

Greenhouse Nitrogen Emissions from Wastewater Treatment Operation: Phase I

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Engineered biological nutrient removal (BNR) processes are used mainly to achieve improved water quality. However, BNR strategies could be a potential contributor to atmospheric nitrous oxide (N₂O) emissions depending on reactor configurations and operating conditions. In the future, as BNR is implemented at wastewater treatment plants (WWTPs) around the nation, the flux of this greenhouse gas (GHG) to the atmosphere could increase. Increased releases would be of possible concern because the greenhouse impact of N₂O on a mass equivalent basis is about 300 times that of carbon dioxide.

This project represents one of the first attempts to characterize thoroughly nitrogenous greenhouse gas (N-GHG) emissions from WWTPs and to develop a methodology to collect full-scale plant data from BNR facilities in the United States.

Building on previous work by the project team, this information will be integrated into mechanistic activated sludge process models, which will be refined through this project by the addition of autotrophic pathways for N₂O and NO emissions. The refined mechanistic models will allow the industry to codify the results of this research and develop a tool that will aid in the prediction and, therefore, mitigation of N₂O and NO emissions from WWTPs using a range of wastewater treatment processes. Ultimately, this would allow the wastewater sector to engineer strategies for wastewater treatment that minimize gaseous nitrogen oxide emissions.

This study is the first of its kind in the United States, and replaces the Interim Report. Only two other similar studies have been conducted in the Netherlands and Australia. To facilitate a global monitoring effort, the protocol developed in this study was shared upon request with additional groups in Spain, Portugal, Germany, Singapore, South Korea, and Belgium, which are just beginning similar monitoring programs. It is expected that broad application of the protocol will allow WWTPs to quantify their N₂O emissions using a standard analytical approach. Because plant operations have a key role in N₂O emissions, this report provides significant insight towards the mechanisms influencing emissions and direction to ultimately engineer environmentally sustainable BNR operating strategies and configurations.

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Publication Date: 14/01/2013

ISBN13: 9781780404813

eISBN: 9781780404813

Pages: 170

Print:

Standard price: £29 / €36 / \$44

Member price: £22 / €27 / \$33

eBook:

Standard price: £29 / €38 / \$50

Member price: £22 / €29 / \$38

