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We Can Get There From Here: New Perspectives on Transportation Equity

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A White Paper from the National Center for
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About the National Center for Sustainable Transportation

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We Can Get There From Here: New Perspectives on Transportation Equity

EXECUTIVE SUMMARY

Achieving transportation equity is a transportation system goal that is becoming increasingly important in both the public sector and academia. An equitable transportation system would ensure that the benefits and burdens created by transportation projects, policies, and plans are shared fairly such that no groups would be unduly burdened by a lack of access to adequate transportation nor by the negative effects of proximity to transportation infrastructure. Such a system would also ensure that public participation in the transportation decision making process is meaningful and effective and that participants would have a reasonable expectation that their voices would be heard and decisions changed in response.

The purpose of this white paper is to provide an overview, synthesis, and critical assessment of academic research and transportation planning practice in order to provide a shared foundation for the many parties working toward equitable transportation systems. Throughout, we highlight key dimensions of transportation equity to provide a common language and to facilitate collaboration among transportation decision makers, planners, policymakers, advocates, and the general public. These groups will also be able to use the white paper to identify key research needs and promising strategies for advancing transportation equity goals. We hope that this shared understanding of the definitions, challenges, and opportunities in this field will enable often conflicting parties to collaborate in achieving the common goal of transportation equity: in other words, to “get there from here.”

We begin with a review of the empirical evidence on the differences in travel behaviors across demographic groups. We find that many of the results point in the same direction: the race and ethnicity of a traveler is likely to affect the transportation resources available to them and the decisions they make regarding the amount of travel they undertake and the mode they use to undertake it. The implication of these collected findings is that different types of transportation infrastructure will be used at different rates by different groups. These differentials will affect the ratio of benefits and burdens that are experienced by each group. Thus, any effort to understand the impacts of a project, plan, or policy has to consider the demographics of existing and potential users as well as these effects over time and space.

We then review the evidence on the distribution of benefits and burdens and their relationship to transportation infrastructure and land use, finding disparities in the distribution of both. From the transportation accessibility literature, which focuses on the ease with which people can reach desired destinations (e.g., parks, places of work, schools, etc.), it is clear that a lack of access to needed goods and services and social connections affects health and quality of life. Furthermore, disparities in access to jobs, healthy food, and health care are widely observed along income and race and ethnicity dimensions. While people of color and low-income populations have adequate access to parks and walkable environments in many areas, there

may be disparities in the quality of those facilities. Additionally, the means of travel (often called the travel “mode” in the academic literature) can have significant impacts on health and well-being. Access to a vehicle and the quality of transit play critical roles in the accessibility to a variety of destination types. From literature focused on transportation burdens, we see that in most parts of the United States, low-income people and people of color are more likely to live near busy roads, potentially exposing them to greater air pollution and noise impacts. Collision risks are also greater for these populations. While race, ethnicity, and income are commonly evaluated, there is also potential for disparate impacts among other groups, including rural, transit-dependent, and elderly populations. Furthermore, while these conditions are found throughout the country, there are also regional variations in the type of benefit or burden that must be addressed.

The research literature on these topics is growing increasingly sophisticated. At the same time, methodological and analytical challenges remain. Future research should continue to improve upon analytical approaches to evaluate the patterns of inequity in transportation benefits and burdens as well as analyze the potential for tradeoffs between equity and other planning and policy objectives (e.g. placing affordable transit-oriented development in congested urban areas). Furthermore, additional research is needed to assess the design of policies to mitigate and reverse existing disparities. In this white paper we have attempted to provide a summary of broadly applicable findings, but in practice the details matter, and it is important to account for variation across regions, populations, and policy spheres.

Fortunately, there are a number of promising directions for practical analysis and policy that can be drawn upon for this finer grained analysis. Regions—geographic areas defined by economic connections through shared labor and housing markets, politically through planning agencies, and often ecologically through common air and/or water basins—have become important sites for social equity advocacy and organizing. Regional equity advocates often focus on the underlying causes of spatial differences in opportunity that arise from differential tax bases, school quality, and job opportunities across a metropolitan area. More recently, public agencies with regional responsibility for transportation planning are also seeing increasing levels of engagement related to issues of infrastructure spending, access to opportunities, gentrification and displacement, and affordable housing.

The authors share a belief that, even though the equity challenges and disparities we present in this white paper may seem at best intractable, by placing a central focus on equity, transportation policy makers, planners, advocates, and researchers “*can get there from here.*” Based on our community-engaged scholarship, we also see that some of the most promising approaches to advance the goals of transportation equity are not being generated by planning agencies or academic researchers, but by communities themselves. Community-directed equity analyses, with geographic units and performance measures selected through community input, have the potential to empower advocates and lead to improvements in the health and well-being of local residents. To sustain such community engagement will require policy strategies

such as securing dedicated funding streams to support community engagement and meet the priority unmet needs of disadvantaged communities.

1. Introduction

Transportation planning and policy efforts seek to achieve a number of different, sometimes conflicting, goals for system performance. Although congestion mitigation has historically dominated transportation decision making (1-3), since 1991 the concept of performance has been broadened to include safety, environmental impacts, and accessibility, among other goals (4-8). Although these goals and progress towards them are often measured in the aggregate at the regional level, not all population groups or the places within a region will experience the same level of performance.

This white paper provides an overview and critical assessment of our understanding of transportation equity—a transportation system goal which considers the equitable distribution of transportation benefits and burdens across people and place and the related concepts of fairness and justice. Fairness and justice have become fundamental concepts in the analysis of public policy (e.g., 9, 10, 11). The concept of *transportation equity* has been increasingly discussed in the academic literature and among practitioners and policy makers, including the U.S. Secretary of Transportation Anthony Foxx (12-14). Although it is challenging to achieve consensus on particular definitions, several dimensions of transportation equity have been identified, and all have points of connection with law and regulatory guidance that enshrines them as requirements of transportation planning efforts. Four commonly cited, analyzed, criticized, and discussed aspects of transportation equity include:

1. Participation. Transportation infrastructure projects and transportation plans must incorporate the needs and interests of those members of the public they are most likely to affect. Opportunities to participate should be provided at convenient times, in convenient locations, and in culturally appropriate ways (e.g., language). To reach particular populations, efforts beyond traditional public meetings might need to be undertaken (15, 16). To be most effective, participation should be undertaken before major decisions have been made, so that the outcomes of deliberation can affect important decisions. Achieving truly meaningful participation, where individual members of the public and advocacy organizations from the grassroots to the national level feel their voices have been heard and acted upon is a very difficult standard to meet in practice (17). This difficulty occurs in other areas of public administration as well, including economic development, regulatory policy, and land use planning (e.g., 18, 19, 20).

2. Benefits. Investments in transportation systems should confer benefits to the populations that use and depend on them. These benefits include, but are not limited to, travel time savings, congestion mitigation, opportunities for physical activity, local hiring and job training for construction, maintenance, and operation, and accessibility. There is widespread acknowledgement that transportation accessibility is the benefit of primary importance and whose distribution must be fully understood to grasp the equity impacts of a plan or project (e.g., 21, 22, 23). Much of the advocacy and applied

work on transportation equity has turned on the implied distribution of accessibility benefits (e.g., 23, 24, 25-27).

3. Environmental and quality-of-life burdens. The environmental burdens associated with transportation systems—especially those arising from the automobile—have been well-studied (28, 29). These include air pollution, greenhouse gas emissions, vulnerability to climate impacts (e.g., heat stress and weather-related travel delays), noise, water quality, and concomitant effects on public health that accrue differently in different places and populations. Transportation infrastructure can also physically divide communities, destroying neighborhood cohesion and degrading community vitality (30). Conversely, a lack of connectivity can result in *de facto* segregation of people of color and low-income people within cities and regions. While walking and cycling for transportation can bring substantial and lasting health benefits, continued automobile dependence creates a range of health impacts including those stemming from a sedentary lifestyle to those associated with exposure to poor air quality (31-33).

4. Financial burdens/affordability. Owning, operating, and maintaining an automobile is costly. Housing costs in locations where public transportation is accessible and convenient can also be high. Combined transportation and housing costs have been calculated to understand the magnitude of these burdens (34, 35). Some households may forego automobile ownership and endure long commutes by public transit in an effort to reduce costs. These households are effectively trading off money and time. This is an inequitable outcome especially for those who would seek residence closer to desired destinations but cannot due to barriers such as exclusionary zoning practices that hinder the development of high-density, affordable housing or due to displacement and gentrification pressures. Affordable transit-oriented development can bring health and economic benefits to families that can forego auto ownership and still meet their transportation needs without undue burden.

Combining these definitions, an equitable transportation system would be one where participation is meaningful and effective: participants' voices are heard and respected and decisions shaped in response. The benefits and burdens created by projects, policies, and plans would be shared equitably. It is important to differentiate equity from equality. Given the spatial dimension of transport systems and their interaction with particular land use configurations, it is not reasonable to assume that everyone would enjoy *equal* benefits or costs (22). However, in an equitable system no groups should be unduly burdened by a lack of access to adequate transportation nor by negative effects from proximity to transportation infrastructure.

Transportation equity, then, refers to the social dimensions of transportation infrastructure or those factors that “focus on people, their attitudes, behavior and well-being” (36, p. 4). Boschmann and Kwan (37) include equity in their definition of socially sustainable urban transportation, stating that a socially sustainable system is one that “provides equitable access to urban opportunities, minimizes social exclusion, and improves or does not overly diminish an

individual's quality of life" (p. 139). Here, social exclusion refers to transportation's role in restricting or facilitating individual and collective access to the activities and social connections necessary to maintain a meaningful life (38).

Although a range of promising practices exist for public participation (e.g., 15, 16, 19), the quantitative study of equity-related impacts is less well-developed. Despite increasing interest in the academic literature, rigorous analyses of equity impacts rarely appear in transportation planning practice or other planning subfields like economic development or climate change planning (39-43). As the literature discussed in this white paper makes clear, disparities in the benefits and burdens related to the transportation system have persisted despite the efforts of many to reduce or eliminate them. Although transportation plans and projects must be assessed for their distributive effects in accordance with U.S. laws and regulator guidance including Title VI of the 1964 Civil Rights Act and President Clinton's Executive Order 12898, these analyses rarely uncover findings that result in changes to decisions already made or the creation of entirely new projects or policies (42, 44). While this outcome is due in part to limitations associated with transportation governance institutions such as MPOs and political power and representation (45), it is also due to methodological choices and limitations in the quantitative analyses that are conducted to understand (and ideally avoid or mitigate) impacts (e.g., 46, 47).

The purpose of this white paper is to provide an overview, synthesis, and critical assessment of academic research and transportation planning practice in order to provide a common language for the many parties working toward equitable transportation systems: transportation decision makers, planners, policymakers, advocates, and the public. A schematic overview of the influences of transportation equity and the relevant sections of this white paper is shown in Figure 1.

Fairly distributing the benefits and burdens of a transportation system is key to achieving transportation equity. Whether a particular transportation system—including hard infrastructure like roads, bridges, transit systems, and sidewalks as well as institutions, policies, and practices—results in an equitable or inequitable distribution of benefits and burdens depends fundamentally on both the system itself and on the travel behaviors of the population. The transportation system creates benefits and burdens directly, for example, by connecting two locations (benefit) or creating air pollution emissions (burden). Both the design of the system and the behaviors of users will affect their benefits and burdens. For example, a highway interchange improvement may provide little benefit for a family without an automobile, and an individual who can locate far from freeways is burdened little from the air pollution automobiles create. Various constraints, including income, housing/employment discrimination, and de facto segregation can affect where individuals live and work and how they travel. Travel behaviors, and their variation by race, ethnicity, and income, are discussed in Section 2, while observed patterns in the distribution of benefits and burdens are discussed in Section 3. Section 4 synthesizes the current state of research on transportation equity.

To the extent that outcomes are judged to be inequitable, both direct participation in the planning process through advocacy as well as litigation and innovative policies can be pursued to directly affect the transportation system. These are discussed in Section 5. A key strategy that emerges from the literature and practice is the elevation of the needs and preferences of disadvantaged communities within transportation planning processes by prioritizing transportation investments that benefit them and appropriately resourcing advocacy organizations to hold policy and planning institutions accountable. Community-directed transportation and land use scenarios and equity analyses have been shown to succeed in improving the equity of transportation processes and outcomes. Although the equity challenges and disparities presented in this white paper may also seem at best intractable and, at worst, impossible to address, we believe that “*We can get there from here*” by implementing innovative and collaborative policies and practices.

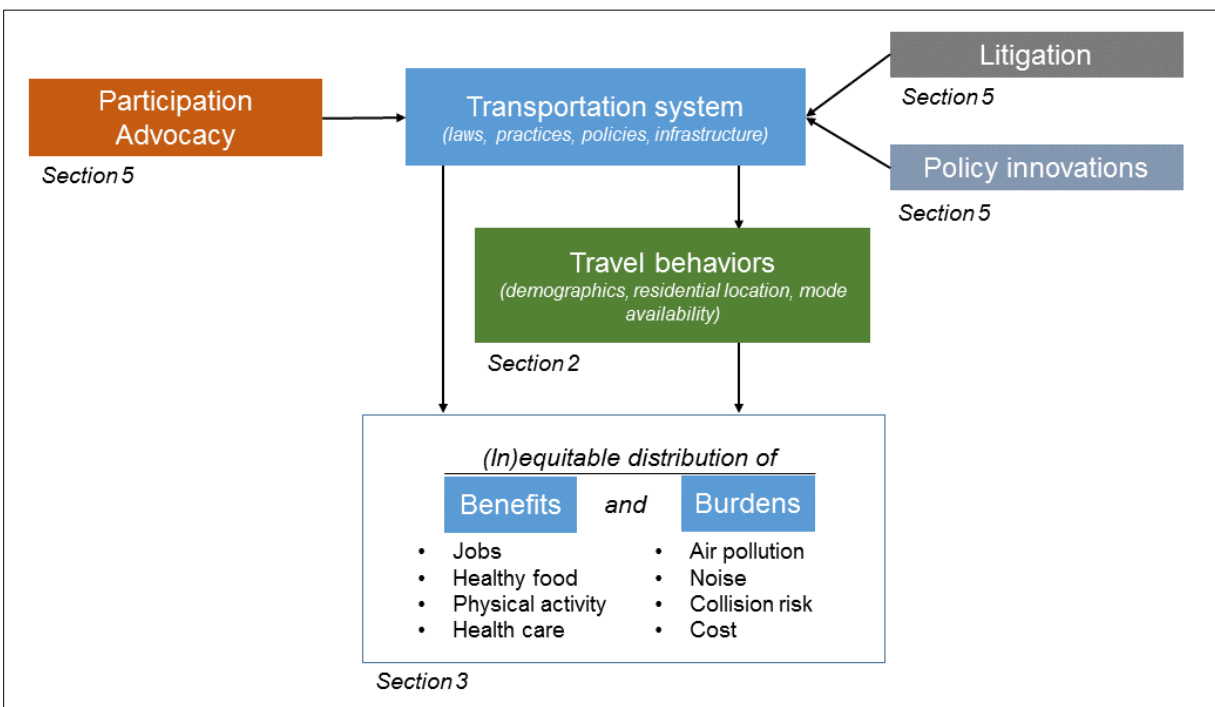


Figure 1: Schematic overview of the influences on transportation equity presented in this white paper

2. Demographics of Travel Behavior

Major transportation infrastructure, including highways and fixed-guideway transit like heavy and commuter rail, provides benefits to those who use it but often burdens those who live near it. In many cases, the populations that benefit from and are burdened by a particular project will be the same. Those who live near an expressway interchange, for instance, derive a benefit from the ease of accessing the facility and also bear noise and air quality burdens from it. But if that same resident does not regularly have access to a vehicle, they will bear the burden of the facility without benefit, a situation often associated with low-income people or people of color.

Differences in automobile ownership rates and observed travel behaviors including average trip distances will affect who benefits from highway investments. Similarly, differences in transit use overall and by mode of transit (e.g., heavy rail vs. local bus) will affect the beneficiaries of various categories of public transit investments. Prior work has shown the use of roadway congestion and level of service metrics combined with analytical models developed to solely represent automobile travel skew transportation benefits towards drivers by prioritizing investments that mitigate congestion or reduce auto travel times (48). Additionally, a lack of data available to researchers and planners about variation in travel behavior limits the ability of travel demand models to capture and evaluate the experiences of a range of populations, including those least well-served. This section summarizes the academic literature on differences in travel behavior in three categories: overall travel patterns and automobile ownership, public transit use, and differences within public transit modes.

2.1 Overall Travel Patterns and Automobile Ownership

The empirical evidence shows that there are substantial differences in the travel behavior of different demographic groups. Travel demands are affected by a number of different factors, including family size, the presence of children, employment status, income, automobile ownership, among others. (49). There also appear to be independent effects associated with race, ethnicity and gender, even when controlling for these other factors. A number of studies have used the National Household Travel Survey (NHTS; previously the National Passenger Travel Survey, NPTS) to examine differences in travel behavior in different populations. In a study using the 2001 NHTS, McGuckin et al. (50) found that whites were the most physically mobile of all racial groups, undertaking 16,900 annual passenger-miles of travel compared to 13,000 and 12,000 for Blacks and Latinos, respectively. In general, higher income households also generate more travel. Using the same dataset, Pucher and Renne (51) report that households earning less than \$20,000 per year made an average of 3.2 trips per person per day, while those earning greater than \$100,000 per year made an average of 4.8 trips per person per day. Similar results were reported based on data from other iterations of the NHTS (52-55). Higher proportions of Black and Latino households are likely to not own any vehicles, although the gap between these two groups and whites has been shrinking over time (56). Some groups of recent immigrants have high levels of sharing rides and borrowing vehicles. Their opportunities to engage in these activities, therefore, depend upon social capital, family connections, and the demographic profile of the neighborhood as a whole (57). Members of lower income households are more likely than those in higher income households to use income and lump sum payments like tax returns to purchase automobiles(58), but the longevity of automobile ownership among low-income people, people of color, and immigrants is precarious (59).

These relationships can be explained, in part, by patterns of residential location. For example, throughout most of the 20th century, people of color and low-income people have tended to be concentrated within central city areas in the United States, although more recently some inner ring suburbs have become locations of growing poverty (60). Central city locations also coincide with the highest density of transit service. In order to determine whether differential settlement patterns are influencing the observed differences in transportation modes,

statistical analyses must be conducted that control for other known determinants of travel behavior.¹

Giuliano (63) identified the independent effect of race and ethnicity on travel behavior after controlling for variables representing residential location (inside central city and metropolitan statistical area) and land use (variables at the tract level included proportion owner occupied units, proportion foreign born – thought to be a proxy for immigrant neighborhoods, mixed use, and density) using the 1995 NPTS. She modeled total trip time and distance as a function of demographic and land use characteristics. Giuliano’s most important finding is that there are differences in the effect of income, automobile ownership, and age when race is taken into account. Sometimes these differences result in more travel by racial and ethnic populations relative to whites (e.g. the effect of automobile availability for Latinos) and sometimes they result in less (e.g. the effect on low-income status on travel by Blacks and Latinos). The effect of more travel on overall utility or well-being can be either positive or negative since greater distances generally allow travelers to reach more opportunities, but long distances could also be undertaken out of necessity rather than by choice, indicating a lack of opportunities nearby.

Comparing the commute distances of people of color to whites and low-income to high-income commuters has long been a concern of the “spatial mismatch” literature that seeks to understand the extent to which disadvantaged populations are disproportionately burdened by ongoing changes in labor markets and residential settlement patterns (64-66). Specifically, this literature queries whether the suburbanization of jobs and poverty is likely to result in more onerous commutes for people of color and low-income people. Giuliano concludes that by using overall average measures of travel behavior (e.g. commute time or distance) without controlling for race and ethnicity means that between group variations cannot be assessed. Below, we discuss additional work that controlled for additional factors known to influence travel behavior when assessing the relationship between income and observed patterns of public transit use.

2.2 Public Transit Use

The relationship between demographics and public transit use patterns have been of great interest to researchers and transportation planners. Understanding the market segments and land use types that are conducive to transit use can lead to improvements in transit service and the expansion of transit’s market share. Contemporary transportation policy treats investments in public transit, the development of supportive land uses, and investments in non-motorized modes and first-last mile access as antidotes to automobile dependence (e.g., 67). Transit vehicles with modest ridership produce fewer emissions per passenger, consume less energy, require less road space, encourage local economic development, and support the types of

¹ Even if controlling for these various locational factors would completely eliminate the apparent differences between racial and ethnic groups, the overall differences evident from demographic comparisons would still need explanation. On this point, the urban studies literature highlights historic patterns of discrimination in mortgage lending and restricted settlement in U.S. cities that has led to enduring patterns of segregation (61). These historical patterns continue to shape the landscape of opportunity for people of color and low-income people in the U.S. today (e.g., 62).

dense, mixed-use developments that have long been the goal of those working to develop sustainable communities (68-70).

There was a flurry of research on the socio-demographics of transit users in the late 1990s and early 2000s (52, 63, 71-73); but since then, work has been scarcer. In a comprehensive study of multiple public datasets including the 1990 NPTS, 1990 decennial census public use micro-sample (PUMS) data, and the 1991 American Housing Survey, Rosenbloom (72) examined the propensity to use transit for work and non-work purposes by travelers with a range of demographic features (including all categories of sex, race and ethnicity, vehicle ownership, age, education, household income, immigration status and time in the U.S., and mobility-restricted groups). Specifically, she compared the overall transit use rate within these groups to the average across all metropolitan areas in the U.S. The overall national averages showed that 14 potential demographic groups used transit at higher rates than the average, including Blacks, Latinos, and Asians. Because people of color are more likely to be low-income than the general population, the analysis also controlled for income, by cross-tabulating racial and ethnic categories by income and comparing transit use rates within those categories to average rates by income. In this analysis, people of color showed higher transit use rates than the general population. These high rates persisted even when characteristics of the metropolitan region (population size and density) were similarly controlled. Rosenbloom summarizes her findings as follows: “In short, race, ethnicity, sex, higher educational attainment, and even immigrant status were often indicators of transit use where low income was not” (p. 20). Additionally, “Regardless of income, black, Hispanics, and Asians are all more likely to use public transit than the average metropolitan worker” (p. 12). Consistent with Rosenbloom’s findings, Polzin et al. (52) employ a binary logit model and 1995 NPTS data to illustrate that the propensity to use transit for non-work travel is much higher among Blacks when other determinants of transit use are controlled.

2.3 Differences in Use of Transit Modes by Group

In addition to broad differences between transit and non-transit users, a transportation equity framework focuses attention on differences between different modes of transit and their users. Differences between groups are evident in use rates of particular modes of public transit (74). Rosenbloom (1998, p. 9) included educational attainment in her demographic categories and noted that travelers with a college degree or greater had higher transit use for work trips than the average population but that these higher rates came almost entirely from increased heavy and commuter rail use. This finding is consistent with the literature on transit ridership, which has consistently identified two groups of transit users: choice riders and transit dependents (75-77). Choice riders typically have an automobile available but choose to use heavy and commuter rail transit for its high level of service during the peak period. Transit dependent riders typically have no car available and have to use transit or non-motorized modes for all of their trips. Demographic factors appear to affect preferences for public transit modes.

On their face, these differential preferences do not necessarily provide evidence of inequities. But if actual transit planning and funding practices tend to prioritize modes that are patronized by groups dominated proportionally by wealthy and white riders over others, then these

practices may be discriminatory. In their review of decades of NHTS/NPTS and transit operating data, Taylor and Morris (77), writing in 2015, find that there has been a distinct shift in transit finance away from those modes used by transit dependent riders towards those used by wealthier, often white riders. Further, few transit agencies adopt serving transit dependent riders as an explicit goal. These findings echo those described in earlier work (24, 75, 78).

Distinctions between funding allocated to transit modes have often been at the center of debates about transportation equity in practice (24, 25, 79, 80). For example, a 2005 class action lawsuit filed against the Metropolitan Transportation Commission (MTC; the metropolitan planning organization for the nine-county San Francisco Bay Area) by a class of bus riders and civil rights advocates turned on the relative proportions of funding allocated to local bus, heavy rail, and commuter rail projects in a long-range regional transit expansion plan (81). At the time of the lawsuit, the local bus operator's ridership was 80% people of color and heavily low-income, while the agencies providing heavy and commuter rail service had riderships that were only 57% and 40% people of color, respectively. In MTC's long-range regional transit expansion plan, proposed local bus projects were funded at a much lower rate than were heavy and commuter rail projects. After an initial finding of discrimination, a California appeals court found that the planning agency had been justified in their preferences for heavy and commuter rail, since these were the only modes whose projects were judged to be "congestion reducing." Despite disparate impacts on people of color and low-income people, congestion reduction was deemed to be a "facially neutral" decision criterion employed by the agency. Such disputes are not unique and were at the center of an earlier lawsuit in the Los Angeles region filed against the Los Angeles County Metropolitan Transportation Authority (25, 82). There, transit justice advocates, organized under the Bus Riders' Union, successfully argued that Metro was subsidizing the construction of rail modes at the expense of bus. The case was settled and the resultant consent decree held bus fares low and expanded service over a 10-year period.

2.4 Conclusion

The travel behavior studies cited above all operationalized behavior differently and employed different datasets. Nevertheless, many of the results point in the same direction: the race and ethnicity of a traveler is likely to affect the options available to them as they make decisions regarding the amount of travel they undertake and the mode they use to undertake it. Although most of the studies refrain from speculating on the underlying causes of these differences, it is conceivable that Blacks use transit at a higher rate than other groups because of historical experiences with transit, knowledge about the mode, and lower stigma associated with transit use. Similarly, Latinos' higher rates of carpooling could be due to their location in ethnic enclaves with tight social or cultural connections (57, 83, 84). The implication of these collected findings is that different types of transportation infrastructure will be used at different rates by different groups. These differentials will affect the balance of benefits and burdens that are experienced and enjoyed by each group. Unfortunately, commonly employed travel demand modeling methods often gloss over much of this demographic variation. Any effort to understand (and act appropriately on) the equity-related impacts of a project, plan, or

policy, and to comply with relevant laws, has to consider the demographics of existing and potential users as well as these effects over space and time.

3. Distribution of Benefits and Burdens of the Transportation System

Transportation equity encompasses the distribution of both the range of costs of transportation systems and the benefits that arise from it. In this section, we review the academic literature and summarize evidence on the existing conditions faced by communities in the U.S. related to the distribution of both. We focus first on the research findings that determine the distribution of benefits that are conferred by the transportation system. We then discuss the distribution of burdens.

3.1 Distribution of Benefits

At the most basic level, the primary purpose of a transportation system is to bring people and goods from their origins to their destinations. This benefit is captured by the concept of *accessibility*, which refers to the ease with which people and things can reach intended destinations (21, 22). Accessibility is affected by the configuration and level of service provided by a transportation network (roads, transit systems, sidewalks, bike paths, etc.), vehicle ownership, travel cost, as well as land use patterns—the location of destinations in relation to where people live and work. Inevitably, accessibility varies across the diverse landscapes and populations of the country. Although achieving *equal* accessibility across all places and people is not likely to be possible or even desirable, inequities in accessibility likely to affect quality of life for specific groups should be identified and mitigated through planning actions (85).

Accessibility plays a critical role in leading a healthy and fulfilling life and is a critical ingredient in mitigating what is known as transport-related social exclusion (86, 87). The transportation system affords users access to myriad opportunities, including jobs, healthy food, opportunities for recreation and physical activity, health care, among others. Transport-related social exclusion arises from the combination of transport disadvantage (a lack of accessibility) and social disadvantage or vulnerability (38). Transport disadvantage is not necessarily a problem on its own. Some individuals and families are transport disadvantaged by choice; for example, they choose to live in suburban areas with little access to public transportation to enjoy other amenities like high quality schools, recreational opportunities, and a sense of safety. With automobile ownership in these households, access to other regional opportunities is also likely to still be high, even if access by transit to local opportunities may be low. On the other hand, transportation disadvantage combined with social disadvantage can lead to transport-related social exclusion (38). Low-income people and people of color, for example, might be unable to afford their own vehicles and also live in communities with poor transit service. This situation effectively excludes them from economic, educational, and social opportunities, further entrenching economic disadvantage and isolation. As described below, in many cases vulnerable populations (including people of color and low-income people) across a given region have access to fewer opportunities than the population in general. In some cases, specific populations and places such as the rural poor also see access to fewer opportunities.

The literature on this topic is extensive, with a vast array of studies evaluating various aspects of the distribution of accessibility for various populations and locations. Below we present findings broadly applicable to U.S. populations, as described in meta-analyses and literature reviews. Where broad studies are not available, we describe a sample of national or regional studies to provide an indication of the type of analyses that can be conducted. The results are summarized in four areas: jobs, healthy food, physical activity, and health care. We then discuss potential strategies for addressing disparities in accessibility.

3.1.1 Jobs

The “spatial mismatch” hypothesis, first proposed by Kain (64), posits the existence of spatial disparities in access to jobs and concomitant impacts on employment outcomes for people of color. In Kain’s analysis, spatial mismatch refers specifically to a shortage of jobs in areas where there are a high proportion of Black residents, leading to Black workers facing greater difficulty finding a job, lower pay, or longer commutes (66). The spatial mismatch hypothesis has been empirically verified in a number of studies (see 66, 88 for reviews). Challenges faced by Black workers seeking jobs in the suburbs include overly long commutes, limited transit options, hiring discrimination, and difficulties searching and learning about jobs in predominately white areas. Spatial mismatch may be especially problematic in large cities and cities with de facto housing segregation and limited reverse commute transit options (66, 88). However, since the initial development of the theory, metropolitan development patterns have grown increasingly complex with inner ring suburbs now facing many of the challenges previously faced by inner city areas (89, 90), and with geographic challenges faced by Latino and low-skilled workers more generally (66, 88).

Ong and Miller make a distinction between the geographic separation of workers and jobs (spatial mismatch), which occurs throughout metropolitan areas, and workers’ lack of access to a private car (transportation mismatch) (91). They find that in Los Angeles, transportation mismatch has a greater adverse impact on employment outcomes, particularly in neighborhoods with a higher proportion of transit dependent residents. Similar results were reported for Detroit (92). In other words, automobile access can mitigate or eliminate the effects of spatial mismatch. Hu (93) reports consistent results based on a comparison of 1990, 2000, and 2007-2011 data on travel times by automobile, demographics, and employment information for the Los Angeles region. Specifically, she demonstrates that the suburbanization of employment has not harmed the employment prospects of low-income people residing in inner city areas who have access to private automobiles. Her work did not look at travel times or mode shares by public transit. In summary, access to an automobile can mitigate the worst effects of spatial mismatch in at least some locations.

These studies do not consider the combined effects of housing and transportation costs on a household’s total expenses nor do they consider the congestion or other environmental implications of shifting large portions of the low-income population from being transit riders to automobile commuters. Still, they are helpful for illustrating the advantages of the automobile relative to transit and can serve as a benchmark for transit planners. Recognizing the desirability of transit service and its essential function in linking workers to jobs in congested

metropolitan regions, Golub and Martens (85) developed an “accessibility poverty” indicator by comparing the ratio of transit accessibility to automobile accessibility for a particular geographic area. They posited that the ratio should be at least 0.3 for an area not to be considered access impoverished. The maps and indicators they developed can be used to guide planning and policy decisions and mitigate disparities.

3.1.2 Healthy Food

There is a robust literature on disparities in access to healthy food, including several review studies (94-96), and even a review of the reviews (97). This literature indicates that communities of color, low-income communities, and rural communities in the U.S. generally have less access to healthy food and more access to unhealthy food (94-97). This result is concerning because peoples’ diets and therefore diet-related health conditions are highly influenced by the food options in the areas in which they live. This link is strongest for those who lack access to an automobile (95).

A number of studies indicate that low-income communities, communities of color, and rural communities are more likely have limited access to supermarkets and chain grocery stores, which often offer healthier and more affordable options (94, 95, 97). One study examined the prevalence of supermarkets at the zip code level across the U.S., finding that communities in zip codes that are predominantly rural, low-income, Black, and Latino have 14%, 75%, 52%, and 32% as many chain supermarkets as comparable areas that are predominantly urban, middle-income, white, and non-Latino respectively. This controls for population, region, and demographic and urbanization covariates, but does not account for the fact that non-chain supermarkets and grocery stores are more common in the low-income and minority areas (98). Racial and ethnic disparities in supermarket access have been shown to be worse in low-income areas than in affluent areas (94, 95). Several studies also find that there are fewer healthy food options (e.g. fresh produce, low-fat foods, or high fiber bread) in food stores that are located in communities of color and low-income communities (94, 95, 97).

At the same time, research also indicates that there is more access to unhealthy food options, including convenience stores and fast food restaurants, in low-income communities and communities of color. These findings are consistent across many nationwide studies (94, 96, 97, 99). Similarly, some research indicates that restaurants in low-income areas offer fewer healthy options (94). There is mixed evidence that food prices may also be higher in these areas (97). A few studies indicate that schools located in low-income communities and communities of color also have greater access to convenience stores and fast food restaurants (94).

Disparate access to healthy food is of concern in light of initial evidence suggesting that the availability of healthy food options is related to eating habits and the risk of obesity (94, 97). For example, residents living in areas with more access to supermarkets have been found to be more likely to consume healthier food (97), and these findings are more pronounced for Black residents and food stamp recipients (94, 100). Greater access to supermarkets has also been tied to lower rates of obesity (94). Conversely, food environments with fewer convenience stores has been tied to healthier eating and a reduced risk of obesity, particularly for Black and

Latino adolescents (100). The evidence tying access to fast food restaurants to obesity is mixed (94, 97, 99). All told, disparities in transportation can result in disparities in access to healthy food with a range of potential health impacts.

3.1.3 Physical Activity: Built Environment, Parks, Recreation, and Youth

Physical activity is well established as a contributor to physical and mental well-being. The transportation system and the built environment can encourage physical activity by facilitating active travel (walk and bike trips) (31). Many studies indicate that characteristics of the built environment and transportation options that are consistent with the principles of smart growth and compact development (e.g. well-connected street grids, diverse land use mix, short distances to transit, and high accessibility) are positively related to walk trips in general (101, 102), although a handful of studies indicate that this relationship may be weaker for people of color and low-income populations (100).

One national study attempted to explain the greater obesity rates experienced by Black and Latino populations by accounting for characteristics of the built environment (103). The study's analysis indicates that while compact and walkable urban forms (density, street connectivity, proximity to parks) and walk commute rates are tied to lower rates of obesity, controlling for these built environment and walk commute variables at the neighborhood level actually magnifies the relationship between obesity rates and individual-level race and ethnicity variables (103). In other words, differences in neighborhood-level built environment variables and walk commute rates do not themselves meaningfully influence the greater obesity rates present in Black and Latino populations. On the contrary, some studies have found that the built environment may slightly mitigate disparities in obesity rates, as wealthy white respondents tend to live in areas that are tied to greater obesity rates (neighborhoods that are less dense, have less connected streets, are farther from parks) (103). This finding is consistent with evidence that U.S. low-income, Black, and Latino populations are more likely to live in dense, compact areas (100) and in some areas these populations may be more proximate to desired destinations for work, services, and recreation (104).

There is some evidence that sidewalk condition and the presence of trails and exercise facilities is positively related to better health outcomes and physical activity for low-income and low-socioeconomic status (SES) populations (100). In some regions, walking and biking trails may be less common in low-SES areas (100) and in some areas sidewalks are in worse condition in low-income communities and communities of color (104, 105). However, there is some research that identifies more complex relationships between race, ethnicity and income, and neighborhood design that is conducive to walking and biking. Sidewalks and streetlights are more common in low-SES areas in general, possibly due to their location in central cities (100). Studies of sidewalk presence in communities of color have mixed findings, with one national study finding that Latino respondents reported more sidewalks in their neighborhood than white respondents, while Black respondents reported fewer sidewalks than both groups (100). Overall, sidewalk presence alone is not a predictor of physical activity for low-income and low-SES populations (100).

Access to parks and open space may also bring about health benefits by providing opportunities for physical activity as well as recreation, socializing, and enjoyment of nature. The history of park design and race and class is complex; for example some states historically had racially segregated park systems, and the construction of some parks displaced poor communities and communities of color (106). People of different races and ethnicities have been found to value and visit parks for different reasons: whites for solitude and exercise, Blacks for social and sports opportunities, Latinos for social and group activities (with some differences between native born and immigrant populations), and Asians for scenic beauty, group visits, and exercise (106). Many studies explain differences in park use by people of different races, ethnicities, and income as a function of people's preferences and characteristics (e.g. ability to pay entry fees, differing values, experience of discrimination in parks) and transportation access (reliance on transit, proximity to parks) (106). Two national studies indicate that people of color and low-income people live closer to parks than white and high-income people residing in areas of comparable urbanization levels (107, 108). These findings contrast with previous studies that contested such relationships (107, 108). Interestingly, middle-income people live farther from parks than both their poorer and wealthier counterparts (108). People of color and low-income people also live in areas with less green space (natural areas that may have recreational or aesthetic uses, including open space, grass, shrub, and forests but excluding intensive agriculture) (107). A notable exception to these findings is in rural areas, where low-income areas are farther from parks but have more open spaces surrounding them (107).

While physical proximity to parks may be higher for low-income communities and communities of color, several studies suggest that park safety and quality is lower in non-white and low-SES areas in many regions (107, 109). Similarly, neighborhood safety has been reported to be worse by low-SES people and people of color (100, 104). These disparities may be partially responsible for lower rates of physical activity, as perceptions of safety and aesthetics have been positively tied to physical activity for low-SES people and people of color in several studies (100).

Youth access to parks and facilities that foster physical activity has been a focus of a subset of the equity and physical activity research, as youth activity levels are related to positive health outcomes and may lead to lifelong patterns of physical activity and health (109). Similar to patterns of activity for the general population, active travel to school and youth physical activity may be influenced by land use and transportation characteristics (e.g. positively related to density, land use mix, proximity to schools, presence of commercial land uses, access to parks and recreation areas, low traffic levels, and suburban neighborhood type) (109). Street connectivity and the presence of sidewalks has a mixed relationship to youth physical activity (109).

A national study of 20,000 adolescents examined residential proximity to a range of physical activity facilities (including schools, public parks, recreation centers, sport facilities, gyms, pools, youth centers, golf courses, and more) and individual-level physical activity and health outcomes. It found that residents of lower SES communities and communities of color have less access to physical activity facilities, particularly in areas with both low-SES and high proportions of non-white populations. A similar pattern held for public facilities, parks, schools, YMCAs, and

youth organizations (110). Limited access to facilities for physical activity was—unsurprisingly—correlated with lower levels of physical activity and a greater likelihood of being overweight (110). In sum, while the patterns are complex, lower access for certain populations to places to recreate can have significant health implications and should be a concern to transportation and land use policy makers and planners.

3.1.4 Health Care

Accessibility to health care facilities has been tied to indicators of health outcomes. A 2013 review of 61 U.S. studies of barriers to primary care and chronic disease care found that transportation barriers have been linked to missed appointments and failure to fill prescriptions or missing doses of medication (111). Many studies find that a lack of automobile access is a significant barrier to health care access and these findings are more pronounced for low-income patients (111). Similarly, the cost of transit has been reported as a transportation barrier to health care, and lack of transit has also been observed to affect the rate of missed appointments with nurses (111).

The 2013 review concludes that the relationship between transportation barriers to health care access and distance to health care services is complex, with the majority (but not all) of the studies reviewed that examine distance or urban/rural location present evidence that distance is a barrier to care (111). While the 2013 study reviews literature that relies largely on self-reported data, a 2004 review of spatial accessibility of healthcare (e.g. density and proximity-based measures of access) also indicates that many studies find an inverse relationship between distance to care and utilization of care (112).

Transportation barriers to health care disproportionately affect people of color and low-income people. Evidence from a number of studies clearly indicates that low-income patients experience greater transportation barriers to health care (111). Several national studies also indicate that people of color are more likely than whites to experience transportation barriers to health care and experience reduced medical care due to transportation barriers, even holding economic status constant (111). Similar findings for people of color and low-income people have been reported in studies that rely on distance or density-based measures of transportation access. For example, using the 2001 NHTS, Probst et al. (113) find that Black people's medical trips take longer than whites' trips although the distance traveled does not significantly differ. In particular cities such as Washington DC, there is a lower density of pediatricians in Black and low-income areas (114) and in Illinois, socio-demographics (including race and income) are tied to lower travel time to primary care (115). The national study by Probst et al. (113) finds that rural residents travel farther and longer to access health care. Children (especially inner city and migrant farm children), the elderly, veterans, and women are all populations that face serious transportation burdens to health care (111).

3.1.5 Strategies to Mitigate Disparities in Transportation Benefits

There are a number of approaches that local and regional governments, private industry, foundations, and community-based organizations can undertake to mitigate disparities in accessibility to vital goods and services. These include:

- Strategies to address spatial mismatch focusing on locating jobs near workers through economic development initiatives, locating workers near jobs via the provision of affordable housing, and improving the ability of workers to commute to and learn about distant jobs (66, 88).
- Neighborhood revitalization efforts accompanied by policies such as rent control, inclusionary zoning, and affordable housing requirements on new development to prevent displacement and maintain affordable housing in gentrifying areas.
- Efforts by local and regional planning agencies to establish bike- and car-share services in low-income areas with limited access to private automobiles to respond to limited transit service.
- Policies to address disparities in healthy food access including public-private partnerships and economic development programs and incentives to bring supermarkets to underserved areas, improving transportation options in impacted communities, supporting the development of mobile markets, encouraging healthier options in food outlets, and implementing complementary nutrition education programs (96).
- Policies focusing on improving both the built environment as well as perceptions of the built environment to mitigate disparities in opportunities for active travel such as investing in park development and maintenance, traffic safety, community arts projects, and community policing (109).
- Addressing disparities in park access at the national level by improving the quality of parks in low-income communities and communities of color and increasing the number of parks in poor rural areas (107).
- Public and private health insurers providing travel reimbursements for trips to health providers, investments in telehealth, and home medication delivery to mitigate disparities access to health care include (111).

More broadly, policy makers and planners should consider improvements in health (e.g., through health impact assessments) as a core part of their land use, neighborhood design, school placement (including safe routes to school) (109). At the broadest level, policy makers, planners, and other civic leaders must consider transportation equity as a core element of access to the fundamental resources and opportunities necessary for a healthy and successful life and for contributions to the welfare of society as a whole.

3.2 Distribution of Burdens

The origins of the environmental justice movement were rooted in concerns about disproportionate exposure to the harms generated by locally undesirable land uses like power plants, landfills, hazardous waste facilities, and transportation infrastructure (116-118). Similar to transport-related social exclusion, disproportionate exposures to environmental harms are especially important when they affect socially vulnerable populations. For example, children, the elderly, and people with existing health conditions are particularly susceptible to adverse health outcomes resulting from pollution exposure (119, 120). Additionally, low-income people and people of color can be more vulnerable to pollution because of their higher rates of existing

health conditions, greater exposure to cumulative environmental hazards, reduced access to health care, and greater day-to-day levels of stress (119, 120). Furthermore, these same populations tend to be marginalized in planning processes, decreasing their ability to avoid or mitigate these disproportionate environmental hazards.

As with the distribution of benefits of the transportation system, the literature on the distribution of transportation-related burdens is well developed in many areas. We again focus on broadly applicable findings for the U.S. and provide additional examples in areas where research is more limited. Our review focuses on air pollution, noise, and safety. As with transportation benefits, in any given region or for a specific community or policy question, studies that target a specific region, population, or policy may be more applicable.

3.2.1 Air Pollution

Air pollution exposure may be the most studied environmental impact of the transportation system (121). Exposure to vehicle pollutants including nitrogen oxides, carbon monoxide, air toxics, particulate matter, and diesel exhaust, among others, can adversely affect the respiratory and circulatory systems and can increase cancer risk (122-126). A variety of studies employing different methods, including exposure analyses, epidemiology, and proximity studies indicate that transportation-related air pollution exposure is greater for low-income communities and communities of color, although there is variation in these relationships from region to region (121).

Air pollution concentrations are elevated near roads (127) and proximity to heavily traveled roads has been linked to a number of adverse health outcomes including low birth weight, childhood cancers, and asthma hospitalizations (128). Two national studies highlight disparities in the demographics of the population living near busy roads in the U.S. Tian et al. (129) examine road and traffic density at the census tract level, finding that both measures are correlated with the share of Blacks, Latinos, and people living in poverty. Rowangould (130) evaluates proximity to high-traffic roads and traffic density at the census block level, similarly finding that people of color and low-income households are more likely to live near busy roads, and this finding holds for Latinos, Blacks, and Asians (but not Native Americans). He also evaluates disparities in reference to county-level demographics. While disparities vary across the country, 83% and 84% of U.S. counties have a disproportionate share of low-income residents and people of color, respectively, living in traffic-dense areas. Port facilities and their surrounding demographics have also been the subject of environmental justice air quality analyses (e.g., 131, 132).

Studies of proximity to roads and traffic provide a simplified representation of the distribution of the burdens of air pollution concentrations. Transportation-related pollution concentration studies are typically confined to a localized area or region. For example, a recent study modeled dispersion of PM_{2.5} from roadways in Los Angeles, finding that communities exposed to greater concentrations of PM_{2.5} had lower average incomes and higher proportions of people of color, particularly Latino residents (133).

These studies focus on pollution sources in reference to the demographics of nearby residences. It is also possible to examine other locations or travel patterns. For example, Gaffron and Niemeier (134) examine disparities in the demographics of students in reference to the proximity of schools to vehicle emissions in the Sacramento, Calif. area. The results indicated that schools with greater shares of students of color and students that are eligible for subsidized meals are more likely to be located near higher levels of vehicle emissions.

3.2.2 Noise

Traffic noise is elevated near roads. High noise levels can have adverse health effects, including increased stress, elevated blood pressure, hearing loss, and sleep loss (135). The demographics of the affected population can be evaluated using geospatial analysis and noise modeling (136, 137).

While several European studies examine the relationship between noise and demographics (e.g. 138), few studies have examined the distribution of transportation noise impacts in the U.S. A study of the noise impacts of airport operations in Phoenix, Ariz., finds that Latino ethnicity and poverty status are strong predictors of transportation-related noise impacts, even controlling for measures of political and economic influence (139). Chakraborty et al. (137) conduct a hypothetical analysis of high levels of truck traffic along an existing road alignment in Ohio, finding that impacts would disproportionately affect people of color and low-income people, although federal standards would not be exceeded.

We were unable to find a U.S. study that examines the equity of road noise impacts using actual or proposed conditions. However, in light of the proximity of low-income people and people of color to busy roads (129, 130), it is not unlikely that road noise impacts are inequitable in most regions. This would be a fruitful direction for future research.

3.2.3 Safety and Collision Risk

A number of studies indicate that children's pedestrian, bicycle, and traffic-related collision rates, injury, and mortality rates are greater in neighborhoods containing greater shares of low-income people and people of color (140). These results are consistent with evidence that neighborhoods with higher proportions of low-income, Medicaid, or uninsured residents have higher pedestrian and bicyclist injuries and motor vehicle injury and fatality rates (141).

There are several potential influences on the greater collision risks borne by low-income people and people of color. Traffic characteristics, including traffic volumes, speeds, modal speed differences, and the presence of trucks, are related to collision rates and collision severity for vehicles, cyclists, and pedestrians (142-147). As noted above, busy roads are more likely to be located near the residences of low-income people and people of color, and people without cars are more likely to walk and bicycle to get to destinations. These combined factors may lead to greater collision rates for these populations.

In many cases, it is difficult to characterize the risk of collisions to an individual cyclist or pedestrian (versus the number of collisions at a given location) due to a lack of data on

exposure, or pedestrian and cyclist activity. Some studies use indicators of potential activity (e.g. walkability) to attempt to control for exposure or at least to control for factors that may relate to exposure. For example, an evaluation of collisions in the Chicago area found that crash rates are higher in areas with a disproportionately high share of low income people and people of color; a greater likelihood of crashes in walkable and transit-served areas explained part (but not all) of the observed difference (148).

To the extent that there are significant disparities in the built environment across neighborhoods, they may, in part, cause differences in collision risk. For example, a study in Montreal found that wealthier neighborhoods scored better on measures of safety (which included cyclist and pedestrian safety) (149). Morency et al. (150) studied pedestrian, cyclist, and motor vehicle injuries while controlling for population density, traffic volume, and intersection geometry (number of major roads, number of legs at an intersection) in Montreal. The results indicated that elevated injury rates observed in low-income areas were explained in large part by greater traffic volumes, more major roads, and more pedestrians and cyclists. Conversely, traffic-related risks could be reduced as traffic levels and intersection geometry in low-income areas are improved to match conditions in wealthier areas (150).

3.2.4 Strategies to Mitigate Disparities in Burdens

There are a number of different approaches that local and regional governments, foundations, private industry, and community-based organizations can undertake to mitigate disparities in exposure to environmental and health harms. Investments in clean vehicles (both private automobiles and transit), incentives to take “clunkers” off the road, installation of built and living barriers (e.g., trees) to roadway pollution can reduce air pollution and noise burdens. Local government and MPO investments in traffic safety projects (e.g., crosswalks, slow streets, stop lights, and crossing guards), traffic enforcement, improved non-motorized travel routes (well-marked and/or off-road bike lanes) can reduce traffic-related injuries and deaths and promote more walking and biking. Land use plans that consider disproportionate transportation impacts on vulnerable populations such as siting of affordable housing and schools near busy roadways are also crucial strategies.

4. Synthesis: State of the Research

As presented above, the research related to the distribution of transportation impacts is varied in terms of focus, methods, geographic region, and findings. However, a number of overarching themes consistently appear in the literature.

Based on our review of the literature, we find that the race and ethnicity of a traveler is highly likely to affect the transportation resources available to them and the decisions they make regarding the amount of travel they undertake and the mode they use to undertake it. That is, different types of transportation infrastructure will be used at different rates by different groups. These differentials will affect the distribution of and relationships between of benefits and burdens that are experienced by each group. Thus, any effort to understand the impacts of

a project, plan, or policy, has to consider the demographics of existing and potential users as well as how these factors vary by community and region.

Disparities are evident both in the distribution of the benefits and burdens arising from transportation systems. Table 1 presents key themes highlighted by the transportation equity literature (Section 3) alongside examples illustrating potential disparities associated with each theme. From the transportation accessibility literature, which focuses on the ease with which people can reach desired destinations, it is clear that a lack of access to needed goods and services and social connections affects health and quality of life. Furthermore, disparities in access to jobs, healthy food, and health care are widely observed based on income, race, and ethnicity characteristics. While people of color and low-income populations have greater access to parks and walkable environments in many areas, there may be disparities in the quality of those facilities. Additionally, the means of travel, or the travel mode, matters. Access to a vehicle and the quality of public transit play critical roles in accessibility to a variety of destination types.

From the research literature focused on transportation burdens, we see that in most parts of the U.S., a greater share of low-income people and people of color live near busy roads, potentially exposing them to greater air pollution and noise impacts. Collision risks are also greater for these populations.

Table 1: Transportation equity themes highlighted in academic research and discussed in Section 3

Theme	Examples of potential disparities
Transportation accessibility benefits:	
Access to jobs	<ul style="list-style-type: none"> • Inequitable access to jobs (by distance, travel time) <ul style="list-style-type: none"> ○ by travel mode (automobile, transit, etc.) ○ for all jobs, for jobs that match commuters' education/income level (and aspirations)
Access to healthy food	<ul style="list-style-type: none"> • Inequitable access to food outlets with healthy options: grocery stores, supermarkets • Limited healthy options at proximate food outlets • Inequitable access to food outlets tied to unhealthy options: fast food and convenience stores • Inequitable access to affordable food options
Access to physical activity	<ul style="list-style-type: none"> • Inequitable access to a built environment that fosters active travel (connected streets, diverse land use, proximity to transit, high access to destinations) • Disparities in sidewalk and trail quantity and quality • Disparities in streetlight presence • Disparities in park and green space quantity and quality • Inequitable access to physical activity facilities
Access to health care	<ul style="list-style-type: none"> • Inequitable access to health facilities by vehicle and transit • Inequitable to access to affordable and culturally-appropriate health services
Environmental and health burdens:	
Exposure to air pollution	<ul style="list-style-type: none"> • Inequitable proximity to and concentrations of car, truck, locomotive, ship, or airport pollution
Exposure to noise	<ul style="list-style-type: none"> • Inequitable proximity to road, rail, port, or airport noise
Exposure to safety and collision risks	<ul style="list-style-type: none"> • Inequitable risk of pedestrian, bicycle, and vehicle collisions

In addition to these findings from the literature review, Table 2 highlights other dimensions of transportation equity related to economic considerations, including the distribution of revenue (investments in the transportation system) and household travel costs, meaningful participation in the transportation planning process, and other considerations. Because of space limitations, the topics listed in Table 2 are not covered in detail in this white paper, but they regularly appear in the academic literature and are routinely raised by equity advocates.

Table 2: *Transportation equity themes highlighted in academic research not discussed in detail in this white paper*

Theme	Examples of potential disparities	Further reading
Participation in the planning process	<ul style="list-style-type: none"> Inadequate opportunities for input on transportation planning (convenient time, place; culturally appropriate) Limited influence on the transportation planning process (meaningful consideration of input) 	(15, 17, 30)
Investments in the system	<ul style="list-style-type: none"> Inequitable distribution of capital vs. operations and maintenance costs, tax burdens, user fees, etc. to benefit diverse demographic groups Inequitable shares of funding dedicated to various modes 	(25, 74, 77)
Combined housing and transportation costs	<ul style="list-style-type: none"> Inequitable burdens of household housing and transportation costs Limited location efficiency (affordable housing and proximity to destinations) 	(34, 151)
Employment opportunities	<ul style="list-style-type: none"> Disparities in hiring and job training for construction, maintenance, and operations 	(152, 153)
Neighborhood stability	<ul style="list-style-type: none"> Vulnerability to and protections from gentrification and displacement 	(154-156)

While the discussion above focused primarily on transportation equity findings rather than methods of analysis, it is clear from the literature that the methods used to evaluate disparate impacts are continuing to evolve and improve. As computational resources advance, analysts are increasingly able to study broader geographic areas, use smaller scale units of analysis, and rely on more complex modeling. For example, rather than relying only on proximity or density measures, accessibility studies can use travel model outputs or geographic information system (GIS) methods to estimate travel times (157) and air pollution studies can rely on detailed dispersion modeling to estimate fine-grained pollution exposures across a region (133). A growing body of research is also examining other vulnerable groups alongside the more commonly evaluated populations of color and low-income populations, such as transit-dependent, rural, and elderly populations (47, 158). These types of analyses provide important insights into the complexities of transportation vulnerabilities.

At the same time, researchers continue to face methodological challenges. In the transportation accessibility literature, for example, the appropriate scale of analysis is a matter of debate. Analytical units should reflect peoples' perception of their area and encompass their likely travel patterns, but in practice this is difficult. Differences between the physical accessibility of a place (e.g., the distance between two locations) and the accessibility experienced by the people that live in that place based on cost, vehicle availability, transit routes and other factors have been examined in the literature (e.g., 159, 160). However, these

advances have been slow to diffuse throughout transportation planning research and practice. Information on destinations is often proprietary and difficult or expensive to acquire. For this reason, prior work has often relied on aggregate measures of job totals, sometimes disaggregated by industry, usually provided by metropolitan planning organizations (MPOs) or regional councils of government (COGs). Many methodological challenges in the transportation equity literature are no different from those that are present in the transportation studies literature more broadly. For example, many collision risk studies examine the absolute number of collisions rather than the risk of a collision by identifying an appropriate denominator because of data limitations, hindering our ability to understand the factors that influence risk. This limitation is relevant to much of the pedestrian traffic safety literature as well as to studies of traffic safety of vulnerable populations.

Also similar to the transportation literature more broadly, many transportation equity studies fall short of exploring the underlying causes that shape the research findings. For example, the research on transportation barriers to health rarely consider the nature of barriers (e.g. cost, travel mode, safety, and vehicle availability) (111) and research on access to healthy food glosses over reasons for the disparities (e.g. causes of new store openings and closures of old stores) (95). The travel behavior literature has often identified disparate patterns based on race and ethnicity even when other important determinants of travel behavior are controlled for, yet authors typically stop short of offering a full interpretation of these findings. In particular, much of the transportation literature does not address the historical and structural factors behind the racial, ethnic, and class disparities displayed through their quantitative analyses. Building interdisciplinary research teams with planners, engineers, social scientists, and other scholars will be necessary to provide such causal analyses.

It is also difficult to disentangle residential location choice, transportation system design specifications, and other factors that may shape observed disparities, as most studies use cross sectional research designs that rely on existing differences between places rather than tracking changes in a single place over time. The attempt to distinguish the siting of harmful land uses from the location choice of vulnerable residents is not unique to transportation (e.g., 161), and has been presented as a way to establish the presence of injustice (121). In the case of racial and ethnic discrimination related patterns of environmental injustice, the locational “choice” of low-income people and people of color is hardly a choice at all given histories of racialized land uses and housing segregation (162). Determining “which came first” can provide a better understanding of the source of disparities, although some argue there has been too much emphasis on siting intent (vs. impact) in environmental justice research overall, as other unjust factors can lead to disparate outcomes and disparate outcomes are important to understand regardless of the cause (121). In transportation in particular, the destruction of the social, political, and economic base of Black communities due to the siting of interstate highways through low-income communities of color and the lasting trauma of this displacement is well-documented (163, 164).

Public transit infrastructure has also been sited in ways that has led to lasting negative effects on communities of color. In Oakland, Calif., for example, the West Oakland station for the Bay

Area Rapid Transit (BART) system and related overhead infrastructure was located in a thriving Black business district that was largely destroyed by the new construction (165). The fact that this pattern of displacement coupled with the locating hazardous facilities near low-income communities and communities of color and the degrading of assets in these same communities has been repeated across the country for generations, represents the profound challenge of those seeking transportation justice (166, 167). These persistent sets of decisions and infrastructure development actions have lasting effects on places that are difficult, if not impossible, to understand within narrow conceptions of causality (see also 24, 168). However, without such deep analysis of historical and structural racism and classism, transportation policy and planning is doomed to repeat and exacerbate these unjust patterns.

Many studies examine the distribution of impacts by race or ethnicity and income, but fail to account for the interaction of these effects (121). Where the inequitable conditions experienced by people of color are independent of income it may be that the causes are more complex than simple economic explanations. For example, research may be needed to explore the extent to which greater environmental burdens are outweighed by monetary savings associated with lower housing costs. Environmental justice research suggests that the “race or class” dichotomy presents a false choice and that the deeper causes and implications of environmental inequities is to be found in how they intersect in time and space (169).

These challenges suggest many promising avenues for future study. Potential methodological improvements in the accessibility literature include delving deeper into the mechanisms that limit accessibility, using multiple data sources and community-based “ground-truthing” location data (170), and using more sophisticated network-based measures of access that account for travel time, cost, and mode. Future studies should evaluate the relationship between transportation benefits and costs, and health and quality-of-life outcomes, for example, by evaluating the relationship between access to health care and health outcomes (111) or using global positioning system (GPS) devices to measure physical activity levels and locations in active travel studies (109).

Additionally, there is a tension between the potential benefits and harms associated with different transportation systems. For example, proximity to busy roads can indicate greater accessibility and a more vital business climate on the one hand and greater exposure to air pollution and noise on the other. Most studies focus on one type of transportation impact rather than presenting a comprehensive view of the overall impact. There is a need for studies that take a multifaceted approach to evaluating impacts (121).

Another avenue for further exploration is the extent to which transportation equity objectives align with or conflict with other transportation planning objectives (e.g., environmental sustainability and economic growth). For example, the recent push for compact development to reduce greenhouse gas emissions risks exacerbating air pollution exposures in areas where vulnerable communities are currently disproportionately affected (171). Another paradox of “green” cities is that in an increasingly warming climate, the push to encourage more walking

and bicycling among the population may have unintended consequences as heat exposure is likely to increase and will fall disproportionately on low-income populations (172). Additionally, infill development and urban redevelopment more generally risks displacing low-income residents from central city areas as the cost of housing increases. This has been termed “green gentrification” and inspired calls for cities that are “just green enough” to reduce the risk of displacement (173, 174). More research on this emerging tension within social movements and public policies for environmental justice is needed to ensure that transportation equity does not exacerbate social and economic disparities.

Similarly, there is a vibrant movement emerging around the idea of bike equity which has not historically been well-integrated into discussions of transportation equity (175). However, the two movements may have a range of complementarities and conflicts. For example, bicycles can increase access for low-income populations but also present greater traffic safety concerns, provide less access than vehicles and public transit, and draw transportation resources from other modes (176). Research on these tradeoffs would be very timely.

Finally, we note that in any particular region or for a particular policy question, there is a need for region-specific or policy-specific analyses. In this review we have attempted to provide a summary of broadly applicable findings, but in practice the details matter and it is important to account for variation across regions, populations, and policy spheres.

5. We Can Get There From Here

In addition to the research findings on transportation equity, social movements have emerged and adapted to changing regulatory, legal, and planning practice contexts to engage in struggles for just distributions of the benefits and burdens of transportation infrastructure. These movements and their engagement are vitally important to ensure that “*We can get there from here*” and achieve sustained progress on transportation equity goals. In this section we highlight the crucial role of transportation equity advocacy as a resource for transportation researchers, policy makers, and planners who seek to improve collaboration with these important partners.

5.1 The Limits of Litigation for Achieving Transportation Equity

In 1994, a grassroots organizations called the Bus Riders’ Union (BRU) successfully challenged the transportation decision-making of the Los Angeles County Metropolitan Transportation Authority (LACMTA) (25). Specifically, the BRU alleged that LACMTA’s policies and practices were creating two separate and unequal transit systems by raising fares and cutting local bus service mostly used by low-income people of color to fund rail expansions that would be mostly used by wealthier white residents. The case was ultimately settled, with LACMTA agreeing to a consent decree that forced them to hold fares constant while expanding service.

Although it was not the first such lawsuit, the BRU case was the first that was successful, so it spawned others to follow its approach. Related lawsuits and administrative complaints, like

those pursued in the San Francisco Bay Area in the 2000s (24, 177), combined with the bifurcated demographics of transit ridership have historically set the stage for transportation equity advocacy.

Legal options for mitigation are particularly attractive since Title VI of the 1964 Civil Rights Act and President Clinton’s 1994 Executive Order prohibit both racially discriminatory decision making on the part of recipients of federal funds and disproportionately high and adverse impacts on low-income and people of color populations. As defined in the Civil Rights Act and other anti-discrimination law, “racially disparate impact” can be demonstrated by showing that a particular behavior, policy, or practice results in racially disparate outcomes in the absence of a legitimate justification for same. Thus, disparate impacts can manifest even in the absence of an intent to discriminate. Litigious approaches to achieving equity, however, are limited, especially in the wake of the Supreme Court’s 2001 decision in *Alexander vs. Sandoval* that enshrines a legal standard of “intentional discrimination” in cases where individuals allege violations of Title VI. This decision means that private individuals are unable to litigate Title VI-related claims on the basis of disparate impact alone, and must demonstrate there has been an intention to discriminate against them (178, 179).

The implications of this court decision are profound. While disparate impacts can be proven with data and analysis, intentional discrimination is very difficult to demonstrate (180) and transportation inequities manifest due to the accumulated decisions and actions of many different actors making decisions over extended periods of time (e.g., 165, 181, 182). The enduring legacies of segregation and racism ensure that certain racial and ethnic groups are restricted to certain locations in American cities and face legacies of economic disparity and political disenfranchisement and thus have vastly differential access to transportation benefits.

In the absence of a private right of action, federal agencies must be relied upon to enforce civil rights legislation and principles using an alternative legal tool called an administrative complaint (183). Administrative complaints present lower barriers than filing a lawsuit, but embody a number of drawbacks. Importantly, prioritizing the investigation of administrative complaints is at the discretion of the agency administrator who is typically a political appointee. Additionally, the parties to the complaint must use mediation that disadvantages low-resource environmental justice organizations while depriving them of the legal “hammers” of regulation and litigation (184). Finally, there are no hard deadlines or expected timing for decision making and the party making the complaint is generally left out of the investigation.

5.2 The Promise of Linking Regional Advocacy and Analysis

The shifting legal landscape and difficulties with securing redress under the law have led to shifting research foci and advocacy strategies. Regions—geographic areas defined by economic connections through shared labor and housing markets, political jurisdictions, and often shared environmental conditions in the case of air basins—have become important sites for social equity advocacy and organizing (185). Regional equity groups often focus on the underlying causes of spatial differences in opportunity that arise from differential tax bases, school quality, and job opportunities across a metropolitan area (186, 187). At the same time, public agencies

with responsibility for financing and coordinating transportation plans, policies, and infrastructure are also seeing increasing levels of engagement related to issues of infrastructure spending, access to opportunities, gentrification and displacement, and affordable housing. Importantly, these regional agencies are required to regularly certify their compliance with Title VI. In the past, agencies' self-certifications have been accepted with little scrutiny (44), but a number of recent developments in travel demand and land use modeling are advancing the frontier of analytical—and therefore political advocacy possibilities. Some authors have pointed to the limitations inherent in the methods commonly employed by transportation planning agencies—including metropolitan planning organizations and public transit agencies—and proposed alternative approaches that are better able to highlight existing inequities and target mitigations in response (46, 47, 188).

The most promising innovations are not being generated by planning agencies or academic researchers, but by equity advocates and the communities they represent. Community-directed equity analyses (sometimes conducted in partnership with academic institutions) have the potential to empower advocates and lead to policy relevant results (189, 190). Two recent examples of this approach are particularly promising: focusing the assessment on community-identified groups or geographic areas and modeling a scenario guided by regional equity ideals. The first approach has not been extensively studied in the literature to date. It must be based upon a robust public engagement effort that seeks to identify and address the needs of underserved and disadvantaged communities. Rowangould et al. (46) showed how this process can be applied in practice by using travel demand model outputs from Fresno County, in California's rural San Joaquin Valley, to study the implications of different definitions of environmental justice communities on the outcomes gleaned from a transportation equity analysis. The results are instructive for transportation policy makers and planners. Specifically, when the analysis highlights conditions in disadvantaged unincorporated communities identified by community groups, the results can be quite different than those that are produced when a more regional, or aggregate, approach is taken to community definition. In that work, transit accessibility in the identified locations was shown to be a fraction of that expected elsewhere in the region. The results of this analysis were used to advocate for the adoption of a needs assessment and grant program by the Fresno County Council of Governments. The program is now being used to identify areas of need and provide funds to design and implement transportation improvements in those areas (191).

Another example is provided by efforts in the San Francisco Bay Area, where there is a history of assessing and modeling regional transportation plans crafted by community-based organizations. Prior transportation and land use planning scenarios were generally focused on traditional environmental issues or smart-growth-type scenarios. In response to the 2013 regional transportation plan update, a regional equity coalition bridging traditional transportation-related concerns along with affordable housing, community development, public health, and economic opportunity sought to include an equity-focused scenario among the alternative plans considered by the Metropolitan Transportation Commission (MTC). The community-developed scenario, titled Equity, Environment, and Jobs (EEJ) was ultimately included in the environmental impact report (EIR) prepared by MTC (190). The results of the

accompanying performance analyses demonstrated that EEJ outperformed MTC's preferred plan in terms of greenhouse gas emissions, air toxics emissions, transit ridership, and displacement risk. The reasons for this performance were clear. EEJ emphasized increasing transit levels of service and increasing the supply of affordable housing in suburban areas with high concentrations of low-wage jobs to affordable housing as well as proximate to high quality transit stations. While the EEJ scenario was not adopted in its entirety, some changes to the proposed scenario were won, including the potential for increased transit operating funds and anti-displacement protections. It has also been influential on similar organizing in other regions (192).

Importantly, these results indicate that policies and practices that advance transportation equity goals can simultaneously meet environmental sustainability goals as well. Both the Bay Area (190) and San Joaquin Valley (191) examples also highlight the need for a diversity of advocacy organizations to develop a strong and sustainable coalition. Both brought together policy advocates, representatives of environmental justice, conservation, smart growth, and health movements as well as base-building organizations to mobilize the grassroots. Similar recommendations for community-led processes and discussion of their potential cross-cutting benefits can be found elsewhere (192).

5.3 Policy Solutions

In addition to these promising advocacy strategies, a number of public policy opportunities can be pursued to advance the goals of transportation equity. As noted above, different types of policies and programs can be implemented to increase access to equitable economic opportunities, healthy food, health care, and opportunities for physical activity and recreation (66, 88, 96, 109, 111).

In addition to these general policy prescriptions, two very specific policies could be undertaken to address disparities more systematically. The first is related to a new rule promulgated by the U.S. Department of Housing and Urban Development (HUD) to improve the implementation of a provision in the extant Fair Housing Act known as "Affirmatively Furthering Fair Housing" (AFFH) (193, 194). The second is the targeting of funding to advance the goals of transportation equity by meeting needs that are identified by disadvantaged communities (195). The AFFH rule requires recipients of HUD funding to carry out an assessment of fair housing (AFH) that identifies and seeks to mitigate past patterns of segregation and exclusion from opportunity. A particular "community asset" that the rule identifies is access to transportation. Targeting funds to meet the needs of disadvantaged communities has rarely been undertaken in the transportation realm, but has precedent in the allocation of different types of public funds, including 25% of revenue generated from California's cap-and-trade program for greenhouse gas emissions (196). We discuss both of these potential policy options in turn.

The notion of affirmatively furthering fair housing—as opposed to simply avoiding overt discrimination—has technically been the law of the land since 1968 Fair Housing Act. While this policy was meant to foster integrated communities and a truly open housing market, ambiguities around its implementation and local resistance have prevented the policy goals

from being met (197). HUD’s final AFFH rule, published in July 2015, refines and operationalizes the concept of AFFH by requiring the completion of a number of steps designed to foster “meaningful action, in addition to combating discrimination, that [overcomes] patterns of segregation and [fosters] inclusive communities free from barriers that restrict access to opportunity based on protected characteristics”.² The ultimate goal of the AFFH is to replace “segregated living patterns with truly balanced and integrated living patterns, transforming racially or ethnically concentrated areas of poverty into areas of opportunity.”³ Because of the inherent links between land use, transportation, and economic opportunity, there are likely to be strong synergies that can be gained from incorporating findings from an AFH into a regional transportation plan, or a sustainable communities strategy prepared pursuant to California’s Senate Bill 375 (The Sustainable Communities and Climate Protection Act). The likely effects of transportation investments and policies on patterns of segregation can then be evaluated and mitigated.

A final policy opportunity involves a strategy to dramatically improve public involvement efforts by allocating specific resources to address the needs of disadvantaged communities at the outset. In the past, public involvement has focused largely on improving the openness and responsiveness of the process by holding meetings at convenient times and providing information in languages that are appropriate for the local population. Yet these approaches do little to compensate participants for their time and expertise. Furthermore, even with a robust public participation process, the actual impacts on the policy and planning decisions, and on allocations of resources are typically small. The policy solution proposed here involves dedicating a portion of discretionary funding to meet needs identified by community-based organizations and resourcing their participation in the process. Without funds dedicated to support community-based organizations in providing input, an exercise that purports to direct resources to disadvantaged communities is at risk of perpetuating past injustices. Full and fair participation and a recognition of the diverse knowledge of communities is a prerequisite to just outcomes (198). In California’s San Joaquin Valley, the Fresno County Council of Governments established a mini-grant program to support the public involvement efforts of advocacy organizations and schools during their most recent regional transportation plan update (191).⁴

Once community-based organizations are appropriately resourced, a four-step process outlined by Marcantonio and Karner (195) can be used to determine whether a project or plan will indeed advance equity goals. The steps are:

1. Does it meet an important need identified by a disadvantaged community?
2. Are the benefits associated with it significant, rather than incidental?
3. Are those benefits targeted to low-income residents?
4. Does it avoid substantial harms to the community?

² 24 C.F.R. §5.152.

³ 24 C.F.R. §5.152.

⁴

This framework avoids many of the shortcomings of traditional public participation efforts by putting communities in the “driver’s seat” with respect to defining and determining progress towards their stated goals. It could also replace or partially supplement traditional quantitative equity assessments that rarely lead to more equitable outcomes. By establishing a proportion of funding at the outset that could be targeted to meet community needs, the potential for litigation would be likely to be diminished.

6. Conclusions

In this white paper, we reviewed the state of the literature and practice on transportation equity in order to provide a common language that can facilitate collaboration among the many parties seeking to achieve more equitable transportation systems. The review demonstrates that neither the benefits nor the burdens of the transportation system are shared equitably across space or across demographic groups. The current situation is clearly not equitable and it is not sustainable. An equitable transportation system would be one where participation is meaningful and effective and ultimately, the benefits and burdens created by projects, policies, and plans are shared equitably such that no groups would be unduly burdened by a lack of access to adequate transportation nor by the negative impacts associated with proximity to transportation infrastructure. Several key findings emerge from this review, including the following:

1. Race, ethnicity, and income must be considered in policy and planning for transportation options and decisions.
2. There are significant disparities in the distribution of transportation benefits such as access to jobs, goods and services, opportunities for physical activity, healthy food, and health care. These findings vary greatly depending on whether a traveler has access to a car or is reliant on public transit.
3. There are also significant disparities in exposure to transportation burdens, such as exposure to air pollution or the risk of collision.
4. The distribution of benefits and burdens varies from region to region and for different populations. In addition to race, ethnicity, and income-related disparities, transportation analysis must also look for disparate impacts among other groups, such as rural, transit-dependent, and elderly populations.
5. Regions have become important sites for bringing disparities to light and addressing them.
6. Community driven analysis and planning solutions are a promising direction for equity analysis and planning practice.

Academic research is helpful for demonstrating the scale, scope, and nature of disparities, and analytical methods continue to evolve to aid in their identification. Tracking changes over time to determine whether conditions are improving or getting worse is also quite important. Yet academic research alone does not result in changes to policy or practice. These changes typically originate from members of the public who come together to influence the decisions

that affect their lives. In this realm of advocacy, too, important innovations are occurring, as prior legal approaches are rethought and new approaches tested. Continued experimentation and innovation is needed, especially given the recent federal priority on performance measures and new rules emanating from executive agencies other than the U.S. Department of Transportation such as Housing and Urban Development. New forms of collaboration between academic researchers and advocates can produce solutions that are informed by the best available research, and the expertise and visions of the affected communities. In summary, although the equity challenges and disparities that we present in this white paper may seem at best intractable and, at worst, impossible to address, we believe that “*We can get there from here*” by implementing innovative policies and practices that place social equity and the well-being of historically underserved populations at the center of our concern.

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