laws, the Board of each water business reports to the Minister for Water. In turn, the Minister is responsible for reporting to Parliament on the performance of each water business.

The Essential Services Commission (ESC) is responsible for regulating prices and service quality for the entire Victorian water industry, and is also the regulator for trade waste. The ESC have issued a Trade Waste Customer Service Code (refer to Annex).

The *Water Industry Act 1994 (Vic)* was introduced to establish the framework under which the three Melbourne water retailers are regulated. It provides the regulation framework and service standards and establishes the ESC as the water industry price regulator. It also allows the Minister to issue Statements of Obligations (SOO) to each water business. Each water business has a SOO that specifies a number of requirements for the water business to follow. SOOs are based on a combination of water legislation requirements and government policy. The retail water companies are also obliged to manage trade waste along with industry. Figure 3.14 illustrates the relationships of the various organisations involved in trade waste management in Victoria.

EPA Victoria monitors and oversees the environmental performance of the State's water sector, which includes licensing for the discharge of treated wastewater into waterways and the management of recycled water and biosolids generated at treatment plants. Under its new 'corporate licence' program, each water business will have a single licence with the EPA to cover all of its wastewater facilities. Previously, a separate licence was required for each wastewater facility. The corporate licence sets out a number of requirements covering:

- a joint, public commitment by the EPA and the water business to increase sustainability of the water business; and
- performance requirements for the water business to meet.

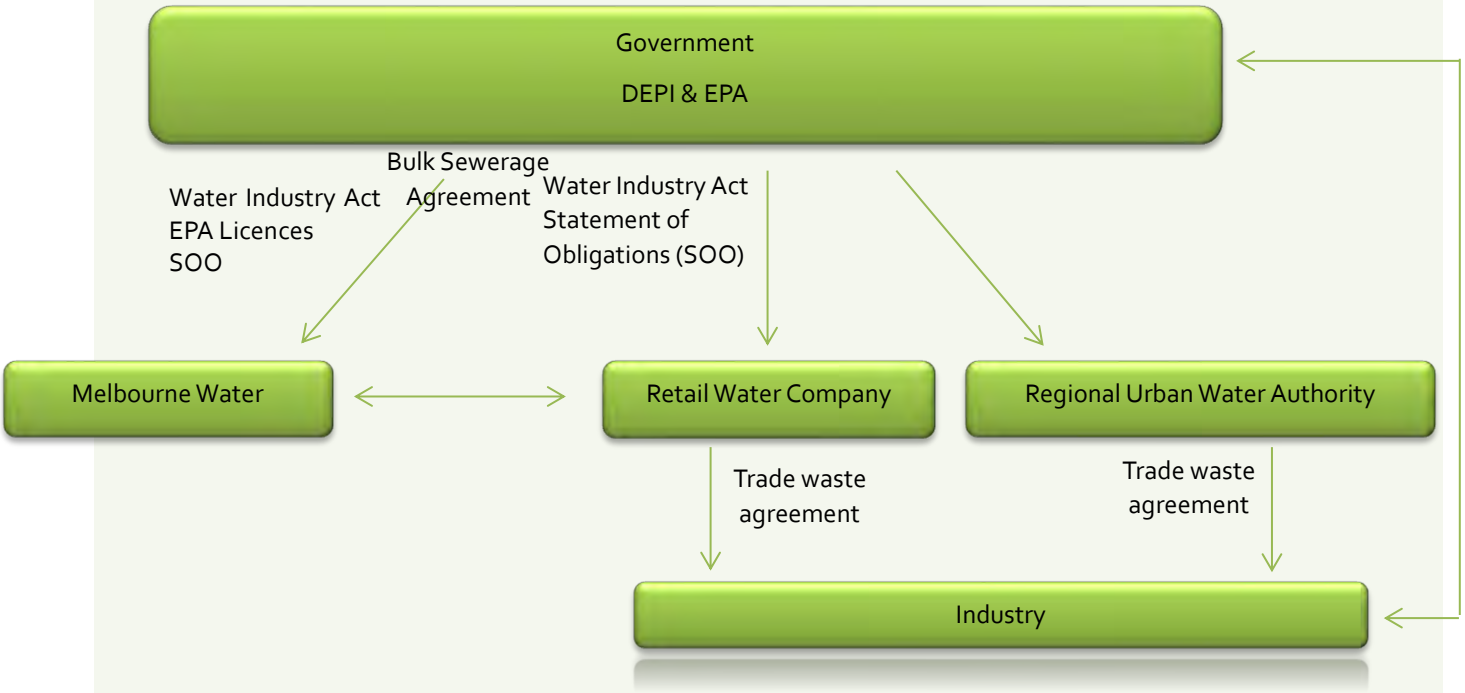


Figure 3.14: Victorian Trade Waste Management Process

Pollution control approaches

The retail water companies have systems in place to manage the relationship with industry and ensure that performance is monitored and maintained, predominately tied in to a Trade Waste Agreement. Plant Capacity Statements are documents that have been developed to provide the retail water companies an indication of how the plant performed in terms of treatment capacity and limiting contaminants.

Melbourne Water passes on wholesale prices for treatable pollutants including total Kjeldahl nitrogen (TKN), biological oxygen demand (BOD), suspended solids (SS) and in some cases TDS, which are passed on to the customers. These are based on forecast loads provided by the retail water companies and necessary augmentation of the plant based on growth and compliance. Figure 3.15 illustrates the wastewater system and the types of associated risks.

The Haz Waste fund (see Case Study 3.3) is one such strategy to reduce waste in industry.

Case Study 3.3 HazWaste Fund, Victoria

The HazWaste Fund was established in 2008 to support Victorian industry to fast-track reductions to the volume and hazard of hazardous waste generated in Victoria, as well as to increase the active remediation of contaminated land. AU$30 million was provided in Grants over a period of four years.

Grants were awarded to various organisations across a number of industries with wastes, ranging from organic waste to chemical and metallic wastes.

Two Victorian leather producers were awarded grants, including:

- ***Howe Leather***
  - This project included an analysis of total petroleoum hydrocarbons in filter cake, to determine if Category B is a false reading due to animal fat residuals. The project was completed in 2008 and diverted up to 400 tonnes of waste; and
- **Rosedale Leather**
  - This project investigated the composting potential of Rosedale Leather's waste. The program was proven highly successful, with the results of the composting trials indicating that both the chrome-containing and chrome-free prescribed waste could be effectively managed through composting.

See http://www.epa.vic.gov.au/our-work/programs/hazwaste-fund/hazwaste-fund-recipients for further examples of successful grant recipients.

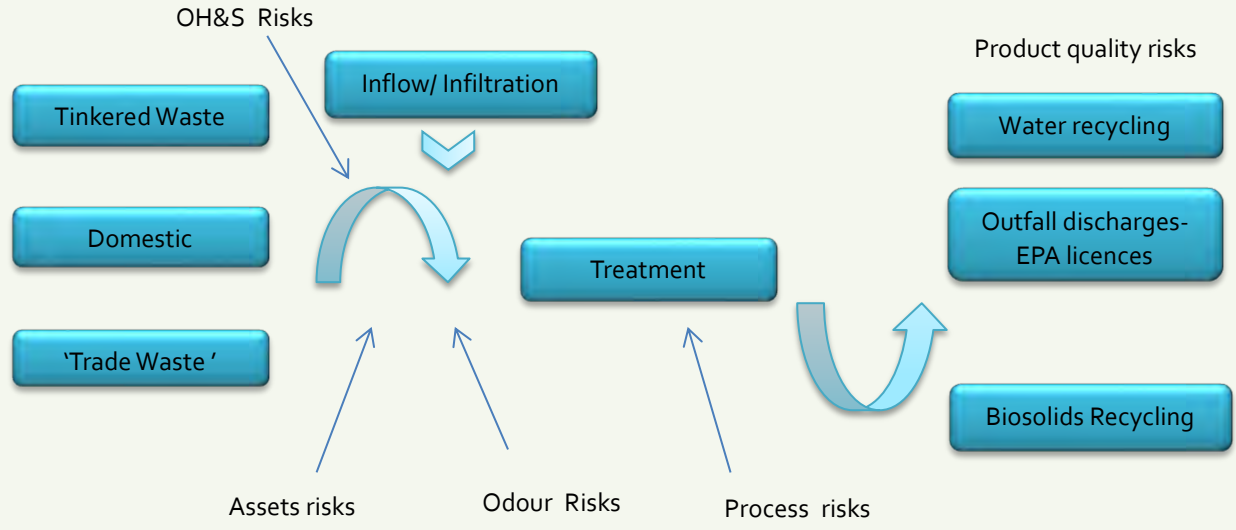


Figure 3.15: Wastewater Treatment System

Controls and preventative measures that are used to ensure that the quality and quantity of wastewater produced by industry is acceptable for the wastewater treatment plants include:

- Negotiation of Trade Waste Agreements;
- Risk based monitoring and inspections;
- Management of the compliance process;
- Charges associated with Trade Waste Agreements, non-compliance and variations;
- Education regarding cleaner production and waste management process; and
- Incentives for improved performance.

Trade Waste Agreements are negotiated taking the following points into consideration:

- Understanding of process properties of substances involved in processes (Material Safety Data Sheets);

- Volume and concentration limits for allowable substances (Trade Waste Standards);
- Monitoring Requirements
    - Company self-monitoring
    - Monitoring conducted by the retail water companies;
- Treatment and waste management requirements; and
- Risk Assessment Plans.

Effluent Discharge Pricing

The pricing applied to effluent discharges is designed to:

- Reflect the costs of providing services to customers;
- Promote the sustainable use of Victoria's water resources;
- Enable customers to readily understand and respond to the pricing signals;
- Have regard to the interests of low income and vulnerable customers; and
- Be administratively simple

An example of the relationship between customer risk rank, monitoring frequency and Trade Waste Agreement fee is provided in Table 3.29.

Table 3.29 Relationship between Customer Risk Rank, Monitoring Frequency and Agreement Fee

Customer Risk Rank	Monitoring Frequency	Agreement Fee
Risk Rank 1 (highest risk)	2 week inspections	$12,271
Risk Rank 2	6 week inspections	$10,178
Risk Rank 3	12 week inspections	$5,110
Risk Rank 4	26 week inspections	$1,116
Risk Rank 5 (lowest risk)	52 week inspections	$211.92

Melbourne Water wholesale charges are approved by the Essential Services Commission. The usage charges are based on average cost models including fixed and variable costs. The fees are based upon the total volume of water entering the treatment plant as well as the load of the contaminant to be treated.

Compliance management

A customer is non-compliant with their Trade Waste Agreement if they:

- Discharge a substance with a concentration or load greater than their Trade Waste Agreement allows; or
- Breach an administrative requirement and are issued a non-compliance notice.

A staged process is implemented to manage non-compliance. The process focuses upon the retail water companies working with industry. Melbourne Water must be notified if the non-compliance poses a significant risk. The process is co-operative in the initial stages and coercive in the final stage. Non-compliance impacts on a customer's risk rating through increased monitoring requirements and fees.

Customers that cannot meet standards require approval from Melbourne Water for their wastewater to be accepted by the trade waste sewer. A 1 microgram per litre limit applies to substances not listed on the Trade Waste Agreement. The variation process involves the completion of a risk assessment. A conditional agreement may be granted which is time limited. A management plan for the pollutant being a requirement of the conditional agreement.

4.0 The Road Map

The proposed Road Map provides a strategy to deliver real benefits to the Ganga and the community of Jajmau. The recommended priority areas present both relatively inexpensive actions that can be introduced in the short term and more capital intensive items that will require a longer time frame to implement.

Five priority areas are identified in the Road Map:

1. Support the Tannery Industry;
2. Cleaner Production / Water Efficiency Programs;
3. Optimisation of the Current Treatment System;
4. New Plant and Operational Model; and
5. Community Development.

An illustrative representation of the Road Map is represented in Figure 4.1. The dollar signs of the figure demonstrate the relative spends for the different priority areas. For example, Priority Areas 1 and 2 are relatively inexpensive (represented by $) compared to Priority Area 4 (represented by $$$) which will involve a significantly greater spend. Similarly, the timelines on the figure illustrate that the first two priority items can be completed in the short term, while the construction of a new treatment plant (if required) will take considerably more time.

The first four priority areas are interrelated. The implementation of the initial priority areas are expected to have immediate results as well as reducing costs associated with actions linked to the following priority areas. However, the Priority Area activities are not necessarily successive. These actions can take place concurrently with the feasibility, design and construction phases of the project. The Community Development program will be run in parallel with the other four Priority Area actions.

The activities associated with Supporting the Tanneries Industry and Cleaner Production/Water Efficiency are considered to be short term high priority items. These initial activities should result in significant pollution load reduction to the wastewater treatment network, therefore likely reducing the size, complexity and expense of future infrastructure upgrades and/or replacement.

Community development programs will need to be instituted throughout the entire Road Map program. These actions will complement the activities proposed for the other four priority areas, with the aim of advancing the well-being of the residents of Jajmau.

It is important to note that the Road Map is a dynamic document. Some of the activities listed in the following sub-sections have already been commenced.

A strong Industry Association equipped with suitable resources is considered fundamental to ensure the ongoing and long term success of any improvement plan.

Plate 4.1 Kanpur Residents in the River Ganga

The Road Map overview

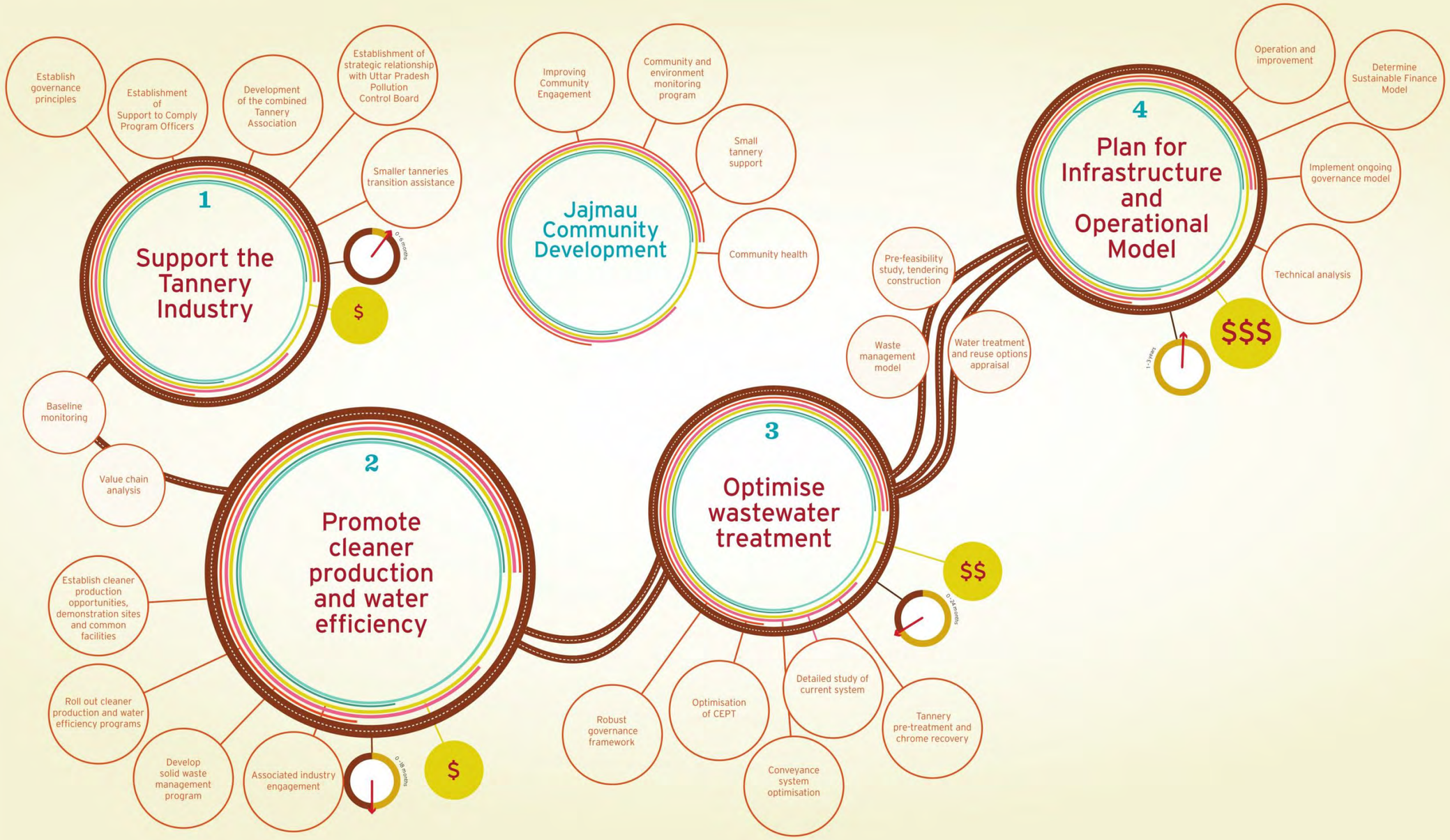


Figure 4.1 The Road Map Overview

4.1 Support the Tannery Industry

Priority Objective

The objective of Priority Area 1 is to establish and build the capacity of a single Tannery Association to support a sustainable tannery industry in Jajmau,

Importance

The strong support of the Tannery Industry is critical to the success of the Road Map. Three tannery associations currently represent the tanning industry in Jajmau. These associations have endeavoured to represent the diverse collection of tanning operations in Jajmau with limited resources and support to assist their efforts. The associations are made up of influential leaders within the tannery industry who are looking for opportunities to partner with government to resolve environmental and regulatory concerns.

The development of an influential, respected and sustainable tannery association, (the Association) is an essential first step for the implementation of improved operational and waste management practices for the Jajmau tannery cluster. This is particularly important in relation to restoring the confidence of the regulators that the industry is willing and able to take the necessary steps to comply with regulatory requirements within a reasonable time frame. Additionally, a strong industry association will establish a clear role in the trade effluent governance framework.

Priority Outcomes

An Association with appropriate resources playing a central role in the delivery of:

- Delivery of training to demonstrate to tannery operators simple methods to reduce the use of water and chemicals in all tanneries;
- Provision of ongoing support to tannery operators to implement business improvements to reduce the use of water and chemicals;
- Establishment of appropriate trade effluent management requirements as part of the established governance framework; and
- Delivery of incentives to tannery operators that demonstrate that they are treating and disposing of wastes by acceptable methods.

The Association will need to be responsible for interacting with and regularly reporting on progress to the UPPCB. The improved avenue for communications between the UPPCB and the tanneries will enable the Jajmau tannery operators to build more productive relationships with regulators.

Stakeholders

Stakeholders include tanneries, the newly established tannery association, UPPCB and the Jal Nigam as the current CETP operator.

Activities

Priority Area 1 consists of the following activities:

- Development of a combined tannery association;
- Establishment of a support to comply program;
- Establishment of an improved governance
- Establishment of a strategic relationship between the Association and UPPCB.

These activities are described in detail below.

Strengthening of the Industry Association

Key Performance Indicators

1. Set up and Resourcing of Association Office Space.
2. Establishment of an Association Charter.
3. Institution of the Jajmau Tanneries Leadership Program.
4. Creation of Program to Deliver Benefits to Association Members.
5. Establishment of Support to Comply Officers.
6. Launch of Knowledge Exchange Program with other Indian Tannery Groups.
7. Establishment of Trade Effluent Management Requirements
8. Agreement to Memorandum of Understanding with UPPCB.

4.1.1 Establishment of Tannery Association

A single Association will need to be established to represent and support all tannery operators in Jajmau.

This will need to include:

1. Establishment of Association Resources

An administrative assistant will need to be hired to assist with the establishment of the association.

An Association office will need to be established in Jajmau. The office will need to include:

- Office space for Support to Comply Officers (see Section 4.1.3);
- Desks and computers available for use by Association members;
- Desks and computers available for use by companies providing benefits, environmental or otherwise, to the Jajmau tannery industry;
- Access to suitable facilities for conducting industry meetings and training sessions; and
- Access to suitable facilities for hosting meetings with government agencies.

2. Establishment of Association Arrangements

The establishment of the Association will include:

- Incorporation under Section 25 of the Companies Act (1956). Requirements relating to the Association constitution and reporting will need to comply with the Companies Act (1956). Shares in the Association would likely be based in proportion to the production capacity of each tannery.
- Development of an Association Charter for Members. The Association members will need to develop and sign a charter that detailing a set of commitments that each tannery agrees to follow as a member of the Association. This Charter will serve as a demonstration to the regulator and the Jajmau community, of the dedication of all of the tanneries to minimise the impact of tannery operations upon the environment and the surrounding community. It is anticipated that the Charter will include pledges to:
    - Improve tannery operations to ensure the sustainable transport, treatment, reuse and disposal of tannery effluent;
    - Dispose of solid waste in a manner that is acceptable to the regulator and the community; and
    - Reduce wastage of water and chemicals.

3. Development of Framework for Trade Waste Agreements

The Tannery Association will need to develop a framework to provide adequate controls for each tannery operation to reduce risks to waste treatment infrastructure. Initial trade waste agreements will focus on support to comply and cleaner production aspects and form a commitment by tanneries to embark on improvement process.

4. Establishment of Tannery Membership Fees

Contributions to the fund by the tanneries will need to be proportional to the production capacity of each tannery. The fund will be used to save money to contribute towards potential future large spends on infrastructure by the tanneries.

5. Development of Services and Benefits Offered to Members

The Association will need to provide a variety of services and benefits to all of its members:

- Productive engagement with regulators through a Support to Comply Program (see Section 4.1.2).
- Support for improved management of tannery operations (i.e. seminars and advice on ISO accreditation);
- Support for cleaner production for large and small operators (see Section 4.2);
- A leadership program to provide tannery industry workers with opportunities to build upon their leadership skills. The program will be targeted to emerging tannery industry leaders.
- Beneficial collective arrangements - an example may be the bulk order of speciality chemicals by the Association, with the savings passed on to the individual tanneries.

Regular meetings will be held where the Association members can discuss ways in which the Association can assist their operations.

4.1.2 Establishment of a Support to Comply Service

Resources and capability will be developed within the Tannery Association to provide advice on cleaner production, regulation and compliance. This will include:

1. Support to Comply Officers

Two Support to Comply Program Officer roles, in addition to a manager and an administrative assistant will be established within the Association. The positions will specialise in understanding regulatory requirements and cleaner production opportunities and the role of the regulators.

The Program Officers will:

- Liaise with UPPCB inspectors
- Conduct cleaner production and water efficiency support work continue to maintain skills and knowledge by visiting other tanneries outside of Jajmau and keeping up with best practice; and
- Prepare information and technical notes that can be distributed to tanneries.

2. Knowledge Management System (Knowledge Hub) and Exchange with other Tannery Associations and Research Organisations

The Association will develop resources (Knowledge Hub, see Section 4.2.4) to enable information exchange with other tannery associations and research organisations throughout India. In particular, knowledge regarding cleaner production and water efficiency program interventions and successes will be stored.

Study tours will be arranged for Association members to tour other industry clusters in India, such as in Tamil Nadu where waste management initiatives have resulted in the reduction in water usage by tanneries of up to 40%. Likewise tannery experts from around India will be invited to Jajmau to exchange knowledge with Jajmau tannery operators. International study tours, to location such as Australia, to learn about waste management best practice will also be conducted.

4.1.3 Assistant Funding Framework

The establishment of an assistance to funding framework is required to be undertaken early in the implementation of the Road Map as it establishes the rules governing the distribution of funds. There are a variety of options for the funding framework including small grants, one-to-one financing, and low interest loans that may be considered under this framework.

4.1.4 Establishment of Strategic Relationship with Regulatory bodies

A key function of the Association will be to improve communications and establish a strategic relationship between the Jajmau Tannery Industry and the UPPCB that delivers quantifiable environmental outcomes. This will include:

1. Creation of an Ongoing Dialogue with the regulators

Meetings between the UPPCB and the Association will be scheduled at regular intervals (e.g. monthly). Priority issues will be agreed upon at these meetings. Other industry groups in India will also be contacted for advice with regards to regulator communications. An independent mediator should be present for the initial meetings to facilitate communications between the groups.

2. Establishment Clarity on Systems for the Management of Waste

It is proposed that the Association work with the UPPCB to discuss and agree upon a risk-based system - similar to those used by leading pollution managers internationally (see Section 3.7) - that will be implemented for the management of risk posed by the tannery industry in Jajmau.

This will include the identification of hazards and their associated risks to the environment and worker safety. The identification of hazards and risks will be guided using established processes from the International Standards Organization (i.e. ISO 22000). These risks will in turn inform the necessary control measures, e.g. customer requirements for sampling and reporting, customer inspections, wastewater network monitoring etc.

Information systems will also need to be developed to provide regular reporting to the UPPCB on tannery operator and total wastewater system performance.

Customer inspection frequency will vary based on the risk posed, for example, size of operation, history of compliance etc. This ensures that support to comply resources are targeted to the highest risk and biggest potential benefits.

3. Development of a Memorandum of Understanding between Association and Regulators

A MoU is to be signed between the Association, on behalf of the tanneries, and the UPPCB. The MoU will clearly define the relationship between the parties and will outline objectives, roles and responsibilities.

4.2 Cleaner Production and Water Efficiency

Priority Objective

A cleaner production and water efficiency program will need to be established by the Association to realise immediate and continuous gains in reducing waste discharge from tanneries. The implementation of initiatives such as support to comply, education, cleaner production and optimisation of existing infrastructure demonstrate immediate action to reduce pollution and lead to more sustainable industry practices.

Importance

In Jajmau there have been no significant successful cleaner production interventions to-date, as a result, tanneries produce significantly more pollution per unit of product than other locations in India, such as Tamil Nadu. A number of cleaner production technologies have been considered however none have been successfully implemented (see Section 3.5.1). It has been demonstrated elsewhere in India (e.g. Tamil Nadu) that cleaner production can reduce, effluent volumes and pollutant loads by up to 40%.

In addition to pollution reductions, the implementation of cleaner production and water efficiency (CP/WE) interventions have a number of important benefits including:

- The potential to realise immediate and significant reductions in pollution entering the Ganga River;
- Being a driver for business / operational efficiency and know-how leading to improved competitiveness;
- Being a means to significantly reduce requirements for high cost end of pipe treatment infrastructure; and
- Acting as a means of supporting broader pollution control governance (i.e. regulation and enforcement).

Priority Outcomes

Priority outcomes of the Clean Production and Water Efficiency Program are:

- Reduced resource use, particularly water and chromium.
- Improved quality of tannery effluent, particularly for the limiting parameters of TDS and chromium.
- Reduced volume of tannery effluent and solid waste.
- Improve efficiency and competitiveness of tannery operations; and
- Demonstrated benefits of these initiatives in reducing downstream impacts and costs.
- Demonstrate the benefits of customer assistance programs in a total governance framework.

Indicative key performance indicators are provided in Table 4.1.

Stakeholders

Stakeholders include tanneries, the newly established Tannery Association, UPPCB and the Jal Nigam as the current CETP operator.

Activities

Priority Area 2 will consist of the following activities:

- Case study pilots / demonstrations;
- Large tanneries CPWE Program;
- Small tanneries CPWE Program;
- CPWE Communication; and
- Solid Waste Management.

Based on the outcomes of these it may be necessary to engage with associated industries, e.g. hide preservers, chromium suppliers etc. to improve raw product suitability to further enhance CP/WE opportunities. This may lead to additional activities to meet the above objectives.

The above listed activities are described in detail in the proceeding section.

Table 4.1 Key Performance Indicators for Cleaner Production and Water Efficiency

Cleaner Production and Water Efficiency
Key Performance Indicators 1. Demonstration of benefits of Cleaner Production Initiatives through Demonstration Site Program 2. Implementation of Large Tannery Cleaner Production / Water Efficiency Program that Achieves: a. 30% Reduction in Effluent Discharge b. 30% Reduction in Chromium Load in Effluent Discharge c. 20% Reduction in TDS Load in Effluent Discharge 3. Implementation of Large Tannery Cleaner Production / Water Efficiency Program that Achieves: a. 25% Reduction in Effluent Discharge b. 25% Reduction in Chromium Load in Effluent Discharge c. 10% Reduction in TDS Load in Effluent Discharge 4. Demonstrated Tannery Staff Education in Cleaner Production and Water Efficiency 5. Evidence of Cost Savings to Tannery Operators 6. Implementation of Cleaner Production and Water Efficiency Communication Program 7. Reduction in Volume of Illegal Solid Waste Disposal

4.2.1 Case Study Pilots / Demonstration Sites

Case Study Pilots / Demonstrations will need to be conducted to test and demonstrate positive and quantifiable environmental and business benefits of cleaner production and water efficiency for tanneries.

Work associated with this activity would entail:

1. Baseline monitoring

In order to demonstrate CP/WE improvements, it will first be necessary to determine baseline (current) water and raw product use throughout the tanning process. This will then allow for the identification of CP/WE improvement opportunities and provide the basis for a clear comparison once these improvements have been implemented and embedded.

2. Identify and establish arrangement with suitable analytical laboratory

A local analytical laboratory will need to be engaged to analyse water samples for the establishment of a baseline.

3. Analysis of improvement opportunities

Once sufficient data is available, potential improvement opportunities can be evaluated for water and raw product saving potential. This would include a detailed review against international best practice for CP/WE in tanneries (see Section 3.5).

4. Improvement interventions

Interventions will be implemented by working directly with each individual tannery operator and their staff. The exact nature of the engagement will be determined by the interventions, however it is expected this will at a minimum include staff behaviour change, process step changes and installation of new equipment.

Interventions may also be related to new infrastructure which is a resource for all tanneries, such as a common wash facility (see Section 4.3).

5. Analysis of changes and refinement of interventions

Changes in water and product use, waste stream qualities, and expenditure will be evaluated. Graphs and diagrams will be used extensively to provide information in a way that is easy for stakeholders to understand.

6. Communicating success

There will be a range of communication activities to promote achievements to the broader tannery industry and stakeholders, including open days at demonstration sites and industry seminars to share experiences.

Outcomes

Outcomes expected from this work include:

- Positive examples to generate enthusiasm among stakeholders;
- Demonstration of what can be practically achieved in reducing water use and tannery discharge concentrations;
- Capacity building of local stakeholders to further implement cleaner production and water efficiency;
- Data to assist in determining total infrastructure needs for best total cost outcomes; and
- Evidence to support outcomes agreed between the Association and the UPPCB under the proposed MoU.

4.2.2 Large Tanneries Cleaner Production / Water Efficiency Program

A CP / WE Program, tailored specifically to larger tanneries will need to be designed and implemented to:

- Reduce water use and effluent concentrations for key parameters at large tannery sites;
- Instil behavioural change in tannery staff for improved outcomes; and
- Realise cost savings to each business from improved practices.

Work associated with this activity would entail:

1. Identification and implementation of CP / WE interventions

A similar approach undertaken during demonstrations (see Section 4.2.1) would be used to identify and implement interventions including:

- Monitoring and auditing;
- Analysis of improvement opportunities;
- Improvement interventions;
- Analysis of changes and refinement of intervention; and
- Each site will be extensively audited for existing practices related to water and raw product use, with baseline measurements recorded and monitoring equipment installed as necessary.

Using the data collected, all opportunities for reducing water and product use will be evaluated with the tannery operator, considering:

- Water saving potential;
- Raw product saving potential;
- Energy implications (does saving water and products increase / decrease energy use);
- Expenditure saving potential (what will be the money savings for the business);
- Return on investment timeframes (how long will it take to pay back); and
- Triple bottom line outcomes, in particular potential to reduce environmental impact.

From this analysis, bespoke solutions will be agreed for implementation, including behaviour change for staff, installing equipment and reuse systems, establishing new business processes etc.

2. Allocation of assistance funding based on expected ROI and pollution reduction potential

Once implemented, interventions will be assessed for effectiveness and refined as necessary. Ongoing monitoring will demonstrate the reductions achieved at the site.

4.2.3 Small Tanneries Cleaner Production / Water Efficiency Program

A CP / WE Program, tailored specifically to smaller tanneries will need to be designed and implemented to:

- Reduce water use and effluent concentrations for key parameters at small tannery sites;
- Instil behavioural change in tannery staff for improved outcomes; and
- Realise cost savings to each business from improved practices.

Work associated with this activity would entail:

1. Establishment of CP / WE (Small Tannery) Working Group

A working group would be established under the Association to oversee the implementation of CP / WE Program (small tannery) activities. Small tannery sites (processing less than 200 hides per day) will be engaged on CP / WE concepts and best practice. It is estimated approximately 300 tanneries in Jajmau would be considered small sites.

2. Identification and implementation of CP / WE Interventions

Sites will need to be visited by CP / WE experts to advise on simple measures that can be introduced, with ongoing support available. Follow-up visits will check on progress and measure the success of any changes made at each site.

3. Guidance on best practice CP / WE

Small tanneries will need to be provided with guidance on best practice cleaner production and water efficiency (based on demonstration exercises – see 4.2.1), with easy to follow instructions on implementing changes to their business to reduce water and raw product use.

Guidance will need to include:

- Fact sheets with simple instructions on common problems and solutions
- Open days at demonstration sites to explain what improvements can be easily made
- Seminars where small tanners can gather to share experiences and hear / learn from experts

4.2.4 On-site visits and on-going support for Cleaner Production / Water Efficiency Communication

A CP / WE communication and engagement strategy will be developed to:

- Provide easy to understand guidance on cleaner production and water efficiency in large and small tanneries.
- Provide multiple avenues for tannery operators to access and share information on cleaner production and water efficiency.
- Promote the success of Cleaner Production and Water Efficiency across the Jajmau tannery precinct.

The strategy will consider the differing needs and most effective means of engaging tannery operators (large and small) – i.e. language etc.

The work for this activity will need to include:

1. CP / WE knowledge facility

A CP / WE (Large Tannery) knowledge facility housed in the overall Tannery Association Knowledge Hub (see Section 4.1.2) will be established. This facility will be managed by Tannery Support to Comply Officers. Information will include:

- Information booklets;
- Case study fact sheets;
- Details and videos of industry best practice and technology; and
- Question and answer portal for individual tanners to post questions.

2. Fact sheets and guidance

Documents will be prepared that explain the issues posed by tannery effluent to the Ganga River, common problems at large and small tannery sites and the best solutions to these problems. All guidance will be written so as to be easy to understand and follow, including extensive use of pictures, diagrams, tables and graphs.

3. Open days

Demonstration sites will be used as a focal point for the industry to gather and witness firsthand the potential for business improvements due to cleaner production and water efficiency. The managers of the demonstration sites will lead all tours, explanations and discussions to encourage other tannery managers to engage in the process.

4. Industry seminars

Seminars will be used to gather large numbers of tannery operators together to share experiences and knowledge on cleaner production and water efficiency.

5. Training sessions

Specific training sessions on key aspects of CP / WE will be run for multiple stakeholders to attend. Stakeholders would include tannery operators, industry association staff and regulators.

4.2.5 Solid Waste Management Program

A Solid Waste Management Program will be established with the aim of minimising solid waste entering landfill and being illegally dumped by the tannery industry. Emphasis will be placed on identifying opportunities for resource minimisation, reuse in production processes, and creation of bi-products.

The work for this activity would be required to consist of:

1. Assessment of current solid waste production and management at tanneries.

Baseline monitoring will be undertaken to establish with reasonable confidence:

- The quantities of raw materials used by the tanneries,
- The amounts of solid waste that is generated; and
- How the solid waste is managed or disposed of.

2. Investigation of options for solid waste management.

Knowledge sharing may be between Jajmau tanneries, other Indian tannery clusters and international tanneries and companies.

Solid waste management options will be ranked and prioritised according to which options will results in the greatest improvements.

3. Implementation of improvements.

Criteria for implementation will be refined, but will be based on the Pareto Principle. That is, that in many instances, most potential savings (for example 80% of saving potential) will result from simple / lower cost interventions. The remaining 20% of savings potential will be much more difficult and costly to obtain.

4. Supporting businesses

Businesses (such as offcut composters, chrome sludge traders) that could participate in solid waste management schemes will be identified. Discussions will be held with these businesses to identify the variability and profitability of potential solid waste management schemes.

4.3 Wastewater Treatment Optimisation & Governance

Priority Objective

To optimise the current waste water treatment and conveyance infrastructure in order to minimise environmental impacts associated with the Jajmau Tannery Industry prior to the implementation of new infrastructure (as opposed to an upgrade of treatment infrastructure as presented in Section 4.4).

Importance

The current CEPT has not been effective in preventing pollution from entering the Ganga River for several reasons:

Pre-treatment and Conveyance:

- The quantity of wastewater delivered to the CETP significantly exceeds the treatment capacity of the CETP;
- Wastewater received by the CETP has not received the appropriate level of pre-treatment; and
- Wastewater received by the CETP includes stormwater, ground water infiltration and liquid waste associated with illegal sewer connections.

Tertiary Treatment:

- Common Chrome Recovery Plant (CCRP) is not being utilised by the majority of tanneries.
- The CETP is not operating in accordance with the original design specifications, in order to treat the maximum amount of tannery effluent it can process that is delivered by the conveyance system.

New infrastructure for the treatment of tannery waste may not be implemented for a number of years and has significant cost implications. Optimisation of the current system will provide a means by which impacts to the environment can be reduced until the new treatment plant is constructed. Optimisation is also expected to significantly reduce longer-term infrastructure spending as there will be less waste that requires wastewater treatment.

Priority Outcomes

Optimisation of the current system aims to:

- Deliver appropriate quality tannery effluent to CEPT. Minimise non-tannery industry flows entering the tannery industry effluent treatment conveyance network;
- Prevent chromium polluted wastewater from tanneries entering the domestic sewage conveyance system;
- Protection of sewer assets from corrosion or failure as a result of sewage qualities.
- Improve the use and operation of:
    - Existing pre-treatment and chrome recovery facilities at individual tanneries;
    - The current CCRP; and
    - The current CETP.
- Minimise the quantity of untreated and contaminated tannery effluent entering the Ganga.

Stakeholders

Key stakeholders likely to be involved with the implementation of Wastewater Treatment Optimisation include tannery operators, the tannery Association, UPPCB and UP Jal Nigam (and CETP staff). The roles of each stakeholder will include:

- Tannery Operators – current practices may need to be adapted by tannery operators to optimise the use of the current system.
- Tannery Association – will take on the role of monitoring tannery discharges to the treatment system.
- Uttar Pradesh Pollution Control Board (UPPCB) – The UPPCB will be responsible for monitoring the discharge of wastes from the CETP and working with the Tannery Association to ensure that Tannery Operators segregate and/or treat their wastes to the appropriate standard prior to discharge.
- Uttar Pradesh Jal Nigam – The Uttar Pradesh Jal Nigam are responsible for the operation and maintenance of the CETP.

Activities

Priority Area 3 will consist of the following activities:

- Detailed study of the current system (drawing on previous literature);
- Advancement of pre-treatment and chrome recovery systems;
- Conveyance system optimisation and management;

- Optimisation of current CETP.

These activities are described in Table 4.2 below.

Table 4.2 Wastewater Treatment Optimisation

Key Performance Indicators
1. Completion of Detailed Water Balance of the Jajmau Tannery Industry and Associated Treatment Systems 2. Establishment of Accredited Trade Waste Management Principles and Systems 3. Improvement in the Quality of the Effluent Disposed of by Tanneries 4. Improvement in the Quality of the Treated Effluent Disposed of by the CETP

Plate 4.2 Pumping stations across the Jajmau conveyance system.

4.3.1 Detailed Baseline Study of Current System

A detailed quantitative study of the current system will be conducted to fill gaps in the work done to date, and identify actions to optimise operation of the current system. The aim of this work is to provide a detailed water balance of the volume and nature of the water/effluent that enters the current conveyance system and is delivered to the CETP.

The work for this activity will consist of:

1. **Review of current information about the system**

A review of the work completed to date (e.g. IITK papers, DPRs etc.) including: current system specifications (e.g. system design specification, materials, equipment) and anecdotal / qualitative information gathered through engagements with various stakeholders (e.g. tanneries, UPPCB, CETP, IITK).

2. **Design and implementation of system monitoring**

A strategic and cost effective monitoring program will be designed and implemented. This will include on-site flow monitoring and flow monitoring at critical control points across the system including key junctions along confluence, at pumping stations, and at stormwater overflows.

Monitoring will be conducted throughout the year to assess variations in flow quantity and quantity that result from:

- Periods of low and high leather manufacturing activity; and
- During periods of low and high rainfall.

3. **Quantification of illegal connections and illegal dumping**

Monitoring data and network inspections will be used to estimate the extent of illegal connections/dumping into the tannery and/or municipal sewage conveyance system.

4. **Spatial representation of wastewater system.**

Identification of existing GIS information (e.g. satellite imagery, municipal land info, etc.) and detailed land, asset and customer ground survey.

4.3.2 Advancement of Tannery Pre-Treatment and Chrome Recovery Systems

A program to advance existing and potential pre-treatment and chrome recovery systems will need to be implemented

The work for this activity is required to include:

1. **Appraisal of the pre-treatment and chromium recovery facilities**

The effectiveness of the pre-treatment and chromium recovery facilities that are currently used by the tanneries will be investigated. The appraisal will include an evaluation of the quantity and composition of wastewater flows that are directed to pre-treatment and chrome recovery facilities and the composition of the streams following the operation of the pre-treatment and chrome recovery systems. The cost of the operation of the pre-treatment and chrome recovery units by the tanneries will also be assessed, including ease of use and skills and competencies of relevant staff. Chromium manufacturers will be consulted regarding their requirements with regards to recovered chromium.

2. **Enhancement of Tannery Pre-treatment and Chromium Recovery Systems**

Solutions to improve the effectiveness of tannery pre-treatment and chromium recovery systems will be recommended and implemented. Such solutions may include the distribution of incentives to tanneries that demonstrate they are treating wastewater to an acceptable standard. Where beneficial, training will be supplied to operators on the efficient operation and maintenance of pre-treatment and chromium recovery equipment. Grants may also be sourced /supplied to tanneries for the repair or replacement of old equipment.

3. **Common Chrome Recovery Plant**

An audit will be conducted to assess the use of the CCRP by the tanneries that do not have their own chrome recovery facilities. For these facilities, it will also be assessed whether the separation of chrome and non-chrome process streams is adequate or if training or process modifications are required to ensure all chromium impacted waste water is collected, stored and transported to the CCRP.

4. **Optimisation of the CCRP**

The performance of the CCRP will be reviewed to ensure a suitable product is produced from the process. Chromium manufacturers will be consulted regarding their requirements in relation to recovered chromium.

4.3.3 Conveyance System Optimisation

The design and construction of new sewerage infrastructure in Jajmau will take several years to complete. A conveyance system optimisation and management program will be established. This will include:

1. **Conveyance system appraisal and repair**

Conduct a feasibility assessment for the repair and / or replacement of existing sewer infrastructure (prior to major upgrades at the CETP) using information gathered during 4.3.1. Based on the results of this work, pursue options for financing detailed design, tender and construction (see Section 4.4.3).

2. **Conveyance system repair**

Implement strategic repairs to the existing conveyance system (Note: this does not include full upgrade of the system).

4.3.4 Optimisation of Current Common Effluent Treatment Plant

Optimisation of the performance of the current CETP will be conducted in parallel with CE / WE interventions (Section 4.2) and other WWT Optimisation activities outlined above.

The work for this activity will consist of:

1. **CETP and Sewage Treatment Plant (STP) Operation Review and Options Analysis**

A review of current operation and management of the CETP plant and STP will be conducted. The review will consider the quality of treated sewage from the municipal STP and opportunities for blending the two treated wastewater streams for improved environmental impacts.

Building on existing work, an options analysis will be conducted to determine the most optimal and efficient options for treatment of current and future effluent volumes after various stages of CP / WE and Conveyance Optimisation intervention.

A risk assessment will be conducted to evaluate short-term actions (before the construction of a new CETP) that can be introduced to minimise the harm caused to the environment from untreated tannery effluent.

2. **Wastewater treatment modelling**

Process modelling of the CETP will be conducted to further support directions for more effective tannery effluent treatment. It is expected that modelling will provide an assessment of actual plant capacity and impact of various upstream CP / WE and conveyance interventions.

3. **On-going support for optimisation interventions**

WWT experts will provide support to CETP and STP managers and operators to implement optimisation interventions. Actions and funds required for appropriate operation and maintenance of the CETP will be assessed and funding will be sought for the period until the construction of the new CETP. Recommendations from the review of the operation of the CETP will be implemented to optimise the performance of the CETP.

4.3.5 Trade Effluent Governance

1. **Conduct trade effluent governance options analysis**

A detailed study and stakeholder engagement on regulation and incentive options will be conducted and activities to test these options will be carried out.

2. **Conduct facilitated workshop**

A facilitated workshop with key stakeholders will be conducted to discuss current / potential roles and responsibilities in trade waste governance. Ideally, the workshop will lead to the development of a framework and work program for developing these governance arrangements in greater detail.

4.3.6 Trade Effluent Management

Development of a robust trade effluent management system for operation and management of upgraded infrastructure (see Section 3.7) that ensures the effective management and operation of the treatment network will be required.

1. **Establishment of trade waste management principles, objectives and systems**

Build in the principles of trade waste management within the Tannery Industry Association through capacity building (see Section 4.1). Management systems will be setup to ensure adequate controls for the identified risks posed with the aim of establishing a framework for future trade waste agreements with tannery operators.

Effluent quality objectives will be developed based on international best practice including occupation health and safety, protection of the effluent transfer system, protection of the treatment system, protection of the environment and ensuring fit for purpose reuse options.

An institutional framework with clear and transparent roles and responsibilities for regulators (pollution discharge and services), wastewater treatment operators and tannery businesses will be developed.

Model wastewater agreements / licensing (link to knowledge sharing opportunities) and progressive licensing by SPV / Tannery Association will be developed.

A plan for implementation of the regulatory framework (identify those that can be done first) will be developed.

A compliance management system will be developed (based on lessons gained through the implementation of priority areas 1 and 2) that focuses on collaboration between the SPV, industry and PCB, is co-operative in the initial stages and coercive in the final stage.

Management systems for illegal connections and illegal dumping systems will be setup to identify and prevent illegal sewer connections and dumping to the tannery and domestic sewage systems and to improve management of inflow and infiltration.

2. **Establishment of continual improvement mechanisms with the long term goal of obtaining ISO accreditation.**

The implementation of ISO accreditation will help to ensure the ongoing maintenance of the conveyance system and help to instil a new culture of performance. It is noted that the Ranipet CETP in Tamil Nadu has obtained ISO quality certification.

4.4 Plan for Operational Model and Modular Infrastructure

Priority Objective

To establish an operational model with appropriate institutional, regulatory, financial and managerial mechanisms which supports continuous improvement and ensures the long-term, sustainable operation of wastewater treatment infrastructure.

Importance

The successful conduct of Priority Areas 1-3 is expected to significantly reduce the volumes of water and pollutant loads being generated and sent to the CETP. This work will also build strong foundations for the further development of a sustainable operational model.

Priority Area 4 is expected to draw on the results of these initiatives to complete the move to a holistic and sustainable solution to the Jajmau tanneries waste issue.

Priority Outcomes

Priority outcomes of the Priority Area 4 are:

- Prevention of contaminated tannery wastewater from entering the Ganga;
- Upgrade and sustainable operation of treatment plant; and
- Realization of standards on discharge, reuse and recycling of treated tannery effluent.

Activities

Priority Area 4 will consist of the following activities:

- Water treatment and reuse option appraisal;
- Refinement of a operation and management model for upgraded Jajmau treatment system;
- New / Upgraded CETP pre-feasibility study, tendering and construction; and
- Continuous improvement during operation.

These activities are described in detail below.

Stakeholders

Stakeholders will include:

- Jajmau tanneries;
- Jal Nigam (as current CETP operator); Community of Jajmau;
- UPPCB; and
- UP and National government.

New Plant and Operational Model

Key Performance Indicators

1. Construction of new CETP (if required).
2. Implementation of Sustainable Model for Waste Treatment System Operation
3. Prevention of Discharge to the Ganga of Effluent from Tanneries that Contravenes Regulatory Guidelines.
4. Beneficial Reuse or Compliant Discharge of Treated Tannery Wastewater

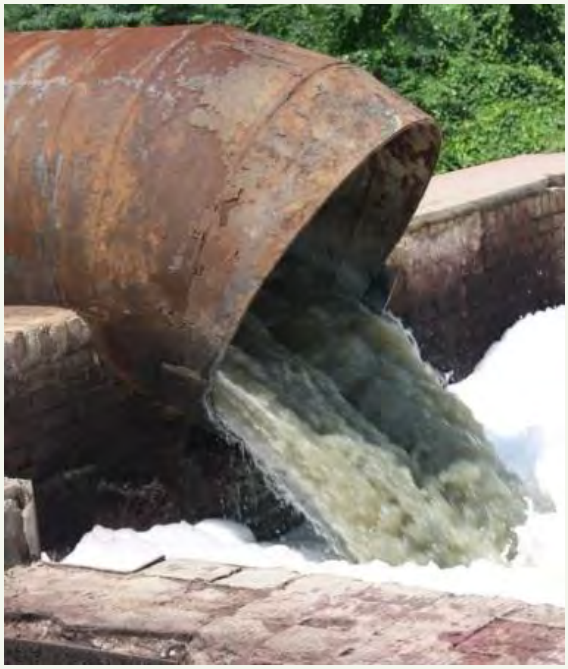


Plate 4.3 Combined discharge from the Jajmau STP and CETP.

4.4.1 Water Treatment and Reuse Options Appraisal

A Water Treatment and Reuse Options Appraisal will need to be conducted to recommend the most suitable water treatment and reuse option for the Jajmau Tannery Industry. These recommendations will inform prefeasibility of the CETP upgrade.

Various options for the upgrade of the CETP and related infrastructure have been proposed including:

- Common rawhide soaking facilities;
- Separation at tanneries of soak liquor, chrome liquor and other wastewater for treatment; and

- Separation at tanneries of chrome and non-chrome waste water streams.

Various options regarding the use of reverse osmosis technology to enable the reuse of treated wastewater have also been proposed. In addition there are various methods of implementation that must be considered.

Areas of work will need to include:

1. Knowledge exchanges with other similar facilities in India with regards to technology options;
2. Technical and financial evaluation of options for on-site pre-treatment
3. Balance between reducing what goes into the systems and the potential cost of customer controls to ensure effluent is suitable for treatment plant capability.
4. Technical and financial evaluation of options for the conveyance system;
5. Technical and financial evaluation of options for segregation of process streams;
6. Technical and financial evaluation of CETP effluent quality and cost implications for different options for reuse (i.e. RO plant and other treatment options). This will also include an evaluation of tannery water quality needs to ensure reuse water supplied will be fit for purpose and hence lowest cost;
7. Regulatory implications and required supporting mechanisms for preferred options; and
8. Recommendation of system based on assessment findings.

4.4.2 Waste Management Financial Model

Development of a waste management financial model will be required, including:

- Development of water and effluent discharge pricing and water buy-back framework which reflects the cost of providing the services to customers; promotes sustainable use and protection of water resources; sends clear price signals to customers; is equitable for small and large tanneries; and is administratively simple.
- Conduct financial analysis of potential business models for tannery businesses, SPV, and CETP operators including the:
  - Completion of a risk assessment focusing on ensuring a bankable and sustainable project.
  - Analysis of the fundamentals of the preferred option - is the project needed (by the public), affordable (for consumers and government), attractive (to investors) and legal (without new laws)?

Development of a PPP framework (involving the IFC and State Government):

- Review international examples (including Victoria);
- Establish ownership with State government (i.e. Urban Development Agency PPP cell);
- Review PPP options and recommend a transaction structure; and
- Promote project to potential investors and get their feedback.

4.4.3 Pre-feasibility Study, Tendering, Construction

Staged upgrade of the CETP to enable compliant discharge and the maximum reuse of treated effluent for beneficial applications including:

a. Pre-feasibility study (non-bankable);
b. Preparation of tender documents;
c. Tendering process that does not restrict non-conforming bids;
d. Tender selection;
e. Upgrade of tannery conveyance - Note that based on the results of previous activities the upgrade of the conveyance may be done separately and at a different time to the upgrade of the CETP; and
f. Staged upgrade of the CETP.

4.4.4 Operation and Continuous Improvement

The system should continually analyse itself through planned mechanisms and implemented improvements (for example through the use of an ISO22000 framework).

Work associated with this activity would entail:

1. Development of program for continual analysis and improvement;
2. Development of potential options for sustainable growth ; and
3. Development of program for continual national and international knowledge sharing.

4.5 Jajmau Community Development

Priority Objective

To include the community in environmental and social enhancement and monitoring activities and improving the overall liveability of Jajmau.

Importance

The Jajmau community has been impacted by inappropriate waste management and treatment processes associated with the tannery industry. This includes both effluents to the Ganga and solid waste from tannery operations (including hairs and fats) that are dumped along the roadside and the banks of the Ganga. Ineffective treatment of wastewater by the CETP and STP has impacted the Jajmau agricultural industry as well as affecting the health of members of the community. There may also be long-term contamination issues that are yet to be discovered.

The residents of Jajmau depend upon the tannery industry to provide employment for local residents. Previous priority action items described in this roadmap will reduce impacts associated with tannery operation upon the community in the future. The actions described for this priority item will address the challenges that are currently faced by the Jajmau community.

The Tannery Industry is a fundamental component of the Jajmau community. Improvements in tannery operations and waste management need to be integrated with other initiatives to provide benefits to the community that will deliver long lasting benefits to the people of Jajmau.

Priority Outcomes

The following outcomes will be achieved through the delivery of the proposed activities:

1. Involvement of the community in monitoring of environmental impacts associated with the Jajmau Tannery industry;
2. Upgrade of public spaces and infrastructure for the people of Jajmau;
3. Improvements to workplace and community health and safety; and
4. Implementation of a support program for community initiatives that indirectly support the tannery industry.

Stakeholders

The following stakeholders will benefit from the activities associated with this Priority Item.

1. Tannery Operators – The Association will work with the Jajmau community to implement the proposed actions.
2. State and municipal Departments of Health and Family Welfare – Theses agencies will work with the tanneries association on community health and safety actions.
3. State and municipal Departments of Labour and Employment – These agencies will work with the tanneries association on OH&S actions.
4. Jajmau Community - Community members will be consulted and involved with all of the proposed actions.

Activities

Priority Area 5 will need to consist of the following activities:

- Environmental and Social Assessment and Management;
- Establishment of a Community environmental monitoring program; and
- Establishment of a Jajmau Community Driven Development Program.

These activities are described in detail below.

Plate 4.4 Jajmau Resident

4.5.1 Environmental, Social Assessment and Management

An Initial Environmental and Social Evaluation will need to be carried out to better understand and manage the environmental, socio-economic and health and safety dimensions of implementation of the Roadmap.

This evaluation should consider relevant IFC Performance Standards.

Work areas include:

1. **Environmental and social baseline assessment**

Collect baseline information on the physical, biological, social (including health and cultural) conditions of the area. Examine the potential positive and negative risks and impacts of proposed interventions, and inform appropriate design alternatives and mitigation measures.

2. **Working conditions and labour baseline assessment**

As noted in Section 3.3, safe working conditions are imperative in the tanning industry, particularly due to the high numbers of workplace risks including chemical use, machinery and vapours. Collect OH&S baseline information and examine the potential positive and negative risks and impacts of Roadmap implementation.

3. **Resource Efficiency and pollution prevention evaluation**

This is a key output of the Roadmap and includes the water treatment options analysis and Cleaner Production and Water Efficiency Assessment.

4. **Community Health and Safety Evaluation**

Impacts of tannery effluent on the Jajmau community should be understood to assist tanneries and policy makers in developing effluent limits and strategies for pollution reduction. Collect community health baseline information and examine the potential positive and negative risks and impacts of Roadmap implementation on the Jajmau community.

5. **Sustainable Management of the Ganga**

The Ganga accounts for 30% of India's water resources and more than 40% of India's population. As a result it is a crucial resource to the advancement of India as a nation. Pollution threatens not only humans, but also more than 140 fish species, 90 amphibian species and the endangered Ganges river dolphin. Collect baseline information and examine the potential positive and negative risks and impacts on biodiversity conservation, ecosystem services and sustainable management of biological resources in the Ganga River and environment surrounding the Jajmau cluster.

6. **Study on Natural Cultural Heritage of the Ganga**

The Ganga carries an immense cultural and religious meaning for Hindus of every region. It is important on a cultural level to enhance the quality of the Ganga for present and future generations.

7. **Development of an environmental and social risk management, mitigation and monitoring framework**

For all the environmental and social impacts identified, management measures will be recommended where possible to prevent or minimize these impacts. These measures will be outlined in a risk management framework.

4.5.2 Community and Environmental Monitoring Program

This program should be developed to encourage the participation of community members in environmental monitoring at Jajmau.

Activity 5.1 will need to include the following components:

1. **Establishment of community Environmental Impact Reporting Systems**

The Tannery Association will set up systems for community members to report upon environmental impacts caused by tanneries in Jajmau. Environmental impacts may include the dumping of solid waste to the road side or the river, or the incorrect disposal of liquid waste. Reporting may be anonymous via phone, email or mail. The Tannery Association will document the community reports on a register that will be publicly available, and what actions have been taken in response to the community reports.

2. **Formation of Community Environmental Monitoring Group**

The Tannery Association will set up a community environmental monitoring group that community members will be able to join. The monitoring will document the status of the Jajmau environment at regular intervals. Based upon the environmental

monitoring, recommendations will be agreed to regarding priorities for the implementation of remediation or upgrade actions.

3. **Tanning Industry Community Forums**

The Tannery Association will host community forums at regular intervals (quarterly or half-yearly). At the community forums, the Tannery Association will report upon monitoring that has been completed since the last meeting and what initiatives have been progressed by the Tanning Industry. Members of the community will be able to raise concerns or put forward questions to the Association.

4.5.3 Community Driven Development Program

A Jajmau Community Driven Development Program will need to be established to support and strengthen the community's ability to contribute to planning, design and implementation of the following activities:

1. **Public health and safety awareness program.**

A public health and safety awareness program will be established to educate the Jajmau community (i.e. tannery owners, workers, their families and the wider community) about the public health risks posed by tannery operations.

It is envisaged that this program will help strengthen drivers for addressing current pollution issues associated with tanneries in the area.

2. **Public space and community infrastructure improvement initiative.**

Currently there are open spaces in Jajmau, including areas along the riverside, that are used for the dumping of solid waste. It is proposed that these areas are transformed into public spaces that can be used by Jajmau residents.

Funding will be sought for the improvement of roads, drainage and public walkways within Jajmau. Such works will not only benefit the community but will also make it unacceptable for waste to be disposed on the roadside. Improved roadways will also be important for proposed tanker collection services. Improvements to the stormwater drainage system will prevent stormwater from entering the tannery or sewage treatment network, to minimise the potential for contaminated stormwater entering the Ganga and to maximise reuse opportunities

3. **Small-Business Support Program**

Small business that can demonstrate business opportunities that reduce impacts associated with the tannery industry will be provided with support to become established in Jajmau. Such businesses may include the conversion of tannery wastes into useful products or provision of clean technologies. Assistance may be provided in a number of forms, including:

- The provision of desk space at the Tannery Association office;
- The provision of materials from the tanneries; and/or
- The provision of financial assistance in the form of grants.

Investment into clean technology and similar businesses will also provide employment opportunities for residents of Jajmau.

5.0 Implementing Arrangements

The Roadmap will guide the Jajmau Tannery Industry towards a more environmentally and financially sustainable future.

5.1 Institutional Arrangements

It is envisaged that the Road Map will be implemented under the broader National Ganga River Basin Project.

During detailed design of the initiative, a series of workshops will be conducted to develop the appropriate institutional arrangements for the Road Map.

Institutional arrangements are likely to include:

- Policy support and guidance provided by the Ministry of Environment and Forests and State Ganga River Conservation Authorities;
- Program Management provided by the National Mission for Clean Ganga (NMCG) and State Program Management Groups (SPMGs);
- Executing Agency(s) (EA) - to be determined at a later date – consisting of technical agencies with the mandate of industrial pollution control at either or both the state and national level (e.g. Pollution Control Board);
- Industry implementing body consisting of a single Tannery Association responsible for ensuring improved performance and compliance with regulations.
- Project and Technical Consultancy consisting of local and international experts to support the implementation of the Road Map.
- Partner agencies which will provide additional specialised expertise and capacity to the main implementing agencies.

5.2 Work Program

An initial five (5) year program is envisaged. This program is expected to deliver significant short-term results through industry support programs, cleaner production initiatives and optimisation of existing infrastructure, while at the same time, informing planning and flexible design of longer term infrastructure and governance mechanisms.

A schedule for implementation is provided in Figure 5.1 below, which will enable a cost effective reduction in pollution whilst enabling a sustainable Jajmau Tannery Industry.

Further to the Schedule for Implementation, Table 5.1 below summarises the key anticipated benefits and reductions to pollution / volumes associated with the implementation of each priority area within the roadmap by year.

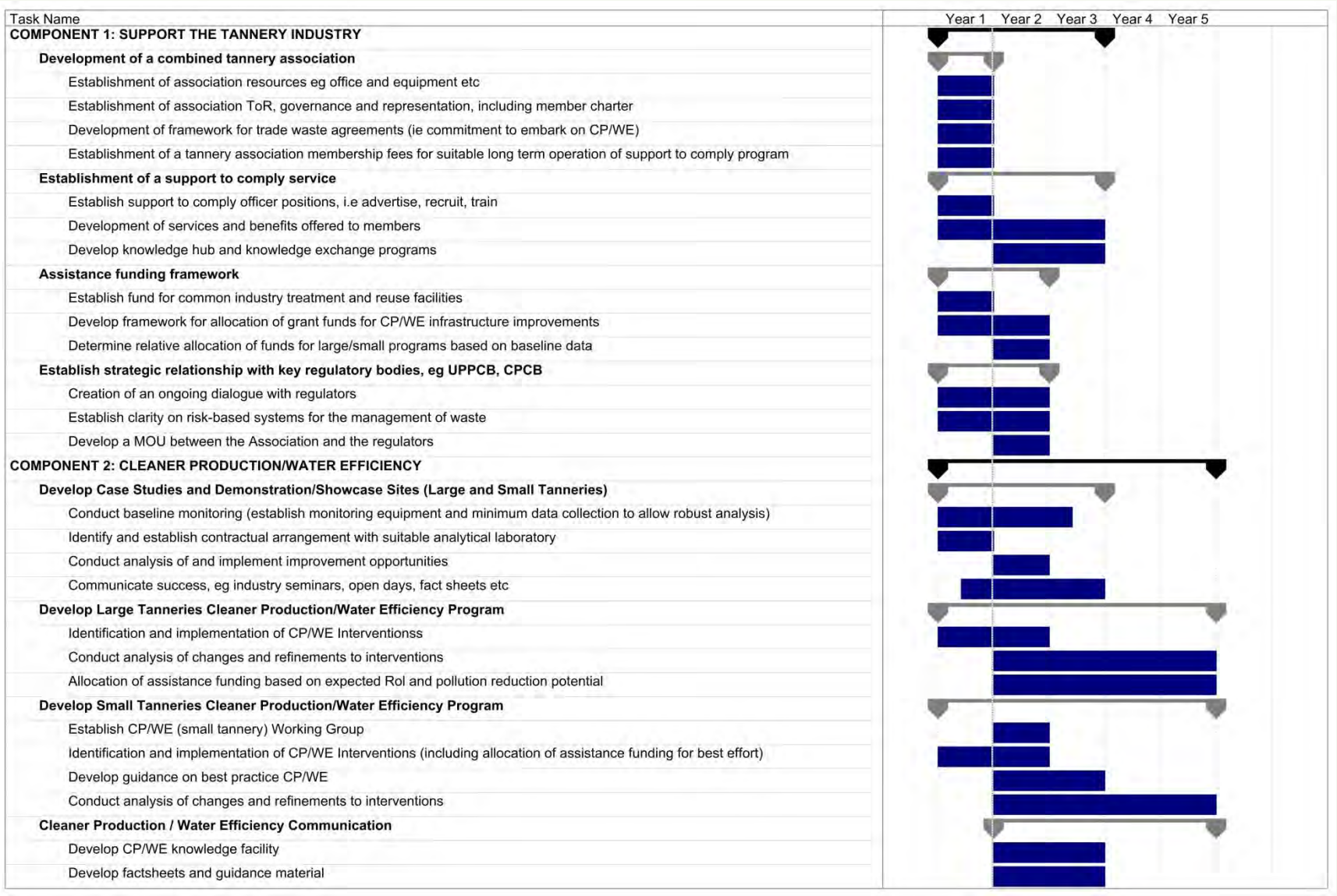
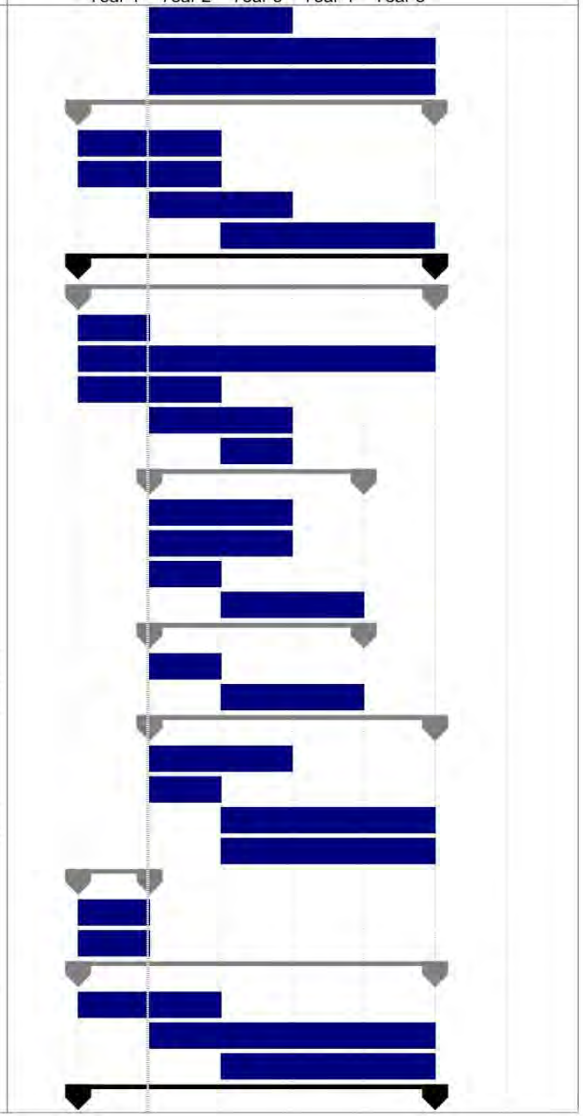


Figure 5.1 Schedule for Implementation

Task Name	Year 1	Year 2	Year 3	Year 4	Year 5
Conduct CP/WE open days					
Conduct CP/WE Industrial Seminars					
Conduct CP / WE training sessions					
Solid waste management program					
Assessment of current solid waste production and management at tanneries					
Investigation of options for solid waste management, including knowledge sharing with other jurisdictions					
Implementation of solid waste management improvements					
Supporting business (business opportunities)					
COMPONENT 3: WASTEWATER TREATMENT OPTIMISATION AND GOVERNANCE					
Detailed Baseline study of the current systems					
Review of current information about the system					
Design and implementation system monitoring					
Quantification of illegal connections and illegal dumping					
Spatial representation of all inputs to wastewater system					
Report for recommendations of infrastructure repair and re-installment					
Advancement of treatment, pre-treatment and chrome recovery systems					
Appraisal of pre-treatment and chromium recovery facilities					
Enhancement of tannery pre-treatment and chromium recovery systems					
Audit of the common chrome recovery plant					
Optimisation of CCRP					
Conveyance System Optimisation					
Conveyance system appraisal					
Conveyance system repair					
Optimisation of Current Common Effluent Treatment Plant					
CETP and sewage treatment plant operation review and options analysis					
Wastewater treatment modelling					
Undertake interventions to improve treatment					
Ongoing support and refinement for optimisation interventions					
Trade Effluent Governance					
Develop trade effluent governance options analysis					
Facilitated workshop and agreement of governance roles and responsibilities					
Trade Effluent Management Model					
Establishment of trade waste management principles, objectives and systems					
Implementation management systems					
Establishment of continual improvement mechanisms with goal of achiving ISO accreditation					
COMPONENT 4: PLAN FOR OPERATIONAL MODEL AND MODULAR INFRASTRUCTURE					



Task Name
Water treatment and reuse options appraisal
Knowled exhanges with other similar facilities in India with regards to technology options
Technical and financial evaluation of options for onsite pre-treatment
Techincal and financial evaluation of options for segregation or process streams
Technical and financial evaluation of SETP effluent quality and cost implications for different resue options
Assessment of regulatory implications and required supporting mechanisms for preferred options
Recommendation of system based on assessment findings
Waste Management Financial Model
Development of water and effluent discharge pricing and water buy back framework
Conduct of financial analysis of potential business models
Development of PPP framework
Pre-feasibility study, tendering and construction
Pre-feasibility study (non-bankable)
Preparation of tender documents
Tendering process (that does not restrict non-conforming bids)
Tender selection
Upgrade of tannery conveyance
Staged upgrade of the CETP
Operation and continuous improvement
Develop a program for continuous improvement
Development of potential options for sustainable growth
Development of program for continual national and international knowledge sharing
COMPONENT 5: JAJMAU COMMUNITY DEVELOPMENT
Environmental and Social Assessment and Management
Undertake environmental, health and social baseline assessment
Conduct environmental and social impact assessment
Develop environmental, health and social risk management, mitigation and monitoring framework
Communty and Environmental Monitoring Program
Establishment of community reporting system
Formation of community monitoring groups
Run tannery association community forums
Community driven development program
Public health and safety awareness program
Public space and community infrastructure improvements
Small business support program

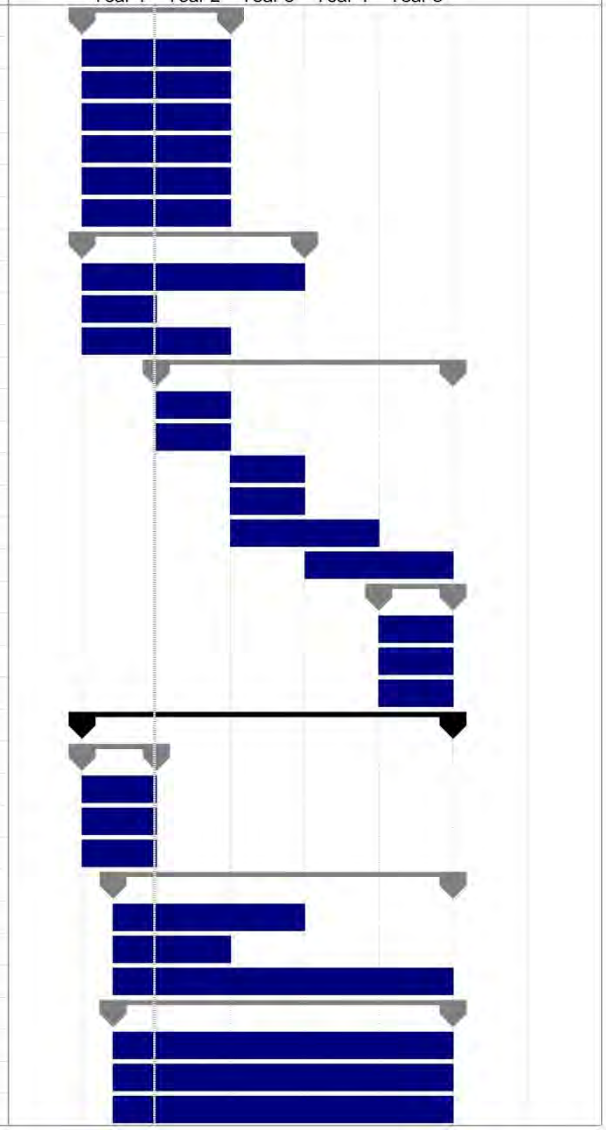


Table 5.1 Anticipated Benefits and Pollution / Volume Reductions associated with Key Activities

Year	Key Activities	Anticipated benefits	Anticipated Pollution / Volume reduction (against current baseline)
1	Establish industry association	Enhanced relationships between all stakeholders, particularly regulators	5% reduction in wastewater volume to sewer
	Establish support to comply program	Direct support to tanners will immediately raise profile and alter performance positively	5% reduction in TDS
	Baseline monitoring	Monitoring equipment installation will immediately modify behaviour positively	10% reduction in Cr
	Develop case study / demonstration sites	Improved problem quantification via monitoring and assessment	
	Establish trade effluent governance	Monitoring installed in priority locations for long term management	
	Environmental and social assessment	Roles and responsibilities clearly understood by stakeholders	
2	Build support to comply program	Tanners engaged and industry leaders driving peers towards improvement	10% reduction in wastewater volume to sewer
	Establish funding framework for improvements	Clear evidence of potential for improvement via demonstration sites	10% reduction in TDS
	Showcase improvements at demonstration sites	Monitoring and management systems affecting tanner behaviour positively	20% reduction in Cr
	Develop detailed cleaner production / water efficiency programs	Potential wastewater treatment improvements identified	
	Assess existing wastewater treatment		
	Implement trade effluent management systems		
	Establish community environmental monitoring	Community engaged and actively supporting environmental improvement	
3	Cleaner production / water efficiency programs roll out	Significant reductions in trade effluent volume and qualities from support programs	25% reduction in wastewater volume to sewer
	Funding allocated for onsite infrastructure improvements		20% reduction in TDS
	Trade effluent management systems implemented	Trade effluent management identifying and actioning underperforming tanners	Cr effectively fully removed from wastewater

Year	Key Activities	Anticipated benefits	Anticipated Pollution / Volume reduction (against current baseline)
	Investigation of common treatment facilities		
4	Continue delivery of cleaner production / water efficiency programs	Continued reductions in trade effluent volume and qualities from support programs	30% reduction in wastewater volume to sewer
	Continue funding allocation for onsite improvements	Reduced additional inputs to sewers from illegal discharge / connections	15% reduction in additional inputs to sewer
	Undertake improvements to sewer and treatment infrastructure	Wastewater treatment improved resulting in improved discharge qualities	25% reduction in TDS
	Imbed trade effluent management	Underperforming tanners improving towards regulatory standards	
5	Continue delivery of cleaner production / water efficiency programs	Continued reductions in trade effluent volume and qualities from support programs	35% reduction in wastewater volume to sewer
	Undertake improvements to sewer and treatment infrastructure	Continued reduction in inputs to sewers from illegal discharge / connections	20% reduction in additional inputs to sewer
	Imbed trade effluent management to business as usual	Underperforming tanners achieving compliance with standards	30% reduction in TDS

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7.0 Annexes