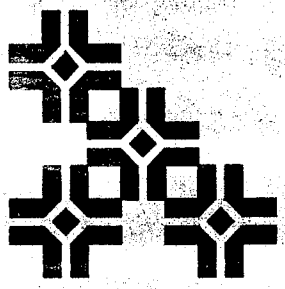
METHODS FOR EXAMINING ENVIRONMENTAL EQUITY ISSUES IN PUBLIC TRANSPORTATION



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METHODS FOR EXAMINING ENVIRONMENTAL EQUITY ISSUES IN PUBLIC TRANSPORTATION

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December 1999

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16. Abstract

This research demonstrates how the use of geographic information systems and other study methods can assist in identifying potential adverse impacts of transit programs and activities on minority and low-income populations. A process for examining the relationship between transit facilities and mobile pollutant sources, demographic characteristics, and land use patterns is provided to assist transportation professionals in identifying the location of minority and low-income populations and the potential for adverse impacts on their health and quality of life. Remediation alternatives are also presented.

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OVERVIEW

This research demonstrates how various impact analyses and other study methods can assist in identifying any potential adverse impacts of transit programs and activities on minority and low-income populations. The first section in this paper discusses the history of the environmental justice movement in the United States, including federal non-discrimination legislation and policy. Also included is an overview of the United States Department of Transportation environmental justice strategy and the Clean Air Act Amendments of 1970, 1977, and 1990. The subsequent section provides a general discussion of the potential environmental impacts of transit facilities and activities on adjacent communities. The final section of this document presents various processes for examining the relationship between transit facilities and mobile pollutant sources, demographic characteristics, and land use patterns. The use of one or more of these processes can assist transportation professionals in identifying the location of minority and low-income populations and the potential for adverse impacts on their health and quality of life. Remediation alternatives are also presented to address any anticipated negative impacts revealed during the analysis stage.

BACKGROUND

Historically, low-income and minority populations have been underrepresented in transportation planning and project development. Limited access and knowledge of the decision-making process increased the potential that a group would be adversely impacted by a transportation project and reduced the likelihood that opportunities would be identified to address neighborhood needs or objectives. In order to increase the representation of these groups in the planning and project development process and protect minority and low-income populations, federal civil rights legislation was enacted to ensure the protection of minority and low-income individuals from discrimination through federally funded activities.

Title VI of the Civil Rights Act of 1964 provides, "No person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." Federal environmental justice regulations reiterate the importance of ensuring that the civil rights of minority and low-income populations are not violated by a transportation plan, project, program, or activity.

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations*, calls for strategies to identify and address disproportionately high and adverse human health and environmental impacts of federal actions on low-income and minority populations. To comply with the Executive Order, the U.S. Department of Transportation (USDOT) established an environmental justice strategy for the National Environmental Policy Act (NEPA) process, Title VI of the 1964 Civil Rights Act, and other applicable statutes concerning planning, public participation, social and economic factors, and health issues. This strategy also promotes public involvement efforts targeted for minority and low-income groups, to facilitate access to general information and input into transportation and project decisions.

TRANSIT AND ENVIRONMENTAL EQUITY

While there is a growing awareness of the important role transit plays in the quality of life for minority and low-income groups, environmental justice analysis enables us to identify any adverse impacts that may be presented by transit facilities. Transit projects such as bus garages and/or intermodal facilities and terminals and transfer facilities can be evaluated to determine whether the project or activity will result in disproportionate adverse impacts to a minority or low-income population.

Transit buses are the primary cause of air pollution at or near transit facilities and should be considered when evaluating the potential for adverse impacts from transit projects and activities. Likewise, the noise created by transit vehicles, such as diesel buses and locomotives, is also a factor to be considered when evaluating transit impacts. In addition, many maintenance activities generate hazardous wastes at transit facilities. Maintenance operations that clean and repair trains or transit buses may generate and/or discharge a variety of hazardous wastes, including strong acid or alkaline materials, used cleaning and degreasing solvents, paint wastes, used oil, and lead-acid batteries. Stormwater runoff from garages, equipment, vehicles, and parking/storage areas is also a consideration.

Transit facilities and activities may also have negative social or economic impacts on a community. Economic considerations may include how the facility impacts the mobility for citizens of the community or the effect on the real property values in an area. Social considerations may include how the transit project or activity impacts the safety, and aesthetics of a community. The cumulative effects of a project, comprised of the incremental impact(s) of the action added to other past, present, and anticipated future activities should also be examined as well as any secondary impact(s) that may be expected.

THE PROCESS FOR EXAMINING ENVIRONMENTAL EQUITY IN TRANSIT

Environmental equity is a public policy goal that ensures that adverse human health or environmental effects of government activities do not fall disproportionately upon minority or low-income populations.[1] Public transit is a government activity. Therefore, identifying and evaluating the potential for negative impacts on population groups by transit projects and activities provides the information needed for making decisions that are respectful of environmental equity goals.

A number of methods exist for examining environmental equity in transit projects. As provided later in this study, the use of GIS can assist in examining the relationship between transit facilities, proximity related impacts, and demographic characteristic and the potential threat of adverse impacts on protected populations.

If the process used reveals that low-income and minority communities will be or have been adversely affected by transit facilities, potential methods for addressing these impacts can be

[1] David J. Forkenbrock and Lisa A. Schweitzer, *Environmental Justice and Transportation Investment Policy,* (Public Policy Center, University of Iowa, 1997),1.

identified and implemented. Potential methods, as discussed in this research, could include avoidance, minimization, mitigation, and enhancement. Transit agencies should coordinate with impacted communities to develop solutions that are mutually beneficial.

THE HISTORY OF ENVIRONMENTAL JUSTICE IN THE UNITED STATES

The following section has been developed in order to provide the reader with a solid understanding of the history of the environmental justice movement in the United States. A discussion on the significant linkage between minority and low-income communities and public transportation, federal policy on environmental justice and transportation, and the Clean Air Act and related subsequent amendments is provided below.

ENVIRONMENTAL JUSTICE

The environment justice movement began as a response to the transport and illegal disposal of toxic waste in Warren County, North Carolina. Oil laced with highly toxic polychlorinated biphenyl (PCB) was illegally dumped along roadways in 1978. In 1982, the roadways and adjacent areas were cleaned. However, a disposal site was needed for the highly toxic soil that was removed from the area. Warren County, North Carolina, a rural, primarily African-American community, was selected. While the protesters were unsuccessful in blocking the PCB landfill, they did bring national attention to siting inequities occurring in communities such as Warren County and the rise of the environmental justice movement in the United States.

FEDERAL POLICY

On February 11, 1994, President Clinton signed Executive Order 12898 on Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The Order has as its main purpose the reinforcement of existing environmental and civil rights legislation to ensure that these special populations are not subject to disproportionately high and adverse environmental effects from transportation related activities and projects.

The Order reinforces Title VI of the Civil Rights Act of 1964 which prohibits discriminatory practices in programs receiving federal funds. Additionally, it focuses the spotlight back on the National Environmental Policy Act (NEPA), a law that directs federal agencies and agencies receiving federal funding, to analyze *"the environmental effects, including human health, economic and social effects, of federal actions, including effects on minority communities and low-income communities."* Both policies are strongly linked to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and its successor, the Transportation Equity Act for the 21st Century (TEA-21). ISTEA also required transportation plans to comply with Title VI of the Civil Rights Act of 1964, which prohibits discrimination in the use of federal funds, investments, and transportation services.[2] This policy will be continued through TEA-21.

[2] Ibid.

Lastly, the Order calls for the use of improved methodologies, such as GIS, for assessing and mitigating impacts, and collecting data on low-income and minority populations that may be disproportionately at risk.

DEPARTMENT OF TRANSPORTATION ENVIRONMENTAL JUSTICE STRATEGY

In response to the Executive Order, the United States Department of Transportation (DOT) developed an implementation strategy for relevant programs and activities sponsored, supported and undertaken by the Department. The DOT's goal to become a model transportation agency for protecting and enhancing the environment and quality of life of its inhabitants directly parallels the strategy set forth in the President's Executive Order.

The central objective of the order is to ensure that the DOT explicitly considers the effects of transportation projects on minority populations and low-income populations. Such effects include, but are not limited to:

- Bodily impairment, infirmity, illness, or death;
- Air, noise, and water pollution and soil contamination;
- Destruction or disruption of manmade or natural resources;
- Destruction or disruption of community cohesion or a community's economic vitality;
- Destruction or disruption of the availability of public and private facilities and services;
- Vibration;
- Adverse employment effects;
- Displacement of persons, businesses, farms, or nonprofit organizations;
- Increased traffic congestion, isolation, exclusion, or separation of minority or low-income individuals within a given community or from the broader community; and
- Denial of, reduction in, or significant delay in the receipt of benefits of US DOT programs, policies, or activities.

The following terms are used in the USDOT order, and are important to a transportation professional or other analyst conducting an environmental justice assessment:

Low-Income - a person whose median household income is at or below the Department of Health and Human Services poverty guidelines.

Low-Income Population means any readily identifiable group of low-income persons who live in geographic proximity, and, if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity.

Minority - a person who is Black, Hispanic, Asian American, American Indian or Alaskan native. Minority Population means any readily identifiable groups of minority persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who will be similarly affected by a proposed DOT program, policy or activity.

Cumulative Effects - Cumulative impacts are defined as "the incremental impact(s) of the action when added to other past, present, and reasonably foreseeable future actions..." (40 CFR 1508.7)

Disproportionately High and Adverse Effects on minority and low-income populations means an adverse effect:

> *"is predominately borne by a minority population and/or a low-income population, or will be suffered by the minority population and/or low-income population and is appreciably more severe or greater in magnitude than the adverse affect that will be suffered by other populations not classified as minority and/or low income."*

In the Executive Order, the term "environmental" applies not only to the physical environment (e.g., air and water quality), but also to the built environment - the setting within which people live, work, and recreate. Applying this broader interpretation, aesthetically displeasing structures or traffic congestion are antithetical to environmental justice.

THE CLEAN AIR ACT AMENDMENTS

The dominance of the automobile in metropolitan commuting has led to concerns over automobile congestion and poor air quality. The Clean Air Act Amendments of 1970 were established to reinforce the government's position to address environmental concerns that increased during the latter part of the 1960s. This act created the Environmental Protection Agency (EPA) and empowered it to set ambient air quality standards.[3] Under the Act, the EPA was authorized to require states to formulate and implement plans to meet ambient air quality standards. It emphasized changes in transportation systems for attaining air quality standards, including reductions in pollution from mobile sources.

The EPA was given broader control after the Clean Air Act Amendments of 1977 were adopted. The amendments increased the flexibility and local responsibility in the administration of the Act and required state and local governments to draft plans for meeting air quality standards in areas of non-attainment. In 1990, the Act recast transportation planning to improve air quality and mobility in non-attainment areas. In addition, Section 309 of the Act directed the EPA to ensure that agencies have fully analyzed the environmental effects on minority and low-income communities, including human health, social, and economic effects.[4]

Public transit projects, which help reduce trips by single occupancy vehicles, are frequently used as part of a strategy to improve air quality and mobility in non-attainment areas. Ironically, while the Clean Air Act Amendments support the development of transit projects to mitigate poor air quality in non-attainment areas, these projects may be contributing to increased emissions in low-income and minority communities.

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[3] Edward Weiner, Urban Transportation Planning in the United States: A Historical Overview, (Praeger, 1987), 40.

[4] U.S. Environmental Protection Agency, Interim Final Guidance for Incorporating Environmental Justice Concerns in EPA's Compliance Analysis, September 30, 1997. Page 6.

SUMMARY

Historically, public transit has been a key ingredient in the social and economic advancement of minorities and low-income persons. The environmental justice movement revealed that these groups have borne greater health and environment risk burdens than society in general.[5] There is evidence to suggest that they face increased exposure to air pollution, hazardous waste sites, and industrial facilities. Transportation projects in low-income and minority communities may improve mobility, but may also increase the concentration of air pollution and environmental hazards. The Executive and DOT Orders on Environmental Justice combine Title VI of the Civil Rights Act with the NEPA, ISTEA, and TEA-21 to bring to the forefront the importance of involving special populations in the transportation planning process.

ENVIRONMENTAL IMPACTS OF TRANSIT

As stated earlier in the report, this research is focused on how the use of GIS can assist transportation professionals to identify any potential negative impacts of transit projects and activities, and the subsequent impacts on low-income and minority communities. This section describes the potential environmental impacts of transit facilities and associated activities, including the physical impacts such as noise, scrap tires, hazardous waste, and stormwater runoff; the social and economic impacts; and any cumulative or secondary impacts.

AIR POLLUTION

Transportation is responsible for massive emissions from vehicles, refineries, road construction, maintenance, and fuel stations. In the United States, mobile sources are estimated be responsible for approximately 64 percent of carbon monoxide; 36 percent of nitrogen oxides; 27 percent of volatile organic compounds; and 44 percent of particulate matter.[6]

Many transit systems use buses powered by diesel engines that contribute to the air pollution found at or near transit facilities (i.e., bus garages, terminals, and stops). Diesel buses emit carbon monoxide (CO), nitrogen oxides (No_x), volatile organic compounds (VOC_s), sulfur dioxide (SO_2), and particulate matter (PM_{10}). Research completed by Balogh et al. showed that urban buses are a major source of air pollution, especially particulates.[7] While this study was conducted within an area having a high ratio of buses to automobile traffic, it does illustrate the potential impacts of diesel bus emissions within an area.

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[5] Robert Bullard, Solid Waste Sites and the Black Houston Community. Sociological Inquiry 53, Spring, 1983, 273.

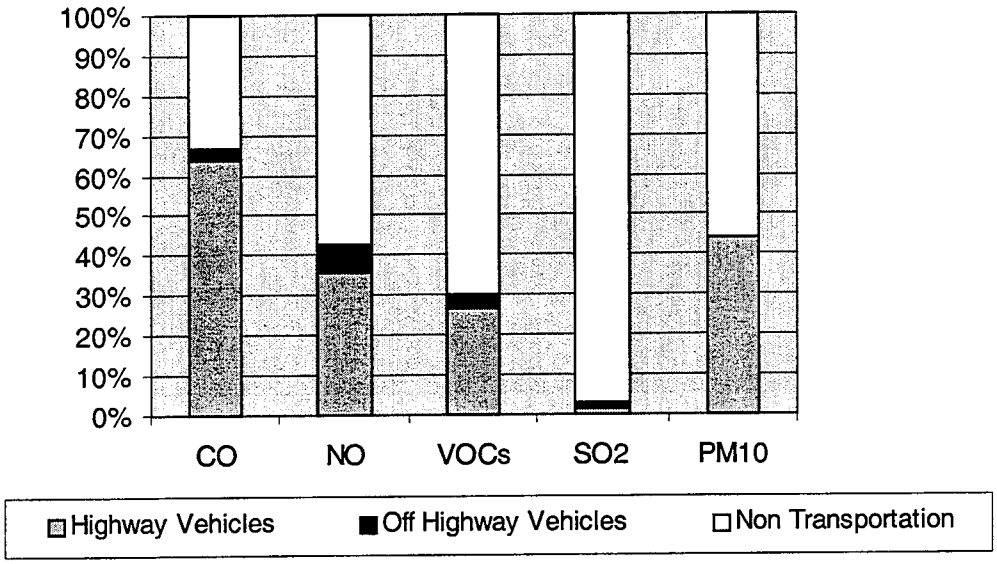
[6] United States Environmental Protection Agency (EPA), National Air Pollutant Emission Trends, 1990-1995.

[7] Balogh, et al. Analysis of Fine Particulate Matter Near Urban Roadways, Transportation Research Record 1416, 1993, 25.

Data from 1995 emission estimates are shown in Figure 1. As these data show, highway vehicles are a significant source of air pollution. While diesel buses may not represent a significant percentage of total highway vehicles (in the study area mentioned above, diesel transit and tour buses represented 5% of the hourly vehicle traffic or 30 vehicles per hour) it is important to consider their impacts when assessing emissions.

Carbon monoxide is formed when fuels are incompletely burned. Its production is highest at low air-to-fuel ratios such as when a car is started, idling, or improperly tuned.[8] Carbon monoxide can displace oxygen in the bloodstream, thereby adversely affecting mental function, visual acuity, and alertness. Those most at risk from CO exposure are those with heart disease.

Figure 1
National Emissions by Source Category



Nitrogen oxides are released from fuel combustion, irritate the lungs, contribute to respiratory illness, and pulmonary infection. *Volatile organic compounds* are composed mainly of hydrocarbons emitted primarily as unburned components of petroleum. In the presence of heat and sunlight, No_x and VOC_s react to form ground-level ozone or smog. High levels of smog can irritate the mucous membranes of the nose and throat, impair normal lung function, and contribute to property damage as the result of its reactions with building and vehicle paints.[9]

[8] Forkenbrock and Schweitzer, 24.

[9] U.S. Department of Transportation, Federal Transit Administration, Sourcebook on Transit-Related Environmental Regulations (Washington: Government Printing Office, 1995), 1-2.

Particulate matter (particulates) is very small pieces of grit, which range from 0.1 to 0.2 micrometers (microns) to ten times this size. Particulates are easily inhaled and may contribute to respiratory infections such as pneumonia, asthma, and the aggravation of bronchitis. Small and Kazimi concluded that of all measurable air pollutants, particulates very well may be the most detrimental to human health.[10] Additionally, research on particulates has revealed that increased exposures to PM_{10} have been linked to higher mortality rates. Table 1 shows the proportion of total particles resulting from different fuel types with aerodynamic diameters smaller than 0.2m (micrometer) and 10m.[11]

Table 1
Particle Size Distribution by Type of Fuel[1]
(Cumulative %)

Fuel Type	Under 0.2m	Under 10m
Leaded	23	64
Unleaded with catalytic converter	87	97
Unleaded without catalytic converter	42	90
Diesel	73	100

Source: Balogh et al. 1993, p. 26

[1] Because not all particulates are 10m or under, the cumulative proportions do not sum to 100 percent. All of the particulates released by diesel engines are smaller than 10 m.

SO_2 are emitted from motor vehicles that operate using diesel engine and contribute to particulate formation and acid rain.

The literature has shown a narrow association between transportation-related pollutants and some health problems. The research did reveal that some low-income and minority populations have higher rates of asthma and heart disease. Transportation related pollutants may serve to exacerbate these conditions.

Diesel buses and diesel locomotives can produce significant particulate emissions within a community. There may be a greater risk of negative health effects from diesel emissions in

[10] Kenneth A. Small and Camilla Kazimi, On the Costs of Air Pollution from Motor Vehicles, Journal of Transport Economics and Policy, Volume 29, Number 1 (1995): 8.
[11] Ibid.

communities where there are bus garages and heavy bus traffic. While the literature reveals that seniors and growing children are at greatest risk from the health problems that may result from exposure to emissions, there is no direct correlation made between the incidence of those health problems and diesel emissions. However, an analysis of the impacts of a transit facility and associated activities should recognize the potential for adverse health effects from concentrated diesel emissions, resulting from significant idle time, heavy volume or poor maintenance of the vehicles.

It is important to note that with the full implementation of the Clean Air Act Amendments of 1990, the Environmental Protection Agency has more strictly defined transit vehicle emission standards. Transit vehicle manufacturers are producing buses that use alternative fuel technologies such as clean burning diesel and compressed natural gas. Electric buses are also being manufactured and are being used in increasing numbers.

NOISE

Noise from transit buses, trains, and maintenance operations can have a significant impact on the quality of life for communities near transit facilities and where transit vehicles operate. Noise[12] can be viewed as unwanted or detrimental sounds that may cause sleep disturbance, communication interference, and general annoyance. "Annoyance" generally describes physical and psychological stress.[13] There is no precise sound threshold for annoyance. According to a World Health Organization task group, daytime noise levels of less than 50 decibels (dBA) outdoors cause minimal annoyance, while at night an outdoor level of 45 dBA exceeds common urban sleep criteria.[14]

Sources of noise associated with transit vehicles include engine and related equipment operation, brake friction, airbrake operation, transmission and drive train friction, horns and whistles, and maintenance-related noise. Diesel engines, particularly, when cold-starting, can be an unpleasant source of noise. In addition, the sounds from motors and exhaust systems of buses can be augmented by the "canyon" effect from narrow streets and tall buildings reverberating these noises. An analysis on the cost of noise estimated that traffic noise reduces home property values by $6 to $182 per decibel.[15]

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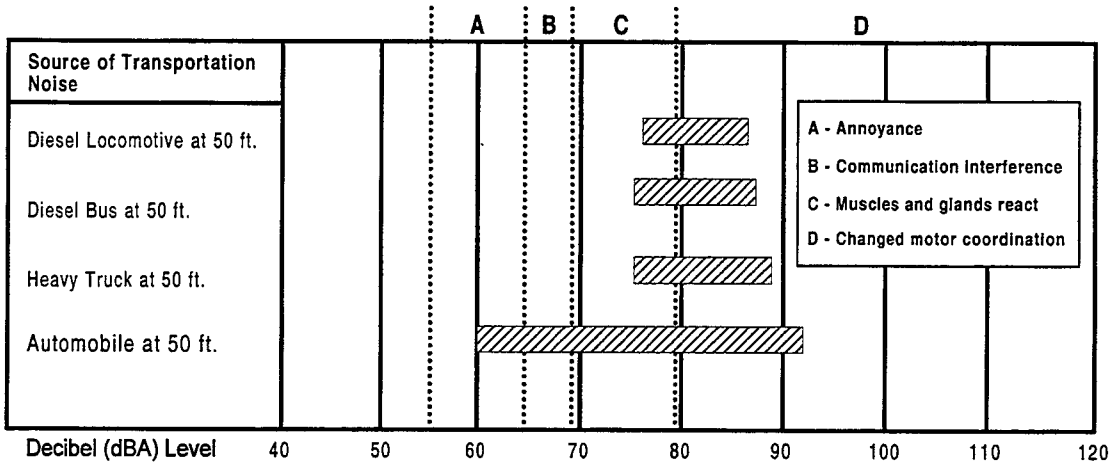
[12] Sound is measured in units called decibels (dB). Adjusted sounds are called "A-weighted levels" (dBA).
[13] Forkenbrock and Schweitzer, 36.
[14] http:www.content@solstice.crest.org
[15] Ibid.

Figure 2 summarizes the results of increasing noise levels, and the noise levels associated with different types of vehicles. This figure helps to communicate the potential impact of noise generated by transit vehicles. It illustrates that noise created by transit vehicles is beyond annoyance. The noise levels 50 feet from a diesel bus range from 75 to 87 dBA depending on speed and condition of the vehicle. The sound impact of buses on urban streets is higher than in rural areas. Bus sounds are intensified by reverberation in built-up areas and are increased when pulling away from stops.[16] The exterior noise levels 100 feet from a diesel locomotive range from 76 to 86 dBA depending on train length and operation speed. Elevated lines are 2 to 5 dBA higher than at-grade levels, primarily due to increased vibration.[17]

Figure 2
Source of Transportation Noise



Source: Protective Noise Levels (EPA, 1979, p. 5)

SCRAP TIRES

Transit agencies acquire and dispose of tires in the course of maintaining buses and other agency vehicles. The disposal of scrap tires is an environmental problem that goes unnoticed in several minority and low-income communities. An estimated 1.5 to 3 billion vehicle tires have been disposed along roadsides, in vacant lots, and in dumps and landfills across the U.S.[18] Dumping and stockpiling of scrap tires creates an environmental concern by inviting rodents and insects and

[16] Ibid.
[17] Ibid.
[18] U.S. Department of Transportation, Federal Transit Administration, Sourcebook on Transit-Related Environmental Regulations (Washington: Government Printing Office, 1995), 2-1.

providing fuel for fires. Occasionally, areas where this dumping and stockpiling occur are in commercial or industrial areas often located near protected populations.

HAZARDOUS WASTE

Most transit agencies are involved in operations that generate hazardous wastes at their maintenance facilities. Maintenance operations in which trains are cleaned and repaired might generate a variety of hazardous wastes, including strong acid or alkaline materials, spent cleaning and degreasing solvents, ignitable paint wasters, used oil, and lead-acid batteries. Operations performed at maintenance facilities that serve rail, bus, and other vehicles involve the removal of oil and grease, rust, dirt, or paint, and other potentially hazardous products. This may include the following products:

- rust removers that contain strong acid or alkaline solutions;
- carburetor cleaners that contain flammable or combustible liquids;
- part cleaners and degreasers that contain toxic chemicals;
- paint thinners that are ignitable or contain toxic constituents;
- motor oil and other petroleum products; and/or,
- vehicle batteries.

Chemical wastes from oil, cleaners, etc., contain many toxic constituents. If not properly handled and disposed, these products can contaminate ground and surface water to unusable levels. For example, most transit agencies have multiple underground storage tanks (USTs) that contain petroleum products (e.g., gasoline, diesel fuel, heating oil) at their vehicle fueling sites and maintenance facilities. When these tanks leak, the products they release can contaminate nearby surface and ground water.

STORMWATER RUNOFF

Transit facilities where vehicle maintenance, cleaning and storage activities take place can also become a source of water pollution as rain washes substances from the ground, garages/buildings, equipment, vehicles, and parking/storage areas into the sewer system or directly into nearby rivers and streams.

Stormwater runoff may carry many pollutants emitted from diesel buses. When rain falls, emissions such as particulates, and other chemical aerosols in the air wash out and are deposited on the ground. The rain waters that flows across the surface carries with it these deposited substances into rivers, streams, lakes, and coastal waters. Similarly, heavy metals, fuel, and oil generated at transit maintenance facilities are carried in the flow of rain water.

ECONOMIC AND SOCIAL CONSIDERATIONS

Besides the environmental impacts that a transit facility may have on adjacent and surrounding communities, the noise and emissions generated may also have economic and social impacts. Economic considerations may include how the facility affects mobility for citizens in the community, and its effect on real property values. Social considerations may include culture, safety, and aesthetics. Existing methods can provide an evaluation of the economic and social impacts that a transit facility may have on a community. A few are discussed in this section. Occasionally the economic and social values of a community are subjective, and thus, difficult to measure. However, using GIS to evaluate the impacts that a transit facility has on the economic and social welfare of a community is possible.

Economic Considerations

The transit facilities identified in this study (i.e., garages, terminals) serve a dual role: they are a functioning component of the transit agency, but they also serve as locations where citizens can gain employment and board and alight transit vehicles. Thus, these transit facilities can provide access to transportation especially for people without personal vehicles. This is important since minority and low-incomes populations within most urban areas are more likely to use public transit. While a transit facility may generate some health concerns for citizens in the host community, it provides access to opportunities and services such as employment, daycare, medical facilities, and shopping.

Like other major transportation projects, the proximity of a major transit facility, such as a garage, can adversely affect residential property values. A report by the Federal Highway Administration (FHWA) showed that in large urban areas property values near freeways can decline up to 10 percent in value. The decline is higher for properties abutting the freeways than for non-abutting properties, and depends on whether the highway is elevated, at-grade, or depressed.[19] Transit facilities may have similar effects on real property values. Besides the air pollution and noise, the resulting decreased aesthetic quality and local access may have an adverse impact on property values. Using GIS to show transit facilities, and the range of property values for houses in proximity to the facility, is another method of showing the potential environmental impacts of transit on minority or low-income populations. Additionally, an economic impact analysis can be useful in measuring possible impacts on the economic well-being of a community that is near a transit facility. Economic impact analysis satisfies the mandate under NEPA to ". . . fulfill the social,

[19] Forkenbrock and Schweitzer, 50.

economic and other requirements of present and future generations of Americans."[20] This type of analysis can be combined with GIS to show economic impacts of transit facilities on a community.

Social Considerations

The literature suggests that transit facilities can have social impacts on communities, and should be considered when completing an environmental justice assessment. In many cases, social impacts are perceived values that citizens place on various aspects in a community. As result, measuring the social impacts of a transit facility on a community is sometimes difficult. Forkenbrock and Schweitzer suggest three general areas that should be considered in assessing social impacts. These may be described as community culture, safety, and aesthetics.

Many communities are defined by their culture. This may include the types of activities that occur in the community, the ethnic populations that reside in the community, or the physical environment and geographic boundaries of the community. The social interaction that takes place within these parameters gives citizens a sense of comfort and safety. The literature suggests that transit facilities can adversely affect efforts to build cohesion and maintain safety, within a community. For example, emissions and noise from transit buses may deter neighbors from having social gatherings outdoors, especially in communities that have limited open spaces. A light-rail system may create a barrier to citizens on opposite sides of the transit right-of-way or structure that may have taken over part of the community's open space through the eminent domain process. Transit buses also compete for space on local streets, thus creating possible traffic problems and a "sense of danger." This is especially an important consideration for children in urban areas that lack off-street recreational facilities combined with more on-street activity.

Aesthetics is an important consideration in an environmental justice assessment. It is perhaps the most subjective impact and difficult to measure. Aesthetic impacts may be referred to as changes in the living environment that cause emotional and physical stress. A significant portion of this research reviewed how emissions and noise can have a detrimental impact on the aesthetics of minority and low-income communities, including ambience, health, and overall quality of life. For example, a light rail structure may disrupt the views or light sources for properties near the facility. An at-grade light-rail system may be preferred to an elevated light-rail system that leads to a sense of enclosure that is aesthetically displeasing.

[20] National Environmental Policy Act, Title I, Section 101(a).

CUMULATIVE AND SECONDARY IMPACTS

The aggregate impacts upon communities from various polluting facilities are rarely considered when evaluating the siting of transportation or other facilities, including transit facilities. Typically, when transit agencies examine the social and environmental impacts of projects, they only look at a narrow list of impacts specific to the project under consideration. Therefore, transit agencies should consider how differing impacts relate to each other, including cumulative and secondary impacts.

Cumulative impacts are defined (40 CFR 1508.7) as "the incremental impact(s) of the action when added to other past, present, and reasonably foreseeable future actions." For example, emissions generated by a transportation project or activity may not have a significant impact on the surrounding area and may not exceed air quality standards. However, when the cumulative effect of emissions from adjacent industrial or other non-transportation related activities, other transportation activities within the area (such as vehicle traffic), and those of the project under study are considered, air quality standards may be exceeded and may impact the surrounding area.

Indirect impacts are those that often occur later in time or further away in the distance than direct project impacts. For example, during the construction of a transit project, access to a business corridor in a minority community may be disrupted. As a result, regular customers may decide to shop and do business at another location. However, once the transit project is completed, lost customers may not return, thus, contributing to the end of a commercial establishment.

SUMMARY

This section presented the environmental impacts associated with transit projects and activities, including the operation of transit vehicles. Identifying the source(s) of any potential adverse impact is the first step in adequately addressing the environmental issues for a community.

ENVIRONMENTAL EQUITY EVALUATION TECHNIQUES

This section presents a process to examine the relationship between transit facilities (i.e., bus and rail garages and terminals) and mobile air sources and demographic characteristics to identify potential environmental impacts on protected populations. It is important to note that the process discussed below mirrors many of the steps involved in Community Impact Assessments conducted in response to the National Environmental Policy Act (NEPA) and associated procedures. The

primary sources of data used for this process include the 1990 Census of Population and Housing, Geographic Information Systems (GIS) and TIGER databases (topographically integrated geographic encoding and referencing), and transit facilities. If an evaluation process reveals the potential adverse impacts on low-income or minority communities, methods to avoid, minimize or mitigate these impacts can be identified. These findings also should be documented. Figure 3 illustrates the process that may be used to perform an environmental equity analysis, including the various analysis options that may be used individually or in combination with one another. The use of whether to use one or more of these analysis techniques should be determined locally. The decision should take into consideration the political climate of the community, the level of trust/distrust among members of the community, any perception that a particular project will have significant negative effects on the community and whether or not specific neighborhoods or communities are or have been disproportionately impacted by other transportation related projects.

ENVIRONMENTAL JUSTICE SCREENING ANALYSIS

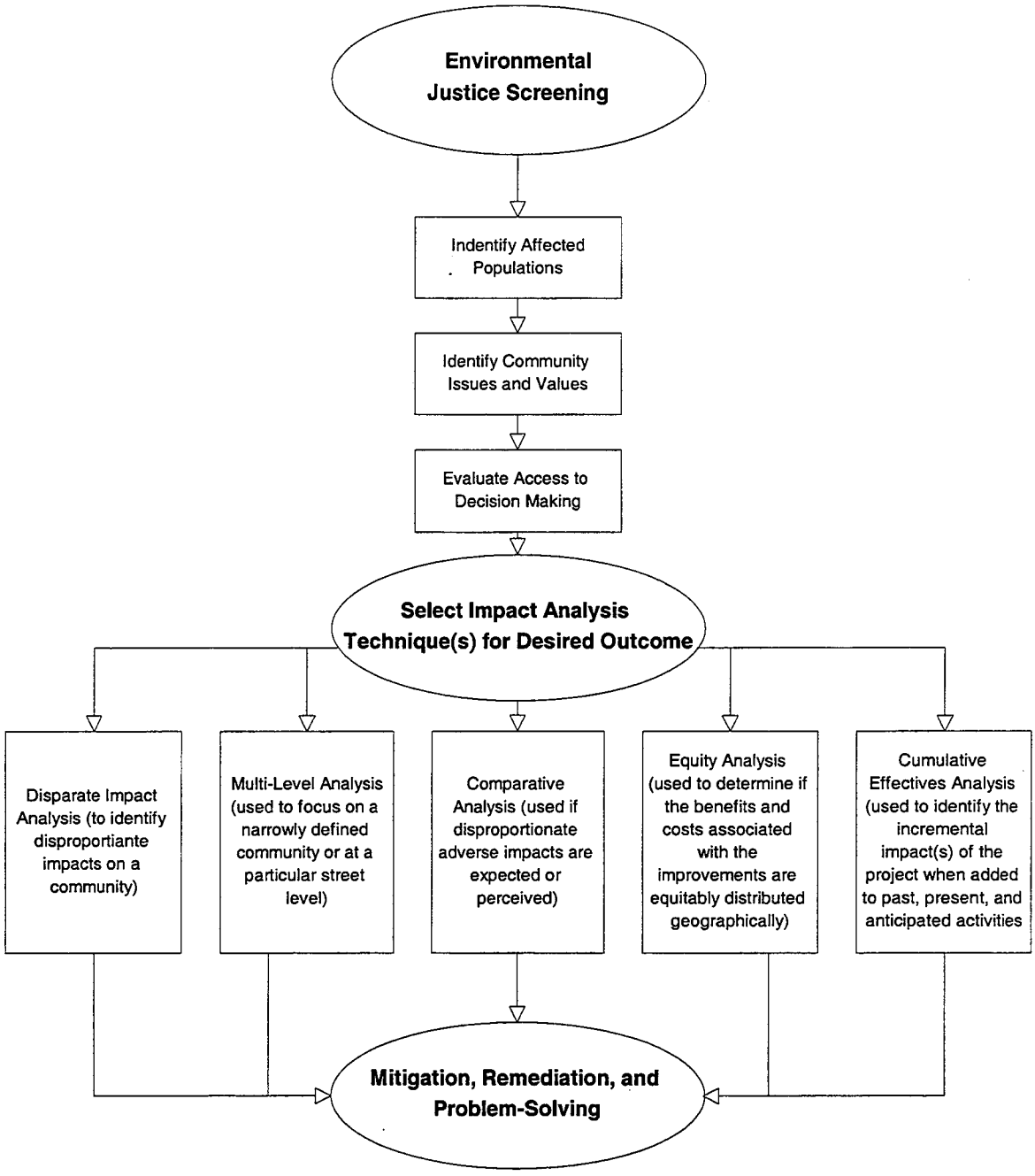
The following steps provide a framework for conducting an environmental justice screening analysis. In essence, the analyst will be answering five key questions:

- Who? Who is the potentially impacted community? Does it include minority and/or low-income populations?
- Where? Where are the study area or project boundaries? Where is the impacted community located?
- What? What type of transportation action is being proposed (i.e., project, program, or activity)?
- How? How might the lives and livelihoods of members of the community be impacted by the proposed action? Is there evidence of cumulative impacts?
- When? When will impacts occur?

Identify Affected Populations

Determine the existence of a minority or low-income group. This analysis should occur as soon as the proposed project is well understood, project specifications are provided, and geographic boundaries are identified. Characterize the populations affected by the proposed transportation project in terms of racial and ethnic composition and in terms of relative income distribution. A number of resources are available to assist in identifying and locating minority or low-income groups.

Figure 3
Environmental Equity Evaluation Techniques



Metropolitan Planning Organizations (MPOs) have detailed information on the local socio-economic characteristics of communities within the metropolitan area, as well as land use and zoning patterns, associated regulations, and area planning history. Local government planning and social service agencies also have or have access to socio-economic data, existing and proposed land use and development patterns, taxing district information, state and local social and economic stimulus programs, and business and marketing information. The U.S. Bureau of the Census is also a source of data, providing socio-economic characteristics at the census tract or block group level. However, an analyst should use caution when using census data due to the limited level of aggregation used in the reporting and the inconsistent nature of the reporting by some minority and low-income populations.

Minority and low-income populations can be identified through field observations or data from non-traditional sources, such as local governmental organizations who may be able to provide the location and characteristics of the subject populations and sub-groups within these populations. Surveys can also be used to determine the race/ethnicity, number of persons, and income level of residents near a transportation project. Boundaries of communities or neighborhoods can often be delineated by physical barriers (i.e., highways, waterways, open spaces, etc.), by activity centers, sharply different average home values, and/or selected demographic characteristics (ethnic groups). Again, local planning agencies can help define these spatial boundaries.

Identify Community Issues and Values

An environmental justice evaluation should reflect the values of the community. Community goals, priorities, and values can be identified through public participation forums, published materials, and public hearing transcripts. Partnering with local "grass roots" organizations should begin early in the project development process and continue throughout the life of the project. It may be useful to contact such groups through social welfare organizations, local service centers, and religious institutions. As with any group, minority or low-income groups are comprised of individuals with different concerns, goals, perceptions or needs. These may include:

- access to new local jobs;
- access to existing jobs in suburban locations;
- access to educational facilities;
- access to social services;
- community cohesion;
- public safety and crime;
- housing quality and stock;
- protecting or providing for at-risk sub-groups such as the elderly or very young;

- access to recreational opportunities; and
- access to natural, environmental, or recreational experiences.

The pubic participation process also provides the transportation professional with an understanding of the significance of any potential adverse impacts on the community, possible violation of Civil Rights laws and any displacement impacts, and will help in identifying any cumulative effects. An expert panel can also be useful in this regard.

Wilmington Bypass

The proposed Wilmington Bypass is planned to loop around the City of Wilmington, North Carolina and connect two corridors near this city. To identify the collective values and concerns of the residents in the vicinity of this project, two citizen's workshops were convened. During theses meetings, members of the public in the vicinity of the project were divided into smaller groups, where they developed lists of their concerns. These concerns were reviewed by the project team to determine the central issues that should be evaluated within the framework of environmental justice.

Several analytical tools are currently available to assist analysts and decision-makers in identifying potential civil rights concerns and others are currently being developed. The application of any tool is dependent upon the type of study, the particular attributes of the study area, and the data available to undertake the study. This section provides an overview of some of the available tools and types of analysis that may be useful for identifying and assessing environmental justice concerns.

SELECTING THE ANALYSIS TOOLS

The following section identifies the various tools and approaches that can be used to analyze the impacts of a transit project on an adjacent community. Depending on the size of the project, the potential for impacts, and public perception, among others, an analysts may choose a number of these tools. Through a thorough examination of the project, an analyst can determine what impacts may occur and how severe those impacts may be or may prompt a review of the project for disproportionate impacts.

COMPARATIVE ANALYSIS

The concern that a proposed transportation project will have a disproportionate adverse impact on minority and/or low-income populations can be tested using a Comparative Analysis.[21] This technique asks: Will more of the project's burdens or negative impacts be on low-income and/or minority communities? This analysis follows three steps: 1) calculate the percentage of the low-income and/or minority population in the area(s) affected by the transportation project; 2) do the same for the areas that will not be impacted by the transportation project; and 3) compare the results.

Census tracts are the most commonly used unit of analysis because data are readily available from the Census Bureau. Additionally, if demographic and socio-economic data can be applied, zip codes and traffic analysis zones (TAZs) serve as valid units of analysis.

However, there are problems associated with this approach. No distinction is drawn between areas having only one transportation project and areas that have multiple projects. Another problem is that the project or projects may be so close to the edge of the area that the neighboring area is affected as much, if not more, than the host area. And perhaps the most important issue is that areas such as census tracts, while convenient to use, are statistical or administrative constructs that do not generally represent either an affected neighborhood or the range of the impact associated with a transportation project.

EVALUATE ACCESS TO DECISION MAKING

Evaluate the level of representation of low income and minority groups in transportation decision-making. What effort is being made by the transportation agency to obtain input from low-income and minority communities affected by transportation projects? How and what information is being provided to residents that are being affected by the transportation project? How and when is this information being communicated to the affected population? If no effort is made to involve affected low-income and minority populations, then the potential for the community's perception of discriminatory conduct is high. For this reason, access to decision-making for these affected populations is one of the most critical steps in avoiding potential disproportionate adverse impacts on the communities they represent.

[21] Theodore s. Glickman, "Evaluating Environmental Equity in Allegheny County," *Resources for the Future,* Washington, D.C., 1996.

MULTI-LEVEL ANALYSIS

A multi-level analysis can be used to focus the impact assessment on a particular community or at the individual street level within the study area.[22] Multi-level analysis is useful for directing impact assessment and mitigation to the most vulnerable and affected portions of the population. The analysis is conducted as follows:

Level 1: At Level 1, an impact (s) is selected and assessed in terms of its effect on the study area. For example, changes in traffic, measured in vehicle miles traveled (VMT); displacement, measured in housing stock and value and available relocation site; and affect on employment, measured using employment multipliers. To compare the effects of the impact on a selected population, a separate assessment should be completed for minority and low-income populations, and the relative effect upon each population as compared to the proportion of the population that each group comprises. For example, if a traffic increase will affect 75 percent of the study area, what share of the minority population will it impact? This part of the Level 1 assessment will be similar to completing a Comparative Analysis. A unit of measurement (i.e., census tract, zip codes, etc.) should be determined for this assessment.

Level 2: If the analysis in Level 1 indicates a potential disproportionate impact on a minority or low income population, the assessment should focus on identifying where that impact will occur. If census tracts are used as a unit of measurement, the analyst should determine where a minority or low-income population is located and where most of the impact is on a minority or low-income population. For example, if traffic is the impact being measured, the analyst should use VMT data or traffic modeling to show where the impact would occur in relation to a minority or low-income community.

Level 3: At this level of analysis, the focus is sharpened. Particular and greater attention will need to be paid to the locational characteristics of minority and low-income groups on a more detailed level. This may include the need to identify sub-groups and their particular transportation requirements within these larger disadvantaged populations. Recall that such sub-groups could include the elderly, single-parent families, community and environmental conservation advocates, children, unemployed persons, non-English speakers, and the physically impaired. For example, are minority or low-income residents in public-housing projects affected more than residents in apartments in the same census tract? Will the transportation project increase access to new jobs for some members of the community while limiting access to social services for another group of

[22] Environmental Justice: Methodologies Used to Assess Disproportionate Impacts. William J. Novak and Robin E. Joseph, De Leuw, Gather & Co., Washington, D.C., 1996.

residents? This enables the analyst to determine the context and severity of the impact for particular subgroups.

Level 4: At this fourth level of analysis, potential impacts are identified and addressed, and any appropriate mitigation measures are identified. The analyst should investigate alternatives that will avoid inequitable racial impacts. Title VI and the Environmental Justice Executive Order require planners to adopt available, feasible, less discriminatory alternative measures that will mitigate the adverse effects of a transportation project. Therefore, where measures are available to reduce or avoid disproportionate adverse impacts on a minority or low income community, the transportation agency is obliged to incorporate such measures into the project plan.

The following example from Washington, D.C. provides a description of the multi-level analysis process used for the Barney Circle Freeway project.

Multi-Level Analysis for Barney Circle Freeway

The Barney Circle Freeway project consisted of the construction of a four-lane freeway connection between the existing Anacostia and Eisenhower (I-295) Freeways via a new bridge spanning the Anacostia River in Southeast Washington, D.C. The primary goals of the project were to complete a vital freeway link in the District that would serve as a major commuter route to the central employment area from the northeast and east, and to divert through-traffic from residential streets to higher capacity roadways. The project study area encompassed, in part or in whole, 25 census tracts with a total population of 60,000 persons. Census data showed that in 1990, whites comprised 22.5 percent of the total population in the study area census tracts and minorities comprised 77.5 percent. Many of these census tracts also had 15 percent or more of the households below the poverty level.

Level 1: An indicator to reflect the changes in traffic and the effects of such change on the population was calculated by multiplying the change in vehicle miles traveled (VMT) on each residential street link by the population that is affected by the change, expressed as VMT per person. The higher the population of a census tract and the greater the change in the volumes of VMT, the greater the effect, either beneficial for a VMT reduction or negative for a VMT increase.

Level 2: A more detailed analysis determined that increased freeway traffic would affect the population in eight census tracts, with most of the effect upon low-income populations in two census tracts.

Level 3: At this level of analysis, the focus was sharpened to identify specific low-income communities within the two affected census tracts that would potentially be adversely impacted. In one census tract, 35.6 percent of the population was below the poverty level and were concentrated in several public-housing units. In the other tract, 53.6 percent of the population was below the poverty level. The predominant land use for the tract was either transportation or industrial/commercial.

Level 4: This level of the analysis revealed that increased traffic would have the potential to affect low-income populations adjacent to the Barney Circle project in two ways: (1) increased traffic-generated noise and (2) reduced air quality. A more detailed analysis of these two effects was conducted and abatement measures were also examined. The results of the noise analysis indicated that the Barney Circle project would result in slight noise increases within the two affected census tracts. Construction of noise barriers were identified to mitigate the impact of traffic generated noise. The results of the pollutant emission analysis revealed that elevated emissions were not anticipated to exceed the 1-hour or 8-hour National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO), the major air pollutant of concern, due to the layout, elevation, and vehicle operating modes of the freeway.

DISPARATE IMPACT ANALYSIS

Disparate impacts exist if the project unintentionally but disproportionately affects people of a particular race, color, religion, sex or national origin, establishing the grounds for a potential Civil Rights complaint. If it is anticipated that a project has the potential of creating disproportionate negative impacts on people of a particular race, color, religion, sex or national origin or if it is perceived by the public that this situation exists, a disparate impact analysis should be conducted. The responsible agency must be able to demonstrate that the decision(s) made during the planning process was consistent with or met a legitimate justification, served a broader governmental interest, or that an alternative to satisfy the stated interest was unavailable.

Disparate impact is typically used to challenge employment practices that affect minority groups. There are some examples of using this method to assess disproportionate impacts on minority populations in environmental permitting. As reflected in this section, disparate impact analysis could be used to examine potential violations of the civil rights of minority and low-income groups from a transportation project or decision.

An analysis of potential adverse impacts on minority or low-income populations under Civil Rights law should be based upon the facts and totality of the circumstances. The general framework for determining whether a disparate impact exists has five basic steps.[23]

Step 1. Identifying the Affected Population

The first step is to identify the potential population that might be affected by the transportation project. The population is that which suffers the adverse impacts of the transportation project. The adverse impacts from the transportation project may not be distributed in a predictable and uniform manner. However, proximity to a transportation project will often be a reasonable indicator of where affects are concentrated.

The analyst may use GIS to identify affected populations near a transportation project. Estimates on race and ethnicity and density of populations within certain proximity from the project can also be completed using Traffic Analysis Zones (TAZ), census, zip codes, or surveys of the affected population.

Step 2. Determining the Universe (s) of Facilities and Total Affected Populations

The second step is to identify other transportation projects that have disparate impacts on minority or low-income populations under the jurisdiction of the agency responsible for the transportation project. When added, these transportation projects may present some cumulative burdens that reflect a pattern of disparate impact on the affected population.

Step 3. Conducting a Disparate Impact Analysis

The third step is to conduct a disparate impact analysis that, at a minimum, includes comparing the racial or ethnic characteristics within the affected population. It will also likely include comparing the racial characteristics of the affected population to the non-affected population. This approach can show whether persons protected under Civil Rights law are being impacted at a disparate rate. Generally it is expected that the rates of impact for the affected population and comparison populations to be comparable under a properly implemented transportation project or program. Since there is no one formula or analysis to be applied the analyst may identify, on a case-by-case basis other comparisons to determine disparate impact.

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[23] Environmental Protection Agency (EPA). Interim Guidance for Investigating Title VI Administrative Complaints Challenging Permits.

Step 4: Determining the Significance of the Disparity

The final phase of the analysis is to use statistical analysis to determine whether the disparity is significant under a civil rights law. The analyst should use trained statisticians to evaluate disparity calculations, and confirm disparate impact findings.

EQUITY ANALYSIS

Equity analysis considers the equity of transportation investment and improvement decisions. For a general look at equity issues, evaluate the ratio of transit and road system expenditures by geographic subarea. Determine what percentage of road or transit funding is going to areas with high proportions of minority residents, and how this investment pattern compares to that for the population at large. Consider the transportation system use by the different population groups, compared with the geographic distribution of the benefits of federal transportation investment. To evaluate this factor, review the use of the transportation system by different population groups. Do all members of the population enjoy the benefits (and costs) of the transportation system equally? The 1990 Census contains data on this matter in the Urban Transportation Planning Package. Evaluate the accessibility of the transportation system to different population and ethnic groups in the area. Do transportation improvements help to link housing with services and employment sites? Consider whether the roadway alignment was intentionally planned to follow the path of the lowest property values, thereby disproportionately affecting low-income neighborhoods without adequate study and justification.

CUMULATIVE EFFECTS ANALYSIS

Cumulative impacts are defined as "the incremental impact(s) of the action when added to other past, present, and reasonably foreseeable future actions..." A set of primary methods are available to the analyst to describe the cumulative effects of a transportation project in terms of multiple causation, interactive processes, and temporal and spatial variable effects. The primary methods for developing the conceptual causal model for a cumulative effect analysis are:

Questionnaires, interviews, and panels are important information gathering techniques for analyzing cumulative effects. Such techniques are especially valuable to the analyst, because they collect information on the wide range of actions and effects needed to address cumulative problems. The analyst will often use brainstorming sessions, interviews with knowledgeable individuals, and group consensus building activities to identify the important cumulative effects.

Checklists can help the analyst by providing a list of common or likely effects. Checklists are especially valuable for analyzing cumulative effects because they provide a format for juxtaposing multiple transportation projects and programs in a way that highlights potential cumulative effects.

Matrices are two-dimensional checklists that attempt to quantify the interactions between transportation projects and impacted communities. They are designed to assess the magnitude and importance of individual projects, but have been extended to consider the cumulative effects of multiple projects.

Trend Analysis assesses the status of resources (i.e., community cohesion, services, quality of life, etc.) over time and usually results in the graphical projection of past or future conditions. Changes in the occurrence or intensity of impacts over time can also be determined. Trend analysis provides the historical context that is critical to assessing the cumulative effects of proposed actions.

THE USE OF GIS IN THE EVALUATION PROCESS

In the processes described above, the use of geographic information systems (GIS) has become a valuable tool to assist in evaluating the impacts of transportation systems and projects. A GIS is a computer information system that stores, manages, analyzes, and displays geographic, demographic and other data. A GIS is capable of managing large volumes of both related and unrelated data while providing interactive tools for visualizing and analyzing spatial relationships within these data. A visually distinctive feature of GIS software is that is allows thematic mapping and geographic output data to be overlaid on a map image.[24] Additionally, GIS data systems address spatial patterns and proximity of effects and provide an effective visual presentation.

Geographic Information Systems (GIS) can be used to locate geographical areas where potential environmental justice issues may exist. GIS technologies are useful for comparing spatial data on minority and low-income populations. Such comparisons enable the analyst to determine whether the impacts fall disproportionately on minority and low-income populations. Another advantage to using GIS is its ability to convert geographic data that are not directly compatible with other software but are amenable for analysis. TransCAD, Maptitude, and MapInfo are some GIS software packages with this capability.

A general procedure for using GIS for analyzing environmental justice impacts of a transportation project is provided in *Environmental Justice & Transportation Investment Policy*. The key data

[24] Gary S. Spring and Joseph Hummer, Identification of Hazardous Highway Locations Using Knowledge-Based GIS: A Case Study, Transportation Research Record 1497 (1995), 84.

requirements of a GIS database for mapping potential impacts of a transportation project are summarized in Table 2.

Table 2
Components of the GIS Database

Information Required	Data Source
Street network geometry and address range information	Census TIGER/Line Files
Census tracts	Census TIGER/Line Files
Socio-demographic data at the census tract level	Census of Population and Housing Files

Source: *Environmental Justice & Transportation Investment Policy*, Forkenbrock and Schweitzer, 1997.

Census TIGER/Line files contain digital data that describe the street network for the entire U.S. and define census tracts and tract boundaries.[25] TIGER files can be translated and imported as geographic files. Demographic and socioeconomic characteristics from the Census of Population and Housing at the tract level can be linked to corresponding census boundaries from the TIGER files to build a GIS database. All of the necessary data are available for locations throughout the U.S. in CD-ROM format from the Bureau of the Census.

In addition to Census data, a statistical description of the study area can also be developed from survey data. A survey of residents in the study area can be used to determine the race, number of persons, and income level of residential dwellings.

To assess the potential for environmental justice impacts using GIS and census information, the following general steps can be followed:

1. Establish a reference population for comparison. This reference population must correspond to a physical study area for the project (e.g., country, state, county, or smaller subdivision).
2. Identify location of transportation facility or alignment of a proposed transportation project within the study area.
3. Using census data, identify the number of census tracts within the study area - reference population.

[25] TIGER is an acronym for topographically integrated geographic encoding and referencing.

4. Use census or survey data to develop a demographic profile of each census tract. This step will assist the analyst to determine census tracts with the highest concentration of minority and low-income groups.

After these census data are collected and compiled into a database for the study area, geographic data can be added and compiled into a database for analysis using GIS.

Examples of Remedial Practices Using GIS

As part of this study, a literature search on remedial practices using GIS in other fields such as hazardous and solid waste management was conducted. This included an information search of the Environmental Protection Agency's Website and National GIS Program, Transportation Resource Information System (TRIS), the Center for Urban Transportation Research - Resource Information Center (CRIC), and the Clark Atlanta, Environmental Justice Resource Center. The search revealed several studies on GIS applications in public transportation and solid and hazardous waste management.

The following section discusses a number of environmental justice studies conducted by the Environmental Protection Agency (EPA). While the literature search revealed some examples of where GIS has been used for assessing environmental equity issues, it lacked clear examples of this practice in assessing the impacts of transit facilities on local communities. Thus, this section is supplemented by a few studies of environmental equity and low-income and minority communities.

Existing EPA Projects

In July 1992, the EPA published a report entitled "Reducing Risk for All Communities," which noted that minorities and low-income populations experience higher than average exposures to selected air pollutants, hazardous waste facilities, and other forms of environmental pollution.[26] Because of its broad contact with affected communities, EPA's programs and regional offices have attempted to address equity concerns. The following EPA regional offices have initiated projects, using GIS, to address high risk factors in minority and low-income communities.

EPA Region II is using 1990 Census information and GIS to factor concerns about environmental justice into decision-making. The Region II Environmental Working Group has modeled census demographic data on minority composition, population density, and income to identify areas of potential environmental justice concerns in the region. Potential environmental justice concerns are

[26] EPA Region IX Website: Http://www.epa.gov/region09/cross_pr/ej/assess.html.

identified using the Human Health Risk Index (HRI) and GIS. This system was designed to compare potential exposures and toxicity from pollution sources. Besides the census data, pollution source and ambient concentration exposure data are used in the evaluation. The GIS component mathematically ranks the Census Block Groups as to their potential for environmental justice concerns based on the HRI evaluation. When areas of high potential environmental justice concern are identified, the mapped indexes can be combined and displayed with other information (e.g., risk data or facility location information) to define high priority communities. This information can then be used to target and rank compliance, enforcement, pollution prevention, education, and outreach activities. In addition, Region II is conducting a study that will document if there is more Superfund/Comprehensive Environmental Response, Compensation, and Liability Act Sites (CERCLIS) in minority/poor communities in New York and New Jersey. This study will use census data and GIS to map the location of Superfund and CERCLIS and demographic information. The research will also identify the key factors in determining the remediation at Superfund sites.

Region III's Environmental Risk Initiative will develop environmental risk profiles for socioeconomic subgroups in the Baltimore and Washington, D.C. area using GIS maps. The GIS will serve in the analytical work and be used in presentations to the public. The risk profiles will be used to decide whether environmental impacts within the study area disproportionately fall upon a specific socioeconomic class.

Region VI has developed GIS and Comparative Risk capabilities to evaluate environmental equity concerns in that region. A methodology has been developed that identifies susceptibility factors as part of risk evaluations for human health. These factors include age, pregnancy, genetics (race), personal income, pre-existing diseases, and lifestyle.

EPA Region IX has begun to identify and address environmental justice (EJ) issues through an EJ Assessment Project. The Agency will use GIS to target low-income and minority communities that are near several potential pollution sources. Because of their spatial relation to pollution sources, these "EJ communities" have a greater likelihood of exposure, and a potential for higher risks. The Agency expects to use the results to support the following activities: allocating special grants and focusing staff attention on communities with environmental justice issues; identifying communities where the Region needs to increase public involvement in addressing environmental problems; revising the Operating and Strategic Plans for Region IV; identifying state programs that require special environmental justice emphasis; and developing a system/criteria for identifying environment justice issues and priorities.

Besides initiatives and programs by the EPA's regional offices, the agency has developed the Brownfields Economic Redevelopment Initiative to empower states and local stakeholders in economic redevelopment to work together to prevent, assess, clean up, and reuse sustainable

brownfields. (A brownfield is an abandoned, idled, or underused industrial or commercial facility where expansion or redevelopment is complicated by real or perceived environmental contamination.) Many brownfield initiatives will create or maintain a GIS database that will contain information on environmental conditions of brownfields; will list potential brownfields redevelopment opportunities; and will integrate site-specific data into existing GIS.

GIS APPLICATION IN WATERLOO, IOWA

GIS is used in a trial application to assess disproportionate impacts from a highway on minority and low-income populations in Waterloo, Iowa. Census data at the block group level are used in this example.

Waterloo is a city in northeastern Iowa that had a population in 1990 of 66,467. Black Hawk County (the Waterloo Metropolitan Statistical Area or MSA) had a population of 123,798. Table 3 provides a comparison of the population of the City of Waterloo and the MSA.

Table 3
Population Comparisons – City of Waterloo and MSA

	Percent of Population	
	Minority (1990)	In Poverty (1989)
City of Waterloo	13.2	16.7
Waterloo MSA	7.0	13.6

Source: *Environmental Justice & Transportation Investment Policy,* Forkenbrock and Schweitzer, 1997.

Running north and south through the center of Waterloo is U.S. Highway 63C the corridor used in this analysis. U.S. Highway 63 connects with Rochester, Minnesota, to the north, and ties into U.S. Highway 218, which leads to Interstate 380 on the southern edge of the city. North of the city center this route runs through minority and low-income neighborhoods. GIS was used to examine the relative accessibility of these populations to various trip destinations with and without an improvement to the highway.

For this analysis, minority and low-income households were geocoded within census blocks. For analysis related to environmental justice, schools and major employment centers that are likely to be among the most commonly examined destinations, were also geocoded. With this information GIS software and TIGER files were used to compute the shortest paths between origins (geocoded households) and destinations (geocoded destinations). (This analysis can be completed using the

transportation system, both before and after proposed improvements, to show potential impacts on accessibility for minority and low-income populations. The results can be expressed in terms of units of distance, time en route, or number of people crossing a particular street or corridor.) This analysis showed that improvements to U.S. Highway 63 would have a disproportionate impact on minority children who would cross an upgraded urban roadway en route to or from school. Approximately 69 percent of schoolchildren crossing this highway are members of the minority population. A lesser impact would be on low-income schoolchildren. Twenty-six percent of the schoolchildren are from low-income households.

MITIGATION AND PROBLEM SOLVING

The DOT Order states that DOT operations will be administered so as to identify and avoid discrimination and avoid disproportionately high and adverse effects on minority populations and low-income populations by:

1. **Identifying and evaluating** environmental, public health, and interrelated social and economic effects of DOT programs, policies, and activities;

2. **Proposing measures to avoid, minimize and/or mitigate** disproportionately high and adverse environmental and public health effects and interrelated social and economic effects;

3. **Providing offsetting benefits and opportunities** to enhance communities, neighborhoods, and individuals affected by DOT programs, policies and activities, where permitted by law and consistent with the Executive Order;

4. **Considering alternatives** to proposed programs, policies, and activities, where such alternatives would result in avoiding and/or minimizing disproportionately high and adverse human health or environmental impacts, consistent with the Executive Order; and

5. **Eliciting public involvement opportunities** and considering the results thereof, including soliciting input from affected minority and low-income populations in considering alternatives.

Ironically, mitigation measures for transportation projects can sometimes incur disproportionate impacts on minority populations in a study area. For example, the decision as to whether or not to provide noise walls is in part a function of the economics of the surrounding area. Federal requirements call for a cost/benefit analysis to determine whether the added cost of a wall is warranted. Using this method, neighborhoods with higher property values will warrant a noise wall

and be offered the option, whereas low-income neighborhoods will receive little or no noise mitigation. This raises the clear potential for disproportionate adverse impacts of transportation projects on low income and minority neighborhoods.

Using avoidance to address disproportionate impacts on low-income and minority communities from a transportation project may not be the appropriate mitigation strategy either. For some projects, residents want the project to go through their community as part of a community revitalization and economic development initiative. For example, U.S. Highway 70 runs north-south through Forrest City, Arkansas, and links to other highways and state roads in northeast Arkansas. In September 1996 a proposed plan for an interchange in the Forrest City was cited as having potential environmental justice concerns. The project would have impacted the central area of Forrest City, which is predominately a minority community. The project would have required the relocation of 29 minorities households. The Arkansas Department of Transportation used the avoidance strategy to mitigate the impact of the project on this minority community. As a result, in November 1997 the Department selected a site on the fringes of the Forrest City to construct the interchange. However, members of the minority community were opposed to the new site, stating that an interchange would help spur economic development outside Forrest City, resulting in an environmental injustice for the residents of the community. A public hearing on this project concluded that the claim of an environmental injustice was without substantial evidence, and approved the alternative location for the interchange.

The adverse impacts of a transportation project can be mitigated as part of a revitalization plan. Interstate 165 in Prichard, Alabama links I-65, which runs north of Prichard with I-10 in Mobile. Prichard is one of the poorest communities in the nation. When originally planned, Mobile was opposed to the project, while Prichard strongly supported it. Key officials in Prichard supported the project because they believed it would bring needed economic development and revitalization to the community. A partnership was formed between the City of Prichard, Alabama Department of Transportation and the Federal Highway Administration to propose the alignment and design of the project. The community of Prichard opposed the original plan that included a bypass around the City asserting the benefits of going through the community. For this project, the bypass alternative, which could have served as an avoidance strategy, was viewed as having a negative impact on a low-income community. While avoidance can sometimes mitigate environmental justice issues, some low-income and minority communities may actively lobby for the project, and not view the project as having a negative impact but rather providing a benefit to the community.

Providing enhancements to a community that is directly impacted by a project can reduce adverse impacts and preserve the community culture. This can be achieved by adding public artwork or a façade to a transportation facility to match the aesthetic design goals of a community. For example, Vine Street in Philadelphia links the Benjamin Franklin Bridge, on the eastern edge of the city with the Schuylkill Expressway to the west. Vine Street also passes through the Chinatown community of

Philadelphia. An expansion of Vine Street to an expressway was proposed, which would have had a direct impact on Chinatown. To reduce the adverse impacts of this project, several enhancements to the community were included in the project to preserve the community culture. Some enhancement features included an extra-wide vehicle/pedestrian bridge added to maintain access to a local church and school; design features such as cultural icons and aesthetic fencing which reflected the community culture was completed; and retaining walls were angled inward to minimize traffic noise in the community.

Relocation of residents and businesses provides another strategy for mitigating adverse impacts of a transportation project. For example, the final segment of the East-West Expressway in Durham, North Carolina links I-85 and I-40 in central North Carolina. This last segment of the expressway traverses a small African-American neighborhood in Durham know as Crest Street. Part of the mitigation strategy to reduce impacts to the community involved a comprehensive restructuring of the entire neighborhood, including relocating residents to new housing units and rehabilitation of housing units in place. An objective of this mitigation strategy was to maintain community cohesion. This was achieved by finding suitable vacant land in the Crest Street community for the residents that were relocated to new housing. This mitigation strategy resulted in the construction of 178 housing units. Through relocation benefits and housing assistance 56 percent home ownership was achieved.

CONCLUSIONS

Over the past several years, we have learned a great deal more about the impacts of various transportation investments including the negative consequences that may be associated with exposure or proximity to public transit facilities. We have also gained a new concern for how equitably the impacts of our investment decisions are born by various population groups in our society. Greater knowledge and sensitivities are enabling us to be more proactive in assessing the potential impacts of transit investments in advance and explore ways to minimize or otherwise avoid these impacts falling disproportionately on any single segment of society.

In many cases, evolving technologies and requirements for environmental impact mitigation are enabling us to eliminate or lessen some of the negative impacts. Other impacts, particularly social or cultural ones, may not be minimized by technology and hence we need

To assist the transportation industry accomplish these ends, a number of methodologies have been and are being developed to identify situations where there may be a disproportionate impact and to help quantify that impact. This knowledge then can be used to ensure fully informed, fair decisions and to help in planning amelioration and mitigation activities.

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