

Technical Notes

Tempe BioIntel Opioid Wastewater Monitoring Data

Last Updated: September 2024

Purpose

The purpose of this document is to detail processes leading to the final posted values on the [Tempe Wastewater BioIntel Program Opioids Dashboard](#) are analyzed in Eurofins's wastewater testing lab for the City of Tempe.

Target Analytes

A drug metabolite is the substance produced by the body when it breaks down a drug. Metabolites are a better measure of drug use than the parent drug itself because they provide evidence of consumption. For parent drugs, it is possible that the target was introduced into the wastewater system by disposal and not consumed at all. Some drugs do not currently have a metabolite that is measured in wastewater and others have multiple metabolites that can help to determine consumption. Wastewater monitoring data cannot distinguish between prescription and Illicit use. Prescription-use may contribute to the consumption measurements of Codeine, Fentanyl, Oxycodone, and their respective metabolites. These drugs are available by prescription in the State of Arizona. Each target analytes' s type (parent or metabolite) and their prescription availability are listed in the table below.

Analyte	Drug Type	Prescription Availability
Heroin	Parent Drug	Heroin is a Schedule I Drug in the United States and is not available by prescription.
6-Acetylmorphine	Metabolite of Heroin	Heroin is a Schedule I Drug in the United States and is not available by prescription.
Fentanyl	Parent Drug	Fentanyl is a Schedule II Drug in the United States and is available by prescription.
Norfentanyl	Metabolite of Fentanyl	Fentanyl is a Schedule II Drug in the United States and is available by prescription.
Oxycodone	Parent Drug	Oxycodone is a Schedule II Drug in the United States and is available by prescription.
Noroxycodone	Metabolite of Oxycodone	Oxycodone is a Schedule II Drug in the United States and is available by prescription.
Codeine	Parent Drug	Codeine is a Schedule II Drug in the United States and is available by prescription.

Xylazine	Parent Drug	Xylazine is not currently a federally controlled substance. However, Bill H.R. 1839 has been introduced to congress and if it is passed, would make Xylazine a Schedule III drug under the Controlled Substances Act. Currently, it is available by veterinary prescription and not approved by the FDA for human use.
----------	-------------	--

Calculations

Collection Areas

The methods for calculating concentrations for collection areas were developed by the Arizona State University Biodesign Institute and the City of Tempe. Two sampling locations (ME01 and ME02) are used to calculate final concentrations but are not collection areas themselves. They will not be represented on the dashboard.

Collection Areas 1, 2 and 3 receive influent flow from other sampling locations. Collection Area 7, Collection Area 9, and ME01 flow into Collection Area 1. Collection Area 6 flows into Collection Area 2. ME02 flows into Collection Area 3. To prevent superficially inflated concentration measurements, it is necessary to subtract the concentration of these sampling locations from their destination area concentration. For more details on this process, please reach out to strategic_management_innovation@tempe.gov. Area analyte load per day, after subtractions, is measured in mg per day using the following calculation:

$$\text{Area Analyte Load per Day} \left(\frac{\text{mg}}{\text{Day}} \right) = \frac{\text{Concentration} \left(\frac{\text{mg}}{\text{L}} \right)}{\text{Flow Rate} \left(\frac{\text{L}}{\text{Day}} \right)}$$

Consumption

After concentration has been corrected for the required areas, drug consumption can be calculated.

The equation for drug consumption comes from a 2023 paper by M. Psichoudaki et al. titled Wastewater-based monitoring of illicit drugs in Cyprus by UPLC-MS/MS: The impact of the COVID-19 pandemic.

The drug consumption is expressed in terms of mg per day per 1000 inhabitants:

$$\text{Drug Consumption (mg/day/1000 inhabitants)} = \frac{C \cdot FR \cdot CF}{PE} \cdot 1000 \text{ inhabitants}$$

where,

C is the concentration of each drug in wastewater (mg/L), FR is the flow rate per day (L/day), CF is the correction factor, unique for each compound, and PE is the population equivalent (i.e. the estimated population served).

Correction Factors

Correction factors are sourced from academic literature. The correction factor for each drug's measured compound is dependent on the molar mass ratio of the parent drug and the drug's excretion rate. The table below provides the correction factor for each drug's compound and where it was obtained.

Heroin and Xylazine do not have a correction factor, 1 is used as the correction factor in calculation.

Analyte	Correction Factor	Source
Heroin	NA	NA
6-Acetylmorphine	86.8	Gushgari et al. 2023
Fentanyl	16.7	Gushgari et al. 2023
Norfentanyl	1.6	Gushgari et al. 2023
Oxycodone	11.2	Gushgari et al. 2023
Noroxycodone	4.7	Gushgari et al. 2023
Codeine	1.7	Gushgari et al. 2023
Xylazine	NA	NA

Acknowledgements

We would like to express our gratitude for the support from the following partners for providing resources and data that are essential for the final dashboard output.

- City of Tempe
- Eurofins
- Arizona Department of Health Services

Contact

Questions and comments on this document or about the calculations performed can be directed to wastewater.surv@maricopa.gov.