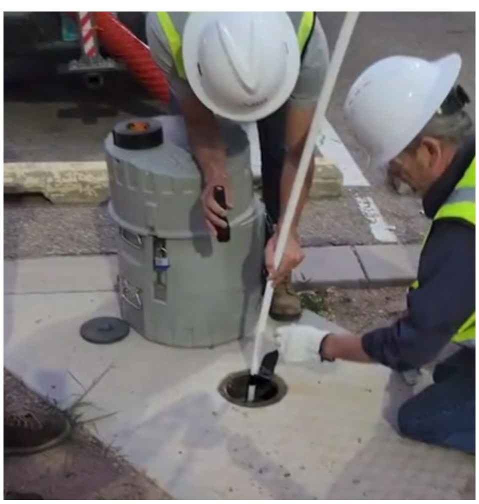
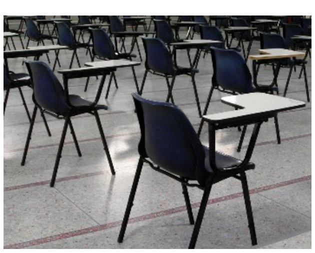
Final Report:

Wastewater Drug Monitoring in New Mexico Public Schools





Final report prepared with support from:
ERG

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If you or someone you love is struggling with addiction, resources are available. Call or text 988 to access trained behavioral health counselors. 988 can open the door for all New Mexicans to seek mental well-being or substance use help.

Healing, hope, and help are happening every day in New Mexico.

Summary

On September 8, 2023, Governor Michelle Lujan Grisham signed Executive Order 2023-132, declaring a public health emergency due to drug abuse, including the misuse of prescription opioids, heroin, and other illicit substances. A September 15, 2023, Public Health Order from New Mexico Department of Health (DOH) Cabinet Secretary Patrick Allen directed New Mexico Environment Department (NMED) Cabinet Secretary James Kenney to "develop a program to conduct wastewater testing for illicit substances, such as fentanyl, at all public schools." NMED developed the strategy and contracted with ERG to provide technical support and logistical coordination for a statewide wastewater testing program on drugs of abuse in public and charter high schools. At the conclusion of this effort, wastewater was sampled from 184 schools where 97,166 students go to school, at the cost of about $7 per student.

This report shares both the methodology and findings of work completed by NMED and ERG pursuant to the Public Health Order in support of the Governor's Executive Order. This report can inform and hone strategies at every level of government as well as serve as catalyst for non-profits, community leaders, and families to implement more effective local strategies for science-based decision making and discussions.

1. Introduction

1.1. Project Goal

The goal of this project was to collect a wastewater sample from every public and charter high school in New Mexico for the analysis of drugs, including opioids and stimulants. This includes illicit drugs, such as heroin and methamphetamine, as well as prescription drugs that may be abused, such as oxycodone, or illegally manufactured, such as fentanyl. The resulting data provide information to support data-driven decisions for public health interventions aimed at reducing drug use.

1.2. Project Limitations

Wastewater testing for opioids and other drugs is a developing field, so there are several knowledge gaps that limit data interpretation. Specifically, the results can't be used to determine if a drug was legally prescribed and consumed, how many people used a drug, or the dose each user took.

Additionally, the results from this project provide information on drugs and metabolites detected in the wastewater on the day when each school was sampled. They do not represent drug use by the school population over a week, month, or year. The wastewater samples collected capture everyone who used the restrooms on the day those samples were taken—students, faculty, staff, and visitors. Therefore, the drugs detected cannot be attributed to a specific population within the school campus.

1.3. Project Scope

This project involved the following key activities:

- Developing project sampling and monitoring protocols
- Recruiting and enrolling schools
- Conducting virtual or on-site reconnaissance at schools
- Compiling information on school enrollment and attendance
- Collecting on-site wastewater samples and coordinating sampling logistics
- Coordinating shipping and laboratory analyses
- Compiling and maintaining field and analytical data in a project database
- Analyzing and interpreting results
- Developing a public-facing dashboard

Due to limited NMED staffing, sampling equipment, and laboratory capabilities, ERG subcontracted field work support to two local engineering firms: Souder, Miller, and Associates (SMA), with offices located throughout New Mexico, and Zia Engineering & Environmental Consultants, LLC, based in Las Cruces. ERG had previously worked with these firms when supporting NMED's COVID (SARS-CoV-2) wastewater monitoring program in congregate care settings. For laboratory analyses, ERG subcontracted with Weck Laboratories, Inc., in California.

1.4. Project Timeline

ERG supported this project from October 2023 through May 2024, as detailed in Table 1 below.

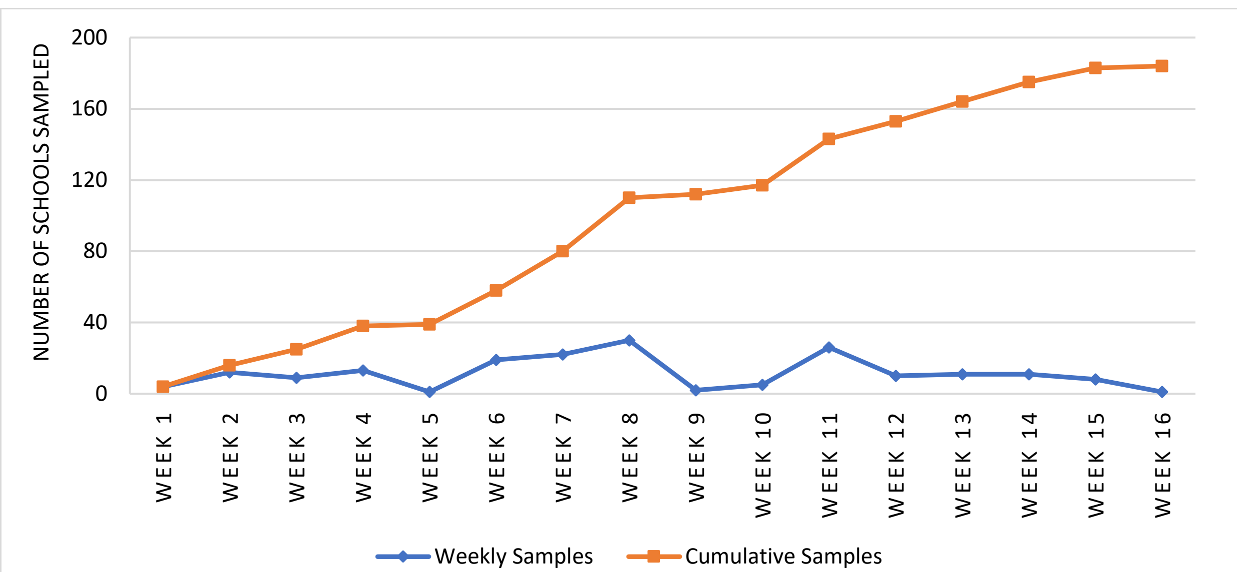
Table 1. Project Timeline

Month	**Activities Completed**
October 2023	• Met with multiple laboratories. Identified Weck Laboratories as having the necessary expertise and capacity to analyze wastewater samples for drugs of abuse. • Developed protocols. • Compiled a list of schools potentially eligible for sampling. Prioritized the schools on that list, based on a review of their characteristics. • Developed a database for tracking school recruitment and sampling. • Obtained all necessary sampling equipment and materials. • Began sample collection with Albuquerque Public Schools. **Schools sampled: 9**
November 2023	• Continued sampling in Albuquerque and expanded into Santa Fe. • Prepared a summary of the first round of analytical results. • Developed a database for field and analytical results. **Schools sampled: 45 (total of 54)**
December 2023	• Continued sampling in Albuquerque and Santa Fe. • Expanded sampling into Farmington, Roswell, Carlsbad, and Hobbs. **Schools sampled 58: (total of 112)**

Month	Activities Completed
January 2024	• Continued sampling in Albuquerque, Roswell, Carlsbad, and Hobbs and began sampling near Las Cruces. • Helped develop the concept for a public-facing dashboard; prepared data to be uploaded to that dashboard. • Initial results were released on the Governor's Wastewater Drug Monitoring Dashboard. **Schools sampled: 44 (total of 156)**
February 2024	• Completed sampling in all areas. • Continued compiling field and laboratory data. • Continued providing data updates for the public-facing dashboard. **Schools sampled: 28 (total of 184)**
March 2024	• Received all remaining analytical data from the laboratory. • Compiled all analytical data for the dashboard. • Returned equipment and materials, as appropriate.
April and May 2024	• Completed final close-out activities, including organizing and compiling project documents and preparing a brief summary report.

An overview of sample collection by week is provided in Figure 1, covering the week beginning on October 23, 2023, through the week beginning on February 19, 2024. In total, samples were successfully collected for 184 schools.

Figure 1. Timeline of Sample Collection



1.5. Project Cost & Workload

The total cost for this project was $689,461. This includes $630,300 for contractor and subcontractor services and expenses and $59,161 that was paid for New Mexico gross receipts tax. Dividing the total project cost by the count of 190 samples collected across 184 schools gives an estimated average cost per sample of $3,629 or just over $7 per student enrolled at those schools. This estimated per-sample cost includes startup expenses (such as developing sampling protocol documents), recruitment efforts at all schools, and costs related to sample collection at schools where field teams could not collect a sample or had to make repeat attempts. Future sampling would not duplicate such startup expenses.

Labor was the largest expense for the project, with nearly 50 people contributing over nine months. This effort required collaboration across state agencies, including 12 staff members from DOH, the Public Education Department (PED), and NMED. Labor costs for state employees are not included in the $689,461 total. This team managed and directed ERG's work, receiving regular, biweekly updates, providing guidance on key decisions, and ensuring transparent communication of sampling plans and results to school leaders and the public. Contractors and subcontractors had 37 employees contribute to the project.

Non-labor costs amounted to $259,844. This includes $93,750 for laboratory analysis and $10,791 for supplies such as bottles, tubing, and packing materials. Additional non-labor expenses related to the sampling effort—covering sampling devices, ice, field team travel, and sample shipment—totaled $155,303.

2. Sample Locations

All public and charter schools in the state with high school-level students were considered for wastewater testing. ERG reviewed a list of 1,198 public and charter schools across 146 school districts provided by PED that educate a total of 308,913 students. For the purposes of this project, high schools were defined as having grades 9, 10, 11, 12, or any combination thereof, and could include younger grades.

A total of 263 schools on PED's list met this criterion. Of these, 191 were chosen for sampling. Table 2 documents the reasons for excluding the other 72. Examples of these reasons:

- During the initial scoping phase, ERG identified some schools that were in buildings that house other activities (e.g., community colleges, private businesses). These schools were not sampled because their wastewater could not be isolated from these other activities' wastewater.
- Schools that were determined to be closed or only offer virtual learning at the time of testing were excluded.

Table 2. Reasons Schools Were Excluded from the Program

Initial List of Schools	**263**
Rationale for Exclusion	**School Count**
Special education facility	11
School embedded within a university	10
School located within a detention center	9
School serves homebound or hospitalized students	9
School currently offers only virtual learning	9
School serves less than 50% of students in grades 9+	5
School sewer line indistinguishable from main village sewer line	5
School permanently closed	4

School serving only students below grade 9 misclassified as a high school	4
No suitable sampling site could be identified	3
School determined to be a mixed-use building	2
Tribal school not interested in participating	1
Total Removed	**72**
Schools Targeted for Sampling	**191**

3. Sample Collection

In October 2023, NMED announced the upcoming wastewater testing program during a regular meeting between PED and superintendents across the state. Sampling began shortly after, in late October, at public high schools in the Albuquerque Public Schools district. At each school, automatic sampling devices were used to collect eight-hour composite samples. Depending on the school, samples were collected in either manholes or cleanouts. In all cases, samples were collected at locations assumed to best represent the entire school population, including students, teachers, staff, and visitors, over an eight-hour period reflecting the school day.

An overview of the process used at each school is provided below.

1) NMED established communication with school administrators and facility staff.
2) ERG verified the school's eligibility for sampling and ensured there were no barriers to collecting a high-quality, representative wastewater sample.
3) ERG obtained the school's bell schedule and noted any early release days or days when students would not be on campus. Students needed to be present for a viable sample to be collected.
4) ERG coordinated with the school facility manager to identify a sampling location that represented the entire school and schedule a sampling date. In some cases, field teams visited schools before sampling to ensure accessible sampling locations, sufficient wastewater flow, and suitable conditions for composite sample collection (e.g., a safe area for securing sampling equipment). In other cases, the ERG team reviewed facility maps and other documents to help find appropriate sampling sites.
5) ERG and local subcontractors collected an eight-hour composite sample.
    - Samples were collected using ISCO composite samplers (models 3700 and 6712).
    - Sampling equipment was either set up the afternoon before the day of sampling and programmed to begin collecting wastewater the following morning or set up the morning of sample collection, at least 30 minutes before the start of school.
    - Samplers were packed with ice to keep samples cold during collection.
    - Samplers were programmed to collect 15 milliliters (mL) of wastewater every 15 minutes over an eight-hour period. Field teams increased this volume if low flow was observed during setup to ensure wastewater was successfully pumped into the collection jug.
    - Field teams retrieved wastewater samples and sampling equipment the day of sampling.
6) ERG and local subcontractors prepared the samples to be sent to the laboratory for analysis.
    - After the samples had settled for several minutes, field staff used syringes provided by the laboratory to extract liquid from the top of the composite sampling jugs. A filter was attached to remove suspended materials as the sample was expelled from the syringe into

two 40mL vials. If the liquid could not be passed through the filter, the vials were filled with unfiltered wastewater and labeled as such.

- Samples were kept on ice before and during transit and shipment.

7) ERG and subcontractors completed field sheets, documenting the date, start and end time of collection, as well as any other observations (e.g., use of filter, sample description, unusual conditions/setup).

Once weekly, all samples collected the previous week were shipped to Weck Laboratories for analysis.

ERG developed documentation to ensure consistent data collection, including:

- Sampling protocols
- Sample packing instructions
- Sample shipping instructions
- Standard school onboarding form
- Standard field notes form for documenting all aspects of sample collection
- Standard sample identification and labels
- Laboratory chain of custody forms
- Excel files to track sample collection, laboratory delivery, and results receipt

These documents were available to NMED in real time throughout the project on a secure SharePoint site. The documents were also submitted to NMED at completion of the project.

4. Laboratory analysis

ERG determined that no laboratories in New Mexico could analyze wastewater samples for drugs of abuse and therefore subcontracted with an out-of-state commercial laboratory. ERG requested quotes from four laboratories and met with each to assess its capacity and experience in analyzing wastewater samples for the target analytes. Weck Laboratories was chosen based on its expertise and cost.

Weck Laboratories analyzed samples for 15 drugs of abuse and/or their metabolites using an adaptation of EPA method 1694, designed for measuring pharmaceuticals and personal care products in wastewater. This method employs liquid chromatography with tandem mass spectrometry, a common analytical technique for environmental samples. Target compounds were separated, ionized, and mass-filtered, with quantification achieved by comparing results to standards and isotopically labeled homologs.

Results were reported by the laboratory in units of nanograms per liter (ng/L), with a method detection limit (MDL) and method reporting limit (MRL). For this project, NMED reported detections down to the MRL, which represents the smallest analyte concentration that can be reliably reported by the laboratory (the lowest calibration level).[1] All drugs and metabolites included in this program have MRLs of 10 ng/L. Analytes presented as “not detected” were not measured at concentrations above this value.

Table 3 lists the target analytes for this project, along with their MDLs and MRLs. The table also indicates whether an analyte is a parent compound or a metabolite. Because the human body breaks down drugs

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[1] Weck Laboratories reported results down to the MDL, which in some cases is lower than the MRL. The MDL is a statistically determined minimum concentration at which an analyte can be confidently identified as above zero with 99% certainty. Values between the MDL and the MRL are not bracketed by calibration standards and are reported as “estimated values.”

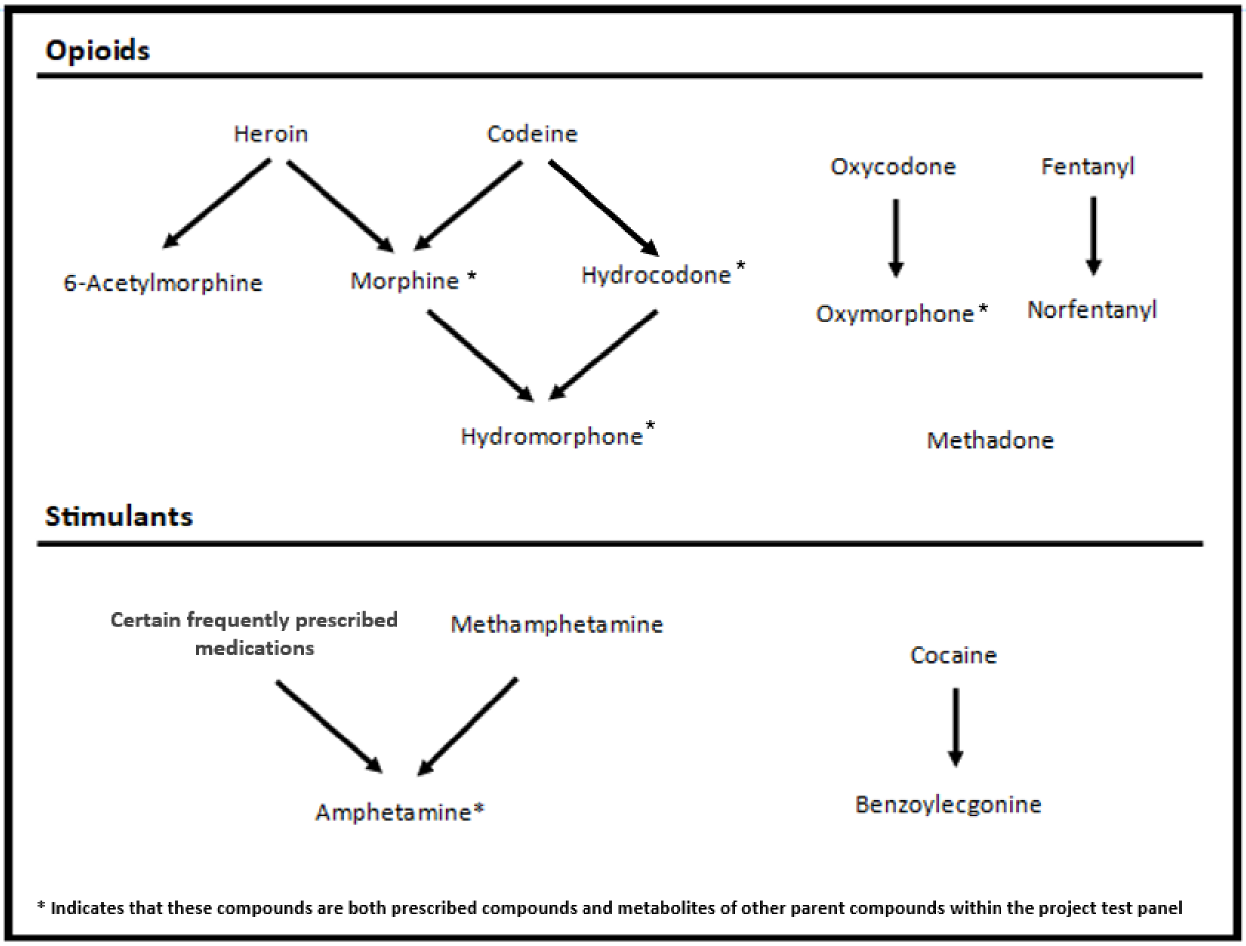
(parent compounds) after they are consumed, it is important to also test for the chemical compounds that these drugs break down into (metabolites). Each drug has different pharmacokinetics, meaning it is metabolized and eliminated through various pathways and at different rates. Some of the target drugs are rapidly metabolized, making them difficult to detect in wastewater unless they were consumed recently or flushed directly. For example, fentanyl has a half-life of about three to seven hours. Therefore, it was essential to test for both fentanyl and its metabolite, norfentanyl.

Table 3. Target Analytes

Analyte	Parent Compound	Metabolite (Parent)	MDL (ng/L)	MRL (ng/L)
Opioids				
Heroin	X		4.3	10
6-Acetylmorphine		X (heroin)	10	10
Fentanyl	X		10	10
Norfentanyl		X (fentanyl)	10	10
Oxycodone	X		3.4	10
Oxymorphone	X	X (oxycodone)	10	10
Hydrocodone	X	X (codeine)	3.4	10
Hydromorphone	X	X (hydrocodone, morphine)	10	10
Codeine	X		10	10
Morphine	X	X (codeine, heroin)	10	10
Methadone	X		4.5	10
Stimulants				
Methamphetamine	X		4.2	10
Amphetamine	X	X (methamphetamine)	10	10
Cocaine	X		4.1	10
Benzoylecgonine		X (cocaine)	10	10

Several of the metabolites tested are specific to the consumption of certain target drugs. For example, 6-acetylmorphine is only produced through the metabolism of heroin, norfentanyl from metabolism of fentanyl, and benzoylecgonine from cocaine metabolism. Other metabolites can be produced following consumption of various compounds. For example, amphetamine is a metabolite of methamphetamine, but also many other prescription drugs, such as those prescribed to treat attention-deficit/hyperactivity disorder (ADHD). Additionally, some of the analytes in Table 3 are both parent compounds and metabolites of other drugs. For example, codeine is metabolized into morphine, which is further metabolized into hydromorphone, making morphine both a parent compound and a metabolite. Wastewater measurements for such analytes should be interpreted with caution. These relationships are outlined in Figure 2.

Figure 2. Parent Compound and Metabolite Mapping

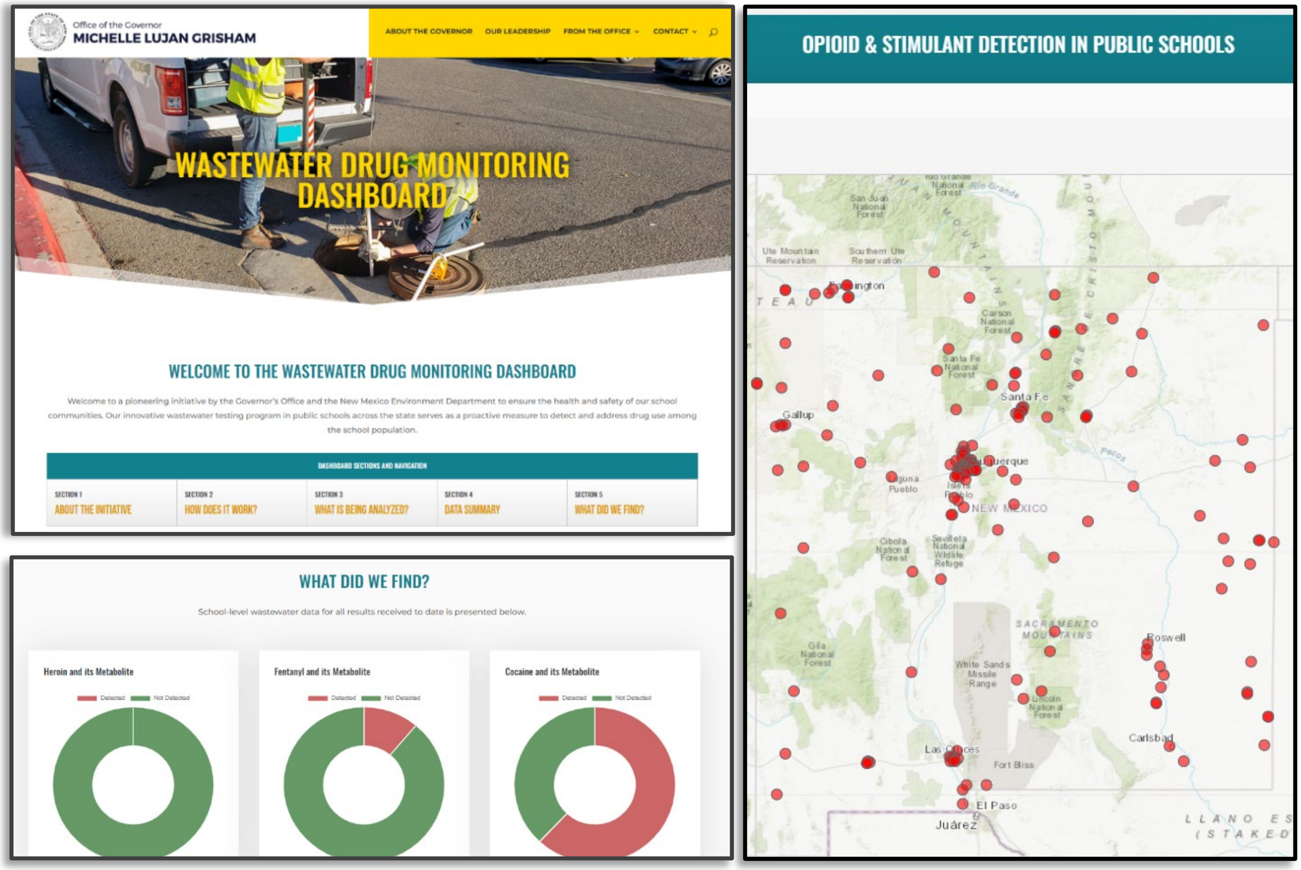


5. Data Reporting & Dashboard

The laboratory typically reported results within three weeks of receiving the samples. ERG reviewed the results thoroughly, including critical quality control parameters (e.g., matrix spike recoveries, inhibition flags), and followed up with Weck Laboratories as needed. ERG maintained a project database of all analytical results, which NMED had access to throughout the project.

ERG provided NMED with a summary of analytical results within two business days of receiving them from the laboratory. These data were formatted and uploaded to a public-facing dashboard at the Office of the Governor's website (https://www.governor.state.nm.us/wastewater-testing/). This dashboard provides background information on the project, an overview on analytical results (including percentages of schools with detected results for specific drugs), and detect/non-detect observations for each school in both tabular and graphical formats. Figure 3 shows screenshots of the dashboard.

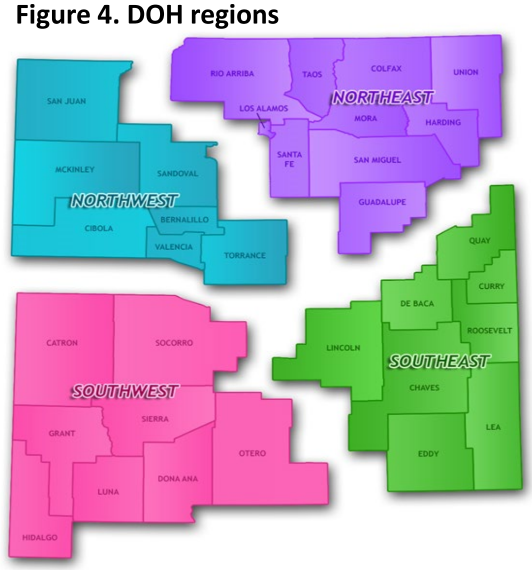
Figure 3. Public Dashboard



6. Sample Results

Of the 191 schools where sampling was attempted, 184 schools were successfully sampled serving a total of 97,166 student. The most common reason for failure to sample a school was low sewage flow, often attributed to a small student population. Occasionally, the sewer system design did not allow for collection at access points (sewer cleanouts or manholes) where there was sufficient flow. In six cases, two schools shared a campus, and field teams collected a single sample that represented both schools. In total, 178 samples were analyzed for drugs of abuse. For this analysis, we considered the total number of samples without double-counting those representing two schools. As a result, the findings here may differ slightly from those on the public-facing dashboard.

Figure 4. DOH regions



From: https://www.nmhealth.org/about/phd/region/

The most frequently detected opioids in wastewater across all schools were hydrocodone (20%), morphine (17%), and oxycodone (17%). Fentanyl and its metabolite, norfentanyl, were detected less often, in 11 (6%) and 19 (11%) schools, respectively. All stimulants in the test panel were detected, with methamphetamine detected in 68% of samples, cocaine detected in 45% of samples, and benzoylecgonine (the metabolite of cocaine) detected in 53% of samples. Note that amphetamine, a metabolite of methamphetamine, was detected at a relative high frequency of 72% of samples. However, amphetamine is a parent drug and also a metabolite of various commonly prescribed medications, including several ADD and ADHD medications.

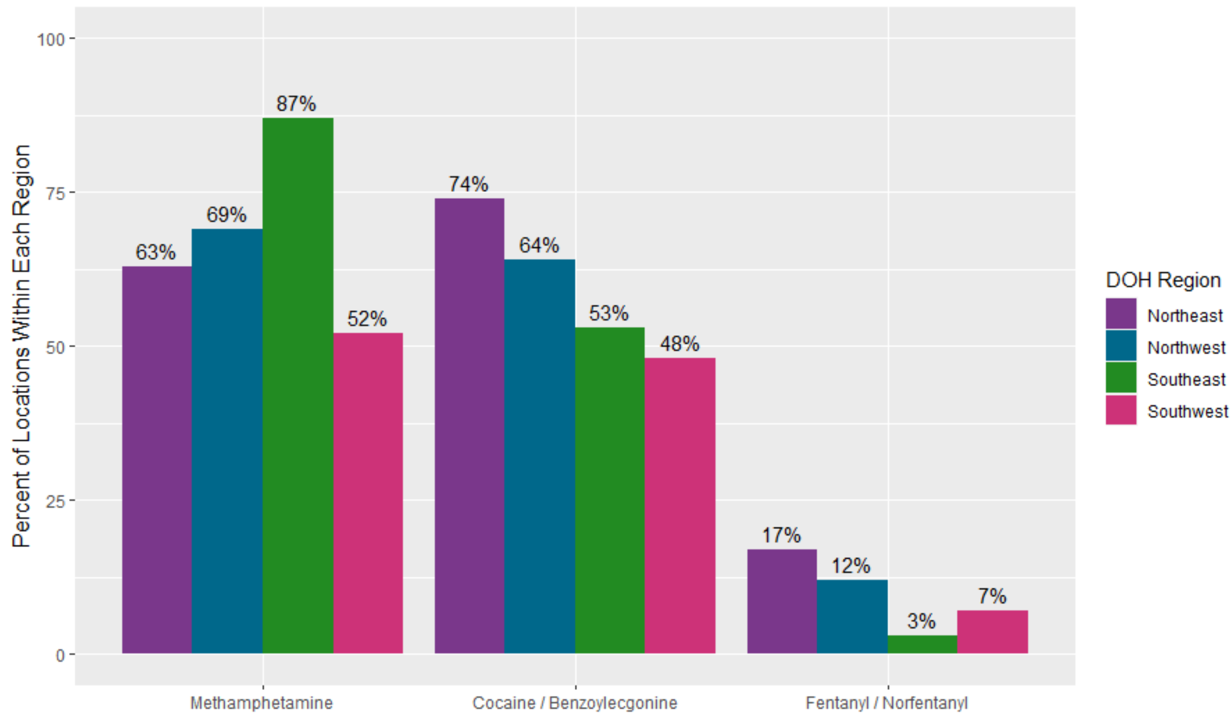
To better understand where drugs of abuse were detected in wastewater, ERG used the DOH Public Health Regions to categorize sample site locations (see Figure 4). Nearly half of sampling sites (86 schools or 48%) were in the Northwest region. Thirty-five schools (20%) were in the Northeast region, 30 schools (17%) were in the Southeast region, and 27 schools (15%) were in the Southwest region. See Table 4 and Figure 5 for a summary of drug detections by DOH region. Another presentation of these data is provided in Attachment A.

Table 4. Frequency of Detection for All Analytes by DOH Region

Drug Type	Compound	Positive Detect n (%)*				
		Total n = 178	DOH Region			
			Northeast (n = 35)	Northwest (n = 86)	Southeast (n = 30)	Southwest (n = 27)
Opioids	Heroin	0	0	0	0	0
	6-Acetylmorphine	0	0	0	0	0
	Fentanyl	11 (6%)	3 (9%)	7 (8%)	0 (0%)	1 (4%)
	Norfentanyl	19 (11%)	6 (17%)	10 (12%)	1 (3%)	2 (7%)
	Oxycodone	30 (17%)	6 (17%)	17 (20%)	5 (17%)	2 (7%)
	Oxymorphone	20 (11%)	4 (11%)	13 (15%)	2 (7%)	1 (4%)
	Hydrocodone	36 (20%)	6 (17%)	14 (16%)	9 (30%)	7 (26%)
	Hydromorphone	19 (11%)	3 (9%)	10 (12%)	3 (10%)	3 (11%)
	Codeine	25 (14%)	7 (20%)	11 (13%)	3 (10%)	4 (15%)
	Morphine	30 (17%)	9 (26%)	15 (17%)	2 (3%)	4 (15%)
	Methadone	23 (13%)	6 (17%)	15 (17%)	1 (3%)	1 (4%)
Stimulants	Methamphetamine	121 (68%)	22 (63%)	59 (69%)	26 (87%)	14 (52%)
	Amphetamine	128 (72%)	25 (71%)	59 (69%)	23 (77%)	21 (78%)
	Cocaine	80 (45%)	17 (49%)	43 (50%)	8 (27%)	12 (44%)
	Benzoylecgonine	95 (53%)	23 (66%)	46 (53%)	14 (47%)	12 (44%)

** All percentages shown are column percentages (e.g., 15% of schools in the Northwest region tested positive for oxymorphone).*

Figure 5. Frequency of Detection for Selected Analytes by DOH Region



Note: The bars represent the percentage of schools in a DOH region where the analyte was detected. For example, the first bar shows that methamphetamine was detected in 63% of schools tested in the Northeast region. The second bar shows that methamphetamine was detected in 69% of schools tested in the Northwest region.

Simple logistic regression models were used to evaluate differences in the likelihood of detecting methamphetamine, cocaine (and its metabolite benzoylecgonine), and fentanyl (and its metabolite norfentanyl) by DOH region. Detection of either the parent compound or its metabolite was considered a positive indication of the parent compound's use. Amphetamine, being a metabolite of methamphetamine and several other prescribed medications, was excluded from the methamphetamine analysis. The Southwest region was selected as the reference group for these models.

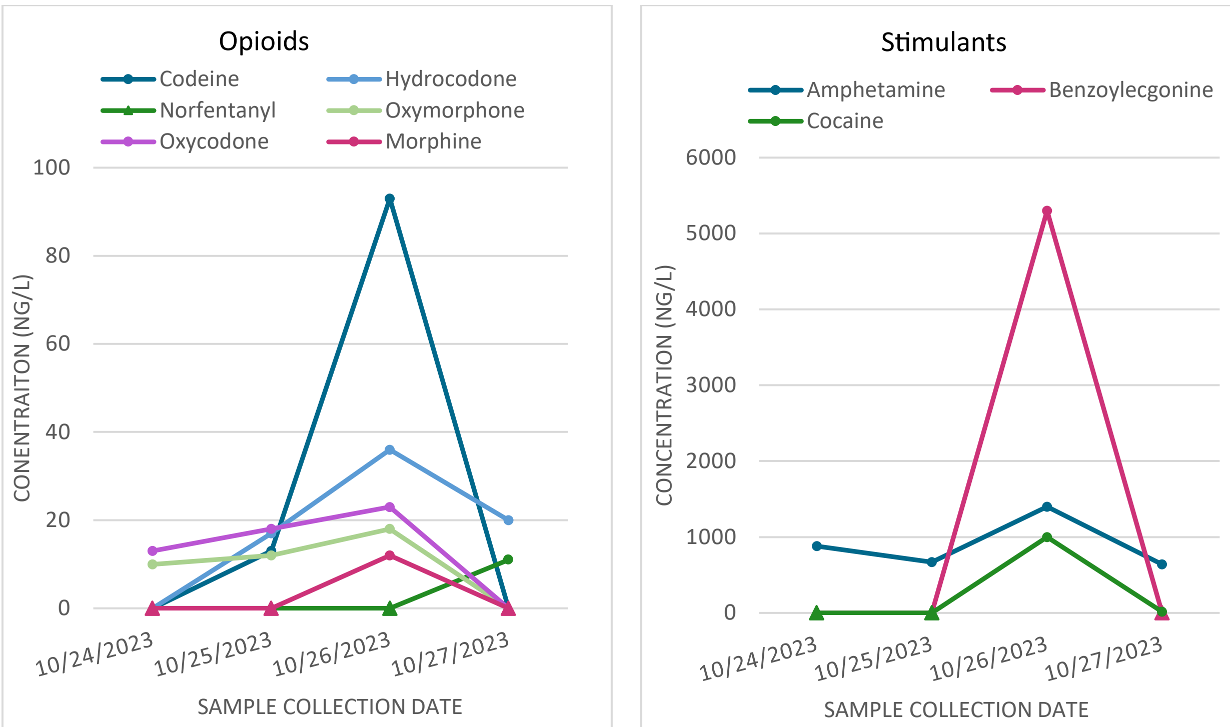
Methamphetamine was significantly more likely to be detected in the Southeast region than in the Southwest region and cocaine/benzoylecgonine was significantly more likely to be detected in the Northeast region than in the Southwest region (p value of <0.05). There were no other significant differences in the likelihood of detecting methamphetamine, cocaine/benzoylecgonine, or fentanyl/norfentanyl between any of the other regions and the Southwest region (Attachment B).

6.1. Repeat Samples

To assess variability in the drugs measured and detected from one day to the next, repeat samples were collected at selected schools; four samples were collected on consecutive days from two schools, while two samples each were collected on the same day of the week but in consecutive weeks from four other schools. Figure 6 shows measured results collected on consecutive days from one school. As the figure shows, drugs were not consistently detected each day (non-detect observations are shown as concentrations of 0 ng/L in both figures and with a triangle marker). Similar trends were observed in other repeat sampling data.

This day-to-day variability illustrates a potential limitation of collecting one eight-hour composite sample for a school. The samples collected through this program provide a snapshot of drugs detected in wastewater on the day of collection. Positive results confirm the presence of drug use at the school, but negative results do not exclude the possibility of drug use within the school population.

Figure 6. Concentrations of Opioids and Stimulants from Repeat Samples at a Single High School



Note: Heroin, 6-Acetylmorphine, fentanyl, hydromorphone, and methamphetamine were not detected in samples from this school on any of the four days and are therefore not shown here. Triangle markers represent non-detect results.

7. Conclusion

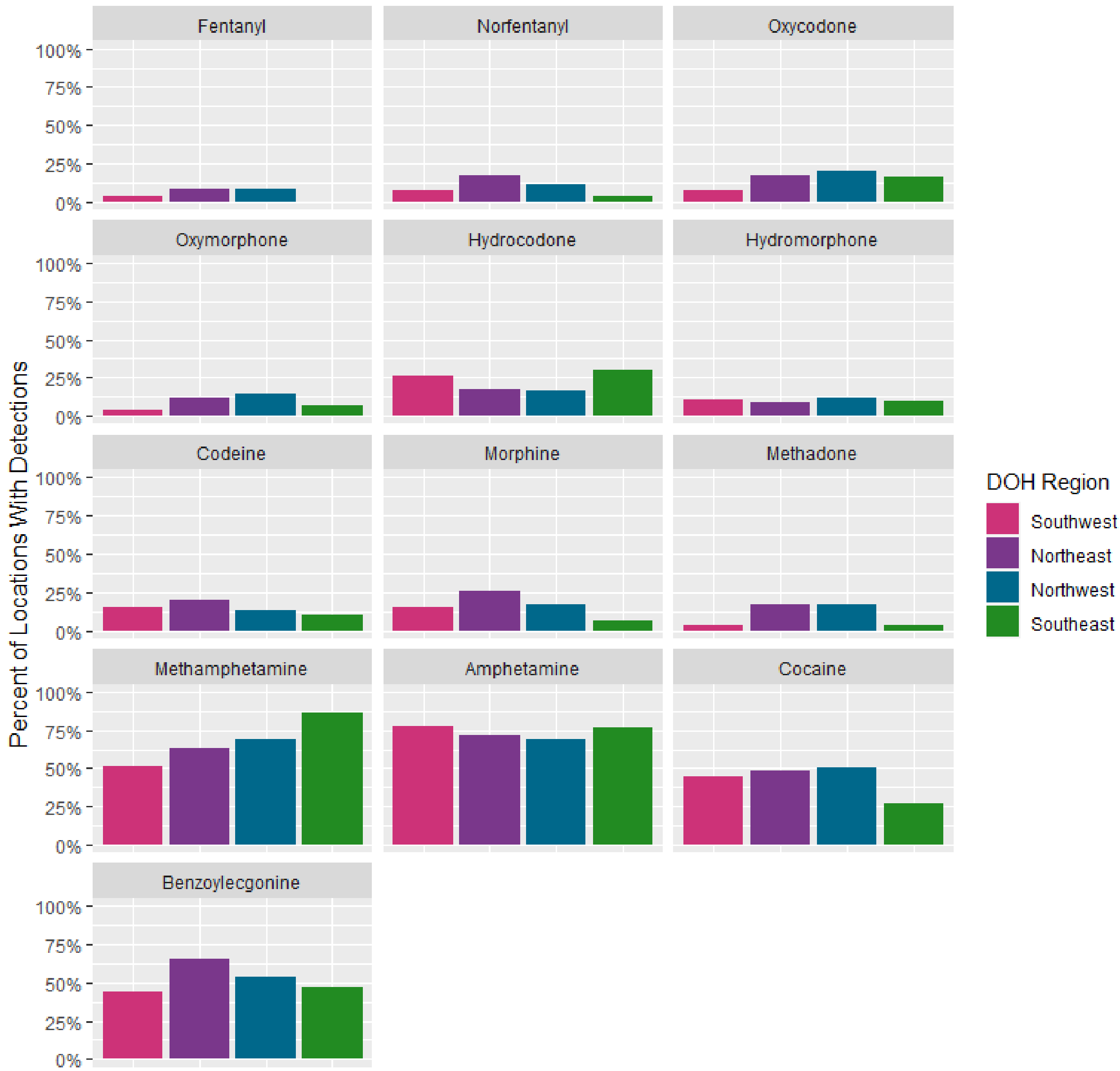
Wastewater epidemiology is a powerful and cost-effective surveillance tool to aid in identifying public health concerns at the community level.

Collecting wastewater samples at public or charter high schools allowed NMED and ERG to determine the presence or absence of a drugs within individuals using the restroom at the school. These school-level data reflect drug use in the community associated with the public or charter high school. Over the course of six months, NMED and ERG tested 184 schools where 97,166 students go to school. While the cost of each test was $3,629, that averages out to just $7.10 per student.

The most frequently detected opioids were hydrocodone (20% of schools), morphine (17%), and oxycodone (17%). Fentanyl and its metabolite, norfentanyl, were detected less frequently, in 11 (6%) and 19 (11%) schools, respectively. Stimulants were detected more frequently, with amphetamine detected at 72% of schools, methamphetamine at 68%, cocaine at 45%, and the metabolite of cocaine, benzoylecgonine, at 53%. Individual public and charter high school data are available on the public-facing dashboard here: https://www.governor.state.nm.us/wastewater-testing/.

This effort provided baseline data for public health officials and public policy makers to consider the effectiveness of interventions in public and charter high schools and within the broader community. From this baseline effort, we gain a better understanding of the types of drugs that are generally used with the greatest frequency at public and charter high schools across the state. The data also offer insights into whether the types of drugs most commonly used in high schools vary by geographic area, which allows for more tailored community-level interventions.

Attachment A: Drug Detections by DOH Region



Attachment B: Drug Detection by DOH Region (Logistic Regression Output)

DOH Region	Methamphetamine		Cocaine/Benzoylecgonine		Fentanyl/Norfentanyl	
	Odds Ratio (95% Confidence Interval)	p Value	Odds Ratio (95% Confidence Interval)	p Value	Odds Ratio (95% Confidence Interval)	p Value
Northeast	1.6 (0.6, 4.4)	0.4	3.1 (1.1, 9.4)	0.04	2.6 (0.5, 18.8)	0.3
Northwest	2.0 (0.8, 4.9)	0.1	1.9 (0.8, 4.6)	0.2	1.6 (0.4, 11.2)	0.5
Southeast	6.0 (1.8, 24.8)	0.007	1.2 (0.4, 3.5)	0.7	0.4 (0.02, 4.8)	0.5
Southwest*	1.0	NA	1.0	NA	1.0	NA

*Reference group

NEW MEXICO
ENVIRONMENT DEPARTMENT