

To: Board of Public Health & Environment, Residents of Denver, and other Interested Parties

From: Danica Lee, Director, Public Health Investigations Division

Date: February 26, 2020

Re: Research and Recommendations regarding Regulation of Vibrations in Denver

This report summarizes research on the regulation of vibrations in Denver and other municipalities, as well as recommendations for Denver.

Glossary

BPHE: Board of Public Health & Environment which governs certain functions of the Denver Department of Public Health & Environment

CDOT: Colorado Department of Transportation

DDPHE: Denver Department of Public Health & Environment, the accredited local public health authority for the City and County of Denver

DEH: Denver Environmental Health, former name of DDPHE and changed in 2017 DOTI: Department of Transportation and Infrastructure for the City and County of Denver

DPH: Denver Public Health, entity which DDPHE contracts with to provide some public health services

DRMC: Denver Revised Municipal Code, which details the charter and legal authority of governing bodies for the City and County of Denver

EPA: Environmental Protection Agency

GES: Globeville and Elyria Swansea neighborhoods in north Denver OSHA: Occupational Safety & Health Administration

PHI: Public Health Investigations Division, one of the six divisions in DDPHE and the division responsible for enforcement of the Noise Ordinance and creation of this report

1. DDPHE Overview

The Denver Department of Public Health & Environment's (DDPHE) mission is to empower Denver's communities to live better, longer; DDPHE advances this mission through a variety of regulatory activities, direct and indirect services, education, technical assistance, and policy development and implementation. As Denver's accredited local public health agency, DDPHE is responsible for improving the health of people and pets who live, work, and play in Denver by fulfilling foundational capability services of local public health agencies, as described in Colorado's 2008 Public Health Act. Furthermore, §2.12.1 of Denver's Charter charges DDPHE with the responsibility of overseeing the physical and mental health and wellbeing of Denver's inhabitants.

Central to DDPHE's work is a recognition that our definition of 'health' has changed over the last three decades to include mobility, built environment, local access to healthy foods, health equity and social and

racial justice; and that a broad lens should be used to evaluate factors that impact physical and mental health and wellbeing.

2. Background on this Report

In August 2019, the Board of Public Health & Environment (BPHE) heard and granted a variance to the Noise Ordinance (Chapter 36, DRMC) to allow Kiewit Meridian, a contractor responsible for the redevelopment of a section of Interstate 70 in north Denver, to conduct nighttime work on behalf of the Colorado Department of Transportation (CDOT). BPHE approved the variance with a number of conditions, including ongoing community outreach; a 24/7 complaint line operated by Kiewit Meridian; one week advance notice for noise intensive activities that activate the variance, a voucher program for hotel, meal and transportation for those impacted by noise levels exceeding standards in the variance; and other conditions intended to provide protections for area residents and businesses.

The August 2019 variance approval was the second one-year variance requested for the project, slated to be conducted from 2018-2022. Both the first variance hearing in September 2018 and the second in August 2019 generated extensive community participation and public comment from people living in the Globeville, Elyria, and Swansea (GES) neighborhoods in north Denver, as well as community members and activists from outside of GES. The vast majority of comments received were in opposition to the variance, some citing noise concerns and some more generally opposed to the project. At the August 2019 hearing, many community members testified about vibrations from the I-70 and other construction projects negatively impacting their daily lives as well as a history of environmental exploitation and disregard for wellbeing of residents in GES.

After extensive deliberation, BPHE voted to approve a one-year variance in lieu of the timeframe being sought by the contractor that would cover the duration of the project. As in 2018, the 2019 approval contained many conditions recommended by DDPHE intended to be protective of the people residing in areas impacted by the project. In response to the community testimony and BPHE's request at the hearing, PHI staff committed to research the issue of vibrations, as well as to continue community outreach to seek input on the health impacts of the project. This report presents the findings to date.

3. Background on Vibrations

Vibrations are characteristics of light, noise, electromagnetic fields, ground movement, and other natural and human-caused phenomena; this report considers the types of vibrations most commonly impacting residential dwellings and causing disturbances to residents in Denver and other urban areas.

Impacts of Environmental Noise and Vibrations

Vibrations can impact human and environmental health in a variety of ways¹. Brief and sustained exposure to strong, sharp vibrations and noise, such as an explosion, can cause injury or death. Exposure to intermittent explosions, such as fireworks or artillery, can trigger mental and physiological responses, particularly with people who suffer from post-traumatic stress disorder and pets. Exposure to loud industrial noises or amplified music can cause hearing loss. Recurring use of equipment that vibrates violently, such as jackhammers, can cause hand-arm injuries.

Lower-grade environmental noise and ground vibrations, which can emanate from a number of different sources can also have health impacts. The most common impact is annoyance, which if sustained, can interfere with sleep and cognitive function and serve as a physiological and mental stress.² The impact of such stressors can vary significantly depending on the individual and societal factors, but evidence supports that some exposures may contribute to cardiovascular and other physiological impacts.³

In addition to nuisance and potential health impacts, vibrations can also impact built structures.⁴ The condition of the structure, type and strength of vibrations, composition of the ground in the area, and other factors can affect the impact of such vibrations and whether superficial or structural damage can occur.

Calculating and Measuring Vibrations

There are established methodologies for reliably predicting and measuring vibrations, and they vary depending on the emission source and medium through which vibrations are traveling (i.e. air, water, ground).

Calculations take into account the emission activity, the type of waves causing vibrations, the medium through which vibrations are traveling (air, water, ground, and ground composition), presence of structures, humidity, weather and other factors. Accurate measurements and source confirmation require expensive equipment in multiple locations and modeling and can vary depending on the type of vibration.

4. Regulation of Vibrations in Denver

Vibrations are features of many different phenomena, so it is necessary to distinguish the different categories of vibrations that were considered in this report, as well as the corresponding Denver regulatory agency, where applicable.

a. Vibrations Originating from Structures

The type of vibrations that most frequently impact residential dwellings are generated within the dwelling, such as from pipes, ventilation, heating systems, closing of doors, use of appliances or medical equipment, and movement of people. Research has shown that most of these low-level noises are perceived as routine household noises and do not disturb inhabitants, although low frequency humming vibrations, such as from mechanical equipment, can be disturbing to some people in residential environments.² In DDPHE's research, no regulatory standards were identified in any jurisdictions addressing vibrations generated within a structure outside of noise ordinances addressing amplified sound.

b. Vibrations from Explosions

Explosions most often occur in the context of mining and fracking, neither of which occurs in Denver or close enough to impact households in Denver. Fireworks and gunshots on ranges occur in Denver, and resulting noise is subject to the Noise Ordinance. Enforcement is generally not conducted against events with fireworks that are properly permitted with the Fire Department. DDPHE has not received any complaints regarding noise from firearms.

c. Vibrations from Transportation

Rail and road vibrations are caused by features of vehicle mechanics, their components, and their interaction with one another and road or railway materials, as well as the underlying ground composition and receptor structures. These impacts can intensify with deteriorated road, rail, ground, or structure conditions.⁵ The impacts of transportation-related ground vibrations receive extensive consideration during both the rail or road design and the vehicle design. Due to their relative regularity, ground disturbances from rail and roadways are generally less bothersome to people than similar level noises that are irregular, such as industrial and construction ground disturbances.⁶ However, marked irregularities in road or railways, such as potholes or other irregularities, can cause bothersome noise and vibrations within nearby structures.

Complaints of noise and vibrations resulting from road disrepair are responded to by the Department of Transportation and Infrastructure (DOTI, formerly known as Department of Public Works). DOTI interfaces with other entities to investigate such issues when appropriate, e.g. with the Colorado Department of Transportation.

Another category of transportation-related noise originates from the use of compression release engine brakes, sometimes known as “jake brakes,” on diesel engine vehicles. Compression release engine brakes can cause noise and vibrations and may be perceived as significant disturbances by some people. They slow a diesel vehicle by opening exhaust valves in the cylinders, thus releasing compressed gas. They can be used to brake in lieu of the conventional brake system and can therefore reduce wear and tear on the conventional brakes. A number of jurisdictions across the country have passed ordinances prohibiting the use of compression release engine brakes on certain roadways on the basis that they are a nuisance. During the next round of revisions to the Noise Ordinance, DDPHE will consider pursuing authority to address compression release engine brakes.

d. Construction-Related Ground Vibrations

Construction-related vibrations are most often caused by large infrastructure projects versus activities involved in constructing a single building. If vibrations do result from the latter, they are generally limited in duration and time. Complaints about vibrations from such projects in Denver are responded to by the Department of Community Planning and Development.

Larger projects, such as roadway and other infrastructure construction and redevelopments, fall under the purview of DOTI. DOTI establishes requirements for contractors to survey impacted areas to assess for projected impacts for vibrations and that they monitor for vibrations during the construction phase.

e. Music-Related Vibrations

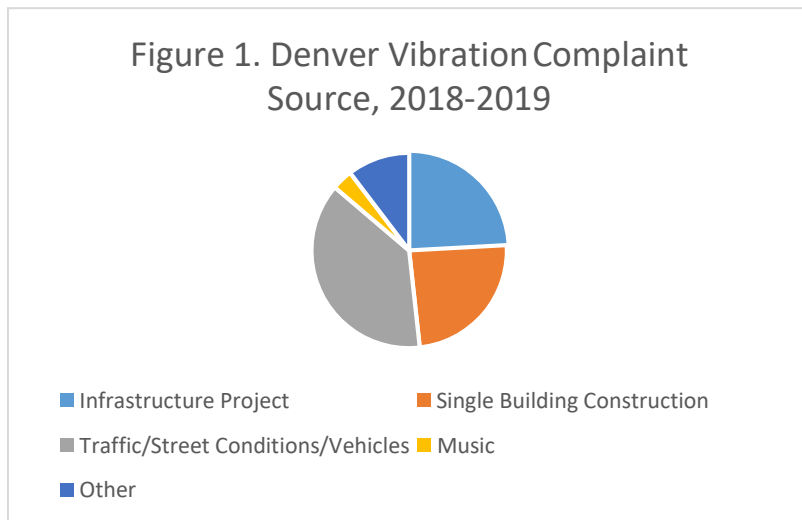
Amplified music can create significant vibrations and low frequency noise. In Denver, amplified sound is regulated through the Noise Ordinance. Currently, the Noise Ordinance only addresses sounds measurable on the A scale, which aligns with those pitches that are most discernible to the human ear. However, some music, particularly music with heavy bass like electronic dance music and some rock music, can be in compliance with the Noise Ordinance but still cause significant vibrations and disturbances. Low frequency bass noise is measurable on the B and/or C scales, which are not currently addressed in Denver’s Noise Ordinance. Some jurisdictions have standards

to address noise under the B and C scales; Denver will evaluate potential revisions to address the vibrations from amplified bass during the next round of revisions to the Noise Ordinance.

5. Denver Complaints regarding Vibrations

At the August 2019 BPHE meeting, BPHE heard testimony about the impact of ground vibrations on GES residents. DDPHE made efforts to follow up on these issues through outreach to residents, participation in community meetings, requests to community groups, and information posted on our website however received no further communication regarding complaints relating to vibrations. During daytime and nighttime monitoring of areas most heavily impacted by the I70 project, no significant vibrations were observed by DDPHE investigators. However, it should be noted that DDPHE does not have an accelerometer, so no empirical data around ground-shaking observations is available; and that vibrations would presumably be tied to very specific activities that are not static and therefore difficult to investigate after the fact. Furthermore, some residents may not feel comfortable or safe reporting complaints to government entities. DDPHE continues to interface with community groups and members to respond to suggestions about making complaint systems more accessible to all and reinforces that immigration status of community members is not requested nor does it impact how complaints are investigated.

Figure 1 shows the source of the 31 vibration complaints received by the City and County of Denver from the start of 2018 through November 2019 by complaint source.



6. Existing Denver Authorities Relating to Vibrations

The Denver Revised Municipal Code has three references to vibrations:

- §5-37 references a requirement to disclose impacts of airport activities to potential buyers of homes located in the Airport Influence District;
- §7-13 references the Dept of Excise & License’s authority to address vibrations related to licensed amusements that emanate outside the facility where they are located;
- §56-45 addresses durability requirements for sewer and water service pipes

Denver’s Noise Ordinance, Chapter 36, DRMC, does not specifically reference vibrations, but it does address noise, which is caused by air vibrations, measurable on the A scale. The A scale aligns with the range of noise most commonly perceived by the human ear. DDPHE is initiating a

stakeholder process in 2020 to consider potential changes to the Noise Ordinance, including whether noise measurable on the B and C scales should be addressed.

In addition to the authorities above, Chapter 24 of the DRMC, titled “Health and Sanitation,” gives DDPHE broad authority to take measures necessary to address public and environmental health hazards in public and private settings. This authority has been successfully used to conduct enforcement in a wide variety of circumstances where evidence supported that a significant environmental or public health hazard existed.

Refer to the section (4) above, “Regulation of Vibrations in Denver,” for information about the other City of Denver agencies that are involved in response to complaints about vibrations. For each complaint received in the last two years containing the tag word “vibrations,” it is important to note that a City agency has a responsibility to respond.

7. Research on Regulation of Vibrations in other Municipalities

Research on regulatory approaches in other municipalities focused on ground vibrations resulting from construction, since those vibrations were the source of the request for researching this topic and DDPHE had limited time and resources to collect information. The jurisdictions referenced in research from Earth Justice, an environmental law firm representing some GES community groups, in a letter to BPHE in July 2019 were evaluated, as well as a number of medium and large cities commonly used as Denver comparators. Many jurisdictions have no reference to vibrations in their codes and ordinances. Those municipalities that did have references had them almost exclusively in their building codes and regulations, and none were found with references to vibrations in their health codes.

Many jurisdictions specifically exempt or do not address earth-shaking vibrations. Others provide a mechanism to address them if they present a nuisance but without any measurement standards. In our research, no specific measurable vibration limits were identified as regulatory thresholds in any codes or ordinances.

8. Recommendations and Next Steps

In October 2019, DDPHE temporarily modified 311 scripts to ensure that all calls referencing “vibrations” are routed through DDPHE. This allows DDPHE to verify that a City response is provided to the caller, even if the issue is not under the regulatory purview of DDPHE and DDPHE. It also allows DDPHE to evaluate the adequacy of the City response to the customer and potentially intervene if environmental or health impacts are referenced and not adequately addressed by any co-responding agencies. DDPHE committed to providing this oversight until the 2020 variance request.

Given the disparate sources of vibrations and the existing jurisdiction across various Denver agencies over processes that cause them, DDPHE does not plan to pursue authority over vibrations caused by ground shaking equipment. After extensive research, DDPHE believes that the agencies that are most appropriate and effective to respond to complaints are the agencies which regulate the sources of the vibrations.

In addition to tracking complaints to generate info about impacts in 2020, DDPHE will also work, to the best of our ability and resources, to address complaints about vibrations that arise, in conjunction with other applicable regulatory agencies.

DDPHE also recommends that DOTI review processes and standards for addressing construction-related vibrations and ensure they are effective, consistently applied, and comply with best practices.

Even without directly applicable regulatory standards, DDPHE has some ability to resolve issues. For example, in the case of a power-lifting gym located at the bottom of a residential building, residents complained of vibrations early in the morning when heavy weights were dropped in October 2019. DDPHE served as a mediator, and the gym agreed to extra mitigation measures and limited daytime hours for such activities.

9. Limitations

This report was composed without allocated funding or staff and is outside the routine operations of DDPHE/PHI, whose resources are dedicated to responding to complaints, conducting investigations, and establishing controls for public health hazards. DDPHE/PHI's current staffing levels are stretched to capacity, and staffing levels are lower than those recommended for local public health agencies. Several staff were used to conduct research and analysis outside of regular work hours. No policy analysts were available to assist with this report.

10. Acknowledgments

Residents of the Globeville and Elyria Swansea neighborhoods
DDPHE's Board of Public Health and Environment
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Office of Health Equity, DDPHE
North Denver Cornerstone Collaborative
GES Coalition
Interpreter Services
Kiewit Meridian
CDOT
Office of Councilmember Candi CdeBaca
Office of Councilmember Debbie Ortega
Mayor Hancock's Race and Social Justice Initiative
Denver Office of Arts & Venues