Current Practises in Australian Wineries for Wastewater Minimisation and Treatment: Advantages and Limitations

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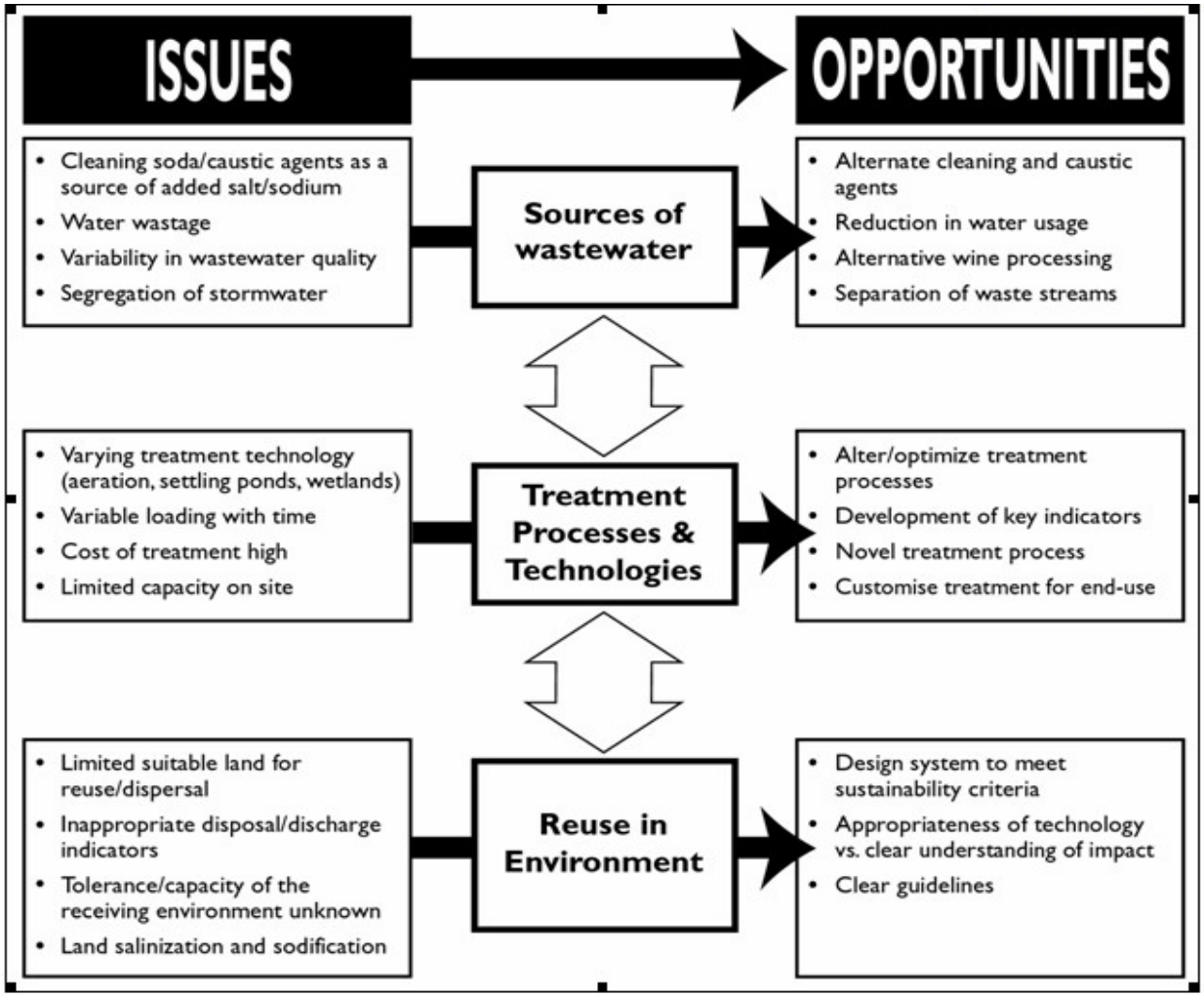
Introduction

- **Developing a Systematic Approach to Winery Wastewater Management**
  - **GWRDC/CSIRO**
  - Provisor, Wineries, Industry consultants

- **Review current winery wastewater management practises**
- **Audit winery wastewater production in representative wineries**
- **Investigate current wastewater treatment technology and options for wineries , evaluate their efficacy and cost**

Current issues and future opportunities for improving winery wastewater management



First Order Audit of Winery Wastewater

- Objectives
- Design
- Winery selection
- Data Analysis
- Results
- Recommendations

First Order Audit

- **Capture information to quantify the state of the industry and current best practise**

- **Objectives**
  - Construction of a “plug and play” wine production process and winery wastewater treatment model
  - Formulate Relevant Guidelines
  - Define key performance indicators (KPI’s) for winery wastewater management
    - What compounds contributes to COD in waste stream?
    - What processes in the winery are producing the wastewater chemical data?
  - Assess the range and economies of technologies and best practises in the industry

First Stage Audit of Winery Wastewater Management

- **Design**
  - Development of a questionnaire
- **Winery selection**
  - Known to prioritise environment with waste minimisation in place
  - Adopters of new technology
  - Have knowledge of sources and volumes of wastewater (audits)
  - Cover a range of size, regions and regulatory environments

Data Analysis

- **45 wineries (70% return rate)**
- **Winery size**
  - equivalent crush = crush + juice
- **Winemaking Process**
- **Winemaking process complexity**

Total no. of process steps = No. of processes x volume of wine through each process

Estimated number of transfers = $\frac{\text{Total processed volume}}{\text{Average batch size}}$

- **Estimated No. of Barrels Washed**

  No. of barrels, average barrel size, no of refills per clean
- **Cleaning chemical and Diatomaceous Earth Use**
  - Mass of chemicals added per equivalent crush
  - Mass of DE used per equivalent crush

Data Analysis

- **Water and Wastewater Measures**
  - Water use (kL/equiv.crush)
  - Wastewater volume produced – untreated and treated volume (kL/equiv crush)
  - Wastewater quality – mass of BOD and salt ions (kg/equivalent crush)
  - Wastewater process assessment by operating cost, capital cost and area ($/kL treated water, m^2/kL treated water).
  - Wastewater process assessment by efficacy of treatment - % BOD (COD) removal

RESULTS

- **DISTRIBUTION OF WINERIES**

State	No. of Wineries	Equivalent Crush t/annum	Distribution Compared with Industry	
			% total sample	% industry
SA	23	200-8000	48	50
VIC	10	200-17000	7	18
NSW	5	1000->100000	43	29
WA	6	200-10000	3	2
QUE	1	400	0.1	0.01

Results - Water Use

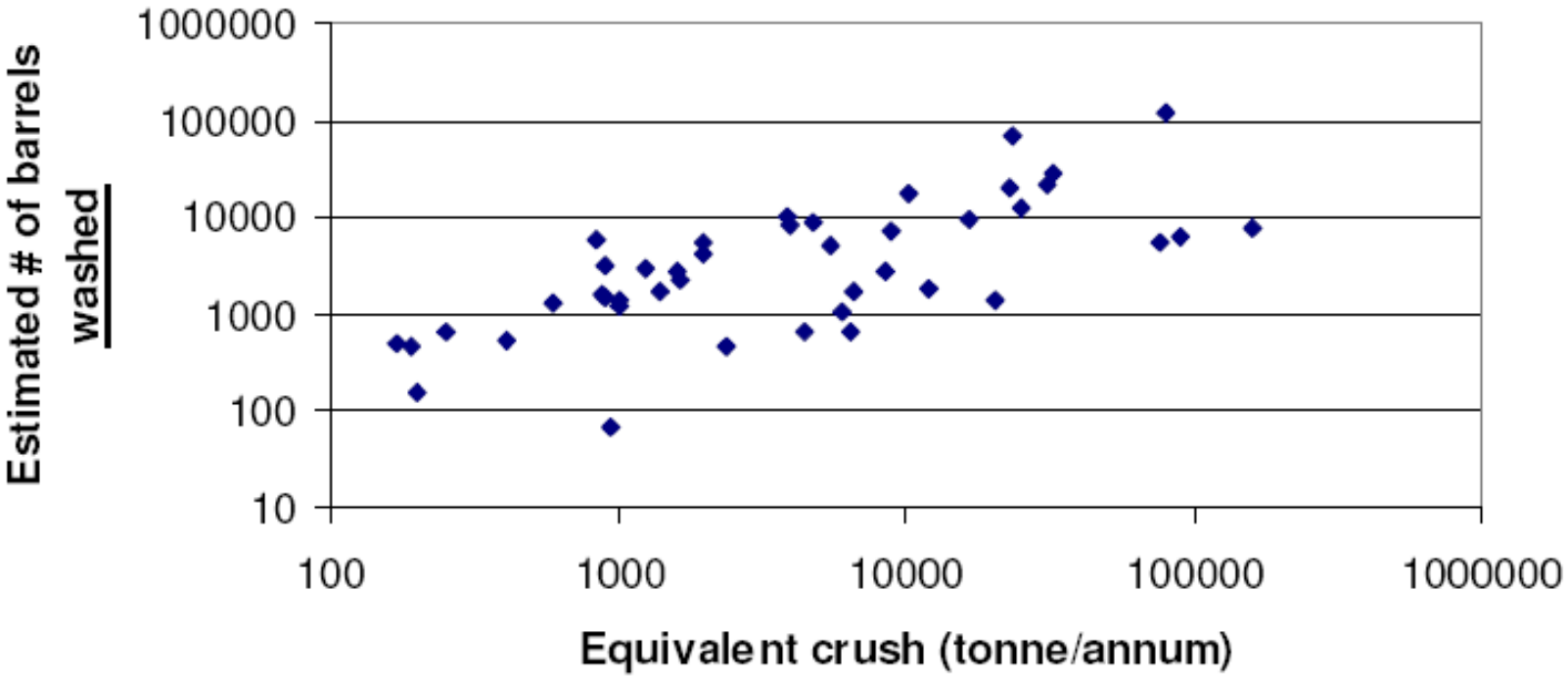
- **2.0 L/bottle wine (750 ml)**
- **Best practise 0.4 L/bottle. Worst practise 8L/bottle**

C. WFA previous values of 1.9 L/750 ml; Europe – 0.6 L/ bottle.

- **Bottling significantly increases water use from 1.4L/bottle – 2.5L/bottle (40% of wastewater) (perceived as not having a major impact on volume)**
- **No relationship was found with water use and the proportion of bulk processing**
- **No relationship between water use and the estimates of process complexity (no of process steps or line transfers (perceived as having largest impact in medium to large wineries)**
- **Lowest water use wineries were > 20,000 tonnes, located in SA**

Barrel Use and Cleaning

- ~ 50 L water/ barrel
- 75% clean after every use, remainder every 3 fills



Minimisation of water use

Method	Water minimisation score component	Number of wineries who use method
High pressure sweep	3	45
Dry sweep	1	38
Automatic hose nozzles	2	26
Inert gas push throughs	4	18
Pigging	5	9
Use of recycled water	--	2

- In 1 winery no water minimisation – highest water use >10L/bottle)
- Based on water minimisation score, no correlation between these practises and water use.
- No consistent trend of pigging and inert push throughs with overall water use/unit production. Although, winery with lowest water use 100% inert push through.
- Re-using stormwater did not reduce overall water use (2.8 vs. 2.4 kL/tonne)

Wastewater quality – untreated and treated

Parameter	Untreated		Treated	
	Median	Range	Median	Range
pH	4.8	3.4 - 6.2	7.6	3.2-10.1
EC	1400	180 - 5200	1600	210-3900
TSS	420	100-5000	125	14-2300
BOD	3750	800-50000	225	5-7600
COD	10600	4400-39000	250	13-28000
TP	9.5	4.1-120	2.7	0.4-44
TN	64	38-300	11.4	2.2-140
Na	45	17-400	165	18-720
K	190	95-1400	180	17-810
Ca	55	13-139	26	0-810
Mg	12	6.9-45	13	5-55

Wastewater treatment

- **Aerobic lagoons most popular method**
- **Victorian wineries tend to treat their water to a lower level than other states**
- **Wineries <10000 t tended to use lower levels of treatment and used different methods like reed beds and bioreactors.**
- **Extensive secondary treatment of wastewater (including the use of activated sludge or anaerobic lagoons) was mainly employed in wineries that irrigated with their treated wastewater**

Cleaning Chemical Use

- **NaOH and citric acid most common chemicals used**
- **Use/unit production is highly variable. Lower use in larger wineries**
- **Alternatives for NaOH were sodium silicate and sodium carbonate**

Wastewater treatment process – cost, footprint and problems

- **Capital and operating costs were $4.1/kL treated water and $4.0/kL treated water respectively.**

- **Footprint for ww treatment (ex. Irrigation area) was 0.49m² / kL water treated.**
  - Pre-treatment 0.16m²/kL
  - Reed beds 1.3m²/kL
  - Extensive secondary treatment 0.96m²/kL
- **About 33% indicated no problems with their current system.**
- **Remainder had odour problems and overloading at vintage leading to reduced treatment quality.**
- **Many did not know the true cost of ww treatment. Extra labour and running of pumps etc.**

Unanswered questions

- **What components of wastewater contribute most COD?**
  - Ethanol ~78%
  - Glucose/fructose – up to 40% in vintage.
  - Organic acids – 10%
  - Acetic acid – 2.6%
  - Glycerol – 3% (Colin et al. 1995)
- **What process steps contribute most water, organic and ionic load?**
- **Which treatment system offered the best option for various winery size and operations given different space and budget constraints? (especially for small wineries).**
- **What is the environmental impact of current wastewater dispersion practises?**

Recommendations for Improving Wastewater Management

- **Minimise number of process steps and transfers**
- **Choose processes that minimise product loss and water use**
- **Cleaning practises that minimise chemical use**
- **Cleaning chemical with low sodium levels**
- **Water use minimisation practises**
- **Waste stream segregation**

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