

# Water Treatment Unit Operations—Design Parameters

To be used as part of PSet6

CENG 340—Introduction to Environmental Engineering

Instructor: Deborah Sills

In Class: 21 October, 2013

## Introduction

You have been asked to design a water treatment facility to meet the following criteria:

- Design capacity = 3.25 MGD
- Source is river water with an initial turbidity of 10 NTU, an alkalinity concentration of 50 mg/L, at 10 °C, with dynamic viscosity of  $1.307 \times 10^{-3} \frac{\text{N}\cdot\text{s}}{\text{m}^2}$  and pH = 7.
- Unit operations: coagulation (rapid mix), flocculation, sedimentation, rapid sand filtration, disinfection
- Additional constraints: units must be sized according to acceptable ranges. Design must accommodate maintenance and repair.

## Approach

1. Identify contaminants to be removed
2. Prepare a block-flow diagram of necessary unit operations, in proper order
3. Complete a conceptual design of each unit operation

Table 1: **Typical values used in design of water treatment systems** (adapted from our textbook).

Unit Operation	Design Basis	Calculate
Coagulation–rapid-mix tank	$\theta = 1\text{--}2 \text{ min}$ $\bar{G} = 600\text{--}1000 \text{ s}^{-1}$ Coagulant type	Volume Number of tanks Mixing Power (P) Coagulant dose Alkalinity req'd
Flocculation Tank	$\theta = 10\text{--}30 \text{ min}$ $\bar{G} = 20\text{--}50 \text{ s}^{-1}$ (horiz. paddle) $\bar{G} = 10\text{--}80 \text{ s}^{-1}$ (vertical shaft)	Volume Number of tanks Mixing power (P)
Sedimentation tanks	$\theta = 2\text{--}4 \text{ h}$ OFR = 700–1400 gpd/ft <sup>2</sup> Weir loading rate = 20,000 gpd/ft	Area Volume Number of tanks Weir length
Filtration (rapid sand)	Hyd. loading rate = 2–6 gpm/ft <sup>2</sup> Depth = 2–6 ft	Area Volume Number of filters
Chlorination	$\theta_{\min} = 15 \text{ min}$ (at peak hourly flow) $\theta_{\min} = 30 \text{ min}$ (at average hourly flow)	Volume Chlorine dose