Driving Environmental Inequality: The Unequal Harms and Benefits of Highways

Pierce Greenberg[a]*, Ryan Wishart[b], and Sabrina Danielsen[b]

[a]Department of Sociology, Anthropology, and Criminal Justice, Clemson University, Clemson, SC, USA; [b]Department of Cultural and Social Studies, Creighton University, Omaha, NE, USA

*Pierce Greenberg, Corresponding author, Assistant Professor, Department of Sociology, Anthropology, and Criminal Justice, Clemson University, Address: 132 Brackett Hall, Clemson University, Clemson, SC, 29634-1356, Email: pierceg@clemson.edu, Phone: 1-864-656-3238

Pierce Greenberg is an assistant professor in the Department of Sociology, Anthropology, and Criminal Justice at Clemson University. His research focuses on questions related to environmental and spatial inequality—which has been published in journals such as *American Sociological Review, Social Problems, Social Science Research,* and *Rural Sociology*. He earned his Ph.D. in sociology from Washington State University.

Ryan Wishart is an assistant professor in the Department of Cultural and Social Studies at Creighton University. He is an environmental sociologist who studies environmental justice issues in the Appalachian region, social movements, and elite political organization and mobilization. His work has appeared in journals such as *Energy Research and Social Science, Social Science Research,* and *Organization and the Environment*. He earned his Ph.D. in sociology from the University of Oregon.

Sabrina Danielsen is an associate professor in the Department of Cultural and Social Studies at Creighton University. She also is the director of the Kripke Center for the Study of Religion and Society at Creighton and the editor for the *Journal of Religion and Society*. Her research—primarily focusing on the sociology of religion—has been published in *American Journal of Sociology*, *Journal for the Scientific Study of Religion*, *Social Science Research*, and *Environmental Research Letters*. She earned her Ph.D. in sociology from the University of Pennsylvania.

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Highway construction projects have created extensive environmental and social burdens on racially segregated neighborhoods in urban areas in the U.S. However, few studies examine how some places benefit from highways and contribute to the harms in highway-adjacent communities. This paper aims to fill this gap by (1) conducting a case study of three highway projects in Omaha, Nebraska, and (2) using location-based services data to compare the neighborhood racial demographics of highway drivers to the racial demographics of highway-adjacent neighborhoods. In doing so, our paper heeds the call for more research on relative distribution environmental inequality and environmentalized urban sociology. Our historical case study elucidates how highway planning differed across three highway projects in racially segregated Black, Hispanic, and White neighborhoods. Further, the descriptive statistics show that modern-day drivers on highways in Black and Hispanic neighborhoods are from disproportionately more White neighborhoods compared to the neighborhoods bordering the highways. However, the reverse is not true: drivers using the highway in a majority White neighborhood are from neighborhoods that largely match the demographics of bordering neighborhoods. We discuss the implications of these results for future studies of transportation-related environmental and social inequality and current policy initiatives to remedy these harms.

Keywords: highways; interstates; environmental inequality; environmental justice; racial segregation; transportation justice;

Introduction

Highway construction in U.S. cities boomed during the latter half of the 20th century. Aided by the Federal Highway Act of 1956, the federal government constructed 41,000 miles of highway between the late 1950s and the 1970s (Gamboa et al. 2021). While this policy enabled a burgeoning car culture and economy, it reinforced urban racial and environmental inequality (Archer 2021; Avila 2014; Kimble 2024; Rothstein 2018). According to estimates from the Department of Transportation, more than 450,000 households and one million people across the country—many of them poor and people of color—were forcibly removed from their homes to make way for interstates and other highway projects (Gamboa et al. 2021). Many scholars note that destroying low-income and Black neighborhoods was not just an unintended consequence of highway construction, but often a key goal (Mohl 2002). Highway construction tore at the social fabric of close-knit communities of color and compounded other explicitly racist practices such as redlining (Bullard 2003; Rothstein 2018). Highways through communities of color also locked those places into geographic positions of socioeconomic disadvantage (Sharkey 2013). In the present day, neighborhoods near highways face significant environmental health hazards such as air and noise pollution (Boothe and Shendell 2008). While scholars have documented highway-related pollution as a source of distributive environmental inequality where communities of color disproportionately experience those harms (Greiner and McKane 2022; Liévanos 2019), there is a gap in considering highways as a source of relative distribution environmental inequality—where highway pollution burdens one social group and benefits another.

Our paper aims to fill this gap by analyzing environmental inequality related to three highway construction projects in Omaha, Nebraska. We present a mixed method approach that includes a case study and descriptive statistics from a unique source of transportation data from a location-based services data provider called Streetlight. We selected three prominent highway projects in the city: (1) the North Freeway, which bisects historically Black North Omaha, (2) the Kennedy Freeway, which borders predominantly Hispanic South Omaha, and (3) the West Dodge Expressway, built for commuters from Omaha's majority-White suburbs. Our case study highlights inequities in the planning process for each of these projects. The descriptive statistics in Streetlight reveal how these historical processes led to a modern-day inequality by highlighting how the demographics of drivers' home neighborhoods compare to the demographics of the neighborhoods burdened by the historical, social, and environmental impacts of highway traffic.

Literature Review

Our research builds on two different emerging literatures: (1) examining relative distribution environmental inequality in cities (Downey 2005), and (2) "environmentalizing" urban sociology (Angelo and Greenberg 2023). Our analysis highlights relational environmental inequality related to highways—investigating how some social groups benefit from highway projects, while others are harmed by the highways' pollution. Downey's (2005) comprehensive categorization of types of environmental inequality notes that relative distribution environmental inequality examines not just how one group is disproportionately affected by harms—but also about the composition of who benefits from the production of environmental harm. Seamster and Purifoy (2021) build on this concept in their notion of relational uneven development through racial capitalism—the idea that the development of some urban places are explicitly linked to the underdevelopment of other places due to race and class-based hierarchies. Our study also relates to recent efforts to "environmentalize" urban sociology because it considers highway development as both a social and environmental burden (Angelo and Greenberg 2023). While urban sociologists historically separated conceptions of nature from society, our study considers urban development and the daily flows of people between places as environmental dynamics that can have implications for racial health disparities and inequality.

Relative Distribution Environmental Inequality

Environmental inequality research in sociology largely focuses on the uneven distribution of environmental goods and bads. These studies often aim to establish that a disadvantaged social group—based on race and/or class—lives disproportionately closer to a set of environmental hazards (Brulle and Pellow 2006). While these studies are instructive for documenting inequities among disadvantaged groups, they often do not consider “the flip side of the coin”—how certain groups benefit from environmental harms. Downey (2005) challenges scholars to consider the presence of relative distribution environmental inequality—which can exist when studies fail to show that advantaged groups don’t bear a proportionally larger amount of environmental burden consistent with their larger contribution to creation of those environmental harms. In a review of quantitative environmental inequality studies, relative distribution environmental inequality is commonly supported—as the proportion of burden in relation to benefit is rarely met (Downey 2005).

Seamster and Purifoy (2021) similarly discuss relational development via racial capitalism—which is when certain places are underdeveloped in order to benefit other places. In other words, places that are wealthy and predominantly White extract and hoard resources from disadvantaged communities of color. In their case study of an area on the outskirts of Houston, Texas, a majority-white community thrives and develops rapidly at the expense of a predominantly Black unincorporated community. The white community dumps the waste from the development of luxury shopping and residential centers in the Black community, but also seeks to encroach upon the community with additional development. One community’s struggle for basic infrastructure is tied directly to another community’s prosperity (Seamster and Purifoy 2021). These findings connect to the idea that environmental privilege is linked to environmental burden (Park and Pellow 2011). Pulido’s (2000) seminal work in California shows that environmentally unequal outcomes for communities of color is connected to white privilege, with highways playing a prominent role.

Highways are an ideal subset of hazards to examine as a form of relative distribution environmental inequality and relational uneven development—as they are built specifically to create economic growth through faster and more efficient car transportation between places. Fundamentally, highway construction transforms places and reveals the preferences of growth-minded economic elite (Logan and Molotch 1987), dominated by white social networks (Seamster 2015), and focused on maximization of "exchange values" associated with property ownership and development rather than "use values" of place. As the concepts of relational uneven development and relative distribution environmental inequality reveal, the people and places benefiting from highway development have a "flip side" of communities that are disadvantaged by development. So, while highway construction enabled "white flight" from center cities via the creation of the suburbs (Baum-Snow 2007; Clement et al. 2023), it also had lasting social and environmental effects on neighborhoods of color (Bullard, Johnson, and Torres 2004; McGee, Ergas, and Clement 2018). Our aim in this paper is to provide a case study and some empirical evidence of one related benefit-burden relationship—which places benefit from uses the highway infrastructure in relation to the places most exposed to pollution from it.

The Burdens of Highway Construction

The quintessential cultural ideas around cars, driving, and highways are freedom, mobility, and prosperity. But the story of highway construction in U.S. cities is also one of displacement and division. Following the passage of the Federal Highway Act of 1956, cities across the U.S. began to plan highway routes. Federal planners emphasized that highways should go through—rather than around—dense cities, which led to debate about where to put them (DiMento and Ellis 2012). This planning strategy necessitated the destruction of existing urban neighborhoods. Highway construction occurred at a time when there was also an emphasis on urban “slum removal”—which led to communities of color being targeted for destruction to make way for the highways. In his classic sociological work, Gans (1962) illustrates how an ethnic enclave was perceived by outsiders as a slum—but was a healthy and well-kept neighborhood and community. This might explain why some neighborhoods designated as “slums” organized in opposition to highway construction through their communities with varying levels of success (DiMento and Ellis 2012; Fellman and Brandt 1970). In some cities, such as Miami and Nashville, highway projects divided communities of color while in others, such as Birmingham, Alabama, highways inscribed a “color line” between communities of color and White communities (Archer 2020; Rothstein 2018). The destruction of homes for highways led to decreased social capital in affected communities (Archer 2020).

The benefits of highway construction—such as access to economic opportunity and increased public investment—have also not been realized by neighborhoods of color, which have higher rates of transportation insecurity despite their disproportionate exposure to transportation-related pollution (Murphy et al. 2022). Scholars have also interrogated the spatial mismatch hypothesis—which contends that well-paid jobs and other social goods are located further from the communities of color that could benefit from them the most (Wilson 1987). Highway construction contributed to the relocation of jobs—primarily in manufacturing—to the suburbs, while cities rarely invested in public transportation infrastructure to reach those employers (Sharkey 2013). So, while the highways displaced people and destroyed neighborhoods, they did not make racially segregated neighborhoods more connected to economic opportunities. The damaging economic effects of highway construction have also persisted in the decades following their construction. For example, property values are lower for houses directly adjacent to large highways (Allen, Austin, and Swaleheen 2015).

In addition to the historical social burdens placed on neighborhoods near highways, highway construction generated persistent environmental burdens on neighborhoods. The most prominent form of environmental burden is traffic-related airborne particulate matter (PM). PM can cause numerous health problems such as respiratory, pulmonary, and cardiovascular diseases and death (Boothe and Shendell 2008). Studies have found traffic-related pollution could also influence mental health outcomes (Pun, Manjourides, and Suh 2019), childhood academic performance (Stenson et al. 2021), and adverse birth outcomes (Feng et al. 2016). Some of these negative effects can occur at very low levels of PM exposure—even lower than some published regulatory standards (Feng et al. 2016). In addition to air pollution, noise pollution from highways has also been documented to have negative physical health and psychological effects on people (Stansfeld, Haines, and Brown 2000). Another environmental risk is increased pedestrian deaths in highway-adjacent neighborhoods, caused by restructuring of the surrounding transportation environment (Nehiba and Tyndall 2023).

Air pollution from highways adds to other industrial and commercial sources that disproportionately impact neighborhoods of color. Jones et al. (2014) used fixed-air sensors in neighborhoods across six cities to find that participants in neighborhoods that were more than 60 percent White had lower levels of air pollution than neighborhoods that were less than 25 percent White. They also find that majority-Hispanic neighborhoods have higher levels of air pollution. In a study of 196 cities across the U.S., Greiner and McKane (2022) show that PM levels are higher in census tracts that were redlined in the 1930s. This coincides with additional literature showing higher levels of air pollution in more racially segregated neighborhood contexts (Woo et al. 2019). Research has also found evidence of Latinx and Asian populations being correlated with disproportionate levels of PM pollution exposure (Liévanos 2019). Multiple studies have also found that exposure to highway-related pollution has a stronger correlation with racial and ethnic demographics than social class or education-related variables (Boehmer et al. 2013; Tian, Xue, and Barzyk 2013).

This existing research has documented the social and environmental burdens of highway proximity on neighborhoods of color. While social movements noted that those mid-century projects represented “white men’s roads through black men’s homes” (Archer 2020), there have been few systematic efforts to empirically measure the claim. One notable study in Los Angeles finds that commuters from majority White tracts travel through majority non-White tracts at a much greater rate than the inverse—thereby disproportionately contributing to increased pollution burden in non-White tracts (Boeing, Lu, and Pilgram 2023). Specifically, commuters from non-White tracts do not travel through majority White tracts at proportional levels of majority White tract commuters traveling through majority non-White tracts. Their analysis relied on an estimation of commuting patterns by mapping Census estimates of home-work census blocks onto the tract level. Our data differs in that it is derived from of a representative sample of actual location-based data, rather than travel routes estimated from surveys. Further, our analysis centers on a smaller city (Omaha, Nebraska)—which may be less of an outlier than Los Angeles and more similar to other mid-sized city contexts across the U.S.

This literature illustrates the importance of considering an environmentalized urban sociology, which considers social and environmental inequities together (Angelo and Greenberg 2023). Bullard (2003) was an early pioneer of this approach, specifically as it relates to transportation inequity. He notes that transportation outcomes fall under three broad categories of inequity: (1) procedural inequity around who makes decisions about transportation projects; (2) geographic inequity related to the positive and negative geographic impacts of transportation; and (3) social inequity related to how transportation benefits and burdens are unequally distributed and can sometimes cause generational impacts. Our study includes a mixed method study design with two forms of analysis: (1) a historical case study of three highway development projects in Omaha, and (2) unique descriptive statistics comparing the modern racial make-up of drivers' home neighborhoods compared to the racial make-up of highway-adjacent neighborhoods. This work aims to elucidate each of Bullard's (2003) three forms of transportation inequity—tracing differences in historical decision-making processes across highway projects and connecting that procedural inequity to modern geographic and social inequity on who benefits from and is burdened by those highway projects.

Case Study: Highways and Race in Omaha

Case Study Methods

For the historical case study of three highway development projects in Omaha, we relied on primary sources such as local newspapers. There are three primary databases of historical newspapers that we accessed. First, we accessed the Omaha World Herald Collection with Historical Archives (1878–Present) on NewsBank Databases. The Omaha World Herald (1878–Present) is the largest daily newspaper in Omaha. Second, we accessed the Gilbert M. and Martha H. Hitchcock Omaha Star Digital Archives (1938–2011) also on NewsBank Databases. The Omaha Star (1938–Present) is a newspaper based in North Omaha, a historically Black community, and is the only remaining African-American newspaper in Omaha. Third, we accessed the World Collection on Newspapers.com, which includes many newspapers for specific neighborhoods. In this database, we collected articles in: (a) The Omaha Evening Bee-News (1872-1937), which was a daily regional newspaper and over time developed a reputation as a sensationalist tabloid newspaper associated with the Nebraska Republican Party; (b) The South Omaha Sun (1925-1963), a weekly newspaper for the South Omaha neighborhood; (c) The North Omaha Booster, renamed The North Omaha Sun (access to 1950-1958), a weekly newspaper for the North Omaha neighborhood; (d) The Benson Times, renamed The Benson Sun (1907-1963), a weekly newspaper for the Benson neighborhood and surrounding neighborhoods in west Omaha; and (e) The West Omaha and Dundee Sun (1968), a weekly newspaper for the Dundee neighborhood and neighborhoods further in west Omaha.

We included keyword searches in these databases for the terms “freeway,” “highway,” and “expressway” and also in conjunction with terms “construction,” “planning,” “North (Omaha),” “South (Omaha),” “West (Omaha),” and “West Dodge.” Many names for the three planned highways were used by different actors over the years. When a new term was found in an article to refer to one of these three highways, that new term was then searched through these three databases. Keywords of key actors’ names, governmental offices, or organizations were also searched to find more articles about particular moments in highway planning and construction. Key articles informing our understanding of these three case studies spanned from May 1935 to the present, with most South Freeway articles in 1957–1963; most North Freeway articles in 1973–1982; and most West Dodge Expressway articles in 1958–1970 and 1998–2006.

Finally, these newspaper databases were supplemented by primary sources available through the Center for Public Affairs Research at DigitalCommons@UNO Publication Archives (1963–2000), which was helpful for accessing published research reports that were contracted by local governmental agencies to study planned highway routes. To highlight some of the impacts of the highway projects, we also use historic satellite imagery supplied by Douglas County, Nebraska to provide a visual summary of neighborhoods before and after construction of the three highway projects.

Case Study Results

The city of Omaha, Nebraska provides a unique case setting to observe relative distribution environmental inequality related to highways. The city has a long legacy of racial segregation—with a historically Black and redlined North Omaha, a majority-Hispanic South Omaha, and wealthy white enclaves in West Omaha. Further, each of these sections of the city had highway projects constructed in the last 50 years—which allows for a comparative analysis of each highway's surrounding neighborhoods and the neighborhoods of drivers that use the highway.

According to the 2020 U.S. Census, Omaha is the 40th most populated city in the country. It also contains a history of racial segregation that is characteristic of other cities in the U.S. For example, Omaha's map of redlining in the 1930s designates majority-Black North Omaha as "hazardous" for investment (Fletcher Sasse 2016; Strand 2016). North Omaha also experienced systematic disinvestment, white flight following school desegregation, over-policing, and other dynamics common in Black neighborhoods (Fletcher Sasse 2016). South Omaha is the site of Omaha's industrial meatpacking operations. Historically, the area had vast stockyards—which eventually transformed into more modernized meatpacking plants. The presence of industry in South Omaha made it a popular destination for immigrants. Polish and Greek immigrants in the early 1900s were replaced by waves of immigrants from Central America and Mexico in the latter half of the 20th century. The area now has a distinct cultural identity—and many storefront signs in South Omaha are in Spanish. The student body at Omaha South High School is 85 percent Hispanic and the school's mascot is the Packers—a nod to the area's industrial identity. South Omaha has also dealt with disinvestment typical of many immigrant communities. For example, a decision by the city of Omaha to require citizenship as a condition for pandemic rental assistance likely prohibited some South Omaha residents from accessing the aid (Gonzalez 2022).

West Omaha is majority-White—featuring a sprawl of large residential suburban areas. During the latter part of the 20th century, private developers of suburban properties used "sanitary and improvement districts" (SIDs) to receive tax-exempt public financing for the roads, sewers and other infrastructure, including private clubs (Strand 2016). Developers maximized their profits via lower interest rates, tax exemption, and favorable bankruptcy rules while producing racially exclusive housing for the affluent. The SIDs were governed by developers and repayment of the municipal bonds they issued (which included profit for the developers) was eventually shared by all taxpayers in the city. As Strand (2016:227) describes: "While Black residents were channeled to the 'Near North Side,' White residents who could afford larger, newer, more expensive homes and the expense of maintaining a private automobile availed themselves of new suburban homes in SIDs west of the Omaha city limits that eventually, through annexation, became western Omaha. When SID debt was assumed by City of Omaha taxpayers at large, Black taxpayers contributed to paying off that debt. Black taxpayers in Omaha thus helped to subsidize western SID development from which they were excluded."

Figure 1 highlights how the major highway construction projects in our study intersect with differing neighborhood racial contexts in Douglas County, Nebraska. The North Freeway intersects majority Black tracts, the Kennedy Freeway bisects majority

Hispanic neighborhoods, and the West Dodge Expressway serves the majority White west Omaha.

[Figure 1 about here]

Controversy and Power Around Three Highway Projects

Planning for each of these three highway projects reflected varying power relationships between stakeholders, who want to build and use the freeway, and residents and businesses, who would be displaced or impacted by highway construction (Annor 1970). North, South, and West highways were first proposed in Omaha in the mid-1950s, primarily to alleviate traffic congestion in the city, but also to move cattle more quickly in and out of the stockyards and increase the number of emergency military routes (Anon 1957b; Fletcher Sasse 2016; Montag 2015). The planning for each of the three projects weighed concerns about community impact differently.

The Kennedy Freeway was the first of the three highways to be constructed. The process for selecting the project route incorporated the concerns of local residents.[1] Initially, planners routed Kennedy Freeway through the core of "stable" South Omaha residential neighborhoods and South Omaha's business district (Anon 1957a). However, community members and engineer consultants voiced their concerns and supported an alternative route that steered the freeway closer to the industrial traffic of the packinghouses and stockyards (Anon 1958). Government officials approved the alternative route, moved forward with construction, and finished the freeway in 1966.

Planning and construction for the North Freeway was a longer process, with many residents noting "the serious degenerative impact that the uncertainty surrounding

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[1] At the time of the Kennedy Freeway planning and construction, many ethnic populations from countries such as Mexico, Italy, Greece, Poland, and Czechoslovakia lived and worked together in South Omaha (Arbelaez 2007). It wasn't until the latter half of the 1900s that Hispanic residents became the majority in South Omaha.

the North Freeway has had on North Omaha over…20 years" (Henningson, Durham, and Richardson, Inc. 1975:I-2). In contrast to the Kennedy Freeway, officials approved a route that was not supported by residents of the surrounding community—as they foresaw the displacement of homes and businesses to come. Engineering consultants studied three routes for the potential North Freeway. The Central Alignment was expected to dislocate "the most residences and businesses and severs more neighborhood areas" (Henningson, Durham, and Richardson, Inc. 1975:I-2). The West Alignment was the cheapest route to construct, while a proposed East Alignment was slightly more expensive than the Central Alignment, but dislocated the fewest residences and businesses and had the most public support. Despite being more disruptive to the predominantly-Black neighborhoods affected, the Central Alignment was the one approved and built, with cost cited as a rationale (Anon 1980).

Residents continued to fight the North Freeway even as construction continued. Ernie Chambers, the state senator of the impacted area, argued the North Freeway "devalues property, divides the neighborhood and destroys our community" (Thompson 1980:4). He and others fought the highway construction in the Nebraska Legislature and sought to sway powerful local stakeholders and federal funders (Anon 1982; Thomas 1981). Fights over freeway construction continued even after most of the neighborhood was demolished, noting that the impacts were not just in the destruction of the local neighborhood but the actual harm of the freeway itself in physically dividing the community and in "noise and air pollution" (King and Kelly 1981:2). Nonetheless, the North Freeway finally opened in 1988.

While the West Dodge Expressway was also proposed in the mid-1950s, its construction was fought and largely stopped by the predominantly-white and wealthy neighborhoods that would have been impacted. Plans for a westward freeway were repeatedly made, shown to be highly controversial among residents, and subsequently shelved (Howe 1964; Landale 1958; Silber 1961). Planners originally routed the West Expressway to go through Dundee, one of the wealthiest residential neighborhoods in Omaha and predominantly-white (Anon 1961). Similar to residents fighting the North Freeway, residents of this wealthy neighborhood were also concerned with pollution and health effects from living near the West Expressway (Anon 1970). Planners eventually widened the main east-west road through Dundee, but never developed it into an expressway as originally proposed. It was not until 2006 that a controlled-access overpass highway was finally completed to ease traffic issues. The West Dodge Expressway only covers two miles of a commercial area—well beyond the wealthy residential neighborhoods where it was originally proposed.

Diverging Impacts of Three Highway Projects

The construction of the North Freeway had many of the negative effects documented in the literature on Black communities and highway development. Local historians estimated that 2,000 buildings were destroyed to clear way for the highway (Fletcher Sasse 2016). The project severed community access to important local resources—such as a thriving Black-owned business district and Metropolitan Community College. When completed, the highway did not feature adequate on- or off-ramps into the neighborhood—disincentivizing economic development or investment into local businesses. In 2019, a community theater in north Omaha staged a play portraying how the North Freeway destroyed tight-knit, but politically disenfranchised, neighborhoods (Biga 2019). Figure 2 shows aerial satellite imagery illustrating the impact of highway construction. The image from 1962 shows a neatly-gridded residential neighborhood, while the image from 1993 highlights the displacement of that area.

[Figure 2 about here]

The construction of Kennedy Freeway in South Omaha had fewer dramatic impacts. The alternate route for the highway that was eventually built mostly follows railroad tracks and industrial areas—rather than directly dividing and displacing thousands of residents, as the original proposed route would have done. Planners used existing railroad infrastructure as one of the main criteria used to site highways in the mid-20th century, which may contextualize why South Omaha citizens were able to reroute the highway away from the core of their community (DiMento and Ellis 2012). However, this led to the highway compounding other sources of industrial pollution such as the Union-Pacific railroads and the meatpacking plants. The construction of the Kennedy Freeway allowed easier access to downtown Omaha from the bordering community of Bellevue, Nebraska—home to the Offutt Air Force Base. Similar to the North Freeway, the Kennedy Freeway allowed commuters from Bellevue to quickly bypass minority neighborhoods on their way to downtown Omaha. Figure 3 shows how the highway in 1993 runs along a similar curvature as the railroad from 1962. The highway narrowly avoids S. 24th Street, the historic core of South Omaha, just one block to the East.

[Figure 3 about here]

The West Dodge Expressway was completed in 2006 to speed up access from the suburbs of West Omaha to midtown and downtown Omaha. The $53 million, two-mile long expressway was built on top of Dodge Street—a main thoroughfare that borders areas that were already commercial, rather than residential. Figure 4 below illustrates how this highway construction project minimized impact on surrounding properties by being constructed on top of the existing road and adjacent to commercial, rather than residential, areas.

[Figure 4 about here]

These three highway projects—and the processes around their development—highlights procedural inequity related to highway development in the city. Thousands of vehicles pass through these neighborhoods each day—and it is important for transportation inequality and injustice to understand more about the neighborhoods that benefit and are burdened from each project. The history of these three highways show diverging histories and impacts: (1) major displacement in North Omaha, (2) compounding industrial risks in South Omaha, and (3) minimal impact in West Omaha. The histories of these highways suggest the presence of relative distribution environmental inequality: they are often constructed to make access and transportation easier between places that are wealthier and Whiter. However, there is no empirical data in past research or reports to examine whether that is true and provide an estimate of potential inequities that exist. Therefore, we complement this case study with an analysis of descriptive statistics related to the racial characteristics of highway drivers' neighborhoods compared to the racial demographics of highway-adjacent neighborhoods across these three projects.

Descriptive Analysis

Streetlight Data and Methods

One of the unique empirical contributions of this study is to provide descriptive statistics about the residential neighborhoods of drivers on each of the three selected highway segments and Omaha—and compare those contexts to the demographics of the neighborhoods bordering the highways. The data on drivers' home neighborhoods comes from a location-based services data provider called Streetlight. Streetlight specializes in providing transportation data to local government agencies in support of urban and transportation planning. Streetlight acquires location based services data from digital devices, primarily mobile phones—as well as location data connected to vehicles—that can trace individuals' and vehicles' movements throughout the day and processes samples into average trip patterns (Streetlight 2022b, 2022a). They obtain information on where the phone or vehicle "spends the night" before—and then collects 2020 U.S. census block-level demographic data for that location. Combined with data on where the phone or vehicle travels throughout the day, Streetlight generates average demographic estimates of the users of roadways during specified time periods.[2] Using the Streetlight interface, our research team selected street segments on each of the three highways and received a file with the average neighborhood racial demographics of vehicles and phones that traveled through those segments from March 1st, 2019 to April 30th, 2019 and September 1st, 2019 to October 31st, 2019. We selected these months as representative averages of 2019 prior to the onset of COVID-19, which disrupted normal traffic patterns.

It is important to note that these average neighborhood demographics are not reflections of individuals who travel on the highway. Individual demographics are not provided by Streetlight for privacy reasons—and instead the service provides data associated with the driver's census block.[3] However, this comparison is appropriate given that literature on relative distribution environmental inequality and uneven relational development considers how some *places* benefit at the expense of other

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[2] The sample includes devices from across North America and thus includes not only commuters within the city or county but also commercial vehicle trips.

[3] Streetlight data is exempt from institutional review board approval because it is a secondary use of existing data, and therefore is not human subjects research. Streetlight also takes many steps to ensure that individuals and their movements cannot be identified in their data. For example, the company automatically flags queries containing street segments below a minimum threshold of 50 trips per month for manual privacy review. Any data that could potentially cross-referenced to identify individuals are censored. All Streetlight users are also contractually required to agree they will not attempt to use the data to identify individuals.

places (Seamster and Purifoy 2021). Other researchers have demonstrated the utility of this method of demographic estimation through location-based data for studying racial and income differences in mobility and spatial segregation within cities (Moro et al. 2021; Yabe et al. 2023). Streetlight has also published analysis showing the representativeness of their data models for minority populations to be similar or more reliable than the National Highway Travel Survey (Streetlight 2020).

Streetlight only provides summary statistics for road segments, which limits our analysis to sharing descriptive statistics below. Due to the nature of this data, we are not able to calculate inferential statistics—such as a chi-square test—to examine whether the differences between drivers' neighborhoods and highway-adjacent neighborhoods are statistically significant. We are provided only the mean racial demographics and the average number of daily drivers from Streetlight for each highway segment—and no other information. The Streetlight data is estimated from a sample size of 182,000 devices and more than 1.9 million trips. Therefore, the estimated mean racial demographics of drivers' neighborhoods have sufficiently large sample sizes to be accurate. Likewise, U.S. Census estimates of tract-level racial demographics are reliable—and the data for highway-adjacent neighborhoods has face validity, since the demographics match the historical character of each neighborhood based on racial segregation patterns.

For the purposes of our study, we are limited to racial categorizations provided by the U.S. Census which includes the following racial categories: White, Black, American Indian, Asian, Pacific Islander, Other Race, and Multiple Races. Ethnicity—which includes Hispanic and non-Hispanic—is a separate variable. We limit the categories to simply non-Hispanic White, Black, and Hispanic—since these are the three largest racial categories and those most relevant to our analysis of segregated neighborhoods. We gathered 2020 U.S. Census data on the census tracts that intersect the highway projects from the National Historical Geographic Information System (Manson et al. 2023).

Our analytic approach below simply aims to examine whether the historical patterns of uneven highway development lead to modern-day racial inequities between the places that benefit from and are burdened by highway proximity. We would expect the North Freeway and Kennedy Freeway drivers' neighborhoods to have larger percentages of White residents than in neighborhoods adjacent to those highways.

Streetlight Results

Table 1 provides average annual traffic figures for each highway.

[Table 1]

Figure 5 shows how the racial demographics of drivers' neighborhoods differ from neighborhoods bordering the highways. First, the North Freeway contains drivers from less diverse neighborhoods than the neighborhoods surrounding the freeway. The neighborhoods surrounding the freeway are 40.17 percent Black, while the neighborhoods that drivers live in are just 18.88 percent Black, on average. As expected, drivers who use the North Freeway live in more White neighborhoods than neighborhoods adjacent to the freeway.

The Kennedy Freeway in South Omaha has an even starker racial mismatch between drivers' neighborhoods and surrounding neighborhoods. Drivers on the Kennedy Freeway are from neighborhoods that are only 19.24 percent Hispanic, on average—while the bordering neighborhoods average 69.90 percent Hispanic residents. Drivers' neighborhoods are 68.86 percent non-Hispanic White, while the neighborhoods bordering the highways are only made up of 30.17 percent White residents.

However, on the Dodge Street Expressway in West Omaha, the driver neighborhood demographics are nearly identical to the surrounding neighborhood demographics—especially in the most prominent racial category, White. Drivers' neighborhoods have a slightly higher Hispanic make-up (a 2.48 percentage point difference) and a slightly lower Black make-up (a 1.14 percentage point difference) than highway-adjacent neighborhoods.

[Figure 5 about here]

Discussion

Most studies of distributive environmental inequality only consider the disproportionate presence of environmental harm in disadvantaged communities. Our work expands the study of relative distribution environmental inequality by considering which places benefit from highway-related pollution in comparison to those who are burdened. The case study of three highway projects in Omaha shows the divergent power relationships, historical dynamics, and impacts from highway construction in different areas of the city. Further, the results from the Streetlight data analysis show that drivers from less racially diverse neighborhoods are both contributing to the pollution that disproportionately impacts neighborhoods of color *and* benefit from the pollution more via the use of the highway. While historical and/or qualitative evidence has documented "white men's roads through Black men's homes", this study provides empirical support and specificity for those claims in one city in the U.S.

The mismatch between drivers and highway-adjacent neighborhoods is most stark in South Omaha where there is a near-50 percentage point gap between the percent Hispanic in neighborhoods and the neighborhoods of drivers that use the Kennedy Freeway. This dynamic is reflected in North Omaha, as well—to a lesser degree (40%

Black in highway-adjacent neighborhoods, but only 18.8% Black in drivers' neighborhoods). However, the West Dodge Expressway in West Omaha shows that it is possible for highway drivers' neighborhood demographics to match areas adjacent to the highway—an equity that only exists in majority white West Omaha. Similar to the findings of Boeing et al. (2023), these data show that drivers from majority White neighborhoods contribute to pollution in majority-minority neighborhoods—but the reverse is not documented.

One limitation of this data is that it does not necessarily reflect environmental conditions or exposures in each of these neighborhoods. Table 1 shows that the highway in West Omaha has significantly more traffic on a daily basis than the highways in racially segregated North and South Omaha. So, while there may be fewer racial disparities between drivers and highway adjacent neighborhoods, there could be more negative effects of pollution from that highway. However, the case study—and Figure 5—show that the elevation pollution from more traffic may be mitigated by the highway being directly bordered by commercial rather than residential land uses. This is why it is important to understand the historical, social, and geographic context for these cases.

Another limitation of this study is that these results could be specific to places such as Omaha—where the concentration of minority-majority neighborhoods in the downtown area is unique for the broader region. The city's core is surrounded by suburban and/or rural majority-White areas such as eastern Iowa and the counties bordering Omaha. Therefore, highway projects facilitate connectivity between those places and downtown Omaha. These dynamics may be different in other metropolitan contexts where suburbs are diversifying or where the baseline of racial make-up in the region is more diverse. However, utility improvement districts in exurban Houston do share similarities to Omaha's SIDs in that they have been used to shift costs between jurisdictions in ways that favor majority white over non-white communities (Seamster and Purifoy 2021). Additional research could use location-based services data across cities to see how the trends we document in Omaha are similar or different across other U.S. contexts.

One of the aims of this paper is to also inspire sociologists to consider the methodological benefits of location-based services data such as Streetlight. These data allow researchers to understand the flows of people across space—similar to a recent focus in the literature on racial and class spatial segregation during daily life (Moro et al. 2021; Yabe et al. 2023). While Streetlight compiles third-party data from other services, sociologists who collaborate with computer scientists or other location based services data experts may be able to access raw data that can produce more predictive or inferential analysis, rather than simple descriptive statistics.

In recent years, the U.S. federal government has increasingly acknowledged the racial inequalities built into the highway system. Millions of dollars in grant programs have been devoted to addressing mobility and economic development harms and air pollution reductions in disadvantaged communities (Stehlin 2023).[4] Many policy solutions to remedy or reduce highway-related pollution have been proposed: (1) increasing funding for public transportation, (2) having higher fuel efficiency standards in vehicles, (3) building housing near jobs to shorten commuting distance, (4) incentivizing people to work from home and drive less, and (5) removing, burying, or capping highways (Boeing et al. 2023; Stehlin 2023). However, the implementation of these policies—and the potential political conflict they may generate—will require local

[4] The Metropolitan Area Planning Agency, City of Omaha, and community development group SPARK were selected in 2023 for a US DOT Thriving Communities Program to study to the impacts of 75 North.

governments to understand not just who highways harm, but the interests of those who benefit from them. For example, cleaner or more efficient public transportation funding does not necessarily lead to more equitable outcomes—because it is often not built in areas that would benefit people who need it the most (Galaskiewicz, Anderson, and Thompson-Dyck 2021).[5] Further, Curran (2018) notes in terms of the moral legitimacy of different environmental inequalities, those "in which the advantages of some cause the disadvantages of others… can be picked out as a basis for significant social and political change" (Curran 2018:313). The relative distribution of environmental harms and benefits may help policymakers understand how interest groups may respond to proposals to remove, bury, or cap highways—with communities pursuing plans that have different impacts on inequality reductions (Stehlin 2023).

Conclusion

In summary, an understanding of the environmental and social burdens and benefits of transportation-related inequalities are an important aspect of environmental inequality. Transportation projects such as highway infrastructure do not only confer advantages or disadvantages to one social group or place—instead there are deep-rooted relationships between places. When social forces coalesce to distribute goods and bads across space, some people and places can benefit at the expense of others. Further, new location-based services data that track the movement of people across places can help better measure relative distribution environmental inequality and relational uneven development.

[5] As an example: the largest recent investments in public transportation in Omaha are along it's East-West corridor, including a nearly half-billion-dollar streetcar between midtown and downtown Omaha to drive urban real estate investment and development, alleviate parking concerns in the city center and bolster tourism.

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Tables

Table 1. Average Daily Traffic on Each Highway Project

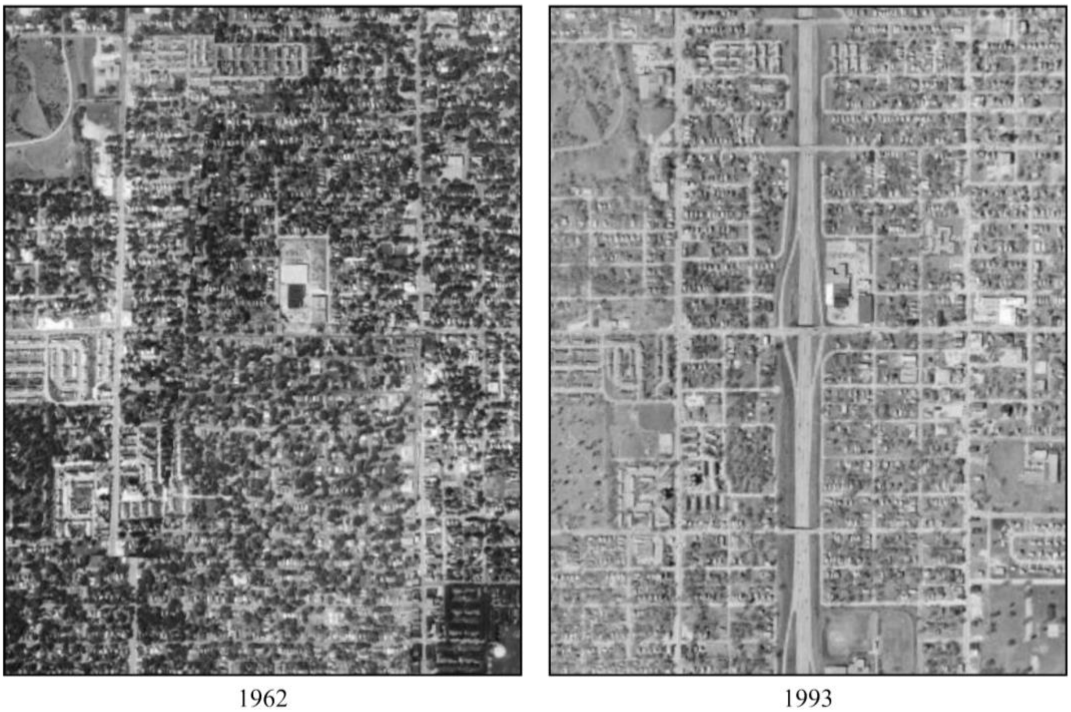
North Freeway	17,583.75
Kennedy Freeway	28,202.02
West Dodge Expressway	44,417.50

Note: Data provided based on average number of vehicles or phones traveling through each highway from March 1, 2019 to April 30, 2019 and September 1 to October 31, 2019.

Figures

Figure 1:

Figure 2 :



Note: Aerial imagery provided by Douglas County, Nebraska

Figure 3:

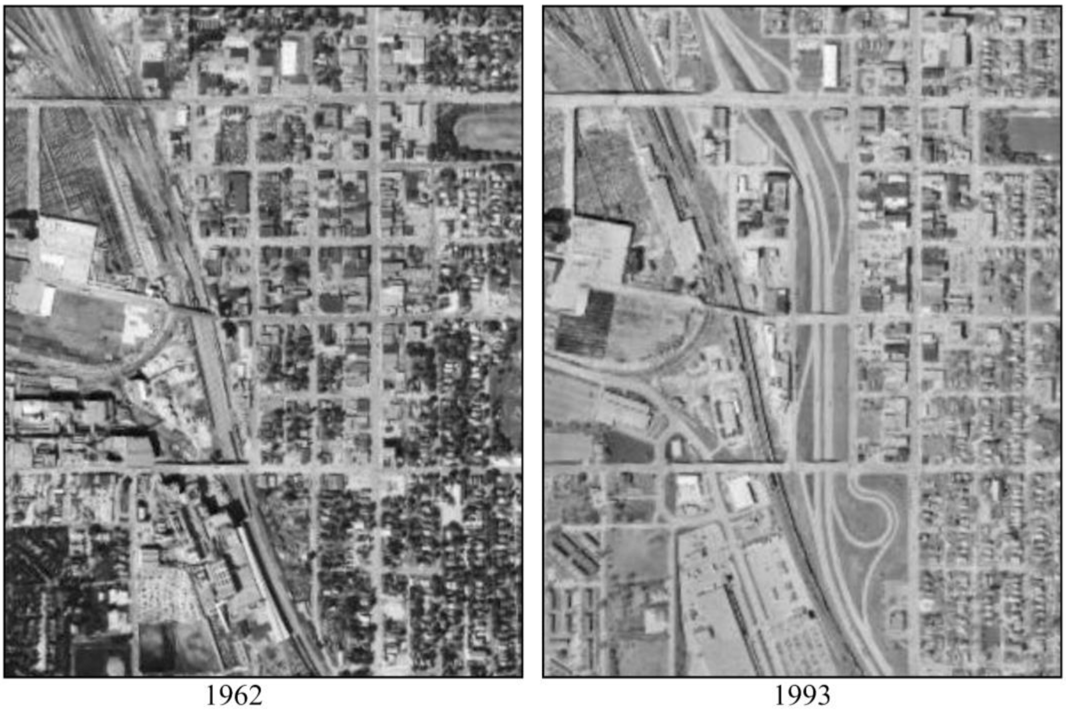


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Figure 4:

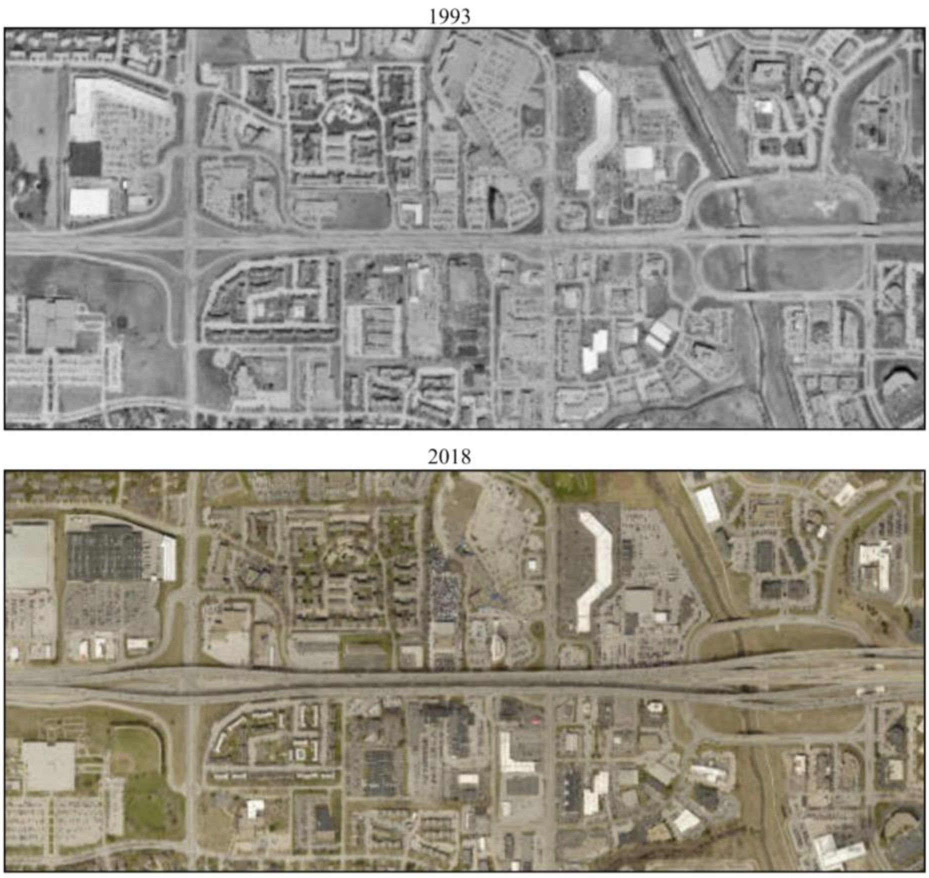

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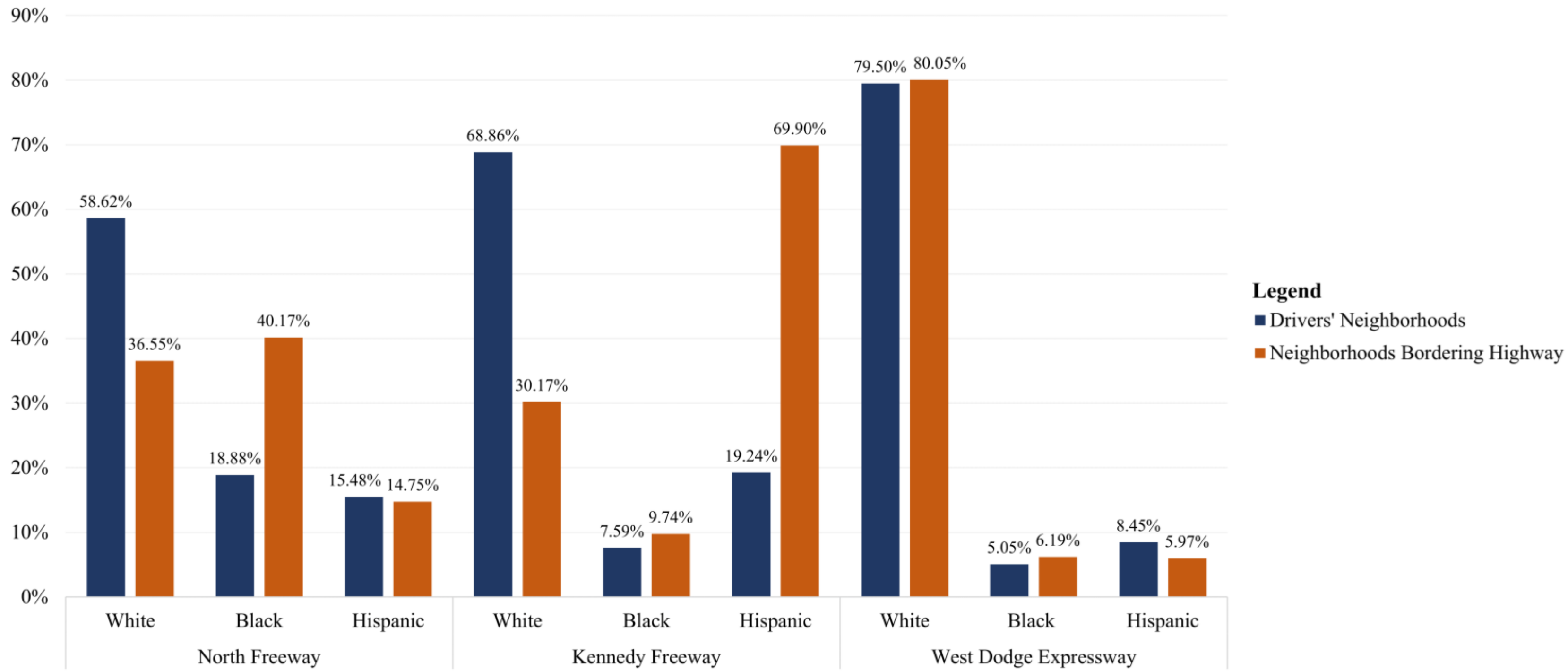
Figure 5.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Drivers' Neighborhoods
Neighborhoods Bordering Highway

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