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NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

NCFRP REPORT 16

Preserving and Protecting Freight Infrastructure and Routes

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Subscriber Categories
Freight Transportation • Planning and Forecasting • Terminals and Facilities

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TRANSPORTATION RESEARCH BOARD

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NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

America's freight transportation system makes critical contributions to the nation's economy, security, and quality of life. The freight transportation system in the United States is a complex, decentralized, and dynamic network of private and public entities, involving all modes of transportation—trucking, rail, waterways, air, and pipelines. In recent years, the demand for freight transportation service has been increasing fueled by growth in international trade; however, bottlenecks or congestion points in the system are exposing the inadequacies of current infrastructure and operations to meet the growing demand for freight. Strategic operational and investment decisions by governments at all levels will be necessary to maintain freight system performance, and will in turn require sound technical guidance based on research.

The National Cooperative Freight Research Program (NCFRP) is a cooperative research program sponsored by the Research and Innovative Technology Administration (RITA) under Grant No. DTOS59-06-G-00039 and administered by the Transportation Research Board (TRB). The program was authorized in 2005 with the passage of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). On September 6, 2006, a contract to begin work was executed between RITA and The National Academies. The NCFRP will carry out applied research on problems facing the freight industry that are not being adequately addressed by existing research programs.

Program guidance is provided by an Oversight Committee comprised of a representative cross section of freight stakeholders appointed by the National Research Council of The National Academies. The NCFRP Oversight Committee meets annually to formulate the research program by identifying the highest priority projects and defining funding levels and expected products. Research problem statements recommending research needs for consideration by the Oversight Committee are solicited annually, but may be submitted to TRB at any time. Each selected project is assigned to a panel, appointed by TRB, which provides technical guidance and counsel throughout the life of the project. Heavy emphasis is placed on including members representing the intended users of the research products.

The NCFRP will produce a series of research reports and other products such as guidebooks for practitioners. Primary emphasis will be placed on disseminating NCFRP results to the intended end-users of the research: freight shippers and carriers, service providers, suppliers, and public officials.

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FOREWORD

By William C. Rogers
Staff Officer
Transportation Research Board

NCFRP Report 16: Preserving and Protecting Freight Infrastructure and Routes provides practical tools for public and private stakeholders to develop, preserve, protect, and enhance freight transportation infrastructure and routes for all modes of transportation. The report provides guidance to decision makers involved in freight facility operations, freight transportation planning, and land use on how to avoid conflicting land uses, or mitigate existing ones, by (1) providing information about freight transportation and its importance to people's everyday lives; (2) illustrating the types of conflicts between freight and other land uses and their consequences; and (3) providing tools and resources to preserve facilities and corridors, including prevention or resolution of these conflicts. An innovative contribution of the research is the development of a website, EnvisionFreight.com, which is intended to complement this report. For many of the topics covered in this report, more detailed materials are available on the website. References to the website are provided in this report where relevant. The appendixes to the contractor's final report are included herein on *CRP-CD-103* and are available for download on the TRB website as an ISO image.

Freight transportation infrastructure and operations are threatened by a variety of factors and trends. Examples include gentrification along truck routes connecting to urban freight-generating facilities such as manufacturing and distribution facilities and marine ports that create pressures to reduce or constrain freight activities; prohibitions placed on freight operations because of noise, visual pollution, and emissions impacts; and incompatible land development adjacent to century-old port and rail facilities. Without better planning, the projected growth in urban areas in the United States, combined with the corresponding increase in freight demand, will result in the continued threat to freight infrastructure from "higher value" land use. Once encroachment by incompatible development has occurred near freight facilities, mitigation can be an expensive, lengthy, and often unsuccessful process. Similarly, freight relocation often negatively impacts freight transportation by increasing travel distances or by adding complexity to freight interchanges, ultimately resulting in increased costs to business and consumers. A better approach is to plan for and identify potential areas of encroachment and conflict before they occur and provide governmental agencies and private stakeholders with the knowledge and tools to prevent incompatible development near critical freight infrastructure. Where freight and non-freight land uses co-exist, decision makers may want to adopt more effective strategies for mitigation, conflict mediation, and redevelopment approaches that integrate freight facility preservation into broader public planning efforts.

Under NCFRP Project 24, Christensen Associates, with the assistance of the University of Texas at Austin – Center for Transportation Research, Grow & Bruening, and Kathryn H.S. Pett, was asked to provide guidance to public and private stakeholders on how to

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develop, preserve, protect, and enhance freight transportation infrastructure and routes for all modes of transportation. To accomplish the research objectives, the research team (1) described the general benefits and importance of an integrated multimodal freight transportation system for communities, regions, and the nation; (2) identified and categorized the common conflicts and barriers between goods movement activities and public interests and concerns; (3) identified and evaluated a variety of North American and international efforts and approaches to preserve, protect, and enhance freight infrastructure and routes; (4) conducted three in-depth case studies of the application, acceptance, and effectiveness of these efforts and approaches; (5) developed guidelines that define the suggested role of government at all levels and opportunities for private stakeholders in preserving, protecting, and enhancing freight infrastructure and routes; (6) developed a web-based self-learning instruction tool providing practical knowledge and methods to apply recommended guidelines to real-world situations; and (7) held a peer exchange to evaluate the guidelines and self-learning instruction tool.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

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SUMMARY

Preserving and Protecting Freight Infrastructure and Routes

NCFRP Report 16 is the final report of NCFRP Project 24, "Preserving and Protecting Freight Infrastructure and Routes" (FY 2009). The purpose of this project was to provide practical tools to preserve and protect freight facilities and corridors. This report

- Presents information about freight transportation and its importance to everyday life;
- Illustrates types of conflicts between freight and other land uses, and their consequences; and
- Provides tools and resources to preserve facilities and corridors, including prevention or resolution of these conflicts.

The target audience for this study consists of decision makers involved in freight facility operations, freight transportation planning, and land-use decisions. This includes state departments of commerce and transportation, metropolitan planning organizations (MPOs), local officials and their planning offices, legislators and their staffs, freight facility developers, freight operators, and real estate concerns.

One innovative contribution of the NCFRP Project 24 was the development of a website, entitled EnvisionFreight, found at http://www.EnvisionFreight.com, and an associated guidebook. The "beta" version of the website and guidebook were previewed at the NCFRP Project 24 workshop, held in January 2011. For many of the topics covered in this report, more detailed materials are available on the website. References to these website materials are provided in this report where relevant.

The Importance of Freight Transportation

Freight is an essential and ubiquitous part of our economy. Transportation services are needed to deliver raw and intermediate materials to producers and to deliver final products to retailers and final customers. At its core, freight and its transportation are an integral part of supply chain management (SCM). SCM involves decisions about what to produce, what inputs to use, how to configure a distribution network, how much inventory to maintain, and how to transport inputs and products. Logistics management refers to the part of SCM that involves decisions about how and when to get raw materials, intermediate goods, and finished goods from their respective origins to their destinations. Included in logistics management are inter-related choices of modes of transportation (rail, truck, water, air), shipment characteristics (less-than-load vs. full load, etc.), warehousing, and levels of inventories to maintain.

Freight volumes and the transportation of those volumes are driven by consumption. Moreover, a key determinant of consumption growth is population growth, which makes growth in freight volumes and the need to transport these increasing volumes a virtual certainty. According to the most recent information from the Commodity Flow Survey (CFS), on average, 42 tons of freight

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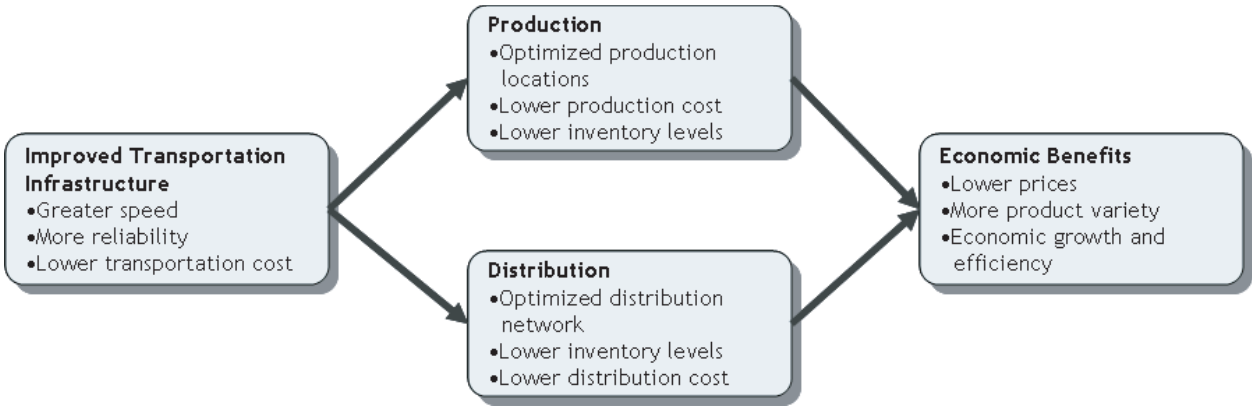

Source: Christensen Associates.

Figure S-1. The role of freight transportation in efficient production and distribution.

worth $39,000 was delivered to every person in the United States in 2007. When considering the distance involved in transporting this freight, an average of 11,000 ton-miles was delivered to every person in the country. To gain perspective on the amount of transportation involved, this is equivalent to carrying one ton of freight for every man, woman, and child in the United States 11,000 miles, or each of the 42 tons of freight for every person over 260 miles.

Many factors affect producers' logistical choices and supply chain configurations. These include the relative costs of transportation modes, the comparative speed and reliability of transportation modes, the ease of switching between modes, the costs of holding inventory, and the amount of logistical costs as a share of total production, distribution, and marketing costs. Improvements in information technology also can improve the utilization of transportation services, making them more attractive relative to the use of other logistics inputs. For example, with just-in-time inventory management, fast and reliable transportation has been combined with information technology to reduce the need for maintaining large inventories.

Figure S-1 illustrates the vital link provided by freight transportation in supply chains and economic performance. Improvements in freight transportation efficiency, reliability, and level of service have numerous economic benefits for production efficiency, optimization of distribution networks, and product choice, and—ultimately —the cost to consumers. As improvements are made in transportation infrastructure, producers are able to centralize their production operations and site their operations in lower-cost areas, because the uncertainties concerning the movement of goods to customers are reduced. Transportation infrastructure improvements also allow a more efficient design of the distribution network. The cost of inventories can be reduced as the needed hedge against transportation uncertainties is reduced. This also allows firms to change their inventories quickly in response to customers' changing needs or desires. This ultimately leads to lower cost and greater product variety for customers.

The U.S. Freight Transportation System

In 2008, 4.5 million people were employed in transportation and warehousing industries in the United States, a little over 3 percent of total U.S. employment. Trucking was the largest employer within the for-hire transportation section with almost 1.4 million employed. The railroad industry employed 231,000, and water transportation employed 67,000. Another key component of logistics services and supply chains, warehousing and storage, employed 672,000 (U.S. Department of Transportation RITA/BTS 2010, Table 3-19b). Latest available data (2007) show that there were almost 220,000 employer establishments in the transportation and warehousing sector of the

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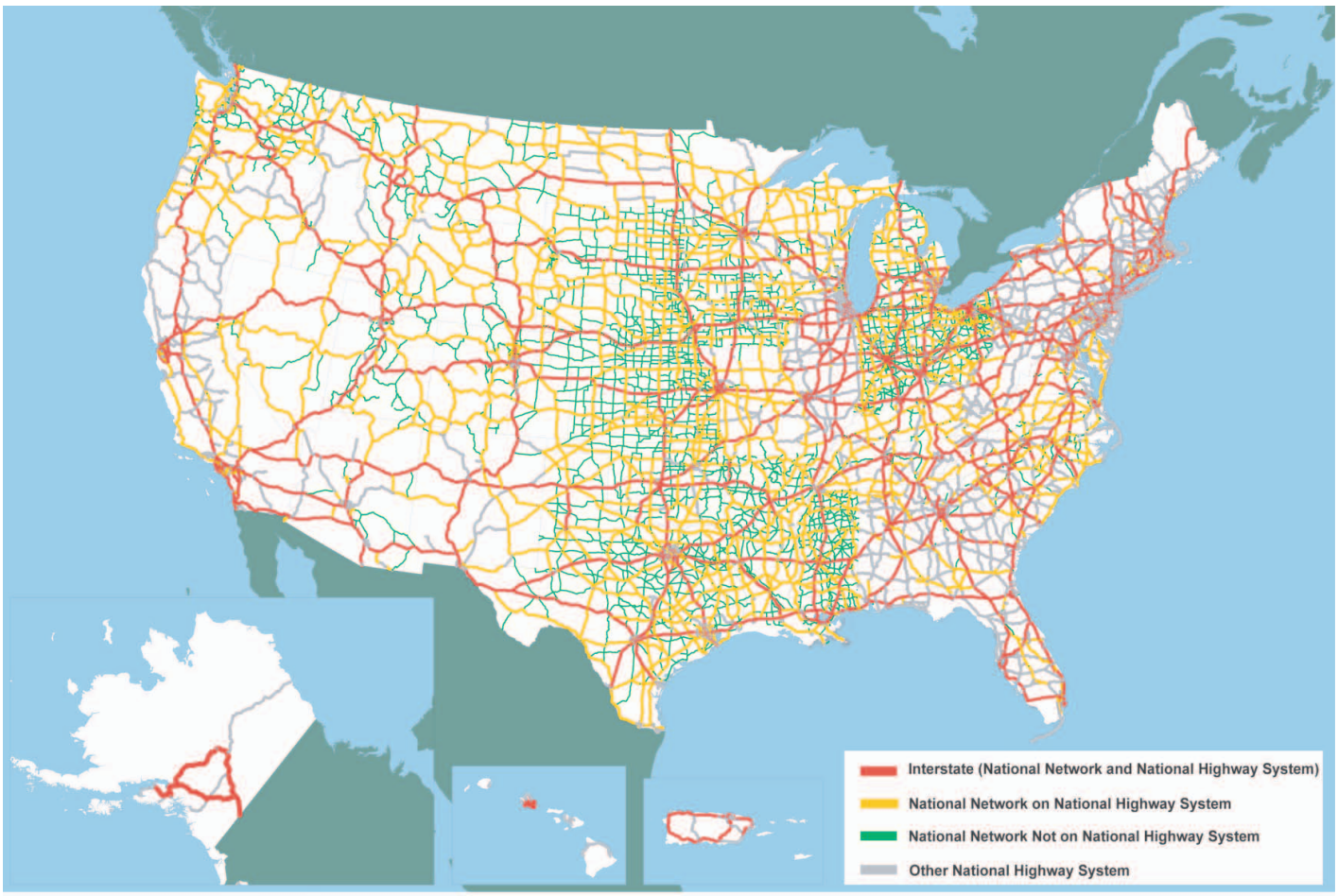
U.S. economy with revenues of almost $640 billion and annual payrolls of more than $173 billion. In addition, there were more than 1 million non-employer establishments with revenues of almost $67 billion (U.S. Census Bureau 2007).

The U.S. surface freight transportation network includes 4,016,741 miles of highways, 94,942 miles of Class I freight railroad tracks, 46,474 miles of regional and shortline railroad tracks, and 26,000 miles of navigable inland waterways (U.S. Department of Transportation RITA/BTS 2010, Table 2-1-1). In addition to these inland waterways, marine transportation options include coastal marine corridors along the Atlantic, Pacific, and Gulf Coasts, and a number of routes that traverse the Great Lakes. Other important components of the freight transportation network include air freight and pipelines.

Figures S-2 through S-4 show major surface transportation corridors in the United States. Figure S-2 shows primary highway routes used by trucks, Figure S-3 shows major rail networks, and Figure S-4 shows marine highway corridors.

An illustration of the importance of U.S. freight transportation corridors and transportation modes is found in Figure S-5, which shows freight tonnage on U.S. highways, railroads, and



Notes: This map should not be interpreted as the official National Network and should not be used for truck size and weight enforcement purposes. The National Network and the National Highway System (NHS) are approximately 200,000 miles in length, but the National Network includes 65,000 miles of highways beyond the NHS, and the NHS encompasses about 50,000 miles of highways that are not part of the National Network. "Other NHS" refers to NHS mileage that is not included on the National Network. Conventional combination trucks are tractors with one semitrailer up to 48 feet in length or with one 28-foot semitrailer and one 28-foot trailer. Conventional combination trucks can be up to102 inches wide.

Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 2.2, 2009.

Figure S-2. National highway network for conventional combination trucks (U.S. Department of Transportation FHWA FM&O 2009a).

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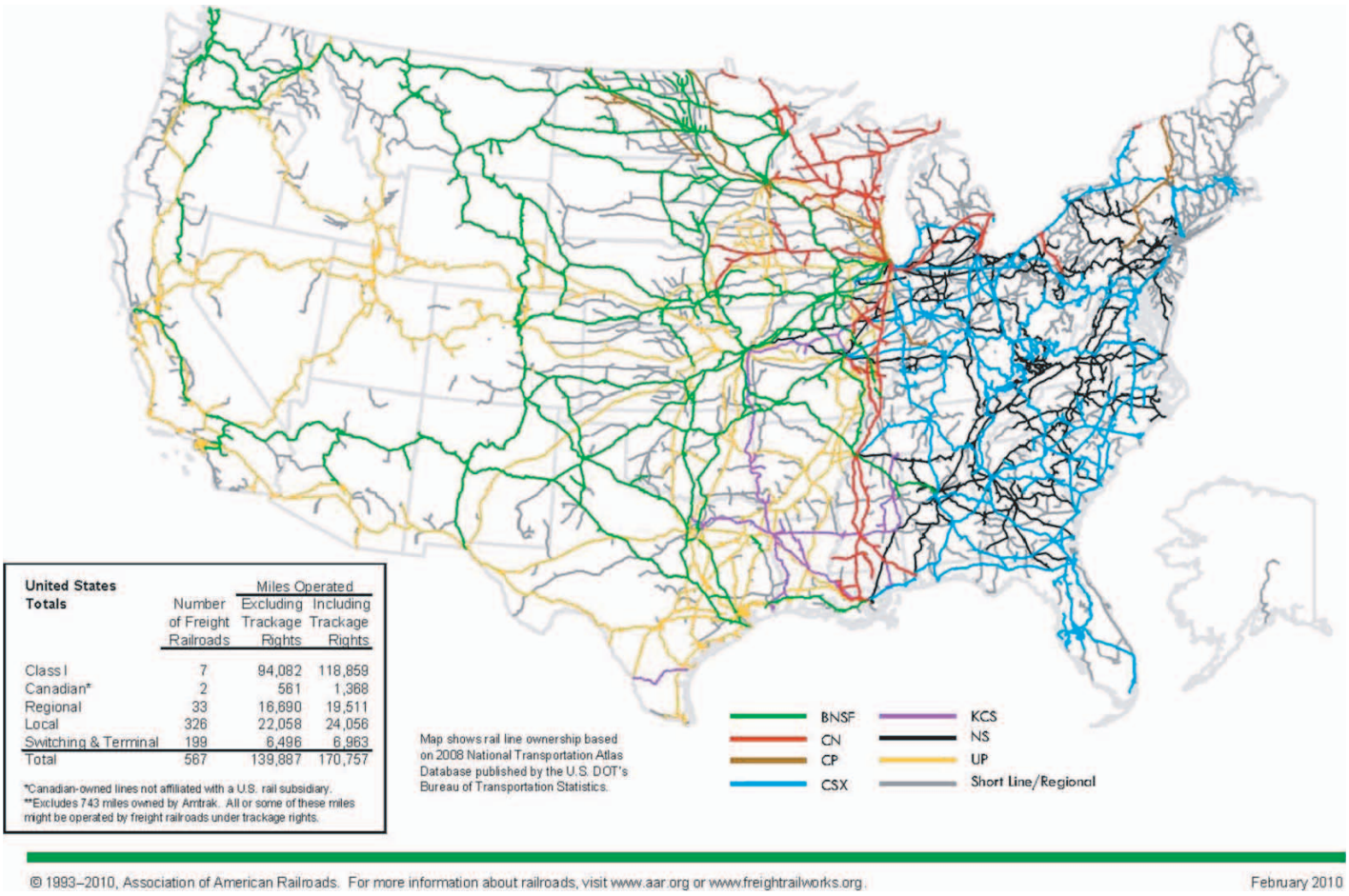

Figure S-3. Major railroad networks in the United States (Association of American Railroads 2010).

inland waterways. It illustrates that supply chains extend across the country and into other parts of the world via key ports such as Los Angeles/Long Beach, Houston, New Orleans, and New York/New Jersey, which are gateways to foreign trade as well as the origins and destinations of substantial shipments throughout the United States. A majority of freight tonnage is transported along a handful of key corridors. In addition to the rail traffic coming out of the Power River Basin in Wyoming and water traffic along the Mississippi and Ohio rivers, there are dense corridors of highway traffic throughout the eastern part of the United States and along the West Coast. Figure S-5 also illustrates the importance of Chicago as a key U.S. freight transportation hub.

Conflicting Land Uses and Freight-Transportation-Related Services

When incompatible land uses exist in close proximity to each other, these uses often interfere with each other, resulting in potential conflicts. For example, a freight yard or corridor located near a residential neighborhood, a school, or hospital is often a source of conflict. Conflicts can be physical in nature and/or involve nuisance, health, or safety concerns. From the freight perspective, these conflicts often result in barriers to efficient freight transportation operations and can affect the ability to expand operations to accommodate growing volumes. In some instances, conflicts between freight and non-freight uses result in freight activities being labeled as a "nuisance" that causes relocation of freight operations.

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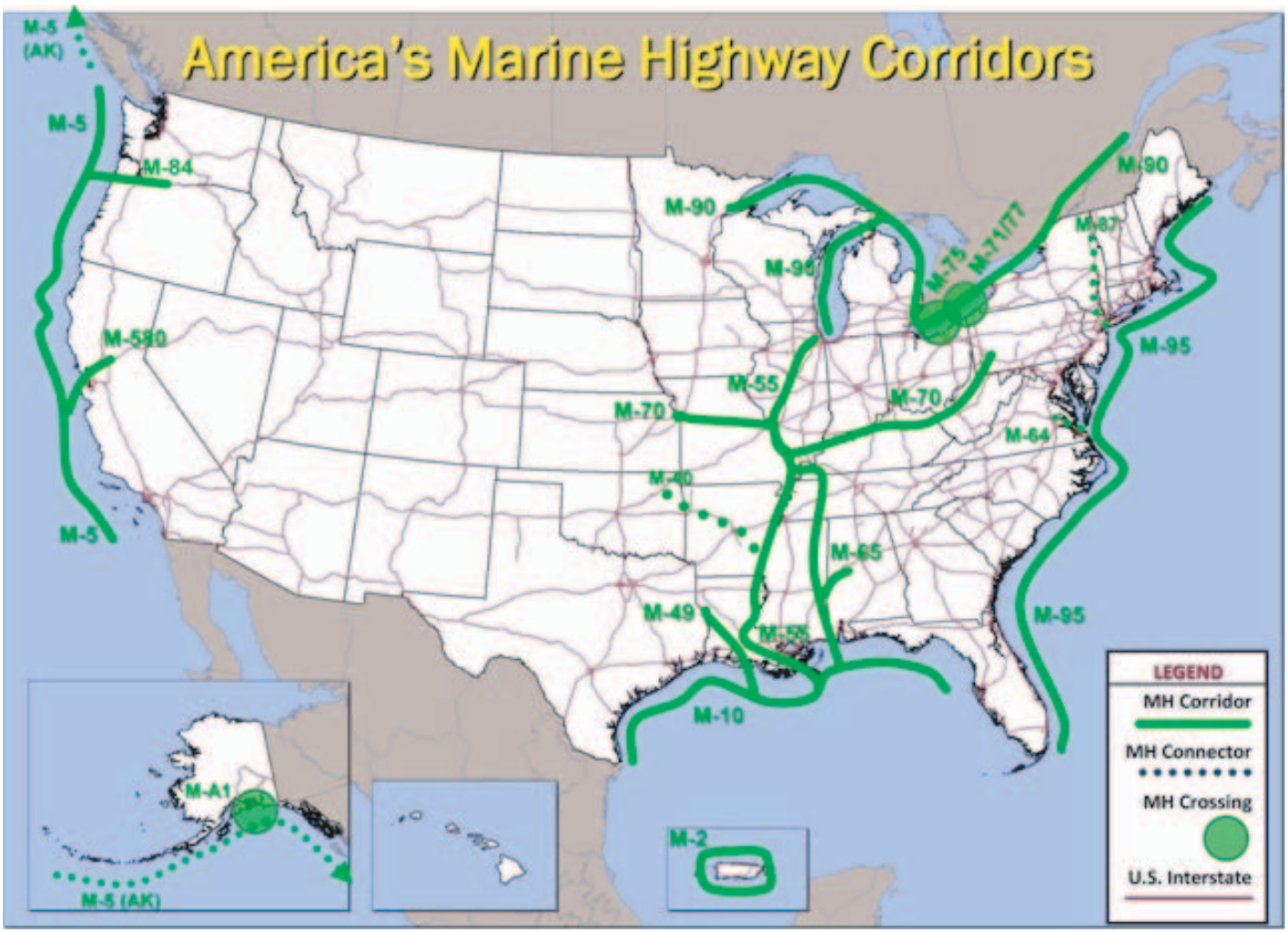

Figure S-4. Marine highway corridors in the United States (U.S. Department of Transportation 2011).

Most residential, educational, and medical-related land uses are often incompatible with freight activity. Among the major conflicts non-freight interests have with freight-transportation-related services are

- Air and water pollution,
- Light pollution,
- Noise pollution,
- Effects of vibration,
- Safety issues,
- Congestion, and
- Environmental justice issues.

Some conflicts—such as noise, light, and vibration—are common to all of the primary freight modes. Environmental justice issues also can be a concern when a minority or low-income community is disproportionately affected by freight activity. Other conflicts are more specific to particular modes. For example, the potential for dangerous trespass tends to be specific to railroads.

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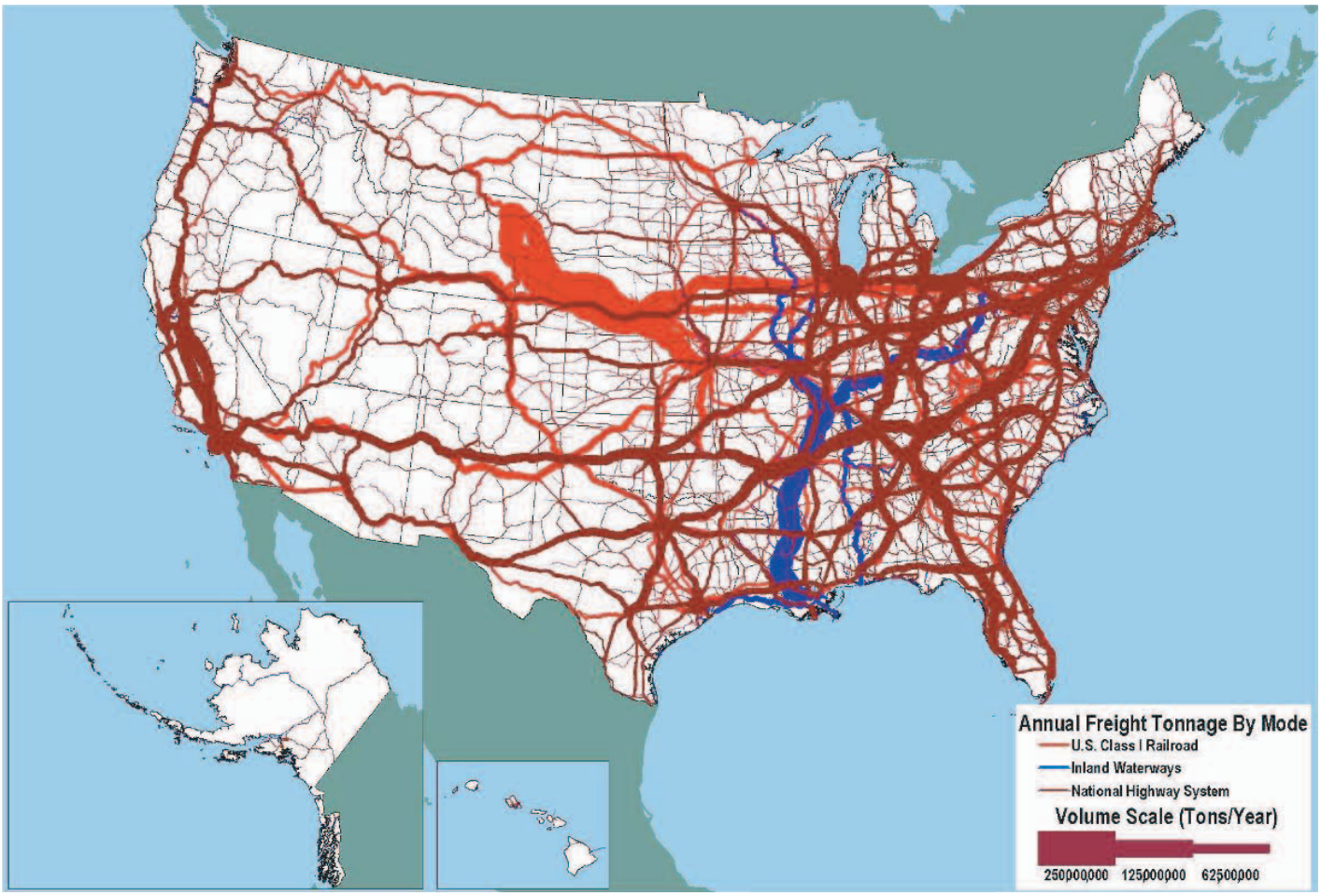

Figure S-5. Tonnage on U.S. highways, railroads, and inland waterways (U.S. Department of Transportation FHWA FM&O 2007).

Barriers to Freight Transportation

From the perspective of freight interests, barriers to efficient freight-transportation-related services often emerge as a result of unresolved conflicts. Barriers or impediments to economically efficient freight transportation can be due to numerous factors, including land-use decisions that create conflicts with other land uses, insufficient funding for the maintenance or expansion of freight facilities and corridors, and public policy decisions that impede or do not sufficiently accommodate the needs of freight transportation. Such barriers typically result in higher production and distribution costs. In this context, examples of potential barriers or interference with freight-transportation-related services include the following:

- Speed restrictions;
- Limitations on hours of operation;
- Height and clearance impacts;
- Size and weight limitations;
- Corridor design impacts;
- Environmental permitting;
- Limitations on dredging operations and/or the depositing of dredged material;
- Backlog of waterway lock or channel maintenance;

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- Hazardous material (hazmat) routing restrictions; and
- Gentrification that displaces, impedes, or increases the costs of freight transportation.

Some barriers can be mode-specific (e.g., highway and road design impacts on trucking activities or dredging impacts on waterway transportation), while other barriers may be more general across modes (e.g., limitations on hours of operation). Barriers not only affect freight activities along particular corridors and facilities, but also can affect route choices and the ability to access freight and manufacturing facilities. For example, if roads are designed with turning radii that are too tight, particular types of trucks may not be able to use these routes or access facilities along these roads.

Issues Identified and Lessons Learned from Research

The NCFRP Project 24 research team produced six case studies to illustrate examples of preserving freight capacity, planning for freight needs, and dealing with actual or potential conflicts between freight and other land uses. These real world examples provide a unique contribution to the understanding of the variety of freight preservation issues that have been encountered around the country and the complex nature of solutions to these issues. Although each case study was borne out of particular geographic and historic contexts, the purpose of the case studies is to demonstrate potentially transferable solutions that have been undertaken around the United States. Some case studies focused on a specific infrastructure asset to be preserved, while others involved comprehensive plans governing a broader area.

The critical issues identified and discussed in the research are as follows:

1. There is no single entity at the federal level with responsibility for freight planning, financing, or project implementation in the United States.
   - Multiple federal agencies oversee different aspects of the U.S. freight network and none have authority over land-use planning activities.
   - Federal funding for freight preservation and protection activities has been sporadic and is complicated by the fact that significant portions of the U.S. freight network are privately owned.
2. The land-use planning arena is the primary forum where conflicts between freight and other land uses are either avoided or created, and where preservation of freight corridors and facilities are either helped or hindered.
3. Local governments have primary jurisdiction over land-use planning in the United States.
4. In general, land-use planning processes inadequately accommodate freight needs. There are many reasons for this, including
   - Land-use planners are typically not taught about freight as part of their standard educational curriculum.
   - Maps that identify freight facilities and corridors generally lack sufficient accuracy and detail to ensure informed land-use decisions.
   - Freight entities are generally not significantly involved in local land-use and transportation visioning and comprehensive planning processes.
   - Local jurisdictions have a financial incentive to zone for uses with high tax values.
5. Because the primary responsibility for land-use planning lies with local jurisdictions, planning for freight needs that is done is performed on a piecemeal basis that does not account for the fact that most freight transportation corridors transcend jurisdictional boundaries.
   - State and regional planning agencies do not typically have the land-use planning authority to fill the gap in freight planning.
   - MPOs are not authorized to conduct transportation planning outside of their designated areas.

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6. Regional visioning exercises generally do not deal adequately with freight.
7. Funding is often lacking or insufficient for freight planning and preservation.
8. There is a lack of effective communication among freight and land-use/transportation planning stakeholders.

The project team's research identified a number of potential solutions to these issues, including

- State enabling acts should ideally be amended to require that freight be one of the key elements that states, local jurisdictions, and planning agencies account for in both transportation planning and land-use planning.
- Guidance needs to be provided to land-use planners regarding appropriate planning and zoning practices that relate to freight. For example, zoning overlays and industrial protection zones can be put in place not just for the industrial areas that are serviced by freight, but also for the corridors that link to them.
- Accurate mapping of freight facilities and corridors should become part of the comprehensive planning process. Mapping of such facilities will contribute to the preservation and protection of these facilities.
- Cooperative regional planning efforts, such as regional visioning processes, should include freight entities as key stakeholders and make freight a significant focus.
- State and national associations related to planning or development should provide the appropriate education and tools related to freight planning for city and county planners.
- Freight entities should participate as stakeholders in local, regional, and state planning and visioning processes.
- Private-sector groups, including local chambers of commerce, can play an important role in keeping freight issues on the agenda and ensuring buy-in from the business community when a preservation project is proposed.
- Freight groups (both private sector and government) need to partner with educational institutions to ensure that the underlying principles of freight activity are included as part of the curriculum at the graduate and undergraduate levels in planning, architecture, policy, engineering, business, and law disciplines.
- Ports, which have started tracking port-related job impacts throughout the region, need to make a similar scale effort to quantify the congestion and noise impacts that they produce outside of the immediate port area. Port master plans should illustrate affiliated congestion and chokepoints beyond their own properties. Similar activities should be undertaken by other types of freight operations that cannot be easily relocated.
- Innovative funding practices, including public-private partnerships and rights of first refusal, are needed for freight planning and preservation.
- Real estate contracts and other notice-type documents provided to purchasers and lessees should include sections discussing the possible freight-related impacts that may occur as a consequence of living in proximity to freight activities.

Freight Preservation and Protection Strategies

Preservation of freight facilities and corridors is extremely important. The loss of freight facilities, yards, and other ancillary facilities that may serve the network can create bottlenecks, increase costs, and affect consumers through increased prices. Re-parceling lost corridors is often cost-prohibitive and can run up against community complaints. Preservation of freight facilities and corridors can be achieved not only through long-range planning activities, but also through a number of other approaches, including delineation of corridors, freight support and preservation initiatives, maintenance activities, and purchase of corridors to preserve them for future freight use.

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Tools for Achieving Freight-Compatible Development

The concept of freight-compatible development is proposed as an ideal or guiding principle for land-use planning and development. The main objectives of freight-compatible development are to (1) ensure that freight-transportation-related services are not affected by, or do not affect, other land uses that are placed close to the freight corridor or facility; (2) reduce and minimize community impacts that arise because of the proximity of sensitive land uses, including residences, schools, hospitals, and emergency services; and (3) incorporate the preservation and protection of freight facilities and corridors as a forward-looking component of general planning and economic development policies.

However, in many cases, incompatible land uses already exist close to freight-transportation-related services, and conflict already exists. In these cases, at least in the short run, measures such as design standards and mitigation approaches are a means to minimize conflicts.

Four major tools are available—either individually or in combination—to achieve the goals of freight-compatible development. These are

1. Long-range planning,
2. Zoning and design,
3. Mitigation, and
4. Education and outreach.

Table S-1 lists some of the specific freight corridor and facility preservation and protection strategies under the four major tools that can be used to achieve better freight-compatible development. Table S-1 is not an exhaustive list that covers every possible scenario. Rather, it is

Table S-1. Tools for achieving freight-compatible development.

Long-Range Planning	Zoning and Design	Mitigation	Education and Outreach
State Enabling Acts	Zoning Standards	Buffer Areas	Informal Negotiations
Regional Visioning	Buffer Areas	Noise and Vibration Treatment	Public Involvement
Comprehensive Plans	Overlay Districts	Track Treatment	Multi-Jurisdictional Agreements
Freight Facility Inventories	Lot Orientation	Yard Re-Alignment	Stakeholder Round Tables and Freight/Community Committees
Official Maps	Property Design	Grade Crossing Management	
Purchase and Advance Acquisition	Construction Standards	Port Gate Management	
Land Swaps	Sound Proofing Standards	Environmental Measures	
Protective Condemnation		Zoning Measures	
Permit Development		Public Outreach and Education	
Access Rights		Relocation	

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designed to provide examples of tools, policies, and strategies that have been found to be effective in particular contexts.

All of the tools described in this report, and found in more detail on the EnvisionFreight website, http://www.EnvisionFreight.com, can be utilized by different stakeholders as they plan to prevent, consider, and, in some instances, deal with conflicts that arise because of the proximity of incompatible types of land uses near freight facilities. The following are examples of how various stakeholders can use the EnvisionFreight website.

For planners and elected officials, EnvisionFreight has been designed to help to

- Understand how freight fits into the local, national, and global economy;
- Understand the issues that arise from conflicts and how they impact freight-transportation-related services and a community; and
- Consider the kinds of tools, scenarios, communication, and educational outreach that they might want to use to improve freight planning and preservation capacity.

For developers, EnvisionFreight aims to ensure that they consider how freight activities may affect and intersect with residential and other sensitive types of land use they may be planning.

For freight entities, EnvisionFreight is intended to provide education and assistance regarding land-use planning and zoning processes.

For individual citizens or community groups, the goal of EnvisionFreight is to provide basic information about the various freight modes as well as impacts that arise because of freight activity and proximity to incompatible land uses, and show some of the types of tools that can be utilized to more effectively plan for freight.

For state legislators and staff, EnvisionFreight is designed to provide information and ideas for potential legislative changes that would facilitate better integration of freight and land-use planning.

The Role of Planning and Zoning

Figure S-6 summarizes the planning and zoning process and the role of various elements, including regional visioning, long-range planning, and the comprehensive plan. An important goal of freight-compatible development is to effectively use these tools so that mitigation measures are not necessary or are minimized.

Process	Time Horizon	Scale	Subjects
Regional vision	25–50 years	Regional	Multi-issue
MPO long-range plan	20-30 years	Metropolitan area	Transportation
Comprehensive plan	20 years+	City or county	Land use, transportation
Zoning	≈10 years	City or county, often adjusted for specific project	Land use
Site plans & subdivisions	Today	Specific project or phase of project	Land use & infrastructure

Many of these processes are authorized, mandated, and/or regulated by state enabling acts

Source: Grow & Bruening.

Figure S-6. Planning process summary.

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CHAPTER 1

Introduction

NCFRP Report 16 is the final report of NCFRP Project 24, "Preserving and Protecting Freight Infrastructure and Routes" (FY 2009). An important aspect of freight preservation and protection activities is the prevention or resolution of potential conflicts between land use for freight transportation purposes and alternative uses.

This report

- Presents information about freight transportation and its importance to everyday life;
- Illustrates types of conflicts between freight and other land uses, as well as their consequences; and
- Provides tools and resources to preserve freight facilities and corridors, including prevention and resolution of these conflicts.

The target audience for this study consists of decision makers involved in freight facility operations, freight transportation planning, and land-use decisions. This includes state departments of commerce and transportation, MPOs, local officials and their planning offices, legislators and their staffs, freight facility developers, freight operators, and real estate concerns.

The Importance of Freight Transportation

A smoothly functioning freight transportation network is essential to the operation of the U.S. economy. Efficient freight transportation is a very important part of producing products and getting them to consumers. Freight transportation services are combined with other logistics inputs such as warehouses, inventories, and information technology in order to provide goods and services to final consumers in a timely fashion.

According to the most recent information from the U.S. Commodity Flow Survey (CFS), on average, 42 tons of freight worth $39,000 was delivered to every person in the United States in 2007. When considering the distance involved in transporting this freight, an average of 11,000 ton-miles was delivered to every person in the country. To gain perspective on the amount of transportation involved, this is equivalent to carrying one ton of freight for every man, woman, and child in the United States 11,000 miles, or each of the 42 tons of freight for every person over 260 miles.

Quite simply, the highly specialized system of producing and distributing products to consumers that is the cornerstone of our economy could not exist without the freight transportation network. Freight is hauled by various transportation modes—truck, rail, air, water—and combinations of these modes. The choice of transportation modes or combinations of modes depends on a number of factors including type and value of commodity, shipment size, distance, and desired speed and reliability of transportation.

Conflicts between Freight and Other Land Uses

U.S. economic and population growth creates increasing competition for the land resources underlying the freight transportation infrastructure. Amid such competition, a key to preserving freight transportation facilities and corridors is to prevent or resolve conflicts between freight-transportation-related services and other land uses. Some conflicts are obvious, such as bridge interference with the vertical clearance of railroad corridors or other shipping lanes. Other conflicts may not be as apparent, such as noise, vibration, or environmental effects caused by freight activities.

From the perspective of the community at large, these conflicts generally lead to nuisance, safety, or health concerns. From the perspective of freight interests, these conflicts can create barriers to efficient transportation that diminish economic performance.

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Preservation and Protection Strategies and Freight-Compatible Development

Preservation of freight facilities and corridors is extremely important. The loss of freight facilities, yards, and other ancillary facilities that may serve the network can create bottlenecks, increase costs, and potentially affect consumers through increased prices. Re-parceling lost corridors is often cost-prohibitive and can run up against community complaints. Preservation of freight facilities and corridors can be achieved not only through long-range planning activities, but also through other approaches, including delineation of corridors, freight support and preservation initiatives, maintenance activities, and purchase of corridors to preserve them for future freight use.

The goal of *freight-compatible development* is to preserve existing freight facilities and corridors, effectively plan for future freight activities, and reduce impacts that occur because of the proximity of incompatible land uses around freight corridors and facilities. Thus, the main objectives of freight-compatible development are to (1) ensure that freight-transportation-related services are not affected by, or do not affect, other land uses placed close to freight corridors or facilities; (2) reduce and minimize community impacts that arise because of the proximity of sensitive land uses, including residences, schools, hospitals, and emergency services; and (3) incorporate the preservation and protection of freight facilities and corridors as a forward-looking component of general planning and economic development policies.

In many cases, incompatible land uses already exist close to freight-transportation-related services, and conflict already exists. In these cases, at least in the short run, measures such as design standards and mitigation approaches are a means to minimize conflicts. In the future, preservation of these facilities and corridors should become a normal part of the planning activities performed at the local level. This also requires that local jurisdictions and regional and state planning agencies partner and work together to create seamless integration of freight transportation planning across jurisdictional levels.

Four major tools are available—either individually or in combination—to achieve the goals of freight-compatible development. These are

1. Long-range planning,
2. Zoning and design,
3. Mitigation, and
4. Education and outreach.

EnvisionFreight Website and Guidebook

An innovative contribution of NCFRP Project 24 is the development of a website, http://www.EnvisionFreight.com, which is intended to complement the final report. The "beta" version of the website was previewed at the NCFRP Project 24 workshop, held in January 2011. For many of the topics covered in this report, more detailed materials are available on the website. References to these website materials are provided in this report where relevant. Appendices are available on CD-ROM.

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CHAPTER 2

The Role of Freight Transportation in Product Supply Chains

Transportation services are needed to deliver raw and intermediate materials to producers and to deliver final products to retailers and final customers. Supply chain management (SCM) involves decisions about what to produce, what inputs to use, how to configure a distribution network, how much inventory to maintain, and how to transport inputs and products. Logistics management is the part of SCM that involves decisions about how and when to get raw materials, intermediate goods, and finished goods from their respective origins to their destinations. Included in logistics management are choices of modes of transportation (rail, truck, water, etc.), shipment characteristics (less-than-load vs. full load, etc.), warehousing, and levels of inventories to maintain. These are interrelated and not independent decisions.

This chapter provides an overview of the role of transportation in product supply chains, a description of the U.S. freight transportation system, and an illustration of how conflicts between freight and other land uses can disrupt supply chains. More details on these issues can be found on the EnvisionFreight website, http://www.EnvisionFreight.com/.

Supply Chains and Transportation

Many factors affect producers' logistical choices and supply chain configurations. These include the costs of transportation modes, reliability of transportation modes, the ease of switching between modes, the costs of holding inventory, and the amount of logistical costs as a share of total production, distribution, and marketing costs. Some of these other logistics inputs can be used as substitutes for freight transportation, while others are complements. For example, if a firm cannot rely on fast and reliable transportation, it can still accommodate the demands of its customers by siting its warehouses closer to its customers (while at the same time constructing warehouses with smaller capacity), increasing its inventory levels so that it can respond to unexpected increases in final demand, and/or siting its production closer to the locations of its final demand (once again requiring that each production site have smaller capacity). When transportation services are improved, the firm can better optimize warehouse and production operations and maintain lower overall inventory levels. Improvements in information technology also can improve the utilization of transportation services, making them more attractive relative to the use of other logistics inputs. An example of this complementary relationship is the widespread adoption of just-in-time inventory management. With just-in-time inventory management, fast and reliable transportation has been combined with information technology to reduce the need for maintaining large inventories, improving the overall efficiency of the logistics process.

In general, some shipper responses to changes in transportation costs and reliability are short-term in nature, while others are for the longer run. For example, consider the impact of an increase in rail rates. In the short run, the producer might consider drawing down inventories with the plan to rebuild them when rail rates come back down. If the rate increase is viewed as permanent, the producer might seek alternative modes of transportation and, to the extent possible, decrease use of rail transportation; but this might take a bit more time than drawing on inventories. In the much longer run, the producer could make changes to plant location and distribution design. It should be noted, however, that even in the long run, some shippers may still have limited options. For example, the site of a coal-burning electricity generating plant is essentially fixed (although the plant operator has some flexibility in the use of the plant's capacity and its dispatch order). A recent study by the U.S. General Accountability Office (GAO) discusses the adjustments businesses may make in response to reduced freight reliability in their supply chains. Adjustments could include carrying higher inventories in warehouses for meeting production needs, planning for longer-than-normal transit time, and not serving specific markets that cannot be reliably accessed. Furthermore, industries that use just-in-time production processes that rely on predictable transportation are especially

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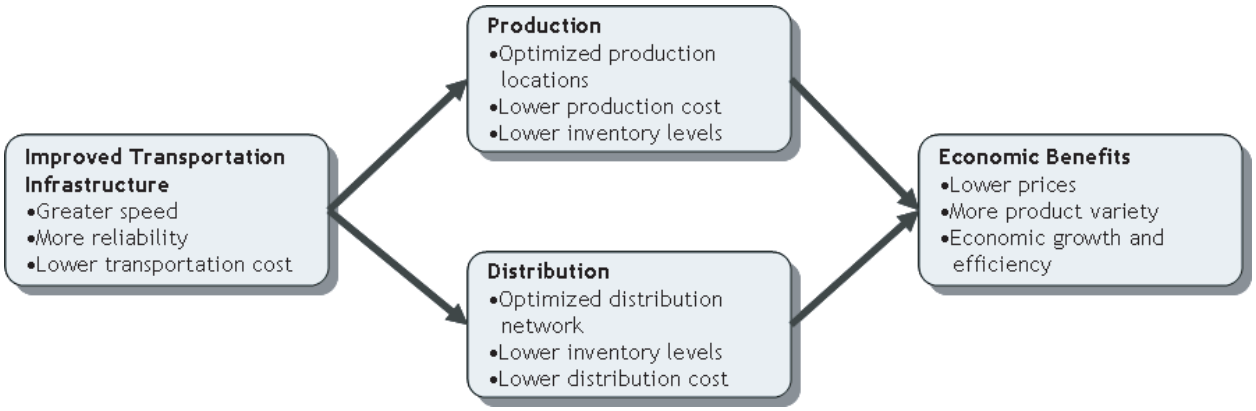

Source: Christensen Associates.

Figure 2-1. The role of freight transportation in efficient production and distribution.

likely to be affected by diminished freight transportation reliability (U.S. General Accountability Office 2008, 21).

Figure 2-1 illustrates the vital link between freight transportation in supply chains and economic performance. Improvements in freight transportation efficiency, reliability, and level of service have numerous economic benefits for production efficiency, optimization of distribution networks, and product choice and cost to consumers. As improvements are made in transportation infrastructure, producers are able to centralize their production operations and site their operations in lower-cost areas, because the uncertainties concerning the movement of goods to customers are reduced. Improvements in transportation infrastructure also allow a more efficient design of the distribution network. The cost of inventories can be reduced as the needed hedge against transportation uncertainties is reduced. This also allows firms to change their inventories quickly in response to customers' changing needs or desires. This ultimately leads to lower cost and greater product variety for customers.

Figures 2-2 through 2-4 provide examples of the role of transportation product supply chains. Figure 2-2 shows the various stages of automotive manufacturing. Connections between the stages consist of some mode of transportation. In the case of auto manufacturing, truck and rail are the primary modes of transportation between the stages of production.

Figure 2-3 shows the top ports through which imported containerized goods enter the United States. These goods, which range from consumer goods to parts and unfinished goods for further processing, reach inland destinations via truck, rail, and/or water over the domestic transportation infrastructure.

Figure 2-4 illustrates the role of transportation in the export of grain from the production stage to its arrival in the destination country. In this supply chain, truck, rail, barge, and ship are the modes of transportation that are typically involved.

Examples of the role of transportation in the supply chains of various commodities can be found in a series of case studies on the EnvisionFreight website at http://www.EnvisionFreight.com/value/. These include short commodity, imported containerized goods, and grain.

The U.S. Freight Transportation System

In 2008, 4.5 million people were employed in transportation and warehousing industries in the United States, a little over 3 percent of total U.S. employment. Trucking was the largest employer within the for-hire transportation section with almost 1.4 million employed. The railroad industry employed 231,000, and water transportation employed 67,000. Another key component of logistics services and supply chains, warehousing and storage, employed 672,000 (U.S. Department of Transportation RITA/BTS 2010, Table 3-19b). The latest available data (2007) show that there were almost 220,000 employer establishments in the transportation and warehousing sector of the U.S. economy with revenues of almost $640 billion and annual payrolls of more than $173 billion. In addition, there were more than 1 million non-employer establishments with revenues of almost $67 billion (U.S. Census Bureau 2007).

A study prepared for FHWA reports that transportation costs accounted for 63 percent of 2002 logistics costs, inventory carrying costs (including warehousing, interest costs, taxes, obsolescence, depreciation, and insurance) accounted for 33 percent, and administration accounted for 4 percent. In 2002, transportation costs were composed of intercity truck (50 percent), local truck (27 percent), railroad (6 percent), logistics administration (6 percent), water (4 percent), air (4 percent), oil pipelines (1 percent), and shipper-related costs (1 percent). Relative to the overall economy, total logistics costs were equal to almost 9 percent of U.S. gross domestic

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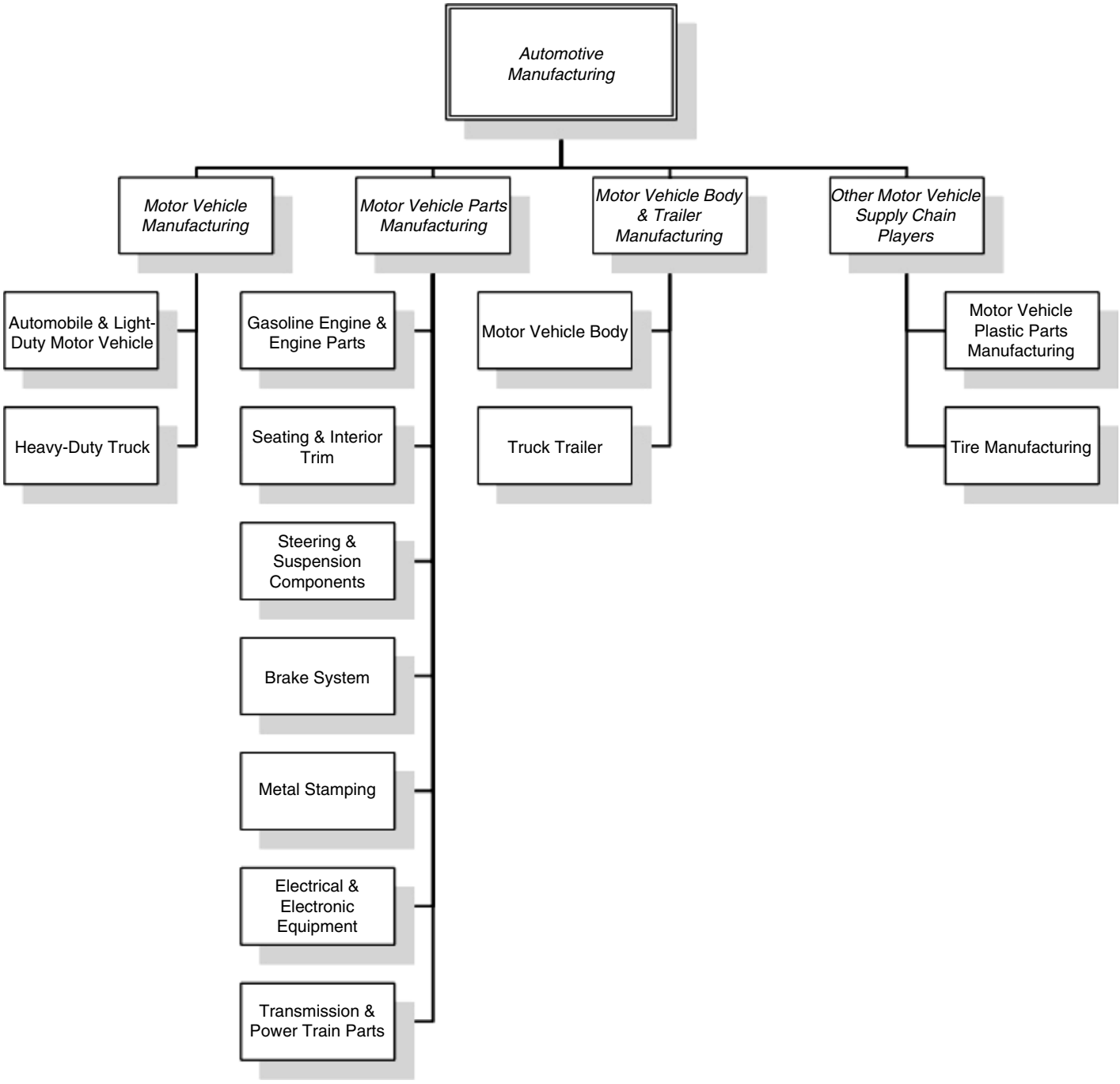

Source: Christensen Associates.

Figure 2-2. Automotive manufacturing supply chain.

product (GDP) in 2002 (MarcoSys Research and Technology 2005, 7-8). An update of these figures indicates total logistics costs climbed to 10.1 percent of GDP in 2007 and fell to 7.7 percent of GDP in 2009 (Material Handling & Logistics 2010).

The U.S. surface freight transportation network includes 4,016,741 miles of highways, 94,942 miles of Class I freight railroad tracks, 46,474 miles of regional and shortline railroad tracks, and 26,000 miles of navigable inland waterways (U.S. Department of Transportation RITA/BTS 2010, Table 2-1-1). Other important components of the freight transportation network include air freight and pipelines.

An illustration of the importance of U.S. freight transportation corridors and transportation modes is found in Figure 2-5, which shows freight tonnage on U.S. highways, railroads, and inland waterways. Figure 2-5 illustrates two key features of

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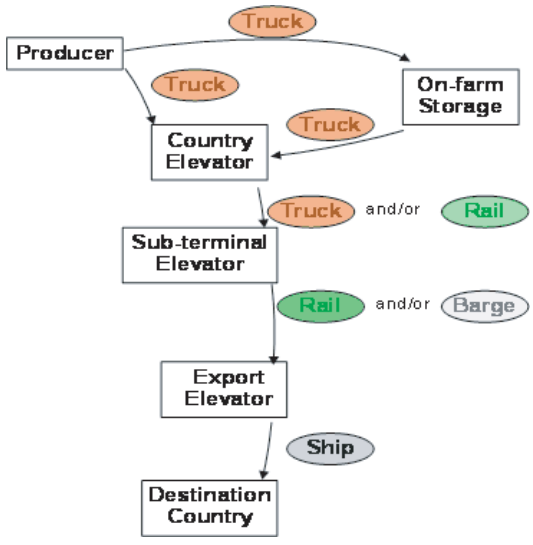
Figure 2-3. Top 25 container ports for U.S. international maritime freight, 2008 (U.S. Department of Transportation RITA/BTS 2009a).



Source: Christensen Associates.

Figure 2-4. Typical modal flow of grain exports.

today's transportation network. First, the figure illustrates how supply chains extend across the country and into other parts of the world via key ports such as Los Angeles/Long Beach and New York/New Jersey, which are gateways to foreign trade as well as the origins and destinations of substantial shipments throughout the United States. Second, the figure shows that a substantial amount of freight is transported along a handful of key corridors. In addition to the rail traffic coming out of the Power River Basin in Wyoming and water traffic along the Mississippi and Ohio rivers, there are dense corridors of highway traffic throughout the eastern part of the United States and along the West Coast. Figure 2-5 also illustrates the importance of the Chicago area as a key U.S. freight transportation hub.

In terms of volume of freight hauled by transportation mode, Figure 2-6 illustrates the growing importance of truck and rail relative to other modes of freight transportation, because their shares of domestic ton-miles of freight increased significantly between 1980 and 2007. Associated with the increased proportions of rail and truck ton-miles were

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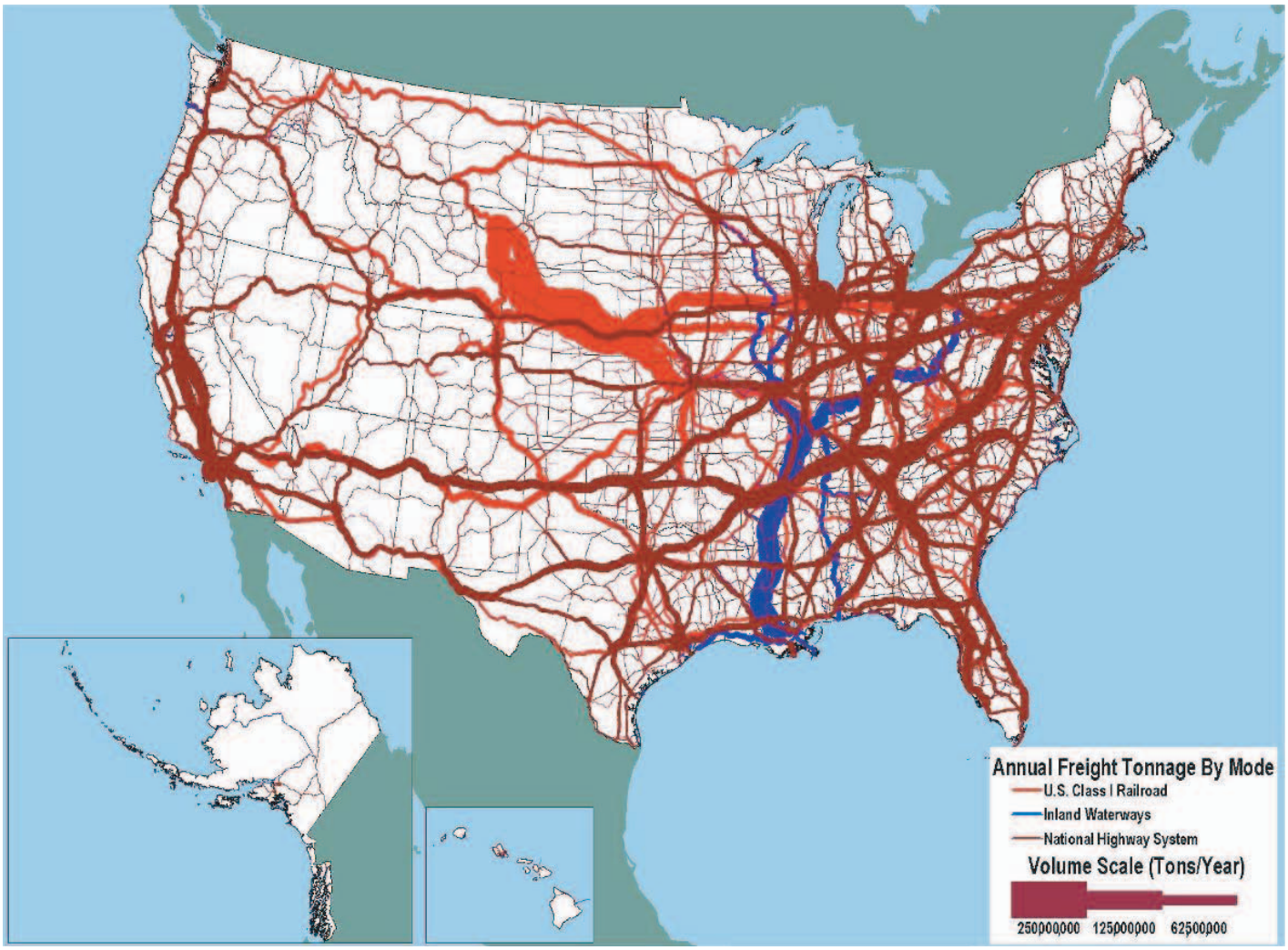

Figure 2-5. Tonnage on U.S. highways, railroads, and inland waterways (U.S. Department of Transportation FHWA FM&O 2007).

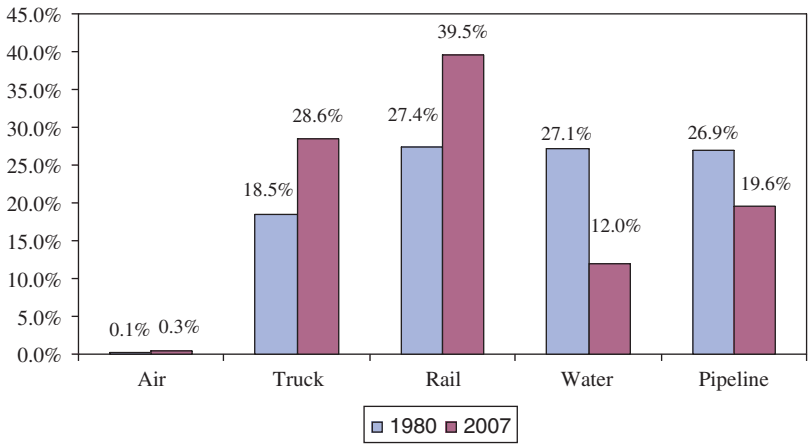

Figure 2-6. Shares of domestic ton-miles by mode, 1980 and 2007 (U.S. Department of Transportation RITA/BTS 2010, Table 1-46b).

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significant pieces of legislation that largely deregulated these industries—the Staggers Rail Act of 1980 and the Motor Carrier Act of 1980. Intermodal shipments also are growing in importance, particularly truck and rail, in terms of ton-miles, and truck and air for high-value and/or time-sensitive shipments (e.g., UPS and FedEx).

The U.S. Commodity Flow Survey (CFS), produced through a partnership of the Bureau of Transportation Statistics and the Census Bureau, provides a comparison of the value of shipments and the weight and distance of shipments (e.g., ton-miles) by various transportation modes. For example, while rail accounted for about 40 percent of CFS ton-miles, rail shipments composed only about 4 percent of CFS shipment value in 2007. These figures reflect that rail shipments largely consist of lower-value commodities that are shipped relatively longer distances (e.g., coal). In contrast, trucking accounted for 29 percent of CFS ton-miles but over 70 percent of CFS shipment value in 2007. Intermodal shipments (not shown in Figure 2-6) accounted for about 12 percent of CFS ton-miles and 16 percent of CFS shipment value in 2007 (U.S. Department of Transportation RITA/BTS 2009a).

Figure 2-7 illustrates the top gateways (by value) for U.S. foreign trade. The top water gateways are the Ports of Los Angeles and Long Beach on the West Coast, the Port of New York and New Jersey on the East Coast, and the Port of Houston on the Gulf Coast. The top air gateways are JFK International Airport in New York, O'Hare International Airport in Chicago, and Los Angeles International Airport. The top land gateways are Detroit, Michigan; Laredo, Texas; and Port Huron, Michigan.

A description of the various freight transportation modes and some of the major conflicts and forms of encroachment they face can be found on the EnvisionFreight website at http://www.EnvisionFreight.com/modes/.

The Effects of Capacity and Congestion on Freight Transportation

The expected travel times of shipments and the variance of these expected travel times (i.e., reliability) is a reflection of the transportation network's capacity and the degree of network congestion. Both capacity and congestion can be affected by the conflicting land uses with freight-transportation-related services, such as the degree of encroachment of freight corridors and facilities. If congestion increases the average travel time or its variance, the level of transportation service declines. The degree to which shippers respond to increased congestion with changes in logistics choices is dependent upon the degree

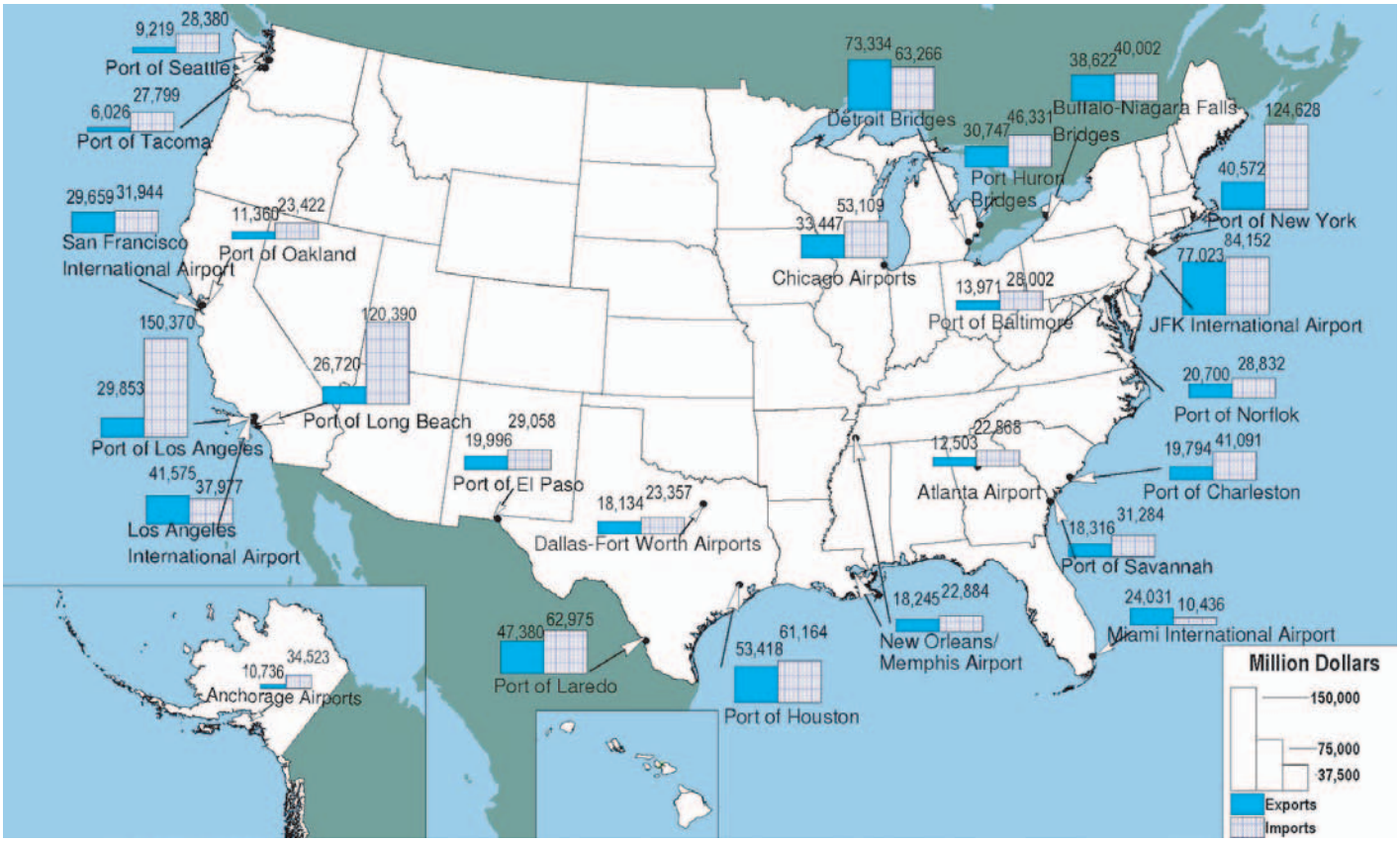

Figure 2-7. Top 25 foreign trade gateways by value, 2007 (U.S. Department of Transportation FHWA 2007).

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to which logistics inputs, including alternative transportation modes, can be substituted for each other. The responsiveness of transportation demand with respect to changes in congestion is typically smaller in the short run than in the long run. For example, suppose that there is a reduction in congestion levels for a particular rail corridor due to the resolution of encroachment issues, such as the elimination of grade crossings. In the very short run, contractual commitments and production schedules may limit the degree to which the firm can take advantage of this reduced congestion. In a slightly longer timeframe, the firm may be able to shift some of its highway transportation to this now less congested rail corridor. In the longer run, firms may decide to relocate production operations and warehouses to make further use of that rail corridor. This will lead to further shifts in transportation utilization across modes and corridors.

Given that most corridors are shared use, congestion is caused by a combination of both freight and passenger volumes. However, major contributions to congestion also include insufficient transportation capacity and/or inability to expand capacity. These capacity constraints are often related to encroachment issues such as physical barriers and incompatible adjacent land uses, particularly in densely populated areas. The GAO study reports that areas surrounding critical freight infrastructure are increasingly dense with development, making it more difficult and expensive to build or expand centrally located freight facilities. The GAO study notes that land near the Port of New York that was previously vacant or used for freight warehouses has recently been redeveloped into high-value commercial and residential property. As a result, freight distribution centers have moved away from the urban core to the New Jersey suburbs and eastern Pennsylvania where land values are comparatively low. However, access to ports is more difficult from these locations (U.S. General Accountability Office 2008, 14–15).

Congestion that affects freight mobility has direct effects on users of freight transportation such as producers and end users of the products. Transportation costs and increases in these costs due to congestion are factored into the prices of the goods being transported. The GAO study cites one study that estimates that roadway congestion delays cost shippers approximately $10 billion per year and notes that although the freight sector experiences about 27 percent of congestion costs, truck traffic represents only 5 percent of total vehicle miles (U.S. General Accountability Office 2008, 18–19). A study by Winston and Shirley analyzed the impact of highway congestion on shippers' inventory costs. These costs are related to the importance of timeliness of the goods being shipped and the consequences of additional transit times. Congestion also forces a shipper to hold higher inventories, which increases inventory holding costs. The authors concluded that $7 billion is the best estimate of inventory costs incurred by shippers for delays of shipments due to highway congestion (Winston and Shirley 2004, 1). There are a number of indirect effects of freight transportation congestion as well. Such indirect effects include the costs of congestion on passenger traffic and negative environmental effects, such as increased air pollution.

The effects of congestion on freight mobility, reliability, and costs have future implications for supply chains and logistics. For example, the GAO study observes that current supply chain strategies may not be economically beneficial in the future should freight mobility decline, and there are increasing costs in the form of higher transportation costs, higher warehousing and operational costs, or missed opportunities for other investments of production (U.S. General Accountability Office 2008, 21).

The costs associated with encroachment can affect a variety of producers and consumers distributed over wide geographic regions. The fact that these costs are dispersed and encroachment issues may not be particularly newsworthy can create situations in which planners may not be aware of the full economic impact of encroachment. Furthermore, because the importance of freight transportation in supply chains often spans broad geographic expanses, the widely dispersed benefits of preventing or relieving freight corridor encroachment also are difficult to assess from a more localized perspective. Costs and benefits of encroachment can be viewed from two perspectives—the costs and benefits associated with the status quo, and the costs and benefits associated with changes to the current situation (e.g., preventing or alleviating encroachment). It is these two perspectives that provide the framework for properly assessing encroachment issues. Without the appropriate perspective and tools, there is a high probability of inadequately assessing both the costs of encroachment and the economic benefits derived from freight corridors.

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CHAPTER 3

Overview of Conflicting Land Uses and Freight-Transportation-Related Services

When competing and incompatible land uses exist in close proximity to each other, these uses often interfere with each other, resulting in potential conflicts between them. For example, a freight yard or corridor located near a residential neighborhood, school, or hospital is often a source of conflict. Conflicts could be physical in nature and/or involve nuisance, health, or safety concerns. For the individual, these conflicts often create nuisance and pollution issues that can imperil the peaceful enjoyment of one's property, or are the source of safety issues. From the perspective of planning agencies, planning to reduce these types of conflicts is extremely difficult given the immense pressure local jurisdictions face to ensure that tax revenues stay constant and that land is developed according to its highest and best use. From the freight perspective, these conflicts often result in barriers to efficient freight transportation.

This chapter provides an overview of conflicting land uses and their impact on freight-transportation-related services. Chapter 4 provides greater detail on these issues, including the sources of such conflicts and possible solutions for the preservation and protection of freight infrastructure and routes.

Conflicting Land Uses

Most land uses related to residential, educational, and medical use often are incompatible with freight activity. Among the major conflicts non-freight interests have with freight-transportation-related services are the following:

- Air and water pollution,
- Light pollution,
- Noise pollution,
- Effects of vibration,
- Safety issues, and
- Congestion.

Some conflicts—such as noise, light, and vibration—are common to all of the primary freight modes. Other conflicts are more specific to particular modes. For example, the potential for dangerous trespass tends to be specific to railroads. Figure 3-1 shows the main conflicts that arise with respect to freight activity.

Another issue that cannot be ignored in this context is that local jurisdictions have an incentive to maximize property and sales tax revenues. In many cases, this has created pressure to change zoning designations from industrial to non-industrial classifications if it is believed that non-industrial uses will generate greater tax revenues. Demand for affordable land that is situated near city and downtown amenities has also aggravated this issue, since many freight facilities are situated in these areas because of their long history.

Not surprisingly, these conflicts often affect property values. Differing land uses can have adverse effects on landowners due to either rising or falling values, depending on the use involved. For example, freight-transportation-related services can lower property values because of noise, vibration, pollution, and general access issues, potentially resulting in pressure from other landowners to move the freight operation. On the other hand, land uses such as residential neighborhoods and commercial districts that are incompatible with freight-transportation-related services can cause a rise in property values and property taxes, making freight-transportation-related services in the area more expensive.

Barriers to Freight-Transportation-Related Services

From the perspective of freight interests, barriers to efficient freight-transportation-related services often emerge as a result of unresolved conflicts. Barriers or impediments to the economically efficient transportation of freight can be due to numerous factors, including land-use decisions that create conflicts with other land uses, insufficient funding for the maintenance or expansion of freight facilities and corridors, and public policy decisions that impede or do not sufficiently accommodate the needs of freight transportation.

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Noise Sensitive Uses	Dwelling units (residential, motels, etc.); educational uses (childcare, schools, colleges, etc.); libraries; hospitals and other residential health care providers; playgrounds.
Light Sensitive Uses	Dwelling units (residential, motels, etc.); and hospitals and other residential health care providers.
Vibration Sensitive Uses	Dwelling units; educational uses; vibration sensitive industries (such as precision high-tech industry); all buildings not constructed to withstand the fatigue caused by rail vibrations.
Pollution/Air Quality Sensitive Uses	Dwelling units (residential, motels, etc.); medical (hospitals and other residential health care providers); educational(childcare, schools, colleges, etc.); park and recreational facilities.
Uses Requiring Potentially Incompatible At-grade Crossings	Dwelling units; educational uses; libraries; hospitals and other residential health care providers; commercial uses; emergency services; park and recreational facilities.
Uses Associated with the Potential for Dangerous Trespass	Dwelling units; education uses (especially childcare facilities and schools); libraries; playgrounds; commercial uses.
Time Sensitive Uses	Night-time sensitive uses*; dwelling units, hospitals and residential care facilities.
Traffic and Congestion Sensitive Uses	Dwelling units; emergency service provider uses; residential health care facilities.
Height Sensitive Uses	Residential and commercial uses that may impact approach and landing flight paths.

* Nighttime sensitive uses are those types of uses that may cause disruption in the sleep pattern of an individual. The Day night average noise level that was developed by the Department of Housing and Urban Development recognizes the heightened community annoyance caused by late-night or early-morning operations of certain industries and transportation uses. Where nighttime sensitive uses is utilized, it specifically refers to freight activities that may create noise that impacts residential land uses.

Source: UT-CTR.

Figure 3-1. Land uses and conflicts adjacent to freight activity.

Such barriers typically result in increased production and distribution costs. In this context, examples of potential barriers or interference with freight-transportation-related services include the following:

- Speed restrictions;
- Limitations on hours of operation;
- Height and clearance impacts;
- Size and weight limitations;
- Corridor design impacts;
- Environmental permitting;
- Limitations on dredging operations and/or depositing of dredged material;
- Backlog of waterway lock or channel maintenance;
- Hazardous material (hazmat) routing restrictions; and
- Gentrification that displaces, impedes, or increases the costs of freight transportation.

Some of these barriers can be specific to a particular mode (e.g., highway and road design impacts on trucking activities or dredging impacts on waterway transportation), while other barriers may be more general across modes (e.g., limitations on hours of operation). Barriers not only affect freight activities along particular corridors and facilities, but they also may affect route choices and the ability to access freight and manufacturing facilities. For example, if roads are designed with turning radii that are too tight, particular types of trucks may not be able to use these routes or access facilities that use these roads.

Conflicts and Barriers Matrices

The types of conflicts and resulting barriers to efficient freight transportation are summarized in the conflicts and barriers matrices found in Appendix A.

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CHAPTER 4

Issues Identified and Lessons Learned from NCFRP Project 24 Case Studies and Surveys

Introduction

The NCFRP Project 24 research team produced six case studies (Table 4-1) to illustrate examples of dealing with actual or potential conflicts between freight and other land uses. These real world examples provide a unique contribution to the understanding of the variety of freight preservation issues that have been encountered around the country and the complex nature of solutions to these issues. Although each case study was borne out of particular geographic and historic contexts, the purpose of this illustration is to demonstrate potentially transferable solutions that have been undertaken around the United States. Some case studies focused on a specific infrastructure asset to be preserved, while others involved comprehensive plans governing a broad area. The full case studies can be found in Appendixes B through F and on the EnvisionFreight website at http://www.EnvisionFreight.com/issues/ and on CRP-CD-105.

Information also was collected by two surveys that were conducted during the course of NCFRP Project 24—a freight industry survey and a public sector survey for planners in local levels of government and MPOs. The surveys are described in Appendix J.

From these case studies, surveys, and other research conducted by the project team, a number of underlying causes of conflict were identified, as were process improvements for preventing or resolving land-use conflicts. The following factors were identified as underlying causes of conflict:

- Planning for freight is generally inadequate;
- Zoning approaches regarding freight are typically inadequate;
- Funding for planning, corridor preservation, and conflict mitigation is often lacking or insufficient; and
- Lack of communication exists among stakeholders.

The following general process improvements for preventing or resolving land-use conflicts identified were:

- Improved planning and zoning practices,
- Cooperative regional planning,
- Improved notification procedures,
- Innovative funding practices, and
- Efforts at better communication between stakeholder groups.

Sources of Conflict Between Freight and Other Land Uses

Inadequate approaches to land-use planning and zoning are obvious candidates for sources of conflict between freight and other land uses. Perhaps not so obvious, the research effort also found that inadequate funding for planning, corridor preservation, and mitigation, as well as a lack of effective communication and cooperation among interested stakeholder groups (e.g., freight interests, residential and commercial interests, residents, and the public sector), are important contributors to such conflict.

Planning and Zoning for Freight Is Generally Inadequate

The primary forum where conflicts between freight and other land uses are either avoided or created is the land-use planning area. As a general rule, nothing is built in America unless and until the use of the land involved has been approved in a city or county general plan, the property has been specifically zoned for that use, a development site plan has been approved, and a building permit issued. These are all local government functions. Almost all issues about future land uses that may affect the present or future viability of ports, rail lines, airports, highways, and other freight facilities arise—or come to a head—in the context of zoning or development site plan approvals.

Land-use planning is primarily controlled by local governments with input from state and regional entities, such as state DOTs, MPOs, councils of governments (COGs), or regional

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Table 4-1. NCFRP Project 24 case studies.

Case Study	Mode	Government Level
Staten Island, NY, Railroad (Appendix B)	Rail, Port	State, Regional, Local
Baltimore, MD, Maritime Industrial Zoning Overlay District (Appendix C)	Port	State, Local
Portland, OR, Guilds Lake Industrial Sanctuary District (Appendix D)	Waterway, Rail, Trucking	Local
Joliet Arsenal, IL, Redevelopment (Appendix E)	Intermodal–Rail, Trucking	Federal, State, Regional, Local
Norfolk Southern, Austell, GA, Terminal Relocation (Appendix E)	Intermodal–Rail, Trucking	Regional, Local
Atlanta, GA, Regional Freight Mobility Plan (Appendix F)	Rail, Trucking, Air	Regional, Local

visioning organizations. Zoning and site plan decisions are made in the context of a city or county's general or comprehensive plan, which contains the desired long-term development form for the local jurisdiction. Developers, homebuilders, and landowners often make property acquisition, investment, and planning decisions based on the local general or comprehensive plan.

Accommodation of freight needs in land-use planning is typically not conducted in a comprehensive fashion in state, regional, or local venues. Most general or comprehensive plans, as well as most zoning codes, do not adequately account for freight needs or potential conflicts. For example, Kansas City, which is a major freight hub, makes almost no mention of freight in its "physical framework plan."

As a root cause for the lack of integration into land-use plans, the researchers found that freight was a seldom-mentioned topic within the standard land-use planning curriculum in most universities. Furthermore, it was not found to be a common topic of seminars or continuing education courses for planning professionals. Many local planners view freight as a state or federal issue. Most state codes contain required or optional elements to be included in local comprehensive or general plans; however, with few exceptions, freight is not mentioned with respect to land-use issues.

Moreover, little design guidance for developing around freight facilities or corridors is readily available. The best examples of design guidelines that the research team could find were (1) the guidelines developed by the U.S. Department of Housing and Urban Development (HUD) in the early 1980s for HUD-assisted developments near or adjacent to hazardous commercial and industrial facilities and (2) guidelines produced by the California Air Resource Board in its *Air Quality and Land Use Handbook,* which provides recommendations for siting new sensitive land uses such as residences, schools, and playgrounds beside rail yards, distribution centers, truck stops, and airports. Although airports provide the best guidance for noise and vibration mitigation in their manuals, aircraft noise is quite different from noise created by trains, trucks, or port activity. Furthermore, most airport planning manuals do not consider the nuisance created by light. Thus, a "one-size-fits-all" approach does not adequately address issues encountered by the various freight transportation modes; issues faced by different modes require different approaches.

General awareness of freight activity is further hindered by the inadequate identification of freight facilities and corridors on maps used for planning purposes. The lack of information about the location of freight facilities and corridors contributes to the granting of zoning, permitting, and variance requests that place incompatible land uses (e.g., residential developments) in close proximity to freight activities, or even encroaching on freight corridors. As the Atlanta Regional Freight Mobility Plan (ARFMP) case study indicates, mapping of freight facilities is a significant and expensive undertaking. Although private entities, such as railroads, have detailed maps of their facilities, they may be hesitant to enter them into the public record, because they may contain confidential and competitively sensitive information.

Another reason for the failure to incorporate freight in land-use planning is the lack of involvement of freight entities in local land-use and transportation visioning and planning processes. Freight entities may be notified of specific project proposals when they own property in proximity to the proposed project, but they generally are not seen as key stakeholders in local land-use planning and zoning decisions.

Another important zoning issue that confronts revenue-strapped localities is the amount of tax revenue to be collected from parcels of land and their uses. Zoning to protect

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or preserve freight facilities and corridors can lead to a short-term loss of revenues for a community. Baltimore's Maritime Industrial Zoning Overlay District (MIZOD) was critiqued on this front by researchers at the Abell Foundation, who noted that unconditional preservation and protection of under-utilized or marginal properties denied a cash-starved city, with the highest tax rate in the state, the opportunity to generate greater benefits from otherwise feasible alternative uses. Finding the right combination of zoning (both proscriptive and prescriptive) to promote, protect, and preserve freight facilities and corridors without depriving the local area of legitimate development opportunities is a delicate balancing act.

Multimodal freight needs are not well integrated into comprehensive and general plans and zoning structures. Because freight needs are not adequately accounted for, inadequate comprehensive plans are produced that create the potential for recurrent conflict. Similarly, zoning codes generally do not protect freight facilities from conflicts, and there is no readily available specific model freight zoning code that could be adopted by local jurisdictions. For example, although typical zoning codes might include generic industrial classifications, they do not conform to the specific attributes or needs of freight activity. Furthermore, although industrial zoning designations may be applied to freight facilities, they do not extend to corridors.

State and regional planning does not do much to fill the gap. Most state DOTs and MPO long-range plans deal with freight only in a cursory way, largely because of a lack of resources. A 2003 survey found that only 22 percent of MPOs have a staff person dedicated to freight, and most MPOs spend less than 5 percent of their staff time on freight (Association of Metropolitan Planning Organizations 2003). Regional visioning processes, such as Envision Utah or Envision Central Texas, rarely put much emphasis on freight. Freight entities generally are not involved as stakeholders in state and regional planning and visioning processes.

In summary, notwithstanding the considerable time, money, and staffing effort (both public and private sector) involved in land-use planning and zoning efforts, freight and its impact on land use is a topic that is only handled sporadically. Compounding the issues, transportation planning involving freight generally does not deal much with land use.

Funding Often Lacking or Insufficient for Planning or Preservation

Producing information on a region's freight facilities for planning purposes is an expensive undertaking. For example, Atlanta's regional freight planning development cost $4 million and took over 4 years to develop a baseline map of the city's freight network, chokepoints, bottlenecks, and critical facilities. Furthermore, the stated costs do not include time that was donated to this process by both the public and private sector.

Relocation and preservation activities can run into the millions of dollars, particularly when projects are stretched over many years. Although New Jersey and New York both had excellent laws regarding the right of first refusal to purchase rail corridors that may be abandoned, finding access to funding at the moment of abandonment may not always be easy. In the case of the Staten Island Railroad, the State of New York was fortunate in that an ISTEA earmark allowed the corridor to be purchased. However, the New Jersey side of this equation exhausted the fund that the state legislature had created to purchase abandoned rail corridors. This fund has not hitherto been replenished. This also speaks to the importance of understanding just how imperative it is to preserve corridors. Repurchasing or re-parceling of any long, linear, and contiguous corridor is cost prohibitive, and the use of eminent domain to aggregate parcels can be very controversial in many locations.

One way to deal with the lack of funding is through proactive planning. It is generally cheaper to avoid conflicts through proactive land-use planning and zoning rather than to mitigate conflicts that already exist. For example, if a local comprehensive plan and zoning code ensure that housing is not located in a way that conflicts with a rail line, the costs of sound walls, property purchase, or even relocation of the rail line can be prevented.

Lack of Effective Communication among Stakeholders

Poor communication is at the core of many conflicts between freight entities and other stakeholders. Poor communication also often exists between various levels of government entities. Among other things, lack of communication leads to conflicting expectations and lack of buy-in for solutions.

The importance of involvement by freight operators in community outreach or informational sessions that local and state planners hold for multiple long-range and other planning efforts was underscored in the case studies. For example, in the case of the Whitaker Intermodal Terminal in Austell, Georgia, Norfolk Southern initially assumed it had public support for the project and did not engage in a concerted public outreach effort. This lack of engagement with the local community was seen as a factor in the failure to gain public support. This case illustrates how quickly a community can turn against a project if it feels it has not been engaged or feels threatened by a project.

Often, a regional or state entity may have a more holistic view of the benefits of freight than will a local jurisdiction, which is only directly affected by a piece of the freight system. One prominent example is the State of Oregon's industrial

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lands task force, convened by the governor, which noted that the "state has an interest in discouraging conversions of prime industrial lands" (Oregon Industrial Conversion Study Committee 2004). Conversely, local governments with close ties to the business community are often the first to find out about new private initiatives that may have a regional or statewide impact.

Process Improvements for Preventing or Resolving Land-Use Conflicts

The research performed in the NCFRP Project 24 case studies and previous experience of the project team also uncovered a number of approaches for preventing or resolving land-use conflicts between freight entities and other relevant stakeholder groups.

Improved Planning and Zoning Practices

As discussed, land-use planning and zoning usually do not adequately deal with freight. Improved planning and zoning practices must begin with education. The following section describes specific tools encountered in the case studies that could be more widely used.

Although most cities and counties utilize an "industrial" zoning designation, they generally do not create specific zoning categories for freight facilities and corridors. Freight is industrial activity, yet its impacts are distinct from other forms of heavy industry. As an exception to the general rule, some cities have attempted to protect freight through the implementation of "industrial sanctuaries" or "industrial overlay districts." These are zoning mechanisms designed to preserve land for freight-related land uses and prevent the encroachment of incompatible uses. Both Portland's Guild's Lake Industrial Sanctuary (GLIS) and Baltimore's MIZOD were based, in part, upon the rationale that zoning change requests led to business uncertainty and an inability to secure continued funding for some of the freight facility components because of the loss of contiguity of this area.

Industrial sanctuaries and overlay zones can overcome some of the shortcomings of the lack of specific freight-related zoning categories, but they have limitations. The most noticeable of these is that the overlay zone may not effectively protect the corridors that lead into the overlay zone. MIZOD was heavily critiqued for this limitation by local consultant groups reviewing its effectiveness. MIZOD was found not to consider or address off-dock and off-port land use that facilitates and supports port growth and expansion. Another limitation to overlay zoning is that it does not protect other freight facilities that may not be geographically contiguous to the overlay but are a necessary component within the overall supply chain.

It is difficult to maintain boundaries of an industrial overlay zone without specific, intuitive, and clearly marked boundaries that separate industrial from non-industrial use. Baltimore's MIZOD, for example, is considered successful because it is based on marine access with at least 18 feet of draft. This criterion set out in unambiguous terms the areas where port and associated industrial operations need to be protected. Conversely, MIZOD has been critiqued because it did not establish effective buffers (for either new development or around existing freight facilities) or define what traditional uses should be located therein.

Although Portland's GLIS set out parameters for areas of protection, the zones at the margin of this sanctuary were viewed as having a less logical function than the sanctuary's overall objective and purpose. The ambiguity also led to the adjacent community of Linnton's thwarted attempt to instigate a zoning change to allow a downtown mixed-use type development in between its energy cluster components. This illustrates that, notwithstanding years of planning and development of an overlay zone, a city adjacent to the overlay can forge ahead with plans that fly in the face of the previous planning activities. Linnton was heavily involved in the discussions and meetings that led to the development of GLIS, so it came as quite a surprise to the energy industry groups that this zoning variance was being considered by the city's planning commission.

The Linnton example also provides another argument for ensuring that boundaries that are set around an industrial cluster should be communicated to outlying communities. This would also reduce real estate expectations. At the demarcation point between industrial facilities and residential or commercial properties, transitional stepped-down zoning from one use to another requires careful consideration and development. In many communities, these areas are some of the last remaining real estate parcels that can be developed to maximize taxable revenues. The demarcation of these areas is critical to ensure that any overlay zone retains its contiguity and efficacy, and so that cities and counties can continue to ensure development of their tax base.

Industrial sanctuary zones are a tool that could be more frequently incorporated into the city/county's comprehensive plan as a policy element. Portland, for example, adopted the GLIS vision statement, policies, and objectives into its comprehensive plan. This is critical to continued long-term planning for freight and will help to ensure that when the comprehensive plan is updated, freight will still have a seat at the table.

In addition to industrial sanctuaries and overlays discussed above, other zoning mechanisms can be used to facilitate freight initiatives. Property developer CenterPoint benefited by the Ellwood, Illinois, creation of a new I-4 flexible zoning designation for manufacturing and distribution that enabled

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the development to proceed. This designation laid out a plan for container storage expansion through a new ordinance. The public-private partnership process can lead to the development of better understanding of freight needs and, subsequently, to the development of effective tools for codes and zoning.

A final note on overlay zones, industrial sanctuary zones, and other zoning tools is that, while they can be a very useful means for preventing conflicts, they cannot be used to mitigate for conflicts already in existence.

One way to ensure that freight planning occurs more often and more thoroughly at the local level is by amending state codes to include freight as one of the required elements of local general and comprehensive plans, not just as a transportation issue but as a land-use issue, preservation topic, and economic development goal.

Cooperative Regional Planning

It was clear from the case studies that planning for freight facilities cannot be delegated to a single entity, and it is required across multiple levels of government—from the state level to the local level. Because of the far-reaching effects of local decisions on geographically extended supply chains and other economic activity, preservation of freight corridors and facilities typically needs to transcend the local level and take into account these wide-ranging considerations. The preservation and revitalization of the Staten Island Railroad is an example of a long-term priority held by multiple state and local parties whose continued engagement led to a successful output. Similarly, the establishment of Baltimore's MIZOD was assisted by the participation and support of the Maryland DOT, which runs the port, and the State of Maryland. Maryland had invested heavily in the port and had a strong vested interest in seeing the port remain viable into the future. City and state planners also were aware that if existing assets at the port were not preserved, the port had no other alternative but to shrink in size and scope. Since not all ports, airports, truck and rail yards, and corridors will be able to garner support for long-term planning and across-the-board funding, this may limit the transferability of MIZOD to other areas. At the same time, other areas may not have the specific limiting factors that Maryland faced in terms of access to deeper draft channels and dredging constraints.

When freight plans are created at the state, regional, or local level, they typically focus on transportation needs and pay little attention to land use. The best example of comprehensive regional planning studied was ARFMP. Although a milestone in terms of its complexity, partnering, and communication efforts, Atlanta's regional freight plan still only devotes a total of five pages to land use. The plan recommended that land-use and zoning codes should be amended. However, if this recommendation was to be a springboard for better land-use activities, it has not yet borne fruit. According to the city's zoning code website, as of November 2010, it had not yet made any changes to its zoning code regarding freight and land use as recommended by ARFMP.

Many regions throughout the country are involved in regional visioning processes at one time or another. These processes tend to be voluntary efforts involving cooperation among various public and private stakeholders. They can be led by regional governance groups, such as COGs, or by private entities, such as chambers of commerce. These efforts typically look at future scenarios involving various land-use and transportation choices for the region, but they generally do not expend much effort examining freight, nor are freight stakeholders usually heavily involved. If freight stakeholders become more closely involved in visioning processes, and if visioning processes include freight as a key issue, these visions could help to direct local land-use and transportation decisions for decades to come. One key outcome of a regional visioning process is educating stakeholders about the long-term implications of various decisions; a regional vision could be a significant tool for educating land-use decision makers about the importance of planning for freight.

Improved Notification Procedures

Conflicts between freight and other land uses often arise because of lack of notice and the creation of investment-backed expectations. Improved notification in various settings could help prevent or mitigate many types of conflicts. For example, real estate contracts and other notice documents could include sections discussing the possible freight-related impacts that may occur as a consequence of living in proximity to freight activities.

Notification to communities that are in proximity to a freight facility or corridor also forms a subset of communication, as well as planning and permitting processes. In the discussion that surrounded the continued utilization of Baltimore's MIZOD, press releases from Baltimore City planning staffers indicated that better management of buffer zones was needed, requiring the addition of language into real estate contracts noting that one may live near a freight facility.

Similarly, the Joliet and Austell case studies highlighted how intermodal facilities can impact a community and must be addressed both through communication and, at some levels, through notification to the community about impacts. Austell provides an example of how a project that seemed to be a solution to a problem quickly turned into another problem, with concomitant costs in litigation fees and other required permitting and mitigation engineering activities.

When overlay zones are created, planners also need to be aware that goods movement and the freight industry are dynamic and may require future land-use components to tie

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into the existing industrial/freight area, yards, facilities, or corridors. Forward planning—such as that performed by Will County in Illinois regarding the Joliet facilities, including the creation of the cargo container storage model ordinance—provided certainty among the multiple parties involved in developing future acreage for capacity improvements. This also provides an element of notification that this area will continue to have freight activity and that any purchases of property should be made bearing this in mind.

As part of improved notification, mapping of freight facilities and corridors needs to be improved. Maps that have been created within local jurisdictions, MPOs, COGs, and state DOTs, to show the location of the components of the freight facilities and networks, could be amalgamated together for future utilization by both planners and developers.

Given the extreme costs of developing geographic information system (GIS) components from scratch, freight groups could become a partner in improving the freight mapping process. In many instances, freight groups already have in-house GIS layers that show where their routes, yards, and facilities are located geographically. They also have knowledge of bottlenecks and other elements that are necessary for business functions (e.g., truck rest areas). However, it is recognized that access to maps is a contentious issue given the fact that once maps are provided to state, local, or federal agencies they become part of the public record and are subject to Freedom of Information Act rules. Security concerns may also play a part here, since freight groups may be wary of providing detailed mapping information, especially for hazardous materials, because of the potential for terrorist threats against infrastructure.

Although freight entities may be hesitant to share confidential maps with others, their knowledge could be very useful to planning entities when comprehensive plans are created or updated. Such mapping would also begin the process of teaching the general public about freight itself and shifting the public mindset toward thinking about how freight affects their individual lives and communities. It also would provide planners with specific knowledge of facilities to reduce the permitting and variance requests that often lead to residential development being placed into proximity with freight activities.

Innovative Funding Practices

To deal with the lack of funding for freight planning, preservation, acquisition, and other activities, innovative practices are needed to leverage investments. First, the entity spearheading the preservation strategy must secure the right and standing to become an investor. Certainly, New York's and New Jersey's statutory right of first refusal for potential railroad abandonments was a key factor in the successful reinstatement of the Staten Island Railroad.

In many instances, prime opportunities for freight-related acquisition have come from the base realignment and closure process undertaken periodically by the U.S. military. Multiple military sites that were closed following the end of the Cold War were redeveloped as freight facilities. Examples include San Antonio and Austin, Texas; Rickenbacker, Ohio; Richards Gebaur Air Force Base in Kansas City, Missouri; the 440th Air Reserve Base in Milwaukee, Wisconsin; and Alameda Navel Air Station in Alameda, California. The EPA's *Turning Bases into Great Places: New Life for Closed Military Facilities* was produced to aid communities in redeveloping these sites.

The Joliet Arsenal case study is an example of successful redevelopment. Although the success rate of conversion from military to freight use is far from perfect, these sites often make logical freight/industrial development platforms because they have already been through an environmental remedial process during closure, are already zoned for a heavy industrial type of activity, and have buffers from residential use.

ARFMP highlights the benefits of donation of private sector groups' time and efforts to a planning process. In the case of Atlanta, the representation of freight groups on the boards and committees that advised the planning process also led to the development of projects to mitigate some of the conflicts that arose because of land-use and freight activity intersections. Task force participants created a list of congestion bottlenecks along with suggested remedies. This led to the formation of the regional priority freight highway network. As the priority freight highway network was developed, it also led to improved knowledge of how corridors contributed to the region's economic geography. This led to the discussion of how this should be a crucial consideration for network and land-use management. Donating the time of staffers and expertise into the planning process by the freight segment delivers multiple benefits and can lead to policy and planning changes.

Resolving Communication Challenges

The case studies uncovered a number of specific communications challenges that needed to be overcome in the process of preventing or resolving land-use conflicts. Some of these challenges were met more successfully than others.

In the example of the Staten Island Railroad, one of the largest communication challenges was in conveying the indirect congestion benefits to citizens in New Jersey who did not expect to realize the more tangible job creation benefits of the project. Delivering a freight-supportive message is especially complicated for areas that are already split between freight and non-freight use. In the case of MIZOD, Baltimore has areas around the port that have been redeveloped into mixed-use and residential developments. Residents around the harbor could not see or understand the difference between

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areas that no longer have deep-water access, which were being redeveloped into higher value uses, and areas with deep-water access, which were being preserved for uses dependent on that access. In the example of the Whitaker Intermodal Terminal, the residents of Austell had never had direct experience living next to a rail yard and had an instinctively negative impression of what would be likely to happen if the terminal was built. Basic miscommunication in this area included the fact that the site's total acreage, which was much larger than the physical footprint of the industrial site to allow for buffering, was used as a negative talking point against the project, when it actually made the site less intrusive to surrounding uses than smaller freight yards in Atlanta.

Communicating the importance of preservation of industrial land and freight connections is extremely important because, in many instances, suitable and available property for relocation is not available. In the case of Baltimore's MIZOD, analysis also found there were many suitable substitute locations for attractive mixed-use development within the urban area, but there were no substitutes for deep-water frontage. Communication and outreach efforts sometimes pay dividends far into the future. The wide-ranging discussions of future uses for the Joliet Arsenal facility, which began even prior to its closing, helped the project to overcome some early hiccups—such as the proposed placement of a landfill on the site—and emerge with a stronger, sounder plan at the end.

Portland and the State of Oregon have undertaken multiple inventories and reviews of Portland's industrial land holdings to redress perceptions that industrial land is unimportant. Portland's 2004 industrial districts atlas noted that "Portland's industrial districts are unknown territory to most residents" (City of Portland 2004). The governor, in convening the industrial lands task force, tasked it with "addressing the perception that many of the fast growing areas critical to Oregon's economy have not maintained an adequate supply of industrial lands . . ." (Oregon Industrial Conversion Study Committee 2004). Although Oregon and Portland are to be commended for their activities, the cost of continuously conducting inventories to make the case for preservation underlies the need for better communication about the value of freight to our economy (locally, regionally, and globally), and the tax revenues and other benefits that a community gains because of a vibrant freight network.

The Joliet Arsenal redevelopment shows how communication, correctly undertaken, can lead to community support for a project. The most important communication tool that this project developed was the state-created Joliet Arsenal Development Authority (JADA). This authority not only developed a strategic plan for the site's redevelopment, job creation, and tax revenues, but it was also a forum for over a dozen public agencies to work together. The developer of the site, CenterPoint, estimated that it dealt with over 50 government entities while developing the project. JADA also developed a short list of transportation projects as a way of generating agreement among stakeholders as to which projects were most critical. This led to the creation of a transportation management association for the area that is expected to serve as a coordinator for those projects involving multiple jurisdictions.

Communication regarding resumption of freight service is another critical element that the freight groups may need to undertake. In the case of the Staten Island Railroad resumption of service, CSX conducted a significant public outreach campaign to notify the public about the resumed service and also went to schools to ensure that children did not play in the right of way.

Engaging the freight community also can assist a local jurisdiction in ranking the severity of bottlenecks. The freight groups involved in the Atlanta plan provided ranking scores for funding prioritization on projects that were placed into the Transportation Improvement Program submitted to Georgia's DOT. Freight interests also noted that some of the new types of in-fill and urban mixed-use development did not provide for effective freight deliveries. Being able to meet in a neutral forum and discuss such issues is critical to getting planning and site designs formulated to make sure of the appropriate accounting for freight needs.

Specific strategies for improving communication between freight and land-use stakeholders would include the formation of standing planning committees and the regular exchange of internal planning materials and decisions (redacted where necessary). Private-sector groups, including local chambers of commerce, can play an important role in keeping freight issues on the agenda and ensuring buy-in from the business community when a freight-related project is proposed. Improving communication through various levels of government also is required and must be a two-way channel.

Summary of Lessons Learned

The critical issues identified in the NCFRP Project 24 research are as follows:

1. There is no single entity at the federal level with responsibility for freight planning, financing, or project implementation in the United States.
   - Multiple federal agencies oversee different aspects of the U.S. freight network and none have authority over land-use planning activities.
   - Federal funding for freight preservation and protection activities has been sporadic and is complicated by the fact that significant portions of the U.S. freight network are privately owned.

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2. The land-use planning arena is the primary forum where conflicts between freight and other land uses are either avoided or created, and where preservation of freight corridors and facilities are either helped or hindered.
3. Local governments have primary jurisdiction over land-use planning in the United States.
4. In general, land-use planning processes inadequately accommodate freight needs. There are many reasons for this, including
   - Land-use planners are typically not taught about freight as part of their standard educational curriculum.
   - Maps that identify freight facilities and corridors generally lack sufficient accuracy and detail to make informed land-use decisions.
   - Freight entities are generally not significantly involved in local land-use and transportation visioning and comprehensive planning processes.
   - Local jurisdictions have a financial incentive to zone for uses with higher tax values.
5. Because the primary responsibility for land-use planning lies with local jurisdictions, planning for freight needs that is done is performed on a piecemeal basis that does not account for the fact that most freight transportation corridors transcend jurisdictional boundaries.
   - State and regional planning agencies do not typically have the land-use planning authority to fill the gap in freight planning.
   - MPOs are not authorized to conduct transportation planning outside of their designated areas.
6. Regional visioning exercises generally do not deal adequately with freight.
7. Funding is often lacking or insufficient for freight planning and preservation.
8. There is a lack of effective communication among freight and land-use/transportation planning stakeholders.

This study's research identified potential solutions to these issues, including the following:

- Ideally, state enabling acts should be amended to require that freight be one of the key elements that states, local jurisdictions, and planning agencies account for in both transportation planning and land-use planning.
- Guidance needs to be provided to land-use planners regarding appropriate planning and zoning practices that relate to freight. For example, zoning overlays and industrial protection zones can be put in place, not just for the industrial areas that are serviced by freight, but also for the corridors that link to them.
- Accurate mapping of freight facilities and corridors should become part of the comprehensive planning process. Mapping of such facilities will contribute to the preservation and protection of these facilities.
- Cooperative regional planning efforts, such as regional visioning processes, should include freight entities as key stakeholders and make freight a significant focus.
- State and national associations related to planning or development should provide the appropriate education and tools related to freight planning for city and county planners.
- Freight entities should participate as stakeholders in local, regional, and state planning and visioning processes.
- Private-sector groups, including local chambers of commerce, can play an important role in keeping freight issues on the agenda and ensuring buy-in from the business community when a preservation project is proposed.
- Freight groups (both private sector and government) need to partner with educational institutions to ensure that the underlying principles of freight activity are included as part of the curriculum at the graduate and undergraduate levels in planning, architecture, policy, engineering, business, and law disciplines.
- Ports that have started tracking port-related job impacts throughout the region need to make a similar scale effort to quantify the congestion and noise impacts that they produce outside of the immediate port area. Port master plans should illustrate affiliated congestion and chokepoints beyond their own properties. Similar activities should be undertaken by other types of freight operations that cannot be easily relocated.
- Innovative funding practices, including public-private partnerships and rights of first refusal, are needed for freight planning and preservation.
- Real estate contracts and other notice-type documents provided to purchasers and lessees should include sections discussing the possible freight-related impacts that may occur as a consequence of living in proximity to freight activities.

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CHAPTER 5

Overview of Preservation and Protection Strategies and Freight-Compatible Development

This chapter provides an overview of freight preservation and protection strategies, and then introduces the concept of *freight-compatible development* and the tools for achieving it. The next four chapters—Chapters 6 through 9—provide detailed discussions of the four major tools for achieving freight-compatible development.

Examples of Freight Preservation and Protection Strategies

Given the critical role of freight transportation in the economy, preservation of freight facilities and corridors is extremely important. The loss of freight facilities, yards, and other ancillary facilities that may serve the network can create bottlenecks, increase costs, and potentially affect consumers through increased prices. Re-parceling lost corridors is often cost-prohibitive and can run up against community complaints. Preservation of freight facilities and corridors can be achieved not only through long-range planning activities, as described in the next chapter, but also through other approaches, including delineation of corridors, freight support and preservation initiatives, maintenance activities, and purchase of corridors to preserve them for future freight use.

Corridor Delineation

An important first step in freight preservation should be effective delineation of major freight corridors and associated facilities. At the federal level, there have been a number of attempts to prioritize and promote corridors that are important to freight. TEA-21 included the National Corridor Planning and Development Program, which made discretionary grants available for corridor feasibility, corridor planning, multistate coordination, environmental review, and construction. This initiative was replaced in SAFETEA-LU by the Projects of National and Regional Significance, which aimed at funding projects that have potential national benefits but would otherwise not have adequate funding sources. On the maritime side, the designation of America's Marine Highway Corridors by the secretary of transportation in 2010 was a major step toward integrating marine corridor options into the preexisting network of highway and rail corridors for serving freight.

The private sector also has been involved in corridor delineation activities. For example, in late 2010, BNSF announced its "Corridors of Commerce" initiative. The Corridors of Commerce—BNSF's TransCon, Great Northern, and Mid-Con routes—represent more than 11,000 miles of the network and are estimated to reach over 94 million people (BNSF Railroad 2010).

Freight Support and Preservation Initiatives

Neighborhood associations, chambers of commerce, and other freight groups have created initiatives to protect and enhance freight areas. Other groups also have come together to promote corridors and freight program initiatives. Three examples of freight support and preservation initiatives are Portland's Northwest Industrial Neighborhood Association (NINA), the North American Super Corridor Coalition (NASCO), and New York Shipping Association's Port Support Zone Initiative.

NINA—NINA was created with a mission to protect and enhance the industrial business climate of Portland, Oregon's northwest industrial district. NINA's main goals are to

- Ensure the integrity of GLIS;
- Facilitate freight mobility for the benefit of industrial commerce;
- Ensure river access values;
- Facilitate ease of business operations relative to city, county, and state regulations; and
- Keep lines of communication open between members and interested parties.

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NINA is discussed in more detail in the GLIS case study in Appendix D available on CRP-CD-105 and on the TRB website.

NASCO—NASCO was created in 1994 to address critical national and international trade, transportation, security, and environmental issues. Following the I-35 corridor through the central United States and into central and eastern Canada and Mexico, the coalition covers a multimodal transportation network that connects 71 million people and over $1 trillion in commerce between the three nations. NASCO members include cities, counties, states, provinces, and private-sector participants from all three countries.

The North American Inland Port Network (NAIPN) is a subcommittee created by NASCO to advocate for the interests of inland ports (intermodal transportation facilities) along the corridor. NASCO also created a corridor-wide tri-national educational consortium during 2010 to further coordinate freight research activities along the corridor.

Port Support Zone—The New York Shipping Association created the Port Support Zone (also known as the Logistics Support Zone) to protect, encourage, and develop off-port facilities that provide truck parts as well as equipment maintenance and storage and in other ways help to enhance port operations while reducing congestion, removing industrial/commercial operations from residential neighborhoods, and improving quality of life. The association collaborated with the Metropolitan Marine Maintenance Contractors Association, as well as the State of New Jersey, City of Newark, and others, to produce a development strategy that recognizes the critical nature of the maritime facilities that serve the interests of urban areas.

The Port Support Zone provides a concentration of dedicated areas within a 1- to 5-mile radius to conduct port-related operations that do not require pier access. Relocating activities that do not contribute directly to vessel operations can result in greater on-dock space to handle increased cargo volumes without having to expand port land areas, reducing impacts on surrounding residential communities. Activities provided within this area include container depots, overnight secure truck parks, remanufacturing and maintenance, surge capacity facilities, transload facilities, and heavyweight facilities.

For example, secure truck parks equipped with electric hitching posts for use by trucks and refrigerated units are anticipated to dramatically reduce traffic, noise, and air pollution. By providing secure truck parks, the initiative hopes to improve safety for local citizens, reduce truck travel, enhance security of cargo, and keep trucks off city streets and out of residential areas, especially overnight. Freight logistics areas also are seen as a way to encourage development of consolidated facilities for management of freight in a strictly controlled, geographically designated area. Again, the goal behind this was to enhance freight movement from port to customer while segregating these industrial operations from residential neighborhoods to improve quality of life and the environment.

Maintenance as a Means of Preservation

Maintenance of freight corridors is also a critical element in ensuring their continued viability. The Interstate Highway System and state highway networks are maintained by individual state departments of transportation, which are funded through federal and state gas taxes. Maintenance of the railroad network is largely funded by the railroads that own the facilities. Air cargo facilities, for the most part, are found in the national airport system, and on-airport maintenance is funded by airport authorities and the local jurisdictions that often own them. Certain other activities, such as noise reduction program grants, are administered by FAA. The U.S. Army Corps of Engineers (USACE) is responsible for dredging and lock maintenance for the inland waterway system, Gulf Intercoastal Waterway, and U.S. ports. The port facilities themselves are maintained by the port authorities.

Although maintenance is important for all modes, it is particularly important for the preservation of marine transportation. Two critical maintenance activities are dredging and lock maintenance.

Dredging refers to the artificial removal of sediment from the bottom of a riverbed or other body of water, such as an ocean floor. It is performed in order to temporarily deepen a navigable body of water to allow a vessel to freely move without damaging its keel. Sometimes dredging is used to correct irregularities in the sea floor or riverbed to create a uniform depth. To be successful, a dredging operation must remove the sediment and deposit it in an area that will not allow it to resettle at the bottom. The difficulty in removing dredge material depends on the type of sediment to be removed and the depth at which the operation is occurring. Other factors influencing cost include environmental restrictions that impact the rate at which sediment can be removed. Suction dredging is typically the most economical dredge process.

Dredging issues are a common point of contention in determining the optimal balance between freight and non-freight uses of waterways. In general, dredging is split into the following two distinct types:

- Capital (i.e., new work) dredging projects are projects in which a channel is being made deeper or wider.
- Maintenance dredging refers to activity to maintain the present authorized dimensions of a channel when siltation has occurred.

For a number of reasons, capital dredging projects are more controversial than are maintenance dredging projects.

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One reason is that capital dredging is more costly due to the greater probability of encountering varied or rocky soil. Secondly, capital projects, particularly in the marine environment, have the potential to disturb ecosystems that inhabit the seafloor. Finally, capital dredging projects that deepen a channel are sometimes seen as gateways for more intensive freight usage of an area.

Finding suitable locations for dredge material disposal is another pressing concern. This issue is particularly controversial when the dredged soil is contaminated and potentially harmful to human health. Remote disposal of dredge material can dramatically drive up the total cost of the dredging operation.

USACE keeps detailed records on dredging projects around the country and historical records going back to 1963 (U.S. Army Corps of Engineers 2010a). The data show the cost of maintenance dredging, in constant dollar terms, has been increasing since 1990. This increasing cost trend is illustrated in Figure 5-1. Thus, it is becoming considerably more costly to maintain the existing system of dredged channels in the United States.

The 1930s provided the most significant period of lock construction in the United States. Although many locks have been reconstructed or rehabilitated in the decades since, the lock infrastructure of the United States remains, on average, far older than that of the Interstate Highway System. As a result, the maintenance required to keep the lock system functioning continues to grow. On the Ohio River system, more than 25 percent of locks have already exceeded their design life. The percentage of locks that are beyond their design life requirements will surge in the coming decade. The problems associated with an aging lock system are not limited to cost. Maintenance-related lock closings also impinge on the reliability of the waterway system from a shipper perspective, particularly when these shutdowns are unexpected.

Aggressive preventative modernization efforts could help to compensate for the inevitable deterioration that will occur on some parts of the waterway network. For example, by taking advantage of stimulus funding, USACE made the strategic decision to shut down the Columbia River system in December 2010 to replace or repair all eight dams simultaneously. This was to be the longest shutdown in the waterway's history. The waterway was reopened to traffic in late March 2011. As a result, this important marine highway corridor, which had been in danger of cascading failure, has been granted a new life (Walla Walla Union Bulletin 2011).

Acquisition and Banking of Facilities and Corridors

Preservation of freight facilities and corridors also can be achieved through other mechanisms, including banking a facility for future use, or acquiring a facility that the current owner may no longer wish to hold. By far the most common banking and acquisition process involving freight in the past 30 years has been the purchase of abandoned railroad corridors for other transportation uses or for "rails to trails."

Many states have legislation that offers the right of first refusal for purchase of abandoned railroad corridors to the state DOT and to the local jurisdictions that may want to partner with the DOT. North Carolina and Washington have particularly good statutory provisions for the purchase and preservation of abandoned corridors, along with corridor permitting controls for development adjacent to railroad corridors. Washington also has a Freight Rail Assistance Program, which can provide grants through the state DOT to support branch lines and light-density rail lines, provide or improve rail access, maintain adequate mainline capacity, and preserve or restore rail corridors (Engrossed Substitute House Bill [ESHB] 2878, Section 10, Chapter 121, laws of 2008). North Carolina funds freight rail purchases of abandoned

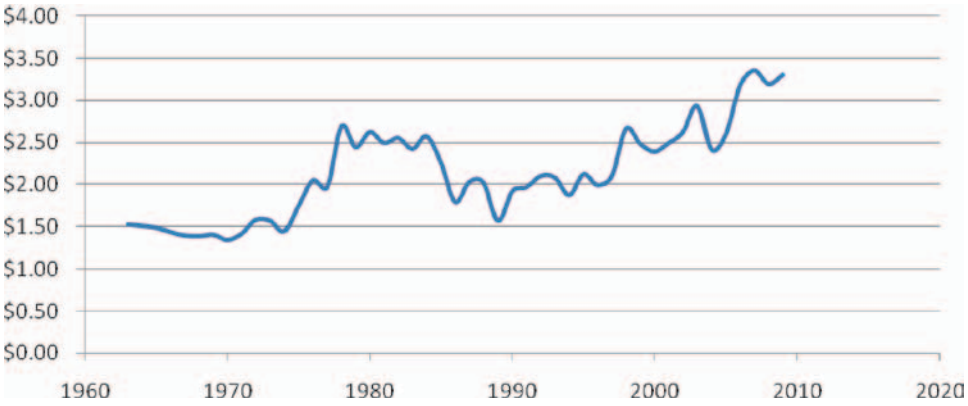

Figure 5-1. Dredging costs per cubic yard of sediment removed (U.S. Army Corps of Engineers 2010b).

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corridors out of general revenue funds (North Carolina General Statute 136-44.36A).

Once a rail corridor has been banked, restoring active freight rail service may vary considerably and will depend on the type and intensity of adjacent land holdings, the duration of the abandonment, and the type of rail service being proposed. The main reasons it is important to preserve freight rail corridors and restrict placing the corridors into rail banking are the issues of reversionary property right interests (where the railroad was acquired through easement and not as a fee-simple purchase) and community reactions to the restoration of service. Research released in March 2011 on abandoned rail corridors reviewed case law on the common law of property and reversionary interests that are held in many of these corridors. Class action challenges to rail-trail conversions in the early 1990s began to be instigated because landowners adjacent to railroads were unhappy that they could not absorb the land back into their property holdings (Morgan et al. 2011). In 1990, the U.S. Supreme Court determined that holding the railroad easement intact for future reactivation was within the scope of a legitimate railroad use (*Preseault v. United States* 1996).

The Staten Island Railroad case study in Appendix B documents the strategy used to preserve a corridor in Staten Island for future freight use. Time is perhaps the most essential element in successfully preserving an abandoned corridor. Agencies that have advance knowledge of a rail operator's intent to abandon have an opportunity to put together the funding and make other arrangements necessary to transfer ownership to a new party and thereby prevent the linear corridor from being subdivided. This is particularly true in cases where a rail corridor is held in easement that is conditional on its maintaining a transportation function.

Tools for Freight-Compatible Development

The goal of freight-compatible development is to preserve existing freight facilities and corridors, effectively plan for future freight activities, and reduce impacts that occur because of the proximity of incompatible land uses around freight corridors and facilities. Thus, the main objectives of freight-compatible development are to (1) ensure that freight-transportation-related services are not affected by, or do not affect, other land uses placed close to freight corridors or facilities; (2) reduce and minimize community impacts that arise because of the proximity of sensitive land uses, including residences, schools, hospitals, and emergency services; and (3) incorporate the preservation and protection of freight facilities and corridors as a forward-looking component of general planning and economic development policies.

Four major tools are available—either individually or in combination—to achieve the goals of freight-compatible development. These are examined in the next four chapters as follows:

1. Long-range planning (Chapter 6),
2. Zoning and design (Chapter 7),
3. Mitigation (Chapter 8), and
4. Education and outreach (Chapter 9).

Although most of these tools are prospective in nature and designed to avoid conflict, incompatible land uses already exist close to many freight-transportation-related services and conflict has resulted. In these cases, at least in the short run, measures such as design standards and mitigation approaches are a means to minimize conflicts.

Table 5-1 lists some of the specific freight corridor and facility preservation and protection strategies under the four major tools that can be used to achieve better freight-compatible development. Table 5-1 is not an exhaustive list that covers every possible scenario. Rather, it is designed to provide examples of tools, policies, and strategies that have been found to be effective in particular contexts.

All of the tools described in this report and found in more detail on the EnvisionFreight website, http://www.EnvisionFreight.com, can be utilized by different stakeholders (for example, various levels of government and government agencies, community interests, freight groups, developers) as they plan to prevent, consider, and—in some instances—deal with conflicts that arise because of proximity of incompatible types of land uses near freight facilities. The remainder of this chapter provides examples of how various stakeholders can use the EnvisionFreight website.

For planners and elected officials, EnvisionFreight has been designed to help to

- Understand how freight fits into the local, national, and global economy;
- Understand the issues that arise from conflicts and how they impact freight-transportation-related services and a community; and
- Begin to consider the kinds of tools, scenarios, communication, and educational outreach that they might want use to improve their freight planning and preservation capacity.

For developers, EnvisionFreight aims to ensure that they consider how freight activities may affect and intersect with residential and other sensitive types of land use they may be planning. With a better understanding of these components, developers should be able to choose appropriate sites and design and incorporate construction and mitigation components to reduce conflicts that may arise.

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Table 5-1. Tools for achieving freight-compatible development.

Long-Range Planning	Zoning and Design	Mitigation	Education and Outreach
State Enabling Acts	Zoning Standards	Buffer Areas	Informal Negotiations
Regional Visioning	Buffer Areas	Noise and Vibration Treatment	Public Involvement
Comprehensive Plans	Overlay Districts	Track Treatment	Multijurisdictional Agreements
Freight Facility Inventories	Lot Orientation	Yard Realignment	Stakeholder Round Tables and Freight/Community Committees
Official Maps	Property Design	Grade Crossing Management	
Purchase and Advance Acquisition	Construction Standards	Port Gate Management	
Land Swaps	Soundproofing Standards	Environmental Measures	
Protective Condemnation		Zoning Measures	
Permit Development		Public Outreach and Education	
Access Rights		Relocation	

For freight entities, EnvisionFreight is intended to provide education and assistance regarding land-use planning and zoning processes. With a better understanding of these processes, as well as tools that can be used to more effectively deal with freight in land-use planning and zoning, freight entities can be more effective participants in such processes.

For individual citizens or community groups, the goal of EnvisionFreight is to provide basic information about the various freight modes and impacts that arise because of freight activity and proximity to incompatible land uses, and to show the types of tools that can be used to more effectively plan for freight.

For state legislators and staff, EnvisionFreight is designed to provide information and ideas for potential legislative changes that would facilitate better integration of freight and land-use planning.

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CHAPTER 6

Long-Range Planning for Freight-Compatible Development

The most successful corridor protection strategies rely on early, consistent, and clear planning. Planning is the first and most important step in creating effective processes and opportunities to achieve freight-compatible development, reduce community-freight conflicts, and preserve critical freight corridors and facilities.

Tools to achieve effective advanced planning can be found on the EnvisionFreight website at http://www.EnvisionFreight.com/tools/default.aspx?id=planning, and include

- State enabling acts,
- Local comprehensive plans,
- State and regional plans,
- Regional collaboration, and
- Mapping.

State Enabling Acts and the General or Comprehensive Plan

The power to regulate land uses—except where limited by federal law—is primarily a power "reserved" for the states under the U.S. Constitution. As illustrated in Figure 6-1, most states have delegated this power to local municipalities and counties under the planning and zoning enabling laws enacted by state legislatures. Most issues about future land uses affecting the present or future viability of freight facilities arise from, or come to a head in, the context of zoning or development site plan approvals. Almost always, nothing is built in America unless and until the use of the land concerned has been approved in a city or county general plan, the property has been specifically zoned for that use, a development site plan has been approved, and a building permit has been issued. These are all local government functions.

As Figure 6-2 illustrates, zoning, site plan, and subdivision decisions are based on guidance from the municipality or county's comprehensive plan (also called a general plan or master plan in some places). One way to avoid poor zoning and site plan decisions is to decide the issues in advance in the regular updates of the city or county's general or comprehensive plan. The comprehensive plan is intended, and in most places required, to guide zoning and site plan decisions. The comprehensive plan also sets expectations as to the allowed use of land in various locations, and developers and builders may make investment decisions based on that plan. Comprehensive planning that protects freight can prevent the formation of investment-backed expectations that may be difficult to unwind in the zoning and site planning processes.

Comprehensive plan updates almost always are performed following a menu of topics provided in the state's planning enabling act. Unfortunately, as illustrated in Figure 6-3, most state enabling acts do not require freight to be included in comprehensive plans. As a result, most city and county staff members do not focus on freight issues, and there are few available tools and little guidance for consideration of freight interests or avoiding conflicts with non-freight land uses when it comes to planning and zoning. If the state enabling laws required or suggested that plans to protect all modes of freight should be included in a general plan, significant new protections would likely evolve naturally in our land-use system nationwide in the next decade or so.

Federal Preemption of Interstate Commerce and Freight

Federal preemption functions to foreclose state and local regulations. The Supremacy Clause of the U.S. Constitution (Art. VI, Cl. 2) states the following:

> This Constitution, and the Laws of the United States which shall be made in Pursuance thereof . . . shall be the supreme Law of the Land; and the Judges in every State shall be bound thereby, any Thing in the Constitution or Laws of any State to the Contrary notwithstanding.

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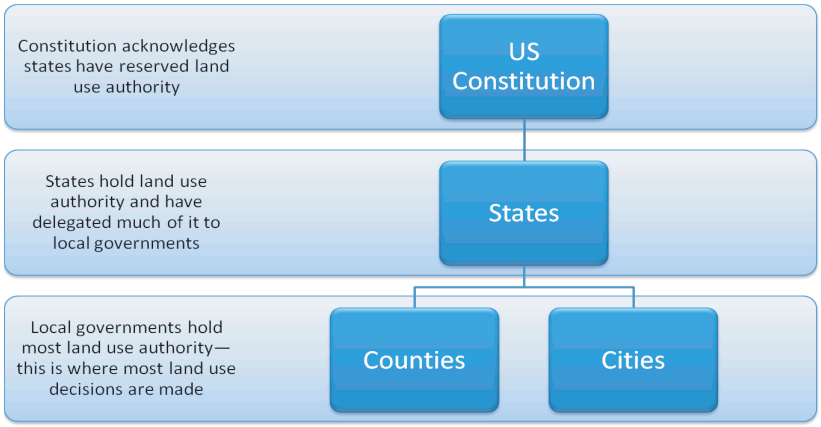
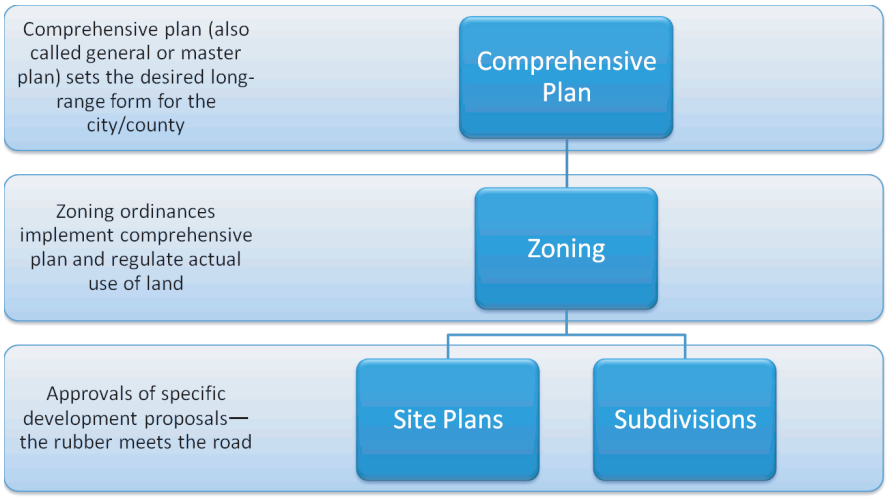


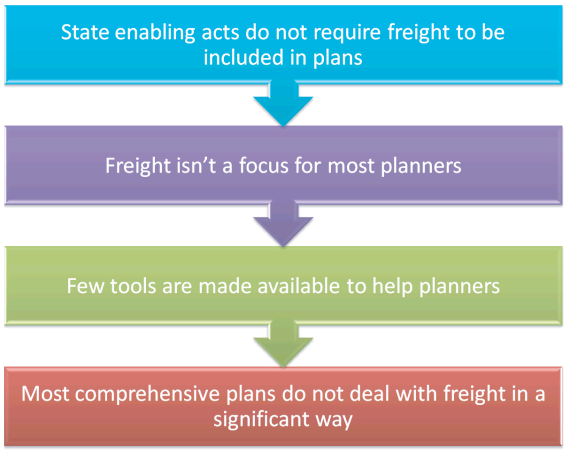
Source: Grow & Bruening.

Figure 6-1. Land-use authority in the United States.



Source: Grow & Bruening.

Figure 6-2. Typical local government land-use system.



Source: Grow & Bruening.

Figure 6-3. State enabling acts often do not account for freight.

This clause is the foundation for the legal doctrine of federal preemption. The Commerce Clause of the U.S. Constitution (Art. I, § 8, Cl. 3) also can be used to strike down local land-use and zoning laws. Under the Commerce Clause, Congress possesses the exclusive power to regulate interstate commerce. This may limit state power to regulate commerce even in the absence of congressional action (481 U.S. 69, 107 1987). However, courts prefer to avoid engaging in a Commerce Clause analysis if they can find preemption under a federal statute (38 F.Supp.2d 1096, 1101, (D. Minn) 1998). Below, this report summarizes federal preemption as it relates to the various freight transportation modes and facilities.

Air Transportation—Federal preemption is not as absolute with respect to air transportation as with other modes. Federal preemption generally holds in land use and zoning around airports. Local regulation of aircraft and airport noise

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is broadly preempted, except when a municipality operates the airport. Federal regulation of land use surrounding airports is principally limited to Runway Protection Zones—established by the federal government to protect its investment in airport facilities—that cannot be modified without federal approval. Local regulations that are consistent with federal requirements or affect areas altogether outside the Runway Protection Zones are not preempted. When zoning prevents airport expansion, the law is unsettled, and local efforts to use zoning powers to prevent expansion may or may not be preempted.

Ports—Federal preemption often does not hold in land-use and zoning actions concerning ports/marine facilities. The Coastal Zone Management Act of 1972 (CZMA) creates a voluntary program for states to create Coastal Zone Management Plans outlining how states will regulate their coastal zones. Courts have recognized that the scheme established by the CZMA strongly suggests against federal preemption of local and state regulation. Accordingly, local land-use regulations surrounding ports are unlikely to be preempted by federal law. The CZMA specifically grants states broad authority to regulate the coastal zone. Further, if local land-use regulations happen to impact navigation, the local regulation will stand as long as it does not directly conflict with federal regulation.

Rail Transportation—Federal preemption of land-use and zoning regulations affecting freight rail transportation is far-reaching. Most local regulations placed on railroad right of ways, operating procedures, crossings, and facilities are preempted by federal law. Most attempts at zoning or land-use regulation will be preempted when such regulations tend to make the operations of railroad carriers more difficult. Federal preemption of regulations on railroads is found in the Interstate Commerce Commission Termination Act of 1996 (ICCTA). The broad definition of "transportation" in the ICCTA ensures that many railroad operations are protected from state and local regulation by federal preemption. Courts, however, have been forced to limit the reach of federal preemption by finding that some facilities do not fall into the category of "transportation" by rail carriers, and that the incidental involvement of a railroad (such as being a landlord) is not sufficient for federal preemption of state and local actions. Furthermore, although most land-use and zoning regulations placed on rail carriers will be preempted by ICCTA, a few state courts have recognized a limited class of regulations that are not preempted. Reasoning that compliance with certain regulations would not substantially disrupt the operations of rail carriers, these courts have upheld some local and state regulations that impose minimal requirements on railroads. However, relatively few cases have allowed for this type of local regulation, and the area is far from settled.

Trucking—Federal preemption has been invoked regarding trucking interests and for services that facilitate trucking such as truck stops. Following the Motor Carrier Act of 1980, Congress clarified that states could not ban trucks that met approved weight and length standards from traveling on federally funded primary routes, with some limited exceptions. In 1990, Congress established uniform rules for the transportation of hazardous materials that include standards for labeling of hazardous materials. Recently, the ports of Los Angeles and Long Beach and Houston have begun to address the polluting effects of the trucks that access these facilities through programs addressing the drayage industry. Issues regarding preemption continue to arise around regulation of trucking activity. In 2008, the American Trucking Associations, Inc., challenged the implementation of concession requirements that were associated with the Port of Los Angeles and Long Beach Clean Truck Program, arguing that they were preempted by the FAA Authorization Act 49 U.S.C. §14501(c) because they improperly attempted to regulate the price, route, or service of any motor carrier. The court found that some regulations imposed by the defendant port on motor carriers were not preempted by the existing motor vehicle safety acts, as they did not fall within the motor vehicle safety exception.

Recommended Changes to Enabling Act Comprehensive Planning Goals Section

In many states, statutes include a list of elements that must or may be included in comprehensive plans. Generally, this list is contained in a section of the state code referred to as the "zoning enabling act" or sometimes the "planning enabling act." One element that is often missing within the enabling act requirements is freight. Ideally, the state enabling act would require local governments to evaluate how to protect current freight systems from incompatible uses and capacity problems, as well as to protect needed future freight facilities. Changing the enabling act transportation and land-use element instructions for the comprehensive plan will result in the inclusion of better freight review within the plan and have a far-reaching impact on local land-use decisions.

There are few national examples of enabling acts that include freight requirements. Washington's Enabling Act has specific elements regarding ports that are required within the comprehensive plan, as follows:

RCW 36.70A.085—Comprehensive plans—Port elements

(1) Comprehensive plans of cities that have a marine container port with annual operating revenues in excess of sixty million dollars within their jurisdiction must include a container port element.

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(2) Comprehensive plans of cities that include all or part of a port district with annual operating revenues in excess of twenty million dollars may include a marine industrial port element. Prior to adopting a marine industrial port element under this subsection (2), the commission of the applicable port district must adopt a resolution in support of the proposed element.

(3) Port elements adopted under subsections (1) and (2) of this section must be developed collaboratively between the city and the applicable port, and must establish policies and programs that
   (a) Define and protect the core areas of port and port-related industrial uses within the city;
   (b) Provide reasonably efficient access to the core area through freight corridors within the city limits; and
   (c) Identify and resolve key land-use conflicts along the edge of the core area, and minimize and mitigate, to the extent practicable, incompatible uses along the edge of the core area.

(4) Port elements adopted under subsections (1) and (2) of this section must be
   (a) Completed and approved by the city according to the schedule specified in RCW 36.70A.130; and
   (b) Consistent with the economic development, transportation, and land-use elements of the city's comprehensive plan, and consistent with the city's capital facilities plan.

(5) In adopting port elements under subsections (1) and (2) of this section, cities and ports must: ensure that there is consistency between the port elements and the port comprehensive scheme required under chapters 53.20 and 53.25 RCW; and retain sufficient planning flexibility to secure emerging economic opportunities.

(6) In developing port elements under subsections (1) and (2) of this section, a city may utilize one or more of the following approaches:
   (a) Creation of a port overlay district that protects container port uses;
   (b) Use of industrial land banks;
   (c) Use of buffers and transition zones between incompatible uses;
   (d) Use of joint transportation funding agreements;
   (e) Use of policies to encourage the retention of valuable warehouse and storage facilities;
   (f) Use of limitations on the location or size, or both, of nonindustrial uses in the core area and surrounding areas; and
   (g) Use of other approaches by agreement between the city and the port.

(7) The *department of community, trade, and economic development must provide matching grant funds to cities meeting the requirements of subsection (1) of this section to support development of the required container port element.

(8) Any planned improvements identified in port elements adopted under subsections (1) and (2) of this section must be transmitted by the city to the transportation commission for consideration of inclusion in the statewide transportation plan required under RCW 47.01.071.

[2009 c 514 § 2.]

Notes:

*Reviser's note: The "department of community, trade, and economic development" was renamed the "department of commerce" by 2009 c 565.

Findings—Intent—2009 c 514:

(1) The legislature finds that Washington's marine container ports operate within a complex system of marine terminal operations, truck and train transportation corridors, and industrial services that together support a critical amount of our state and national economy, including key parts of our state's manufacturing and agricultural sectors, and directly create thousands of high-wage jobs throughout our region.

(2) The legislature further finds that the container port services are increasingly challenged by the conversion of industrial properties to nonindustrial uses, leading to competing and incompatible uses that can hinder port operations, restrict efficient movement of freight, and limit the opportunity for improvements to existing port-related facilities.

(3) It is the intent of the legislature to ensure that local land-use decisions are made in consideration of the long-term and widespread economic contribution of our international container ports and related industrial lands and transportation systems, and to ensure that container ports continue to function effectively alongside vibrant city waterfronts. [2009 c 514 § 1.]

Guidelines for Developing Comprehensive Plan Freight Components

The comprehensive plan should

- Provide a vision of the long-term future character and design of a community,
- Show the importance and interrelatedness of many topics,
- Cover a wide geographic area and show interdependencies among geographic areas,
- Show potential long-term impacts, and
- Represent the interests of a broad range of citizens and stakeholders (Anderson 1995, 7, 14).

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Ideally, local zoning practices also should align with the goals of the comprehensive plan. In many places, such alignment is mandated.

The general or comprehensive plan is usually made up of four main areas: goals, objectives, policies, and maps. These intersect and align to create a comprehensive plan. There may be separate sections within the comprehensive plan dealing with different elements; for example, a land-use element and a transportation element may be separate sections of the plan. Both of these elements are relevant to freight. The economic development element also will have ramifications for freight groups.

Goals are a direction-setting element. They will describe an ideal future that the community wishes to attain that will be related to public health, safety, or general welfare. The goals will encapsulate general expressions of community values and may not be quantifiable or time-specific. Examples of freight goals could include the following:

- A diversified economic base for the city,
- Promotion of global freight connectivity as the [x] largest logistics hub in the United States, and
- Protection of freight facilities or freight corridors to ensure a continued viable economic base for the city.

Objectives will be a specific, delineated end, state, or condition that is a step in attaining the goals set within the plan. An objective should be achievable and have some type of performance metric that is measurable and time-specific. Examples for freight could be

- Mapping of all freight corridors and associated and ancillary facilities by [x] date,
- A reduction in freight-related pollutants around port facilities,
- A 50 percent reduction in industrial land conversion over the next [x] years,
- First Street and Harbor Avenue to be designated as major trucking arterials,
- A new Logistics Center Park to be located in the area bounded by E and H Avenues and Commerce Drive.

Policies are specific statements that guide decision making within the comprehensive plan. Clear policies help in judging whether zoning decisions, projects, public works activities, and other projects are consistent with the general plan. Examples of a policy from the freight perspective could include

- The city shall not approve a zoning ordinance variance to rezone industrial to residential uses that is located within 300 feet of the identified railroad corridors, logistics zone, or port facility.
- The city will not approve or permit distribution center or logistics facility development adjacent to schools, hospitals, residential care facilities, libraries, or emergency service stations.
- The city will not approve the placement of hospitals, schools, residential care facilities, libraries, and emergency service stations within 500 feet of any freight facility that operates on a 24-hour basis.
- Residential neighborhoods within a city should not be placed in proximity to, or adjacent to, port facilities, rail yards, rail corridors, and heavily trucked routes.
- To reduce trespass, schools should not be placed close to railroad tracks.
- The city will establish minimal acceptable level of service (e.g., peak-hour level of service) for major truck thoroughfares.
- The city will develop minimum setback and buffer standards for any new sensitive land use that may be developed close to freight facilities.
- The city will adopt a specific plan for the logistics park.
- Areas designated for freight activity should be placed in industrial/freight zone areas.
- The city will develop a financing program to implement the highway at-grade crossing closure program.

Some comprehensive plans may include implementation measures, which are the action, program, procedure, or technique that will carry out the comprehensive plan's policy. For example, in its guidance on developing comprehensive plans, California notes that all policies developed "must have at least one corresponding implementation measure" (State of California 2003, 16).

Maps will be developed to accompany the comprehensive plan. These will often show land uses, current and future transportation corridors, urban design features, and geologic and other natural hazards. Often, aerial maps and other photographic elements will be placed within the comprehensive/general plan sections. A comprehensive/general plan that effectively addresses freight would conduct a freight inventory that shows major freight corridors (highway/rail), logistics and distribution center facilities, major industrial and manufacturing hubs that are utilizing the multimodal system, ports and marine facilities and terminals, rail yards, large container storage areas, major air cargo facilities, navigation easements and runway approaches, and connecting highways used by trucks to access air cargo facilities. The comprehensive plan also should designate future corridors, needed improvements to corridors, and future expansion of other freight facilities.

The comprehensive plan also should take into consideration (1) the long-range plans and transportation improvement plans that the metropolitan planning agencies are required to prepare under federal law and (2) the state transportation

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plans that often will have a freight multimodal component. This will ensure that the comprehensive plan and any land-use plans created as a consequence of the comprehensive plan effectively consider transportation goals, policies, and projects that are being conducted at the regional and statewide level.

Resources and Materials for Developing a Comprehensive Plan

There are many useful resources and guides provided by the states on to how to develop a comprehensive plan. California's *General Plan Guidelines* (State of California 2003) is a good resource to consider utilizing since California requires a noise evaluation to be considered in the comprehensive plan, and this will require analysis of freight systems and facilities. The Pennsylvania Mon Valley Land Use & Transportation website's freight movement section also provides a useful starting point for integrating freight planning into the comprehensive plan (Mon Valley Land Use & Transportation 2010). (This web resource to support multimunicipal planning was adapted from Pennsylvania DOT's Transportation and Land Use Toolkit.)

Industrial inventories are also an extremely useful item for a city/county to develop and map out industrial facilities and the major freight corridors and facilities. They also often provide an excellent baseline to show the value of freight within the local/regional economy, highlighting, for example, taxes, wages, and building permits issued. As part of industrial inventory activities, local jurisdictions should conduct an Internet search to see if any freight plans may have been developed by the state department of transportation, metropolitan planning association, or other freight stakeholder or freight taskforce groups. These may provide good starting points and, in some instances, may have GIS layering that can be used within the inventory process of the comprehensive plan to develop freight facility and corridor location maps. Freight task groups also may have developed maps that show critical bottlenecks and areas where freight facilities are close to environmental justice communities. For example, in the development of its Regional Freight Mobility Plan in 2007, the Atlanta Regional Commission had multiple freight stakeholders involved in the committees that provided technical and policy advice to the consultants developing the plan (Atlanta Regional Commission 2008a). These groups provided examples of bottlenecks, discussion of how design elements in mixed-use areas were impeding efficient freight delivery, and also mapped out where the environmental justice communities were located in extremely close proximity to freight facilities and corridors.

Examples of industrial inventories include San Francisco's industrial inventory, released in October 2010 (San Francisco Planning Department 2010), and Oregon's *Promoting Prosperity: Protecting Prime Industrial Land for Job Growth,* which reported on the conversion of industrial land to nonindustrial land (Oregon Industrial Conversion Study Committee 2004). This 2004 report found that the State of Oregon had an interest in preserving a supply of prime industrial land for short- and long-term needs. Portland, Oregon, also has undertaken or commissioned reviews of its industrial land inventory, including a market demand analysis (ECO Northwest 2003) for the citywide industrial lands inventory and assessment and a review of Portland's working rivers in 2008 (Abbott 2008). Industrial inventories were undertaken in 1998, 2003 (City of Portland 2003), and 2005, and the city created an Industrial Districts Atlas in 2004 (City of Portland 2004) and developed a Freight Master Plan in 2006 (City of Portland 2006). Many municipal and regional economic development groups and chambers of commerce also may have industrial inventories that can be utilized to develop local industrial plans. For example, the East Tennessee Development District created an Industrial Land Inventory in June 2009 (East Tennessee Development District 2009) that gave details on tract size and acres, service by utilities, and service by rail and barge. In 2010, the City of Chanhassen, Minnesota, created a land inventory map including current available land (City of Chanhassen, Minnesota 2010) that also could be utilized to determine where new freight and industrial areas should be created.

It is recommended that all local jurisdictions develop appropriate maps for use in determining the areas in which new industrial/freight activity should be encouraged to locate and to provide information if any zoning variance applications are made to the city's planning commission. These maps should be updated no less often than the comprehensive plan.

State Transportation Planning

Federal law requires that all state DOTs complete a long-range statewide transportation plan (STP) with a minimum 20-year forecast (United States Code 23 U.S.C. 135 2007). States also are required to complete a Statewide Transportation Improvement Program (STIP) for all areas of the state. The STIP covers a period of 4 years and is updated every 4 years. Areas that are in non-attainment for air quality under the Clean Air Act provisions are required to update the STIP every 3 years. State transportation planning is of primary importance outside of MPO boundaries, because MPOs do the majority of regional transportation planning within their own boundaries.

The STP and STIP developed for each state provide for the development and integrated management and operation of transportation systems and facilities that will function as an intermodal transportation system for the state and an integral part of an intermodal transportation system for the United States. The process for developing the statewide plan and the transportation improvement program is required to

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provide for consideration of all modes of transportation and is required to be continuing, cooperative, and comprehensive to the degree appropriate given the complexity of transportation problems to be addressed. States are required to coordinate with the MPOs. State DOTs also are encouraged to develop the transportation portion of the state implementation plan as required by the Clean Air Act (42 U.S.C. 7401 et seq.).

The scope of the statewide planning process requires that each state provide for consideration and implementation of projects, strategies, and services that

- Support the economic vitality of the United States, the states, nonmetropolitan areas, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency;
- Increase the safety of the transportation system for motorized and nonmotorized users;
- Increase the security of the transportation system for motorized and nonmotorized users;
- Increase the accessibility and mobility of people and freight;
- Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns;
- Enhance the integration and connectivity of the transportation system, across and between modes throughout the state, for people and freight;
- Promote efficient system management and operation; and
- Emphasize the preservation of the existing transportation system.

As part of the development of the statewide transportation plan, the state must provide citizens, affected agencies, freight shippers, private providers of transportation, and other stakeholders with a reasonable opportunity to comment on the proposed plan. These opportunities usually take the form of public meetings.

The STPs and STIPs can be found on the respective state DOTs' websites. These are usually located on the planning department or division's section of the website.

MPO Planning

MPOs are mandated by federal law for most metropolitan areas. An MPO is an organization that includes representatives from local government and governmental transportation authorities. Often, COGs function as MPOs. MPOs are required by federal law (United States Code 23 U.S.C. 134 2007) to prepare and update a long-range transportation plan for its metropolitan planning area, as well as a shorter-range "transportation improvement program" to which construction funds are allocated. The MPO plans determine where federal transportation funds will be spent within the planning area and, for that reason, have a significant impact on freight movement. In addition, local governments often respect and protect corridors shown on MPO long-range plan maps.

An MPO long-range transportation plan is required to be updated every 4 years (or more frequently, if the MPO elects to update more frequently) in the case of each of the following:

- Any area designated as nonattainment, as defined in section 107(d) of the Clean Air Act (42 U.S.C. 7407(d)).
- Any area that was nonattainment and subsequently designated to attainment in accordance with section 107(d)(3) of that act (42 U.S.C. 7407(d)(3)) and that is subject to a maintenance plan under section 175(a) of that act (42 U.S.C. 7505a) (United States Code 23 U.S.C. 134 2007).

The plan is required to be fiscally constrained, indicate resources from public and private sources that are *reasonably expected* to be made available to carry out the plan, and recommend any additional financing strategies for needed projects.

Federal Transportation Bill Requirements for MPO Plans

From the federal perspective, planning for freight changed in 1991 with the introduction of the ISTEA. ISTEA required the MPOs and state DOTs to conduct freight planning as one of 15 factors to be considered as they developed the state and local transportation plans (ISTEA § 1024, codified at Section 134 of Title 23 of United States Code).

This was mirrored in the two subsequent re-authorization acts, TEA-21 and SAFETEA-LU, which also added some specific freight-orientated sections to fund large-scale freight preservation projects such as the Alameda Corridor in California, CREATE in Chicago, and border trade and corridor facilities.

TEA-21 required that the metropolitan planning process for freight seek to

- Support the economic vitality of the metropolitan area by promoting and enabling global competitiveness, productivity, and efficiency;
- Enhance the integration and connectivity of the transportations system, across and between modes, for people and freight;
- Promote efficient system management and operation; and
- Include the freight community in the development of both the Regional Transportation Plan and the Transportation Improvement Plan.

In 2005, SAFETEA-LU added the following:

- MPOs are encouraged to consult and coordinate with planning officials responsible for other types of planning

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activities affected by transportation including planned growth, economic development, environmental protection, airport operations, and freight movement.
- Safety and security of the transportation system are now separate planning factors that are to be considered during the metropolitan planning process.

SAFETEA-LU also added specific programs targeted at freight, which included

- A truck-parking facilities pilot program,
- A highway-railroad crossing safety improvement funding program,
- Allowance to construct truck-idling reduction facilities on Interstate highway rights-of-way,
- A highway bridge funding program,
- A new program for research, training, and education to support freight transportation planning, and
- A freight intermodal distribution pilot program—which gave grants to facilitate intermodal freight transportation initiatives at the state and local level for the relief of congestion and to improve safety and provide capital funding to address infrastructure and freight distribution needs at inland ports and intermodal freight facilities.

Regional Visioning and Freight

Regions, according to Seltzer and Carbonell (2011) are territories defined primarily by function and only rarely by jurisdiction. Regional planning is the development of plans and programs by communities and institutions working collaboratively to address issues that affect their shared geographic territories. Figure 6-4 shows the identified megaregions in the United States. With the likely emergence of freight megaregions that do not respect state or even national boundaries, a new planning dialogue is required to prepare for the next-generation freight system to support these regions. Planning decisions made over the next decade will be critical to our future transportation system efficiencies and regional competitiveness. Local and regional freight planning in this context will require highly skilled freight transportation planners and new strategies and tools, community support, and legislative authority.

Strategic visioning is an emerging approach to problem solving that is being applied in major metropolitan regions across the country. Examples are California DOT's *Regional Blueprints* and the Chicago Metropolis 2020's reports on development and transportation. Strategic visioning recognizes that today's urban challenges have natural or economic boundaries (e.g., air sheds, watersheds, commuter sheds, and commerce

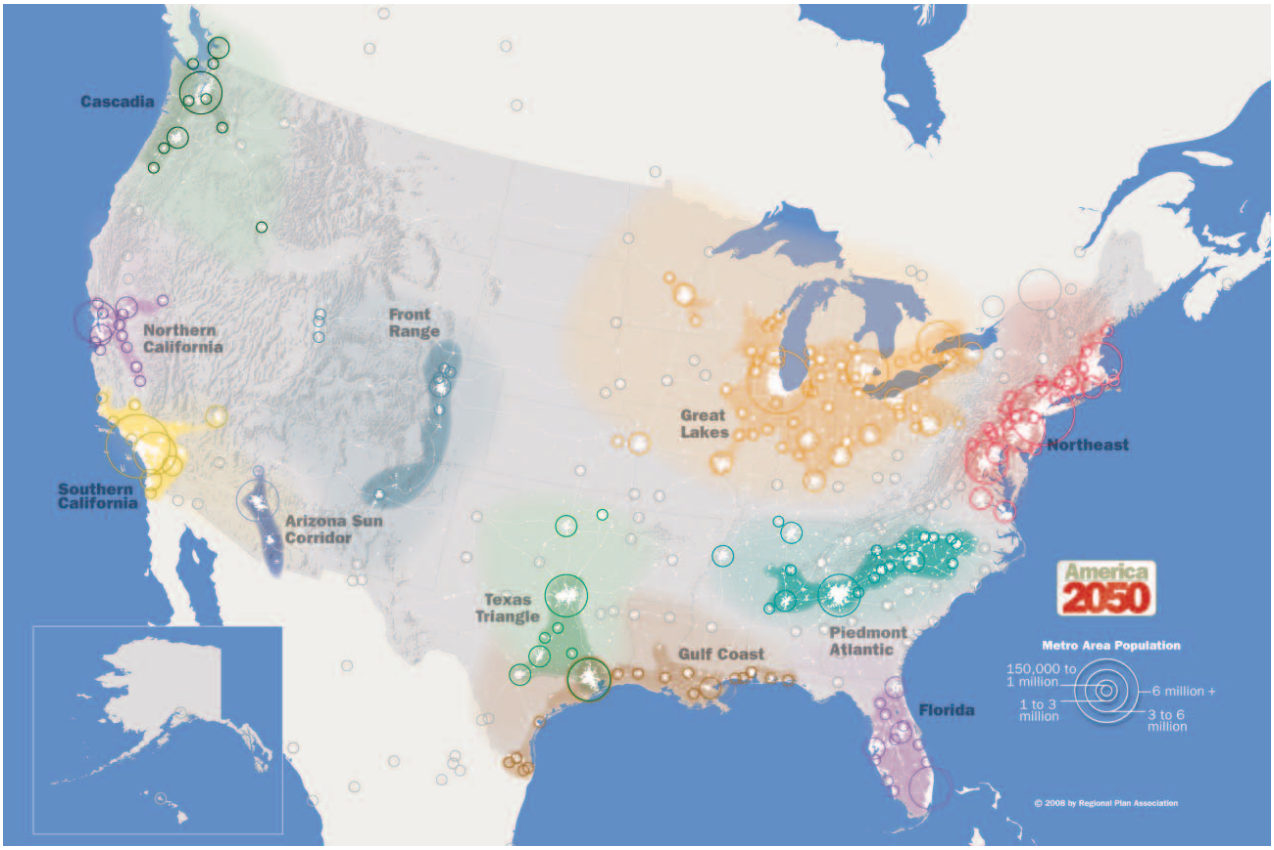

Figure 6-4. Identified megaregions in the United States (America 2050 2010).

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and trade patterns) that must be respected in seeking best solutions. These challenges do not respect city or state boundaries and, with the emergence of megaregions, sometimes do not even respect regional boundaries. The primary goal of strategic visioning is to identify and preserve the widest range of best choices or future possibilities. Strategic visioning uses the analysis of future alternative scenarios to empower stewards to make wise decisions and establish robust strategies that will enhance the probability of the best choices actually coming to fruition.

It has been said that the most common strategy for dealing with the future is denial. As humans, we show an uncanny ability to ride old, expiring trends into the ground before we will engage in deep thinking about the future. A regional visioning process is an attempt to engage in such deep thinking in light of existing trends and future uncertainties—to consider various scenarios for the future of the region in order to explore answers to the question, "What if?" What if the population of the region expands over the coming decades? Where and how will these people be accommodated? What if the price of gas eventually rises to $10 per gallon? What if potential new transportation corridors to or across the region become blocked by surrounding development?

Most regional visions do not currently deal with freight in depth, but tremendous potential exists to significantly affect decision making that impacts freight. Regional visioning processes can expand their thinking about the future to include freight concerns. How important is freight to the economy of the region? What role can freight play in the economic future of the region? How will rapidly expanding freight needs in a region be accommodated? What if the creation or expansion of freight corridors and facilities is blocked by development?

The regional vision is the proper scale for tackling freight issues. An important component in making informed land-use decisions as they relate to freight transportation is an understanding of the economic costs and benefits of these decisions. In the context of freight transportation corridors, economic costs and benefits must be viewed on a large-scale perspective because freight transportation infrastructure is an important factor in the performance of the U.S. economy and a region's competitiveness on a global scale. Decision makers at the local level are typically subject to local political pressure from both residents and developers who often have little concern for local impacts on freight systems. In this context, the cliché "freight doesn't vote," is relevant. Figure 6-5 illustrates how regional visioning fits into land-use decisions.

The freight portion of a regional visioning exercise should include the following aspects:

- **Baseline information gathering,** including maps of component parts of the freight system (freight routes/corridors, distribution hubs, inland ports, waterways, air cargo, etc.), as well as data related to these component parts, such as tonnage, value, routes utilized and density of goods on the routes, capacity of facilities, vehicle trips, economic impacts, jobs created, taxes paid, and current bottleneck areas. Data also should be gathered regarding current trends and future projections. Interviews with industry experts can reveal current and future issues.
- **Inclusion of freight-related stakeholders** in the visioning process to serve on technical and other committees. These stakeholders would include railroads, ports, trucking companies, airports and air freight carriers, government officials, industry organizations, and consultants with expertise in the field.
- **Public outreach that includes freight issues.** Freight can be included in public workshops and open houses, surveys, and other outreach mechanisms.
- **Creation of land-use and transportation scenarios that take significant note of freight considerations.** Land-use scenarios should consider freight needs, including possible future expansion or creation of facilities. Transportation scenarios should not focus on movement of people without adequate consideration of the movement of goods.
- **Technical analysis of the impact of various future scenarios on freight.** Various measures that can be modeled might include congestion and its costs in terms of money, time, and air quality; public safety impacts; freight corridor externalities; economic impact of the freight industry over time; and overall assessment of costs and benefits of alternative land uses.
- **Vision goals and strategies that include freight** as a key component of the economic, land-use, transportation, and environmental future of the region.

Source: Grow & Bruening.

Figure 6-5. Regional visioning and land-use decisions.

Mapping Freight Corridors and Facilities

Much of the research conducted over the past 25 years regarding corridor protection and preservation has noted that mapping of freight corridors and facility elements is a critical element to ensure continued viability.

In some states, advanced planning and approval of transportation corridors do not require a change in statutes or

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regulation. However, corridor approval will require environmental analyses to determine and confirm the final corridor location on a map. Advanced planning allows local governments and private parties to better plan developments while more land is vacant, minimizing social, economic, and environmental impacts (Perfater 1989). Advanced planning also provides notice to citizens, property owners, and developers through adoption of an official thoroughfare protection map (Williams and Marshall 1996).

Official mapping requires state or local statutory authority, although existing statutes may, in many cases, already provide the needed authority. The most often cited example of corridor mapping and management legislation is Florida's 1995 corridor management legislation. Florida requires the designation of corridors in local comprehensive plans consistent with Florida's growth management policy. Florida's law encourages local governments to designate corridors, adopt corridor management ordinances, and create official corridor maps. Local governments are directed to notify the Florida DOT (FDOT) before approving any rezoning, building permit, or subdivision change (within 1,000 feet of the corridors) that may impact the future viability of the corridor. This creates a process whereby FDOT can identify problems and then negotiate for alternatives to mitigate impacts.

Highway corridor preservation research also has found that in conjunction with legislatively authorized mapping powers, several states employ a development review and permitting process to ensure compatible use within and along the corridor. The process for review is simple, as follows:

- Corridors are prioritized, and a map is filed with the relevant local jurisdiction.
- When a developer files a permit request, it is submitted to the state DOT for review and approval.
- The DOT will have a set period of time to approve or deny the request (usually 30 to 120 days).

According to FHWA, this process can involve negotiations with developers to ensure compatible land use at permit approval (U.S. Department of Transportation 2000). Under its official mapping power, the North Carolina DOT can delay a project filed for development along a corridor for up to 3 years. If an agreement is not reached within 3 years, the state must acquire the corridor. North Carolina also was given significant permitting and encroachment prevention procedures regarding rail in its 1988 Rail Corridor Preservation Act. This gave the North Carolina DOT "authority to purchase railroads and preserve corridors" (North Carolina Department of Transportation 2010). The North Carolina DOT can use the same process for rail corridor development permitting that it uses it for highway corridors.

As a recommended best practice, official mapping, along with development permitting, provides the optimal process to protect and preserve freight routes and facilities. This would reduce the speculation that often occurs around industrial land and often leads to inappropriate rezoning. It also would reduce uncertainty that currently exists around many U.S. freight facilities.

Summary

Figure 6-6 summarizes the planning process and the role of various elements, including regional visioning, long-range planning, and the comprehensive plan. Zoning issues will be discussed in Chapter 7.

Process	Time Horizon	Scale	Subjects
Regional vision	25–50 years	Regional	Multi-issue
MPO long-range plan	20-30 years	Metropolitan area	Transportation
Comprehensive plan	20 years+	City or county	Land use, transportation
Zoning	≈10 years	City or county, often adjusted for specific project	Land use
Site plans & subdivisions	Today	Specific project or phase of project	Land use & infrastructure

Many of these processes are authorized, mandated, and/or regulated by state enabling acts

Source: Grow & Bruening.

Figure 6-6. Planning process summary.

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CHAPTER 7

Zoning Activities Related to Freight Facilities and Corridors

There are many zoning tools that cities are already utilizing that can aid in creating a sensible development environment for residential and other developments that are sensitive to noise, vibration, or safety, or for development that is adjacent to freight facilities and corridors.

Across the United States, cities and counties (if they are authorized) enact zoning rules to regulate how development activities will be carried out within their territorial jurisdictions. According to New York City

> Zoning shapes the city. Zoning determines the size and use of buildings, where they are located and, in large measure, the densities of the city's diverse neighborhoods. Along with the city's power to budget, tax, and condemn property, zoning is a key tool for carrying out planning policy (New York City Department of City Planning 2010).

A number of factors have contributed to deficiencies in zoning, lot design, and the development of land uses that should be considered "sensitive" when they are placed in proximity to freight corridors and facilities. These include the following:

- The historical lack of interaction between the freight industry and local and state planning entities;
- The lack of education about freight facilities, their needs, and potential impacts from their activities; and
- The role of developers in projects that do not take freight activities into account.

For many years, the freight industry was not involved in land-use planning decision meetings and did not regularly interact with local and state planning organizations. Moreover, many planners have not had adequate training on freight issues in their formal education. By not properly considering freight issues, the developer community also could be considered the third leg of the stool contributing to the problem of incompatible land uses in proximity to freight corridors and facilities.

Overview of Zoning Approaches

There are the following three main types of zoning:

1. **Euclidian zoning,** which strictly separates out the uses of land. This is the most common form of zoning in the United States and is probably the most intuitive and easy-to-interpret type of zoning. In many instances, the elements under this type of zoning are cumulative. Figure 7-1 provides an example of Euclidian zoning.
2. **Performance zoning,** which is a goal-oriented system that often will use "points." Performance zoning gives planning staff a fair amount of latitude in how they conduct activities, and it is not strictly focused on uses, but rather on output. This type of zoning is rare in the United States. Figure 7-2 provides an example of performance zoning.
3. **Form-based codes,** which are a new type of zoning that has been promoted over the past 20 years by New Urbanist planners. This type of zoning uses transects and pattern books, and has a unified code and a regulating plan. Similar to performance zoning, the focus is not on use but on form. This type of zoning has gained traction in the United States, with Miami, Florida, and the small town of Jamestown, Rhode Island, adopting the use of form-based code in late 2009 (Lydon 2009). Figure 7-3 provides an example of form-based codes.

The purpose of zoning is to protect and promote the public health, safety, and general welfare of a jurisdiction. Zoning also is utilized to implement the policies of the general plan, comprehensive plan, and other long-range plans by classifying and regulating land use and structures in specific areas. For example, Pasadena, California, notes that for the purpose of implementing its comprehensive plan, it is the intent of the city's zoning code to

- Provide standards for the orderly development of the city and continue a stable land-use pattern;

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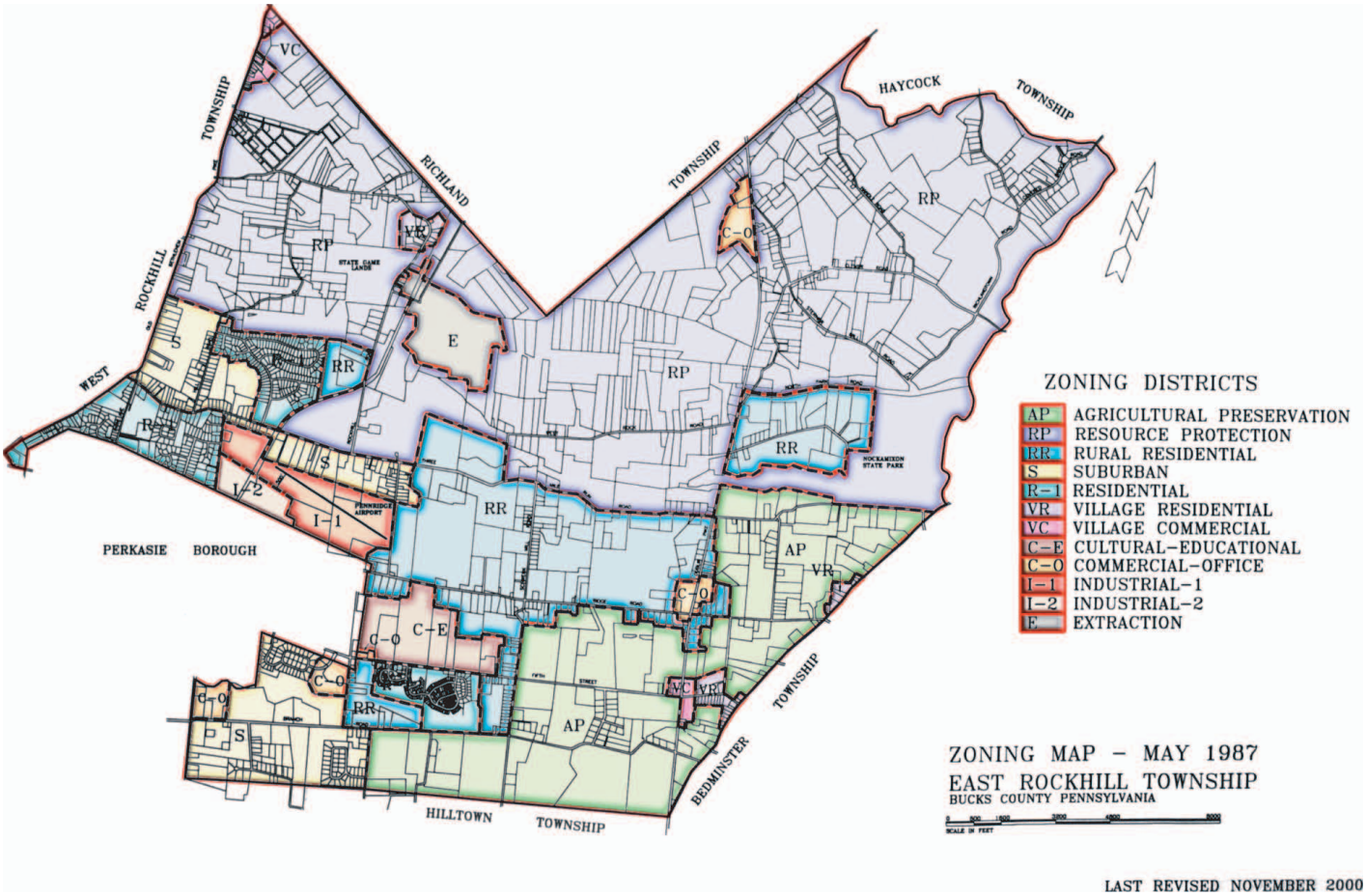

Figure 7-1. Euclidian zoning (Bucks County, Pennsylvania 1987).

Site Conditions Scoring Matrix - R1 Single-Family Zoning District

Criteria	Standard			Points	Possible Combinations	Maximum Points	Points Scored
Open Space & Recreation Features							
Open Space..	(A) ...>1,500 square feet per base lot..	(1)	...as an undeveloped natural area.	75	(A)(1)+(B)(2)=175 (A)(2)+(B)(1)=300	300	
		(2)	...as a developed park.	250			
	(B) ...1,000-1,500 square feet per base lot..	(1)	...as an undeveloped natural area.	50			
		(2)	...as a developed park.	100			
Pedestrian Paths..	(A) ...an 8 foot wide pedestrian path is provided within the development			25	not applicable (graduated scale)	75	
	(B) ...a pedestrian path in a linear park system is provided within the development.			75			
Landscaping/Tree Preservation..	(A) ...at least 3 hardwood trees per base lot are planted in the development.			25	(A)+(B)=50	50	
	(B) ...at least 50% of pre-existing hard wood trees are preserved (20 tree minimum).			25			
Transportation Features							
Entrance Design..	...a landscaped entrance is provided for the development			25	not applicable	25	
Infrastructure Features							
Drainage Design..	...drainage facilities in the rear yards are enclosed.			225	not applicable	225	
					Total Site Conditions Points		

Figure 7-2. Performance zoning (City of Shelbyville, Indiana 2004).

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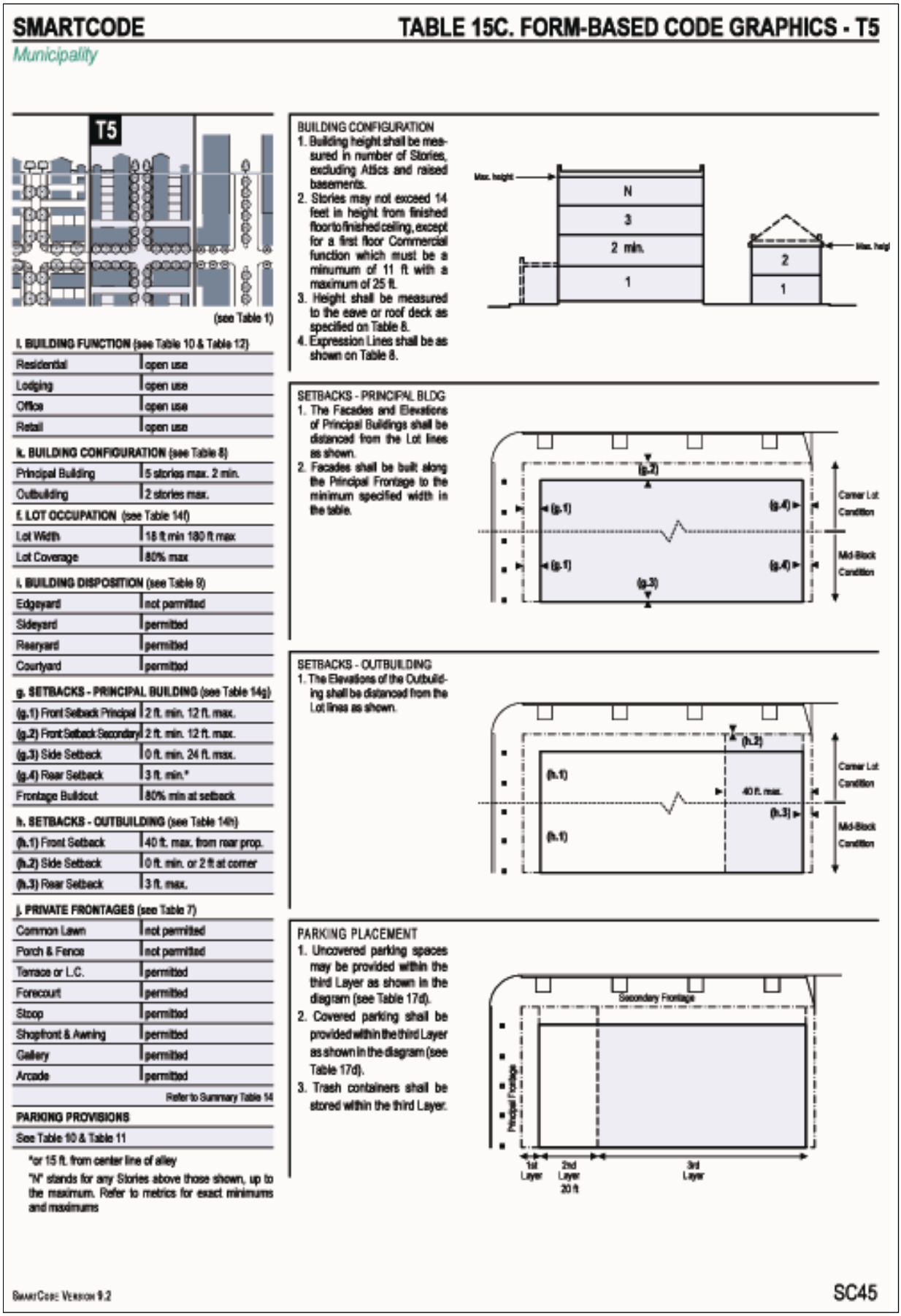

SMARTCODE — *Municipality*

TABLE 15C. FORM-BASED CODE GRAPHICS - T5

(see Table 1)

I. BUILDING FUNCTION (see Table 10 & Table 12)	
Residential	open use
Lodging	open use
Office	open use
Retail	open use
k. BUILDING CONFIGURATION (see Table 8)	
Principal Building	5 stories max. 2 min.
Outbuilding	2 stories max.
f. LOT OCCUPATION (see Table 14f)	
Lot Width	18 ft min 180 ft max
Lot Coverage	80% max
i. BUILDING DISPOSITION (see Table 9)	
Edgeyard	not permitted
Sideyard	permitted
Rearyard	permitted
Courtyard	permitted
g. SETBACKS - PRINCIPAL BUILDING (see Table 14g)	
(g.1) Front Setback Principal	2 ft. min. 12 ft. max.
(g.2) Front Setback Secondary	2 ft. min. 12 ft. max.
(g.3) Side Setback	0 ft. min. 24 ft. max.
(g.4) Rear Setback	3 ft. min.*
Frontage Buildout	80% min at setback
h. SETBACKS - OUTBUILDING (see Table 14h)	
(h.1) Front Setback	40 ft. max. from rear prop.
(h.2) Side Setback	0 ft. min. or 2 ft at corner
(h.3) Rear Setback	3 ft. max.
j. PRIVATE FRONTAGES (see Table 7)	
Common Lawn	not permitted
Porch & Fence	not permitted
Terrace or L.C.	permitted
Forecourt	permitted
Stoop	permitted
Shopfront & Awning	permitted
Gallery	permitted
Arcade	permitted
	Refer to Summary Table 14
PARKING PROVISIONS	
See Table 10 & Table 11	

*or 15 ft. from center line of alley

"N" stands for any Stories above those shown, up to the maximum. Refer to metrics for exact minimums and maximums

BUILDING CONFIGURATION

1. Building height shall be measured in number of Stories, excluding Attics and raised basements.
2. Stories may not exceed 14 feet in height from finished floor to finished ceiling, except for a first floor Commercial function which must be a minumum of 11 ft with a maximum of 25 ft.
3. Height shall be measured to the eave or roof deck as specified on Table 8.
4. Expression Lines shall be as shown on Table 8.

SETBACKS - PRINCIPAL BLDG

1. The Facades and Elevations of Principal Buildings shall be distanced from the Lot lines as shown.
2. Facades shall be built along the Principal Frontage to the minimum specified width in the table.

SETBACKS - OUTBUILDING

1. The Elevations of the Outbuilding shall be distanced from the Lot lines as shown.

PARKING PLACEMENT

1. Uncovered parking spaces may be provided within the third Layer as shown in the diagram (see Table 17d).
2. Covered parking shall be provided within the third Layer as shown in the diagram (see Table 17d).
3. Trash containers shall be stored within the third Layer.

SmartCode Version 9.2

SC45

Figure 7-3. Form-based codes (Center for Applied Transect Studies).

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- Conserve and protect the historical integrity of neighborhoods;
- Maintain and protect the value of property;
- Ensure the provision of adequate open space for light, air, and fire safety;
- Promote the economic stability of existing land uses that conform to the general plan and protect them from intrusions of harmful or inharmonious land uses;
- Ensure compatibility between land uses; and
- Encourage a pedestrian-friendly community by promoting a mix of land uses and pedestrian-oriented development in commercial areas (City of Pasadena, California 2005a).

Under Pasadena's zoning code, most jurisdictions are divided into basic zoning districts. These usually are residential (R), commercial (C), manufacturing (M), industrial (I), public and semi-public use (PS), agricultural (A), and temporary uses (T). Generally, these districts are then divided into various differing density districts. The zoning districts typically regulate

- Permitted uses listed in one or more of the use groups;
- The size of the building in relation to the size of the zoning lot, which is commonly called the floor area ratio (FAR);
- For residential uses, the number of dwelling units that will be permitted, open space requirements for the lot, and the maximum amount of the lot that can be covered by a building (called lot coverage);
- The distance between the building on the lot and its front, side, and rear lot lines;
- Any parking requirements; and
- Other features that may be specifically applicable to the different types of districts (City of Pasadena, California 2005b).

There are many zoning elements that cities use to accommodate residential and other developments that are sensitive to freight externalities such as noise, light, vibration, and safety issues. States with strong building codes (e.g., California, Florida, Massachusetts, Michigan, and New York) also use these as a mechanism to reduce noise and vibration where properties may be situated by high-volume freight corridors or facilities. In many instances, airport land-use plans have developed construction requirements to achieve sound-level reduction and have produced guidebooks and other useful instructional material to assist the city as they issue development permits.

Table 7-1 provides recommended zoning approaches for dealing with freight issues. The following sections provide brief discussions of these approaches. More detailed discussions can be found on the EnvisionFreight website at http://www.EnvisionFreight.com/tools/default.aspx?id=zoning.

Cluster Zoning

Cluster zoning (sometimes called residential cluster development) is a method of land development in which structures are grouped together on a site to save the remaining land for common open space, often for conservation, recreation, and public uses. Cluster zoning could also be used as a tool

Table 7-1. Recommended zoning approaches for accommodating freight activities.

Zoning Activity	Examples
Lot depth and width	Anaheim, CA American Canyon, CA Bakersfield, CA
Buffer areas and non-access easements	Portland, OR Slinger, WI Juneau, AK Wheaton, IL Long Lake, MN Empire, WI
Container storage	Will County, IL
Restricting freight activity hours	Pasadena, CA Peoria, AZ
Delineating truck routes	San Francisco, CA
Hazardous material routing	Boston, MA
Overlay zones	Baltimore, MD Benton, OR Jacksonville, Duval County, FL Portland, OR
Urban noise level information and zoning restrictions	Pasadena, CA
Noise abatement design criteria	The Crossings at Anaheim, CA
Airport noise restrictions	Portland, OR
Airport influence overlay districts and noise disclosure form	Arapahoe County, AZ

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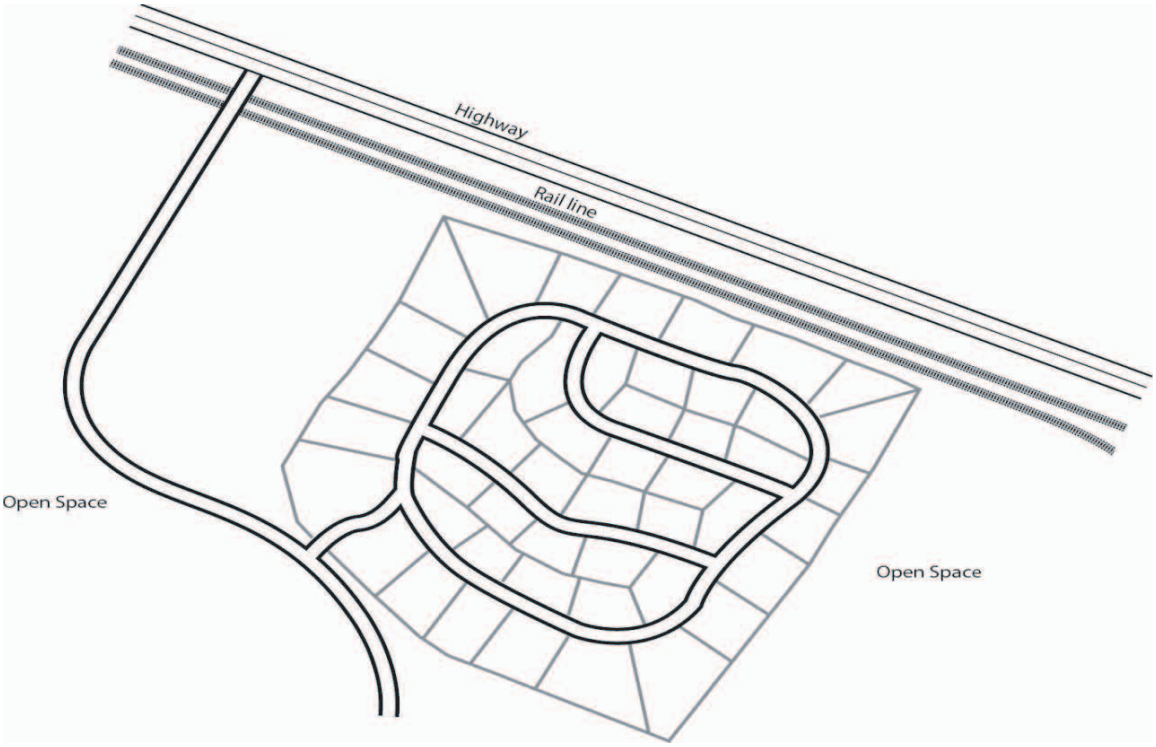

Source: UT-CTR.

Figure 7-4. Residential area adjacent to rail and highway.

to create common open space between the freight facility or corridor and residential development and reduce some of the nuisance elements that may concern residents.

As an example to show how cluster zoning could improve a site where residential development is close to a shared freight/commuter rail line and highway, see Figures 7-4 and 7-5. These figures highlight how cluster zoning could have created a buffer area between the right of way and residences.

The American Planning Association has a model cluster zoning ordinance on their website for cities and counties interested in utilizing this tool (American Planning Association 2006).

Lot Depth

Lot depth is one critical area in which cities can reduce conflict where residential or other sensitive land uses may be developed adjacent to freight corridors and facilities. By increasing lot depth beside these rights-of-way, the city can create an element of buffering between the residential use and the freight activity that may generate noise, vibration, dust, and pollution up to 24 hours a day in many cases. The lot depth increase is either stipulated in actual feet or as a percentage increase in depth. In some instances, lot depths adjacent to limited-access highways or railroad rights-of-way also include some type of treatment—for example, the planting of trees and shrubs in a non-access easement to mitigate noise and vibration.

For example, in 2004, Anaheim, California, enacted Ordinance 5920, in which single-family residential lots adjacent to railroad rights-of-way must have a specified minimum depth as follows:

> Single-family residential lots adjacent to all arterial highways . . . or railroad rights-of-way shall have a minimum depth of one hundred twenty (120) feet and shall not take vehicular access from the arterial highway (City of Anaheim 2004).

American Canyon, California, requires a 20 percent increase in depth for lots adjoining state highways or railroads (Title 19 Zoning, Division 2 Zoning District Permitted Uses and Development Standards). Bakersfield, California, (Title 16 Sub-Division, Chapter 16.28 Design Standards) requires that the minimum depth for a lot with a rear yard abutting a freeway or railroad right-of-way is 120 feet and that the minimum width for a lot with a side yard abutting a freeway or railroad right-of-way is 85 feet on interior lots and 90 feet on corner lots.

Setback Standards

Setback standards are another zoning element for new and infill developments that can reduce conflicts because of the proximity of incompatible land uses between freight facilities and corridors and non-freight uses. For example, the California Air Resources Board developed "Air Quality and Land Use Handbook: A Community Health Perspective," in

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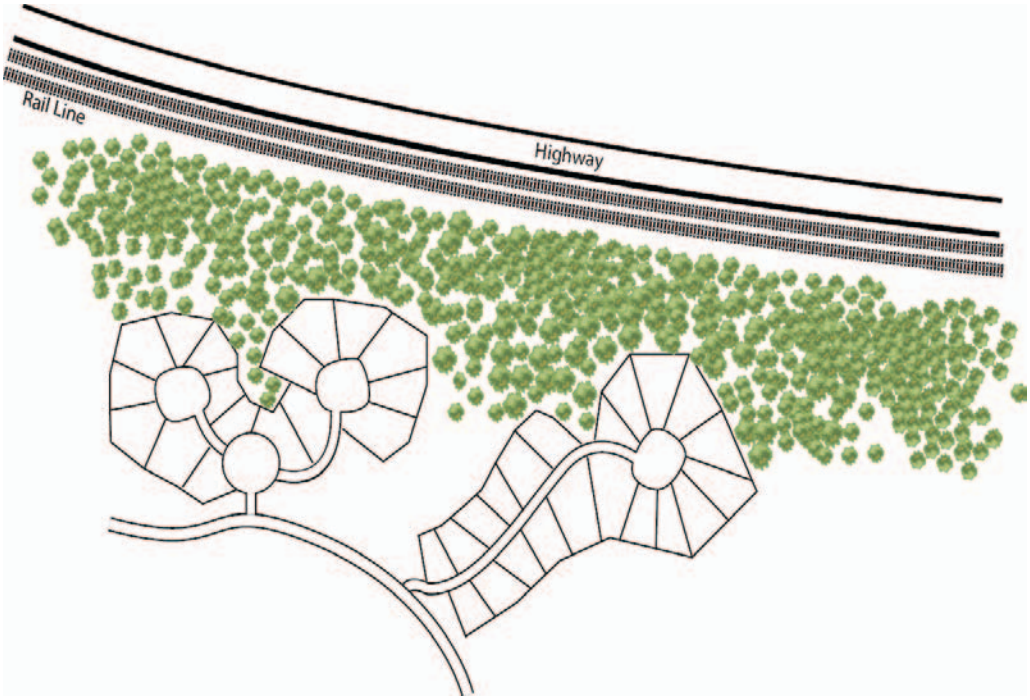

Source: UT-CTR.

Figure 7-5. How cluster zoning could improve residential area adjacent to rail and highway.

2004. The handbook reviews various transportation modes and freight activities and proposes site separation distances.

For freeways and high-traffic roads, the combination of children's health studies and distance-related findings suggest that it is important to avoid exposing children to elevated air pollution levels immediately downwind of freeway and high-traffic roadways. The handbook suggests a substantial benefit can be achieved by a 500-foot separation. For distribution centers, the handbook reports that taking into account the configuration of the distribution center can reduce pollution exposure, and recommends locating any new sensitive land uses away from the main entry and exit points to reduce cancer risk and other health impacts. Specifically, it is recommended to avoid siting new sensitive land uses within 1,000 feet of a distribution center that accommodates more than 100 trucks a day or more than 40 trucks that have transportation refrigeration units. Similarly, for rail yards, the area of highest impact was found within 1,000 feet of the yard.

Other recommended minimum setback standards compiled by the research team can be found in Table 7-2.

Buffer Zones and Non-Access Easements

Another method to minimize noise, vibration, and any environmental effects between freight and non-freight uses in close proximity is the use of buffer zones within setback areas. The buffer zone has no development on it and is often planted with various types of vegetation.

Many cities have standardized their zoning for creating a buffer between incompatible uses. For example, Portland, Oregon, uses buffer zone overlays between non-residential and residential zones. This zoning can be used when the base zone standards do not provide adequate separation between uses. The separation can include restricting motor vehicle access and/or requiring increased setbacks and additional landscaping. In some instances, this separation also requires proof of mitigation for uses that can cause off-site impacts and nuisances. This is marked on official zoning maps with the letter *B.* The zone is applied along the edge of the non-residential zone abutting or located across the street from a residential zone. Within industrial zones, any classification of street can be considered; in commercial zones, the street must be a local service traffic street. The setback required in commercial zones is 10 feet, with landscaping required along all lot lines that are across a local service street or abut the rear-lot line for residential zoned land. In employment and industrial zoned areas, the setbacks are required to be 20 feet and landscaped along all lot lines within the overlay zone. Figures 7-6 and 7-7 show how this zoning should be applied in practice.

In October 2007, Slinger, Wisconsin, adopted a new design standard regarding the treatments around existing or planned limited access highway and railroad rights-of-way for new

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Table 7-2. Recommended minimum setback standards for a municipality to consider in zoning around freight facilities and corridors (in feet).*

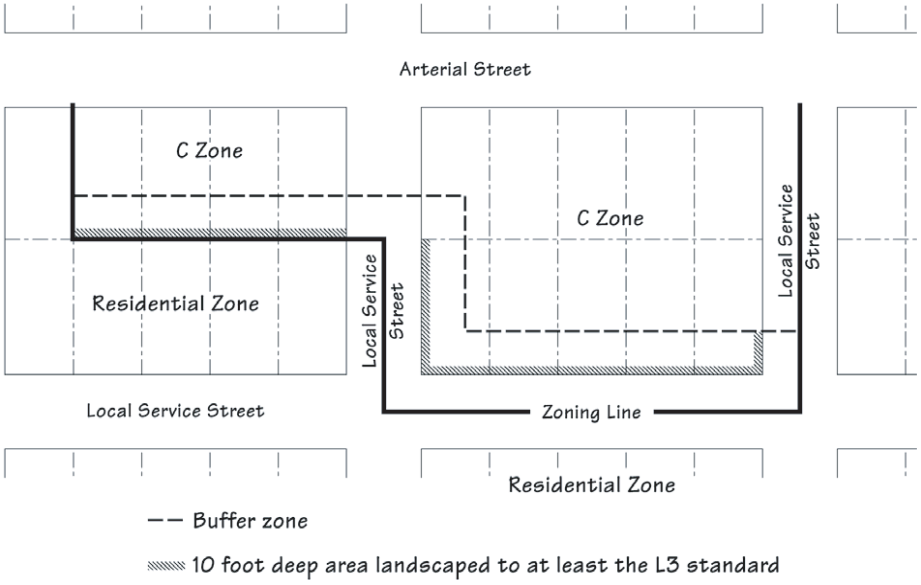
	Residential	Mixed Use	School, Hospital, Residential Day Care Facility**	Commercial	Industrial
Primary freight corridor	250	200	250	100	15
Secondary lines (rail) and major arterials (trucking)	150	150	250	50	10
Passing spurs/small branch lines (rail)	100	100	150	50	10
Rail yard	150	150	150	50	-
Intermodal facility	100	100	150	50	-
Port facility	150	150	250	50	-
Air Cargo facility***	10,000	10,000	10,000	10,000	-

Source: Christensen Associates, UT-CTR, Pett, and Grow & Bruening.

Notes:
* Setback standards should be amended depending on speed, weight, and type of cargo carried by freight components, as well as width of right-of-way (ROW) and the day night average sound level (DNL) 65 noise contour. This will also allow for changes to be made to zoning code if freight activities increase or diminish.

** The City and County of Denver zoning code for hospital districts does not allow railway right-of-way as a permitted use beside schools/hospitals. Researchers consider this to be too exclusionary for all jurisdictions and leave this up to individual municipalities/counties to address.

*** Cities should check with individual airports to determine where any easements have been created, and any airport influence zones, and also should delineate out the 65 DNL contour and flight path approaches as they consider permitting any projects. This recommendation is based on distance to existing or planned runway approaches at a regional, commercial, or air-freight airport.



Source: City of Portland.

Figure 7-6. Buffer for commercial-zoned areas.

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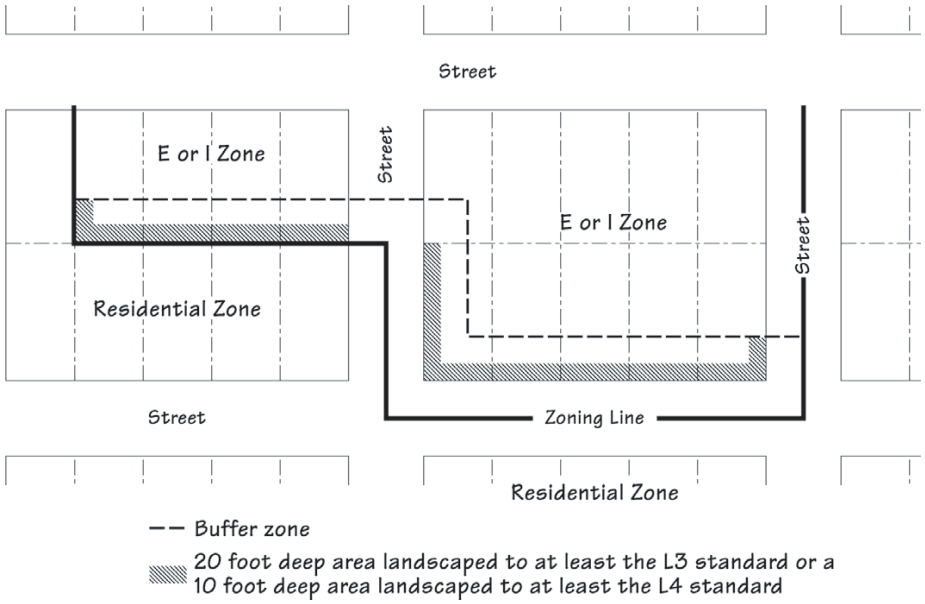

Source: City of Portland.

Figure 7-7. Buffer in employment and industrial zones.

land division or condominium development adjacent to these rights-of-way. The new standard included a non-access easement and planting area of *at least* 50 feet in depth adjacent to the highway or railroad right-of-way. The design standard required that the village zoning ordinance for minimum lot depth should be increased by 50 feet to accommodate the non-access easement.

> This non-access easement and planting area shall be a part of all lots and shall have the following restriction lettered on the face of the plat or certified survey map: "This area is reserved for the planting of trees and shrubs. No access shall be permitted across this area. The building of structures, except public or private utility structures and fences, is prohibited hereon." (Village of Slinger, Wisconsin 2007).

Juneau, Alaska, has a similar easement restriction requiring a planting strip of at least 30 feet in addition to the usual lot depth when subdivision lots are located adjacent to a limited-access highway or railroad. Likewise, Wheaton, Illinois, requires that where

> . . . a subdivision borders on, or is traversed by, a railroad right-of-way or federal or state highway, the city council may require a street on one or both sides of such right-of-way or highway approximately parallel to and at a distance removed suitable for the appropriate use of the intervening land for
> (1) Park purposes; or
> (2) Off-street parking, business, or other uses as permitted by the zoning ordinances; or in lieu of a street it may require deep residential lots with a visual barrier established in a nonaccess reservation strip along the rear property lines (City of Wheaton, Illinois 2001).

The Long Lake, Minnesota, design code states that in a subdivision abutting or containing an existing or planned major arterial or railroad right-of-way

> . . . a street approximately parallel to, and on each side of such arterial and right-of-way, may be required for adequate protection of adjacent properties and separation of through and local traffic. Such service streets shall be located at a distance from the major arterial or railroad right-of-way suitable for appropriate use of the intervening land, as for park purposes in residential districts, or for commercial and industrial purposes in appropriate districts. Such distances also shall be determined with due regard for the requirements of approach grades and future grade separations (City of Long Lake, Minnesota 2002).

Within the design standards of its land division ordinance, Empire, Wisconsin, also restricts the design and placement of vehicular access and streets around railroad rights-of-way. When a proposed land division either contains or is adjacent to a railroad right-of-way, the design is required to provide the following treatments:

- For residential lots that back upon the right-of-way of an existing or proposed railroad, a written restriction noting that direct vehicular access to the right-of-way is prohibited
- Commercial and industrial districts are required to provide a street on each side of the railroad that is approximately parallel to, and at a *suitable distance from,* the railroad for the *appropriate use* of the land between the parallel street and the railroad, which is not less than 150 feet.
- Parallel streets to the railroad right-of-way, which intersect a major street, highway, or collector street crossing the

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railroad, are required to be located at a minimum distance of 250 feet from the railroad right-of-way.
- The avoidance of building minor streets immediately adjacent and parallel to railroad right-of-way.
- When a lot within land divisions backs onto the railroad right-of-way, then there is a required planting strip (landscape bufferyard easement) of at least 35 feet in addition to the normal lot depth. The planting strip is incorporated into the platted lot but must include the following written restriction on the face of the plat: "Landscape Bufferyard Easement: This strip is reserved for the planting of trees and shrubs. The building of structures is prohibited." (Town of Empire, Wisconsin 2010)

There are many examples of buffer zones being created around airports, and where airports have purchased property to create better landing approach zones and reduce the number of properties that are close to the airport. Ports also have created buffer zones through the use of yard re-development plans and through the purchase of property. The Port of Panama City in Florida, for example, has some modest problems with encroachment on the east side of the port. There is significant residential development and, for a long time, the port has had a policy of buying out homes on the eastern side and demolishing houses in order to create a buffer zone. This process has been going on for at least 10 years. The policy started with the intention of using these properties for future port expansion. However, as the port continued to develop, it became clear that the highest value for this property was to provide a buffer so that future problems with land-use conflicts would not arise.

Buffer zones are not a perfect solution for every problem. California's Air Resources Board (CARB) reviewed various options for using "generic buffer zones" around rail yards and port facilities (Tuck 2004). The California Council for Environmental and Economic Balance (CCEEB), in a review session for CARB, noted that community residents and businesses have an interest in ensuring that local governments do not create incompatible land uses in the future through today's land-use control practices. CCEEB reviewed the option of using buffer zones for different land-use source categories based on worst-case assumptions. CCEEB noted that determining an appropriate distance limitation in light of site-specific factors presents multiple challenges and outcomes. Most importantly, using overly generic buffer zones around specific land uses based on worst-case assumptions can lead to zoning that is more stringent than required, wastes land, limits tax revenues, and takes land away from needed social and economic purposes (Tuck 2004). Similar criticisms also were discussed in reviews of Baltimore's MIZOD.

Container Storage Zoning Ordinance

As major intermodal hubs grow, the need for storage of cargo containers also grows. In 2006, it was expected that at least another 200 acres would be needed for future cargo container storage in the Joliet Intermodal Center south of Chicago in Will County. In site project development, it was noted that both users of the intermodal facilities and neighbors of the facilities (e.g., residential) would ideally like to see any cargo container facilities located as close as possible to the intermodal facilities. It was further noted that not only would such a location enhance the efficiency of intermodal operations, but it would minimize the negative impacts on surrounding areas (Will County, Illinois 2006).

As a consequence, in 2006, Will County developed a model ordinance for the storage of containers that is designed to avoid or mitigate conflicts with other land uses and also allows for anticipated future needs for cargo container storage (Will County, Illinois 2006). The model ordinance was expected to serve as a template for governmental units within the county to use as they draft or revise their own ordinances. The model ordinance also was accompanied by a Cargo Container Facility Checklist that could be used by county staffers. Among other things, the model ordinance addresses typical encroachment issues such as location of facilities, distances from other land uses, noise and lighting issues, and screening and landscaping requirements.

Restricted Hours for Truck Activities

Other communities also have implemented special hours for loading and unloading of trucks. For example, Peoria, Arizona, has made it unlawful to operate a truck on certain designated roadways between 9 P.M. and 5 A.M. Violations of this ordinance can result in a $250 fine (City of Peoria 2005).

Delineating Truck Routes, Including Routes for Hazardous Materials

Some cities also specify truck routes based on weight, height, or other community concerns. It should be noted that these routes are advisory only and are not regulatory.

Many of the large ports in the United States have created specific programs to reduce conflicts between local communities and the drayage trucks that access their facilities. For example, the Port of Los Angeles requires all of its port drayage service concession to demonstrate compliance with truck routes and parking restrictions. Licensed motor carriers (LMCs) that apply to become concessionaires

> . . . shall submit for approval by the Concession Administrator, an off-street parking plan that includes off-street parking location(s) for all Permitted Trucks. Concessionaire shall ensure

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> that all Permitted Trucks are in compliance with on-street parking restrictions by local municipalities. Permitted Trucks not in service shall be staged off public streets and away from residential districts. Concessionaire shall ensure that Permitted Trucks adhere to any truck routes specified by local and state authorities or the Port, including routes and permit requirements for hazardous materials, extra-wide, over-height and overweight loads (Port of Los Angeles 2009).

As part of delineating truck routes, some jurisdictions also restrict the routes on which hazardous materials may be transported. In 2006, Boston, Massachusetts, halted all daytime permits for trucks carrying hazardous materials through Boston. The city allowed trucks carrying hazardous materials to travel through the city only between 6 P.M. and 7 A.M., and they were not allowed to use Commercial Street. However, the City of Boston had not consulted with the U.S. Department of Transportation, which must approve all hazmat routes.

> In November 2009, FMCSA issued a pre-emption determination, which said, "This de facto modification to the city's routing designation . . . serves to shift the risk associated with that transportation to neighboring jurisdictions by forcing hazardous material motor carriers to use alternative routes bypassing the city of Boston" (Trucking Info.com 2010).

In May 2010, FMCSA rejected the city's request to reroute hazmat trucks around the city but granted Boston a 45-day extension of its ban to work out an alternative approach. The City of Boston worked with the Massachusetts Motor Transportation Association (MMTA) to come up with a policy to encourage truckers to use Cross Street instead of Commercial Street. The MMTA agreed to work with the city on keeping the traffic on Commercial Street to a minimum during the new hazmat routing study and public comment process required by federal regulations (Trucking Info.com 2010).

Overlay Zones: Industrial and/or Freight Overlay Protection Zones

Many cities use special-purpose zoning "overlay" districts that are placed over certain neighborhoods to create specific unique characteristics or to retain these characteristics. Overlay districts modify the controls of the underlying districts. For example, overlay districts have been used for airport areas of influence and for transit-oriented development (TOD). Overlays usually will be seen on a zoning map as a hatched, or other, pattern that is superimposed over a specific use.

Cities are implementing industrial and freight districts or industrial flexible overlay zones to foster the preservation and growth of industrial areas. Examples include the Port of Baltimore's MIZOD; Benton, Oregon's Flexible Industrial Overlay Zone; Jacksonville, Florida's Industrial Land Preservation Ordinance; and Portland, Oregon's Guild's Lake Industrial Sanctuary Zone.

Baltimore created the MIZOD in 2004 around the Port of Baltimore to balance industrial and non-industrial development, as well as to protect frontage land along the harbor that had access to at least 18 feet of draft. The overlay was carefully crafted to preserve the most vulnerable and critical areas of deep-water frontage for current and future freight use.

Benton, Oregon's Flexible Industrial Overlay Zone was created to ensure the orderly industrial development of six specific parcels that were situated within the urban growth boundary. The industrial overlay allows light industrial uses, including manufacturing uses that may be dependent on trucks. Uses will only be permitted if surrounding land uses will not be adversely affected. If it appears that noise, dust, odors, emissions, or other adverse environmental impacts will extend outside the boundary of a parcel, the planning commission will impose conditions to reduce such adverse impacts so that the use will not create a public nuisance.

Jacksonville, Florida, authorized its Industrial Land Preservation Bill (ORD 2007-0398) in May 2007. The rationale behind the legislation was to protect industrial land from residential conversion and stop the depletion of land available for job creation (Dorsch 2007). Although the ordinance does not prohibit zoning conversion of land, the ordinance makes it costly for residential builders to do this because it requires increased buffer zones at the builder's expense. Almost 56,000 acres have been set aside for industry under this ordinance. As part of the ordinance's development, an industrial technical advisory committee was created. Its responsibilities include review of proposed land-use changes, rezoning, and text changes to the comprehensive plan and zoning code in the areas of situational compatibility and industrial sanctuaries. The committee will make recommendations to the Planning and Development Department and city council based on its reviews.

Portland, Oregon, implemented the Guild's Lake Industrial Sanctuary (GLIS) Zone in 2001. The sanctuary is located between Forest Park in the West Hills and the Willamette River. It contains the majority of the industrially zoned land in Northwest Portland. GLIS forms an important part of Portland's overall industrial sanctuary where land is preserved for long-term industrial use. According to studies commissioned by the city, industrial business was thriving in the district, creating well-paying jobs, and contributing to the region's economy. One study showed that there was a regionwide shortage of readily developable industrial land that could constrain job growth within 7 to 10 years. There was also an acknowledgement that industrial land uses could often be hard to site because of the intensity of industrial uses, and current industrial land was a finite resource. Finally,

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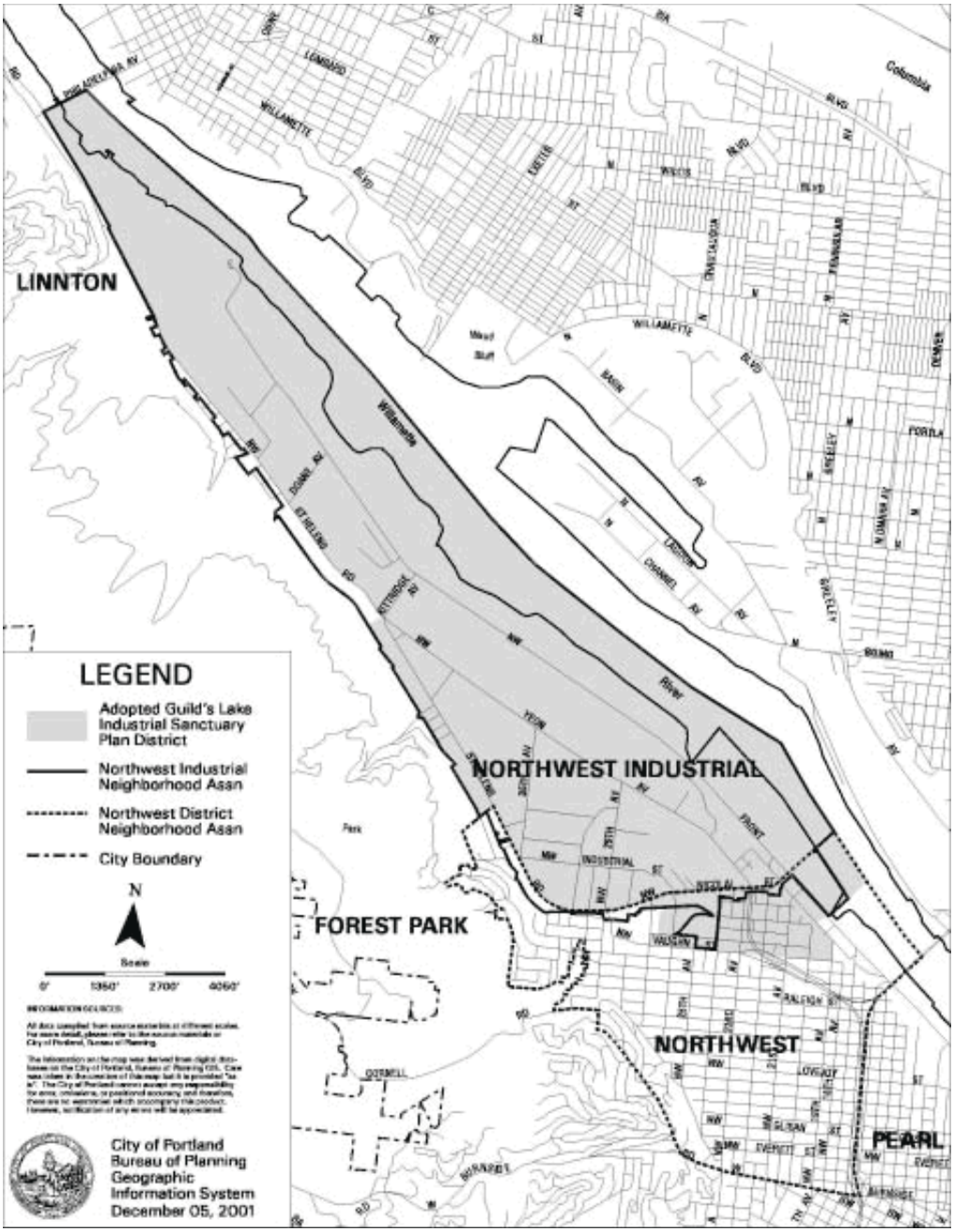

Source: City of Portland.

Figure 7-8. Guild's Lake Industrial Sanctuary Zone.

because of the GLIS proximity to mixed-use and residential neighborhoods and the central city, it was considered to be vulnerable to pressure for redevelopment to non-industrial uses. Figure 7-8 shows a map of GLIS.

According to the city, "Any loss of industrial land represents the loss of an irreplaceable component of the city's economy." Portland's industrial sanctuary policy is designed to preserve and protect industrial lands within the city. This policy is stated, in part, in Portland's *Comprehensive Plan Goal and Policies* as Policy and Objective 2.14, "Provide industrial sanctuaries. Encourage the growth of industrial activities in the city by preserving industrial land primarily for manufacturing purposes" (City of Portland 2006).

Urban Noise Level Information and Zoning Restrictions

Other cities also are requiring that residents of urban housing projects be notified that they are living in an urban area where noise levels may be higher than in a typical residential

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area. Some city ordinances, for example, are requiring such notification when many residential developments face railroads. This type of ordinance is especially useful where a rail corridor is shared with freight-transportation-related services, which may be temporally shifted to nighttime usage to facilitate the development of commuter rail. For example, in its zoning code addressing specific land uses, the City of Pasadena, California, requires

1. Residents of an urban housing development project shall be notified that they are living in an urban area and that the noise levels may be higher than in a typical residential area.
2. The signature of the residents shall confirm receipt and understanding of this information. (City of Pasadena 2005c)

Specific Noise Abatement Design Criteria

Anaheim, California's planning department created mitigation monitoring plans for specific TOD projects. For example, the Crossing at Anaheim had detailed planning specifications placed within the environmental report that were timed for approval prior to project plan approval. These included, for example, measures to make sure that (1) all residential units had weather-stripped solid core exterior doors and exterior wall/roof assemblies free of cut outs and openings, (2) all windows of residential units were sound-rated assemblies with a minimum sound transmission class rating of 35, and (3) all exterior walls had a sound transmission class rating of 46, with stud spaces to be filled with insulation bats and joints caulked to form airtight seals (City of Anaheim, California 2006). Similar types of mitigation could become commonplace for residential or other sensitive types of land uses (e.g., church, hospital, school, or library) that are built in close proximity to freight corridors or facilities.

Airport Influence Overlay Districts

Cities also implement noise restrictions, quite often as an overlay zone, within their zoning code around airport facilities (which are often owned by local municipalities as a quasi-governmental entity). Such types of noise restrictions also could be put in place by cities around freight facilities and corridors that operate on a 24-hour basis or have extremely high volumes of traffic, such as truck routes that serve a port or marine terminal facility.

Portland, Oregon, has implemented an international airport noise impact zone to reduce the impact of airport noise on development within the impact area that surrounds the international airport. The zone achieves this by reducing residential density and requiring noise disclosure statements, noise easements, and noise insulation. The noise zone is based on the LDN 65 noise contour (an average weighting of day and nighttime noise), which was developed in its 1990 noise abatement plan update for the airport and was set as a delineated boundary at this juncture. The application of the noise zone is to all annexed areas located within the LDN 65 or higher noise contours that formed part of the annexation rezoning of the area.

The ordinance requires that all new structures be constructed with sound insulation to achieve a day/night average interior noise level of 45 dBA. Garages, freight and warehouse, and manufacturing and production uses are exempt from this requirement. A registered acoustical engineer is required to certify that the building plans comply with the performance standard for the sound installation before a building permit is issued. The Port of Portland is responsible (at owners' request) for the costs of the noise insulation certification.

Within the LDN 65 noise contour, new residential uses are prohibited unless they are allowed by subsection 33.470.050. If a site is divided by the contour, all dwelling units, accessory structures, and side and rear setbacks must be located *entirely* outside the noise contour. Within the LDN 65 noise contour, residential development is prohibited from developing to a density higher than that of an R10 zone. As part of the ordinance, prior to issuance of a building permit for new residential construction or reconstruction, the owner *must* sign the city's noise disclosure statement, which must be recorded in the county records by the owner.

The airport influence overlay district in Arapahoe County, Colorado, also contains specific instructions regarding the notification that must be provided to prospective property purchasers. Such notification language should be utilized for prospective property purchasers close to freight corridors and facilities, with accompanying language inserted into a freight influence overlay district or industrial overlay type of district.

Summary

Zoning activities are commonplace within the United States and already offer useful tools to reduce and mitigate conflicts, and help to provide for continued protection of vital freight corridors and facilities. However, the use of these specific zoning tools is not yet implemented across the board. With utilization of just the few types of zoning examples provided in this chapter, cities and counties can reduce conflicts between the incompatible uses of freight activity and residences, schools, hospitals, libraries, and other sensitive uses. Two main by-products of this activity will also result, as follows:

1. Local jurisdictions will preserve these vital freight arterials and their freight facilities by preventing incompatible land

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uses from arising and by reducing residential/freight conflict.
2. Local jurisdictions will reduce the impacts that cause much community and individual distresses, such as noise and vibration, health impacts, and light pollution, as well as environmental justice issues that arise when minority and low-income communities are disproportionately affected by freight activity.

For municipalities looking for guidance on noise reduction strategies and building codes, there is a large body of information (including design criteria) that can be found in the airport noise reduction programs funded by FAA. There are also many cities that have airport facilities that have developed policies and procedures to notify residents and prospective buyers and lessees of their proximity to an airport or flight path. Table 7-3 contains much of this information, including suggested setback standards and permit and zoning considerations compiled by the research team. This information can be modified and used in conjunction with other types of freight operations and facilities.

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Table 7-3. Permit and zoning considerations.

	Setbacks for Property Abutting Freight Facility	Minimum Lot Depth (Feet) for Property Abutting Freight Facility	Height Restrictions	Structure Requirements	Noise and Vibration Assessment and Mitigation Responsibility	Buyer Notification about Freight Activity	Other
Residential	250-500 feet or *X* percent of average lot depth depending on freight activity and density.	1,000	Dependent on noise/vibration assessment and whether mitigation required because of freight density and activity.	Achieve 50 dBA inside unit (based on HUD/EPA/FRA/FAA noise guidance) and on land uses—this is Land Use 2 (residence where people usually sleep).	Developer	Yes	Entrances and exits should not be sited near at-grade crossings, and entry/exit points of heavily trafficked distribution facilities, port facilities, and other terminals.
Mixed Use	250-500 feet or *X* percent of average lot depth depending on freight activity and density.	1,000		Achieve 55-60 dBA inside unit; would be lower if Land Use 2 is close to rail line.	Developer	Yes	Entrances and exits should not be sited near at-grade crossings and other heavily truck trafficked areas. Ensure that cross-dock facilities and turning radii for trucks to deliver to commercial components of the facility are sufficient.

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Residential Care Facility	250-500 feet or *X* percent of average lot depth depending on freight activity and density.	1,500		Land Use 2—up to 50 dBA to stay within a no-impact area.	Developer	Yes—recommend that incoming residents are required to sign notification letter.	Entrances and exits, and parking and pedestrian crossing areas, should not be sited near at-grade crossings, and other heavily used truck traffic crossing points.
Hospital	250-500 feet or *X* percent of average lot depth depending on freight activity and density.	2,500		Land Use 2—Up to 50 dBA to stay within a no-impact area.	Developer	Yes	Entrances and exits, and parking and pedestrian crossing areas should not be sited near at-grade crossings, and other heavily used truck traffic crossing points.
School	250-500 feet or *X* percent of average lot depth depending on freight activity and density.	1,500		Land Use 3—Institutional use with primarily anytime and evening use up to 65 dBA.	Developer	Yes	Entrances and exits, and parking and pedestrian crossing areas should not be sited near at-grade crossings, and other heavily used truck traffic crossings. Recommend fencing between school property and freight facility to discourage trespass.

Source: Christensen Associates, UT-CTR, Pett, and Grow & Bruening.

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CHAPTER 8

Mitigation of Conflicts between Freight and Other Land Uses

The negative effects of freight-transportation-related services on nearby land uses include nuisance, health, and safety issues such as air and water pollution, noise, vibration, and light impacts. There are a number of mitigation tools that can be utilized to (1) reduce the effects of being close to freight facilities and corridors and (2) improve development activity (especially for sensitive land uses) to reduce the potential for conflicts to arise.

In this chapter, we provide an overview of some mode-specific mitigation activities for airports, railroads, and ports. In addition to these mode-specific approaches, other tools are commonly used to mitigate or minimize conflicts between freight and other types of land uses including layout and design considerations and hazmat considerations. A more detailed discussion of mitigation programs and approaches can be found on the EnvisionFreight website at http://www.EnvisionFreight.com/tools/default.aspx?id=mitigation.

Airport Mitigation Programs

By far, the most pressing issue that airports face is noise. Incompatible land uses near airports are a major concern and challenge for all airport operations (freight and passenger). These challenges are complicated by multiple layers of oversight and regulation that cover airports juxtaposed with the goals of many airport operators, commercial carriers, and economic development groups who are often focused on increasing revenues and maximizing the utility and operation of the airport.

The primary responsibility for integrating airport considerations into land-use planning lies with local jurisdictions. This presents difficulties for many airports, because they cannot control development in the surrounding communities and yet are held to account by these communities when airport noise adversely affects nearby uses such as homes, schools, and churches.

Examples of airport mitigation programs include

- Noise mitigation,
- Relocation, and
- Community noise round tables.

Federal Role

FAA governs many aspects of airport activities, including the following:

- Developing the national airport system plan,
- Airspace authorization,
- Air traffic control,
- Airport certification,
- Aircraft and airline licensing,
- Pilot licensing,
- Aircraft noise abatement oversight, and
- Aircraft safety and security.

FAA has set standards for noise levels and has programs that can be utilized to redress these issues. Also, FAA has issued multiple items of guidance regarding noise mitigation and land uses identified as incompatible with airport activities. However, in much the same way as is seen across other freight modes, problems may well arise because the jurisdictional responsibility for implementing land-use planning and zoning lies with local jurisdictions that are not necessarily part of any noise reduction or abatement program or involved in planning activities.

In 1979, the Aviation Safety and Noise Abatement Act (49 U.S.C. 47501 et seq.) created the first pilot program where the federal government funded up to 24 noise control plans a year. This was expanded in the 1980s and 1990s, and by the end of the century, the FAA Airport Improvement Program grants totaled over $2.6 billion. The Airport Noise and Capacity Act of 1990 was another pivotal piece of legislation

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recognizing the need for a national aviation noise policy. A critical part of the statute was direction to eliminate the use of older, noisier "Stage 2" aircraft weighing more than 75,000 pounds in the contiguous United States after December 31, 1999. The final revision and rules of this act were established in September 1991 as Part 91. Another important element of the noise policy is the Notice and Approval Airport Noise and Access Restrictions, Part 161, which establishes a program for reviewing airport noise and access restrictions on the use of Stage 2 and newer, quieter Stage 3 aircraft.

Finally, what is known as the FAA's Part 150 Program is another critical noise and land-use program. Airport operators develop their own comprehensive noise and land-use compatibility programs under Part 150, which identify noise mitigation projects and procedures to reduce aviation noise. Part 150 is a voluntary program that encourages airport operators to develop noise exposure maps and noise compatibility programs. These identify noise contours and land-use incompatibilities. The FAA then determines if the airport's Part 150 Program is appropriate. Once this is established, an airport operator can apply for grants to fund studies and airport noise compatibility projects. At year-end 2007, there were 271 airports participating in the Part 150 Program, and 238 had an approved noise compatibility program (Federal Aviation Administration 2009a, 2009b).

Noise projects include residential and public building sound insulation, land acquisition, and the relocation of residents from areas significantly impacted by noise. As part of this, many airports have acquired noise monitoring equipment and installed noise barriers to reduce ground run-up noise, and have created noise round tables composed of stakeholders from the airport, local politicians, and local residents to ensure that these programs run smoothly.

Examples

Airport noise mitigation programs have been implemented at multiple airports around the United States. A few examples are provided on the EnvisionFreight website. For example, Louisville, Kentucky, (the third largest all-cargo airport in the United States by landed weight and one of the larger hubs for Fed-Ex and UPS) has an extensive noise mitigation program, a community noise forum, and large noise-based community relocation programs. The noise mitigation programs for O'Hare International Airport in Chicago also are discussed on the website.

Railroad Mitigation Activities

Railroads have been involved in efforts to reduce the noise and vibration effects of their operations. There also have been efforts by the industry to promote safety and awareness, particularly as is related to grade crossings. Examples of railroad mitigation programs include

- Grade crossing management,
- Quiet zones,
- Trespass prevention programs,
- Operation Lifesaver, and
- Canada Proximity website.

A few of these measures are discussed here, but a more complete discussion can be found on the EnvisionFreight website.

Grade Crossing Management

A railroad grade crossing is an intersection where a roadway crosses railroad tracks at the same level (grade). According to FRA, there are more than 250,000 grade crossings in the United States.

The responsibility for grade crossing safety is shared between the FMCSA, FRA, and FHWA. State DOTs, local jurisdictions, and railroads also are involved in grade crossing safety issues.

Railroads own and maintain the tracks, and they own the property on either side of the tracks. At the grade crossings, they install and maintain the tracks and the roadway surface around and between the rails, as well as any traffic control devices on their right-of-way.

According to FRA, although the railroad owns the track, the roadway at a crossing is owned by either a public or private entity. Public crossings are those at which the highway or roadway is under the jurisdiction of, and maintained by, a public authority such as a municipality, county, or state agency. Private crossings are those where the roadway is privately owned (such as on a farm or within an industrial complex), is not intended for public use, and is not maintained by a public authority. The roadway owner, public or private, typically maintains the road approaching the crossing on either side of the tracks.

FHWA is responsible for public grade crossing issues that affect highway safety. FHWA develops and provides guidelines and standards for the correct design of grade crossings, the assessment of safety at crossings, and the placement of traffic control devices at approaches to grade crossings.

Federal law requires that every time a train approaches an at-grade crossing, it must sound its horn. This is for safety reasons and provides a signal to anyone on the grade crossing, or approaching it, that a train is coming.

Under the Train Horn Rule (U.S. Department of Transportation 2006), locomotive engineers must sound train horns for a minimum of 15 seconds and a maximum of 20 seconds, in advance of all public grade crossings, except as follows:

- If a train is traveling faster than 45 mph, engineers will not sound the horn until it is within one-quarter mile

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of the crossing, even if the advance warning is less than 15 seconds.
- If a train stops in close proximity to a crossing, the horn does not have to be sounded when the train begins to move again.
- There is a "good faith" exception for locations where engineers can't precisely estimate their arrival at a crossing.

Wherever feasible, train horns must be sounded in a standardized pattern of two long, one short, and one long. The horn must continue to sound until the lead locomotive or train car occupies the grade crossing.

One of the best ways to address rail/highway grade crossing safety is to reduce the number of at-grade crossings. Railroads actively work to close public and private at-grade crossings where possible, working closely with communities and property owners. Good candidates for closure include grade crossings that are redundant (other crossings nearby allow access to the same roads or areas), are not designated emergency routes, have low traffic volumes, or are private crossings that are no longer needed or used.

In addition to safety, some of the main benefits of closing grade crossings are fewer traffic delays, idling cars, and greenhouse gas emissions. Most importantly for many communities, closing grade crossings also eliminates noise as whistles are no longer sounded.

Quiet Zones

FRA created a rule for cities to create "quiet zones" in which trains are not required to sound their horns at controlled crossings (grade crossings). FRA's website provides flowcharts for determining whether a city can implement a quiet zone (U.S. Department of Transportation 2010b).

Developing a quiet zone is one way a city can mitigate the negative impacts of a freight rail corridor operating near residential areas. Quiet zones are designed to reduce noise around residential areas, schools, hospitals, long-term care facilities, and other noise-sensitive land uses. Grade crossings within one-half mile of another crossing in a quiet zone are to be included within the quiet zone boundary.

Once a city has decided to move forward with a quiet zone, it is required under 49 CFR 222.43 to notify the freight railroad about the intent to establish a quiet zone. Details that must be included within the letter of notice of intent include the crossing ID number, street name and location, type of warning zone devices that will be deployed, and details of the contact person. Cities also must send a notice of establishment of a railroad zone to FRA.

A quiet zone is created through the use of safety measures that compensate for the absence of horns. For example, this can be achieved through the use of quadrant barriers that are put in place around the crossing. The use of quadrant barriers provides a community relief from whistles and provides a railroad with continued operational functionality to serve a local customer base.

The costs of implementing a quiet zone must be borne by the local jurisdiction—this includes preliminary engineering, construction, maintenance, and replacement of active warning devices or their components. According to FRA, estimates of costs for quiet zone warning devices, wayside horns, or both, vary dramatically (U.S. Department of Transportation 2010a and 2010b). For example,

- Four-quadrant gate system: $300,000 to $500,000;
- Basic active warning system (including flashing lights and gates, constant warning time, power-out indicator, and a cabin): $185,000 to $400,000;
- Basic inter-connect: $5,000 to $15,000; and
- Annual maintenance: $4,000 to $10,000.

An example of a four-quadrant gate crossing is found in Figure 8-1.

Trespass Prevention Programs

One of the major safety issues that occurs because of community proximity to railroads is that of trespass. Railroads across the United States actively discourage trespass on their right-of-way and within their rail yards. Statistics and evidence show that people will frequently use the railroad right-of-way

Figure 8-1. Four-quadrant gate grade crossing treatment in Gardner, Illinois (U.S. Department of Transportation 2008b).

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as a shortcut, often at great danger to themselves. In many communities, schools are found on the other side of the tracks and children will often cross the railroad property as a shortcut. According to FRA, the number of railroad trespass fatalities first surpassed the number of fatalities at highway rail grade crossings in 1997 and continues to be the leading cause of fatalities industrywide.

FRA has developed model state legislation covering trespassing and vandalism on railroad property (U.S. Department of Transportation 2010a). FRA also has a compilation of state laws and regulations affecting highway rail grade crossings (U.S. Department of Transportation 2002). FRA compiled research results in 2007 on trespass on railroad rights of way (U.S. Department of Transportation 2007a).

Operation Lifesaver

Operation Lifesaver is a non-profit rail safety education organization, whose purpose is to provide public education programs to prevent collisions, injuries, and fatalities on and around railroad tracks and highway-rail grade crossings. Its website can be found at http://oli.org/. Operation Lifesaver's national office in Alexandria, Virginia, supports state programs, and develops videos, educational brochures, and instructional information. There are state coordinators located in all 50 states.

Operation Lifesaver began in 1972 as a joint effort between the Idaho governor's office, the Idaho Peace Officers, and Union Pacific Railroad. A 6-week public awareness campaign was conducted to promote highway-rail grade crossing safety. As a result of the program's success, similar programs were adopted in Nebraska, Kansas, and Georgia over the next 2 years. Operation Lifesaver spread to other states and, in 1986, the national Operation Lifesaver office was created to help support state efforts and raise national awareness.

Operation Lifesaver's volunteer speakers and instructors offer free rail safety education programs in all states. Programs are conducted for various groups including schools, driver education classes, community audiences, professional drivers, law enforcement groups, and emergency responders. The Operation Lifesaver programs are co-sponsored by federal, state, and local government agencies; highway safety organizations; and railroads.

Canada Proximity Website

In 2003, the Railway Association of Canada (RAC), in collaboration with the Federation of Canadian Municipalities (FCM), and the Canadian railroads created an initiative to develop common approaches to the prevention and resolution of issues that arise when people live and work in close proximity to railroad operations. The initiative had four major goals, as follows:

1. Effectively work together,
2. Understand one another,
3. Develop a consistent dispute resolution model for handling complaints by localities and communities regarding freight railroad activities, and
4. Produce materials about freight railroad activities and compatible land uses for local jurisdictions and the general public.

As part of this initiative, the Proximity Issues website was created. It can be found at http://www.proximityissues.ca/english/index.cfm. The website is primarily focused on providing information to the general public with the purpose of avoiding complaints and potential conflicts, or resolving them as best as possible.

Since the initiative began and the website was developed, Ontario has adopted provincial guidelines and processes for planning that are based on the output of this initiative. British Columbia also has used the initiative's protocols and guidelines for issues relating to overpasses and for dealing with community issues.

The proximity initiative is continuing to develop new tools, review issues, and continue its educational and outreach mission. For example, noise and vibration measurement is currently being reviewed with the goal of developing specific guidelines. Different types of materials for mitigation are also being reviewed—for example, the use of a glass sound wall in Montreal, and different types of "green" walls. The initiative also continues to conduct extensive outreach, giving presentations to local communities to keep the public educated about railroad proximity issues.

As a consequence of the proximity initiative, the Canadian National and Canadian Pacific Railroads developed rail land-use guidelines. The City of Edmonton also undertook a major initiative to amend its zoning code to include a major commercial corridor overlay ordinance.

Port and Waterway Mitigation Activities

The needs of waterborne transportation include channels and terminals as well as certain types of support infrastructure, such as tie-ups for tugs and barges, fueling facilities, and ship repair facilities. Unlike other transportation modes, it is almost impossible to move these facilities off-site away from the waterfront. Thus, for marine transportation, mitigation options usually entail retrofitting an existing facility instead of relocating it, and developing programs that reduce conflicts with nearby non-freight activities.

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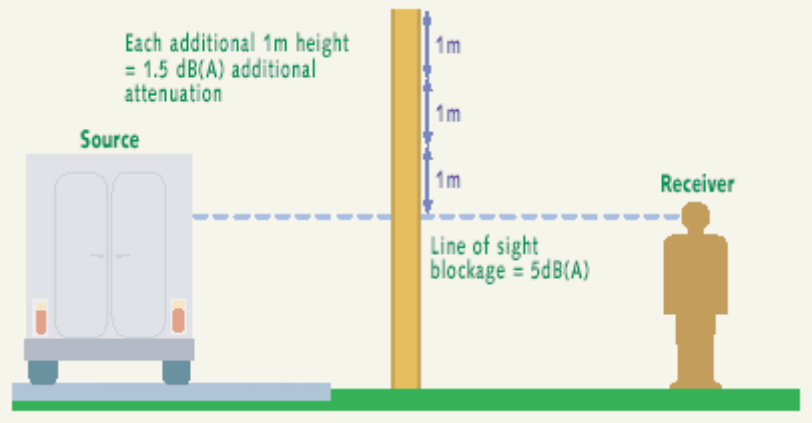

Figure 8-2. Noise barrier height considerations.

Deep-water marine ports have been actively developing programs to reduce environmental impacts and improve air quality, and are another good source of information. For example, the Port of Los Angeles developed a Community Advisory Committee with subcommittees on various issues including air quality, noise, light, and traffic (Port of Los Angeles 2010a). The Port Authority of New York and New Jersey developed a Clean Air Strategy to reduce the port's polluting activity and its impact on the surrounding neighborhoods (Port Authority of New York and New Jersey 2010). Although described as a protection and preservation strategy in Chapter 5, the New York Shipping Association Port Support Zone also can be thought of as an attempt to mitigate the negative effects of port operations. One of the expected benefits of relocating those activities that are able to be located away from the immediate port area was a reduction of negative impacts on surrounding residential areas.

Noise Barriers

Another set of mitigation tools that has been used to reduce noise and vibration effects are sound walls, beams, and barriers. Sound walls have been used mostly around highways and transit facilities.

Noise barriers reduce sound generated by a transportation facility or corridor (e.g., highway) by absorbing the sound, transmitting it, reflecting it, or forcing the sound to take a longer path over and around the barrier. Noise barriers can be constructed from earth, masonry, wood, metal, or other materials.

For noise barriers that are designed to alter the path of sound over and around the barrier, the barrier must be tall enough to block the view of the transportation facility from the area that is to be protected (see Figure 8-2), and should be at least eight times as long as the distance from the noise receiver (e.g., home) to the barrier (see Figure 8-3).

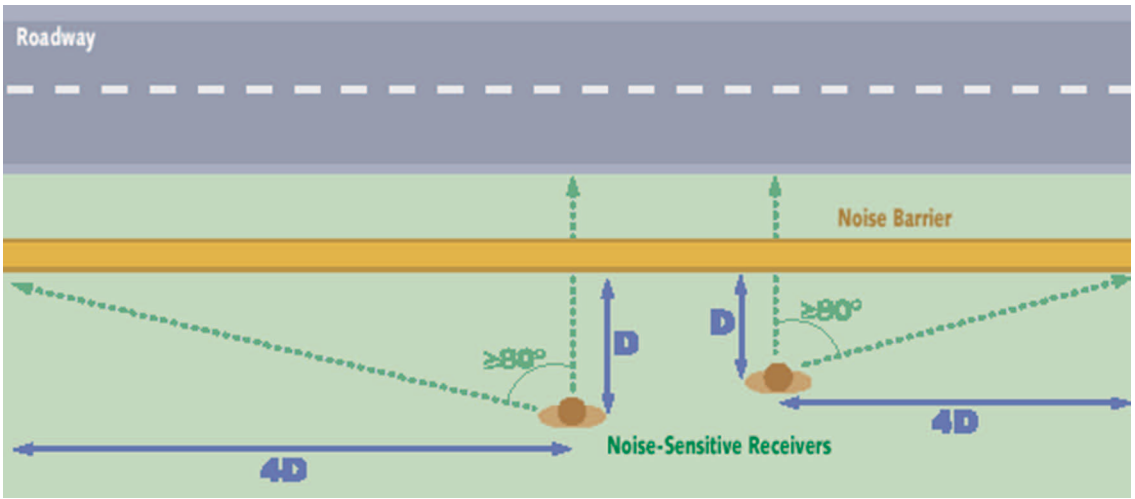

Figure 8-3. Noise barrier length considerations (U.S. Department of Transportation 2010).

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FHWA (http://www.fhwa.dot.gov/environment/keepdown.htm), FTA (http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf), and FRA (http://www.fra.dot.gov/Pages/253.shtml) have all developed noise manuals that discuss the use and costs of sound walls.

Layout and Design Elements

In many instances, poor lot orientation is a primary contributor to noise and vibration and other land-use conflicts between freight and other uses. Although it is not optimal to site multi-family residential, educational, medical, or other institutional type facilities such as schools, daycare facilities, and elderly residential facilities adjacent to freight facilities, there are options that could be pursued to offset some of the land-use conflicts that arise between freight and other uses.

Lot Layout

Often, the placement of residential uses on a lot will lead to residential-freight activity conflicts. Figure 8-4 shows a poor lot orientation adjacent to a freight line that could subject the residents to noise, vibration, and possibly pollutant effects.

There are simple steps that can be taken to assist in mitigating conflicts between land use and reducing the opportunities for conflicts to arise. For example, shifting units within the lot so that they are not placed in such proximity to the freight activity could be an important first step to avoid or eliminate conflict. The optimal solution for mitigating or avoiding conflicts in this type of development would require not only garages to be placed to provide a buffer for the noise and vibration, but also the placement of vegetation that could absorb some of the pollutant effect. This would ideally be placed in a non-access easement on the freight facility side of the lot. This can be seen in Figure 8-5.

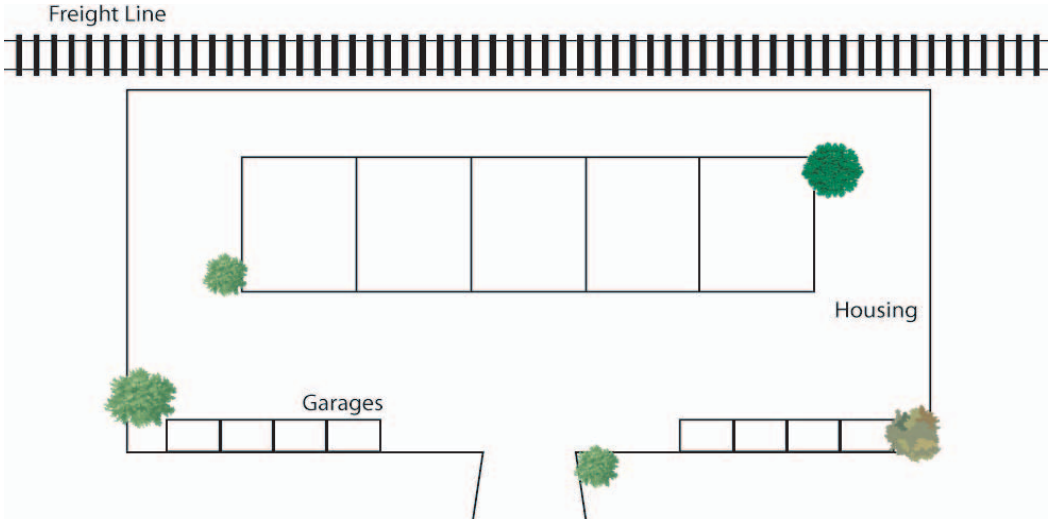
Design Considerations

Figure 8-6 shows a poor residential design layout with the living and dining area facing out onto the freight facility/route area without any buffering or other elements to mitigate for conflicts that may arise. This property is also situated far back on the lot, putting it in close proximity to the freight facility.

Figure 8-7 shows how an optimal layout with the residential development utilizing similar internal buffering techniques. Here, the property places less-used rooms closer to the freight activity, which increases the space and time that noise has to travel, thus reducing decibel levels. The placement of a non-access easement also shifts the property closer to the front lot lines, which again provides a buffering space for decibel levels to be reduced.

Hazmat Issues

Hazardous materials are solids, gases, and liquids that can harm people, animals, property, and the environment. Throughout the United States, hazardous materials are moved by marine vessels, air, rail, and truck. Hazmat chemicals that give freight transportation providers the most cause for concern are the toxic inhalation hazard (TIH) materials. Hazardous cargo is often stored for periods of time in freight terminals, rail yards, and port facilities. Poor planning can place residential and other highly sensitive uses far too close to facilities that have hazardous materials.



Source: UT-CTR.

Figure 8-4. Poor lot orientation.

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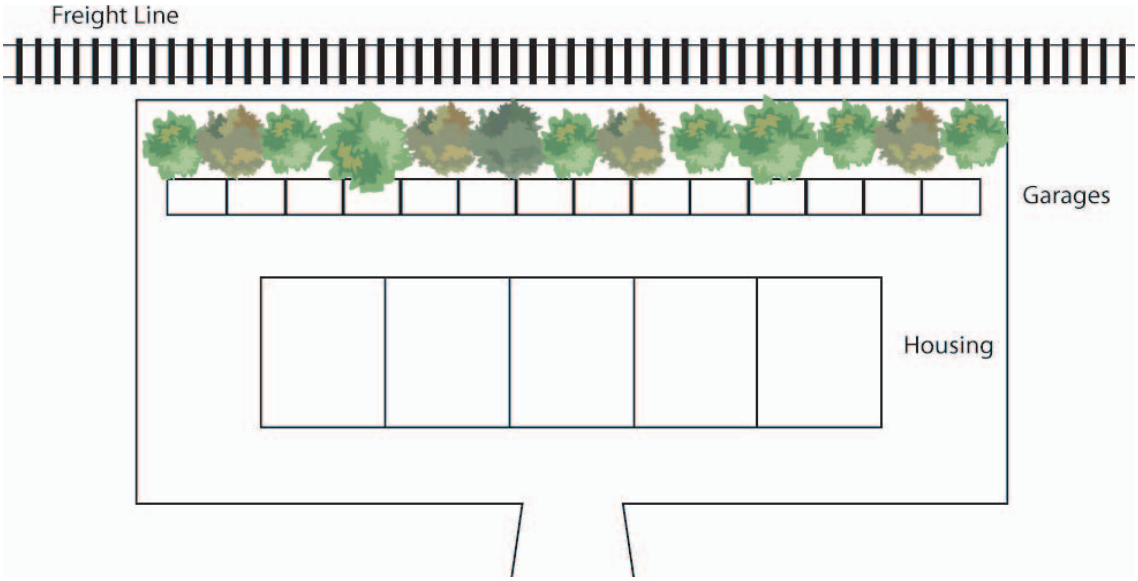
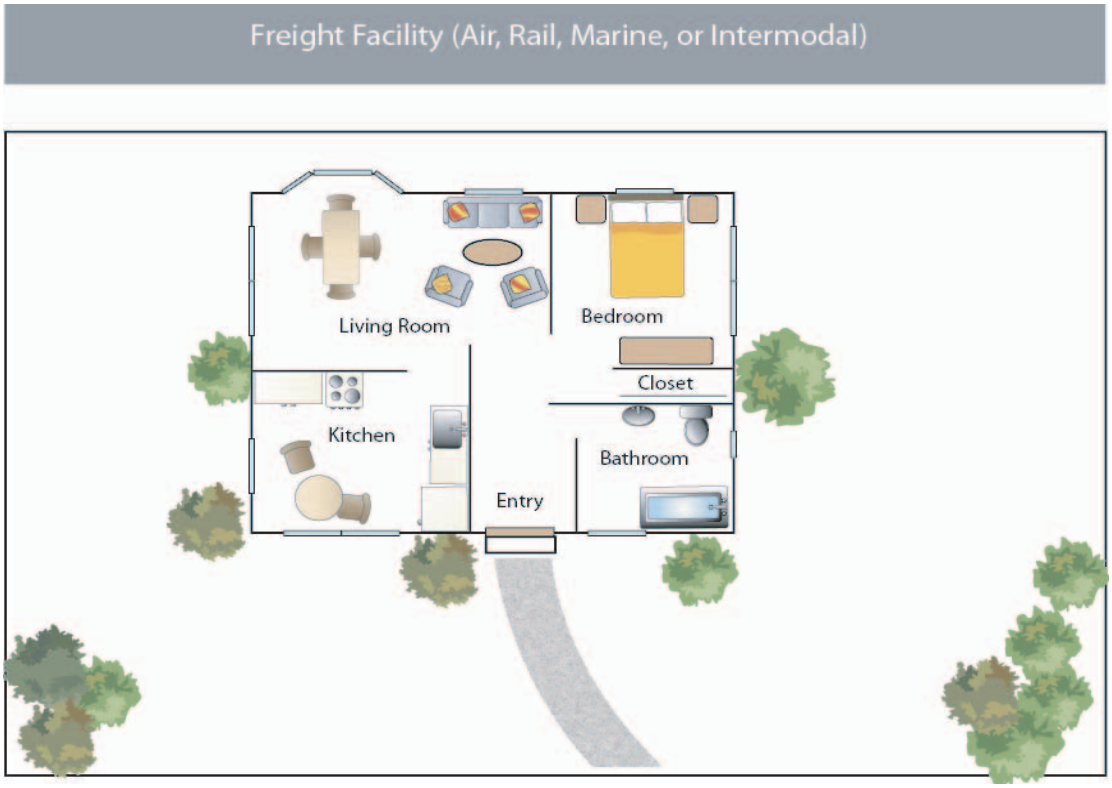


Source: UT-CTR.

Figure 8-5. Optimal lot orientation.



Source: UT-CTR.

Figure 8-6. Poor residential design layout.

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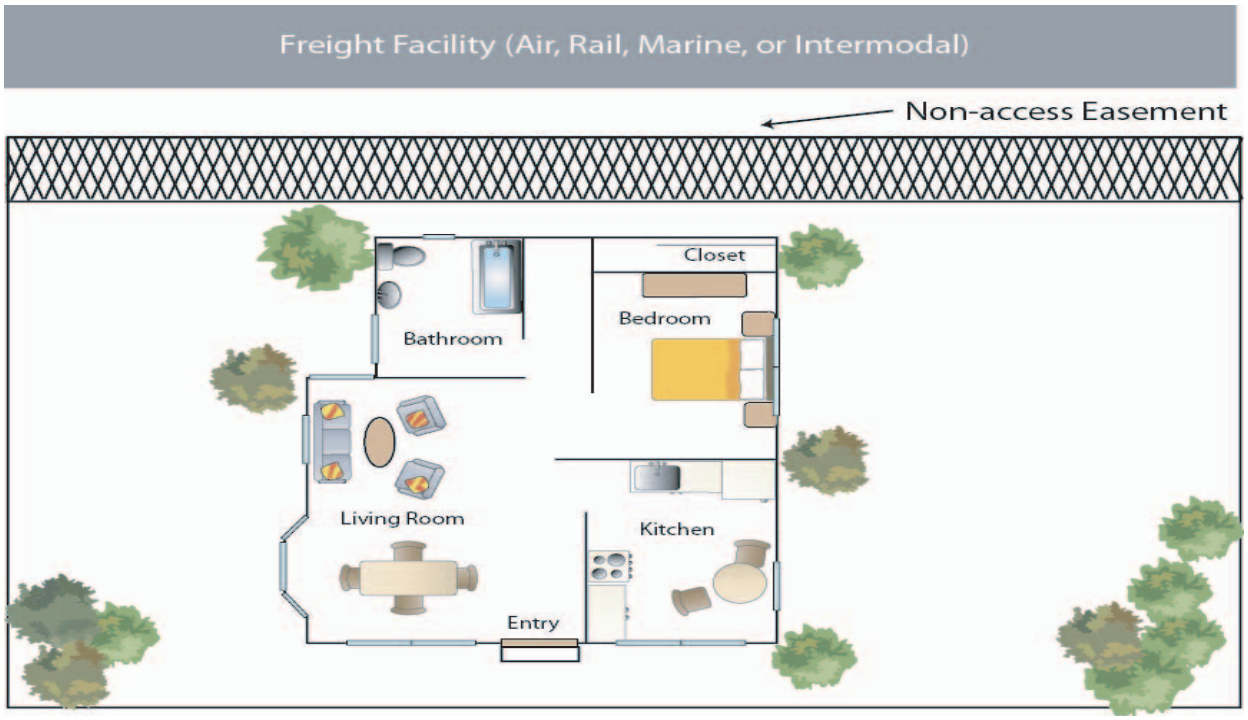

Source: UT-CTR.

Figure 8-7. Improved residential design layout accompanied with non-access easement.

Hazmat Transportation

Federal agencies have issued regulations that require how certain hazardous materials are moved, stored, loaded, and transloaded. Drivers of hazardous materials are required to undergo background checks and obtain a hazmat endorsement background check by TSA. States and cities have also designated specific highway routes along which hazardous material can be transported. This includes restricting the types and combinations (especially in bulk) of hazardous materials that can be transported through tunnels. The National Hazardous Materials Designated, Preferred, and Restricted Routes list was last updated in 2009 (U.S. Department of Transportation FMCSA 2009).

Under the Common Carrier Rule, railroads are required to ship hazardous material (U.S. Department of Transportation 2008a). However, the make-up, general handling, and loading of trains carrying hazardous material are strictly regulated The distances between specific hazmat-placarded cars and tanks along the trains' length are regulated by FRA rules. This is especially the case for loading of Class 1 explosive materials, Class 2 gases, and poisonous and radioactive materials. Rules also proscribe certain train configurations and how the units are moved around in the rail yards to make up the trains. Some hazardous materials are not allowed to be transported together under any circumstances within the same train compilation.

FRA also has issued regulations requiring railroads to perform comprehensive safety and security risk analysis to determine and select routes that pose the least overall risk. The analysis must include 27 risk factors and input provided by state and local governments. Regular safety audits are conducted by FRA to ensure compliance by the railroads (U.S. Department of Transportation 2007b). More information regarding hazmat transportation by rail can be found on the Association of American Railroads' site (Association of American Railroads 2010).

Trucks also carry a large portion of hazardous material throughout the United States. The U.S.DOT, FMCSA, and the Pipeline and Hazardous Materials Safety Administration govern regulations regarding trucking of hazardous materials. One of the main elements required for trucking is the verification of truck drivers by TSA, as part of the implementation of the Patriot Act. The Patriot Act also requires drivers who transport hazardous materials to have a hazardous materials endorsement (HME) background check. Port facilities also produce rules that regulate the transport of hazardous materials in their facilities. The Port Authority of New York and New Jersey, for example, updated its "Redbook" in 2009 regarding the transportation of hazardous materials by truckers in tunnel and bridge facilities that it operates (Port Authority of New York and New Jersey 2009a). More information regarding hazmat transportation by trucks can be found on the American Trucking Association's website (American Trucking Associations 2011).

The U.S. Coast Guard is the primary government agency responsible for the transportation of hazardous materials

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by water. The Maritime Transportation Security Act 2003 laid down new rules for international ship and port facility security, including implementation of the Transportation Workers Identification Credential (TWIC) Program. This issues a tamper-resistant biometric credential to workers who require unescorted access to secure areas of ports, vessels, and the outer continental shelf facilities. Under 33 CFR 12.19, the captain of the port is required to issue permits for *each* occurrence of handing, loading, discharging, or transporting dangerous cargo at the waterfront facility. The permit specifies the limits, quantity, and isolation and remoteness required to handle these materials.

The Coast Guard is harmonizing its regulations with the International Maritime Organization International Convention for the Safety of Life at Sea 1974 regarding maritime bulk solid hazardous materials. This will expand the list of solid hazardous materials authorized for bulk transportation by vessel and will create special handling procedures for these hazmat cargos.

Air cargo hazmat transportation restrictions apply not just to freight cargo but also to items that passengers and cabin crew bring onto aircraft. TSA is responsible for the screening of passengers and air cargo. International treaties also govern the movement of hazardous materials by air.

Figure 8-8 describes the hazmat classes.

Class Number	Class Name	Divisions	Placard
1	Explosives	1.1 Mass explosion hazard 1.2 Blast/projection hazard 1.3 Minor blast hazard 1.4 Major fire hazard 1.5 Blasting agents 1.6 Extremely insensitive explosive	
2	Gases	2.1 Flammable gas 2.2 Nonflammable gas 2.3 Poisonous gas 2.4 Oxygen 2.5 Inhalation hazard	
3	Flammable Liquids	3.1 Flammable 3.2 Combustive 3.3 Gasoline and fuel oil	
4	Flammable Solids	4.1 Flammable solid 4.2 Spontaneously combustible 4.3 Dangerous when wet	
5	Oxidizers and Organic Peroxides	5.1 Oxidizer 5.2 Organic peroxide	
6	Poisons and Infectious Substances	6.1 Inhalation hazard 6.2 Poison 6.3 Toxic	
7	Radioactive Materials	Any material, or combination, that emits ionizing radiation > 0.002 microcuries per gram	
8	Corrosives	8.1 Acids 8.2 Alkali (materials, liquid, or solid that can dissolve skin, tissue, or corrode certain metals)	
9	Miscellaneous	Substances that do not fall into other categories	

Source: Adapted from U.S.DOT, Pipeline and Hazardous Materials Safety Administration.

Figure 8-8. Hazmat classes.

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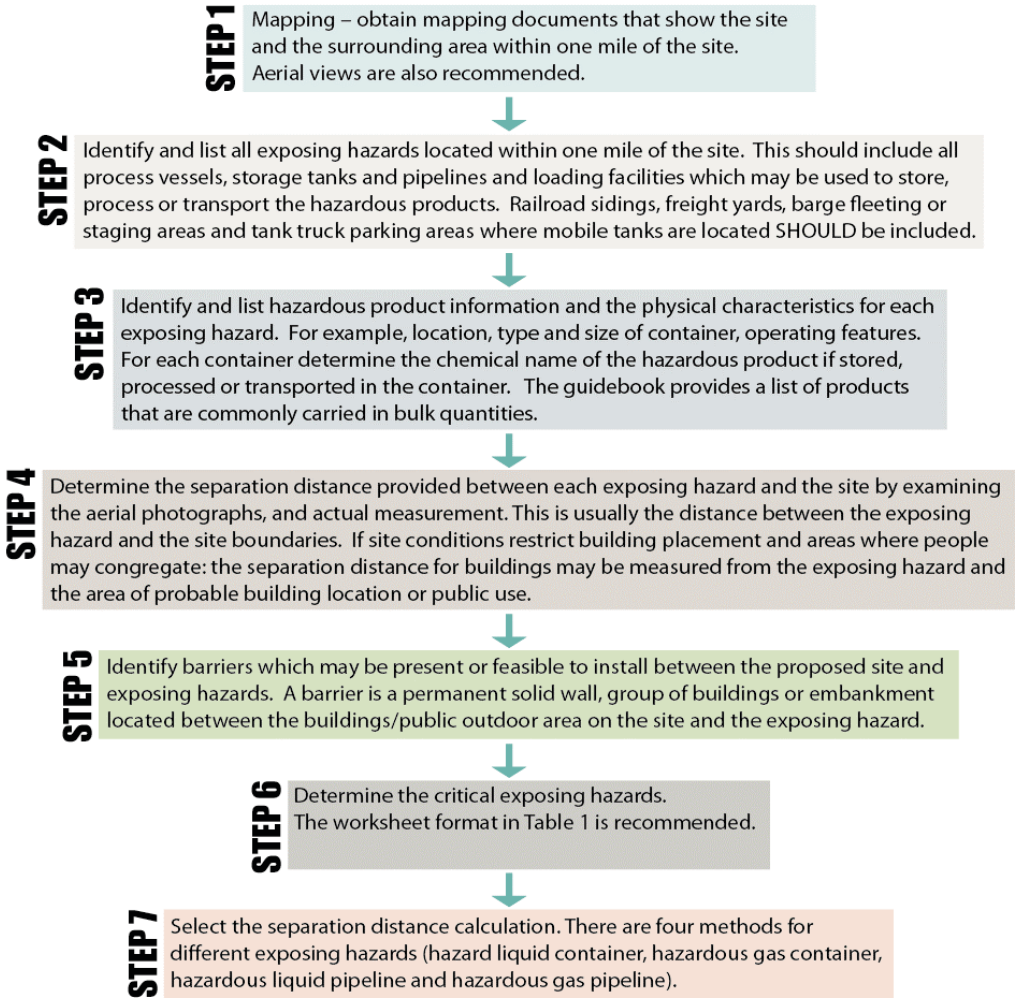
Facility Siting Considerations

The U.S. Department of Housing and Urban Development (HUD) was mandated by the Housing Act of 1949 and the Housing and Urban Development Act of 1969 (42 U.S.C. 1441 (a)) to assure that all HUD-assisted projects were located in a safe and healthful environment. Sub-part C of 24 CFR Part 51 provides the regulatory authority for the implementation of this mandate. As part of the implementation, HUD commissioned two extremely useful guidebooks regarding siting of residential projects near hazardous facilities and urban development siting with respect to hazardous commercial/industrial facilities (Rolf Jensen & Associates 1984; U.S. Department of Housing and Urban Development 1996).

These HUD guidebooks create and provide useful guidance to apply a standard method and calculation for determining and establishing an acceptable separation distance (ASD) for different hazardous materials. The applicability of these methodologies for any type of development around freight facilities or corridors is considered invaluable for planning departments as they develop comprehensive plans and new zoning changes and for developers as they create plans (sub-division or other) that may be in proximity to a freight facility or freight corridor that serves hazmat manufacture and delivery.

The 1984 guidebook provides a series of steps for the planner to use to determine an acceptable separation distance between a hazardous facility and residential development. Seven steps are outlined for data collection and calculation methods. A series of tables also is provided to calculate whether the proposed development falls within the acceptable distance curves created for multiple types of hazardous materials.

Figure 8-9 shows the steps involved in conducting a site evaluation.



Source: Adapted from Rolf Jensen & Associates, Urban Development Siting with Respect to Hazardous Commercial/industrial Facilities, 1984.

Figure 8-9. Steps to conduct site evaluation review.

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CHAPTER 9

Education about Freight Transportation Issues

Education about freight transportation issues can take many forms. Freight transportation issues that were relevant for NCFRP Project 24 include the following:

- The value of freight transportation;
- Planning for freight facilities and corridors; and
- How to prevent or resolve conflicts between freight and other, often incompatible, land uses.

Lack of education or information on these issues is often at the root of many of the conflicts between freight entities and other land uses. Although education on these issues can sometimes be part of a university curriculum for planning students, it is often accomplished in the "real world" through various means that involve communication and interaction between interested stakeholders. Channels of education/communication include

- Education in planning schools regarding freight transportation issues,
- Planning-agency-sponsored freight task forces and round tables,
- Community round tables and working groups,
- Outreach efforts by freight entities, and
- Available previous research.

The NCFRP Project 24 research team noted that most university planning curricula do not include freight in their master's programs for community and regional planning. Although some students might be able to take a multidisciplinary class on multimodal freight issues or multimodal freight planning classes that are often taught in Transportation Engineering programs, these types of multidisciplinary classes—which are on the rise—are not always offered to students from different disciplines. The inclusion of freight issues in university planning curricula would go a long way toward overcoming many conflicts between freight and other land uses.

Beyond formal education, most state DOTs have a freight plan, and some have created freight task forces and freight round tables to provide a venue for stakeholder input as they develop freight plans. Ports and airports are well known for their round tables and community working groups, which are often put together to solve problems and make recommendations where federal grant monies are applied to mitigate for issues such as noise and vibration.

Many of these types of groups produce excellent educational resource materials to better understand and plan for freight. The FHWA Office of Freight Management and Operations also has an excellent webpage for freight planning (U.S. Department of Transportation 2006a), which includes items for freight professional development that a newcomer to freight planning can utilize. Items include access to workshops, the "Talking Freight" webinar series, and the National Highway Institute courses such as "Integrating Freight in the Transportation Planning Process." Other groups, such as California's Air Resources Board, have conducted programs to mitigate for pollution around ports and have developed inventories and mitigation plans that provide useful educational material to understand freight impacts (California Environmental Protection Agency 2005a).

Freight entities also can play a role in the education process in an effort to avoid or resolve conflicts. The research performed for NCFRP Project 24 offered a number of examples where outreach or education efforts by freight entities were valuable. For example, in the case of the Staten Island Railroad (http://www.EnvisionFreight.com/issues/pdf/Task_6_Case_Study_SIRR.pdf) resumption of service, CSX conducted a significant public outreach campaign to notify the public about the resumed service and also went to schools to prevent children from playing in the right-of-way. As another example, the freight groups involved in the Atlanta Regional Freight Mobility Plan (http://www.EnvisionFreight.com/

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issues/pdf/ARC_Freight_Plan_case_study.pdf) provided ranking scores for funding prioritization on projects that were placed into the Transportation Improvement Program submitted to Georgia's DOT.

Specific strategies for improving communication between freight and land-use stakeholders would include the formation of standing planning committees and the regular exchange of internal planning materials and decisions, redacted as necessary. Private-sector groups, including local chambers of commerce, can play an important role in keeping freight issues on the agenda and encouraging buy-in from the business community when a freight-related project is proposed. Improving communication through various levels of government also is required and must be a two-way channel.

Resources for previous research and for freight studies reviewed during this project can be found in Appendix K.

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CHAPTER 10

Conclusions

The U.S. surface freight transportation network includes 4,016,741 miles of highways, 94,942 miles of Class I freight railroad tracks, 46,474 miles of regional and shortline railroad tracks, and 26,000 miles of navigable inland waterways. Other important components of the freight transportation network include air freight and pipelines.

Freight-transportation-related services often come into conflict with other land uses. These conflicts create, or have the potential to create, barriers to the efficient provision of freight transportation. Because of the important role of freight transportation in producing products and getting them to their end users, conflicts between freight and other land uses have an impact on the performance of the U.S. economy and consumer welfare. These impacts are evident from the fact that, for every person in the United States, an average of 11,000 ton-miles of freight is transported annually.

The goals of the NCFRP Project 24 research were to (1) create an awareness of these conflicts, their sources, and consequences and (2) propose solutions to prevent or resolve such conflicts.

Conflicting Land Uses and Barriers to Freight-Transportation-Related Services

When competing and incompatible land uses exist close to each other, these uses often interfere with each other, resulting in conflicts between them. Conflicts could be physical in nature and/or involve nuisance, health, or safety concerns. Most residential, educational, and medical-related land uses are often incompatible with freight activity. Among the major conflicts non-freight interests have with freight-transportation-related services are

- Air and water pollution,
- Light pollution,
- Noise pollution,
- Effects of vibration,
- Safety issues, and
- Congestion.

Some conflicts, such as noise, light, and vibration are common to all of the primary freight modes. Other conflicts are more specific to particular modes. For example, the potential for dangerous trespass tends to be specific to railroads.

From the perspective of freight interests, barriers to efficient freight-transportation-related services are often the result of these conflicts. In this context, barriers can be defined as impediments to the economically efficient transportation of freight due to land-use or policy decisions that create conflicts with other land uses. Examples of barriers or interference with freight-transportation-related services resulting from conflicts with other land uses include

- Speed restrictions,
- Limitations on hours of operation,
- Height and clearance impacts,
- Size and weight limitations,
- Corridor design impacts,
- Difficulty of dredging operations and disposing of dredged material, and
- Gentrification that drives up land values, making siting of transportation or industrial uses costly.

Some barriers can be mode-specific (e.g., highway and road design impacts on trucking activities or dredging impacts on waterway transportation), while other barriers may be more general across modes (e.g., limitations on hours of operation). Barriers not only affect freight activities along particular corridors and facilities, but also can affect route choices and the ability to access freight and manufacturing facilities.

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Sources of Conflicts and Barriers

The land-use planning and zoning functions of government are the primary areas where conflicts between freight and other land uses are either avoided or created. In the United States, land-use planning and zoning are mostly the responsibility of local governments. The NCFRP Project 24 research identified a number of ways in which land-use planning and zoning contributed to conflicts and barriers, including

1. Land-use planning processes generally plan inadequately, if at all, for freight, for a variety of reasons, including the following:
   - Land-use planners are typically not taught about freight and do not understand why it is important to the economy or how it works.
   - There is a lack of maps that identify freight facilities and corridors.
   - Freight entities are generally not significantly involved in local land-use and transportation visioning and planning processes.
   - Cash-starved jurisdictions have an incentive to zone for uses with higher tax values.
2. State and regional planning does not do much to fill the gap in freight planning.
3. Regional visioning exercises generally do not deal adequately with freight.
4. Funding is often lacking or insufficient for freight planning and preservation.
5. Although most cities and counties utilize an "industrial" zoning designation, they generally do not create specific zoning categories for freight facilities and corridors. Freight is industrial activity, yet its impacts are distinct from other forms of heavy industry.

In addition, the NCFRP Project 24 research found that poor communication is at the core of many conflicts between freight entities and other stakeholders. One example of poor communication is the lack of notice in many real estate transactions regarding possible freight-related impacts on the intended land use (e.g., residential development). Poor communication also exists between various levels of government entities in many cases. Among other things, lack of communication leads to conflicting expectations and lack of buy-in for solutions.

Suggestions for Achieving Freight-Compatible Development

The research conducted under NCFRP Project 24 and previous experiences of the project team uncovered a number of approaches for preventing or resolving land-use conflicts between freight entities and other relevant stakeholder groups. These approaches were organized into "tools" under the guiding principle of freight-compatible development. The two main objectives of freight-compatible development are to (1) ensure that freight-transportation-related services are not affected by, or do not affect, other land uses placed close to freight corridors or facilities and (2) reduce and minimize community impacts that arise because of the proximity of sensitive land uses, including residences, schools, hospitals, and emergency services.

The four major tools available—either individually or in combination—to achieve the goals of freight-compatible development are

1. Long-range planning,
2. Zoning and design,
3. Mitigation, and
4. Education and outreach.

Long-range planning and zoning are primarily prospective in nature with the goal of avoiding conflicts. Education and outreach also can be a prospective tool, as awareness and understanding of freight and land-use issues can lead to forward-looking solutions. The following are examples of specific prospective tools:

1. State enabling acts should ideally be amended to require that freight be one of the key elements that states, local jurisdictions, and planning agencies account for in both transportation planning and land-use planning.
2. Guidance needs to be provided to land-use planners regarding appropriate planning and zoning practices that relate to freight. For example, zoning overlays and industrial protection zones can be put in place not just for the industrial areas that are serviced by freight, but also for the corridors that link to them.
3. Accurate mapping of freight facilities and corridors should become part of the comprehensive planning process. Mapping of such facilities will contribute to the preservation and protection of these facilities.
4. Cooperative regional planning efforts, such as regional visioning processes, should include freight entities as key stakeholders and make freight a significant focus.
5. State and national associations related to planning or development should provide the appropriate education and tools related to freight planning for city and county planners.
6. Freight entities should participate as stakeholders in local, regional, and state planning and visioning processes.
7. Private-sector groups, including local chambers of commerce, can play an important role in keeping freight issues on the agenda and ensuring buy-in from the business community when a preservation project is proposed.

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8. Freight groups (both private sector and government) need to partner with educational institutions to ensure that the underlying principles of freight activity are included as part of the curriculum at the graduate and undergraduate levels in planning, architecture, policy, engineering, business, and law disciplines.
9. Ports, which have started tracking port-related job impacts throughout the region, need to make a similar scale effort to quantify the congestion and noise impacts that they produce outside of the immediate port area. Port master plans should illustrate affiliated congestion and choke points beyond their own properties. Similar activities should be undertaken by other types of freight operations that cannot be easily relocated.
10. Innovative funding practices, including public-private partnerships and rights of first refusal, are needed for freight planning and preservation.
11. Real estate contracts and other notice-type documents provided to purchasers and lessees should include sections discussing the possible freight-related impacts that may occur as a consequence of living in proximity to freight activities.

However, in many cases, incompatible land uses already exist close to freight-transportation-related services and conflict has resulted. In these cases, at least in the short run, measures such as design standards and mitigation approaches are a means to minimize conflicts.

Implementation Plan for Disseminating Research Results

The ultimate value of the research conducted under NCFRP Project 24 will be reflected by its usefulness to the various stakeholders who are involved with, or are affected in one way or another by, the freight transportation system. The research team believes that this largely depends on the ability and willingness of the freight, planning, and development communities to understand and communicate with each other.

To this end, an innovative contribution of NCFRP Project 24 is the development of the EnvisionFreight website and its associated guidebook. The "beta" versions of the website and guidebook were previewed at the NCFRP Project 24 workshop, held in January 2011. As discussed, the following are examples of how various stakeholders can use the EnvisionFreight website:

For planners and elected officials, EnvisionFreight has been designed to help to
- Understand how freight fits into the local, national, and global economy;
- Understand the issues that arise from conflicts and how these impact freight-transportation-related services and communities;
- Begin to consider the kinds of tools, scenarios, communication, and educational outreach that they might want to use to improve their freight planning and preservation capacity

For developers, EnvisionFreight aims to ensure that they consider how freight activities may affect and intersect with residential and other sensitive types of land use they may be planning. With a better understanding of these components, developers should be able to choose appropriate sites and design and incorporate construction and mitigation components to reduce conflicts that may arise.

For freight entities, EnvisionFreight is intended to provide education and assistance regarding land-use planning and zoning processes. With a better understanding of these processes, as well as tools that can be used to more effectively deal with freight in land-use planning and zoning, freight entities can be more effective participants in such processes.

For individual citizens or community groups, the goal of EnvisionFreight is to provide basic information about the various freight modes, impacts that arise because of freight activity and proximity to incompatible land uses, and show the types of tools that can be utilized to more effectively plan for freight.

For state legislators and staff, EnvisionFreight is designed to provide information and ideas for potential legislative changes that would facilitate better integration of freight and land-use planning.

In addition to the development of the EnvisionFreight website, as part of the implementation plan for NCFRP Project 24, the research team recommends that the following activities be undertaken to disseminate the research findings and to obtain support from organizations that link to the EnvisionFreight website:

1. Dissemination of results at the TRB 2012 annual meeting.
   - Organize a panel for the TRB 2012 annual meeting.
     – Recommend a host in conjunction with NCFRP Project 23, "Research on Freight Facility Location Selection."
2. Conduct FHWA "Talking Freight" seminars.
   - Recommend delivering two "Talking Freight" seminars during 2011.
     – Combine with NCFRP Project 23 research output.
3. Make presentations at conferences such as
   - Annual meetings of organizations like the Journal of Transportation Research Forum, American Planning Association, National Association of Counties, National

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League of Cities, National Association of Regional Councils, Association of Metropolitan Planning Organizations, Urban Land Institute, and American Bar Association;
- Freight group meetings hosted by the American Association of Port Authorities (AAPA), Association of American Railroads (AAR), American Short Line and Regional Railroad Association (ASLRRA), FRA, Intermodal Association of America (IANA), AASHTO, American Waterways Operators (AWO), state DOT and freight task forces;
- National Governor's Association, Republican and Democratic Governor's Associations, as well as Western, Southern, and New England Governors Associations; and
- Note: members of the research team were scheduled to present at
  - Baltimore Industrial Group meeting (February 2011),
  - National Association of Counties Meeting on Freight (April 2011),
  - Preservation Maryland Annual Meeting (May 2011), and
  - FRA Grade Crossing Conference (2012).

4. Request that groups and organizations place a link to the EnvisionFreight website on their websites, including
   - Trade groups, such as AAR, AAPA, AASHTO, AWO, CARB, and North America's Superior Corridor Coalition (NASCO);
   - Planning entities such as APA and Urban Land Institute;
   - The university transportation centers (note: University of Texas at Austin—Center for Transportation Research [UT-CTR] will place a link to EnvisionFreight, and their communications team will put out a blog posting on the website once it is fully live—this blog is picked up by many of the university transportation research centers); and
   - NASCO has already agreed to put a link to the EnvisionFreight website on their website.
5. Notify NCFRP Project 24 workshop participants, and other interested parties who are known to the research team, of final version of the EnvisionFreight website.
6. In order for the NCFRP Project 24 research to be useful over the longer term, the research team will look for permanent sponsorship for the EnvisionFreight website for upkeep. Possibilities include industry trade groups, planning associations, and/or government agencies.

Publication Plan

The research team will commit to publishing the study results in a manner that reaches a wide audience to broaden the impact of the research. In addition to the EnvisionFreight website, which is the principal mechanism of disseminating the results of the study, the research team will draft a brief summary of key findings for potential publication in a trade journal, such as the *Journal of Commerce.* The purpose of this piece will be to quickly highlight the most important lessons learned from the research and to refer interested parties to the website.

The research team also plans to develop at least one in-depth article for a scholarly publication. The most likely forum for this publication would be the *Transportation Research Record.* Other options for publication include planning journals such as the *Journal of the American Planning Association.*

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APPENDIXES

The appendixes to the contractor's final report are included herein as *CRP-CD-103*. The ISO image of this CD is also available for download from the TRB website.

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Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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