Cryptosporidium Removal in Water Treatment

JITMM Cryptosporidium Workshop
Bangkok, Thailand

Jerry Ongerth, PhD, Honorary Fellow
Environmental Engineering
University of Wollongong

30 November 2007

INTRODUCTION

- ESSENTIAL BACKGROUND
- WATER TREATMENT FEATURES
- WATER TREATMENT QUESTIONS
- DESIGN OF TREATMENT STUDIES
- TYPICAL TREATMENT STUDY DATA
- SUMMARY

C & G--ESSENTIAL INFO

- IN SURFACE WATER EVERYWHERE
- SOURCES--ANIMAL / HUMAN FAECES
- HARDY IN THE ENVIRONMENT
  - Cryptosporidium-- 60 days < t 1/2 < 300 days
  - Giardia -- 5 days < t 1/2 < 30 days
- CONCENTRATION DATA...ESSENTIAL
  - Cryptosporidium -- 0.1/L < [C] < 100/L
  - Giardia -- 0.001/L < [G] < 10/L

WATER FILTRATION --PROCESSES--

- GRANULAR MEDIA “RAPID SAND”
  - Coag->Floc->(Settling)->Filtration
  - Filtration Mechanism is Settling
- DIATOMACEOUS EARTH “PRECOAT”
  - No Chemical Conditioning... (Usually)
  - Filtration Mechanism...Surface Entrapment
- MEMBRANE “MICRO” FILTRATION
  - Pressure Driven Physical Straining

FACTORS AFFECTING FILTER PERFORMANCE

- Water Quality: turb; DOC; part. no. & type
- Chem. Coag: Chem(Fe;Al); Coag/Filt. aids
- Flocculation -> (Settling)
- Filter Design: media size/profile; media comp.; media depth
- Filter Operation: flow/loading (6->30 m/hr); flowrate contr; term. criteria; backwashing

WATER TREATMENT QUESTIONS

- Overall Physical Removal? (...%; or logs)
- Performance of Treatment Components?
- Effect on Performance of Differences in:
  - design features? (eg. different media size)
  - operating features? (eg. different loading rates)
  - water quality features? (eg. high vs low turb.)
- Note: All questions require statistical ans.

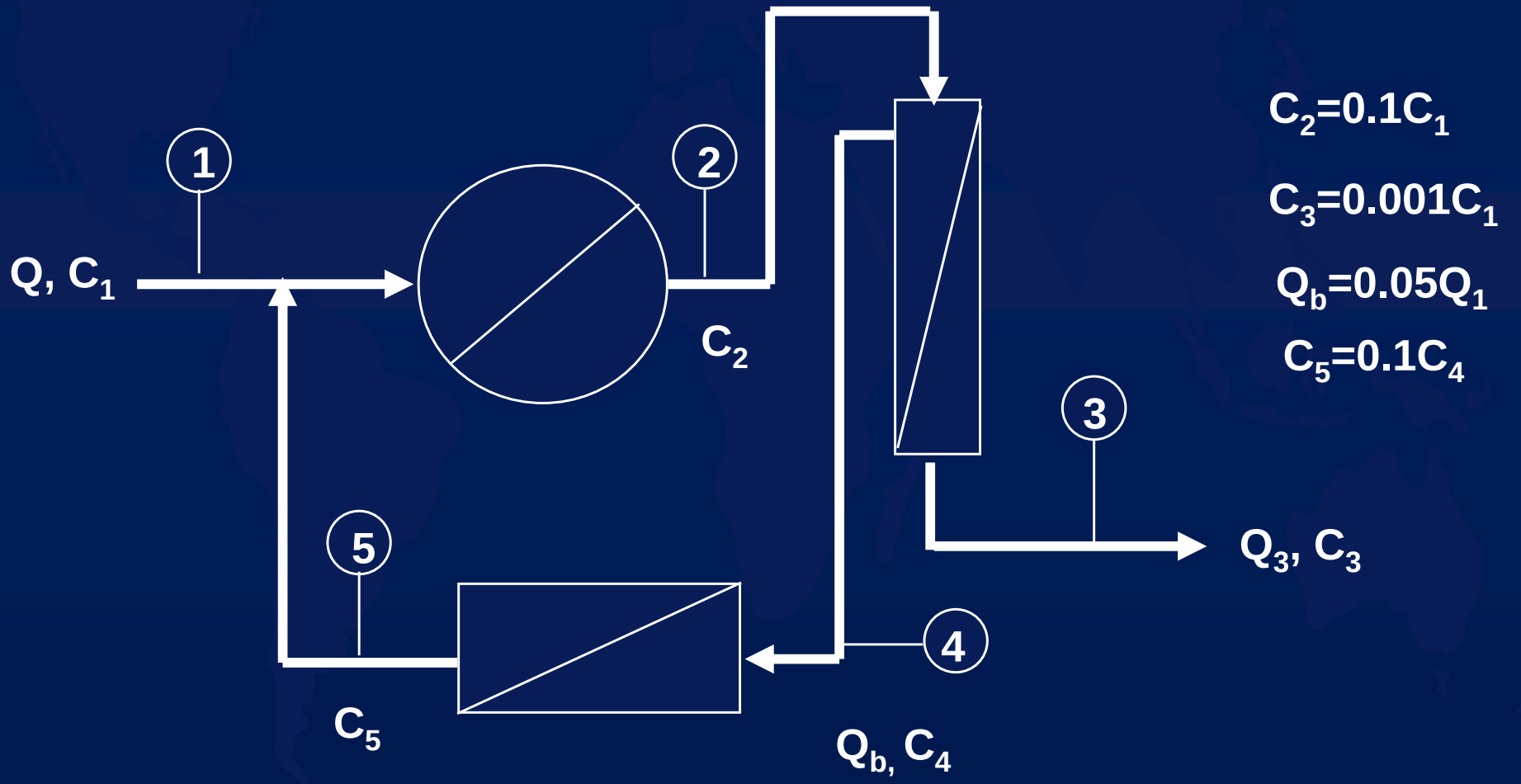
WATER TREATMENT QUESTIONS...CONT.

- Statistical Analysis--Resolve the difference between two measurements...eg. “t” tests
- Ability to Resolve Differences Depends on:
  - Precision (reproducibility) of the assay
  - Number of replicates for each condition
  - Variability in underlying processes
- At Best...Can Resolve Differences ca. 0.2 to 0.5 logs using n=3 (three replicate meas.)

DESIGN OF PERFORMANCE EVALUATION STUDIES

- Organisms (seed): 10^8-10^9 for most runs
  - Organism condition is important
- Application of Seed
- Sampling: locations; volumes; time; control
- Analysis: control (quality); replication (method precision); nonzero results, minimum relative error
- Full-scale plant performance

TREATMENT PERFORMANCE EVALUATION



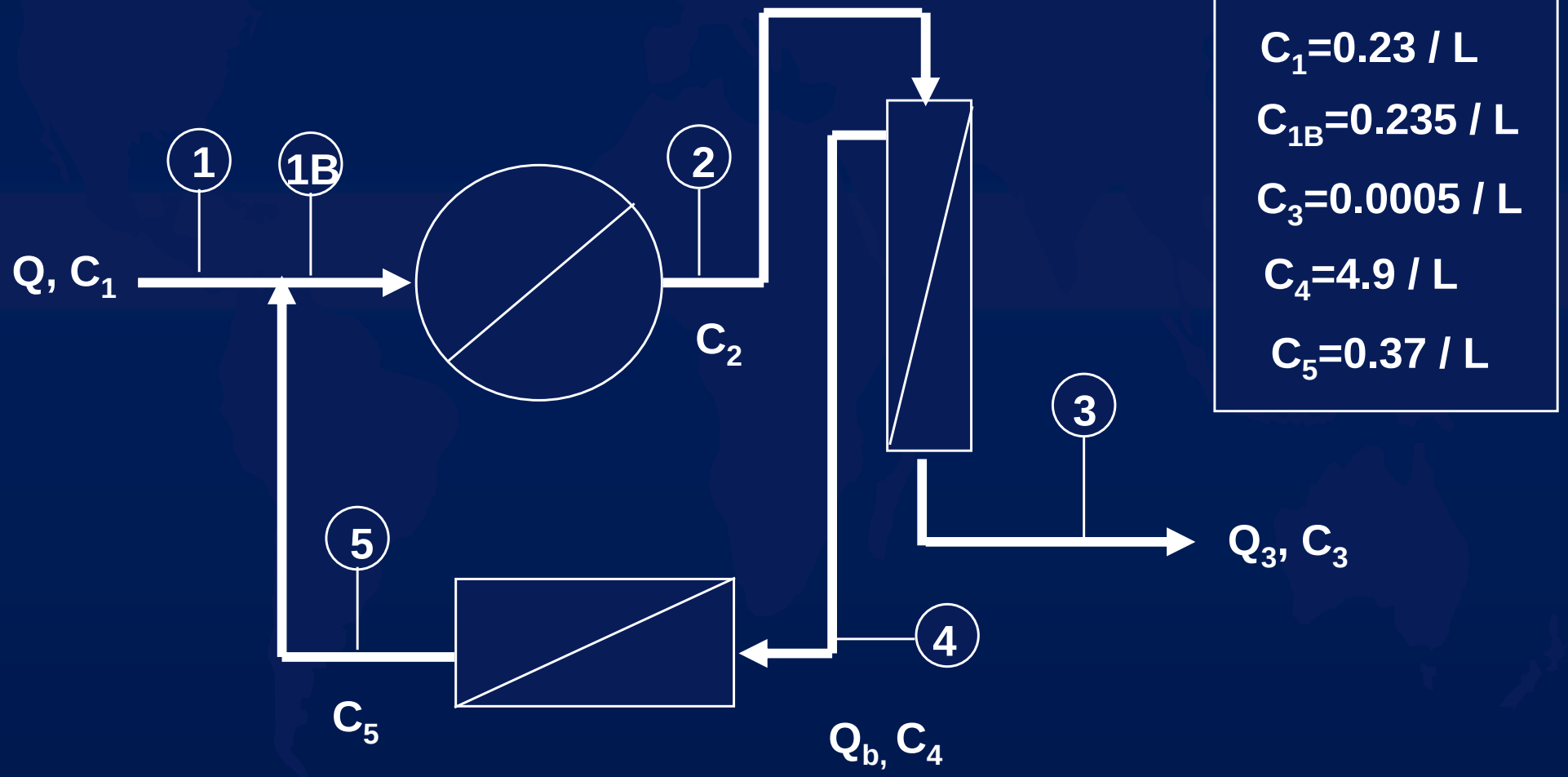
$C_2 = 0.1C_1$

$C_3 = 0.001C_1$

$Q_b = 0.05Q_1$

$C_5 = 0.1C_4$

TREATMENT PERFORMANCE MEASUREMENTS



Treatment Performance Data

Pilot Plant Features	Crypto. R, Logs	Giardia R, Logs
In-line; multi (A/S/G); 1 ntu, Al	2.85 (n=9)	3.30 (n=9)
Cte; dual (A/S) 1 ntu, Al	2.70 (3.25 w/ set.)	2.95 (3.75 w/ set)
Direct; dual (A/S), 1 ntu , Al	3.0	2.5
Cte, dual (A/S) 1 ntu , Al	3.0	3.5
Drct.; deep dual (A/S) 1 ntu , Fe	3.0 to 3.6 (n=3 ea.)	- - -

Treatment Performance Data

Full Scale Plant Features	Crypto. Rem., Logs	Giardia Rem., Logs
Cte; (t. set.) s, 1 ntu, Al	2.5 (n=3)	3.0 (n=3)
Cte; sand, 1 ntu, Ferric	2.8	- -

DE Filtration Features	Crypto. Rem., Logs	Performance
4 M/hr; 5 mg/L b. f.; 1 NTU	6.25 (n=9)	F. turb=0.08 NTU
8 M/hr; 5 mg/L b. f.: 1 NTU	6.40 (n=9)	F. turb=0.07 NTU

SUMMARY

- MUST KNOW TREATMENT DETAILS
- MUST KNOW CRYPTO DETAILS
- MUST FRAME QUESTIONS PROPERLY
- COLLECT DATA TO TEST QUESTIONS
- DON’T TRY IT WITHOUT TESTING IT