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Preface to the Book: "Flocculation in Natural and
Engineered Environmental Systems"

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NWRI RESEARCH SUMMARY

Plain language title

Preface to the book "Flocculation in Natural and Engineered Environmental Systems.

What is the problem and what do scientists already know about it?

The book provides a unique perspective in that it integrates the natural sciences and engineering fields as they relate to the central phenomenon of flocculation. The array of information provided in this book will be valuable to all those interested in flocculation issues within any environment.

Why did NWRI do this study?

This book was compiled to further our understanding of flocculation in multiple environments. This book represents a compilation of flocculation research from freshwater, saltwater and engineered systems. As often the research in these environments remain segregated, this book allows for the cross communication of theories, methods and strategies for flocculation research.

What were the results?

The results are presented in 20 chapters contributed by independent researchers, each representing a unique research focus from either the freshwater, saltwater or engineered environment. Many of the unifying principles of flocculation between these environments are discussed in the concluding chapter.

How will these results be used?

This will be a cutting edge book on the important research topic of flocculation.

Who were our main partners in the study?

This book is edited with the partnership of Ryerson University and The Bedford Institute of Oceanography, Department of Fisheries and Oceans.

Sommaire des recherches de l'INRE

Titre en langage clair

Préface du livre « Flocculation in Natural and Engineered Environmental Systems ».

Quel est le problème et que savent les chercheurs à ce sujet?

Le présent ouvrage offre une perspective exceptionnelle en ce qu'elle combine les domaines des sciences naturelles et du génie qui sont liés au phénomène fondamental qu'est la floculation. L'éventail d'information présenté s'avérera précieux pour tous ceux qui s'intéressent à la question de la floculation, peu importe le milieu où elle se produit.

Pourquoi l'INRE a-t-il effectué cette étude?

Ce livre a été rédigé afin que le lecteur puisse parfaire ses connaissances sur la floculation dans plusieurs milieux. Il constitue une compilation de travaux de recherche réalisés sur la floculation en eau douce, en eau salée et dans des installations artificielles. Il arrive souvent que la recherche propre à un milieu demeure séparée de celle effectuée sur les autres milieux; cet ouvrage permet de faire le lien entre les théories, les méthodes et les stratégies utilisées dans la recherche sur la floculation.

Quels sont les résultats?

Les résultats sont présentés en vingt chapitres préparés par des chercheurs indépendants qui représentent un point de vue unique sur le milieu dulcicole, salin ou artificiel. Le dernier chapitre est consacré à l'examen d'un grand nombre de principes relatifs à la floculation qui permettent d'établir des liens entre ces environnements.

Comment ces résultats seront-ils utilisés?

Il s'agit d'un ouvrage de pointe sur l'important sujet de recherche qu'est la floculation.

Quels étaient nos principaux partenaires dans cette étude?

La publication de ce livre est réalisée en partenariat avec l'Université Ryerson et l'Institut océanographique de Bedford du ministère des Pêches et des Océans.

Preface

In the history of environmental science, there has probably been no greater struggle than the attempt to control the impact of the sediment and solids generated by nature and human influence (including industrial processing) on the terrestrial and aquatic environment and on socioeconomics in general. Untold billions of dollars are spent each year on dredging to maintain navigation channels and harbours. Further costs are added by the need to treat these sediments prior to disposal because of high levels of contamination resulting from anthropogenic impacts on the environment. Significant financial burdens arise as a result of the need to remove solids during drinking water and wastewater treatment processes, a necessity for sustainable development and the protection of human and aquatic health. It is now well established that the majority of particles within natural (freshwater and saltwater) systems are present in a flocculated form (i.e. flocs), and that the formation of flocs is essential for the effective performance of engineering processes such as biological wastewater treatment.

Flocculation is the process of aggregating smaller particles together to form larger composite particles via various physical, chemical and biological interactions. These larger composite particles behave differently in terms of their physical (e.g. transport, settling), chemical (e.g. contaminant uptake and transformation), and biological (e.g. community structure activities and metabolism) behaviour relative to their constituent individual particles due to differences in size, shape, porosity, density and compositional

characteristics. Given these significant behavioural differences between flocs *per se* and their individual component parts, flocculation influences a wide array of environmental phenomena related to sediment-water and sediment-sediment interactions. A few of these include sediment and contaminant transport in various aquatic ecosystems, remediation of contaminated bed sediments, contaminated bed sediment stability, and habitat destruction resulting from sedimentation (e.g. coral reef, salmon spawning beds, mollusk habitat degradation). These concerns, coupled with the ubiquitous nature of flocs within natural and engineered systems and the potential to influence floc properties to better control environmental and engineering processes, have generated an increased emphasis on floc research.

The traditional disciplines within saltwater, freshwater and engineering research have, however, remained somewhat mutually exclusive in their approach to the study of flocculation processes. This reality is facilitated by differences in external variables (e.g. environmental conditions), focus driven research, and discipline bias. Regardless of differences in discipline or approach, there is great scope and utility for the sharing of information between scientists who work in these three floc environments. Often methods used in one environment can, and should, be used in another to further our understanding of flocculation processes. While new developments in genomics, nanotechnology, sampling, and modeling permit increasingly revealing investigations into floc structure, processes, and impact, there is still a fundamental lack of knowledge related to many aspects of the flocculation process.

In light of the importance of flocculation within natural and engineered systems, an international workshop was held on September 4 and 5, 2003, at the Canada Centre for

Inland Waters, Burlington, Ontario, Canada. The workshop brought together academics and government scientists from around the globe to address the critical issue of sediment flocculation within freshwater, saltwater and engineered systems. During the workshop, participants representing these three environments presented their research findings. Three focus areas were used to structure the workshop (a) modeling, (b) physico-chemical and (c) biological aspects of flocculation. Following individual presentations, the participants were divided up into 3 working groups to address assigned topics in the focus areas. Each focus group contained researchers from the freshwater, saltwater and engineered systems to ensure a cross communication of ideas between environments and to facilitate an understanding of the unifying principles of flocculation. Participants ranged from Geographers/Geomorphologists who investigate flocculation as it relates to sediment source, transport and fate within river systems, Sedimentologists interested in flocculation's influence within depositional environments, Biologists focusing on the biopolymeric matrices and microbial consortia of flocs, Oceanographers investigating sediment transport and delivery within estuaries and open ocean environments, and Wastewater Engineers/Biologists interested in floc behaviour within engineered systems.

The peer reviewed 23 chapters which comprise this text are organized by their environment of investigation. The final chapter identifies the unifying principles which were discussed within the workshop focus groups and from the preceding chapters. The text provides a unique perspective in that it integrates the natural sciences and engineering fields as they relate to the central phenomenon of flocculation. We hope that the array of information provided in this book will be valuable to all those interested in flocculation issues within any environment.

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Acknowledgments

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Each chapter has been peer reviewed by two or three reviewers consistent with the standards set for international scientific journals. We would like to thank these reviewers for their efforts in this regard.

Finally, we would like to thank the National Water Research Institute of Environment Canada for hosting the workshop and John Lawrence, Michel Beland and John Preston for their support. The efforts of Elizabeth Wendel, Meenu Pall, Dianne

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