

## CHAPTER 1.0

# INTRODUCTION

### 1.1 Overview

In May 2005, the Water Environment Research Foundation (WERF) selected a research team led by the King County (Wash.) Department of Natural Resources and Parks—Wastewater Treatment Division and CH2M HILL to perform WERF Project 03-CTS-1, “Minimization of Odors and Related Corrosion in Collection Systems.” This team has been assisted by several consulting firms, major research universities, and publicly owned treatment works (POTWs). In addition, this first phase report has been reviewed by a technical advisory committee of experts and regulatory specialists in the collection system odor-related field and by several POTWs.

The multiyear project is divided into three phases: Phase 1, Literature Assessment; Phase 2, Research Agenda Implementation; and Phase 3, Practitioners Guide. This Phase 1 report presents the results of comprehensive literature assessment conducted by the team.

The authors of this report have been involved in a comprehensive odor and corrosion control and prevention research project that seeks to identify and explore gaps in knowledge concerning odor and corrosion issues that affect the wastewater collection system. Participating consultants, universities, and POTWs have provided more than \$1 million of in-kind contributions of time and services for this project.

This report focuses on the odor and corrosion approaches, strategies, success and failure stories, and challenges discovered through a comprehensive literature search. Our efforts to compile the database included information-sharing partnerships with municipal utilities, the academic community, and the profession, all on a global basis. This is the start of a central clearing house related to wastewater collection system odors and corrosion.

### 1.2 Phase 1: Literature Assessment and Review on Collection System Odors and Corrosion

The team has completed Phase 1. The project team completed a comprehensive review of published literature and unpublished documents within the wastewater collection system industry. The project team examined papers and reports associated with nearly all wastewater collection system processes and infrastructure, including pipes, trunks, force and rising mains, pump stations, junction boxes and other related processes or infrastructure. In addition, the project team reviewed “gray literature” describing the experiences of utilities in the wastewater

collection industry with respect to odor and corrosion assessment, measurement, modeling, controls and prevention.

Our research team pulled together existing collection system odor and corrosion knowledge seen in 17 research databases, including information from 33 gray literature sources supplied by utilities, manufacturers, and vendors, and a total of 435 research papers screened from nearly 4,000 abstracts.

### 1.3 Objective

The objective of this report's authors and contributors is to transfer state-of-the-art technology and information gained from the literature survey to the collection system owner and designer on odor and corrosion assessment, measurement, characterization, monitoring, and prevention. The general tasks of this assessment were to summarize the contemporary literature in wastewater collection system disciplines to:

- Improve odor and corrosion characterization for wastewater collection systems
- Determine applicable odor and corrosion assessment models, sampling, and measurement approaches for potential sources for characterization purposes
- Define state-of-the-art odor and corrosion control and prevention technologies, additions, and strategies
- Compile lessons learned for viable and innovative odor and corrosion control and prevention strategies and technologies into a “plain English” guide for owners, designers, and operators
- Identify key gaps in knowledge of technology or infrastructure in addressing odor and corrosion issues from the entire collection system.

### 1.4 Background

Wastewater collection system odors and corrosion issues continue to grow in importance to the community and to system owners and operators. Owners and operators daily address a number of planning, operations, maintenance, odor, corrosion, and regulatory compliance issues to provide cost-effective, environmentally sound, and reliable wastewater collection services to their customers. Collection systems are defined as the conveyance of wastewater through a series of pumps, pipes, trenches, tunnels, and by other means to a wastewater treatment system.

Many collection systems are aging faster than planned due to “odor compound”-induced corrosion, which is typically caused by odorous gases that are generated or released inside the collection system. Collection systems also have a high potential for odors that impact surrounding residents, businesses, and communities. Plus, the collection system is located throughout most communities, cities, and towns, as well as directly connected to most houses, businesses, parks, and other sources of wastewater discharges.

The field of odor and corrosion prevention and control in collection systems is not new, but it is ever-changing. Odor and corrosion prevention in collection systems is as much art as science. Common control methods are selected based on practical experience as opposed to a fundamental understanding of why and when methods will be successful. Although much is known regarding the cause of odorous gases in the collection system, the underlying science and mechanisms of odor generation, sewer ventilation, odor characterization and monitoring, and corrosion mechanisms need further research. The cost of preventing and controlling odors and

corrosion is continuously increasing as collection systems age and outside sources of funding become scarcer. Numerous approaches to odor and corrosion prevention in control in collection systems have been tried over time with varying degrees of success. There is no central clearing house for ideas or successes and failures.

## 1.5 Participants

The project team comprised administrative staff and technical specialists from King County, Wash.; the Los Angeles County (Calif.) Sanitation District (LACSD); Orange County (Calif.) Sanitation District (OCSD); CH2M HILL; the University of Texas at Austin; University of New South Wales, Australia; Odor and Corrosion Technology Consultants; Brown and Caldwell; Environmental Management Consulting; and many others. Oversight was provided by the technical advisory committee, a WERF project subcommittee, and many POTWs, listed below:

### 1.5.1 WERF Project Subcommittee

- Michael W. Sweeney, Ph.D.; RC Liaison, Principal Consultant; EMA, Inc.
- Gail Chesler, Ph.D., P.E.; Central Contra Costa (Calif.) Sanitary District
- Stephen R. Harper, Ph.D., P.E.; Senior Technical Associate; O'Brien and Gere Engineers
- Richard J. Pope, P.E.; Malcolm Pirnie
- James D. Prah, Ph.D.; USEPA Human Studies Facility
- Bradley Striebig, Ph.D., Assistant Professor of Civil Engineering; Gonzaga University
- Amit Parminick Ph.D., Senior Program Director and WERF project manager
- Dirk Apgar; King County (Wash.) Wastewater Treatment Division (coprincipal investigator)
- Jay Witherspoon; CH2M HILL (coprincipal investigator)

### 1.5.2 POTWs

- Butler County Department of Environmental Services, Ohio
- Clayton County Water Authority, Ga.
- Clayton County, Ga.
- Dublin San Ramon Service District
- East Bay Municipal Utility District, Oakland, Calif.
- Gwinnett County, Ga.
- Hampton Roads Sanitation District, Va.
- Little Blue Valley Sewer District, Mo.
- Los Angeles Sanitation District, Calif.
- Melbourne Water, Melbourne, Australia
- Metro Wastewater Reclamation District, Denver, Colo.

- Metropolitan Water Reclamation District of Greater Chicago, Ill.
- Northumbrian Water, Durham, U.K.
- Orange County Sanitation District, Calif.
- Philadelphia Water Department, Pa.
- San Antonio Water System, Tex.
- Stuart, Fla.
- United Water Services, Tex.
- WaterCare Services, Ltd., Auckland, New Zealand
- West Palm Beach, Fla.

## 1.6 Organization

This report contains information compiled by a team of experts who have been working and interacting in the field of wastewater collection system odor and corrosion prevention for many years. Subject matter by chapter is as follows:

Chapter 2 provides a “plain English” description of odor and corrosion issues in collection systems and includes information ranging from odor and corrosion causing compounds, compound formation mechanisms, and various control measures. This section is focused on providing an easy-to-read and understandable plain English overview of the subject matter. The chapters that follow focus on the extensive literature search completed for this study and highlight the state of the art knowledge as defined in the more recent literature. These chapters also identify research knowledge gaps for each general topic.

Chapter 3, Literature Search and Review, reviews the comprehensive approach taken by the team to gather and review collection system odor and corrosion assessment, measurement, and prevention papers, reports, and documents seen since year 2000. Prior to this report, a similar literature search by WERF under WERF Project HMM was conducted that looked at collection system odor and corrosion-related literature from 1990 to 2000. This information, along with grey literature from project completed world wide since 1990, and our current literature search effort were all absorbed and used in this effort.

Chapter 4, Odor- and Corrosion-Causing Compounds, reviews the literature findings related to what odor and corrosion causing compounds have been identified as well as discussing their formation mechanisms and methods for analysis of these compounds.

Chapter 5, Wastewater Collection System Modeling, reviews the literature on how odorous and corrosive gases are emitted and highlights key points about the various emissions models currently used in the industry.

Chapter 6, Sewer Ventilation, reviews the literature findings on how natural ventilation (air movement) occurs in collection systems and discusses key parameters that effect air movement.

Chapter 7, Liquid Phase Odor and Corrosion Control, reviews literature observations and findings on a variety of liquid phase treatment options including oxidation chemicals, iron salts,

pH shifting, and nitrate addition as well as use of bacterial cultures and enzyme supplement products to reduce both odor and corrosion causing compounds.

Chapter 8, Gas Phase Odor Treatment, reviews literature observations and findings on a variety of gas phase treatment options for collecting and treating odorous and corrosive headspace air in collection systems.

Chapter 9, Corrosion Mechanisms and Protection, reviews literature observations and findings related to how corrosion occurs and what measures can be taken to mitigate corrosion such as coatings and linings.

Chapter 10, Research Gaps Evaluation and Summary, provides a summary of all of the research knowledge gaps identified during the literature search and includes both a problem statement as well as a general plan for how the knowledge gap might be investigated and filled.