MELBOURNE WATER'S EASTERN TREATMENT PLANT (ETP): "THE HACCP JOURNEY"

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ABSTRACT

Melbourne Water obtained Quality Assurance (HACCP) certification from Lloyd's Register Quality Assurance (LRQA) in March 2005. This paper presents the methodology undertaken to deliver a certified HACCP Plan for one of Australia's largest sewage treatment plants.

Key process steps and approach of the project are detailed, including areas such as:

- Risk Assessment
- Quality System auditing
- Quality Plan layout
- Additional documentation development and integration into existing systems
- Monitoring the quality system and taking appropriate corrective actions
- Key challenges
- Key outcomes
- Recommendations for other organisations seeking HACCP certification

This paper also describes the context for the HACCP plan significance, in terms of strategic organisational goals in water sustainability, recycling and customer relationship building.

KEY WORDS

HACCP, CCP's, Quality, Risk Management, Class C, Class C2, Effluent, Biosolids

1.0 INTRODUCTION

Melbourne Water, owned by the Victorian Government, manages $8 billion of natural and built assets - Melbourne's water supply catchments, most of Melbourne's sewage, rivers, creeks and major drainage systems. Melbourne Water owns and operates two major sewage treatment plants – the Eastern Treatment Plant (ETP) and the Western Treatment Plant – treating approximately 92% of Melbourne's sewage. Retail water companies treat the remaining 8% at smaller local sewage treatment plants.

As a $1B asset servicing approximately 1.5 million people, ETP treats approximately 40% of Melbourne's sewage (370ML/day), using an activated sludge process, to a secondary standard under an EPA Victoria Licence.

In preparation for a nutrient removal process upgrade, to reduce effluent ammonia discharged via an ocean outfall, ETP required an EPA Works Approval. A requirement of the Works Approval was for Melbourne Water to deliver a process stability plan. After considering stakeholder requirements, the plan format chosen was a Hazard Analysis and Critical Control Point (HACCP) system.

2.0 WHAT IS HACCP?

HACCP is a food based quality safety standard originally developed by NASA to protect astronauts from Salmonella poisoning. Widely adopted in the food and water industry, it is now being used in wastewater as recycling opportunities increase.

HACCP is a preventative risk management system for hazard identification, assessment and management. Using semi-quantitative methodology, it identifies risks and appropriate controls. HACCP is based upon hazard source control and prevention, rather than reliance on end point testing. This is achieved through identification of 'Critical Control Points' (CCP's) – specified limits that require corrective action to ensure a compliant, fit for purpose product.

The system relies on appropriate procedures, monitoring, validation of critical limits; documentation, performance reporting and auditing to verify limits are being met.

The HACCP methodology comprises 5 steps and 7 principles, and is represented in Figure 1:

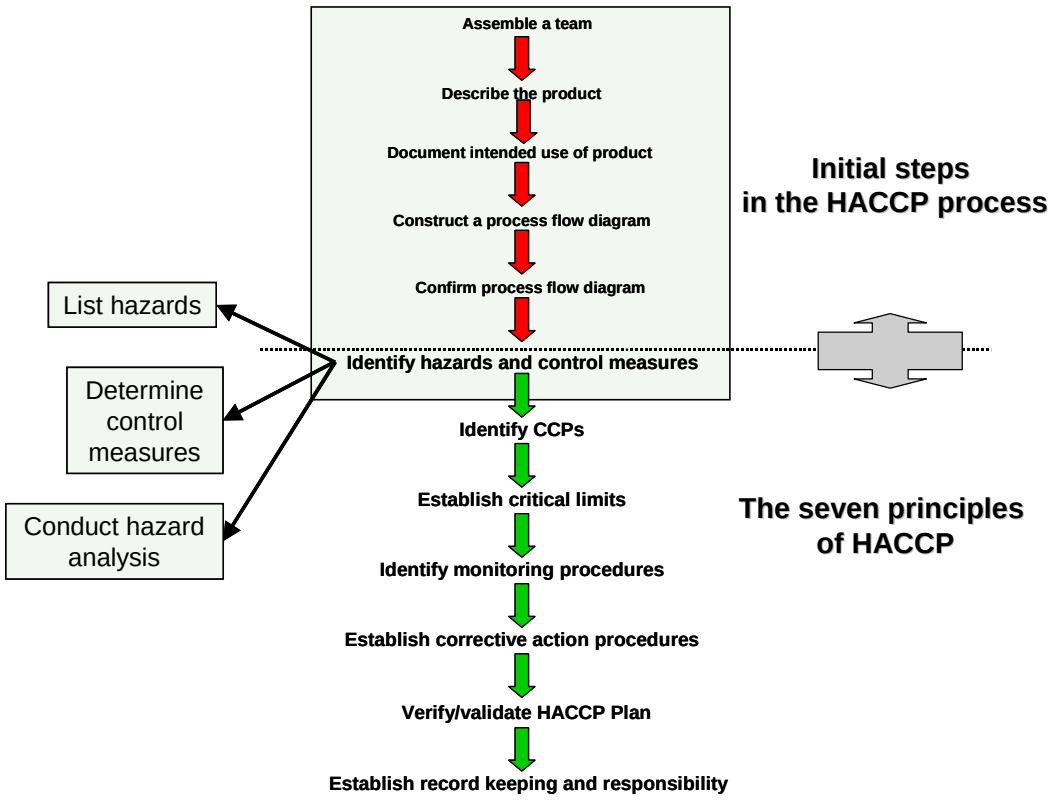

Figure 1: *The HACCP Methodology*

3.0 IMPLEMENTING A HACCP PLAN

HACCP was applied to ETP's two end products, Class C effluent and Class C2 Biosolids, as defined by EPA Guidelines. ETP must conform to these to ensure a compliant product for current and future water and biosolid recycling customers.

Detailed risk assessments identified CCP's in the treatment process – five for recycled water, and one for biosolids. Implementing the plan required a number of key steps, some of which are described in greater detail in the following sections:

- Forming the HACCP team
- Cementing commitment in terms of key supporting resources
- Formulating plan structure
- Risk Assessment
- Developing CCP's (Validation)
- Review – Verification that targets are being met
- Developing additional system documentation
- Auditing and formal plan Certification

3.1 Plan Structure

The format used was to the LRQA specification, and incorporated elements of:

- Management responsibility
- Product information (characteristics and intended uses)
- Process information (flow diagrams, layout)
- Pre-requisite programs
- Hazard analysis
- Control measures (both specific to CCP's and general)
- Parameters and critical limits
- Monitoring and measuring
- Corrective action (response to specification deviation)
- Validation ('science behind the limit') and verification (audit, management review)
- Documentation and records

In addition, the ETP plan also incorporated key reference documents, communication and consultation (stakeholder identification), purchasing controls, and continuous improvement.

3.2 Risk Assessment

Developing the risk assessment is the heart of the plan. It involved a number of workshops with a multi-disciplinary team – internal and external representatives from appropriate areas – planning, operations, asset managers and the Retail Water Companies. Using a specifically developed Process Flow Diagram (PFD), each process step from plant inlet to the ocean outfall discharge point was assessed, using a quantitative matrix (numeric scoring of likelihood and severity) as per the AS4300 Risk Standard.

Risks were identified and ranked, producing a prioritised list based on data, corporate expertise, scientific validation and judgement. The process also identified key focus areas for further investigation (such as specific plant sampling and data analysis) to reduce or eliminate risks. High/Very high risks underwent a secondary analysis for risk mitigation, with those remaining high required Decision Tree Analysis for CCP's and quality control points (QCP's). A table was produced showing each process step, its source, hazard and classification (physical, biological or chemical), preventative and control measures, likelihood (1-5), and severity (1-5) of occurrence (risk), limiting hazard, downstream control measures and their effectiveness, and a mitigated risk score.

For CCP's, appropriate record sources were listed.

Preventative measures include process operational strategies, manual, online and laboratory monitoring, standard operating procedures, maintenance regimes and reports, regulatory and customer agreements, equipment redundancy, auditing, and weekly operational meetings.

The hierarchy of controls for the plan are therefore:

1. *Pre-requisite Programs (PRP's):* These are the basic requirements that are givens in a HACCP plan. They include online monitoring, flow meters, adequate maintenance systems, cleaning regimes, product specifications, pest control and personal behaviour
2. *QCP's:* Process steps with performance specifications, but may fall outside ETP's direct control. Examples include illegal raw sewage discharges and wet weather inflows
3. *CCP's:* Following risk assessment, steps with high residual risk may be deemed CCP's as measured by a *Codex Decision Tree* analysis. Typically, this is where engineering controls, on-line monitoring and real-time management exists

3.3 Developing CCP's

The Codex Decision Tree Analysis determines CCP's by asking:

- Do control measures exist for the identified hazard?
- Is the step specifically designed to reduce eliminate the hazard to acceptable levels?
- Could the hazards occur in excess of (or increase to) acceptable levels?
- Will subsequent steps eliminate the hazard or reduce likely occurrence to acceptable levels?

This risk assessment and Codex Decision Tree, determined the six CCP's for the ETP:

Table 1: ***Eastern Treatment Plant – HACCP Critical Control Points***

CCP	Measurement:	Validation	Record examples
1 – Aeration Air supply (74 kg/s)	Air flow meters for appropriate treatment	Wastewater calculation, Downstream CCP impact	Online data, spreadsheet calculation
2 – Secondary Effluent Turbidity (25 NTU)	Online, Suspended Solids (SS) correlation	EPA Guideline 464.2, Class C limit (30mg/L SS)	Plot of turbidity vs. SS, laboratory data
3– Final Effluent Turbidity (50 NTU)	Online measurement, correlation to SS	EPA Guideline 464.2, Class C limit (30mg/L SS), final effluent basin treatment	Plot of turbidity vs. SS, laboratory data
4 – Final Effluent Screen Differential (1m)	Screen Differential up/downstream	Class C limits for SS, BOD, Ecoli and pH not exceeded	Online data, laboratory data, screen clean work
5 – Chlorine Residual (0.5 mg/L)	Online TRC meter	EPA Guideline 464.2, Class C Ecoli limit	Online and laboratory data
6 – Biosolids	Stockpile testing for all parameters or cannot be sold	EPA Class C2 (EPA Guideline 943)	Primary, secondary, digester sludge and stockpile sampling

3.4 Review

Once the CCP's were established, ongoing verification is required. This was achieved at ETP by the incorporation of a Control Screen into the Process Control System. A pictorial representation is shown in Figure 2. The key screen features are trending of CCP data, warning alarms as a CCP limit is approached, and at the limit, a complete plant representation showing plant layout, all CCP's and QCP's, and text help files detailing corrective actions and incident response procedures for appropriate operator response.

This was supplemented with daily process engineering verification of CCP's, feeding into weekly operational meetings, and monthly management review of performance, culminating in a Melbourne Water wide quality system review across water and sewerage areas.

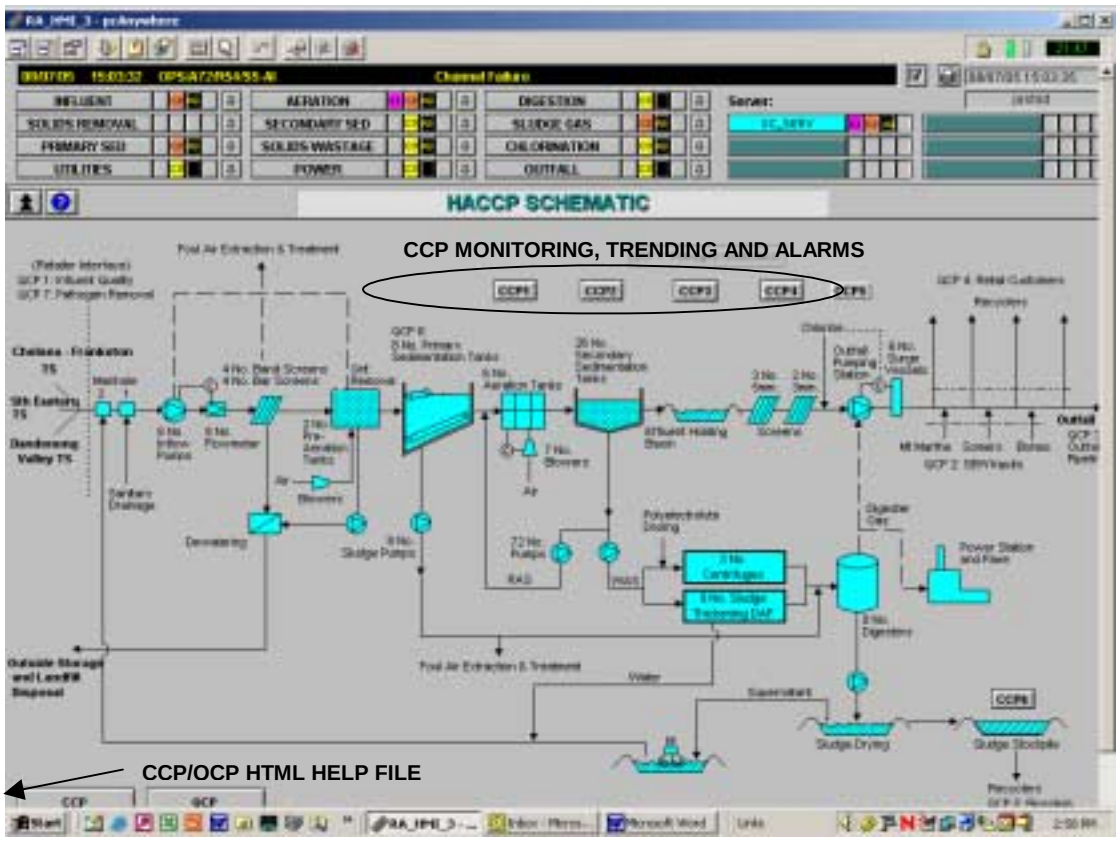

Figure 2: ***The ETP HACCP Control Screen***

3.5 Auditing

Numerous internal and interface audits were conducted. Internal audits were structured as system or process audits. System audits covered areas such as documentation, risk assessment, management system framework, plan implementation, operational controls (staff competency, process stability) and maintenance controls. Process audits covered all CCP's and QCP's, and interface audits such as Laboratory, Maintenance and Cleaning Contractors. A pool of auditors were trained in the HACCP system, and raised corrective actions and observations for improvement. Once internal auditing was complete, LRQA externally audited the system, reporting results to Melbourne Water.

3.6 Additional Documentation Development

To ensure that the plan integrated with current operations, a number of additional documentation systems were required to facilitate ongoing system performance. These included:

- Audit register – tracking progress of audits, observations and improvement notes
- CCP Process Control System data – an Excel based report run periodically to verify CCP values, monitor the number of and time duration of any exceedances, and as a trending and management reporting tool to demonstrate continuous improvement
- Corrective Action Reports (CAR's) – whenever a CCP alarm occurs, a CAR is raised. This allows the HACCP coordinator or others to verify either a genuine exceedance or is a false positive result. In the event of an exceedance, an incident report is raised and immediate corrective action taken (which can include the plant ceasing discharge)
- Master document register – each plan section has a list of documents the reader can source for further information. An electronic hyperlinked register also assists the reader
- Development of a Hierarchy of Data register – ranking online equipment data as high, medium or low criticality, in general operational, HACCP or OH&S areas
- Training – Several documents were required; overview training for induction of staff and contractors, and a detailed training module as part of skill matrix assessment for operators

4.0 KEY CHALLENGES IN IMPLEMENTATION

Key challenges the plan presented to the HACCP team were:

- Developing an entirely new QA system integrating seamlessly with operations, compliance and environmental requirements
- Mindset change to a food based safety standard product/resource, not a "waste" product
- An operational shift from statistical compliance to ongoing product verification
- Developing metrics to demonstrate ongoing compliance
- Customer/stakeholder relationship building (product recyclers and regulatory authorities)

5.0 IMPLEMENTATION OUTCOMES

Key outcomes delivered to the ETP were:

- The system achieved external certification by LRQA, within the projected time/budget
- The largest Australian wastewater treatment plant to achieve this feat
- Skill development for staff across the business in HACCP systems
- Demonstrated rigorous, scientific approach noted by external auditors
- Stakeholder management in the value chain – from upstream supply (raw material) to product (recyclers and general public)
- Demonstrated rigorous risk management resulting in a robust, compliant product that is fit for the intended uses as defined by EPA Victoria Guidelines

6.0 CONCLUSIONS

Delivering an externally certified HACCP plan was an innovative method of focusing on product quality, enhancing opportunities for future effluent and biosolids recycling opportunities, and facilitating mechanisms in the plant's treatment systems for continuous improvement using new and existing management systems.

The context of the ETP HACCP plan was of strategic significance to a number of Melbourne Water's future corporate goals, and integration with the aims of the Victorian Government's White Paper on Water Sustainability.

Firstly, it provided contribution towards meeting the recycled water target of 20% by 2010.

Secondly, it interfaces with the Eastern Irrigation Scheme, a water recycling project providing 5000 million litres per year of Class A recycled water to a range of customers via 50 kilometres of transfer and distribution pipelines. Melbourne Water provides recycled water to its private sector partner TopAq who undertakes further treatment (using ultrafiltration membranes) to produce Class A quality recycled water. TopAq then delivers the Class A water to a number of users:

- The Sandhurst Club residential development comprising of 2000 homes and two 18-hole golf courses in Carrum Downs was the first recycled water customer to be connected under this scheme. It will ultimately use 1200 million litres of recycled water a year for the golf courses and recreational areas, as well as for residential use in gardens and toilet flushing.

- Retail water company South East Water will provide the recycled water retail services to residential customers within the project area.

- The Cranbourne-Five Ways area for irrigation of market gardens, golf courses, a racetrack and for use through a residential development dual pipe system for toilet flushing and irrigation

Finally, a robust and compliant product places the ETP in a prime position to enhance large scale recycling projects, such as the two-year Eastern Recycling Scheme feasibility study, which is currently examining the viability of recycling 100,000 million litres of water to Latrobe Valley power stations.

The approach taken built an extensive management system, allowing ease of audit by LRQA, with the plan implemented intimately linked with regulatory compliance, building efficiency in approach for both systems.

7.0 RECOMMENDATIONS

For organisations seeking to develop a certified HACCP plan, it is recommended that the following aspects be considered:

- There are many ways to construct a HACCP plan. An appropriate methodology needs to be chosen to facilitate ease of audit by an external or third party
- Gain implementation commitment early in the project. Identify project champions, auditors, training, HACCP team members, and key internal/external resources
- It is critical to document all risk assessment process aspects. Typical detail includes quantitative scoring rationale, workshop minutes and evidence of appropriate expertise
- A multi-disciplined approach is taken. Involve operational, engineering, planning, asset managers, managerial personnel and appropriate external stakeholders
- Scientific validation of all critical limits – set up electronic based systems for ease of CCP validation, re-validation periodically and ongoing performance verification
- Ensure all plan changes are approved and validated by the HACCP team – the system must be dynamic to function effectively
- System documentation – hardcopy filing and electronic file tree systems increase efficiency of verification of plan accuracy during audit
- Develop documentation that interconnects with existing systems. Additional operational layers are not as efficient as integration. Examples included for the ETP: Structuring audit checklists format similar to it's Water group HACCP and Environmental Management System (for auditor synergy and familiarity across the business), electronic hyperlinks for audit reports, and linking CCP's to regulatory limits

Finally, it is important to emphasise that obtaining system certification marks only the start of a journey along a continuous improvement path. Melbourne Water will be undertaking six monthly external surveillance auditing to ensure that the implemented system continues to function. This includes intensive aspects of monitoring and reporting to facilitate ongoing HACCP compliant outcomes.

8.0 ACKNOWLEDGEMENTS

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