Professional Traffic Operations Engineer Certification Program Refresher Course

Student Supplement

Module 6
Social, Environmental, and Institutional Issues

1627 Eye Street, NW, Suite 550 | Washington, DC 20006

Introduction to Refresher Course

This Refresher Course provides an overview of topics, key references and independent study materials by topic for practicing engineers who intend to take the PTOE certification examination. The suite of modules includes six (6) webinar recordings on traffic operations analysis, operational effects of geometric designs, traffic safety, traffic control devices, traffic engineering studies, and social, environmental, and institutional issues, each accompanied by a student supplement.

This 2022 version of the course and student supplement is an update and expansion to a July 2016 course managed by Robert K. Seyfried, P.E., PTOE. Contributors to that course were:

- Robert K. Seyfried, P.E., PTOE; President, R. K. Seyfried and Associates, Inc.; Evanston, IL
- Jerome Hall, Ph.D., P.E., Professor Emeritus, Civil Engineering, University of New Mexico, Albuquerque, NM
- Pat Noyes, Principal, Pat Noyes and Associates, Boulder, CO
- Eric T. Donnell, Ph.D., P.E., Assistant Professor, Department of Civil and Environmental Engineering, The Pennsylvania State University, State College, PA
- John M. Mason, Jr., Ph.D., P.E., Associate Dean of Graduate Studies, Research, and Outreach and Professor of Civil Engineering, The Pennsylvania State University, State College, PA
- Martin E. Lipinski, Ph.D., P.E., PTOE, Professor, Department of Civil Engineering, University of Memphis; Memphis, TN

This 2022 version was updated by:

- Peter J. Yauch, P.E., PTOE, RSP_{2i}, Vice President, Iteris, Inc., Tampa, FL

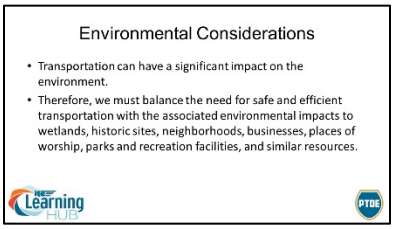
Much appreciation is given to Stephen J. Manhart, P.E., PTOE, PTP, RSP_1, Project Manager for Traffic Engineering, Michael Baker International, Minneapolis, MN, for his review of the student supplements on behalf of the Transportation Professional Certification Board.

Contents

Module 6 - Social, Environmental, And Institutional Issues

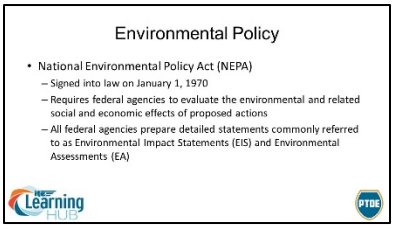
Environmental Considerations

So far in this refresher course, we've focused on providing safe and efficient transportation options. However, we must also recognize that transportation can have a significant impact on the environment. Therefore, in much of our activities, we must balance the need for safe and efficient transportation with the associated environmental impacts to wetlands, historic sites, neighborhoods, businesses, places of worship, parks and recreation facilities, and similar resources.



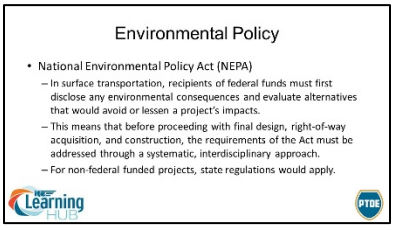
Environmental Policy

In the United States, Congress recognized this need and developed legislation that requires the federal government to use all practicable means to create and maintain conditions under which man and nature can exist in productive harmony. The National Environmental Policy Act (NEPA) was signed into law on January 1, 1970, requiring federal agencies to assess the environmental effects of their proposed actions prior to making decisions. The range of actions covered by NEPA is broad and includes:



- making decisions on permit applications,
- adopting federal land management actions, and
- constructing highways and other publicly owned facilities.

Using the NEPA process, agencies evaluate the environmental and related social and economic effects of their proposed actions. Agencies also provide opportunities for public review and comment on those evaluations.



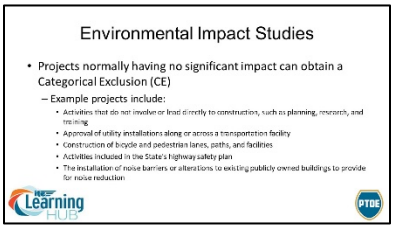
In surface transportation, recipients of federal funds must first disclose any environmental consequences and evaluate alternatives that would avoid or lessen a project's impacts. This means that before proceeding with final design, right-of-way acquisition, and construction, the requirements of the Act must be addressed through a systematic, interdisciplinary approach. All federal agencies are to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions significantly affecting the environment. These statements are commonly referred to as Environmental Impact Statements (EIS) and Environmental Assessments (EA).

NEPA defines the national standards for environmental protection, but because each state has its own set of natural and economic considerations, each state has passed its own laws regarding environmental

issues. As noted, NEMA requirements related to transportation projects occur when federal funding is included in the project; if a project is being implemented without federal funding, then state and local requirements must be considered. It is important to recognize and understand which regulations apply for a specific project.

Environmental Impact Studies

When following the NEPA process, one of the first steps is to determine the significance of the impact of the proposed project. The significance of its impact, not its size or cost, determines the class of action and its requirements for documentation and public involvement.



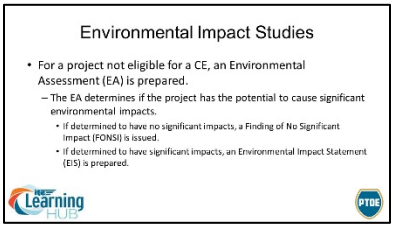
For a project that would normally have no significant impact, a detailed environmental assessment or environmental impact statement will not be required, through a determination known as a Categorical Exclusion (CE). These can include, but are not limited to the following, as excerpted from Title 23 Chapter I Subchapter H Part 771 of the Code of Federal Regulations:

- Activities that do not involve or lead directly to construction, such as planning, research, and training
- Approval of utility installations along or across a transportation facility
- Construction of bicycle and pedestrian lanes, paths, and facilities
- Activities included in the State's highway safety plan
- The installation of noise barriers or alterations to existing publicly owned buildings to provide for noise reduction
- Landscaping
- Installation of fencing, signs, pavement markings, small passenger shelters, traffic signals, and railroad warning devices where no substantial land acquisition or traffic disruption will occur
- Emergency repairs to a facility damaged by an incident or disaster acknowledged by the State's Governor or the President (for example, a hurricane or terrorist attack)
- Acquisition of scenic easements.
- Ridesharing activities.
- Alterations to facilities or vehicles in order to make them accessible for elderly and handicapped persons.

Projects that are normally processed as a CE but are determined to have unusual circumstances, as defined in the regulations, will require further review and in some cases, an environmental assessment or environmental impact statement may be required. Every project processed with a CE requires a statement of purpose and need along with documentation that the project meets the criteria of one of the typical CE classifications.

For a project not eligible for a CE, an Environmental Assessment (EA) is prepared. The EA determines whether or not a federal action has the potential to cause significant environmental effects. Each federal

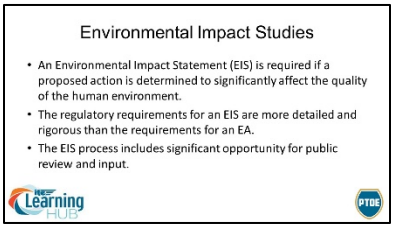
agency has adopted its own NEPA procedures for the preparation of EAs. See NEPA procedures adopted by each federal agency. Generally, the EA includes a brief discussion of:



- The purpose and need for the proposed action
- Alternatives
- The environmental impacts of the proposed action and alternatives
- A listing of agencies and persons consulted.

Based on the EA, the following actions can occur:

- If the agency determines that the action will not have significant environmental impacts, the agency will issue a Finding of No Significant Impact (FONSI). A FONSI is a document that presents the reasons why the agency has concluded that there are no significant environmental impacts projected to occur upon implementation of the action.
- If the EA determines that the environmental impacts of a proposed Federal action will be significant, an Environmental Impact Statement is prepared.



An Environmental Impact Statement (EIS) is required if a proposed action is determined to significantly affect the quality of the human environment. The regulatory requirements for an EIS are more detailed and rigorous than the requirements for an EA. The EIS process includes:

- Publishing a Notice of Intent in the Federal Register, to inform the public of the upcoming environmental analysis and describe how the public can become involved in the EIS preparation
- A draft EIS is published for public review and comment for a minimum of 45 days
- A final EIS is then published, which provides responses to substantive comments
- The EIS process ends with the issuance of the Record of Decision (ROD). The ROD:
    - explains the agency's decision,
    - describes the alternatives the agency considered, and
    - discusses the agency's plans for mitigation and monitoring, if necessary.

An EIS Includes:

- Cover sheet: Includes, among other things, the name of the lead agency and any cooperating agency, agency contact information, the title of the proposed action and its location, a paragraph abstract of the EIS, and the date when comments must be received.
- Summary: A summary of the EIS, including the major conclusions, area of disputed issues, and the issues to be resolved.
- Table of Contents: Assists the reader in navigating through the EIS.
- Purpose and need statement: Explains the reason the agency is proposing the action and what the agency expects to achieve.

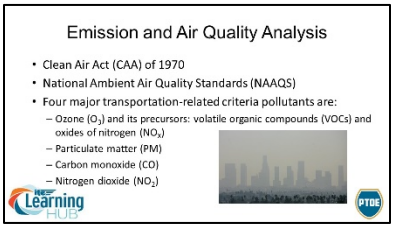
- Alternatives: Consideration of a reasonable range of alternatives that can accomplish the purpose and need of the proposed action.
- Affected environment: Describes the environment of the area to be affected by the alternatives under consideration.
- Environmental consequences: A discussion of the environmental effects and their significance.
- Submitted alternatives, information, and analyses: A summary that identifies all alternatives, information, and analyses submitted by state, tribal, and local governments and other public commenters for consideration during the scoping process or in developing the final EIS.
- List of preparers: A list of the names and qualifications of the persons who were primarily responsible for preparing the EIS.
- Appendices (if required): Appendices provide background materials prepared in connection with the EIS.

A supplement to a draft or final EIS is required when any of the following occurs:

- An agency makes substantial changes to the proposed actions that are relevant to its environmental concerns.
- There are significant new circumstances or information relevant to the environmental concerns that have bearing on the proposed action or its impacts.
- If an agency decides to supplement its EIS, it prepares, publishes, and files the supplemental EIS in the same fashion as a draft or final EIS.

Non-federal agencies may have a similar process for projects under their jurisdiction.

Emission And Air Quality Analysis



Congress established much of the basic structure of the Clean Air Act (CAA) in 1970 and made major revisions in 1977 and 1990. Dense, visible smog in many of the nation's cities and industrial centers helped to prompt passage of the 1970 legislation at the height of the national environmental movement. The subsequent revisions were designed to improve its effectiveness and to target newly recognized air pollution problems such as acid rain and damage to the stratospheric ozone layer.

In response to the CAA, the EPA established National Ambient Air Quality Standards (NAAQS) for various pollutants—known as criteria pollutants—that adversely affect human health and welfare. Four major transportation-related criteria pollutants are:

- Ozone (O_3) and its precursors: volatile organic compounds (VOCs) and oxides of nitrogen (NO_X)
- Particulate matter (PM)
- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)

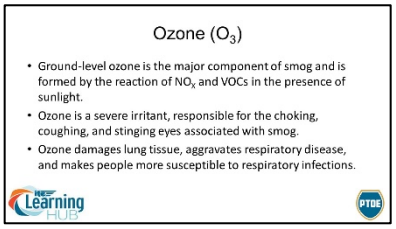
Other criteria pollutants include sulfur dioxide (SO_2) and lead. In the past, motor vehicles were a major source of lead emissions; however, these were virtually eliminated when leaded gasoline was phased out.

Fuel combustion by motor vehicles and other sources releases carbon dioxide (CO_2), which is a greenhouse gas that traps heat within the earth's atmosphere.

Significant progress has been made in reducing criteria pollutant emissions from motor vehicles and improving air quality since the 1970s, even as vehicle travel has increased. The air is noticeably cleaner than in 1970, and total criteria-pollutant emissions from motor vehicles are less than they were in 1970 despite a near tripling of vehicle miles of travel. With the reduction in criteria pollutants, many air toxics have also been reduced.

Ozone (O_3)

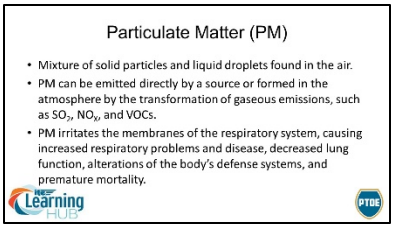
Ground-level ozone is the major component of smog. While ozone in the upper atmosphere (the ozone layer) occurs naturally and protects life on earth from harmful ultraviolet radiation, ozone at ground level is a noxious pollutant. Ground-level ozone is not directly emitted but is formed by the reaction of NO_X and VOCs in the presence of sunlight.



Ozone is a severe irritant, responsible for the choking, coughing, and stinging eyes associated with smog. Ozone damages lung tissue, aggravates respiratory disease, and makes people more susceptible to respiratory infections. Children are especially vulnerable to ozone's harmful effects, as are adults with existing disease. Even healthy individuals may experience impaired lung function from breathing ozone-polluted air. In addition to affecting human health, ozone harms vegetation, resulting in reduced agricultural and commercial forest yields, increased tree and plant susceptibility to disease and other environmental stresses, and potential long-term effects on forests and ecosystems. Peak concentrations typically occur in summer.

Particulate Matter (PM)

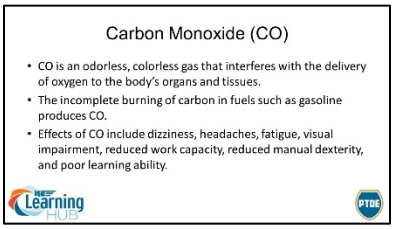
PM is the term used for a mixture of solid particles and liquid droplets found in the air. These particles come in a wide range of sizes and can remain suspended in the air for extended periods. PM can be emitted directly by a source or formed in the atmosphere by the transformation of gaseous emissions, such as SO_2, NO_X, and VOCs. Fine particles result from fuel combustion by motor vehicles and other sources, as well as transformation of gaseous emissions.



Particulate matter irritates the membranes of the respiratory system, causing increased respiratory problems and disease, decreased lung function, alterations of the body's defense systems, and premature mortality. Sensitive groups include the elderly, individuals with cardiopulmonary disease such as asthma, and children. In addition to health problems, airborne particles cause soiling and damage to materials and reduce visibility in many parts of the United States.

Carbon Monoxide (CO)

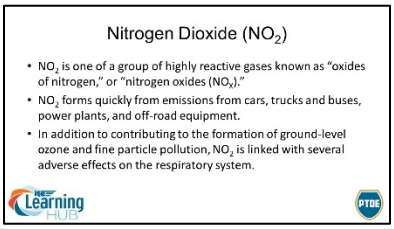
CO is an odorless, colorless gas that interferes with the delivery of oxygen to the body's organs and tissues. Effects of CO include dizziness, headaches, fatigue, visual impairment, reduced work capacity, reduced manual dexterity, and poor learning ability. The health effects of CO vary depending on the length and intensity of exposure and the health of the individual and are most serious for those who suffer from cardiovascular disease.



The incomplete burning of carbon in fuels such as gasoline produces CO. High concentrations of CO occur alongside roads with heavy traffic, particularly at major intersections, and in enclosed areas, such as garages and poorly ventilated tunnels. Peak concentrations typically occur during the colder months of the year when vehicular emissions of CO are greater and nighttime inversion conditions are more frequent.

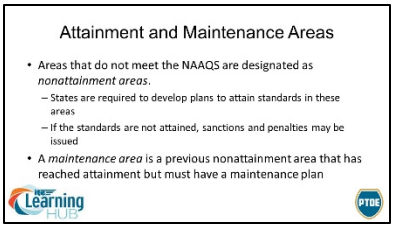
Nitrogen Dioxide (NO_2)

NO_2 is one of a group of highly reactive gases known as "oxides of nitrogen," or "nitrogen oxides (NO_X)." NO_2 forms quickly from emissions from cars, trucks and buses, power plants, and off-road equipment. In addition to contributing to the formation of ground-level ozone and fine particle pollution, NO_2 is linked with several adverse effects on the respiratory system.



Attainment and Maintenance Areas

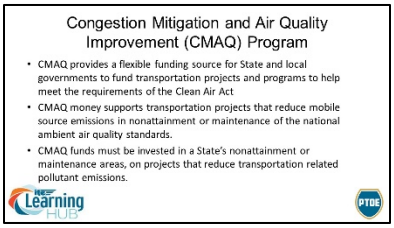
Areas that do not meet the NAAQS are designated as *nonattainment* areas. The CAA requires states to develop implementation plans to attain the standards for each nonattainment area. If the areas do not meet these and other requirements, they face CAA-required sanctions and other penalties, including loss of highway funds. Metropolitan planning organizations and the USDOT must ensure that transportation plans, programs, and projects conform to their implementation plans.



A *maintenance area* is any geographic region of the United States that EPA previously designated as a nonattainment area and subsequently redesignated as an attainment area subject to the requirement to develop a maintenance plan. The maintenance plan normally contains an emissions or modeling demonstration that shows how the area will stay in compliance through the 20-year maintenance period.

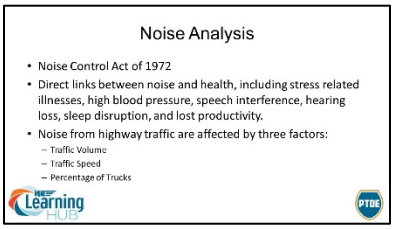
Congestion Mitigation and Air Quality Improvement (CMAQ) Program

The Congestion Mitigation and Air Quality Improvement (CMAQ) program provides a flexible funding source for State and local governments to fund transportation projects and programs to help meet the requirements of the Clean Air Act and its amendments. CMAQ money supports transportation projects that reduce mobile source emissions in areas designated by the U.S. Environmental Protection Agency (EPA) to be in nonattainment or maintenance of the national ambient air quality standards. CMAQ funds must be invested in a State's nonattainment or maintenance areas, on projects that reduce transportation related pollutant emissions.



Noise Analysis

Excessive noise presents a growing danger to the health and welfare of the Nation's population, particularly in urban areas. Congress passed the Noise Control Act of 1972 to establish a national policy to promote an environment for all Americans free from noise that jeopardizes their health and welfare.



The traditional definition of noise is "unwanted or disturbing sound". Sound becomes unwanted when it either interferes with normal activities such as sleeping, conversation,

or disrupts or diminishes one's quality of life. Noise pollution adversely affects the lives of millions of people. Studies have shown that there are direct links between noise and health, including stress related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity. Noise Induced Hearing Loss (NIHL) is the most common and often discussed health effect, but research has shown that exposure to constant or high levels of noise can cause countless adverse health effects.

Studies have shown that some of the most pervasive sources of noise in our environment are those associated with transportation. Residences and businesses often are faced with increased highway traffic noise, both from newly constructed highways and from highways that are already in place. A decibel (dB) is the unit used to indicate the intensity of a sound wave. Sound (noise) is often measured in decibels using an A–weighted scale (dBA) because this method approximates the way humans hear sound.

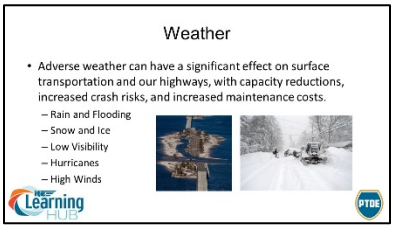
Noise levels from highway traffic are affected by three factors: (1) the volume of the traffic, (2) the speed of the traffic, and (3) the number of trucks in the flow of traffic. Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher vehicle speeds, and greater numbers of trucks. Vehicle noise is a combination of the noise produced by the engine, exhaust, and tires. Some key impacts of traffic characteristics include:

- Traffic at 65 miles per hour sounds twice as loud as traffic at 30 miles per hour.
- 2000 vehicles per hour sound twice as loud as 200 vehicles per hour.
- One truck at 55 miles per hour sounds as loud as 28 cars at 55 miles per hour.

Measures to reduce noise pollution include:

- Limiting noise emission levels on trucks
- Utilize land development planning to keep noise sensitive areas away from major highways
- Prohibiting certain types of vehicles (trucks) from sensitive streets and roadways
- Improving traffic flow through progressive signal timing
- Minimizing vertical alignment changes
- Plant noise absorbing vegetation
- Construct noise barriers

Weather



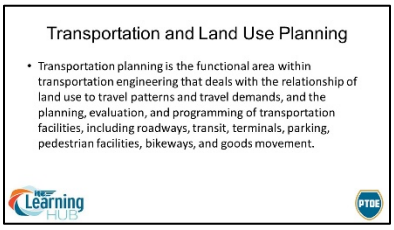
Adverse weather can have a significant effect on surface transportation and our highways, with capacity reductions, increased crash risks, and increased maintenance costs. Key weather issues include:

- Rain and Flooding - Rain causes wet pavement, which reduces vehicle traction and maneuverability. Heavy rain also reduces visibility distance. These impacts prompt drivers to travel at lower speeds causing reduced roadway capacity and increased delay. Rain and wet pavement increase crash risk as well. Flooding reduces roadway capacity by limiting or preventing access to submerged lanes. Inland flooding, usually following the evolution of a tropical storm or hurricane, has typically been the greatest source of fatalities, and caused the most damage to roadway infrastructure.

- Snow and Ice - Over 70 percent of the nation's roads are in snowy regions. Snow and ice reduce pavement friction and vehicle maneuverability, causing slower speeds, reduced roadway capacity, and increased crash risk. Heavy snow and sleet can also reduce visibility. Lanes and roads are obstructed by snow accumulation, which reduces capacity and increases travel time delay. Winter road maintenance accounts for roughly 20 percent of state DOT maintenance budgets, to provide for snow and ice control operations and to repair infrastructure damage caused by snow and ice.
- Low Visibility - Visibility distance is reduced by fog and heavy precipitation, as well as wind-blown snow, dust and smoke. Low visibility conditions cause increased speed variance, which increases crash risk.
- Hurricanes - Hurricanes and tropical storms bring heavy rain and high winds to coastal areas, and often cause inland flooding. Hurricane evacuation activities can have significant impacts on traffic.
- High Winds - High winds reduce roadway capacity by obstructing lanes or roads with drifting snow and wind-blown debris, such as tree limbs. Wind-blown snow, dust and smoke can impact mobility by reducing visibility distance. High winds can also impact the stability of vehicles, particularly high-profile vehicles.

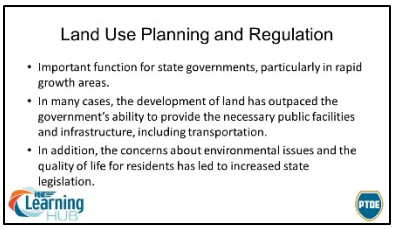
Recent trends in the weather indicate that climate change is having a significant impact, with more severe events occurring more frequently.

Transportation and Land Use Planning



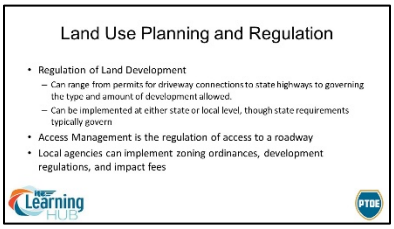
Transportation planning is the functional area within transportation engineering that deals with the relationship of land use to travel patterns and travel demands, and the planning, evaluation, and programming of transportation facilities, including roadways, transit, terminals, parking, pedestrian facilities, bikeways, and goods movement. ITE's Policies document (2020) defines transportation planning as "the application of principles and processes to inform decisions on meeting mobility needs through the provision of safe and reliable access to transportation infrastructure, modes, and services. It considers different disciplines and may be applied across geographic scales from local neighborhoods and corridors, to municipalities, regions, states and provinces, and nations. It may be applied at different time scales from short-term project plans to long-term vision plans. It involves the public, stakeholders, and agencies in the development and evaluation of alternative solutions for the transportation system."

Land Use Planning and Regulation



The regulation of land development is an important function for state governments, particularly in rapid growth areas. In many cases, the development of land has outpaced the government's ability to provide the necessary public facilities and infrastructure, including transportation. In addition, the concerns about environmental issues and the quality of life for residents has led to increased state legislation. The regulation of land development by a state may be as basic as providing permits for driveway access to the state highway system or may expand to governing the type and amount of development allowed. Land development requirements may be set by either

state or local governments, but generally the state requirements take precedence. In addition, agencies may also tax development as a means of helping to fund the added infrastructure.

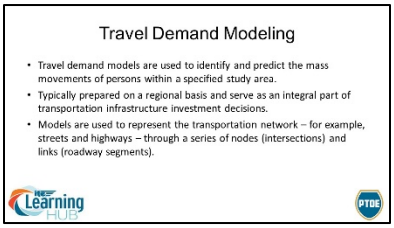


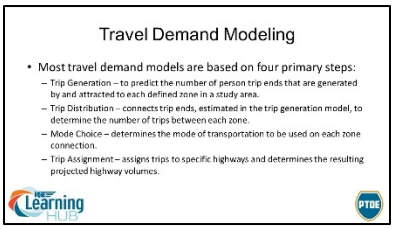
The regulation of access to a state or local roadway is called Access Management, and typically has the objectives of both safety and efficiency. Limiting the number of, or location of, driveway connections can have a significant impact on the capacity and safety of a roadway. Agencies must provide reasonable access, but not unregulated access, to their facilities.

Local agencies can regulate land uses through zoning ordinances, subdivision development regulations, and development impact fees. Zoning ordinances designate the overall type of land use allowed within a specific area. Subdivision regulations address the development of specific sites or areas and include required infrastructure and design standards. Zoning and land development restrictions can be used to manage growth by defining density and public facility requirements.

Travel Demand Modeling

Travel demand models are used to identify and predict the mass movements of persons within a specified study area. These are typically prepared on a regional basis and serve as an integral part of transportation infrastructure investment decisions. Models are used to represent the transportation network – for example, streets and highways – through a series of nodes (intersections) and links (roadway segments). Computerized systems, including Geographic Information Systems (GIS) are often used to provide a graphic representation of the models.





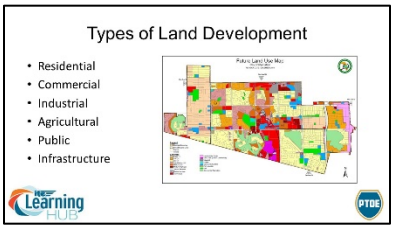
Most travel demand models are based on four primary steps:

- Trip Generation – to predict the number of person trip ends that are generated by and attracted to each defined zone in a study area.
- Trip Distribution – connects trip ends, estimated in the trip generation model, to determine the number of trips between each zone.
- Mode Choice – determines the mode of transportation to be used on each zone connection.
- Trip Assignment – assigns trips to specific highways and determines the resulting projected highway volumes.

You can then see that there is a relationship between land use and transportation. Some land uses generate more trip ends than others; for example, a multi-family condominium complex would normally generate more trip ends than a single-family development on the same parcel. A shopping mall would generate more trip ends than a residential development. These trip ends, and the assignment of trips along highways to connect these land uses, impacts the amount of traffic on our highways.

Development Characteristics

The most common types of land developments are residential, commercial, industrial, agricultural, public, and infrastructure. Residential developments are the most common type of land development and can be located in an urbanized area or a rural or suburban area. Residential developments can include individually owned residences or rental type facilities.



The next most common type of land development is for commercial use. These land parcels are essentially any development that has been set up for business purposes that do not have a significant environmental impact. Industrial developments are the opposite – commercial developments that are used for factories, refineries, warehousing, and other potentially environmentally concerning activities. The types of developments that an industry pursues will generally be dependent on the industry itself.

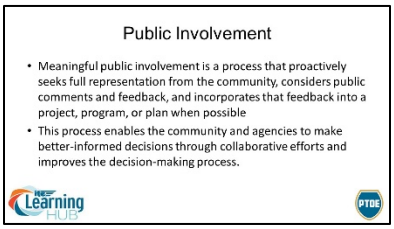
Land that has been classified and established as agricultural farmland is technically still a land development, as the property has been modified or altered in some way to accommodate farming.

Many developments are conducted by the government. The land developments created by the government are technically public property and have been paid for by taxpayers, but not all of these developments were created for public use and may merely be office buildings for various government organizations. These might include schools, parks, police stations and fire stations, hospitals, and other government facilities.

The final major type of land development is our nation's infrastructure, including roads, highways, and bridges that need to be developed for public access to be practical.

Public Involvement

The USDOT defines meaningful public involvement as a process that proactively seeks full representation from the community, considers public comments and feedback, and incorporates that feedback into a project, program, or plan when possible. The impact of community contributions encourages early and continuous public involvement and brings diverse viewpoints and values into the transportation decision-making process. This process enables the community and agencies to make better-informed decisions through collaborative efforts and improves the decision-making process.



Features of meaningful public involvement include:

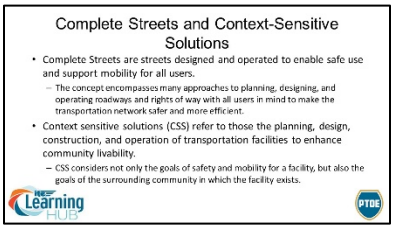
- Understanding the demographics of the affected community
- Building durable relationships with diverse community members outside of the project lifecycle to understand their transportation wants and needs
- Proactively involving a broad representation of the community in the planning and project lifecycle
- Using engagement techniques preferred by, and responsive to the needs of, these communities, including techniques that reach the historically underserved
- Documenting how community input impacted the final projects, programs, or plans, and communicating with the affected communities how their input was used

Meaningful public involvement is a process that lasts throughout the project lifecycle, not only during a single event or activity. It begins early in the planning process and includes full representation from all communities affected. Meaningful public involvement:

- Increases trust between the organization and the community
- Increases the likelihood that projects, programs, or plans will be accepted
- Creates more effective solutions
- Improves a community's knowledge of the project, program, or plan
- Empowers people from different backgrounds to become involved in transportation decision-making
- Delivers a better project, program, or service with diverse ideas that promote equity and inclusion
- Ensures against compliance concerns with authorities such as Title VI and NEPA that require public input and nondiscrimination

Outreach to the full spectrum of interested or affected participants at all levels of a community should result in representation from a cross-section of the communities that an organization serves and impacts. Implementing a thoughtful, respectful, and culturally competent project-specific public involvement plan or a community engagement plan early in transportation planning allows staff the time to identify community partners and advocates, and ways to involve the community more meaningfully. The result is transportation decisions informed by community input that maximize benefits and mitigate the risk of harm to communities.

Complete Streets and Context-Sensitive Solutions



Complete Streets are streets designed and operated to enable safe use and support mobility for all users. Those include people of all ages and abilities, regardless of whether they are travelling as drivers, pedestrians, bicyclists, or public transportation riders. The concept of Complete Streets encompasses many approaches to planning, designing, and operating roadways and rights of way with all users in mind to make the transportation network safer and more efficient. Complete Street policies are set at the state, regional, and local levels and are frequently supported by roadway design guidelines.

Complete Streets approaches vary based on community context. They may address a wide range of elements, such as sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. They can promote walking and bicycling by providing safer places to achieve physical activity through transportation.

Active transportation refers to modes of travel that do not involved motorized vehicles; the most prominent examples include biking and walking, although sometimes active transportation can be supplemented by motorized vehicles (e.g., walking to a transit stop, using manual pedal power on an electric-assisted bicycle). Active transportation is a key element to providing individuals with a choice of transportation options when moving from origin to destination, and is important to enhancing the safety, health, and overall livability of a community. A Complete Street is designed and operated to enable the safe use and support mobility for all users.

Context sensitive solutions (CSS) refer to those the planning, design, construction, and operation of transportation facilities to enhance community livability. CSS considers not only the goals of safety and mobility for a facility, but also the goals of the surrounding community in which the facility exists. This can include factors such as land use, aesthetics, historical considerations, and environmental quality.

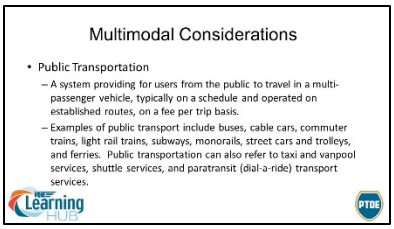
CSS emphasizes a holistic process to transportation development, beginning with a multi-stakeholder community input process, and continuing throughout the lifecycle of the transportation facility to accommodate and enhance the desires of the community. CSS is a necessary, but not sufficient, element of the larger Complete Streets movement; that is, while Complete Streets multimodal access and safety (of which CSS is a critical element), not all CSS requires accommodation of every mode of travel. It could be that in certain contexts, it makes sense to provide separate but parallel routes to different modes of travel, for example, depending on the operating characteristics of the transportation facility, the surrounding land use, and the broader community goals.

Multimodal Considerations

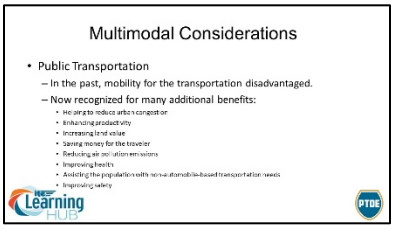
Over the past century, most of our transportation in the United States has been centered on the automobile; while we recognized walking, bicycling, and public transit as valid modes, they did not receive the attention or the investment of the motor vehicle. As a result, we generally have well established roadway networks with significantly lacking facilities for the other modes. In today's transportation environment, the focus needs to be on providing all practical modes of transportation.

Public Transportation

Public transportation consists of a system providing for users from the public to travel in a multi-passenger vehicle, typically on a schedule and operated on established routes, on a fee per trip basis. Examples of public transport include buses, cable cars, commuter trains, light rail trains, subways, monorails, street cars and trolleys, and ferries. Public transportation can also refer to taxi and vanpool services, shuttle services, and paratransit (dial-a-ride) transport services.

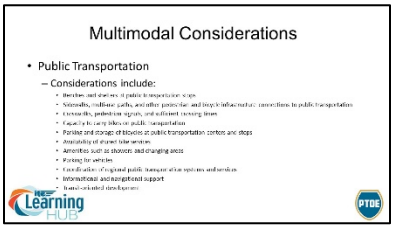


Public transportation has, in the past, been considered primarily as providing mobility for the transportation disadvantaged. However, public transportation is now being recognized as having many benefits, including:



- Helping to reduce urban congestion
- Enhancing productivity
- Increasing land value
- Saving money for the traveler
- Reducing air pollution emissions
- Improving health
- Assisting the population with non-automobile-based transportation needs
- Improving safety

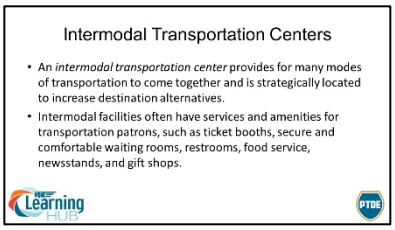
Considerations must be made for safe and convenient access to public transportation facilities, including walking, bicycling, riding feeder public transportation systems (e.g., taking the bus to connect to commuter rail at a station), and driving. When effectively integrated, bicycling and walking to public transportation help advance various environmental, health, and congestion-mitigating benefits for communities. Where and how a public transportation center or stop is situated relative to surrounding land uses is an important factor in multimodal access.



Other considerations include:

- Benches and shelters at public transportation stops
- Sidewalks, multi-use paths, and other pedestrian and bicycle infrastructure connections to public transportation
- Crosswalks, pedestrian signals, and sufficient crossing times
- Capacity to carry bikes on public transportation
- Parking and storage of bicycles at public transportation centers and stops
- Availability of shared bike services
- Amenities such as showers and changing areas
- Parking for vehicles
- Coordination of regional public transportation systems and services
- Informational and navigational support
- Transit-oriented development

Intermodal Transportation Centers



An intermodal transportation center provides for many modes of transportation to come together and is strategically located to increase destination alternatives. Such a center might include facilities for transit, rail, bicycle, carpooling and pedestrian access, so that a user can easily switch between modes. Intermodal facilities often have services and amenities for transportation patrons, such as ticket booths, secure and comfortable waiting rooms, restrooms, food service, newsstands, and gift shops. Some facilities are part of a larger multiuse development that provides shopping, offices, residential, dining, and recreational facilities.

Shared Mobility

In recent years, the sharing of mobility, such as car sharing, bicycle sharing, carpooling, and micro-mobility devices (such as scooters), has become popular in urbanized areas. This comes at a time where the costs of vehicle ownership, including fuel and parking, have become expensive, and many younger members of the population have decided not to become licensed as drivers. Shared mobility meshes well with public transportation, providing the "first- or last-mile" connections between residences, work sites, and transportation facilities.

Some key types of shared mobility include:

- Bike-sharing – bicycles are made available for use at key locations; while different approaches are used, all have some sort of technology-based system that makes it available to a registered user, tracks the location of the bicycle, and then secures it at the end of the trip.
- Car-sharing – automobiles can be shared between registered customers in either round-trip (i.e., return to the origin) or point-to-point applications. As with bike sharing, this shared mobility is technology-oriented for vehicle location and customer authorization and tracking.
- Ride-sourcing – online applications on smart phones and similar devices can be used to connect potential passengers with drivers that use their own personal, non-commercial vehicles. Systems such as Uber and Lyft provide the technology platforms for these services.
- Ride-sharing – includes carpooling, vanpooling, and dynamic ridesharing using a mobile app. Different from ride-sourcing, ride-sharing drivers are typically making the trip for their own needs and bring on others to save on commuting expenses.
- Electric bicycles and scooters – operated similarly to bike-sharing, these are popular in many areas.

Transit Stop Design and Location

Transit stops provide the interface between riders and the transit vehicle. They should help to make the trip easier, safer, and more enjoyable.

Bus stop spacing has a major impact on transit performance. Stop spacing affects both access time and line-haul time, and therefore affects the demand for transit service. In general, there is a tradeoff between: (a) closely spaced, frequent stops and shorter walking distance, but more time on the vehicle and (b) stops spaced further apart and longer walking distance, but less time on the vehicle.

Whether a bus stop should be located at the near side of the intersection, the far side of the intersection, or at mid-block has been a source of debate. In general, far-side stops are preferable; however, other types of stops may be justified in certain situations.

For Bus Rapid Transit (BRT) systems which include bus detection and active signal priority or queue jumper lanes, bus stops should be at the far side. This permits effective use of these priority measures to clear the bus through the intersection with minimal delay. Otherwise, the added bus dwell time variability from a near side stop would complicate, if not preclude, bus detection and green phase extension.

Considerations in designing a transit stop include:

- Access to the shelter for all users, including those using mobility aids, with a good connection to the ramp or lift on the bus
- The use of vandal-resistant and graffiti-resistant materials and an easy to clean and maintain design
- A design that provides for good security with no hidden areas
- A shelter location that prevents interference with pedestrian circulation
- Designs that permit efficient, orderly and rapid flow of alighting and boarding passengers from the stop to the vehicle.

Freight Movement

We depend on freight transportation to link businesses with suppliers and markets throughout the nation and the world. To remain competitive, we need effective freight transportation to operate at minimal cost and respond quickly to demand for goods.

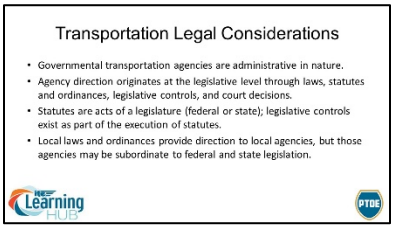
Congestion affects economic productivity in several ways. Businesses require more operators and equipment to deliver goods when shipping takes longer, more inventory when deliveries are unreliable, and more distribution centers to reach markets quickly when traffic is slow. Likewise, both businesses and households are affected by sluggish traffic, reducing the number of workers and job sites within easy reach of any location. The growth in freight is a major contributor to congestion in urban areas and on intercity routes, and congestion affects the timeliness and reliability of freight transportation. Long-distance freight movements are often a significant contributor to local congestion, and local congestion typically impedes freight to the detriment of local and distant economic activity.

Freight operations are an important consideration with respect to improving mobility and productivity. Improved operation can benefit the freight industry through:

- Immediate cost reductions to carriers and shippers, including gains to shippers from reduced transit times and increased reliability, resulting in decreased cost of raw materials and finished goods.
- Reorganization-effect gains from improvements in logistics. The quantity of firms' outputs changes, but the quality of output does not.
- Gains from additional reorganization effects such as improved products or new products.

Additionally, improving freight operations enhances the safety and efficiency of the transportation system for all users by lessening the impact of freight movements on the public and vice versa. Improvements include interchange redesign, truck climbing lanes, ITS improvements, and ramp extensions. During design, however, consideration of freight must extend beyond the geometric considerations associated with commercial vehicles to include operational elements that support enforcement and hours-of-service requirements, as well as elements to improve safety and overall efficiency.

Transportation Legal Considerations



Governmental transportation agencies are administrative in nature, meaning that while they can make and carry out regulations, they do not have the power of the courts of legislative bodies. Agency direction originates at the legislative level through laws, statutes and ordinances, legislative controls, and court decisions. Statutes are acts of a legislature (federal or state); legislative controls exist as part of the execution of statutes. Local laws and ordinances provide direction to local agencies, but those agencies may be subordinate to federal and state legislation.

Legal Authorities

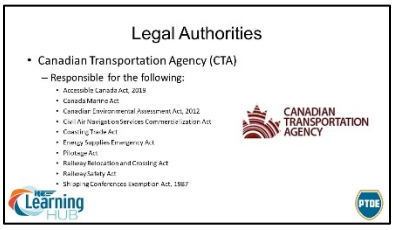
In the United States, the Constitution gives Congress the authority to regulate interstate commerce. Travel between the states is, therefore, subject to federal laws and regulations. The United States Department

of Transportation (USDOT) is the umbrella agency for all federal transportation policies and regulations. Within USDOT are several agencies that administer federal requirements for various types of transportation, including:

- The National Highway Traffic Safety Administration (NHTSA) is responsible for motor vehicle and highway transportation safety standards and regulations
- The Federal Aviation Administration (FAA) is responsible for airport, air traffic and aircraft regulation
- The Federal Highway Administration (FHWA) is responsible for laws pertaining to commercial freight and the maintenance and preservation of highways, tunnels, and bridges
- The Federal Motor Carrier Safety Administration (FMCSA) is responsible for safety regulation laws for large commercial vehicles
- The Federal Railroad Administration (FRA) is responsible for regulating the safety and development of the U.S. railroad system
- The Federal Transit Administration (FTA) provides financial and technical assistance to local public transportation systems

The regulation of roadways not under federal regulation is hierarchal in nature; under the Constitution, states have the authority to regulate transportation within their own boundaries, and most pass along responsibility for lesser roadways to counties and municipalities.

The Canadian Transportation Agency (CTA) is an independent, quasi-judicial tribunal and regulator that has, with respect to all matters necessary for the exercise of its jurisdiction, all the powers of a superior court. It oversees the Canadian transportation system, ensuring that the national transportation system runs efficiently and smoothly in the interests of all Canadians.



The CTA has primary responsibility for carrying out the provisions of the Canada Transportation Act. It also shares responsibility for the following laws:

- Accessible Canada Act, 2019
- Canada Marine Act
- Canadian Environmental Assessment Act, 2012
- Civil Air Navigation Services Commercialization Act
- Coasting Trade Act
- Energy Supplies Emergency Act
- Pilotage Act
- Railway Relocation and Crossing Act
- Railway Safety Act
- Shipping Conferences Exemption Act, 1987

Traffic Control Device Standards

In the United States, the responsibility for the design, placement, operation, maintenance, and uniformity of traffic control devices shall rest with the public agency or the official having jurisdiction, or, in the case of private roads open to public travel, with the private owner or private official having jurisdiction. The MUTCD has been adopted, under the Federal Code, as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel. All States have officially adopted the National MUTCD either in its entirety, with supplemental provisions, or as a separate published document.

The Manual of Uniform Traffic Control Devices for Canada, Sixth Edition (MUTCDC) guides the use of road signs, traffic signals, pavement markings and other devices that inform travelers about road regulations, hazards and temporary conditions. It helps Canada's federal, provincial, territorial and municipal governments to apply traffic control devices in a consistent and harmonized manner, which is an important factor in road safety.

Traffic Regulation Enactment

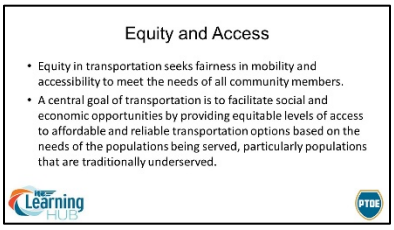
For constitutional and historical reasons, traffic regulations in the United States are enacted and administered by the States rather than the Federal government. The first statewide traffic regulations were enacted in Connecticut in 1901, before automobiles were common on roadways. Other States enacted their own regulations as need and custom dictated. The first version of the Uniform Vehicle Code (UVC) appeared in 1926.

Most aspects of the national body of traffic regulations are consistent because of historical practices, institutional collaborations, and modern Federal oversight. The UVC represents a working consensus, though it has no formal standing as a body of law and has not been updated since 2000. As a starting point for this analysis, however, the UVC provides a common reference for the definition of terms used in framing traffic regulations and the user categories to which the regulations apply. The structure of UVC has also been echoed in many of the States' traffic codes, forming a de facto standard for indexing of the regulations. Similarly, the UVC and State traffic codes generally point to the MUTCD, or the State's version, for the definition of traffic controls with which drivers are to comply.

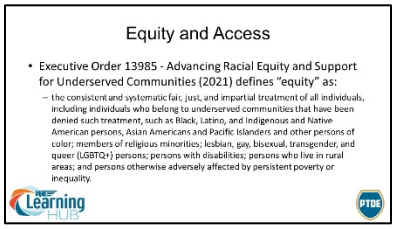
The UVC itself is not a normative source of traffic regulations. It was developed from the larger body of traffic laws being developed by state and local governments as a means of documenting common aspects of those sets of laws and has become the common reference for uniformity of traffic codes. Reviewing existing traffic laws and traffic regulation databases, therefore, requires consideration of a compilation of State and local perspectives.

State vehicle and traffic regulations are in all cases within the authority of the State legislatures. Execution and enforcement of those laws reside with the State motor vehicle administration, transportation, and police/patrol agencies, which may be separate or combined in various ways. Publishing the enacted vehicle and traffic statutes is a legislative function. State transportation agencies are as much users of those statutes as drivers within those States.

Equity and Access



Equity in transportation seeks fairness in mobility and accessibility to meet the needs of all community members. A central goal of transportation is to facilitate social and economic opportunities by providing equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved.

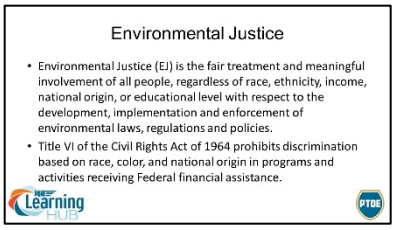


Under Executive Order 13985 Advancing Racial Equity and Support for Underserved Communities (2021), the term "equity" means the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.

It is important to note that transportation equity does not mean equal. An equitable transportation plan considers the circumstances impacting a community's mobility and connectivity needs, and this information is used to determine the measures needed to develop an equitable transportation network. To attain an equitable transportation network, all components of Title VI, environmental justice (EJ), and Nondiscrimination must be considered.

Considering equity early and often through methods such as public participation and data collection and analysis improves the planning process's ability to adequately respond to the needs of the community it serves. It may also improve project delivery by preventing costly and time-consuming delays that could arise from previously unrecognized conflicts as projects move from planning into implementation.

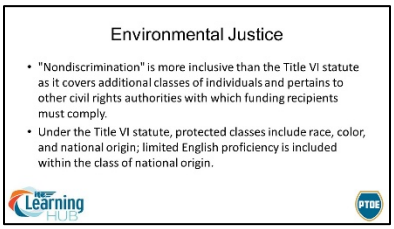
Environmental Justice



Environmental Justice (EJ) is the fair treatment and meaningful involvement of all people, regardless of race, ethnicity, income, national origin, or educational level with respect to the development, implementation and enforcement of environmental laws, regulations and policies.

A prime example of the need for EJ dates to the boom of the nation's Interstate Highway System in the late 1950s through the 1970s. Urban freeways were often constructed through lower income neighborhoods, justified through lower land costs and a desire to redevelop "blighted" neighborhoods ("urban renewal") near downtown areas. Frequently, these neighborhoods were populated by people of color, who were displaced from their long-standing residences through the construction of the freeway.

Title VI of the Civil Rights Act of 1964 prohibits discrimination based on race, color, and national origin in programs and activities receiving Federal financial assistance. More specifically, Title VI provides that "No person in the United States shall, on the ground 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."



"Nondiscrimination" is more inclusive than the Title VI statute as it covers additional classes of individuals, and, pertains to other civil rights authorities with which funding recipients must comply. Under the Title VI statute, protected classes include race, color, and national origin; limited English proficiency is included within the class of national origin. FHWA's Title VI program (in contrast to the Title VI statute) expands the covered classes to include sex, age, disability and low-income.

Title VI, EJ, and other nondiscrimination authorities protect diverse segments of the population which may be at risk of being unduly impacted by, or which have been historically underrepresented, within the transportation decision-making process. Considering the needs of and potential impacts of projects on these populations may result in greater transportation equity as benefits are likely to be more equitably distributed amongst the affected communities.

Equity in transportation seeks fairness in mobility and accessibility to meet the needs of all community members. A central goal of transportation equity is to facilitate social and economic opportunities by providing equitable levels of access to affordable and reliable transportation options based on the needs of the populations being served, particularly populations that are traditionally underserved.

An equitable transportation plan considers the circumstances impacting a community's mobility and connectivity needs and this information is used to determine the measures needed to develop an equitable transportation network. To attain an equitable transportation network, all components of Title VI, EJ, and Nondiscrimination must be considered.

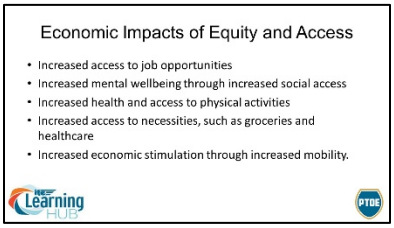
Accessibility

Accessibility to transportation means a system that is accessible to everyone, including those who need it most. For these people who need to access schools, jobs, and necessities, but cannot afford to own and operate a personal vehicle, transit is critical, and needs to be affordable. If people cannot afford transit, then no matter how close or fast it is, it will not be accessible.

Accessibility is not limited to financially disadvantaged individuals. Physically disabled individuals may also be dependent on public transit or other specialized transportation facilities. The Americans with Disabilities Act (ADA) was signed into law on July 26, 1990, by President George H.W. Bush. The ADA is civil rights legislation that prohibits discrimination and guarantees that people with disabilities have the same opportunities as everyone else - to enjoy employment opportunities, to purchase goods and services, and to participate in State and local government programs and services. Modeled after the Civil Rights Act of 1964, which prohibits discrimination on the basis of race, color, religion, sex, or national origin, the ADA is an "equal opportunity" law for people with disabilities. To be protected by the ADA, one must have a disability, which is defined by the ADA as a physical or mental impairment that substantially limits one or more major life activities, a person who has a history or record of such an impairment, or a person who is perceived by others as having such an impairment.

Another large contributor to accessibility is location. People need to access public transit in order to use it, which includes distance to transport, but also frequency. An example of this is people who work night shifts or other irregular hours that may have severely restricted transport options because of their work schedule. Transport options need to be close enough to use, and frequent enough to be useful.

Economic Impacts



The economic impacts of equity and access in transportation include:

- Increased access to job opportunities
- Increased mental wellbeing through increased social access
- Increased health and access to physical activities
- Increased access to necessities, such as groceries and healthcare
- Increased economic stimulation through increased mobility.

Transportation and Public Health

Transportation and health are closely linked concepts. As a derived demand, the choice of transportation modes available to people can often dictate whether they will be actively moving for a significant part of the day (e.g., walking, biking) or engaging in more sedentary forms of travel (e.g., driving). Transportation options can also dictate the level of access to health support facilities such as hospitals and clinics, public recreational facilities, and even such daily essentials as fresh produce and other food resources.

ITE's *Active Transportation Quick Bites* provided a recent discussion on the benefits of transportation and notes it as a social determinant of health. Transportation affects health in several ways, including the following:

- Access to Health-Promoting Destinations - Transportation enables access to health-promoting destinations, such as employment, schools, grocery stores, and healthcare services. Access includes land use and how affordable transportation is.
- Traffic Safety – Over 40,000 people are killed, and hundreds of thousands seriously injured, on U.S. roadways every year. Pedestrians and people of color are disproportionately impacted.
- Active Living - Transportation facilitates active living, or, alternatively, encourages sedentary lifestyles that increase the risk for chronic disease. About 35 percent of coronary heart disease deaths can be traced to lack of physical inactivity.
- Air Pollution - Exposure to traffic-related pollution is linked to respiratory disease, the development of childhood asthma, and cardiovascular disease.
- Noise Pollution - Noise from traffic leads to stress and sleep disturbances, both of which can lead to a higher risk for Type 2 diabetes. Transportation noise is associated with myocardial infarction (i.e., heart attacks), premature death, stroke, and hypertension. Exposure to chronic noise affects learning and affects children's cognitive development.
- Greenhouse Gas Emissions - The transportation sector is one of the largest contributors to greenhouse gas emissions in the U.S. The greatest threat to global health is climate change, which will increase heat-related illnesses and deaths, increase food-, water-, and vector-borne disease, and increase cardiovascular and respiratory illnesses. Children, older adults, low-income communities, and some communities of color are especially vulnerable to the effects of climate change.

- Equity - Opportunities to live in healthy environments and make healthy choices differ by socio-economic status. The benefits or burdens of transportation investments have been uneven among different populations. For example, many communities of color have been severed by freeways and have higher exposures to air and noise pollution.

REFERENCES

Questions for the certification examination are derived and/or documented from a number of professional sources. Some of the most frequently cited references are:

Title: *Highway Capacity Manual, 7th Edition: A Guide for Multimodal Mobility Analysis*
Author(s): Transportation Research Board Inc.
Publisher: TRB, ISBN: 978-0-309-08766-7
ITE Publication Number: LP-674C
Publication Date: 2022

Title: *Manual of Transportation Engineering Studies, 2nd Edition*
Author(s): Edited by H. Douglas Robertson
Publisher: ITE, ISBN: 978-1-933452-53-1
ITE Publication Number: TB-012A
Publication Date: 2010

Title: *Manual on Uniform Traffic Control Devices, 2009 Edition*
Author(s): FHWA/ITE/ATSSA/AASHTO
Publisher: FHWA/ITE/ATSSA/AASHTO, ISBN: 978-1-56051-473-2
ITE Publication Number: MUTCD-10
Publication Date: 2009

Title: *A Policy on Geometric Design of Highways and Streets, 7th Edition*
Author(s): AASHTO
Publisher: AASHTO, ISBN: 978-1-56051-676-7
Publication Date: 2018

Title: *Traffic Engineering Handbook, 7th Edition*
Author(s): ITE, Brian Wolshon and Anurag Pande
Publisher: Wiley, ISBN: 978-1-118-76230-1
ITE Publication Number: LP-691
Publication Date: 2016

Title: *Traffic Safety Toolbox: A Primer on Traffic Safety*
Author(s): ITE
Publisher: ITE, ISBN: 0-935403-43-4
ITE Publication Number: LP-279A
Publication Date: 1999

Title: *Transportation Planning Handbook, 4th Edition*
Author(s): Edited by Michael D. Meyer
Publisher: ITE, ISBN: 978-1-118-76235-6
ITE Publication Number: LP-695
Publication Date: 2016

Title: *Highway Safety Manual*
Author(s): AASHTO
Publisher: AASHTO, ISBN: 978-1-56051-477-0
ITE Publication Number: LP-672
Publication Date: 2010

Title: *Signal Timing Manual - NCHRP Report 812*, Second Edition
Author(s): Tom Urbanik, Alison Tanaka, et al.
Publisher: TRB, National Cooperative Highway Research Program
Publication Date: 2015

Website References

Connected Vehicles, https://www.pcb.its.dot.gov/eprimer/module13.aspx

Freight and Commercial Vehicle ITS, https://www.pcb.its.dot.gov/eprimer/module6.aspx#is

USDOT, ATDM Program Brief: An Introduction to Active Transportation and Demand Management. http://www.ops.fhwa.dot.gov/publications/fhwahop12032/fhwahop12032.pdf

In addition to these professional references, a candidate may find it advantageous to review a general traffic or transportation engineering text. Among the excellent texts currently available, the following was frequently cited in question documentation:

Title: Fundamentals of Traffic Engineering, 16th Edition (Currently not Available)
Author(s): Homburger, W., et al.
Publisher: University of California
Publication Date: 2007

In addition, the following on-line references relate to this current module:

https://www.ite.org/technical-resources/topics/maas-mod-ite-initiative/

https://nacto.org/publication/transit-street-design-guide/stations-stops/

https://ops.fhwa.dot.gov/weather/index.asp

https://www.fhwa.dot.gov/environment/index.cfm

https://www.epa.gov/nepa

https://www.ite.org/technical-resources/topics/transportation-and-health/

https://www.transportation.gov/public-involvement