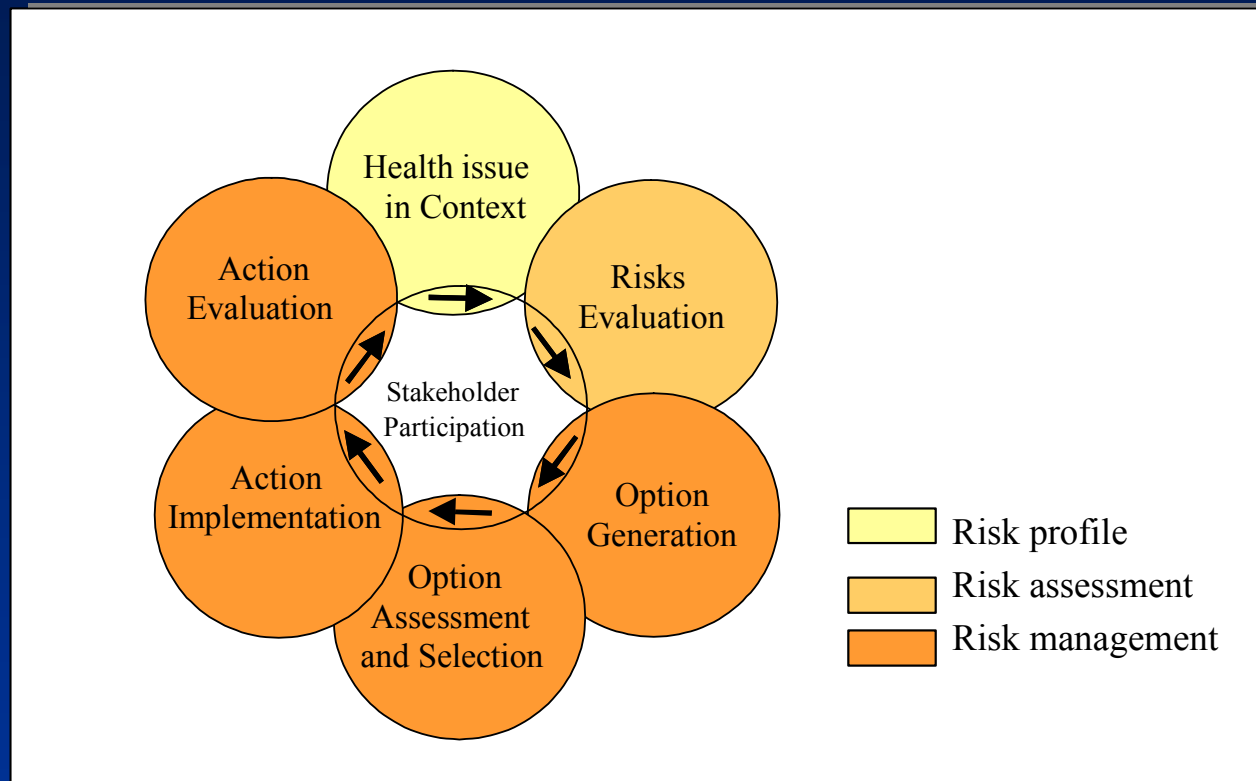

Risk Management in Complex Sociotechnical Systems

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Introduction

- Public health systems as complex sociotechnical systems:
 - » Technological complexity
 - » Pace of change
 - » Potential hazard
 - » Scientific uncertainty
- Complex problems require systematic solutions
 - » Need for a conceptual framework

Proposed WHO Framework

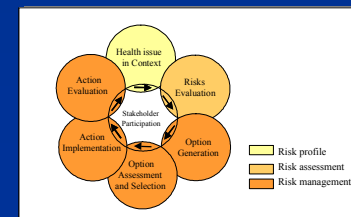


Describes a process (how?), not a structure (what?)

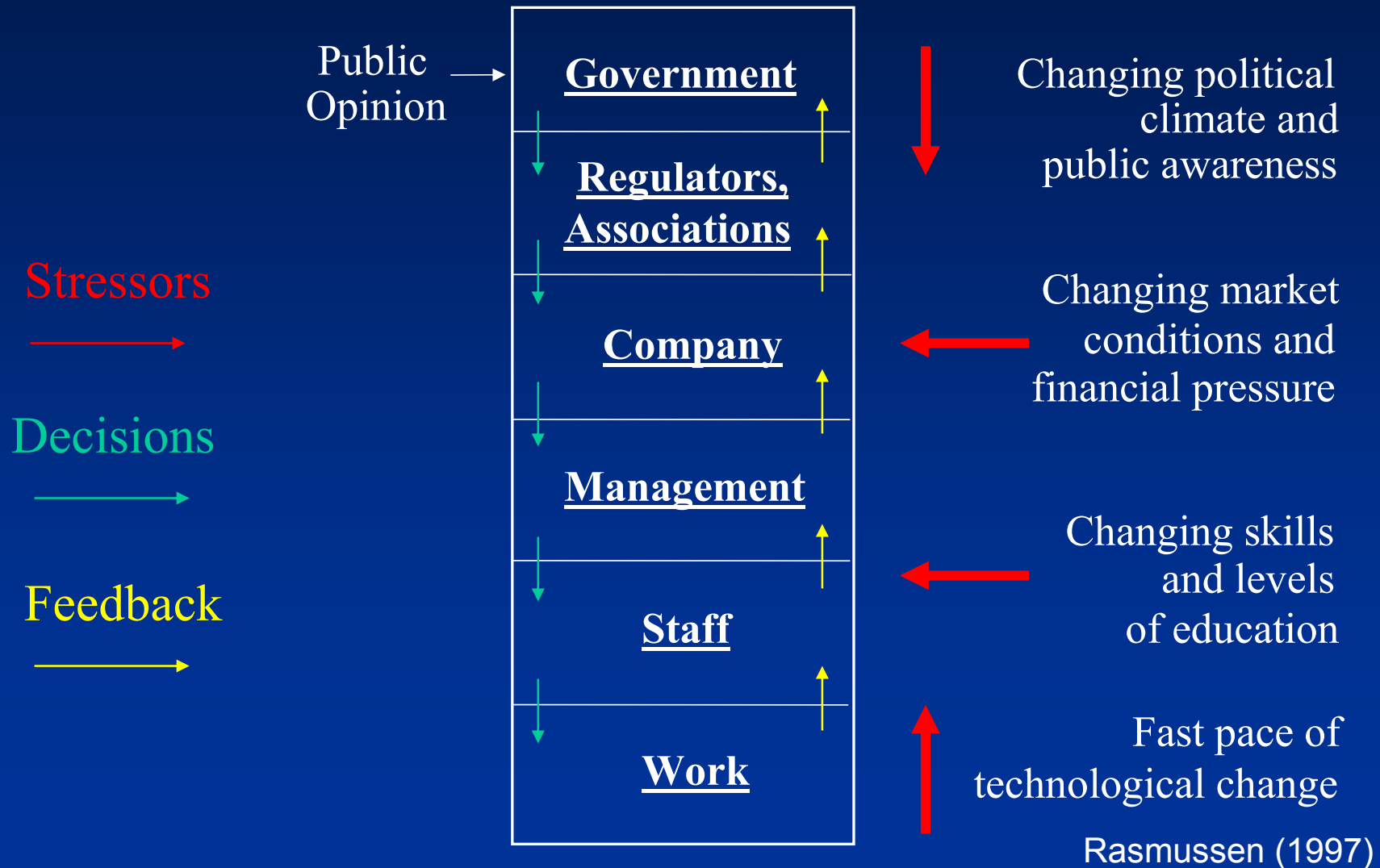
Rasmussen's (1997) Framework

- Safety as a control problem
- Multiple layers of society
- Dynamic pressures
- Lack of vertical integration - threats to safety

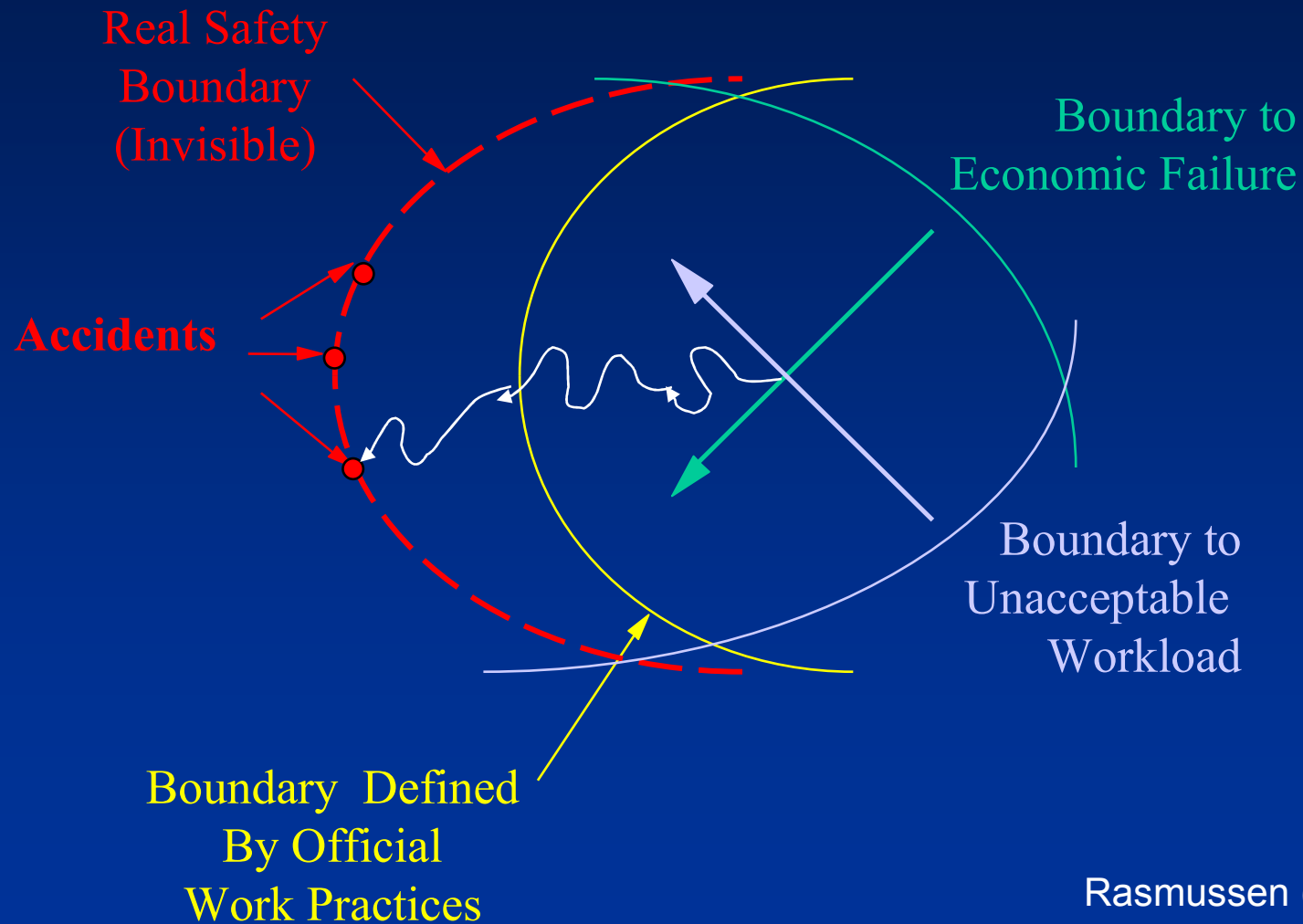
“The weight of political, environmental, social, economic and other factors will need to be made explicit when selecting actions on the basis of precaution”



Structure



Dynamics



Rasmussen (1997)

Case Study

- Example:
 - » Risk management in public drinking water distribution
 - » Walkerton *E. coli* outbreak (Vicente & Christofferson, 2002)

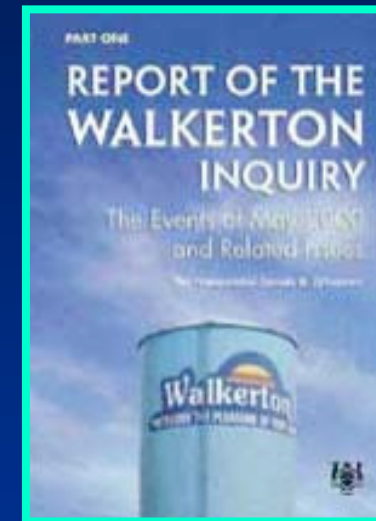


Walkerton *E. coli* Outbreak

- Walkerton, Ontario - May, 2000
- Water supply contaminated with *E. coli*
- 7 deaths, 2300 illnesses, lasting effects
- Economic impact > \$64.5 million CAD

Public Inquiry Commission

- CAD \$9.5 M budget
- >1 million documents
- 95 days of hearings over 9 months
- 221,686 pages of transcripts
- 447 exhibits
- 114 witnesses
- 700 page report



O'Connor (2002)

Sociotechnical System Map

<u>Government</u>	Government of Ontario
<u>Regulators, Associations</u>	Ministry of Environment (MOE), Public Health Authorities
<u>Local Gov't</u>	Municipal Gov't, WPUC
<u>Management</u>	Stan Koebel
<u>Staff</u>	Stan Koebel, Frank Koebel
<u>Work</u>	Walkerton water system

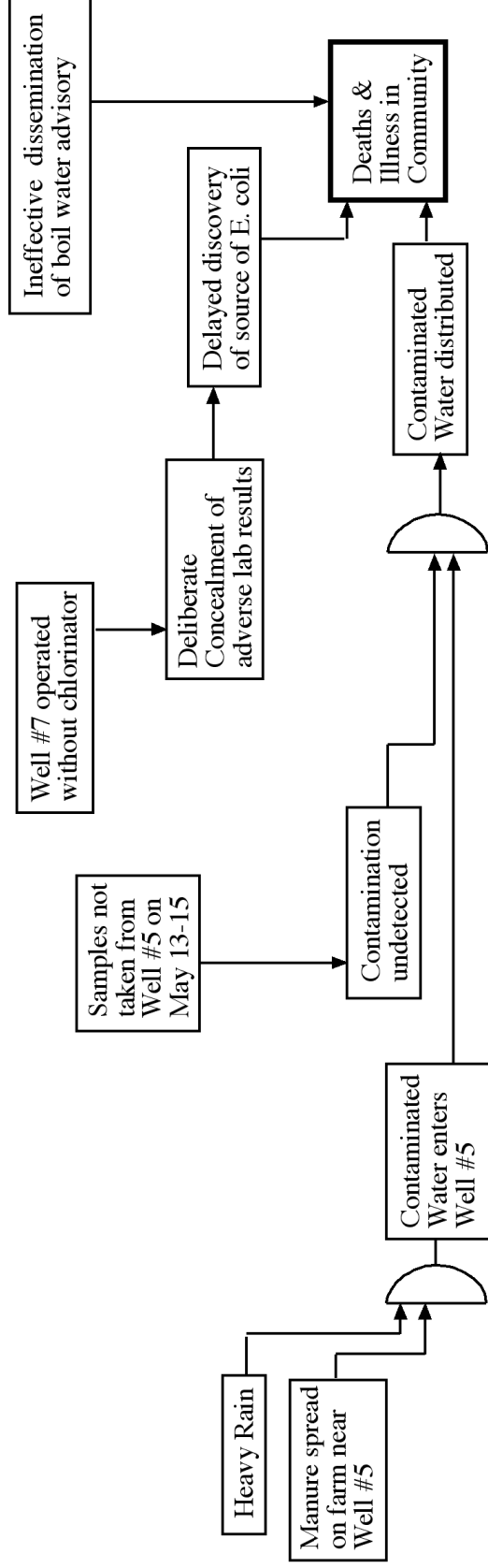
Proximal Sequence of Events

- May 12: *E. coli* enters Walkerton water system through Well 5
- May 13-15: WPUC staff fail to take daily chlorine residual measurements
- May 3-19: Well 7 operated without chlorinator
- May 17: samples collected on May 15 come back positive for *E. coli*

Proximal Sequence of Events

- May 18: first symptoms appear in community
- May 19: local health unit contacts Stan Koebel - does not disclose lab results
- May 21: first confirmed case of E.coli infection; “boil water advisory” issued
- May 22: first death; Stan Koebel turns over lab results to MOE

Physical Processes & Actor Activities



Equipment & Surroundings

- Depth of Well 5 (just 15 m)
- Local geology (fractured & porous)
- No chlorinator on Well 7

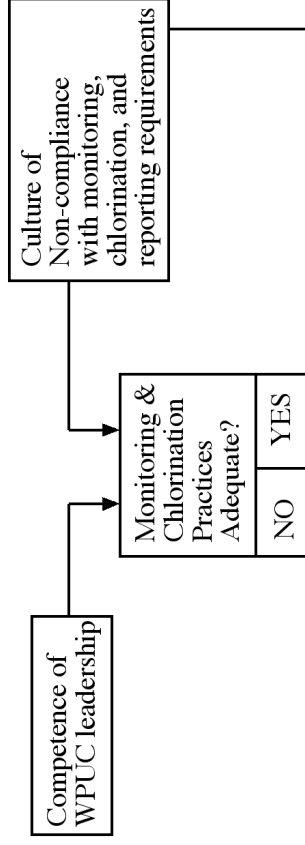
Technical & Operational Management

- History of unsafe practices at WPUC
 - » “for more than 20 years, it had been the practice of employees not to measure the chlorine residuals on most days and to make fictitious entries for residuals in the daily operating sheets”
- Effort gradient
 - » “simply convenience”
 - » “serious disregard for MOE requirements and repeated failures by Stan Koebel to do what he said he would”

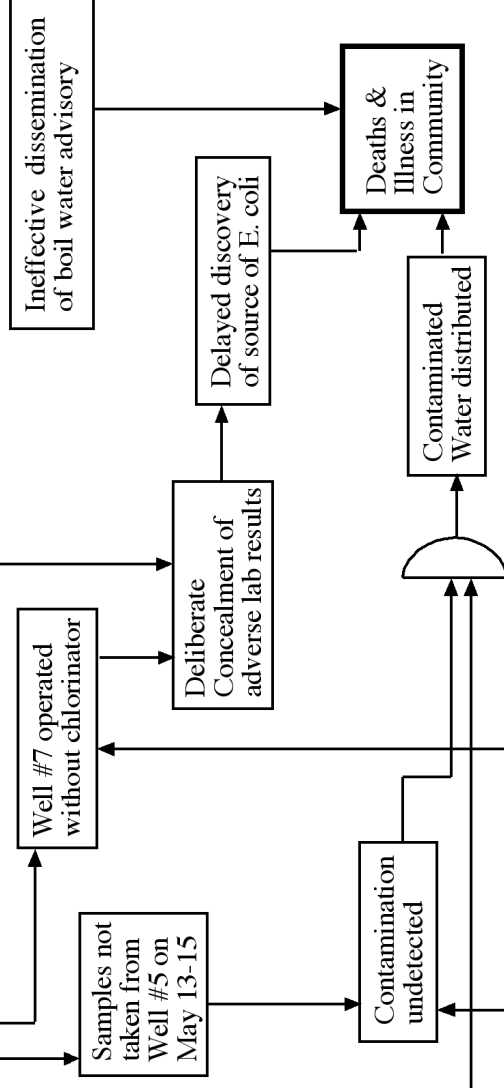
Technical & Operational Management

- Lack of competence
 - » Didn't know what *E. coli* was!
 - » Untreated water “tasted better”
 - » Stan Koebel “continued to drink from a fire hydrant and a garden hose, and on May 22, he filled his daughter's swimming pool with municipal water”

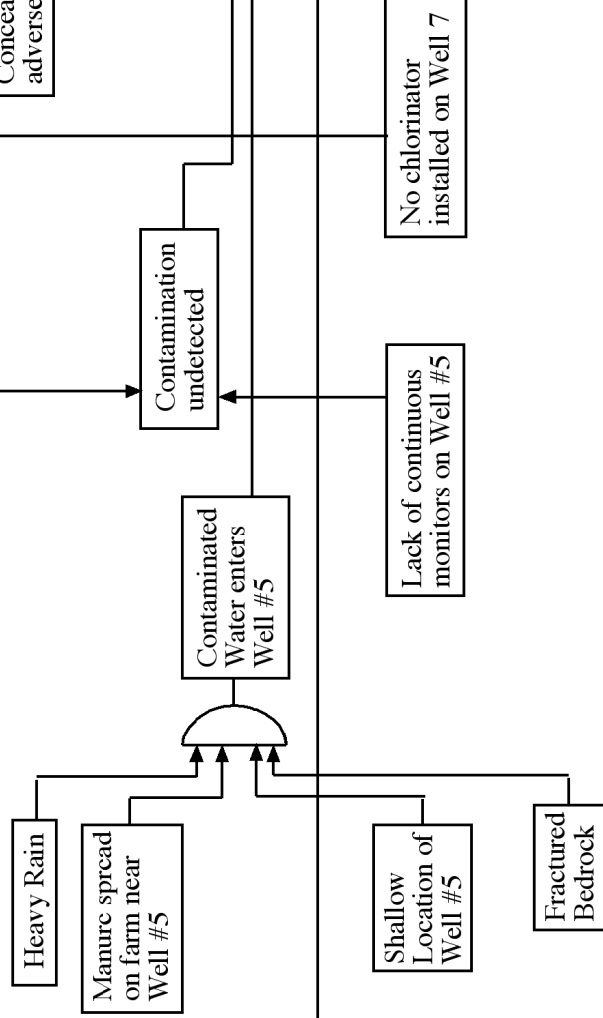
Technical and Operational Management



Physical Processes & Actor Activities



Equipment & Surroundings

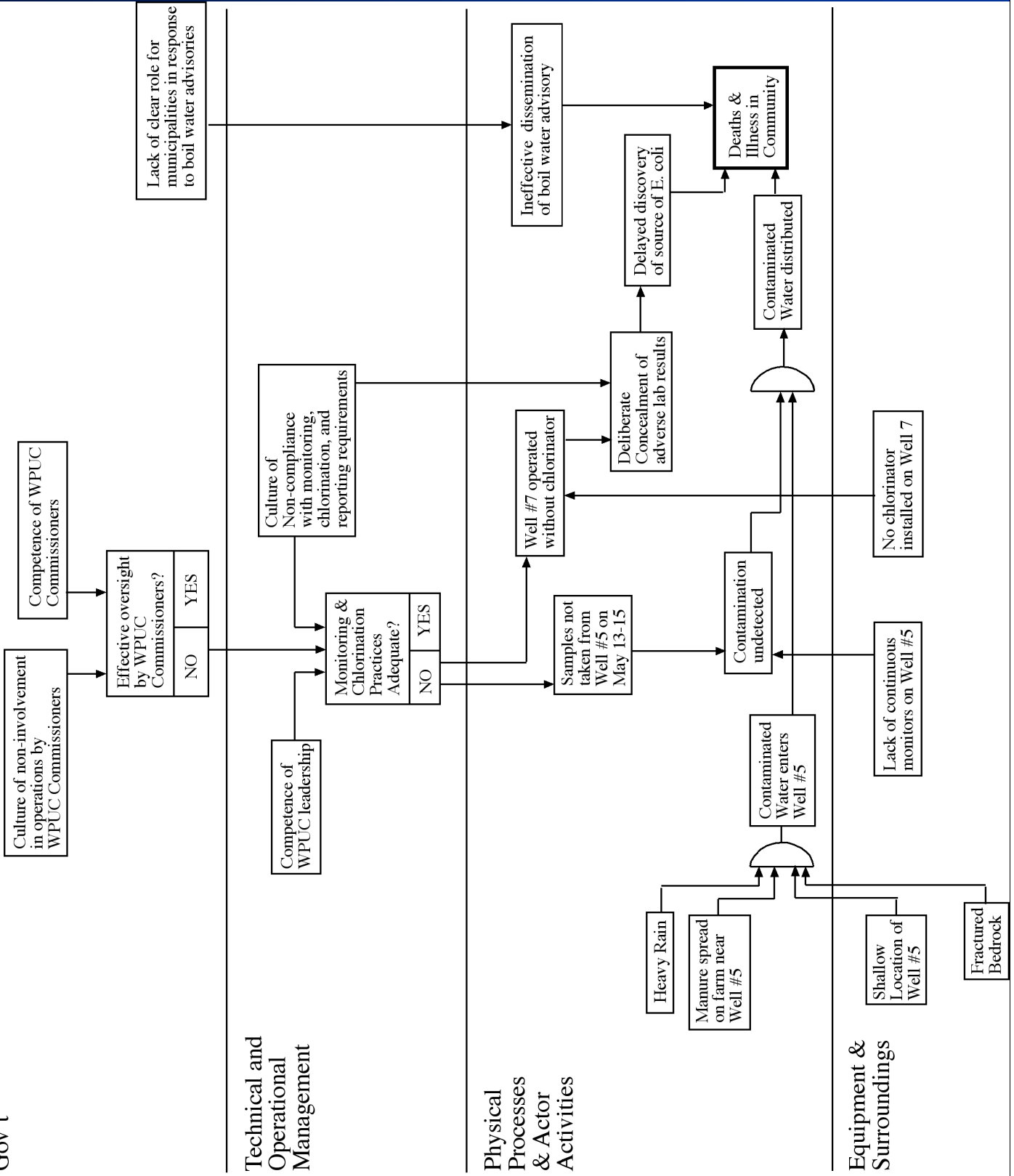


Lack of continuous monitors on Well #5

No chlorinator installed on Well 7

Local Government

- WPUC Commissioners
 - » Focus on finances alone
 - » Lack of technical knowledge, involvement
 - » Inadequate response to 1998 MOE report



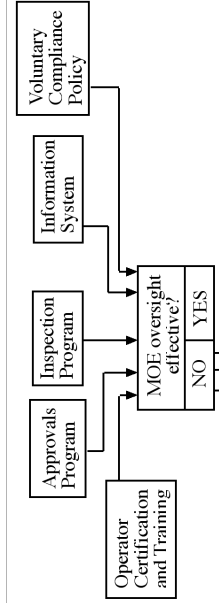
Regulatory Bodies

- MOE
 - » Operator training and certification
 - » Failure to enact effective notification protocol
 - » Voluntary compliance, soft stance

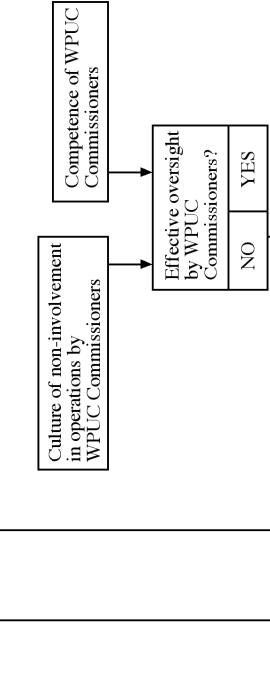
Regulatory Bodies

- MOE lack of feedback
 - » “did not have an information system that made critical information about the history of vulnerable water sources, like Well 5, accessible to those responsible for ensuring that proper treatment and monitoring were taking place. On several occasions in the 1990s, having had access to this information would have enabled [MOE] to be fully informed in making decisions about current circumstances and the proper actions to be taken”

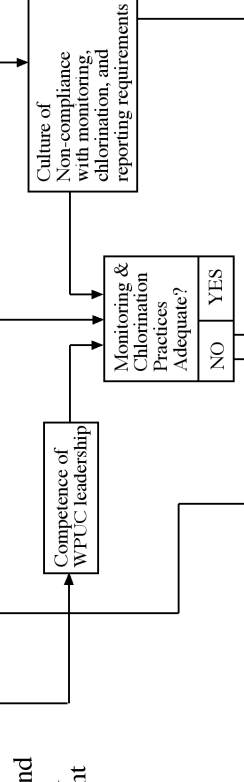
Regulatory Bodies



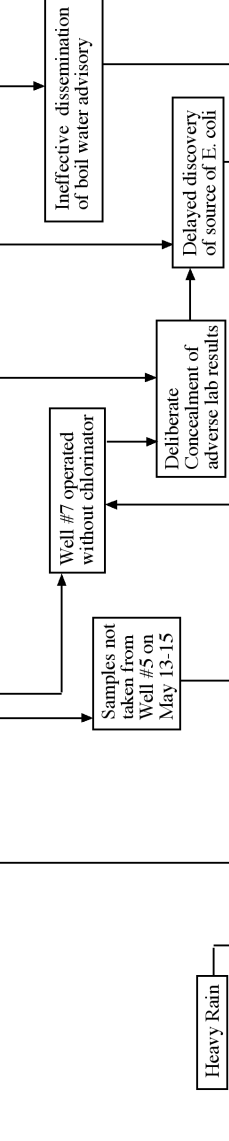
Local Gov't



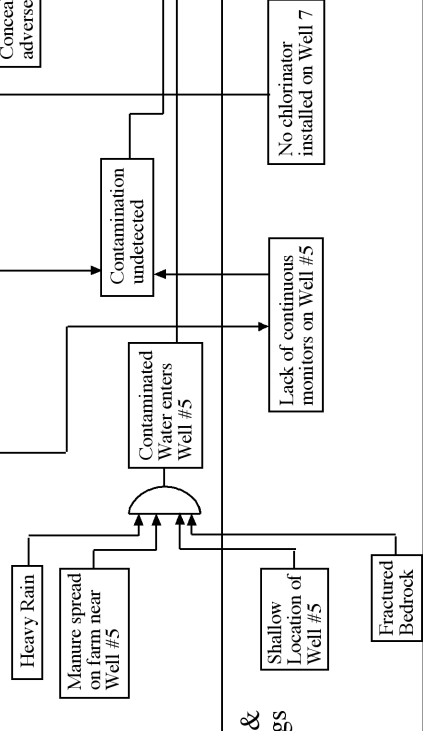
Technical and Operational Management



Physical Processes & Actor Activities



Equipment & Surroundings

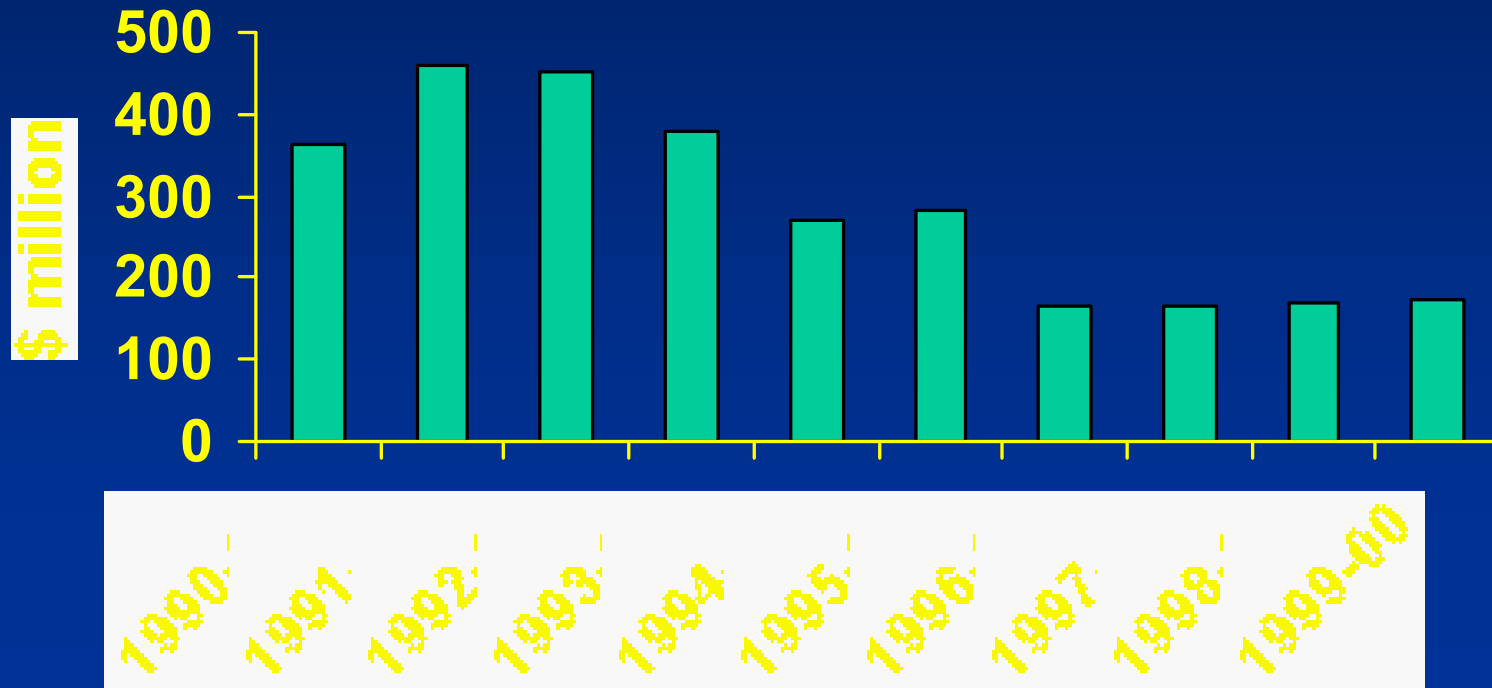


Provincial Government

- Budget cutbacks to MOE
 - » 1996-1998 reduction of > \$200M CAD
 - » Staff reductions >30% (750 employees)
 - » Impact on proactive inspections, approvals
 - » “The Cabinet approved the budget reductions in the face of warnings of increased risk to the environment and human health”

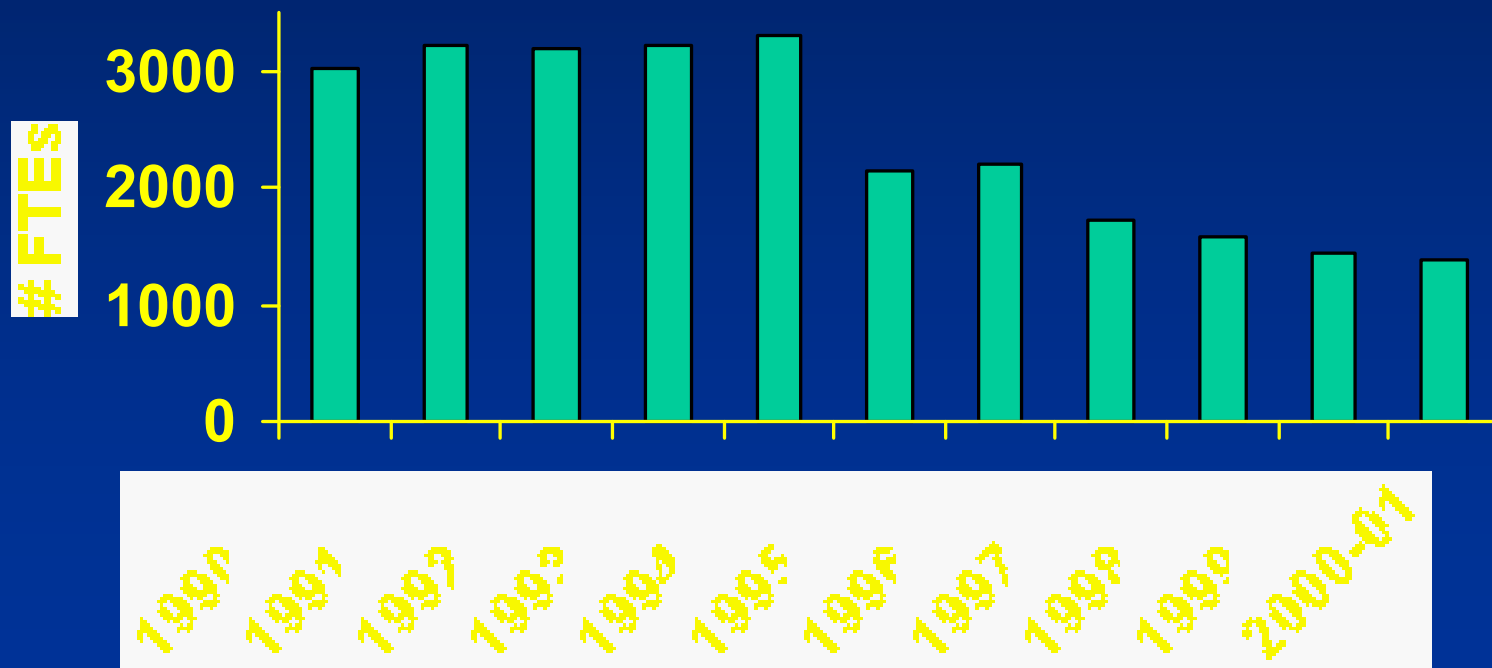
Provincial Government

MOE Operating Budget (1990-2000)



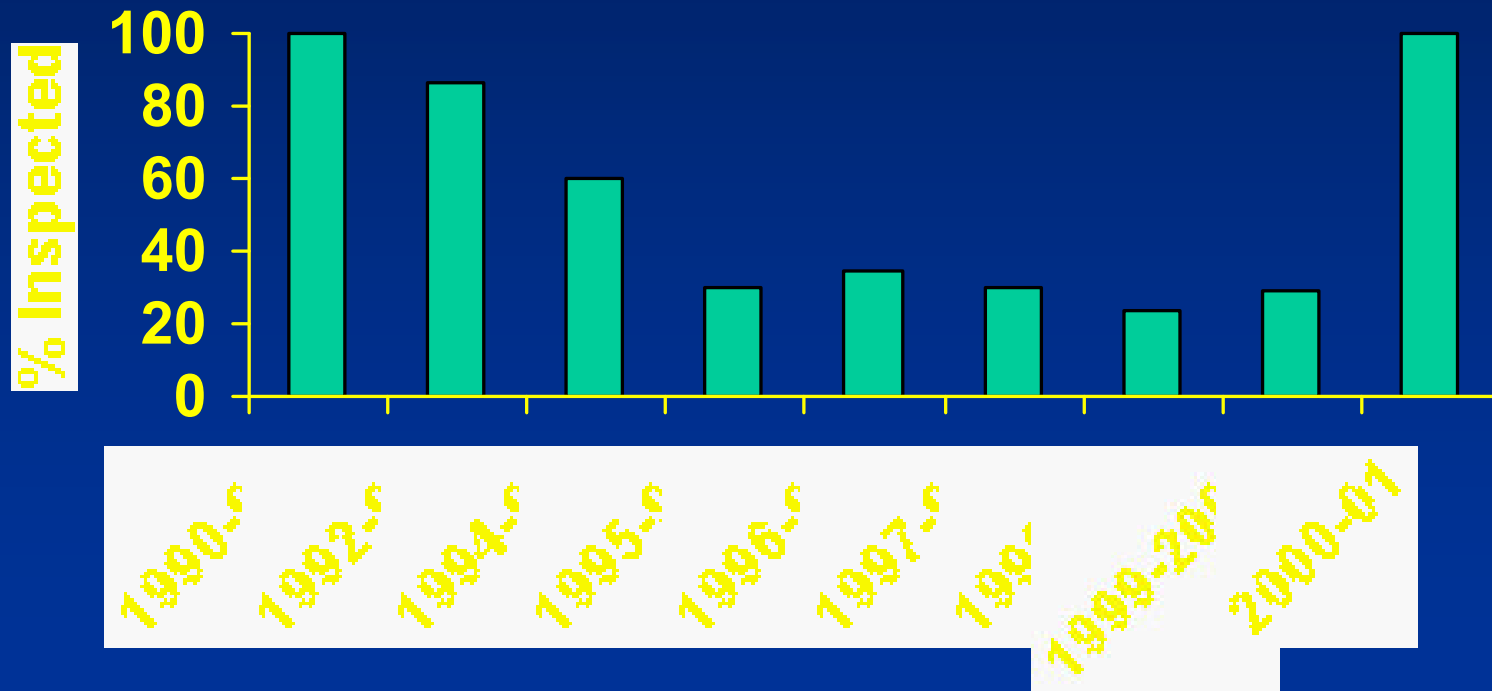
Provincial Government

MOE Staff Complement (1990-2001)



Provincial Government

MOE Water Inspection Rates (1990-2001)



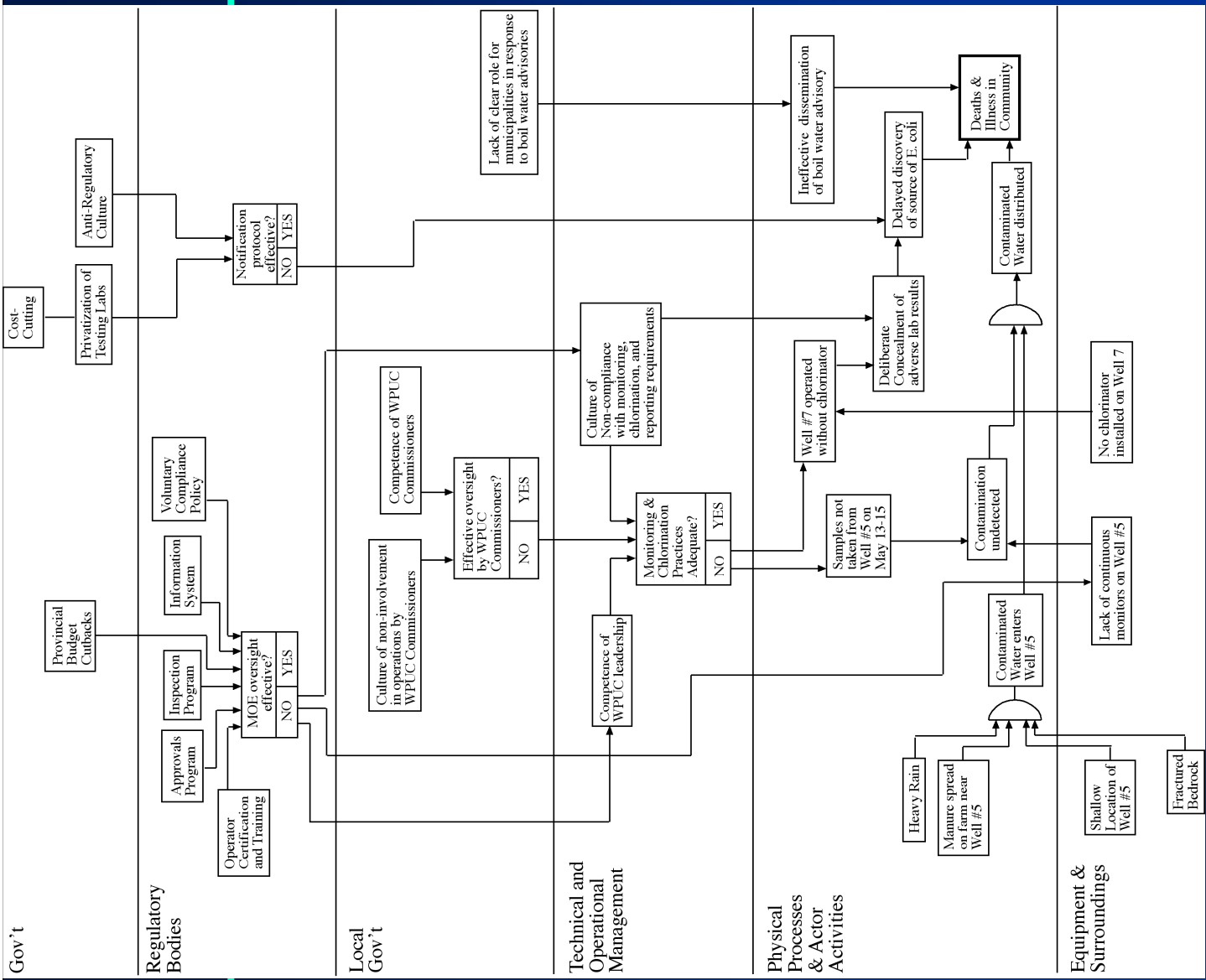
Provincial Government

- No risk analysis
 - » “Despite having knowledge that there could be risks, no member of Cabinet or other public servant directed that a risk assessment and management plan be conducted to determine the extent of those risks, whether the risks should be assumed, and if assumed, whether they could be managed”

Provincial Government

- Anti-regulatory culture
 - » “distaste for regulation”
 - » Red Tape Commission to eliminate “complicated and unnecessary paperwork”
 - » Discouraged enactment of notification regulation

Gov't

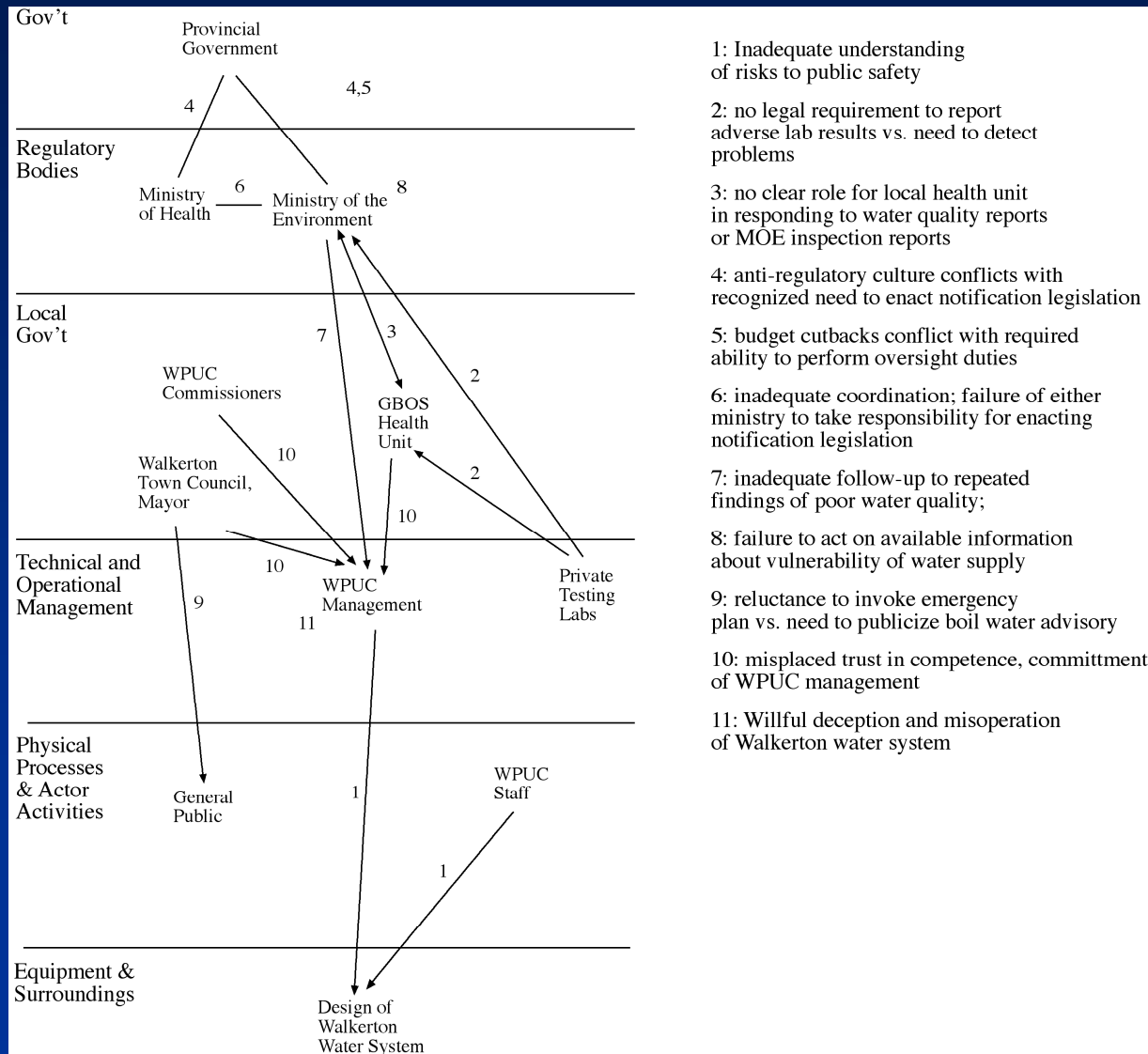


Gov't



Gov't

Conflict Map



- 1: Inadequate understanding of risks to public safety
- 2: no legal requirement to report adverse lab results vs. need to detect problems
- 3: no clear role for local health unit in responding to water quality reports or MOE inspection reports
- 4: anti-regulatory culture conflicts with recognized need to enact notification legislation
- 5: budget cutbacks conflict with required ability to perform oversight duties
- 6: inadequate coordination; failure of either ministry to take responsibility for enacting notification legislation
- 7: inadequate follow-up to repeated findings of poor water quality;
- 8: failure to act on available information about vulnerability of water supply
- 9: reluctance to invoke emergency plan vs. need to publicize boil water advisory
- 10: misplaced trust in competence, commitment of WPUC management
- 11: Willful deception and misoperation of Walkerton water system

Public Health Policy Implications

- Need to look at structure & dynamics as well as process
- Analysts tend to focus on Work and Staff levels (e.g., food safety, SARS)
- Need to look at all levels of a complex socio-technical system
- Vertical integration is critical to safety of public health systems

Acknowledgements

- Klaus Christoffersen, NSERC Discovery grant and E. W. R. Steacie Memorial Fellowship

