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16. Abstract This report, the fourth in a series of four volumes produced on urban railroad relocation by the contractor, describes the nature of the urban railroad relocation problem and estimates its magnitude nationwide. Costs of urban railroad/highway conflicts are estimated at $800 million annually to highway users in delays and increased running costs, and $185 million in accidents. Annual railroad costs are estimated at $75 to $100 million for slowing and accelerating trains in urban areas and $70 million for maintenance of grade crossing surfaces, marking, and warning devices. Community costs from environmental degradation, barrier effects, and incompatible land uses are high but difficult to quantify without detailed site studies.

About two-thirds of the 2,500 communities with railroads in the U.S. with populations over 5,000 in 1970 show evidence of serious railroad conflicts that might be ameliorated by some combination of the following measures: consolidation or relocation of railroad lines; closing of dangerous, low-volume crossings; installation of improved crossing surfaces and warning devices; construction of grade separation structures (including elevated or depressed railroad sections); and encouragement of compatible community development. Programs are outlined for major relocations or consolidations in an estimated 600 to 1100 communities, at a cost of up to $2.8 billion, that would return between $4 and $4.4 billion in present value of reduced highway user, railroad, and community costs. The need for federal and state support of such a program is explored.

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Prepared for:

FEDERAL RAILROAD ADMINISTRATION
FEDERAL HIGHWAY ADMINISTRATION

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I INTRODUCTION

Background

Many cities in the United States grew up around the railroads, but conflict between the railroads and traffic on streets and highways began almost immediately. As motor vehicles became a major factor in urban transportation and vehicular traffic grew, the problems grew, and a number of communities prepared plans for coordination of their railroad and highway traffic in the 1920s and 1930s. Projects for grade separation were numerous in the depression years.

After World War II, there was increased movement of industries to suburban locations and less need for railroads in the downtown area. Meanwhile, the central cities were decaying because of the suburbanization of the population and the rise of suburban shopping centers competing with downtown stores. Communities blamed the railroads for blighting the downtown and making access to it more difficult.

About 200 railroad relocation projects were accomplished between 1950 and 1973, most of them associated with highway or railroad improvement projects. Among the larger projects that were accomplished with public funds were Colorado Springs, Colorado; Niagra Falls, New York; McKeesport, Pennsylvania; Pikeville, Kentucky; Spokane, Washington; Rock Hill, South Carolina; and Beaumont, Texas. Almost 200 other communities have proposed relocation of all or part of their downtown railroads, but insufficient funds kept most of these plans from being implemented.

The Highway Safety Act of 1970 authorized a demonstration project for the elimination or protection of grade crossings in Greenwood, South Carolina. Greenwood, like many other cities in the country, was sectionalized by multiple railroad lines, resulting in downtown traffic congestion and reduced mobility of emergency vehicles. The demonstration project includes the construction of new track and connections that will consolidate operations over existing tracks that bypass the downtown area. The tracks in the downtown area are being removed. When completed, the project will result in improvement in the appearance and cohesiveness of the downtown area, increased highway safety and mobility, and improved railroad operations.

The demonstration in Greenwood prompted other communities to seek federal assistance with their railroad problems. To analyze the potential need for a program of railroad relocation, the Federal Railroad Administration and the Federal Highway Administration initiated a study designed (1) to determine the nature and magnitude of the railroad relocation problem in urban areas and (2) to develop a methodology for planning and implementing local studies aimed at the problem. This report presents the results of the first part of the study--the nature and magnitude of the problem.

Scope of the Analysis

During the course of this work,the study team reviewed reports of over 50 railroad relocation proposals; studied dozens of other related reports; and traveled to 17 cities in the United States. Detailed field investigations were conducted in seven of these cities where planners, railroad personnel, elected officials, and businessmen were interviewed to obtain opinions on the impact of relocation projects on their communities. Railroad facilities and operations were observed in the other ten cities as part of a study of problems in larger cities. In addition, 150 planners in cities with populations greater than 100,000 were surveyed by mail questionnaire, and detailed comments and maps were received from many of these. Maps of over 500 cities were analyzed. A survey of state highway agencies and railroad operating companies was made by FHWA and the Association of American Railroads (AAR). The survey was analyzed by the SRI project team.

The state highway departments in ten states provided information about every urban grade crossing in their jurisdiction. This information was analyzed to determine the potential benefits of eliminating grade crossings.

The results of this work are reported in four volumes:

Volume 1: Urban Railroad Relocation: Nature and Magnitude of the Problem and Planning for Remedial Action.

Volume 2: Guidebook for Preliminary Assessment of Urban Railroad Problems.

Volume 3: Guidebook for Planning to Alleviate Urban Rail-Road Problems.

Volume 4: Urban Railroad Relocation: Nature and Magnitude of the Problem.

II SUMMARY

Evidence of conflict between the railroad operations in urban areas and the activities of the community can be found not only in the delays and increased operating costs for highway users at grade crossings, but also in the hazards to the safety of the community, community barriers created by the railroad facilities, environmental degradation from operations, incompatible land-use patterns created, and reduced railroad efficiency. The relative importance of these elements of the conflict varies from community because there are many differences in topography, patterns of land use, railroad service and traffic density, local economy, and community attitudes toward their environment and toward the railroads.

The ability to measure the intensity of conflict varies greatly with the effect. Costs to highway users at urban grade crossings are estimated nationwide at $800 million per year, based on 1970 traffic levels, and accident costs at about $185 million per year. Community costs from other safety hazards, environmental degradation, barriers, and incompatible land uses are not known because of the difficulty of measuring some costs and because methodology does not exist to measure some of the social costs. Railroad costs due only to slowing and accelerating trains in urban areas are estimated at $75 to $100 million annually. Maintenance of grade crossing surfaces, marking, and warning devices costs almost $70 million per year. There are other railroad costs from losses due to theft and vandalism and use of outmoded facilities.

The conflicts are widespread. Of about 4,100 communities in the United States with populations greater than 5,000 in 1970, there were railroads in about 2500 or 60 percent. An estimated 1,650 of these show evidence of conflict. Thus, two-thirds of communities served by a railroad show evidence of conflict. The conflict is avoided in places where the railroad passes through largely industrial areas; or follows natural barriers such as highways, hills, or rivers; or passes through areas where compatible land uses buffer the effects of the railroad; or where the land uses do not generate large amounts of travel that might conflict with the railroad.

Relocation or consolidation of railroad facilities are potential remedies for the conflict. Railroad relocation generally requires complete rebuilding of railroad facilities in some other location. Local

consolidation of railroad lines into common corridors or joint operations of trains from different railroads over the same line may prove to be a lower cost way of achieving the benefits from railroad relocation.

Benefits from relocation or consolidation include reduction of all aspects of the conflict--elimination of grade crossings thus improving highway traffic flow and eliminating accidents; elimination of barriers; improvements of land values and environment; and cost reductions for the railroad operating companies.

Consolidation of lines may be resisted by a railroad management under circumstances that require the railroad to give up a right-of-way over which it has complete control and exclusive use and become a tenant on another railroad's line. Innovative legal and institutional mechanisms will need to be worked out by industry and government to assure railroads that their interests will be maintained in such arrangements.

Other potential remedies for specific problems include closing of dangerous, low-volume grade crossings; installation of improved crossing surfaces and warning devices; construction of grade separation structures (including sections of elevated or depressed railroad right-of-way); and encouragement of compatible community land development.

Relocation of railroad facilities can be quite expensive. A survey of highway agencies and railroads conducted by the FHWA and the Association of American Railroads showed that construction costs for 111 completed relocation projects averaged $4.7 million (adjusted to October 1973 prices) with the most costly being about $90 million. The survey also revealed 185 potential or proposed projects that will cost almost $2 billion.

The survey and work in analyzing costs of projects revealed that projects fall into three reasonably discrete categories according to the scope:

- Scope I projects that affect only one or two crossings.
- Scope II projects that affect a section of a city, such as bypassing the central business district.
- Scope III projects that bypass all conflicting activities of the city.

Projects in the second and third scope classifications were analyzed to determine the potential cost of nationwide programs that would justify projects by the following benefits:

- Consideration of safety benefits only.
- Consideration of safety benefits, savings to highway users through lower operating costs, and savings to highway users through reduced delays to users.
- Consideration of all of the above benefits plus savings to railroad operating companies.
- Consideration of all of the above benefits in addition to the increases in community land values and other benefits resulting from improved land utilization in the community.

An analytical procedure was developed to estimate the number of projects that would be justified under each of these program criteria and to estimate the cost and benefits of such programs. Uncertainty in the estimates arises because of wide difference in costs and benefits of projects, the fact that sampling is used in the estimate, and from possible alternative assumptions about the nature of available data. A range of estimates is therefore presented. Tables 1 and 2 show the range of number of places, costs, and benefits that are estimated for the programs.

Table 1

SCOPE II PROGRAM NATIONWIDE ESTIMATES

Program	Number of Places	Program Cost ($millions)	Program Benefits ($millions)
Safety	0-53	$ 0-8	$ 0-13
All highway user benefits	122-488	157-247	242-479
Railroad benefits added	412-857	726-748	1,278-1,611
Community benefits added	553-996	916-1,010	1,784-2,116

Table 2

SCOPE III PROGRAM NATIONWIDE ESTIMATES

Program	Number of Places	Program Cost ($millions)	Program Benefits ($millions)
Safety	1-13	$ 8-17	$ 12-25
All highway user benefits	20-261	44-218	58-334
Railroad benefits added	57-410	132-388	174-627
Community benefits added	359-855	1,449-1,746	2,137-3,138

A combined program to conduct Scope II and Scope III projects where they are justified, would result in program estimates shown in Table 3. For this combined program, the number of Scope II projects is used together with the average cost and benefits* of Scope II and Scope III projects, since Scope III projects are assumed to displace Scope II projects where they occur in the same location.

In addition, relocation of yards and terminal facilities would cost about $1 billion to move from 40 to 80 urban railroad yards, producing benefits in excess of the $1 billion cost. Benefits from relocation of these facilities would be classified as community benefits.

Lack of community financial capability has prevented attainment of significant benefits from railroad relocation. Only a few places have succeeded in assembling the large amounts of funds needed for implementation of projects on the scale discussed above. The capability of cities to raise money in the amounts needed is steadily declining. A program of funding is needed that both allocates the financial burden among the

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*Derived from Tables 1 and 2 by: total Scope II and III cost or benefit-(Scope II cost or benefit ÷ number of Scope II projects x number of Scope III projects).

Table 3

NATIONWIDE ESTIMATES FOR COMBINED PROGRAM

Program	Number of Places	Program Cost ($millions)	Program Benefits ($millions)
Safety	1-53	$ 14-17	$ 22-25
All highway user benefits	122-488	175-362	260-557
Railroad benefits added	412-857	767-777	1,275-1,467
Community benefits added	553-996	1,803-1,876	2,763-3,438

interest groups (stakeholders) in proportion to their benefits (or changes in cost), but also provides incentives for the stakeholders to act in the interest of all the parties. Specific incentives are needed to induce communities to pull together as much of their available resources as possible for the accomplishment of the projects. Similarly, the railroads need incentives to make what otherwise might be marginal investments, considering the limited availability of investment capital to the railroads and the many competing demands for this capital.

Federal assistance is needed as part of this incentive package. The justification for federal funding is that the federal government should: support projects that provide benefits to highway users, maintain and improve the national resource represented by the railroad network, compensate communities for the environmental degradation they suffer in maintaining the natural resource of the railroads, and support a national commitment to improving the quality of life in American cities.

A survey of highway and transportation agencies in six states revealed that relocation funds will likely have to be earmarked or appropriated for that purpose because the state agencies are reluctant to divert large amounts of funds from highway needs.

Planning is needed to identify the costs and benefits of these complex projects that will cost millions and have widespread impacts.

Because of the variation in costs and benefits from community to community, the planning should consider a wide range of alternative solutions and identify the impacts well enough so that the solution for relief of the conflict that is most appropriate to community values and resources can be found. Only in this way can genuine improvements in community and railroad circumstances be made.

A comprehensive planning program is identified in Volume 3--the Guidebook--of this series and a way of assessing the need to conduct a planning program is described in Volume 2.

Carrying out a planning program in the estimated 1,650 communities with potential railroad conflicts is estimated to cost $135 million. A program of preliminary assessment may reduce this requirement by further screening of proposals before detailed planning is undertaken. Such a planning program is necessary to rank the eligibility of competing proposals for financial assistance and to allocate costs among the participants.

The potential for system-wide consolidation that would produce a railroad network with fewer and more densely used main lines, as proposed in recent DOT reports concerning the railroads in the Northeast, presents some special considerations for relocation planning. Planners must consider interim handling of main lines that may later be downgraded and proper relocation or isolation of the new, heavily traveled main lines from the activities of the communities that they traverse.

The support of planning for improvement of urban railroad facilities and the implementation of projects for such improvements appears to offer significant benefits that should make these programs competitive with others for improving safety, highway mobility, railroad efficiency, and the quality of life in our cities.

III THE URBAN RAILROAD CONFLICT

The conflict between the activities of the community and the operations and facilities of the railroad affects many persons, groups, and institutions. These effects may be categorized as:

- Delays and increased operating costs for highway users
- Safety
- Community barriers--physical and psychological
- Environmental degradation
- Incompatible or inappropriate land uses
- Increased operating costs for railroads.

Any one or combination of conflict effects may be intense enough to evoke strong community reactions, and the relative importance of the effects varies widely from community to community. These variations are the result of differences in geography, topography, patterns of land use, railroad service, traffic density, and community attitudes toward their environment and toward the railroads.

The ease and frequency of measuring different effects also varies. Highway user costs and safety at grade crossings are readily measured, and railroad costs can be estimated even though there are few examples of such computations. But there is almost nothing in the way of theoretically sound and detailed studies that quantify the economic and social costs of the conflict to a community. This lack of quantification is the result of (1) the limited state of the art for quantification of community values, (2) the many differences in the relative value that communities place on enduring or ridding themselves of annoyances, and (3) the relatively high cost of studies to utilize whatever analytical methodology is available for quantification.

We believe that the companion Guidebook represents the state of the art in measurement of community impacts, and have illustrated its application in studies of Wheeling* and Lafayette.† Results of these two studies show widely different community benefits (high in Wheeling, low in Lafayette), so further experience by application of the Guidebook procedures will be needed before any kind of nationwide pattern is revealed. Nevertheless, we can draw on these and other studies in the general discussion of railroad conflict effects that follows.

Delays and Increased Operating Costs for Highway Users

Highway users are defined as owners, operators, and occupants of automobiles, buses, and trucks that use the streets in a city. A city's economy, form, and patterns of activity are determined in large measure by the patterns of travel over its network of highways and streets. Highway users and the railroads come into a conflict at railroad-highway grade crossings, where a railroad line crosses a street or highway. A vehicle operator must slow his vehicle to determine if it is safe to cross or to avoid effects of roughness at the crossings, and must stop if the crossing is occupied, or about to be occupied, by a train. This slowing and stopping creates an impediment to vehicular travel that may influence the pattern of urban movement.

The results of the delay are one of the most visible problems and the source of some of the most vocal complaints about railroads in urban areas. A local official in Springfield, Illinois, reported that street blockage by trains has been an identifiable issue in every local election that he can remember. In Lafayette, Indiana, scores of editorials have been written about the delays at the railroad crossings.

Slowing and stopping increases vehicle operating costs: more fuel is used to accelerate after slowing than would have been required to maintain speed, and maintenance for brakes, transmissions, and tires is increased. Tire and suspension damage due to crossing roughness also increase maintenance.

Slowing and stopping at grade crossings also increases travel time for motor vehicle occupants. Time delays are more or less important to

*"Railroad Relocation Study," prepared for Wheeling, West Virginia, Gruen Associates, Inc., and Stanford Research Institute, Menlo Park, California (December 1973).

†"Riverfront Rail Relocation in Lafayette, Indiana," Stanford Research Institute, Menlo Park, California (April, 1974).

the occupants, depending on what they are doing and the length of the delay. Delays to commercial vehicles reduce the productivity of both the vehicle and the operator. On the other hand, persons driving for recreational purposes--going to a picnic or just sightseeing--are less concerned with the delay. The effects of any delay are exacerbated by the uncertainty as to the length of the delay--discussions with drivers have indicated that they are uneasy because they cannot see the end of the train and sometimes wonder if it will stop on the crossing.

In only two of seven cities studied in the project were highway user benefits (including accident costs) less than other quantifiable benefits. Highway user costs have been studied extensively and are therefore more easily quantified than other costs of the conflict with the railroad. This may be the reason that highway user costs frequently showed up as the largest single quantifiable benefit in the brief analysis of relocation sites studied in the project.

Using an average value of time and typical values of the roughness of crossings, the speed of approach, and train length and speed, we have estimated that the cost of the time delays and the additional operating cost of all urban grade crossings in the United States was $800 million in 1970. The costs were estimates from a tabulation of the number of crossings carrying ranges of trains and highway traffic,* using procedures described in the Guidebook.

The costs to the vehicle users at grade crossings may be part of the physical measure of a barrier, described later. Closely related accident costs are also a cost to highway users, since highway users are the principal victims of vehicular accidents at and near the grade crossings described in the next section.

Safety

Safety issues related to urban railroad conflicts may be classified into:

- Train/motor vehicle accidents.
- Other motor vehicle accidents in the vicinity of the grade crossing.

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*"Report to Congress on Railroad-Highway Safety, Part II: Recommendations for Resolving the Problem," U.S. Department of Transportation, Washington D.C., p. 36 (August 1973).

- Train/pedestrian accidents.
- Dangers from hazardous materials.
- Interference with emergency services.

Train/Motor Vehicle Accidents

The U.S. Department of Transportation estimates that 7,451 accidents involved trains at urban highway grade crossings in 1970, resulting in 484 fatalities and almost 4,000 injuries.* Using an average economic loss of $25,000 per accident--including loss of productivity from injury or death, treatment of injuries, and repair of property damage--the economic loss represented by these accidents is over $185 million. In addition, the pain and suffering by the victims and the survivors of the deceased are immeasurable.

The accident costs are combined with highway user costs of delay and increased operating cost because the accident costs fall mainly to the motor vehicle user, and because the costs are most conveniently computed at the same time. The accident costs are approximately 25 percent of the other highway user costs and thus constitute a significant portion of the measurable cost of the urban railroad conflict. Collisions between vehicles and trains are usually severe. The fatality rate for train-involved accidents is 40 times that for other motor vehicle accidents. The severity of the accident often arouses expressions of community concern.

In Greenwood, South Carolina, a vicious cycle of delays and accidents was reported that well could occur in other places. Delays from trains made motor vehicle users take chances that resulted in marginal or inadequate times for the vehicle to clear the crossing ahead of the train. The railroad concern with accidents resulted in slower train speeds and more delays, making the reward to the motorist higher if he beat the train through the crossing.

Other Motor Vehicle Accidents in the Vicinity of the Grade Crossings

The slowing and stopping of vehicles for grade crossings create a disruption in traffic flow, and this disruption creates opportunities for vehicle accidents, particularly those in which a moving vehicle

*"Report to Congress," op cit., Part II, pp. 15, 17.

strikes the one in front of it. Little is known about the incidence of these accidents in the crossing environment, because accident reports and statistics do not generally relate this class of accident to the grade crossings. However, improvements in accident reporting are being made, and more improvements are expected.

Train/Pedestrian Accidents

Part I of the "Report to Congress"* reports that pedestrian accidents on the right-of-way resulted in 485 injuries and 353 fatalities per year in urban areas for the period 1968-70. Eighty percent of the pedestrians were on railroad property in unauthorized places, and ten percent were injuries at grade crossings.

Dangers from Hazardous Materials

Hazardous materials are toxic materials, such as insecticides or chlorine gas; explosives, such as military ordnance; flammable products, such as liquified petroleum gas (LPG); corrosive substances, such as acid or caustic soda; and radioactive materials, such as nuclear wastes.

Railroads are used for shipment of these materials because of their bulk and because using exclusive right-of-way provided by the railroad is safer than transport by highways. The use of the railroad to ship hazardous materials--especially LPG and chemical intermediates--is growing. However, accidents involving hazardous materials are relatively rare.

A community is endangered when an accident involving rupture or leakage of the container, fire, or a combination of all three, exposes the population to the effects of the material or its reaction. These accidents are most likely to happen during a derailment, although container rupture and the leakage responsible for LPG accidents have happened while a car is standing in a freight yard, and fires in boxcars containing explosives have not always been related to derailment.

Interference with Emergency Vehicles

Reports from almost every city studied in this project indicated that fire stations are located, in part, so that areas of the community

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*Op cit.

will not be without fire protection as a result of grade crossings being blocked by trains. Greenwood employs a procedure of deploying fire engines to locations on both sides of the tracks after receipt of notice of approaching trains over police radio. Most communities feel concern over interference between railroads and emergency vehicles, and most leaders feel that fire insurance rates would be reduced in some locations if the railroad is moved. However, quantification of these concerns has not been possible.

Physical and Psychological Barriers

More than one community is convinced that a railroad is a barrier that limits access to the central business district and is somehow responsible for the decline of the CBD. An expression, "The railroads are a Great Wall of China that is blocking the progress of our city," repeatedly recurs in promotions of railroad relocation projects.

Development of suburban communities and shopping centers since World War II has reduced the importance of the CBD as a retail center in many cities of all sizes. Many downtown organizations are seeking to recapture the lost retail trade and hope to improve access by removing the railroads. For example, our field investigations in Springfield and Wheeling indicate that new shopping centers are being planned for the suburbs, and downtown interests are concerned with the loss of business.

Such a strategy may be effective, but there are very big questions to consider in determining whether removing the railroad barrier will help:

(1) Does the demand for increased business, land, and space exceed the existing supply? Is the business climate right for such a redevelopment effort?

(2) Is access to the central area restricted by other bottlenecks that will become serious when the railroad bottlenecks are removed?

(3) Will demand, traffic, land use, and parking be coordinated in such a way as to use the central area effectively for the purposes intended?

The city of Beaumont used local funds and financial contributions from the railroads to implement the first of a two-phased railroad relocation project. Completion of the first phase did improve access to downtown, but this improvement, by itself, did not assure automatic

rejuvenation of the business district as expected. Additional studies are now being conducted there to answer the three questions above before the second phase of relocation is undertaken. A study of a potential shopping center in Wheeling related to railroad relocation addressed the three questions.* But such studies are not available in conjunction with any other railroad relocation proposal, and there is no documentation of the claims.

To generalize, the effects on areas isolated by a railroad and otherwise unaffected must be considered secondary effects: Highway users benefiting from a railroad relocation that make a downtown district accessible will pass on the benefits by spending more downtown. But it must be remembered that all or part of the sales lost to businesses in the isolated area are being made somewhere else and are therefore increasing the rents and property values in other locations.

A psychological barrier may be created by any physical barrier that causes increased travel times or inconveniences, or that obstructs the view or presents real or imagined danger. Railroads in particular have historically created this kind of barrier, so that one side of the tracks became the "right" side and the other the "wrong" side, whether or not a good reason existed for the difference. Census data still often show marked differences in the family income or ethnic composition on the different sides of the tracks. The fact that the railroad is the boundary says something about its divisive psychological effect. If a social or psychological barrier has developed because of a railroad line, however, it cannot be assumed that removal of the tracks will break down the barrier without some kind of action program designed to change the attitudes and habits of the community.

In some cases, the barrier effect of a railroad line may actually serve as a buffer that helps separate conflicting land uses that really should be separated.

Environmental Degradation

Noise

Noise, together with the attendant vibration, is the characteristic of trains most generally found to be annoying to persons occupying nearby properties. Train horns and crossing warning device bells, the squeal of the train's brakes and of steel wheels negotiating a curve, and switching

*"Railroad Relocation Study," op. cit.

operations--particularly those where retarders are used in classification yards--all contribute to the obtrusiveness of trains.

The noise profile around the railroad corridor varies with the topography of the surrounding area, the location of grade crossings equipped with warning bells, the design of the railroad cars and the roadbed, the level of track maintenance, and weather conditions. For example, depressing the track or building structures around it will dampen the noise, whereas elevating the track on a steel trestle will distribute the sound more widely. Deep setback of buildings from the tracks, together with screening shrubs, lessens the perceived effect of the train operations, although tests have shown that shrubs have little actual effect on sound transmission. A relatively high noise level in the surrounding area will tend to mask the train noises, so that the effect of railroad noises will be less in industrial and heavy commercial districts.

Measurements of sound level made in Canada at a distance of 100 feet from a freight train traveling at roughly the same grade as the surrounding land are given below:

Source	Sound Level (dBA at 100 feet)
Train horn	100-98
Freight train--50 mph	90
Freight train engine--30 mph	92-87
Freight cars--30 mph	85-75

It has been found that a noise level about 90 dBA can cause workers to make significantly more errors than they make otherwise. Noises above about 80 to 84 dBA are considered noticeable or obtrusive. Outdoor noise levels of 70 dBA are considered to be a reasonable maximum in residential neighborhoods by the U.S. Department of Housing and Urban Development.

Visual Intrusion

Unless a railroad line is depressed below grade or buffered by buildings or landscaping, it is quite visible and usually unattractive. The equipment is designed for durability, not for appearance. Dirt, rust, and lubricants frequently mar the ground along the right-of-way.

Even when painted, railroad cars seem like rolling billboards to many. The motion of the train and its attendant noise attract attention.

Railroad structures have not had the architectural attention that newer mass transit and highway structures are now receiving; consequently, they are frequently austere and functional, and often in need of paint.

Railroad rights-of-way are again maintained for functional rather than visual reasons. Weed control may not be as good as in other parts of the community. Wind-borne paper litter is another added burden to the usual litter of spilled lading and discarded railroad equipment along the right-of-way. This unsightliness prompts citizens to discard even more junk on the right-of-way.

Finally, the railroad is frequently in an older part of town. The age and decay of older structures makes them visually blighting and intensifies right-of-way appearance problems.

One of the principal issues noted in the study of Wheeling, West Virginia, is an old and crumbling concrete railroad viaduct that is visually unattractive, unnecessarily so for its present use, and thought to be an anchor for the blight and crime in that part of town.

Air Pollution

Most areas of the United States have been required to prepare a plan for achieving certain air quality standards, and drastic measures are being contemplated in some areas because of inability to meet the standards by improvements in vehicles. The importance of emissions that can be reduced by modifying railroad facilities is, therefore, related to the difficulty that the community has in meeting the air quality standards. If the standards can be met by an area's current plan, additional reduction may be desirable but not critical. On the other hand, in urban areas where there is a problem of meeting the standards, any contribution to the air pollution problem is of highly critical importance.

Railroad Locomotives--The smoke from the locomotives will contribute to local visual intrusion, both as it is emitted and as it blackens buildings and structures. A well tuned and maintained diesel engine does not normally emit smoke except under periods of heavy load, such as acceleration. Thus areas where the locomotives accelerate or where switching operations are conducted will be especially subject to smoke particles. The amount of the emission from a switch engine is approximately 0.02

pounds of particulate per mile, and from a fully loaded train it is up to 0.3 pounds per mile.*

To help visualize what this means, a heavy diesel truck emits 0.003 pounds of particulates per mile. Of course, the truck carries perhaps 15 tons, while the train may carry 5,000 tons or more. While the emission per unit of load is thus much smaller for the train, the concentration may still be greater.

Another annoyance from diesel engines is the smell and irritation of unburned or partially burned hydrocarbon fuel. The average emissions of the fuel are 0.12 pounds per mile for switching service and up to about one pound per mile for fully loaded trains, using average emission factors.† Comparable diesel truck emissions are 0.007 pounds per mile. Again, the hydrocarbon emission increases under acceleration or hill-climbing, and the emissions will be concentrated around these locations.

Motor Vehicles--As motor vehicles slow down or stop for grade crossings, then accelerate back to speed, they emit more pollutants than they would were they to continue along the same distance at steady speed. The amount of increase in emissions depends on the speed of approach, the crossing roughness, the kind of crossing warning device, the number of trains per day, the train speed, and the length of the trains.

At this time, uncertainty continues on the methods to be used to meet legal limits on emissions from motor vehicles. There is also a continuing debate on the maximum levels of emissions that sould be permitted and the date by which various reductions should take place. Thus, the contribution from elimination of grade crossings is uncertain. When railroad service to a user is discontinued, the trade-off between the emission of trucks and trains should be considered.

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*Computed from average factors of 25 pounds of particulates per thousand gallon of fuel and the fuel consumption data given in Section IX of the Guidebook.

†Environmental Protection Agency, "Compilation of Emission Factors," second edition, publication #AP-42, Research Triangle Park, North Carolina (April 1973).

Incompatible or Inappropriate Land Use

Because of the environmental effects just discussed, the railroad is largely incompatible with land uses where there are people--primarily in residential areas.

Property values are a measure of the conflict. Because of the environmental stigma associated with the railroad and because the railroads tend to be in older parts of towns, property values tend to be lower near the railroad than further away from the tracks. The project team talked to real estate brokers and appraisers in Beaumont and in Lafayette; their experience confirmed the claim that railroads detract from residential property values. The overall impact of increase in land values due to railroad removal was on the order of 20 percent of the highway user cost savings in Lafayette.* Individual units in blocks nearest the railroad were estimated to increase in value by 20 to 30 percent, but these increases were offset by equivalent losses in other parts of the community. A net increase was shown for the community because the parcels freed from the railroad environment were more accessible to major activity centers than the competitive locations.

Development of land from railroad to some higher use close to the center of the city tends to reduce travel times and distances for highway users and so improves the overall efficiency of the highway. Similarly, provision of a highway in a former railroad corridor benefits the highway users, as was found in the study of Lafayette, Indiana.

A study of the railroad-community conflict in Wheeling, West Virginia, showed that removing the railroad tracks from a section about one-mile long would provide a parcel of sufficient size to construct a regional shopping center in a location that would make this center superior to ones proposed for other, less centralized locations. The study showed significant benefits to the city of Wheeling and to the metropolitan area through increased employment opportunities, land-value increase, and increased tax revenues.†

Other incompatible or inappropriate land uses arise from the use of local freight yards. Although industrial land uses have developed around many nonpassenger railroad facilities, railroad yards and shops in or near the central part of a city may be more efficient if moved to some other location. The full potential value of a neighborhood could be realized by

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*"Riverfront Rail Relocation," op. cit., pp. 52-53.

†"Railroad Relocation Study," op. cit., pp. 86-89.

removing the railroad yard and shops when they are incompatible with the other land uses of the neighborhood.

Our field investigations showed one such case in Denver, where railroad yards are being relocated to extend the redevelopment of an urban area lying between the CBD and the Platte River. The Chicago Area Transportation Study (CATS) indicates potential benefits to both the railroads and the community from abandoning under-utilized yards.* One of the purposes of a study being conducted in East St. Louis is to plan the best disposition of land freed from railroad facilities.

Railroad Operating Company Cost and Reduced Efficiency

The Railroad Industry

The railroad industry consists of a number of private enterprises that deliver freight and passengers in interstate and intrastate commerce over an interconnected system of railroad tracks. The railroads that operate over the system are regulated by the Interstate Commerce Commission in regard to location of service, abandonments, rates, and other conditions of service.

The industry has been highly fragmented, with carriers competing with each other for traffic from customers. The area of service has been limited, with one railroad company picking up the freight from a customer, perhaps several other companies hauling the car in trains across the country, and still another delivering the car. There is a trend toward consolidation of companies that will be discussed in a later chapter, but the companies in the industry still are highly interdependent, while at the same time competitive.

Because of several factors, profitability for the railroad industry in general is among the lowest of industries in America, and securing funds in the equity market would be difficult because of this fact alone. There is, of course, a large variation in the profitability of individual railroads. However, in 1970, the largest railroad company in the country, the Penn Central Transportation Company, declared bankruptcy and reorganization is now contemplated only through special legislation. The conditions of the reorganization have made lenders of money extremely reluctant to loan money to an operating railroad (other than money secured by rolling stock) and, as a consequence, even the profitable railroads must operate virtually without access to capital markets. This financial

*"Planning for Freight Facilities, Chicago Area," Chicago Area Transportation Study, Chicago, Illinois (1970).

squeeze governs many railroad actions, since only those projects with quick and high payoffs can be undertaken with the limited capital available.

The objectives of urban relocation projects for railroad companies, listed in Table 4, illustrate the financial and competitive concerns that exist in the business.

Grade-Crossing Maintenance

In most states the railroad is responsible for maintaining the surface of the highway or street area over the ties. This part of a street is particularly difficult to maintain because water enters the area under the surface and either freezes in winter or undermines the subgrade, ballast, and ties. Under these conditions, the surface is further deteriorated by passage of vehicles over the crossing. Crossing surface maintenance, at an average annual cost of $300 per crossing, $24 million per year for the nation.

Maintenance of crossing warning devices is generally also wholly or partly a railroad expense. Annual cost of maintaining warning devices is estimated at $45 million, using cost estimates in the Guidebook and the distribution of crossing warning types from "Report to Congress," Part II.

Accidents

While grade crossing accidents are usually discussed in terms of their effect on the highway users, railroad equipment suffers damage in any train-involved accident. There is frequently litigation over accidents and legal expense, and sometimes the railroad has to pay damages.

Speed Restrictions

In reaction to community and railroad concern over accidents, speed restrictions on trains exist in many urban places. In most of them, the speed is restricted by city ordinance.

Slowing and accelerating a train uses fuel, causes wear, and takes time, and all these things mean costs to the railroad that are higher than would occur if the train did not slow down. The "Report to Congress" states that this cost in all places in the United States is approximately $75 to $100 million annually.

Table 4

A STATEMENT OF GOALS OF RAILROAD
OPERATING COMPANIES IN RELOCATION PROJECTS

1. Maintain a continuous railroad right-of-way through or around an urban area that connects essential railroad facilities. This means that in some appropriate form the railroad right-of-way between essential facilities must be continuous, obviously a key point if a railroad network or system is to be maintained.

2. Maintain railroad access to current and prospective freight shippers and industrial areas. The traffic of railroads depends largely on railroad spur access to individual shippers. To the extent that this is made impossible for either current or prospective shippers or for industrial areas, the railroad traffic position will deteriorate.

3. Maintain or improve the railroad competitive position in relation to other railroads and other transport modes. Relocation proposals have little possibility of accomplishment if they would damage an individual railroad's current competitive position either in relation to other railroads or other transport modes. No railroad's ability to provide service should be adversely affected.

4. Maintain or improve overall railroad operating efficiency. Similarly, the net cost of operating a railroad must not be substantially increased.

5. Reduce railroad-highway grade crossing frequency, accidents, casualties, and railroad operational inefficiencies associated with grade crossings. The elimination of railroad-highway grade crossings, speed restrictions, and the like to improve railroad safety and efficiency is one means to this end.

6. Permit all railroad-controlled urban lands to be given their highest and best use in the interest of maximizing cash flow, market value, and net income for the railroad owner. As property owners, railroads wish to maximize returns from their land. Sale or exchange of land in connection with a relocation project should give equitable consideration to this principle.

7. Realize no net loss in current or projected railroad financial position as a result of the relocation. No railroad can be expected to voluntarily accept a decline in either its current or projected financial (cash or income) position as a result of a relocation.

Table 4 (Concluded)

8. Obtain full compensation for additional railroad operating and capital costs incurred as a result of the relocation, including railroad-furnished capital. Railroads will wish to obtain full compensation for all net additional costs (train operation, maintenance, and so on) resulting from the relocation.

9. Develop an external source of capital to fund railroad relocation projects to the extent desired by each participant to pay its share of the cost determined in proportion to its net benefits received. Railroads generally are short of capital both because of poor earnings and poor credit position. Thus, they prefer to use their scarce capital for internal projects with high rates of return. Developing an external source of capital becomes an important goal.

10. Minimize the adverse environmental impact of railroad operations on the affected community to the maximum extent possible subject to the constraints of other goals. Subject to their other service, operating, competitive, and financial constraints, railroads, readily cooperate in minimizing their adverse environmental impacts on the affected communities.

Outmoded Facilities

The use of railroad yards that are now quite distant from railroad patrons means additional time and cost for the railroad to deliver to or pick up cars from its local customers. The older yards themselves require more man-hours per car throughput than newer yards. In extreme cases--such as gateway cities like Chicago, East St. Louis, and Kansas City--the number of yards and their location generates many delays and additional costs to move cars in, out, and through the gateways.

Railroad Losses from Theft and Vandalism

The location of railroad lines and yards in urban areas makes them accessible to persons who commit theft and vandalism on railroad equipment and freight. The railroad accounting methods identify only a small part of annual losses as theft, but theft of parts from such freight as automobiles frequently is classified as concealed or other damage.

Relocation of the rail facilities to less populated areas would reduce exposure to vandals and thieves, thus reducing these losses. Consolidation of lines may also permit better policing of railroad property, and permit fencing at a lower cost.

IV EXTENT OF THE CONFLICT

The symptoms of conflict described in Chapter III arise wherever there is proximity between a railroad and a community. This could mean that most of the cities with railroad services experience conflict. Those communities with railroads that do not have conflicts have developed so that the railroad:

- Is located in industrial areas.
- Passes through the community in corridors created by highways, hills, or other barriers.
- Is located where land separating the residential and commercial parts of town is unused or used for agricultural or other uses that are not great traffic generators or where large numbers of people live or work.

The conflicts are widespread. Of about 4,100 urban places with populations greater than 5,000 in 1970, an estimated 1,650 have evidence of conflict. The proportion of places with conflicts is estimated at one-third of those places between 5,000 and 25,000 population, increasing to 90 percent for communities with populations greater than 1,000,000.

Population and Regional Subdivision

Stratification by population and region is used in the analysis of the number of places with conflicts. Table 5 shows the number of places and the total population of the United States in each of the eight population ranges that were analyzed.

An initial analysis of maps prepared by the U.S. Geological Survey indicated that these factors could be determined from the maps and that the apparent degree of the conflict changed as the population of the community passed approximately 100,000. Therefore, communities were classified into two size groups--over 100,000 and 5,000 to 100,000--and subsequent analyses were conducted along different lines for the two groups. The map analysis was repeated for the smaller cities, using a more exact procedure and a larger sample. For larger cities, we conducted a survey of planners and engineers in these cities, and carried out more detailed studies on a sample of the cities.

Table 5

U.S. POPULATION CENTERS ANALYZED

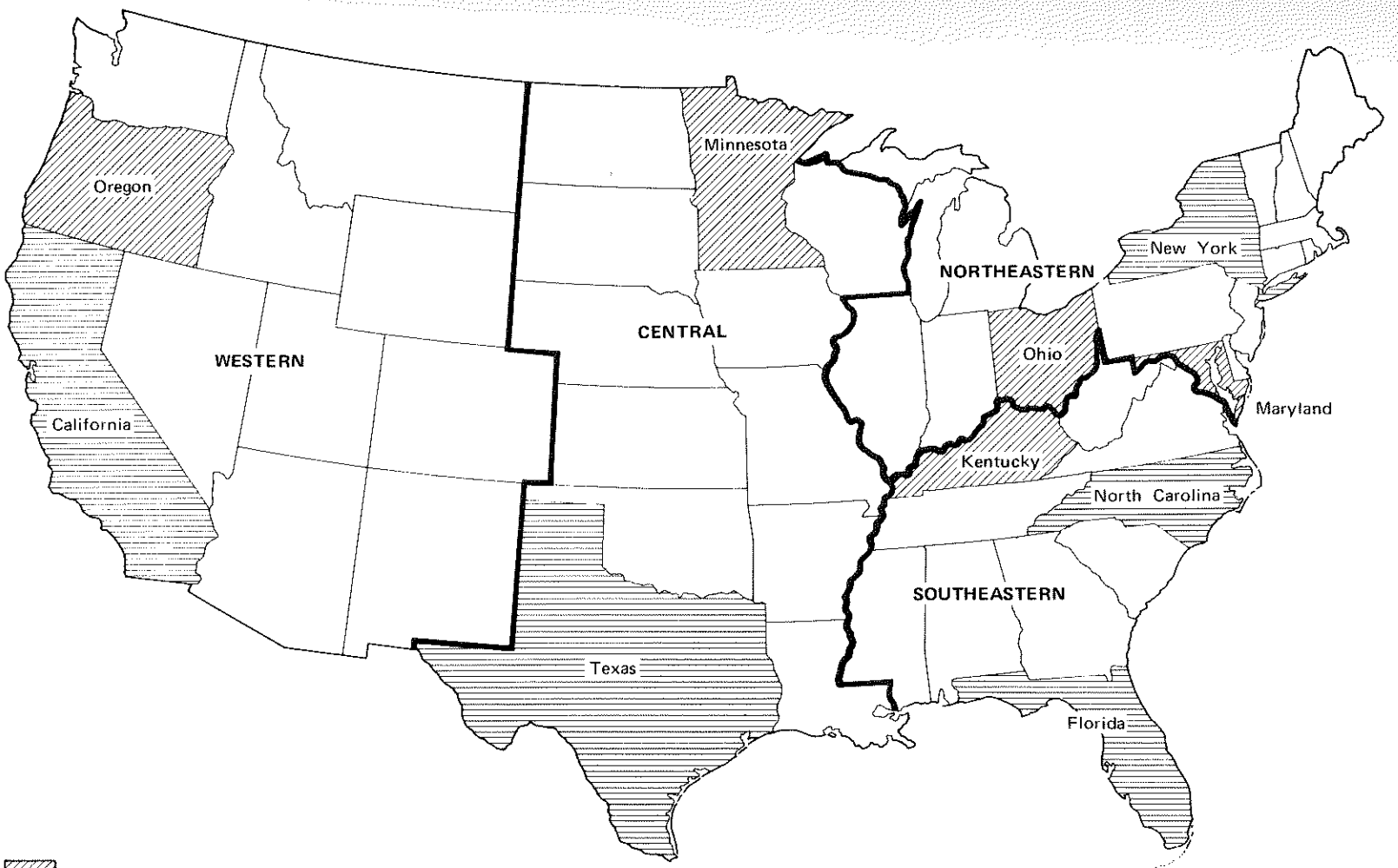
Population of Center (thousands)	Number of Centers	Population in Group	Cumulative Population
5-10	1830	12,930,372	12,930,371
10-25	1385	21,431,385	34,361,757
25-50	520	17,848,705	52,210,462
50-100	240	16,740,130	68,950,592
100-250	100	14,292,614	83,243,206
250-500	30	10,466,400	93,709,606
500-1,000	20	12,989,017	106,698,623
Over 1,000	6	18,770,773	125,469,396

Source: U.S. Census of Population, 1970, Number of Inhabitants, Final Report PC (1)-A1, United States Summary, p. 45, U.S. Bureau of the Census, (U.S. GPO, Washington, D.C., 1971).

As part of both analyses, the coterminous 48 states were divided into four geographical regions, as illustrated by Figure 1, based on the number of railroads operating in the cities of the region, as well as historical and developmental factors. States included in the sample for map analysis are shaded diagonally. Horizontally shaded states on the map provided data for an analysis described later.

Smaller Communities

The analysis of potential urban railroad conflicts in smaller communities (population 5,000 to 100,000) was made from the Geological Survey topographical maps, and inventories of highway and train volume at grade crossings. The map analysis was done to separate the places with potential conflicts, as described above, regardless of their potential intensity. This separation was done, in part, to determine the number of places where planning might be needed to determine the benefits and costs of potential projects. The actual determination of whether a project should be initiated to alleviate the conflict must await the



States subjected to scoring technique discussed in text.

Other states where grade crossing inventory data were analyzed

SOURCE: SRI

FIGURE 1 STUDY REGIONS AND STATES

result of such a detailed planning study, and these studies tend to be costly--$50,000 or more--because of the need to design a new railroad system for the community.

A scoring system was devised to evaluate the potential for conflict in these places. The scoring system reflects the symptoms of the problem described earlier--where there are activities involving people and railroads, there are also conflicts. The listing below shows the scoring criteria. In Category A, the proximity of the railroad to major activity centers is scored, with the highest score going to a railroad that passes through the usual center of activity--the central business district (CBD). Lesser scores are given in communities where the railroad passes through the built-up areas, and negative scores are applied when the railroad passes through only open or rural areas. Categories B and C show the mitigating effects of following common barriers and compatibility with adjacent land use. Finally, the number of railroad corridors in the community shows the breadth of the problem.

- Category A--Proximity of Railroad to Central Business District
  - Passes through CBD, +3.
  - Passes through built-up part of urban area, +2.
  - Lies along edge of built-up area, 0.
  - Passes through only rural areas, -2.
  - No railroad in area (no relocation needed), -5.
- Category B--Railroad Follows Natural or Man-Made Barriers
  - Has no relationship to other barriers, +1.
  - Partially uses other barriers, 0.
  - Parallels other barriers for a significant part of passage through area, -1.
  - Parallels freeway or natural barrier throughout urban area, -2.
- Category C--Relationship of Railroad to Adjacent Land Use
  - Is quite distant from any industrial sites, +2.
  - Provides short access by rail to significant number of industrial sites, -1.

- Services many industrial sites from short spurs on main line, -2.

- Category D--Number of Rail Corridors through Urban Area

  - Two or more, +2.

  - One, +1.

It was assumed that a community has a potential railroad problem if the combined score of all these factors is +2 or greater; it is unlikely to have a problem if the score is less than +2.

Examples of the maps affected by the scoring are shown in Figures 2 and 3. Note in Figure 2 that the railroads pass relatively near the center of Fostoria, then have no obvious relationship to other barriers. While railroads on the southwest side of town serve large industrial buildings, the tracks also move from there northeastward, passing very near the center of town as determined by the location of the post office and main street. Other railroad corridors pass through the built-up areas (indicated by the tone) in the southern part and the northern parts of town. Three railroad corridors cut the town. Fostoria would thus be scored as follows:

Category	Explanation	Score
A	Passes through CBD	+3
B	Unrelated to other barriers	+1
C	Distant from industrial sites	+2
D	Three corridors in urban area	+2
	Total score	+8

The total score indicates that there is a potential conflict in Fostoria.

In contrast, Figure 3 illustrates a location where the proximity of the railroad to the river at the bottom of a narrow valley and the occupancy of that valley by what appears to be a major industrial development indicate that there is not a conflict. The scoring:

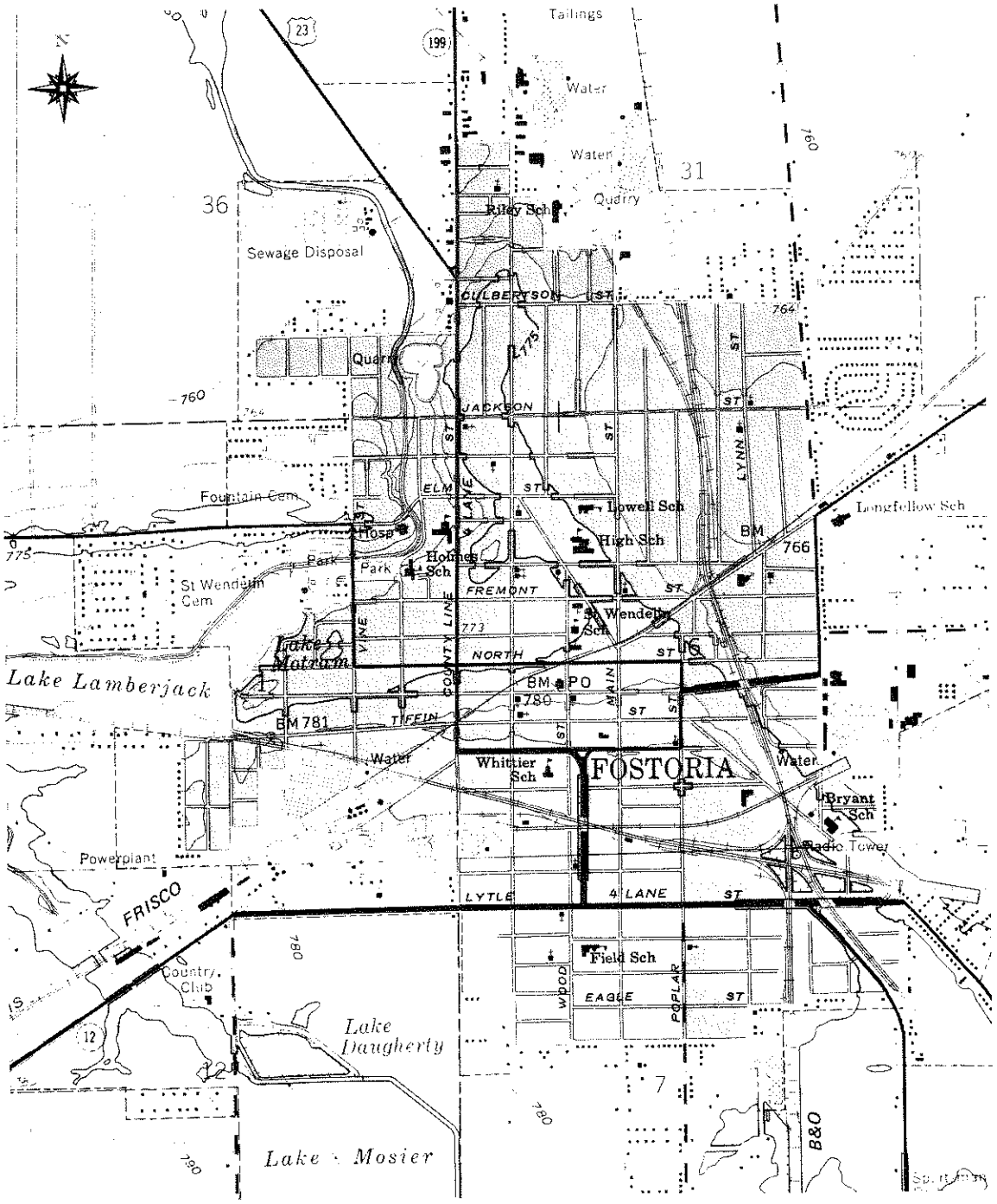


FIGURE 2 ILLUSTRATION OF A COMMUNITY WITH AN INDICATED RAILROAD CONFLICT

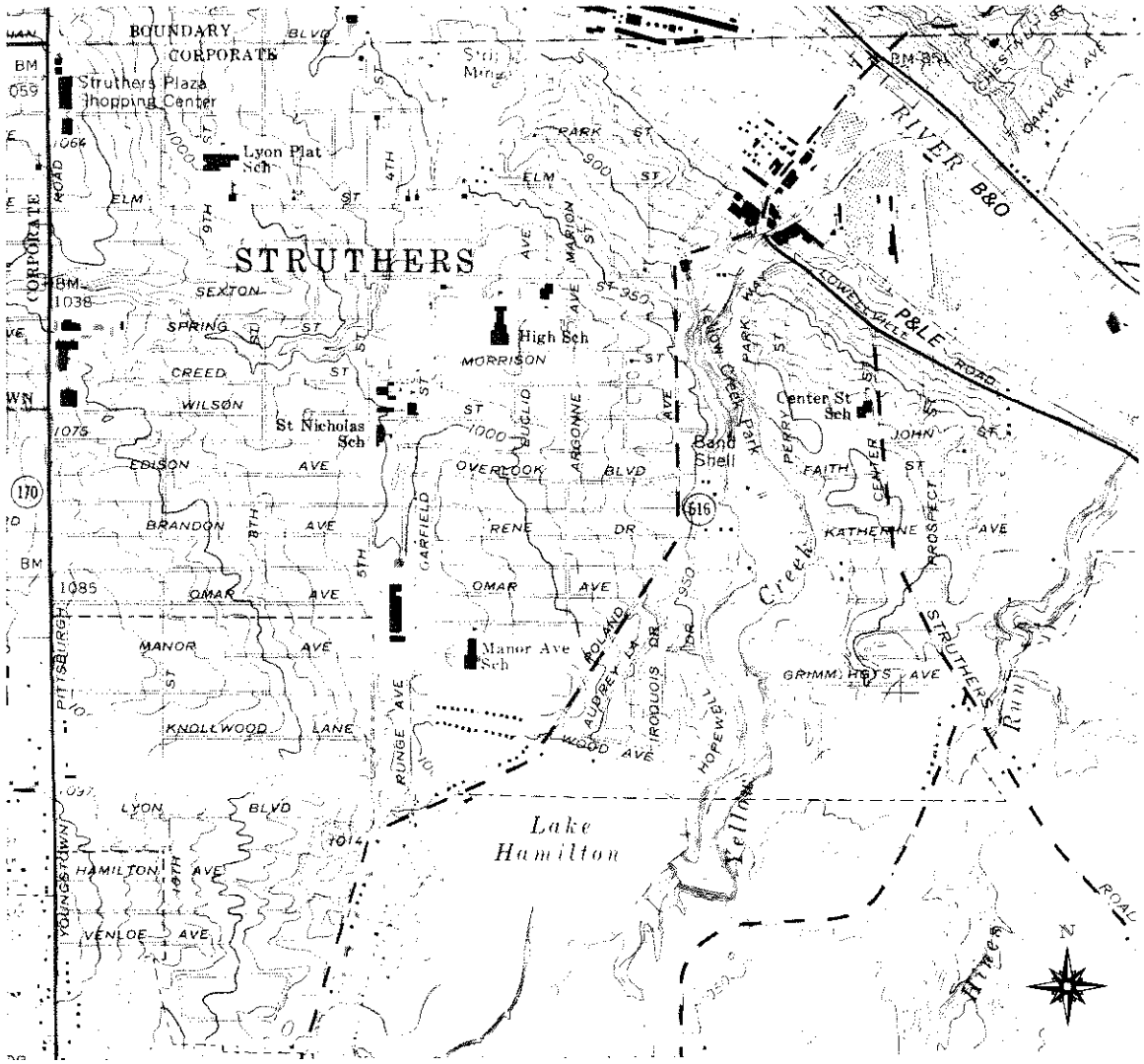


FIGURE 3 ILLUSTRATION OF COMMUNITY WITHOUT RAILROAD CONFLICT

Category	Explanation	Score
A	P&LE at edge of city	0
B	Parallels Mahoning River	-2
C	Close proximity to industrial buildings	-2
D	P&LE on south side of river, B&O on the north	+2
	Total score	-2

This scoring technique was applied to the states shaded diagonally on Figure 1. These states were selected because at that time (mid-1973) they had inventories of train and highway traffic for every grade crossing in the state, both for local streets and federal-aid highways, with the crossing inventory segregated according to urban location in the state. Assuming that there is no relationship between the extent of grade crossing data available in a state and the magnitude of the railroad problem in the state, this approach qualifies as a random selection.

The maps of the cities with populations less than 100,000 were scored, and the results extended by region and population size group to obtain the regional and national totals presented in Table 6. Table 6 shows that about one-third of the places with populations less than 25,000 are likely to have conflicts, while places between 25,000 and 100,000 population have conflicts in about half the locations. Geographically, the Western Region has the highest percentage of conflicts, followed by the Northeastern, then Central and Southeastern with about the same. In the ranking of total number of places with conflicts, the Northeastern leads because of its larger number of cities, followed by the Western, and again, the Central and Southeastern about the same.

Because the estimates in Table 6 were determined from a sample of the total cities in the United States, there is uncertainty in the estimate produced by the sample. Further uncertainty is introduced by the scoring of the maps. The degree of uncertainty is expressed by the width of the 90-percent confidence interval--the range within which there is a 90 percent chance that the true value will fall. A discussion of the uncertainty is presented in Appendix A.

Larger Communities

Because the railroad problem is even more complex to analyze for larger communities (population over 100,000) than for the smaller ones, it was decided to consult the local planner in each large city so as to

Table 6

RAILROAD CONFLICT OCCURRENCE IN THE SMALLER CITIES
(Population 5,000-100,000)

	Population (thousands)				
	5-10	10-25	25-50	50-100	Total
Northeastern Region					
Number of cities in region	803	604	224	106	1,737
Estimated number with apparent railroad conflict	326	223	82	77	708
Southeastern Region					
Number of cities in region	418	276	92	31	817
Estimated number with apparent railroad conflict	76	39	23	8	162
Central Region					
Number of cities in region	345	258	87	38	728
Estimated number with apparent railroad conflict	93	50	26	0	169
Western Region					
Number of cities in region	273	247	117	65	702
Estimated number with apparent railroad conflict	150	189	117	33	489
All U.S. Smaller Cities					
Number of places	1,839	1,835	520	240	3,984
Estimated number with railroad conflict	645	500	248	118	1,511
90% confidence intervals					
Low	542	420	183	70	1,357
High	748	580	313	166	1,665
Population affected by conflict	4,526	7,737	8,496	8,219	28,977

more exactly identify the railroad problem. However, a trial survey showed that the city engineer or traffic chief would also have to be consulted to obtain all the desired information. The questions asked in the final mail survey centered on problems resulting from main-line or principal branch-line tracks interfering with traffic or disrupting the environment, and also on the land in railroad yards that could better be used for other purposes. A copy of the survey report is included as Appendix B, and copies of the questionnaires and transmittal letters in Appendix C.

There was a high degree of interest in the subject, as evidenced by the response of 62 percent of those who were sent the questionnaire.* Of the respondents, 93 percent indicated that the city had a problem involving main-line or branch-line railroads. Asked to assess the severity of the railroad problem relative to other community problems, 13 percent of the respondents scored the railroad problem as major.

Table 7 presents the results drawn from the survey by city size group. Again, since all of the cities did not respond, the estimates are subject to an uncertainty that is dependent on the size of the sample. The confidence intervals of the estimates are also shown in Table 7 and discussed in Appendix A.

Table 8 summarizes the results of Tables 6 and 7. It shows that the greatest number of people live in cities in the larger population groups, while the largest number of places with conflicts is in the smaller population groups.

*A sample of nonrespondents was contacted. As described in Appendix B, the nonrespondents showed characteristics similar to the respondents.

Table 7

RAILROAD CONFLICT OCCURRENCE IN THE LARGER CITIES
(Population over 100,000)

Population (thousands)	Number of Places	Number of Respondents	Percent Respondents Indicating Problem	Estimated Nationwide Incidence (number of cities)	90 Percent Confidence Interval of Estimate		Population Affected by Conflict
					Low	High	
100-250	97	61	93%	90	87	93	13,292,131
250-500	29	17	92	27	25	29	9,629,088
500-1,000	20	14	90	18	17	19	11,690,115
Over 1,000	6	2	*	5	4	6	16,893,969
Total				140	133	147	51,505,303

*Only two respondents: assumed to be 90%

Source: SRI

Table 8

ESTIMATED RAILROAD CONFLICT OCCURRENCE FOR ALL U.S. CITIES

Population Range (thousands)	Number of Places*	Places with Conflict			Population
		Low†	Mean	High†	
5-10	1,839	542	645	748	4,525,630
10-25	1,385	420	500	580	7,736,730
25-50	520	183	248	313	8,495,984
50-100	240	70	118	166	8,219,404
100-250	97	87	90	93	13,292,131
250-500	29	25	27	29	9,629,088
500-1,000	20	17	18	19	11,690,115
1,000-4,000	6	4	5	6	16,893,969
Total	4,140	1,497	1,651	1,805	80,483,051

*U.S. Census of Population, 1970, Number of Inhabitants, Final Report PC (1) - A1 United States Summary, U.S. Bureau of the Census, (U.S. GPO, Washington, D.C., 1971).

†90 percent confidence intervals.

V ALTERNATIVE REMEDIAL ACTIONS

Relocation or consolidation of railroad tracks is a potential remedy for the conflict between the community and the railroad. Benefits from relocation include savings in highway user costs, potential elimination of barriers, improvement in land values, and potential savings for the railroads. The magnitude of the benefits is highly variable. The highway user cost savings are analyzed most thoroughly, since methods for quantification are well developed, and data from five states were available that allowed computation of benefits in individual cities. Estimation of other benefits from relocation was not attempted because of limited data available.

Railroad relocation projects are among the most expensive projects undertaken in communities. Using the extremely limited data from experience in railroad relocation and proposals for relocation projects, the estimated cost of an average project ranges from almost $5 million in cities of 5,000 to 10,000 population to over $50 million for cities of over one million population. Moreover, because of local variations, the cost of a relocation project is highly variable. Costs of planned projects in places over the whole range of population were observed to be between $1 and $90 million. These observed costs varied by as much as a factor of ten from the average for cities of the same population size.

Relocation of urban railroad yards and shops has the potential for making large parcels of land available that might be used in a more efficient manner, and would allow consolidation and improvement of railroad facilities.

System-wide consolidation, through combining parallel main-line tracks into high-volume corridors has the potential for gaining many of the benefits described for railroad relocation or local consolidation of facilities. However, the new high-volume corridors will have to be isolated by local relocation from the community activities in those places where the new corridors pass.

More limited measures--closing streets, improving grade crossing warning devices and surfaces, and grade separation--are applicable in specific situations.

Relocation or Consolidation of Railroad Lines

An obvious way of alleviating the conflict between the community and the railroad line is to separate them--moving the railroad tracks and activities to outlying areas where urban activity is low and the conflict will be minimized, or consolidating all railroad activity into a limited number of corridors. The urban activities in these corridors can be isolated from the railroad activities by compatible land use, and common use of corridors for utilities, highways, and railroads. Combining the railroad with an existing barrier will mean that the pattern of travel will not be disrupted and that existing crossings of the barrier can be made to include a crossing of the railroad. The example in Figure 3 shows that highway bridges that cross the river at the edge of town also cross over the railroad. Some larger cities, notably Memphis, have achieved such a corridor utilization. The railroads in Memphis all come together to cross the Mississippi River over two bridges. The common use of the bridges by several railroads created common corridors early in the city's development, and compatible land use growing up around the corridors minimized conflicts.

Railroad relocation or consolidation projects can take many forms. Sometimes, relocation of tracks by a few hundred feet can improve geometry of crossings or eliminate major grade crossings and thus be quite effective in reducing conflict. Consolidation or relocation of tracks passing in or near the central business district or major activity center into corridors that bypass these activity centers is another form. In extreme cases, the tracks may be relocated and consolidated in corridors that bypass virtually all of the activities in the community. Variations on these configurations of projects occur when the topography of development prevents economical relocation, in which case depression, or vertical relocation, is considered. It appears useful to organize thinking about projects along these lines, so, as mentioned earlier, a classification of the scope of relocation and consolidation projects was developed that codifies these characteristics:

- Scope I projects are those with localized impact, affecting only one or two grade crossings and a limited amount of the adjacent development.
- Scope II projects are those that affect a portion of a community, such as eliminating the barriers to a major activity center. Typically from three to ten or twenty grade crossings will be eliminated.

- Scope III projects are the comprehensive elimination of a major part of the railroad facilities in a community. Virtually all of the railroad-highway grade crossings will be eliminated in a community benefiting from a Scope III project.

Local Railroad Consolidation

One of the opportunities for alleviating many, but not all, of the conflicts in urban areas is the consolidation of railroads into common corridors, using the same trackage where possible. Examples in federal-aid programs are projects in Greenwood, South Carolina, in the 1970 Highway Safety Act; and Lincoln, Nebraska, in the 1973 Act, which included consolidation as part of the remedy. In Greenwood, the merger of the Atlantic Coast Line and the Seaboard Air Line railroads into the Seaboard Coastline Railroad left duplicate trackage through Greenwood. Construction of new track connections outside the city eliminated one of these lines through the center of the business district. In Lincoln, a significant part of the proposed solution includes new track connections to permit the Rock Island Railroad to operate over other existing lines, thereby eliminating the Rock Island's separate corridor through most of the city.

The joint usage of existing tracks and roadbed in these examples certainly reduces the cost of alleviating the railroad conflict with the community. It is not a universally applicable way of reducing costs, however. In Lafayette, both relocation and consolidation are needed to alleviate the conflicts. In that situation, both existing railroads require relocation. Moving the traffic of both railroads into a common corridor creates a very densely traveled railroad corridor, and the location of existing railroads there is not appropriate for such a heavily traveled line.

Outright abandonment can also help, although a line that is a candidate for abandonment is rarely a severe problem because of the light railroad traffic. In Springfield, Illinois, however, the project was simplified and the cost reduced by about seven percent when the B&O railroad (now part of the Chessie System) decided to abandon a branch line outbound from Springfield to a neighboring community. The B&O management was persuaded to extend the abandonment through the city, thus eliminating the need to relocate the B&O, as was included in the planning up to that time.

While joint track and facilities arrangements can be of substantial benefit to the parties involved, consolidation projects have traditionally resulted in a railroad owner-tenant relationship in which the tenant line, operating on a trackage-right basis, suffers some disadvantages:

- The continuity of its formerly owned line would be broken, and cancellation of the trackage rights lease in future years by the owning line might disrupt operations of the tenant line.
- The owning line's dispatcher is often the judge of when the tenant line's trains will be accepted in the joint corridor.
- Train delays may occur to both railroads because of traffic interference, with the tenant line suffering most.

Typically, both advantages and disadvantages will exist for at least one party to joint track and facilities arrangements. Every effort should be made, however, to realize the benefits that can be obtained from the elimination of excess railroad fixed plant.

The disadvantages cited above are of concern to the highest levels of management of the railroad, since they would affect its operation and profitability for many years to come. (Current practice is for the railroad to negotiate agreements for these arrangements, recognizing all advantages, disadvantages, and economic considerations.) Yet the benefits to be gained from such consolidations are great enough, when the total benefit to the community and all railroads is considered, to warrant consideration; however, incentives for this sort of action and these means to ensure an equitable settlement for the tenant line are needed. The potential for action of this sort should be considered at high levels of government and industry as a way of working out acceptable alternatives.

Relocation of Yards and Shops

Many industries that were once served by the railroad have migrated away from the downtown area; thus railroad yard and shop areas are left in parts of the urban setting where their presence conflicts with adjacent land uses. Many older yards are inefficient and their relocation would benefit both the railroad and the community. Benefits to the railroad include more efficient operation and the appreciation of the land occupied by the yard when developed for other purposes. The community

benefits by having a higher tax roll, if the increase in land value is not merely shifted from another location in the community.

The disadvantage of the relocation of a yard is that the project may be of marginal benefit to the railroad because of limited capital, and the community may be unable to undertake the project to gain the benefits on its own.

Our field investigation in Denver was concerned with railroad yard location. The Rice yard of the Colorado and Southern (C&S) is located adjacent to the Platte River, in the middle of an area that is being redeveloped for government, public, and private use. The C&S plans to abandon its Rice yard and develop some income-producing property, such as a high-density residential area on the site. The decision was made on the basis of the profit potential for C&S. The 7th Street yard of the Denver and Rio Grande Western Railroad (D&RGW) is adjacent to the C&S Rice yard. The D&RGW yard lies between newly redeveloped commercial and education areas adjacent to the CBD. Abandonment of the 7th Street yard and development of that area for a higher and compatible use would enhance the values on both sides of the yard; however, the D&RGW lacks sufficient capacity in other yards to handle operations after abandonment of the 7th Street yard, and only a limited amount of flatland suitable for rail yard development is available in the area. The D&RGW management reports that it considers the development of a new yard marginal, even in view of the property values that could accrue.

Yards are potential candidates for relocation when they are located close to the CBD but not close to large industrial developments that the railroad could serve. Analysis of maps of cities in Ohio and Oregon indicated that about 30 percent of yards in urban areas met these two criteria. Applying this 30 percent to a 1956 estimate* of 599 yards in all cities of the United States results in an estimate of 180 yards that might be moved with potential benefit. This estimate based on the 1956 data is borne out by survey results.

Urban planners and other agencies in cities with populations over 100,000 were surveyed on the potential for re-use of urban railroad yards. From the survey results, it is estimated that the yards in 93 of the 156 larger cities with yards (a total of 167 yards) could better be used for other purposes. About a third of the 93 cities have included alternative uses for the yards in their comprehensive plans. In descending order of

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*"Compilation of Railroad Yards and Other Resources in the United States," Stanford Research Institute, Menlo Park, California (1956).

the frequency noted by respondents, the alternative uses include recreational, residential, commercial, industrial, other transportation, public, and government. The average yard covered 132 acres. From data supplied by the planners, it is estimated that an aggregate of $1 billion might be added to the values of these parcels by developing them to some higher value use.

The survey estimates in the 156 large cities confirm the estimate of 180 relocatable yards in all U.S. cities. The nationwide cost of rebuilding all 180 yards at an estimated $25 million each* would be $4.5 billion. However, many of the yards could be combined, and the expected savings in railroad costs, together with appreciated land values, would produce benefits to the railroad and the community in excess of costs. Again, the principle of multiple benefits justifying large projects is demonstrated.

System-Wide Consolidation

The Trend Toward a Rationalized Rail Network

The accelerating trend toward rationalization of the nation's rail network is expected to have a significant impact on rail relocation planning. Increasingly, the federal government, as well as individual railroads, recognize the need to rationalize the rail network because of the high costs of maintaining and modernizing the network in its present form. As this trend progresses, communities will find that the railroads consider the relocation of rail facilities through consolidation of existing corridors and facilities more attractive. In general, such consolidations provide more project benefits per dollar of expenditure than does new construction. Thus, the accelerating trend toward rail network rationalization should increase the extent to which railroad relocation projects are actually accomplished.

As rationalization of the network occurs, traffic flows are expected to become significantly more concentrated on a limited, main-line network. This high-speed, high-capacity network might be considered as comparable to the Interstate Highway System. Because of the high rates of utilization of these lines, they must be separated from surrounding urban activities. Safety and operating efficiency considerations will require the elimination of railroad grade crossings for highway and pedestrian traffic. Ultimately, this network may be automated and partially electrified.

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*Project team estimate, based on recent experience in construction of medium-sized automatic classification yards.

Extent of Possible Network Rationalization

Overcapacity of the nation's rail network at both existing and projected traffic levels has been widely discussed in recent years, particularly in relation to the Northeast railroad problem. Although few quantitative estimates have been made, it is possible to provide some approximations of the extent to which the rail network may be rationalized.

At present, the rail network consists of about 205,000 route-miles. Of these, about 82,000 miles are signal controlled and thus can be considered the primary main-line rail network. A 1971 study by the Federal Railroad Administration* estimated that a truly rationalized rail network (without competing rail lines) would require only 25,000 to 30,000 miles of high-density main-line. Using this estimate, between 52,000 and 57,000 route-miles of main-line could be downgraded to feeder-line status. Despite such an increased concentration of traffic, the same study indicated the high-density main-line core would have a capacity-utilization ratio of less than 30 percent at 1980 traffic levels. Thus, even this fully rationalized core was expected to have substantial excess capacity available to accommodate future demand beyond 1980.

Adjusting these results to allow for those duplicate main lines required to maintain balanced rail competition between major market areas would probably increase the high-density main-line core to no more than 30,000 to 35,000 route-miles. Thus, a reduction of between 47,000 and 52,000 main-line-miles could still be expected.

The FRA study also estimated about 75,000 miles of the present 205,000-mile system would be abandoned if the rail network were truly rationalized. Other economists have estimated that between 50,000 and 100,000 miles of the network should be abandoned. Thus, this mid-range estimate appears reasonable.

The FRA study did not relate rationalization of the rail network to rationalization of rail yards and terminals. However, we expect the latter rail facilities to shrink in approximately the same proportions and areas.

It is generally believed that the Northeastern and Central regions of the rail network will experience the greatest rationalization. Table 9, which lists railroad mileage density by state, supports this thesis.

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*"The Economic Potential of Rationalizing the Railroad Network," Federal Railroad Administration, Office of Policy and Planning (December 1971).

Table 9

RAILROAD MILEAGE DENSITY BY STATE

State*	Miles of Railroad†	Square Miles of Land Area‡	Miles of Railroad per 100 Square Miles
Alabama	4,566	51,609	8.85
Alaska	503	586,412	0.09
Arizona	2,053	113,909	1.80
Arkansas	3,582	53,104	6.75
California	7,432	158,693	4.68
Colorado	3,576	104,247	3.43
Connecticut	664	5,009	13.26
Delaware	287	2,057	13.95
District of Columbia	31	67	46.27
Florida	4,274	58,560	7.30
Georgia	5,435	58,876	9.23
Idaho	2,668	83,557	3.19
Illinois	10,831	56,400	19.20
Indiana	6,416	36,291	17.68
Iowa	8,058	56,290	14.32
Kansas	7,779	82,264	9.46
Kentucky	3,513	40,395	8.70
Louisiana	3,752	48,523	7.73
Maine	1,678	33,215	5.05
Maryland	1,110	10,577	10.49
Massachusetts	1,441	8,257	17.45
Michigan	6,183	58,216	10.62
Minnesota	7,738	84,068	9.20
Mississippi	3,653	47,716	7.66
Missouri	6,351	69,686	9.11
Montana	5,030	147,138	3.42
Nebraska	5,498	77,227	7.12
Nevada	1,574	110,540	1.42
New Hampshire	817	9,304	8.78
New Jersey	1,764	7,836	22.51
New Mexico	2,120	121,666	1.74
New York	5,624	49,576	11.34
North Carolina	4,154	52,586	7.90
North Dakota	5,098	70,665	7.21
Ohio	7,845	41,222	19.03
Oklahoma	5,399	69,919	7.72
Oregon	3,070	96,981	3.17
Pennsylvania	8,371	45,333	18.47
Rhode Island	146	1,214	12.03
South Carolina	3,092	31,055	9.96
South Dakota	3,571	77,047	4.63
Tennessee	3,242	42,244	7.67
Texas	13,616	267,339	5.09
Utah	1,760	84,916	2.07
Vermont	769	9,609	8.00
Virginia	3,880	40,817	9.51
Washington	4,931	68,192	7.23
West Virginia	3,553	24,181	14.69
Wisconsin	5,955	56,154	10.60
Wyoming	1,812	97,914	1.85
Total United States*	206,265	3,608,673	5.72

*Excluding Hawaii

†Source: Railroad Fact Book, 1971, Association of American Railroads, Washington, D.C.

‡Source: U.S. Bureau of the Census, Statistical Abstract of the United States, 1972 (93rd edition), Washington, D.C., 1972

Institutional Forces and Rationalization

The railroad companies themselves have progressed toward a rationalized network through the process of corporate merger and consolidation. Since the late 1950s, the rail merger movement has accelerated. Large, important systems have been created over this 15-year period, including the Burlington Northern, Chessie, Illinois Central Gulf, Norfolk and Western, Seaboard Coast Line, and Penn Central. While physical consolidation of these new systems has been gradual because of limited available capital funds, the trend continues. Although 68 Class I railroads exist today, 15 of these constitute the principal systems.

Most knowledgeable economists expect the rail merger movement to continue until less than ten railroads (and perhaps only two or even one) remain. Governmental, labor, and institutional constraints inhibit both more rapid and more extensive rail consolidation. Although the Interstate Commerce Commission has generally permitted rail consolidations, two or more competing carriers usually remain at major traffic points. Thus, some intramodal competition will probably remain as long as the railroads are privately owned and operated.

Those railroads that are required to continue to compete will usually be reluctant to consolidate their line-haul and/or terminal operations because of their individual unwillingness to subordinate operational control and internal priorities to competitors. Thus, extensive coordination of operations to permit a rationalized network while retaining competing companies seems unlikely.

The reflection of agricultural and other shipper interests through Congressional action to decelerate the pace of rail line abandonments seemingly contradicts the primary thrust toward a rationalized rail network. The introduction of state and federal subsidies to permit continued operation of unprofitable branch lines in the Northeast through the Regional Rail Reorganization Act of 1973 best evidences this counter-trend.

However, as in rail relocation projects, the control over the public policy with regard to a specific unprofitable line subject to abandonment rests largely with the affected community. Reconciliation of the conflicting desires of those within a community favoring retention of a line and those favoring abandonment in lieu of an expensive relocation requires community action.

The Trend Toward Intermodal Operations

A companion trend toward greater use of intermodal operations will also favorably affect rail relocation planning, especially in urban areas. Since late 1950s, intermodal operations have received increasing emphasis by the railroads. Thus, more and more traffic is moved using truck pickup and delivery while railroads handle the line-haul movement. Of course, intermodal operations will not entirely displace conventional rail service because some commodities, such as coal, ore, steel, chemicals, will continue to move via conventional car-load or unit train rail service. However, the extent to which intermodal service replaces conventional car-load service will have a substantial impact on the railroads' local service network, including yard requirements. The potential availability of large blocks of land currently occupied by classification and industrial yards through this changing emphasis toward intermodal operations may render certain rail facility relocations unnecessary.

Some Conclusions

Nowhere have the trends and forces discussed above focused to the extent now occurring in the Northeast. Virtually all of the solutions being discussed for the Northeast crisis (and expected to contribute to an accelerated pace of rationalization of the rail network in that area) are applicable nationwide.

The potential for accelerating the pace of rationalization of the rail network should not be ignored in solving urban railroad relocation problems. Given the dollar magnitudes of major individual projects (in excess of $10 million), it is essential that limited resources are not wasted on projects where the rationalization process may substantially reduce rail-related conflicts in the foreseeable future.

In light of this trend, the use of lump-sum payments or loans should be considered for encouraging physical facility coordination between railroads, especially those that are not natural competitors. Given their inadequate supply of capital, railroads may find such payments necessary so as to accomplish physical consolidation, even if corporate consolidation has occurred.

No plan for a rationalized railroad network exists today. Thus, the application of these concepts to present specific rail relocation problems will require substantial interaction and negotiation between affected railroads, governmental agencies, and communities.

Other Remedies for the Urban Railroad Conflict

Short of moving railroad activities away from the community activities, there are ways of treating the problem of highway user cost by street closing, improved crossing warning devices and surfaces, or grade separation.

Although the improvement of crossing warning devices is clearly desirable, this approach considers only one part of the problem--accidents. The other parts of the conflict--motor vehicle delay, barrier effect, visual blight, land-use problems, and social disruption--are not treated.

Grade-Crossing Closing

Little-used urban grade crossings tend to be less well marked than those on major thoroughfares and the accident rate at these crossings tends to be higher. Elimination of the crossing and diversion of the traffic to nearby arterials with better crossing warning devices is a potential solution to some of the accident problems at grade crossings. The disadvantages of such action are that closing a crossing tends to increase the barrier effect of the railroad and the costs for motor vehicle users who currently use the crossing.

Closing specific low-volume crossings with an especially bad accident rate is probably justified. However, the alternatives of better protection and improved geometries should also be considered.

The increase in the barrier effect brought about by closing a crossing may be severe because the closed crossing discourages short trips by bicycle or by pedestrians, but the discouragement may be preferable to a dangerous unmarked crossing. On the other hand, closing a crossing may solve conflicting traffic movements, or discourage fast through traffic on residential streets.

In summary, the disadvantages of increasing the barrier effect and creating additional motor vehicle operating costs may be overcome by advantages gained in better traffic flow and control, or by elimination of crossings with a high accident rate. Individual analysis of each crossing is needed to determine the appropriateness of this solution.

Grade-Crossing Warning Device Improvement

Improving grade crossing warning devices can reduce accident rates by providing better warning to motorists of approaching trains. These improvements can be justified in economic terms in addition to the saving of lives and injuries. In a report to Congress,* Department of Transportation staff members devised a program for improvement of selected warning devices at 26,000 crossings at a cost of $665 million. The benefits from the program were estimated to be $1,739 million. Of the costs, $278.8 million would be spent for improvements and maintenance of protective devices in urban areas, and the resulting benefits of the urban part of the program alone were estimated at $1,196.9 million: the benefit/cost ratio would be over four.

Grade Separations

Grade-separation structures remove the delays and accidents at railroad-highway crossings by eliminating the crossing. Grade-separation solutions to conflicts with highway traffic are usually most appropriate at selected locations to reduce excessive traffic delay: for example, isolated crossings with high train volume or crossings blocked for a large fraction of the time by switching operations. However, grade-separation structures are costly, and may have adverse effects on the uses of the surrounding land.

Costs of grade separations depend on the width to be spanned, whether the roadway is to pass over or under the railroad, and the size of the highway at the separation. Estimates run from $750,000 to over $2,000,000 for a fairly conventional structure. Because of their high cost, only a limited number of grade-separation structures can be justified on safety or economic grounds.

It is interesting to note, however, that the respondents to our survey of planning officials in cities with populations over 100,000 most frequently identified grade separation as a potential cure for their cities' railroad conflict. The project team theorizes that this is largely due to greater experience with use of grade separations and the availability of funds for such projects.

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*"Railroad-Highway Safety, Part II: Recommendations for Resolving the Problem," U.S. Department of Transportation (August 1972).

Land-Use Controls

A few cities have their railroad facilities and the industries served so intermixed into the community that moving the railroads and the industries would be prohibitively costly. We consider that this may be especially true of large industrial cities. In these cases there are few alternatives except to move the other land uses that generate conflicts in traffic and/or disrupt the environment. This course of action requires considerable time and the transition period is quite painful, but in the end it may be the only solution. The following discussion of the railroad problem in Detroit illustrates the point.

Detroit, in common with other large manufacturing centers, has industrial plants, homes, and commercial buildings so intermixed that each suffers from the interference of the others. Homes suffer from proximity to factories and from industrial traffic flowing through residential streets. Industrial plants have been built in small areas difficult of access and impossible to enlarge. Homes have been built near factories and railroads on sites more suitable for industry. Concentration of much of the automobile industry and its attendant work force into a relatively small area of southeastern Michigan has forced a vast majority of the land into production and caused severe problems of physical arrangement.

The extensive and extremely dense rail and highway networks that serve the industrialized areas of urban Detroit are in severe conflict with one another. In the three years prior to September 1971, there were 250 grade crossing accidents within the city limits. Several crossings are subject to 60 or more train movements per day. Some crossings have a combination of 20 to 40 train movements and 20,000 to 30,000 vehicle crossings per day. The city of Detroit initiated a comprehensive plan in 1971 for the identification, ranking, and improvement of some 350 railroad-highway grade crossings. The pursuit of this approach is, in effect, indicative that the avenues for substantial change are severely limited by the existing pattern of interdependent thoroughfares, industries, railroads, and utilities.

This apparent inability to deal with serious auto-rail traffic problems on any other basis than crossing protection improvement, of course, has implications for resolution of land-use conflicts in the Detroit area. A "conventional" rail/industry relocation solution to the city's land-use problems is eliminated by the fact that many areas have such an interdependent structure of rail facilities and heavy industry that removal of either or both is not feasible within any reasonable planning period.

The city's land-use plan for the area south of West Fort Street (just north of the heavily industrialized River Rouge area) illustrates what may be termed a "reverse" approach to resolving serious land-use conflicts. The noise, traffic, and airborne effects of the industries and rail operations in this area so blight the balance of the district that it is not, and cannot be made, a suitable residential area although there are extensive residential pockets throughout. Where such conditions exist, the Detroit land-use plan encourages industrial development in the area whenever a portion of it is subject to change. Although this "relocate-the-city" approach to land-use planning may have some serious implications for the overall planning process in terms of implied priorities, it nevertheless represents a constructive attempt to deal with a particular serious land-use conflict that could not or would not be otherwise resolved. Several other areas of the city, particularly in the Highland Park and Hamtramck districts, are planned for substantial increases in residential use through release of current industrial land, much of it adjacent to rail lines. Without exception, however, all current rail corridors are planned for retention to serve the present and future industrial needs of the city.

An interesting aspect of the planning process in Detroit, which must, to a large extent, continue to consider rail corridors as givens for planning purposes, is that the severe divisiveness of many of the corridors is now being utilized to define definite neighborhood and school district boundaries. The neighborhoods and districts so formed are to be eventually provided with many of the facilities and services required for essentially self-contained, self-reliant communities. Long-term social implications aside, this approach should reduce the magnitude of rail/auto traffic conflict, including reductions in the impediment to delivery of emergency services, access to educational and recreational facilities, and the like.

VI ANALYSIS OF PROGRAMS FOR REMEDIAL ACTION

Eliminating the conflict between the community and the railroad may produce substantial benefits to highway users, the railroads, and the community at large, as discussed in the preceeding chapter. However, the cost of eliminating the conflict also tends to be large, and will not always be justified by the benefits. Estimates of the size of programs that would consider various criteria for justification of projects are presented in this chapter. The analysis considered relocation of yards and shops separately from relocation or consolidation of railroad lines, since the benefits from the projects tend to be distributed in different ways.

A Survey of Railroad Relocation Projects

Efforts to improve urban railroads and the surrounding community have been going on for many years, although in recent years the pace of project proposals has accelerated. To find out how many relocation projects have been undertaken and how many are contemplated, the Federal Highway Administration conducted a survey of highway departments, and, with the assistance of the Association of American Railroads, of railroad operating companies. The survey was initiated in the late summer of 1974. The survey requested information on projects undertaken since 1950 and those under way or planned. The cost of each project, the number of grade crossings affected, and the type of project--relocation, consolidation, elevation, depression, or railroad yards--were requested of the respondents. In addition, state highway agencies were asked to identify the sources and amounts of funding for projects.

Responses from 41 railroads and all 50 states were received. Over 1,000 reports or projects were tabulated from the responses. After eliminating duplicate reporting (for example, from several different participating railroads and the state), and decomposition of projects involving multiple jurisdictions into the individual jurisdictions, 412 reports remained. The 412 varied in completeness, in that some did not contain cost estimates or funding breakdown.

Costs of projects completed before 1974 and cost estimates made prior to 1974 were adjusted for construction cost inflation to the cost prevailing in October 1973, using the cost index of the Engineering News

Record. The results of the survey are summarized in Table 10. Further information about funding is presented in Chapter VII.

Table 10

SUMMARY RESULTS OF SURVEY OF COMPLETED AND PROPOSED RELOCATION PROJECTS

Type of Project	Completed Cost (Thousands of Dollars) Number	Average	Total	Proposed Cost (Thousands of Dollars) Number	Average	Total
Railroad relocation	69	$3,385	$ 233,565	32	$ 6,912	$ 221,184
Railroad Consolidation	27	927	25,029	35	2,804	98,140
Combination relocation and consolidation	32	5,554	177,728	45	12,659	569,655
Railroad elevation	22	9,716	213,752	15	9,887	148,305
Railroad depression	20	5,117	102,340	7	10,081	70,567
Relocate yards and terminals	50	5,637	281,850	21	17,069	358,449
Unspecified	7	4,518	31,626	30	10,196*	305,867
Totals	227		$1,065,890	185		$1,772,167

*Unspecified (the average cost for all planned projects was used).

Relocation and Consolidation of Railroad Yards and Shops

The largest single benefit of relocation or consolidation of railroad yards and shops is the increase in value of the land so vacated. Table B-9 in Appendix B shows an estimated $1 billion in benefits would be derived from increased land values if the land were developed for other purposes. Other benefits from improved railroad efficiency would doubtless be produced, but it is difficult to estimate these benefits without

an extensive system analysis. It seems reasonable to assume, however, that the railroad reductions in operating cost and real estate taxes would be greater than increases in costs related to longer runs by switch engines delivering cars, or longer runs by trains in reaching the relocated yard. Therefore, a $1 billion expenditure for yard relocation and consolidation would be justified. Using the earlier estimate of $25 million for yards indicates about 40 yards could be relocated for a program of this size. However, not all yards need to be replaced one-for-one. A ratio of two yards removed for each new yard built is probably a maximum, which would put the upper limit of projects at 80.

Therefore, a program to relocate railroad yards and shops in urban areas is estimated to affect from 40 to 80 yards, cost an aggregate of about $1 billion, and produce benefits of about $1 billion.

Relocation of Railroad Lines

In contrast to the benefits from higher value land use that are achieved from railroad yard relocation, the relocation or consolidation of railroad lines may achieve a variety of benefits, related to such goals as improvement of highway safety, improvement of highway mobility, improvement of railroad efficiency, and improvement of the quality of community living. The programs to be analyzed below relate incrementally to these goals as follows:

- Projects justified by safety benefits alone.
- Projects justified by safety benefits, reduction of highway user costs, and reduction of time delays.
- Projects justified by safety benefits, reduction of highway user costs, reduction of time delays, and reduction of railroad operating and capital costs.
- Projects justified by all of these benefits and benefits accruing to the community.

Analytical Approach

The individuality of urban railroad problems has been discussed repeatedly in this report. This individuality leads to wide variations in the costs and benefits associated with a specific type of problem, even for cities of similar populations and configurations. Only a detailed planning study of relocation or consolidation alternatives will resolve

the uncertainty about costs and benefits for each community. The cost of planning simply to obtain such estimates is not yet justified, thus a statistical approach has been devised that utilizes the limited studies that have been done and other available data. This approach has been used to estimate costs and benefits of programs that require projects to be justified by safety, highway user benefits, highway and railroad benefits, and by all benefits. Appendix A describes the analytical procedure. The discussion below shows how the cost and benefit factors for use in the analysis are estimated, then presents the results of the analysis.

The analytical procedure requires an estimate of the mean project cost and its variance as a function of population, and, similarly, an estimate of the mean and variance of the project benefit. The estimates of project benefits compared to population for safety, all highway user benefits, added railroad benefits, and all benefits are shown graphically in Figure 4 for areas outside the Northeastern region.

Project Cost

Project cost statistics were estimated from analysis of the survey of state highway departments and railroad companies conducted by FHWA and summarized in Table 10. Projects reported in the survey were assigned Scope I, II, and III ratings, based on the number of grade crossings that were reported as being affected by the project, the population of the community, and the cost of the project; and other information presented, such as a description of the project that include its geographical scope.

The objective of the analysis was to analyze Scope II and Scope III projects for the northeastern United States and for the remainder of the nation, and further separate the analysis by urbanized and nonurbanized areas.* Lack of data constrained such a highly fragmented analysis. All Scope III projects were analyzed as a unit, and a small adjustment to the level of costs in nonurbanized areas outside the Northeast was made on the basis of the data. Data on Scope III projects was concentrated in the population strata between 25,000 and 100,000 and such projects were not recorded in places over 500,000 population.

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*
- Scope I projects affect only one or two crossings.
- Scope II projects affect a section of a city, such as bypassing the central business district.
- Scope III projects bypass all conflicting activities of the city.

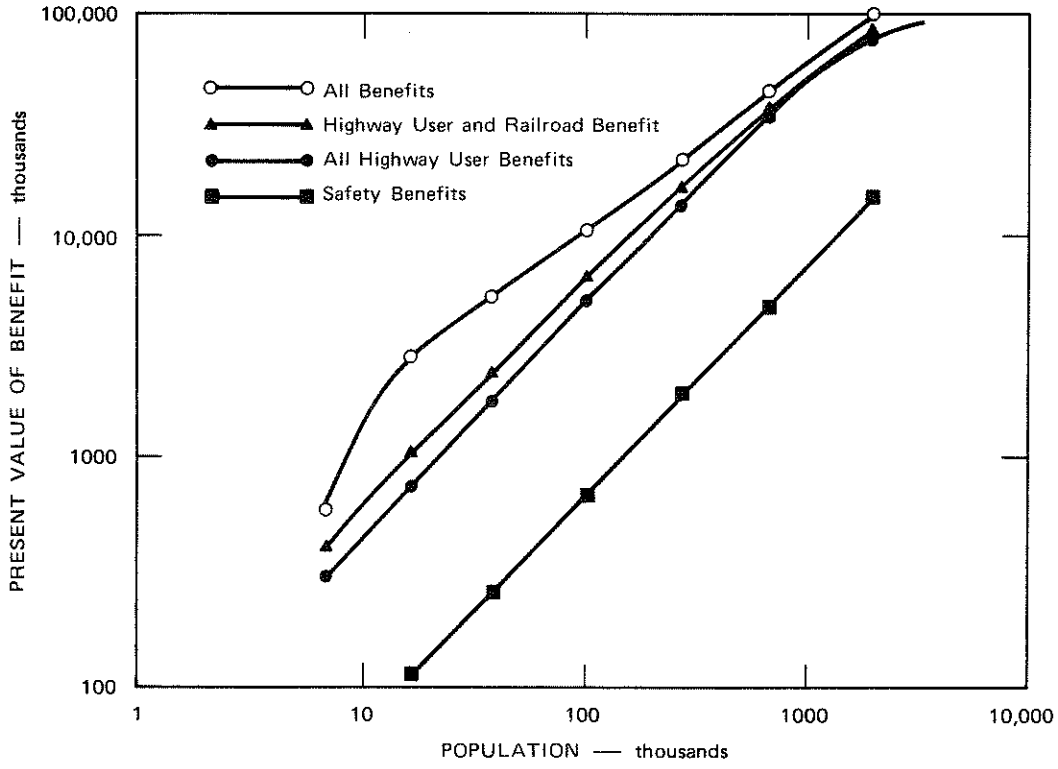


FIGURE 4 BENEFITS COMPARED TO POPULATION FOR URBAN AREAS OUTSIDE NORTHEASTERN UNITED STATES

Similarly, cost estimates for all Scope II projects in nonurbanized areas, regardless of region, were combined because of lack of data points.

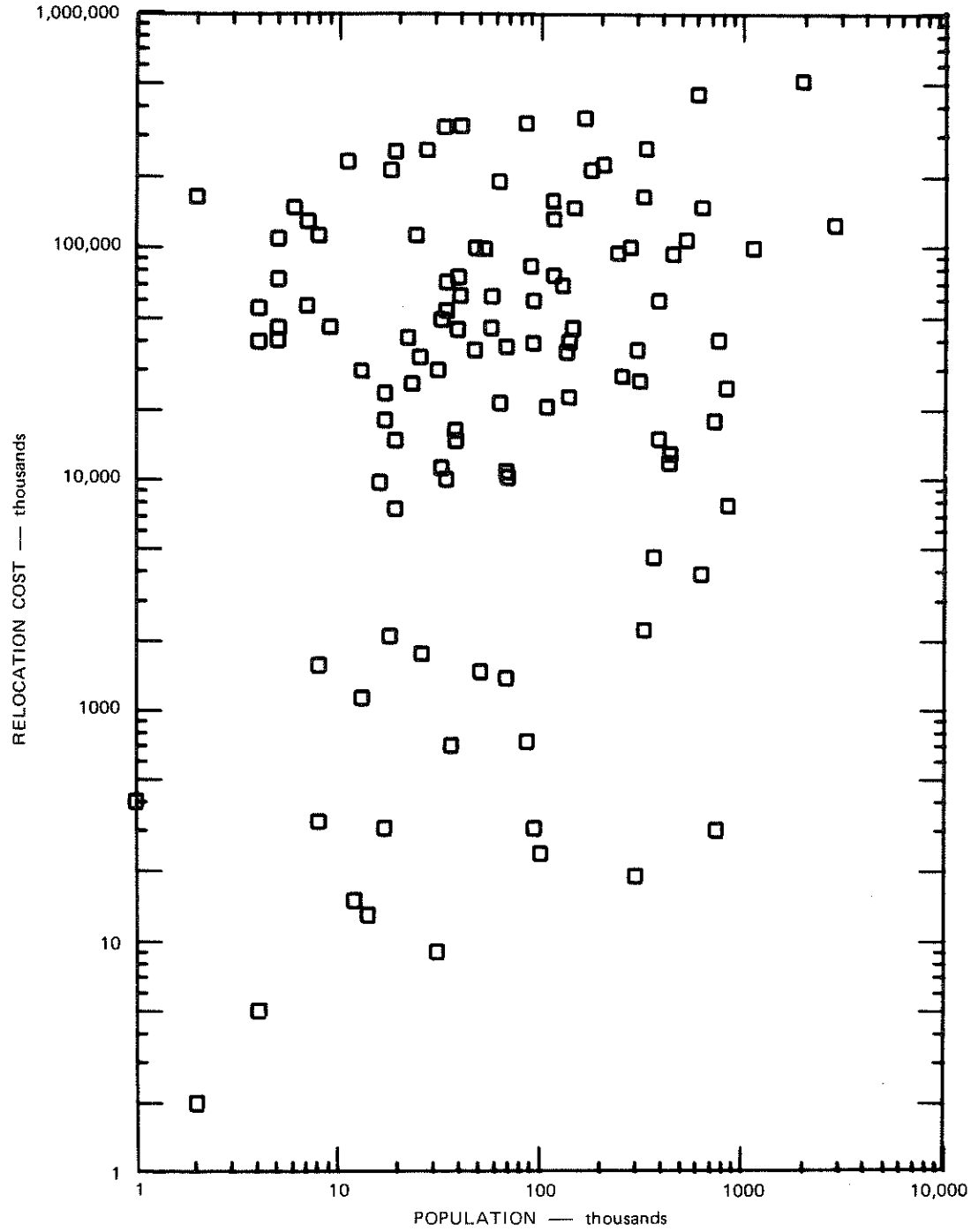
A regression analysis was conducted to determine the relationship between project cost and population for Scope II and Scope III projects. Table 11 shows the number of projects analyzed, by geographical region, and the regression results for the analysis.

Figures 5 and 6 illustrate the range of the cost data plotted against population for all urban railroad line projects.

Table 11

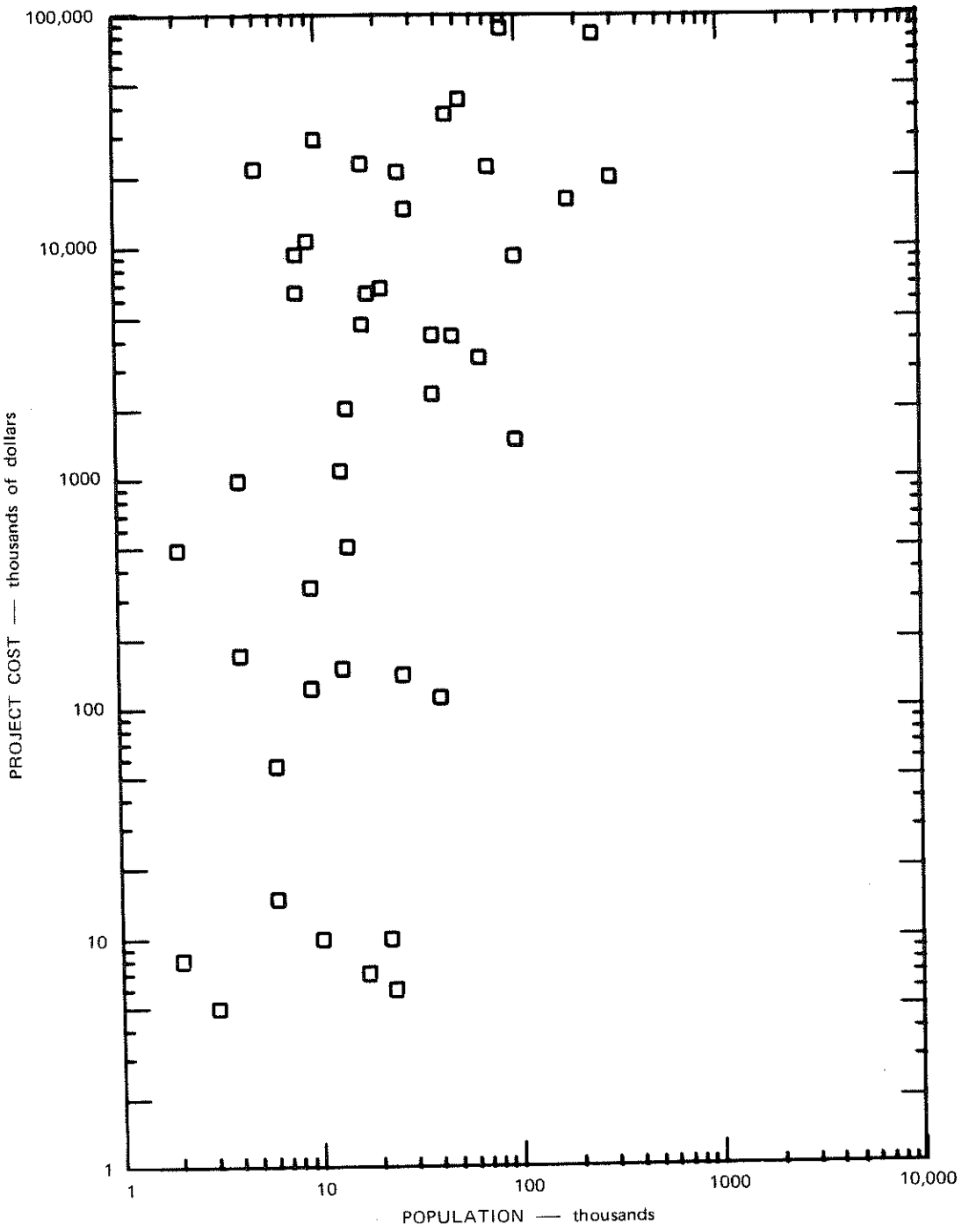
PROJECT COST ANALYSIS

	Scope II	Scope III
Northeastern Region		
Urbanized areas		
Number of projects	42	15
Regression	14.6 + 0.08 Ln (pop)	5.7 + 1. Ln (pop)
Variance	2.4	2.6
Nonurbanized areas		
Number of projects	8	3
Regression	6.1 + 0.87 Ln (pop)	5.7 + 1. Ln (pop)
Variance	2.56	2.6
Remainder of United States		
Urbanized areas		
Number of projects	34	13
Regression	12.8 + 0.19 Ln (pop)	5.7 + 1 Ln (pop)
Variance	2.5	2.3
Nonurbanized areas		
Number of projects	14	9
Regression	6.1 + 0.87 Ln (pop)	5.3 + 1.0 Ln (pop)
Variance	2.56	2.6



SOURCE: FHWA Survey.

FIGURE 5 SCOPE II PROJECT COSTS IN URBAN AREAS



SOURCE: FHWA Survey.

FIGURE 6 SCOPE III PROJECT COSTS IN URBAN AREAS

Project Benefits

Project benefits are estimated for urbanized and nonurbanized areas in the Northeastern region and the remainder of the nation for Scope II and Scope III projects in conformity with estimates of costs just described. In cases noted in the following discussion, some of the segments will be combined to enable meaningful analysis from the limited data.

Safety Benefits--Safety benefits accrue from the elimination of grade crossings or the reduction of railroad traffic at the grade crossing. The amount of the benefit is dependent on the marking or warning devices installed at the crossing. For urban railroad-highway grade crossings, the following equations were used to forecast annual accident occurrence.

For crossings with crossbuck signs and other passive marking:

$$\text{Annual accidents} = \log^{-1}\left\{-3.83\left[\log(\text{ADT})\right]^2 - 0.15 \log (\text{ADT}) + 0.53 \log(\text{TPD})\right\}$$

Where: ADT is the average daily highway traffic at the crossing and TPD is the average number of trains per day at the crossing.

For crossings with flashing lights, wig-wags, or other active devices, but not barriers or gates:

$$\text{Annual accidents} = 1.15\log^{-1}\left\{-2.54 + 0.31\left[\log(\text{ADT})\right]^2 - 0.16\left[\log(\text{TPD})\right]^2 + 0.78\log(\text{TPD})\right\}$$

For crossings with barriers or automatic gates:

$$\text{Annual accidents} = 1.15\log^{-1}\left\{-2.61 + 0.24\left[\log(\text{ADT})\right]^2 - 0.22\left[\log(\text{TPD})\right]^2 + 0.97\log(\text{TPD})\right\}$$

These accident prediction equations are obtained from unpublished results of work being done by the FHWA Office of Research.

Average accident costs are estimated at $25,000 each, as reported in the "Report to Congress on Railroad-Highway Grade Crossing Safety, Part II". Annual accident costs are converted to present value by assumption of one percent growth in accident cost per year due to traffic growth, a one-year delay in receiving benefits after expenditure of construction funds, a 25-year study period, and a ten-percent discount rate. The resulting factor is 9.18 to convert annual benefit to present value.

Safety benefits for Scope II projects are estimated from a sample of 21 projects that were analyzed in detail by the project team. Cost estimates for nine of the projects were prepared by the project team; the cost estimates for the remainder were estimated in relocation project proposals made available to the team. ADT and TPD were obtained from the local city engineers or transportation planning agencies and from the railroads operating in the communities. A regression analysis of these 21 projects with population produced a relationship:

$$\ln(\text{project cost}) = 5.44 + 0.63 \ln(\text{population})$$

The variance is 0.54

Since a Scope III project will eliminate virtually all of the grade crossings in a community, safety benefits for Scope III projects are estimated by analyzing a complete inventory of grade crossings in a sample of cities, and assuming that the safety benefits would be equal to the predicted annual accident costs. Inventories of crossings are available for all urban crossings in nine states:

- Northeastern Region: New York, Ohio, Maryland
- Southeastern Region: Florida, North Carolina
- Central Region: Texas, Minnesota
- Western Region: California, Oregon.

The inventories include ADT, TPD, location, and warning or marking for the crossings. Accident rates and accident costs were computed for each crossing, and the total accident cost in each jurisdiction was determined. The present value of the accident cost was analyzed by determining the mean logarithm of the benefit for each population stratum. Small adjustments in group means were made to provide a smooth curve of benefit plotted against population. Larger variations in variance between groups were adjusted to make smooth curve.

Results of the analysis are shown in Table 12.

Highway User Benefits--Relocation or consolidation of railroad lines may produce savings to highway users by eliminating railroad-highway grade crossings and their attendant delays and the costs of slowing, stopping, and accelerating at the crossing. Estimates of time delay cost and operating cost are made for crossings from the equations:

Table 12

ANALYSIS OF SAFETY BENEFITS FOR SCOPE III PROJECTS

Region and Population Stratum	Mean Log Benefit	Variance of Benefit	Number of Places in Sample
Northeast			
Urbanized areas			
5,000-10,000	11.42	1.12	45
10,000-25,000	11.86	1.10	58
25,000-50,000	12.38	1.07	20
50,000-200,000	13.04	1.03	19
200,000-400,000	13.73	0.94	6
400,000-1,000,000	14.82	0.78	4
Over 1,000,000	15.09	0.59	1
Outside urbanized areas			
5,000-10,000	11.30	1.18	70
10,000-25,000	12.14	0.98	60
25,000-50,000	12.47	0.80	22
Outside Northeast			
Urbanized areas			
5,000-10,000	11.13	0.84	37
10,000-25,000	11.68	0.82	93
25,000-50,000	12.38	0.78	70
50,000-200,000	13.42	0.71	90
200,000-400,000	14.50	0.59	16
400,000-1,000,000	15.36	0.45	7
Over 1,000,000	16.54	0.27	2
Outside urbanized areas			
5,000-10,000	11.68	1.05	173
10,000-25,000	12.18	0.98	145
25,000-50,000	12.76	0.79	35

$\beta = 0.002639$ (TPD)

Operating cost per year = 365(ADT) (0.00479 + 0.0147β)

Time delay cost per year = 365 (ADT) (0.00233 + 0.08217β)

The derivation of the equations is presented in an appendix to Volume 3. Implicit in the equations are assumptions about value of time, approach speed, and other factors. Table 13 presents the nominal values used in the computations.

Table 13

VALUES USED IN HIGHWAY USER BENEFIT ANALYSIS

Train speed: 35 mph

Cars per train: 70

Highway vehicle speed: 35 mph

Crossing roughness index: 1

Vehicle mix

Automobiles 92.7% (includes motorcycles and panel and pickup trucks)	
Single unit trucks:	4.7%
Combination trucks:	2.7%

Values of time

Automobile occupants	$1.80/hr each
Truck occupants	$5.00/hr each

Estimates of highway user benefit for Scope II projects were prepared by analyzing the 21 projects referred to in the discussion on safety. Time delay and operating cost savings were computed with data received from the railroads and from highway planning agencies or local officials. For each community, the time delay and operating cost savings were added to the safety benefits to obtain the total highway user benefit in that place. A regression analysis of the sum of these two benefits against population was performed. The results of the analysis:

ln(Total highway user benefit) = 8.18 + 0.51 ln(population)

The variance is 0.76

Segmentation of the estimate by geographical region or urban character was not possible because of the limited number of points.

The estimates of total highway benefits for Scope III projects utilized the inventory of urban grade crossings described in the discussion of safety benefit estimating (Table 14). Time delay and accident cost savings from elimination of all grade crossings in each jurisdiction were computed from the equations above. Again, the benefit for safety was added to that for savings in operating cost and elimination of time delays. Figure 7 shows the potential highway user benefits for Scope III projects plotted against population for each community in the sample. The mean logarithm for each population stratum in urbanized and nonurbanized places over 5,000 population inside and outside the Northeastern United States was computed, and the variances of the group were computed. Both the means and variances were smoothed by plotting and adjusting the values.

Addition of Railroad Benefits--Railroad benefits were computed for each of the 26 cities for which engineering designs and cost estimates were available. The analysis included computation of changes in operating cost due to changes in route length, rise and fall, reduction or elimination of speed restrictions, and elimination of grade crossings and their attendant maintenance. Annual savings or costs were converted to present values through use of a ten-percent discount factor, applied under the assumption that benefits would flow for a 25-year period and that the benefits would start one year after the construction outlay.

Scope II project benefits were estimated by adding the railroad benefit computed for each location to the total of highway user benefits, and performing a regression on the sum against population. The result:

ln(highway user and railroad benefits) = 9.2589 + 0.4464 ln(population)
The variance is 0.94

Again, the estimate was not segmented by urbanized area or geographical region because the small number of data points would not support this level of detail.

Railroad and highway user benefits from Scope III projects were estimated by adding an estimate of railroad user benefits derived from the sample of 26 projects to the estimate of highway user benefits for each population strata. Benefits from all 26 projects were considered in making the estimate, although only five of the projects were Scope III, and the remaining projects were Scope II. The mean railroad benefit

Table 14

ANALYSIS OF ALL HIGHWAY USER BENEFITS FOR SCOPE III PROJECTS

Region and Population Stratum	Mean Log Benefit	Variance of Benefit	Number of Places in Sample
Northeast			
Urbanized areas			
5,000-10,000	13.40	1.56	45
10,000-25,000	13.58	1.28	58
25,000-50,000	14.34	0.96	20
50,000-200,000	15.36	0.61	19
200,000-400,000	16.13	0.20	6
400,000-1,000,000	16.32	0.20	4
Over 1,000,000	16.64	0.20	1
Outside urbanized areas			
5,000-10,000	12.73	1.44	70
10,000-25,000	13.74	1.04	60
25,000-50,000	14.18	1.00	22
Outside Northeast			
Urbanized areas			
5,000-10,000	12.56	1.30	37
10,000-25,000	13.59	1.07	93
25,000-50,000	14.43	0.80	70
50,000-200,000	15.48	0.51	90
200,000-400,000	16.55	0.16	16
400,000-1,000,000	17.40	0.16	7
Over 1,000,000	18.20	0.16	2
Outside urbanized areas			
5,000-10,000	13.06	0.76	173
10,000-25,000	13.68	0.70	145
25,000-50,000	14.54	0.53	35

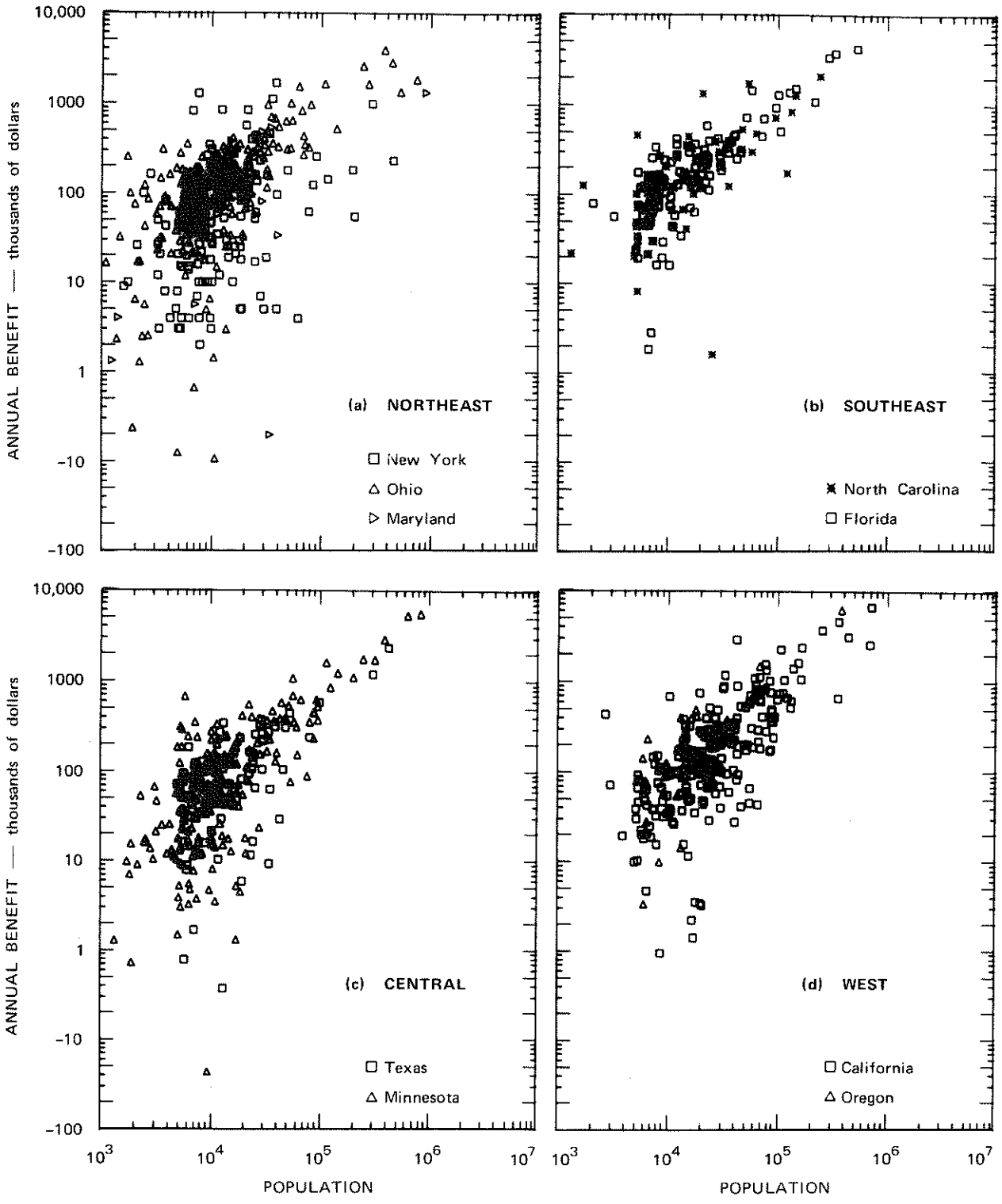


FIGURE 7 POTENTIAL SCOPE III HIGHWAY USER BENEFITS COMPARED TO POPULATION

for each population stratum was computed for these 26 points, and a smooth curve was drawn among the points. Values from the curve were converted to numbers from logarithms, and added to the values of highway user benefit converted from logarithms, and the estimates were converted back to logarithms. The variance estimate did not change significantly with the addition of the railroad benefits, because the variance of the logarithmic distribution represents a multiplying factor. Because the benefit is larger, keeping the variance factor constant means that a larger product results.

Addition of Community Benefits--Community benefit estimates were made for three of the sample communities in project proposals. Community benefits for two other sample communities were estimated as part of detailed studies by the project team. In the remaining 21 places, project community benefits were evaluated by estimating the amount of residential land that would be freed from railroad influence and estimating that a value of about $4,000 per acre would be added to the land and improvements by removing the railroad. If a railroad line were removed from a commercial district, approximately $100,000 was added to values because of increased accessibility, depending on the size of the community and the apparent degree that the railroad restricted access to the area.

In Scope II projects, the community benefits so estimated were added to the total of other benefits from highway users and the railroad and a regression with population was run. The result:

$$\ln(\text{all benefits}) = 10.27 + 0.38 \ln(\text{population})$$

The variance is 0.95

Again, the estimate was not broken down by urbanized areas or geographic region.

Total benefits for Scope III projects were estimated by a procedure identical to that used for adding railroad benefits.

Number of Places with Railroads

The analytical procedure estimates the probability that a project in a location will be acceptable under the benefit criteria being considered. This probability is applied to the number of places in the population stratum to estimate the number of projects, program costs, and program benefits. An estimate was prepared for the number of places in each population strata for the Northeast, outside the Northeast, and inside and outside urbanized areas. The estimate was prepared by noting,

relative to the total number of places, the fraction of places in each population stratum in each state for which the grade crossing inventories were analyzed that had grade crossings. The results of the analysis are presented by Table 15. It should be noted that the inventory for New York contained many place names that were not listed by the 1970 Census. These names tend to add to the uncertainty of the estimates of numbers of places.

Table 15

NUMBERS OF PLACES WITH RAILROADS

Population (thousands)	Northeast		Outside Northeast	
	Inside Urbanized Areas	Outside Urbanized Areas	Inside Urbanized Areas	Outside Urbanized Areas
5-10	0	336	132	642
10-25	101	199	132	412
25-50	67	55	92	138
50-200	88	--	175	--
200-400	7	--	24	--
400-1,000	9	--	17	--
1,000 and up	3	--	2	--

This procedure was used to estimate the total number of places in each size group for the Northeast and the remainder of the nation. The distribution of places between those inside urbanized areas and those outside was accomplished with the aid of a survey of state highway agencies to determine how many places in various size groups contained railroads. The organization of the state replies varied from that needed for this analysis because the state definition of urban area for planning purposes is different from the urbanized areas as defined by the Census in that the state urban areas frequently contain places that are not listed by the Census. However, the estimate of places in urban areas with populations less than 50,000 are the same. Therefore, for places with populations less than 50,000, the number of places with at least one railroad, as estimated by the states, is deducted from the number of places estimated to have railroads in the region. The state estimate is then the estimated number of places outside urbanized areas that contain

railroads; the difference is the number of places inside urbanized areas that contain railroads.

Correlation between Benefits and Costs

Another input to the analysis procedure described in Appendix A is the correlation coefficient between costs and benefits. Briefly, the correlation coefficient is the fraction of the variance in benefits for places of a given population size that is explained by the project cost. In general, higher benefits tend to be associated with higher cost projects, hence the correlation coefficient is positive and greater than zero. From the 21 Scope II projects that were analyzed, the correlation coefficient of 0.43 was computed, and a value of 0.5 was used in the analysis. The project team felt that the correlation between benefits and costs would be greater for Scope III projects, especially since the set of 26 projects contained one (Pikeville, Kentucky) that had a project cost of $22 million for a town with a population of slightly under 5,000, and produced community benefits of $6 million by elimination of flood hazard and by reclaiming land because a river relocation was associated with the highway and railroad relocation. A value of 0.75 was therefore assumed for the correlation coefficient.

Program Results

Using the input estimates developed in the previous pages and the analytical procedure described in Appendix A, the numbers of nationwide programs justified by safety, all highway user benefits, added railroad benefits, and all benefits were estimated. The results are summarized in Tables 16, 17, and 18 for Scope II projects, and in Tables 19, 20, and 21 for Scope III projects.

Uncertainty in Program Size Estimates--As can be seen from Figures 5 and 6, the illustrations of cost and benefit plotted against population, there is considerable scatter in the data points. The ability to measure the mean and the variance of the data is governed by the amount of variability (the size of the variance and the number of points in the data sample); thus, the range of variation about the estimates of mean and variances is larger if the variability is larger, and the range of variation about the estimates of mean and variance is larger if the number of points becomes smaller. Considering the variability of the estimates of the quantities that were used in the analysis, it will be well to apply the analysis to other values of the estimates that could possibly occur if more were known about the world than the sample represents.

Table 16

ESTIMATES OF SCOPE II PROGRAM SIZES--NATIONAL TOTALS

Region and Benefits in Justification	Acceptable Projects	Program Cost (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas (total, 849)			
Safety	19	6	10
All highway user benefits	138	132	263
Added railroad benefits	237	351	788
Added community benefits	262	393	897
Places outside urbanized areas (total, 1,782)			
Safety	34	2	3
All highway user benefits	350	115	216
Added railroad benefits	620	375	823
Added community benefits	734	523	1219

Table 17

ESTIMATES OF SCOPE II PROGRAM SIZES--NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Total Places (with railroad)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas					
Safety	Under 50	168	0	0	0
	50-400	95	1	0	1
	Over 400	12	1	1	1
	Total	275	2	1	2
All highway user benefits	Under 50	168	9	6	9
	50-400	95	13	16	28
	Over 400	12	4	12	25
	Total	275	26	33	62
Added railroad benefits	Under 50	168	21	25	45
	50-400	95	24	48	97
	Over 400	12	5	24	58
	Total	275	50	97	200
Added community benefits	Under 50	168	26	35	65
	50-400	95	24	52	105
	Over 400	12	5	20	47
	Total	275	55	107	217
Places outside urbanized areas					
Safety	Under 50	590	11	1	1
All highway user benefits	Under 50	590	117	38	71
Added railroad benefits	Under 50	590	207	123	271
Added community benefits	Under 50	590	245	172	403

Table 18

ESTIMATES OF SCOPE II PROGRAM SIZES--OUTSIDE NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Total Places (with railroad)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas					
Safety	Under 50	356	4	0	1
	50-400	199	10	3	4
	Over 400	19	3	2	3
	Total	574	17	5	8
All highway user benefits	Under 50	356	50	22	41
	50-400	199	54	57	116
	Over 400	19	8	19	44
	Total	574	112	99	201
Added railroad benefits	Under 50	356	95	77	160
	50-400	199	82	141	330
	Over 400	19	11	36	98
	Total	574	187	254	588
Added community benefits	Under 50	356	113	105	227
	50-400	199	85	149	352
	Over 400	19	10	32	83
	Total	574	207	286	662
Places outside urbanized areas					
Safety	Under 50	1192	23	1	2
All highway user benefits	Under 50	1192	233	77	145
Added railroad benefits	Under 50	1192	413	252	552
Added community benefits	Under 50	1192	489	351	816

Table 19

ESTIMATES OF SCOPE III PROGRAM SIZES--NATIONAL TOTALS

Region and Benefits in Justification	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas (total, 849)			
Safety	0	0	0
All highway user benefits	41	105	158
Added railroad benefits	75	165	246
Added community benefits	186	677	1105
Places outside urbanized areas (total, 1782)			
Safety	13	8	12
All highway user benefits	220	113	176
Added railroad benefits	335	223	381
Added community benefits	669	1069	2033

Table 20

ESTIMATES OF SCOPE III PROGRAM SIZES--NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Total Places (with railroad)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas					
Safety	Under 50	168	0	0	0
	50-400	95	0	0	0
	Over 400	12	0	0	0
	Total	275	0	0	0
All highway user benefits	Under 50	168	7	8	11
	50-400	95	4	10	15
	Over 400	12	0	0	0
	Total	275	11	18	26
Added railroad benefits	Under 50	168	12	17	25
	50-400	95	5	14	20
	Over 400	12	0	0	0
	Total	275	17	31	45
Added community benefits	Under 50	168	43	112	188
	50-400	95	10	39	59
	Over 400	12	0	0	0
	Total	275	53	151	247
Places outside urbanized areas					
Safety	Under 50	590	0	0	0
All highway user benefits	Under 50	590	27	30	44
Added railroad benefits	Under 50	590	48	59	90
Added community benefits	Under 50	590	125	288	501

Table 21

ESTIMATES OF SCOPE III PROGRAM SIZES--OUTSIDE NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Total Places (with railroad)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas					
Safety	Under 50	356	0	0	0
	50-400	199	0	0	0
	Over 400	19	0	0	0
	Total	574	0	0	0
All highway user benefits	Under 50	356	14	11	16
	50-400	199	14	46	68
	Over 400	19	2	30	46
	Total	574	30	87	130
Added railroad benefits	Under 50	356	28	29	42
	50-400	199	18	70	105
	Over 400	19	2	35	54
	Total	574	48	134	201
Added community benefits	Under 50	356	91	218	371
	50-400	199	40	255	404
	Over 400	19	2	53	83
	Total	574	133	526	858
Places outside urbanized areas					
Safety	Under 50	1192	13	8	12
All highway user benefits	Under 50	1192	193	83	132
Added railroad benefits	Under 50	1192	287	175	291
Added community benefits	Under 50	1192	544	781	1532

There is an assumption in the analysis that the sample of project cost data represents a universe of projects, some producing benefits that will justify the costs, others not producing sufficient benefits. In fact, some selection may have been at work, particularly in the completed projects, assuming that they were evaluated by some criteria, although not necessarily those being analyzed here. The proposed projects, similarly, may also have undergone some screening, although perhaps not as rigorous as was applied to the projects actually undertaken. This effect can be seen by analyzing average costs of Types 1 through 5 projects that are completed and those that are planned from Table 10. Completed type 1 through 5 projects averaged $4.4 million, while those planned averaged $8.3 million per project. Both averages are adjusted to the same price level. Thus it appears that the planned projects are almost twice as costly as those completed. Part of this difference can be explained by lack of financing, which favors undertaking of low cost projects but discourages the costly ones. Further, there may be other projects that were not even proposed because the costs looked high relative to the benefits. These projects should have been included in our sample, even though they do not exist. To determine the effect of having more costly projects in the sample, average costs were increased by 50 percent, and the analysis was rerun with the alternative variance estimate of 1.0 from the discussion above. The results of this alternative analysis are presented in Tables 22 through 27.

The results show that the average project cost is increased substantially for both Scope II and Scope III projects, and that the number of projects is decreased. In some cases for Scope II programs, the higher average cost resulted in higher program costs for this alternate computation, even though the number of projects was severely reduced. Because of the more stringent conditions, benefit/cost ratios are higher for this alternate program.

This alternate program is presented to show the potential range of estimates of program size that can result from alternative assumptions and estimates that are derived from the sample data.

Analysis of the Results--The number of projects is higher in places outside urbanized areas because there are more of these smaller places than there are places inside urbanized areas, and also because there is some tendency for these places to receive higher highway user benefits from projects. These higher highway user benefits result from higher total traffic for a place of given size, resulting from through highways that add intercity traffic to the local use; and from less prior work on relocation, grade separation, or other remedial actions. In general,

Table 22

ALTERNATE ESTIMATES OF SCOPE II PROGRAM SIZES--NATIONAL TOTALS

Region and Benefits in Justification	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places Inside Urbanized Areas			
Safety	0	0	0
All highway user benefits	36	94	149
Added railroad benefits	106	364	632
Added community benefits	125	413	720
Places Outside Urbanized Areas			
Safety	0	0	0
All highway user benefits	86	63	93
Added railroad benefits	306	384	646
Added community benefits	428	597	1064

Table 23

ALTERNATE ESTIMATES OF SCOPE II PROGRAM SIZES--NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas				
Safety	Under 50	0	0	0
	50-400	0	0	0
	Over 400	0	0	0
	Total	0	0	0
All highway user benefits	Under 50	0	0	0
	50-400	2	7	10
	Over 400	2	11	18
	Total	4	18	28
Added railroad benefits	Under 50	4	13	20
	50-400	8	40	63
	Over 400	3	29	54
	Total	15	82	137
Added community benefits	Under 50	6	22	32
	50-400	9	45	71
	Over 400	3	23	42
	Total	18	90	145
Places outside urbanized areas				
Safety	Under 50	0	0	0
All highway user benefits	Under 50	29	21	31
Added railroad benefits	Under 50	103	127	214
Added community benefits	Under 50	144	198	354

Table 24

ALTERNATE ESTIMATES OF SCOPE II PROGRAM SIZES--OUTSIDE NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas				
Safety	Under 50	0	0	0
	50-400	0	0	0
	Over 400	0	0	0
	Total	0	0	0
All highway user benefits	Under 50	8	10	15
	50-400	19	45	69
	Over 400	5	21	37
	Total	32	76	121
Added railroad benefits	Under 50	36	70	112
	50-400	47	164	293
	Over 400	8	48	99
	Total	91	282	504
Added community benefits	Under 50	50	106	176
	50-400	50	176	317
	Over 400	7	41	82
	Total	107	323	575
Places outside urbanized areas				
Safety	Under 50	0	0	0
All highway user benefits	Under 50	57	42	62
Added railroad benefits	Under 50	203	257	432
Added community benefits	Under 50	284	399	710

Table 25

ALTERNATE ESTIMATES OF SCOPE III PROGRAM SIZES--NATIONAL TOTALS

Region and Benefits in Justification	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places Inside Urbanized Areas			
Safety	0	0	0
All highway user benefits	1	2	2
Added railroad benefits	4	18	21
Added community benefits	46	317	441
Places Outside Urbanized Areas			
Safety	1	17	25
All highway user benefits	19	42	56
Added railroad benefits	53	114	153
Added community benefits	313	1132	1696

Table 26

ALTERNATE ESTIMATES OF SCOPE III PROGRAM SIZES--NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Acceptable Projects	Program Cost (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas				
Safety	Under 50	0	0	0
	50-400	0	0	0
	Over 400	0	0	0
	Total	0	0	0
All highway user benefits	Under 50	0	0	0
	50-400	0	0	0
	Over 400	0	0	0
	Total	0	0	0
Added railroad benefits	Under 50	1	6	7
	50-400	0	0	0
	Over 400	0	0	0
	Total	1	6	7
Added community benefits	Over 50	13	96	138
	50-400	0	0	0
	Over 400	0	0	0
	Total	13	96	138
Places outside urbanized areas				
Safety	Under 50	0	0	0
All highway user benefits	Under 50	3	25	35
Added railroad benefits	Under 50	7	47	67
Added community benefits	Under 50	44	309	468

Table 27

ALTERNATE ESTIMATES OF SCOPE III PROGRAM SIZES--OUTSIDE NORTHEASTERN REGION

Region and Benefits in Justification	Population Range (thousands)	Acceptable Projects	Program Cost in Group (millions of dollars)	Program Benefits (millions of dollars)
Places inside urbanized areas				
Safety	Under 50	0	0	0
	50-400	0	0	0
	Over 400	0	0	0
	Total	0	0	0
All highway user benefits	Under 50	1	2	2
	50-400	0	0	0
	Over 400	0	0	0
	Total	1	2	2
Added railroad benefits	Under 50	2	8	10
	50-400	1	4	4
	Over 400	0	0	0
	Total	3	12	14
Added community benefits	Under 50	28	171	240
	50-400	5	50	63
	Over 400	0	0	0
	Total	33	221	303
Places outside urbanized areas				
Safety	Under 50	1	17	25
All highway user benefits	Under 50	16	17	21
Added railroad benefits	Under 50	46	67	86
Added community benefits	Under 50	269	823	1228

larger places in urban areas tended to have more probability of justifying a Scope II project than smaller places, because the cost of Scope II projects increases only slightly with population, while the benefits, especially to highway users, increase more rapidly than population, meaning that the ratio of average benefit to average cost of projects in these areas is increasing.

On the other hand, the costs of Scope III projects in large urban places (over 400,000) increases very rapidly, if the data are extrapolated to this range. (Only one cost point is available from the survey.) Since the benefits increase less rapidly, the probability of a Scope III project in a large urban area is remote. Further, information derived from early analysis of the nationwide grade crossing inventory project indicates that land use around railroad crossings (and hence near the railroad) tends to a higher fraction of industrial use as the size of the community increases. It is railroads in industrial areas that are most costly to move and for which relocation gives least benefit.

Combined Program

A combined program can be constructed from the separate results of the Scope II and Scope III, program analysis by adjusting for places where Scope III projects would displace Scope II projects. In such cases, it is assumed that the Scope III projects are incrementally justified over Scope II projects. Therefore, the number of projects is the same as for the Scope II program, and the costs and benefits are derived from the average costs and benefits of the Scope II and Scope III projects contained in the resulting total. Table 28, also shown as Table 3 in Chapter II, gives the resulting combined program.

Table 28

NATIONWIDE ESTIMATES FOR COMBINED PROGRAM

Program	Number of Places	Program Cost ($millions)	Program Benefits ($millions)
Safety	1-53	14-17	22-25
All highway user benefits	122-488	175-362	260-557
Railroad benefits added	412-857	767-777	1,275-1,467
Community benefits added	553-996	1,803-1,876	2,763-3,438

(Tables 1 and 2 in Chapter II give separate summaries for the Scope II and Scope III programs).

Yard and Shop relocation would add from 40 to 80 projects to the combined total, with benefits and costs approximating $1 billion. As noted in the earlier discussion, the benefits from yard relocation result primarily from increased land values. These increases in land value would be classified as community benefits in this analysis--although the railroad company would be one of the principal beneficiaries.

Cost of Comprehensive Railroad Relocation

The analysis leading to Table 28 is based on justification of project costs by various levels of benefit. If there were no limitations on spending other than need, all of the places identified in Table 8 would generate relocation projects. The cost of such a comprehensive relocation program is estimated by using the cost of projects justified by community benefits. These costs were used in place of the unrestrained estimates for all projects that would be implied by the equations presented in Table 11, under the assumption that projects would be scaled to approximate benefits even though there were no formal requirements. The estimates of costs for a universal program are presented in Table 29. The lower estimate is derived from the lower estimate of number of places with conflict and cost factors from the analysis of the nominal case. The higher estimate is derived from the higher estimate of number of places with conflict and the costs from the alternative of project costs.

Table 29

ESTIMATED RANGE OF COST OF RAILROAD RELOCATION OR CONSOLIDATION
IN ALL COMMUNITIES WITH CONFLICTS

Population (thousands)	Low Estimate			High Estimate		
	Number of Places	Cost/Place (millions of dollars)	Total Cost (millions of dollars)	Number of Places	Cost/Place (millions of dollars)	Total Cost (millions of dollars)
5-10	542	$2.0	$1,084	748	$ 2.8	$ 2,094
10-25	420	2.4	1,008	580	5.7	3,306
25-50	183	3.1	567	313	8.2	2,567
50-100	70	3.8	266	166	9.4	1,560
100-250	44	4.5	198	47	11.1	522
250-500	13	5.4	70	15	13.9	209
500-1,000	8	6.3	50	9	30.0	270
Over 1,000	2	7.2	14	3	45.0	135
			$3,257			$10,663

VII FINANCING URBAN RAILROAD RELOCATION

In this chapter we first discuss a planning program to identify the needs for relocation and the beneficiaries of the relocation; then the prospective involvement of state and local governments in planning, financing, and implementing relocation projects; and last, alternative federal assistance policies.

Need for Planning

The analysis in the previous chapter indicated that in only a small fraction of places in the country could the benefits of railroad relocation or consolidation support the cost of the project. In a large number of places, the only way to determine whether the benefits will justify the cost is the preparation of a plan that explores the alternatives in considerable depth.

In projects that do produce benefits that justify the cost, planning is important to identify the distribution of the benefits among the stakeholders, so that equitable financing can be arranged. The most equitable plan would probably be for all interest groups to contribute in proportion to their expected benefits. Difficulties in quantifying all of the expected benefits and differences in financial capability make this ideal hard to attain in practice, but it can be approximated.

The relocation planning should be undertaken in the framework of the regional transportation planning activities, but usually as a separate and discrete step. The topic has long been bypassed by transportation and land-use planners and entails many unique considerations.

The cost of a planning program will vary with the size of the community and the complexity of its railroad problem. An estimate of $75,000 can be made for communities with populations under 100,000, based on our experience in Lafayette and Wheeling and the planning costs for other projects. Communities of up to about 250,000 population would incur planning costs of about $150,000, and some larger communities might require $500,000 or more--as in East St. Louis and the Omaha riverfront project. Based on such estimates of unit costs, the estimated 1655 communities with symptoms of a railroad problem could complete their planning for a nationwide cost of about $135 million.

Our research indicates that few communities base decision making on a comprehensive quantitative benefit/cost analysis. Decisions are more sensitive to the local share of the costs and to the distribution of expected benefits--described in a largely qualitative way--to the inhabitants within the operation of the local political process. The planning guidance, therefore, includes not only a benefit/cost methodology, but analysis of how the costs and benefits are distributed, so that the communication of this necessary information to the affected public can be facilitated and the political process made more effective. This sort of communication is consistent with the current state of the art in evaluation of transportation projects.

Prospective State Involvement in Railroad Relocation Projects

The federal aid highway program has been administered and financed through a combined federal-state program. State experience in the administration of this program and the highway user benefits produced by railroad relocation make the state highway agencies a potential source of planning and technical assistance, and funding.

A survey of six states was conducted from November 1974 through January 1975 to determine their past and prospective involvement in railroad relocation projects. The survey included the following questions:

- Has the state's involvement in past urban railroad relocation projects been favorable? What problems or opportunities do you envision in future involvement with such projects?
- What might be the state's future administrative, technical and financial role in each step of the sequence: (1) preliminary assessment of railroad relocation problems; (2) full-scale feasibility and planning study; and (3) relocation project implementation?
- What priority do you believe that urban railroad relocation projects warrant in comparison with other types of highway improvements in your state?
- To what extent you you believe the financing of urban railroad relocation projects in your state will require additional federal or state highway funds beyond those anticipated to be available in the next 10 to 15 years under current legislation and tax rates? What do you think would be the likely city particpation in such

projects under at 70% federal share? What do you think would be the most appropriate federal share of such projects?

Written and oral responses were obtained from four states--Florida, Georgia, Pennsylvania, and Wisconsin; telephone interviews were conducted with Illinois representatives; and personal interviews were conducted with California representatives. Follow-up interviews were also held with representatives of Pennsylvania and Georgia. Highlights of the responses are summarized below.

- State involvement in relocation projects has varied in the past from essentially zero in Florida and Georgia to extensive involvement in Wisconsin and California. (A more general measure of past state involvement comes from the 1974 FHWA survey of state transportation agencies, which indicated that states participated in about 60 percent of the projects identified and provided 20 percent of the total funds.) Future involvement is expected to be high in all states, depending in some cases on the removal or modification of rather serious legal constraints, and depending also on the existence and level of federal support (see below). The states' interests are in such matters as assuring multimodal and land-use planning for relocations, stakeholder participation in plan development, and a high technical quality of the planning effort.

- The organizations responsible for railroad relocation planning and technical assistance are highway units in Georgia, Pennsylvania, and California, and state DOT planning units in the other three states, but all may use a state DOT planning level if state involvement increases.

- Methods for determining railroad relocation priorities--both between different projects and between relocation projects and other highway improvements--are a source of concern and uncertainty in most states. California has a quantitative rating scheme for determining relocation priorities in competition with grade separation projects within a $15 million annual budget, although they are rarely included. Florida is working on an intermodal evaluation methodology that could resolve the question in five years or so. The other states generally consider projects as they arise, in competition with other highway improvements with safety and congestion benefits.

- Funding approval, requiring up to three years, comes either via the state public utilities commission (PUC) or the state DOT after legislative authorization through the state highway, DOT, or capital outlay budget. State funds for relocation are scarce, and even relocation planning funds are usually of federal origin. There is unanimity on the need for a high federal share of relocation projects--in the range of 80 percent to 90 percent--if there is to be much future relocation activity. There is also a consensus on the desirability of relocation funds being added to present highway funding rather than being earmarked within present tax and authorization levels, so as to avoid further delays in needed highway improvements.

From these responses, we estimate a very low level of state commitment to help plan and fund urban railroad relocation projects if Congress approves only an authorization for use of federal highway funds. Only a few states will get involved, and with only a few cities. If federal highway funds within present tax levels are earmarked for relocation projects on a discretionary basis (to go to states and cities showing evidence of need), there will be some takers at 70 percent federal support, more at 80 percent, and quite a few at 90 percent, because the money would be lost to states and cities that do not provide matching funds. Making additional money available for relocation projects, again on a discretionary basis, will create at least marginally more of a response because the relocation funds will not be as competitive with high-priority highway improvements that cannot otherwise be funded. These conclusions are reinforced by the analysis of city financial resources and willingness-to-pay in the last section of this chapter, which indicates that very few cities will be able to match relocation project costs at more than the 10 percent level.

A more detailed analysis and citation of responses in each subject area follows.

Degree of State Involvement

In Florida, there has been no involvement to date in actual urban railroad relocation, but the Florida DOT is currently studying a major relocation project along the 'gold coast' of southeast Florida. The project extends for

> ...approximately 75 miles from northern Palm Beach County to the central area of Dade County. It involves a 100 foot wide corridor occupied by the Florida East Coast Railway which closely parallels Highway U.S. 1 throughout its length and bisects the core areas of all of the communities through which it passes. It is proposed that, in return for the Department constructing a high speed railway bypass to the west of existing urban development for the use of through freight traffic, the Railway Company will deed to the Department approximately 50 feet of its corridor to ultimately be used by some type of high speed ground transportation. Freight switching within the corridor, which represents about 20 percent of the total train activity, will be continued at times during each day when it will produce minimum conflict with other area activities.*

In addition, Florida sums up well the typical state awareness of the relocation problem:

> Many of the cities in Florida (as in the nation) were created by the advent of rail service into previously undeveloped areas. Consequently, in most cases, communities are bisected by railways and these core locations have become a major liability in our efforts to improve the economic and environmental quality of these areas. Removing or minimizing the adverse impact of railway traffic is an obvious first step in attracting private investment capital to improve and revitalize the central city. At least three obvious major problems are immediately evident: first, finding acceptable bypass rail locations through or close to suburban high quality residential development; second, finding sources of funds necessary to finance these costly undertakings; and third, providing for the equitable disposition of businesses located along the existing corridors that are dependent on rail service.*

Finally, the strong commitment of the Florida DOT to ameliorating relocation problems is reflected in the statement that the department "is charged by law with the responsibility for developing an efficient balanced transportation system for the state. With this mandate we would anticipate being involved in all phases of railway relocation."

Georgia's past and planned future involvement is summed up in the following account:

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*Letter from Thomas D. Moreland, State Highway Director, Georgia DOT, December 16, 1974.

Georgia's involvement in the past rail relocation projects has been miniscule. The projects completed to date were completely funded by the involved railroads and overall results from a traffic point of view have been disappointing. Future projects with State involvement will offer the possibility of reducing in-town rail traffic and possible conversion of portions of the existing rail right-of-way to arterial city streets. The opportunities this opens for improvement to traffic and safety through traffic engineering technology is significant.

If State and or Federal funds are involved the State should administer all phases of the projects, being responsible for the funding and all technical requirements using in-house expertise if possible and contracting where necessary.

This program would naturally have great interest in certain urban areas where existing RR operations significantly hamper traffic patterns. Since the solution is a relocation, this results in acquisition of right-of-way, environmental studies, public hearings and large amounts of funds. These could be stumbling blocks if the solution resulted in only moderation of rail traffic into and through the urban area and not elimination of it. The most promising route seems to be a bi-modal sharing of highway-rail traffic on a bypass route right-of-way.*

The following comments describe the Pennsylvania DOT's past experience:

The State's involvement in the completed project in McKeesport, Pennsylvania, was favorable from the conception of the project... It was anticipated, at the conception of this project, that Federal Highway Funds could be utilized for this project under PPM 21-10. As the project progressed and the State made requests for Federal participation, such requests were denied since the majority of the crossings being eliminated were located on local streets and State Highways which were not included in the Federal System. This is also the primary reason those remaining projects in Report III† have never been initiated.

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*Letter from Thomas D. Moreland, State Highway Director, Georgia DOT, December 16, 1974.

†Report III is the portion of the 1974 FHWA survey that asks for a listing of prospective projects.

The projects listed in Report III were all originally proposed by local agencies. In three instances, detailed studies were made. The studies recommended the major portion of the financing to be done with State and Federal Funds (primarily Highway Funds, secondarily, Urban Redevelopment Funds). Federal Highway Funds were not easily available for the reason previously stated. In all cases, the number of crossings being eliminated because of the relocation and/or consolidation of rail lines and which were located on State Designated Highways on the Federal Aid Highway System were minimal.

It may be important to note here, that of all the projects proposed in Report III, only one involves a railroad relocation as its only alternative. It may be important also to note here, that without commitments from Federal and/or State Agencies at the conception of a project, railroads were very reluctant to cooperate with the local agencies.

The major problem is financing. Without some firm commitment, the project dies in the planning stages. Such projects, if financing becomes available, present tremendous opportunities for enhancing highway safety, community development and both rail and highway transportation efficiency.*

The future state role recommended by Pennsylvania is joint participation in the preliminary assessment, feasibility study, and implementation phases of the project:

The preliminary assessment of railroad relocation problems must be accomplished as a joint effort between Federal, State and local agencies similar to our Highway Planning within the Commonwealth. The administration and technical expertise required would be provided to municipalities by the State. Financing should be with Federal and State Funds.

The full-scale feasibility and planning study must also include a joint effort, but, at this stage the railroad companies will be required to participate. Administration and technical expertise required would again be provided to the municipalities by the State (in cases where the project is in a large city, the local agency may be able to assume this responsibility). Financing of this stage should include

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*Letter from David C. Sims, Deputy Secretary for Highway Administration December 24, 1974.

participation by Federal and State Agencies, and in some instances, by Local Agencies.

Project implementation would be administered and technical expertise provided in a similar manner as provided for in the feasibility and planning stages. Financing would also be similar except the railroad companies would be required to participate also.*

Wisconsin's response to the SRI survey is reproduced in Appendix D because of its length. This response documents a strong and increasing interest by the Wisconsin DOT in urban relocation problems, and raises several issues and proposed guidelines concerning the urban planning process, public participation, legal constraints on condemning railroad property, and funding sources. (See Sections II and III of Appendix D for the type of involvement proposed.)

In California, the state Division of Highways has been successfully active in a minor way in planning, coordinating, and helping to finance several railroad relocations. There now is a backlog of about a dozen relocation proposals in different stages of agreement and planning, few of which are expected to reach the construction stage under present financing arrangements. The Division of Highways lacks the legislative authority at present to offer technical and planning assistance for relocation efforts, because it is state policy to leave these tasks to private consultants, so the Division acts more in coordination and information exchange roles.

Another constraint on relocation efforts in California, which is probably common to many states, is the long-term franchise arrangement under which railroads hold the right to operate within city limits. As railroad franchises in California cities expire, the city may have a lever for getting relocation considered, but the fact that trains are in interstate commerce greatly reduces the effectiveness of local pressure towards such relocation. Industries that might be damaged by a relocation have also been an obstacle in some California proposals, but the state position is that damages need not be paid unless land is actually taken by a railroad relocation. The state cannot legally pay damages for severance of railroad service, but industry pressure on the community and the Interstate Commerce Commission can still block the relocation.

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*Letter from David D. Sims, Deputy Secretary for Highway Administration (Pennsylvania) December 24, 1974.

Organization

The Illinois DOT has had generally favorable experience through district highway engineers in assisting cities with relocation planning in cases when highway congestion and safety are at stake. However, railroad relocation responsibility has now been shifted to the Planning Office at the DOT level where more intermodal considerations and land-use tradeoffs are expected to be considered than was true under highway agency supervision of the function.

The interest of the Illinois DOT in railroad problems is also increasing to include subsidization of railroad operations through the state gasoline tax in some cases.

In California, the Bridge Department of the Division of Highways has historically evaluated and assisted grade separation and railroad relocation projects because grade separations are regarded as highway bridges. In Georgia, the relocation function resides with the State Highway Engineer's Office of Traffic Engineering and Safety.

In Pennsylvania, the Design Bureau in the Highway Administration handles highway utilities and grade crossings in addition to railroad relocation. The railroad relocation function began in Pennsylvania because of the Design Bureau's role as liaison with the Public Utilities Commission of Pennsylvania, which is autonomous and has jurisdiction over grade crossings and railroad relocation but no funds of its own and no way to take initiative in such cases. The PUC can, however, allocate the cost of relocations or grade crossings to different parties, including the state DOT when it acts on an application or complaint. The PUC handles about 40 complaints a year; they are very time-consuming and about 120 are in process at any one time. All three deputy secretaries of the state DOT are involved, however, in some way in getting major relocations. The Assistant District Engineer for Planning in the Highway Administration reports on grade crossings and railroad relocation problems, but has no effective intermodal planning role.

The role of the California State PUC is described below under "Priority Determination."

In Florida and Wisconsin, like Illinois, railroad relocation is a responsibility of the state DOT planning division or office. It seems that this is a logical location for the function, and it will probably be the dominant trend in time.

Priority Determination

The Division of Planning and Programing in the Florida DOT has begun to develop a method for determining transportation project priorities. Their initial effort is being applied to highway projects but it is their hope that "techniques and procedures will evolve which can be applied to multi-modal transportation needs so that our limited resources are expended to produce the greatest benefit without regard to mode.... Available federal, state and local funding, as well as the response of the affected citizens, will probably dictate the priority of initial projects."*

Pennsylvania commented as follows regarding railroad relocation priorities:

> If they are considered from the standpoint of safety and hazard elimination they would be considered at least equal to any other in both urban and rural areas. When considering such projects in this view, protection of the public in providing services, such as ambulance, fire and police protection, must be considered equally with protection to the highway and railroad user. Considered from the standpoint of convenience and efficiency in transportation operations both on the highway and the railroad they should rate a high priority in urban areas. From the standpoint of land use and land use management in urban areas, the studies completed in the various communities indicate a high priority.†

Responses by Wisconsin (see Appendix D), Illinois, and Georgia resemble that of Pennsylvania on the high priority of relocation projects. California, in contrast, felt that (1) safety and congestion relief were the primary benefits to be gained, (2) relocation projects should be considered in competition with grade separation projects throughout the state on the basis of such benefits, and (3) lack of strong city support and willingness to pay something toward relocation costs should be construed as lack of evidence of substantial community benefits from the proposed relocation. The positions of these stakes may only represent differences of emphasis.

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*Letter from Mel. A. Conner, Intergovernmental Planning Director, Florida DOT, January 10, 1975.

†Letter from David C. Sims, Deputy Secretary for Highway Administration, (Pennsylvania) December 24, 1974.

The determination of urban railroad relocation priorities may involve other agencies than the state highway or transportation department. The role of the Pennsylvania PUC and legislature has already been cited, and the role of the California PUC will be described next.

Chapter 8 of the California State Highway Code authorizes the state to fund 80 percent of the cost of grade separation projects; 10 percent is provided by the railroad and 10 percent by local government. An annual $15 million appropriation for grade separation is made from the state highway fund. The state PUC determines the priorities for such grade separations. The 1974-75 PUC priority list included 69 projects, of which only the first ten could be funded within the $15 million limit. A formula has been developed by the Caltrans staff and adopted by the PUC that produces a figure of merit for such grade separations, taking into account its cost, the number of trains, and average daily traffic. A subjective weight may then be added for nonquantifiable benefits or costs. Railroad relocations are also evaluated by the formula in terms of their effect on eliminating grade crossings, and can be included on the PUC priority list. But they are rarely at a sufficiently advanced stage of planning and agreement to be included, and may also be kept off because their magnitude would preclude any PUC money for other grade separations for one or more years.

Funding

State sentiment on the shortage of state highway funds and city funds for railroad relocation is reflected in the following quotations from responses to the SRI survey:

- Florida--Since Florida receives less than one-half of the revenue, from all sources, needed to reach a reasonable degree of transportation adequacy over the next twenty years it is evident that only through additional federal, state, and local financing can we hope to advance railroad relocation projects with any degree of continuity. A few projects may be completed through special funding but no program is presently anticipated.*

- Georgia--No community in Georgia or single railroad could afford the costs of these proposed projects without substantial Federal assistance.

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* Letter from Mel A. Conner, Intergovernmental Planning Director, Florida DOT, January 10, 1975.

Presently, Federal funds in Georgia are matched by state funds, not local. If the cities had to match the Federal funds it would be doubtful if any would accept the offer. There is such a critical shortage of Federal funds for urban areas, any funding for this subject would need to be designated funding or the program would not produce desired effects.*

- Pennsylvania--Not only must railroad relocation funds be additional to the present allocations, but, additional Federal Funds must be available for use on Local Roads and State Designated Highways not included in the Federal Aid System.†

- Wisconsin--Although no attempt has yet been made to estimate the potential costs of railroad relocation projects in Wisconsin over the next 10 to 15 years, the fact that the Department is financially unable to meet highway needs alone at the present time and has recently been forced into drastic reductions in its improvement and maintenance program, suggests quite strongly that additional funding sources would be needed. Although the use of urban system funds would offer an attractive federal cost-sharing ratio for relocation projects, the high costs normally associated with such projects would in many cases exceed the allotted funds or require most of the funds available for transportation improvements in the urban area.‡

Similar sentiments were expressed in the interviews with representatives of California and Illinois.

State responses on the questions of the desirable levels of federal and state support are shown below (Illinois and Wisconsin did not respond to this question):

- Florida--A federal share of 70 percent or more was believed appropriate, with the local share set at 10 percent to 15 percent and the state providing the balance.

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*Letter from Thomas D. Moreland, State Highway Director, Georgia DOT, December 16, 1974.

†Letter from David C. Sims, Deputy Secretary for Highway Administration (Pennsylvania), December 24, 1974.

‡Letter from T. J. Hart, Administrator, Division of Planning, Wisconsin DOT, January 13, 1975.

- Georgia--The recommended federal share was "from 70 percent to 90 percent, preferably the latter."

- Pennsylvania--If Federal Funding were placed at a 70 percent limit, very few cities, in our opinion would be receptive to providing the remaining 30 percent. It is our opinion that none of those listed in Report III would be financially able with one possible exception.

  If such projects are to be implemented at the discretion of the cities, it would be our view that the appropriate Federal Share should be at a minimum of 80 percent and a maximum of 100 percent...The funding should be as follows:

Step	Local	Federal
Preliminary assessment	0%	100%
Feasibility and Planning Study	10%	90%
Implementation*	10%-20%	80%-90%

- California--A federal support level of 90 percent was believed to be necessary for most relocation projects due to their large size and to shortages of city and state funds.

There was frequent reference in state comments to the desirability of insisting on some railroad contributions to the cost of relocation projects, and one state was reluctant to participate in financing without assurance of some railroad support. It had been this state's experience that railroads would often try to avoid financial participation even if they would benefit substantially from the relocation. Other states, in contrast, reported very gratifying railroad cooperation and financial support in at least some relocation efforts.

Ability of Cities to Support Relocation Projects

Information on the past and future ability of cities to support needed railroad relocation projects suggests that probably not over a

*Some participation in this step should be made by the railroad company involved. This participation should reduce the amount of local participation.

tenth of cities with serious railroad conflicts would be able and willing to pay more than 10 percent to 20 percent of the cost of typical projects. A summary of the reasons supporting this conclusion and the suggested basis for federal support of such projects follows:

- The deteriorating financial condition of most American cities has been well documented in recent years, and few cities have the resources to take on expensive new capital projects. While per capita expenditures are higher in larger and older cities where the central city core is deteriorating, small and medium-size cities are also affected by the revenue crunch.
- The causes of city revenue shortages can be traced to the increased unionization and wage demands of municipal employees, the migration of upper and middle income families from the central city to the suburbs and their replacement by groups paying lower taxes but requiring more services, the dependence of cities on tax sources, such as sales and property taxes, whose rate of increase does not keep pace with either inflation or rising city costs, and the concentration of a high proportion of federal concern and expenditures on such nonurban problems as the Vietnamese war. General revenue sharing by the federal government will relieve the situation only temporarily and slightly under its present and planned scope, and no other relief is in immediate prospect, since the trends that have caused the problem are expected to continue.
- Evaluation of outstanding debt per capita by city-size groups demonstrates why relocation costs are the greatest burden on smaller cities, under 50,000 population. Considering the greater competition for funds in large cities and the relatively smaller impact of relocation projects in large cities, it appears that the best prospects for relocation projects will frequently be middle-size cities.
- Local support for past and prospective relocation projects has been heavily concentrated in the range of 20 percent or less--41 percent of completed projects reported in the FHWA survey, and 75 percent of prospective projects, for example, fall within this range. The total population of cities with relocation problems is even less able and willing to pay than this sample.
- Consideration of federal, state, and city responsibilities and ability to pay for urban railroad relocations suggests the creation of a special federal discretionary program under

the Highway Trust Fund, but with added funding, based on one of two policies: (1) a high standard federal support level of 80 percent to 90 percent for justifiable projects, or (2) a more moderate federal support level, say 70 percent, with provision for state support of 50 percent or more of the balance. Criteria for project justification should take into account the relation of expected benefits to project costs and any serious negative impacts of the project on particular interest groups.

Details of these five subject areas are discussed below.

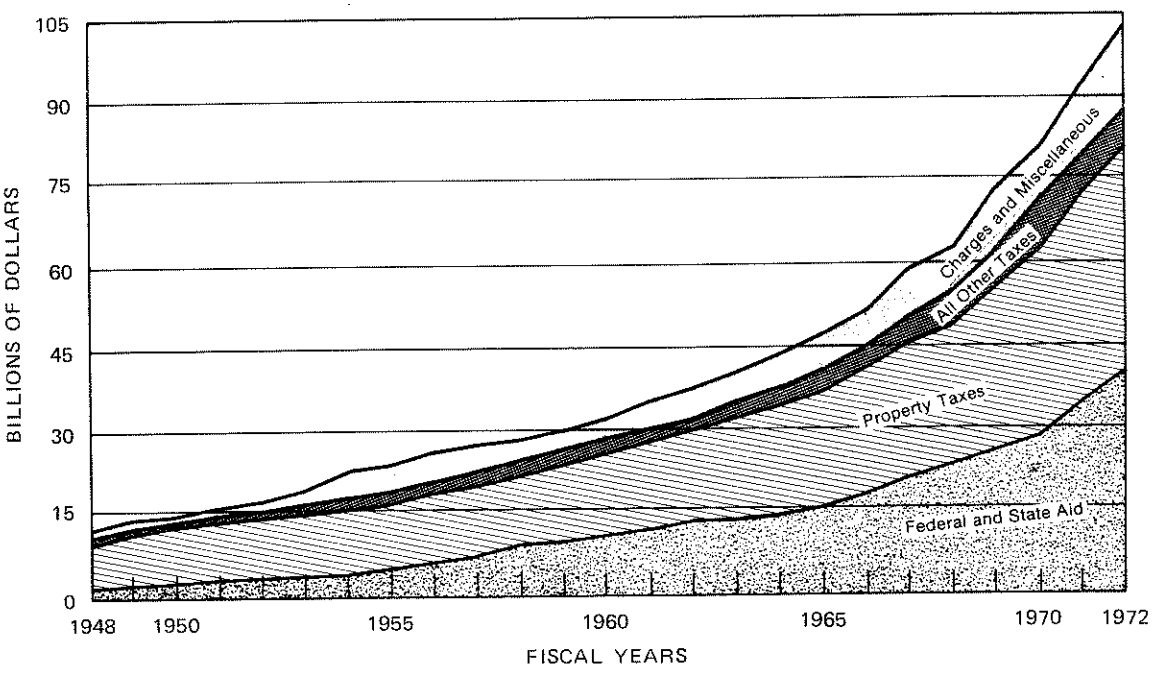
Financial Condition of Cities

The most recent comprehensive review of city finances was a July 1973 report by the Advisory Commission on Intergovernmental Relations (ACIR). This report sums up the financial problem of cities as follows:*

> An incredible and seemingly insoluble array of financial difficulties confront urban governments in America today. The Commission has in previous studies, called for a massive rearrangement in the scale of fiscal resources available to the three levels of government to strengthen our federal system. The Commission has noted that a strong partnership requires that each of the partners be strong, and this condition cannot be met if one partner has the bulk of the resources and the other one has the bulk of the expenditure demands.
>
> Cities have the expenditure problems in our system today. It is in cities that are found outdated capital facilities, demands for increased services for minorities and poor persons, wornout equipment, the inability to increase the tax base because of tax restrictions, the inability to exceed debt ceilings, citizen tax rebellions, competition with other governmental units for State and local revenue sources, and a general inability to make the revenue resources stretch to fit the expenditures mandated by the State and demanded by the people.

Figure 8, from a more recent ACIR report, illustrates the mix of local government revenues, the increasing dependence of local governments on federal and state aid, and the steep rise in local government revenues

*"City Financial Emergencies: The Intergovernmental Dimension," ACIR Report A-42, pp. 3-4, Washington, D.C. (July 1973).



SOURCE: "Federal, State, Local Finances: Significant Features of Fiscal Federalism," ACIR Report M-79, p. 32, Washington, D.C., (February 1974).

FIGURE 8 MAJOR SOURCES OF LOCAL GENERAL REVENUE — FISCAL YEARS 1948 THROUGH 1972

since the mid-sixties. Only about one-third of local revenues are for cities, but the taxes of other local governments--primarily school districts and counties--affect the same population and tax base.

Table 30 compares the trend in city and federal revenues for the decades 1952-62 and 1962-72. Total general city revenues (Line 1) and

Table 30

TRENDS IN CITY AND FEDERAL REVENUES
(Dollars in Billions)

		Fiscal Years			Average Annual Change	
		1952	1962	1972	1952-62	1962-72
1.	General city revenues	$ 6.4	$ 13.1	$ 35.0	7.4%	10.3%
2.	General city revenues from local taxes	4.1	7.9	17.0	6.8	8.0
3.	Federal taxes	59.7	82.3	152.4	3.2	6.4
4.	Gross national product (for previous calendar year)	$328.4	$520.1	$1,050.4	4.7	7.3
5.	City taxes as a percent of GNP (2/4)	1.24%	1.52%	1.62%	2.0	0.6
6.	Federal taxes as a percent of GNP (3/4)	18.18%	15.82%	14.50%	-1.4%	-0.6%

Source: Finances of Municipalities and Township Governments, 1957 and 1972, Census of Governments, Bureau of the Census (USGPO, Washington, D.C.); and SRI.

general city revenues from local taxes (Line 2) have increased at faster rates than either federal taxes (Line 3) or GNP (Line 4). The result is that city taxes as a portion of GNP are 30.6 percent larger in 1972 than in 1952, whereas federal taxes are a 20.2 percent smaller share of GNP. Since dividing by GNP has the effect of deflating state or federal taxes for both population growth and inflation, this comparison indicates a sizable shift in the burden of taxation from federal to city levels.

Since the annual growth rates of city revenues from local taxes (6.8 percent and 8.0 percent) are less than the growth rates of total general city revenues (7.4 percent and 10.3 percent), we must look elsewhere for a more rapidly growing component of city revenues. Table 31 compares recent per capita city revenues from different sources and shows

Table 31

TRENDS IN PER CAPITA CITY REVENUES AND DEBT

	Fiscal Years			Average Annual Change	
	1962	1967	1972	1962-67	1967-72
General revenue	$112.88	$164.46	$264.66	7.8%	10.0%
Intergovernmental sources	22.94	43.33	87.17	13.6	15.0
Taxes and licenses	68.28	89.61	128.62	5.6	7.5
Charges and other	21.66	31.51	48.86	7.8	9.2
Outstanding debt	$230.94	$300.68	$397.63	5.4	5.8
Interest on debt	6.91%	9.51%	15.79%	6.6%	10.7%

Source: Finances of Municipalities and Township Governments, 1957 and 1972, Census of Governments, Bureau of the Census (USGPO, Washington, D.C.); and SRI.

that intergovernmental revenues have been the fastest growing element of city revenues, with rates of 13.6 percent from 1962-67 and 15.0 percent from 1962-72. These are primarily from federal funds. Note that all revenue growth rates are higher for the second five-year period, showing an accelerating rate of growth in recent years. Outstanding city debt per capita and debt interest per capita, also given in the table, show similar growth characteristics.

The growth in outstanding city debt is relevant to financing railroad relocation projects because any substantial city funds for such projects would need to be raised by bond issues. We believe that city debt would have increased more rapidly except for increasingly unfavorable financing opportunities. Some measure of the current problems of debt financing by cities can be seen from Figure 9, which shows the recent declining trend of successful state and local government bond elections. The average for the period 1968-72 is 51.2 percent, compared with an average of 73.0 percent for the five years preceding 1968. Even these data understate the difficulty of raising debt capital for city capital outlays, because high interest rates and the poor prospects of passing bond elections must keep some desired bond issues from being put to the voters.

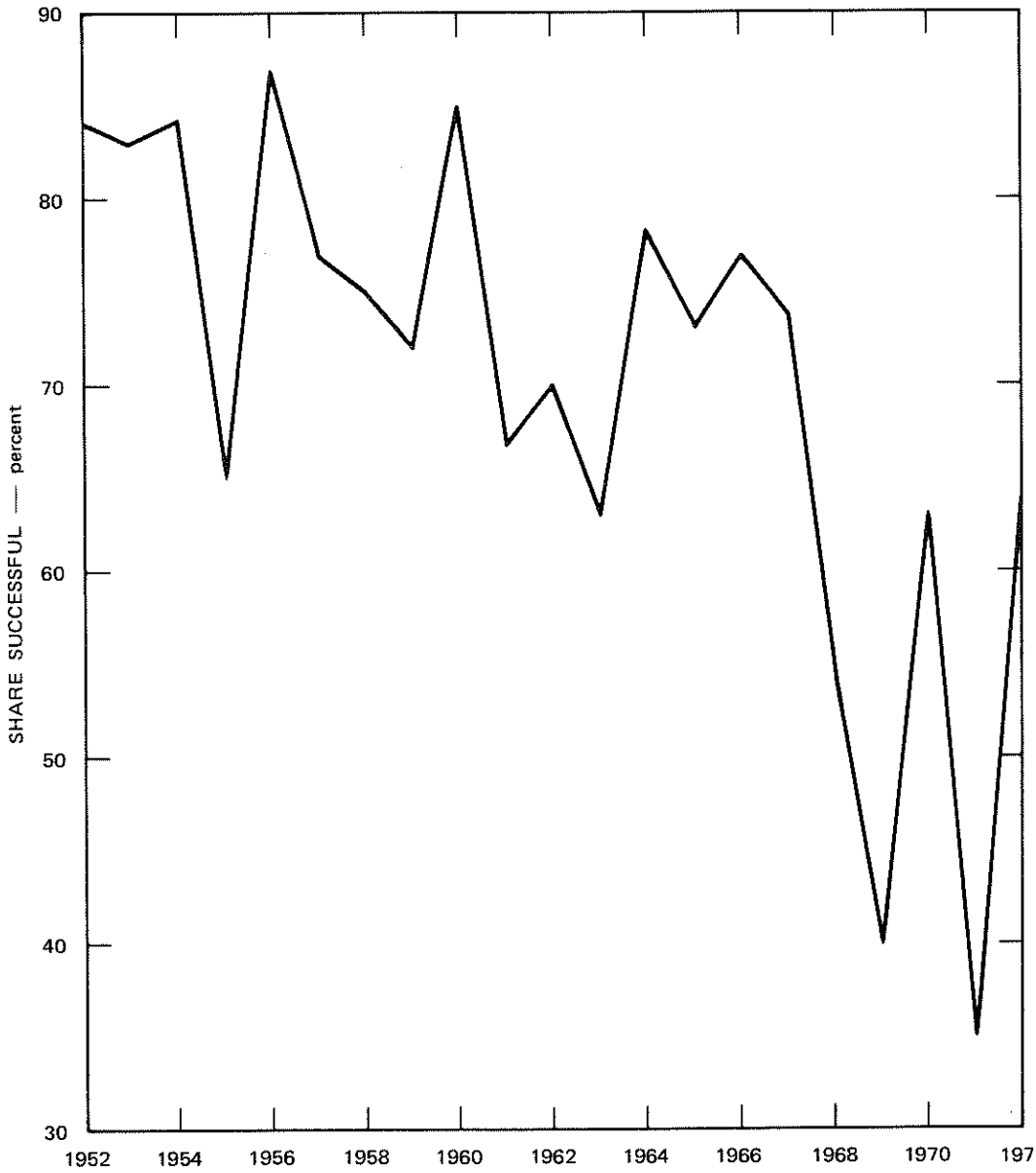
Causes of the Financial Plight

The causes of the rise in city expenditures are described by the ACIR as follows:*

> Current financial pressures on cities stem from the increasing demands for more services, inflationary effects that are intensified by the labor-intensive nature of the services demanded, the impact of external forces chiefly related to labor relations, and the demise of the balanced city with a resultant rise in social and economic disparities among jurisdictions. Although the impact of these factors varies among individual cities, their influence is felt most acutely in the large American cities.

Another view on the causes of rising city expenditures is offered by R. W. Bahl, who argues that union pressures for higher wages and fringe

*"City Financial Emergencies: The Intergovernmental Dimension," op. cit., p. 31.



SOURCE: Federal, State, Local Finances: Significant Features of Fiscal Federalism, 1973-74 Edition, Table 92, p. 142, Advisory Commission on Intergovernmental Relations, Washington, D.C.

FIGURE 9 STATE AND MUNICIPAL BOND ELECTION RESULTS, 1952–72

benefits, plus rising city employment levels (due in part to shorter work weeks and longer vacations), are much more important determinants of city government expenditures than other factors.* Bahl postulates a city expenditure forecasting model based on such factors. Although he does not apply the model to total city expenditures in the United States, it seems likely that continued pressures of the types cited by Bahl and ACIR will keep city expenditures rising rapidly in the future.

The ACIR has recommended the following five policies for correcting the growing imbalance in the distribution of city and federal expenditures and revenue resources:†

1. Sharing of a percentage of the Federal personal income tax with States and major localities.
2. Assumption by the Federal Government of all costs of public welfare and medicaid.
3. Assumption by State government of substantially all local costs of elementary and secondary education.
4. Encouragement of a high-quality, high-yield State tax system through a Federal income tax credit for State income taxes paid.
5. An active State role in the administration of the local property tax.

Of these recommendations, only the first and fifth seem well accepted even in principal, and of these two, only the first has significant short-term potential for adding to city revenue resources. It is therefore worth commenting on the chosen federal policy vehicle for this first recommendation, the $30 billion, five-year federal program of general revenue sharing (GRS) authorized by the State and Local Fiscal Assistance Act of 1972 (Public Law 95-512).

Under the Act, revenue sharing funds are allocated among some 39,000 units of general purpose government through complex formulas during the following seven entitlement periods (EPs):

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*R. W. Bahl, "The Budgetary Effects of Rising Public Employee Costs," Government Finance, pp. 13-18 (August 1974).

†"City Financial Emergencies," op. cit., p. 4.

	Dollars in Billions
EP 1--January 1 to June 30, 1972 (FY-72)	$ 2.65
EP 2 and 3--July 1, 1972 to June 30, 1973 (FY-73)	5.64
EP 4--July 1, 1973 to June 30, 1974 (FY-74)	6.05
EP 5--July 1, 1974 to June 30, 1975 (FY-75)	6.20
EP 6--July 1, 1975 to June 30, 1976 (FY-76)	6.35
EP 7--July 1 to December 31, 1976 (FY-77)	3.32
Total	$30.21

The annual amount of some $5 billion may be compared with recent annual increases in state and local government taxes. Combined state and local taxes grew from $67.5 billion in FY-67 to an estimated $109.3 billion in FY-72,* or an average of 10.1 percent per year. Projecting this rate of increase on the FY-72 base gives estimated increases of about $13 billion per year in state and local taxes. So GRS in total provides about half of a year's natural growth in state and local taxes, or about 5 percent of the total of such taxes.

It seems doubtful whether such a level of federal support will by itself remedy the financial difficulties of cities. In a recent evaluation of GRS, it is estimated that GRS money "rarely amounts to more than 7 percent of local city budgets," especially in the case of larger cities.* Other relevant results of this evaluation are:

> The predominant net fiscal effects of GRS are to (1) support or balance the general budget, including offsetting inflationary cost increases, (2) pay for salary increases, (3) reduce the backlog of projected capital investment, and (4) reduce property taxes.†
>
> Functionally, public safety is the largest single expenditure and hence presumably the overwhelming 'felt need.'‡
>
> Cuts in federal categorical programs are beginning to hurt cities, and hence to absorb some GRS funds--for example, in the Model Cities programs.§

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*"General Revenue Sharing in American Cities: First Impressions," National Clearinghouse on Revenue Sharing, p. 3 (December 1974).

†Op. cit., p. 17.

‡Op. cit., p. 18.

§Op. cit., p. 21.

Moreover, special revenue sharing programs (such as manpower and community development) usually do not fully replace previous categorical grant programs in size or coverage.*

We believe this evidence, while based on very early results, is sufficient to conclude that GRS at present or prospective levels is not likely to seriously improve a city's ability to undertake new and expensive capital outlay projects.

Outstanding Debt versus Relocation Cost by City Size Group

Outstanding debt per capita increases rapidly with increasing city size. Railroad relocation costs also tend to increase with city size--more so for Scope III than Scope II projects--so some feeling for the impact of these costs on cities may be obtained by comparing relocation costs per capita with outstanding debt per capita. Table 32 provides such a comparison for cities over 5,000 population by size group. The

Table 32

COMPARISON OF OUTSTANDING DEBT WITH TYPICAL RELOCATION PROJECT COSTS BY CITY SIZE

Population Group	Debt Per Capita	Typical Relocation Project Costs Per Capita		Relocation Costs as a Share of Outstanding Debt	
		Scope II	Scope III	Scope II	Scope III
1,000,000 or more	$896.03	$ 2	$ 10	0.2%	1.1%
500,000 to 999,999	496.17	4	24	0.8	4.8
250,000 to 499,999	484.40	6	26	1.2	5.3
100,000 to 249,999	384.70	11	45	2.8	11.6
50,000 to 99,999	296.25	20	88	6.8	29.7
25,000 to 49,999	284.95	32	151	11.2	52.8
10,000 to 24,999	250.39	63	257	25.2	102.8
5,000 to 9,999	226.81	120	320	52.9	141.0

Source: Finances of Municipalities and Township Governments, 1972 Census of Governments, Bureau of the Census, p. 35, and SRI.

*Op. cit., p. 23.

"typical" relocation project costs from Table 32 are close to the mean values for projects with benefit/cost ratios ≥ 1.0 given in Table 33

Table 33

MEAN VALUES FOR PROJECTS WITH BENEFIT/COST RATIOS ≥1.0

Population Group	Typical Project Costs ($millions) Scope II	Scope III
1,000,000 or more	$4.0	$26.1
500,000 to 999,999	3.0	18.2
250,000 to 499,999	2.4	9.7
100,000 to 249,999	2.0	7.8
50,000 to 99,999	1.5	6.6
25,000 to 49,999	1.2	5.6
10,000 to 24,999	1.1	4.1
5,000 to 9,999	0.9	2.4

The last two columns of Table 32 illustrate that, for cities under 50,000 in size, Scope III relocation costs would constitute an increase of more than 20 percent in outstanding debt, which would be considered a major-to-overwhelming outlay in most cities. For cities over 100,000, relocation costs are a smaller share of outstanding debt, but several other facts add to the difficulty of funding projects in large cities:

- The high total cost of such projects (see Table 33).
- Larger cities are often in worse financial condition now than smaller cities--that is, they face larger demands on expenditures relative to resources.
- The per capita outstanding debt of cities in the 50,000 to 99,999 size group is larger, and hence often more resistant to further increases, than for smaller cities (this condition, however, depends on the available assessed valuation per capita, which also tends to be higher for larger cities).

This picture changes considerably, of course, if cities only need to raise 10 percent to 20 percent of the cost of relocation projects

locally. Even so, raising the local share could prove an insurmountable burden in the case of costly projects for the smaller cities. Moreover, Table 32 shows only mean values for relocation project costs, and some projects have been proposed, started, or completed at ten or more times these mean costs.

One conclusion from this analysis is that middle-size cities, in the population range of 50,000 to 200,000, will often be in the best financial position to undertake railroad relocation projects, due to the greater financial burden on smaller cities and the greater competition from other expenditure needs (plus the smaller relative impact of such projects) for larger cities.

Other indicators of city revenue capacity and expenditure needs have been reviewed for their relevance to relocation costs, but none seem to have the significance that outstanding debt does. City financial literature was also reviewed for information on remaining bonding capacity of cities by size group, but relevant data were not found.

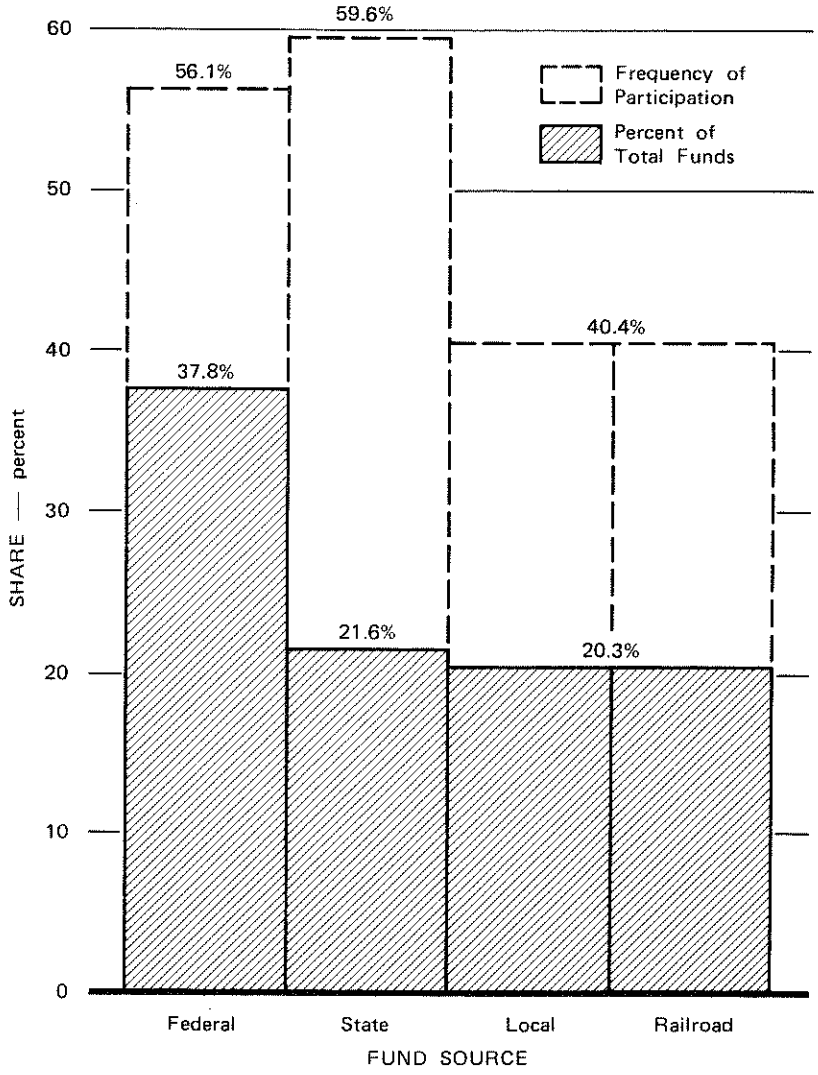
Local Support for Past and Prospective Relocation Projects

Some measure of the prospect of local support for railroad relocation projects may be gained from the actual participation by cities in completed projects and their contemplated participation in prospective projects. These data were part of the results from the 1974 FHWA state survey of relocation projects cited previously.

Twenty-eight states submitted usable responses to the FHWA Survey on the sources of project support, providing financing information for a total of 111 projects, 73 completed and 38 in prospect. Total funding was $155 million for completed projects and was estimated at $184 million for prospective projects, for an average of $2.1 million for completed projects and $4.6 million for prospective projects.

Figure 10 summarizes the fund sources for these 111 projects.

There was no significant difference between the completed projects and prospective projects as to fund sources, so all projects have been lumped together. Total funds, indicated by the solid lines, were about 38 percent federal in origin and about 20 percent each for state, local, and rail. "Other" sources, a fifth category, only amounted to about 1 percent and represented chiefly HUD funds, so they have been added to the federal category.



SOURCE: FHWA and SRI.

FIGURE 10 DISTRIBUTION OF FUNDS FOR 111 RAILROAD RELOCATION PROJECTS BY SOURCE AND RATE OF PARTICIPATION

Tabulating the participation in these 111 projects gives the following data: 56.1 percent had federal participation, 59.6 percent state, and 40.4 percent local and railroad. The numbers add to more than 100 percent because two or more sources typically contribute to a single relocation project. The dashed lines on Figure 10 illustrate these participation rates. The fact that state participation rates are higher than federal while the share of state funding is less than federal clearly means the state participation is at a lower average share of support.

Figure 11 presents the rate of local participation for completed and proposed projects. The figure shows some increase in the proportion of prospective projects with local participation (from 17 percent to 25 percent) plus a downward shift in the share of support. For example, only about 4 percent of prospective projects involve over 30 percent local support level, whereas over 7 percent of completed projects were supported at over the 30 percent level.

If all projects summarized in Figure 11 were of equal magnitude, the average local support would have shifted from 43.8 percent to 19.6 percent. However, both completed and prospective projects enjoyed an average of about 20 percent local support, so many of the completed projects with a high proportion of support in Figure 11 are clearly of smaller than average magnitude. Nevertheless, the shift to a lower distribution of support for prospective projects may be significant in indicating that (1) the small, urgent relocation projects have already been completed, and (2) a lower proportion of local money is likely to be available for future relocation projects. Supporting this conclusion is the observation from Figure 11 that only about 10 percent of prospective relocation projects anticipate over a 10 percent local contribution, about 6 percent over 20 percent, about 4 percent over 30 percent, and about 1 percent over 50 percent. Also, the fact that even the set of cities with advanced prospective relocation plans is probably biased toward cities that have a high ability and willingness to pay for railroad relocation suggests that the total population of cities with relocation problems is even less able and willing to pay than this sample.

Alternative Federal Assistance Policies

The foregoing analysis suggests a choice of three federal support policies if maximum encouragement for railroad relocation is to be offered to cities:

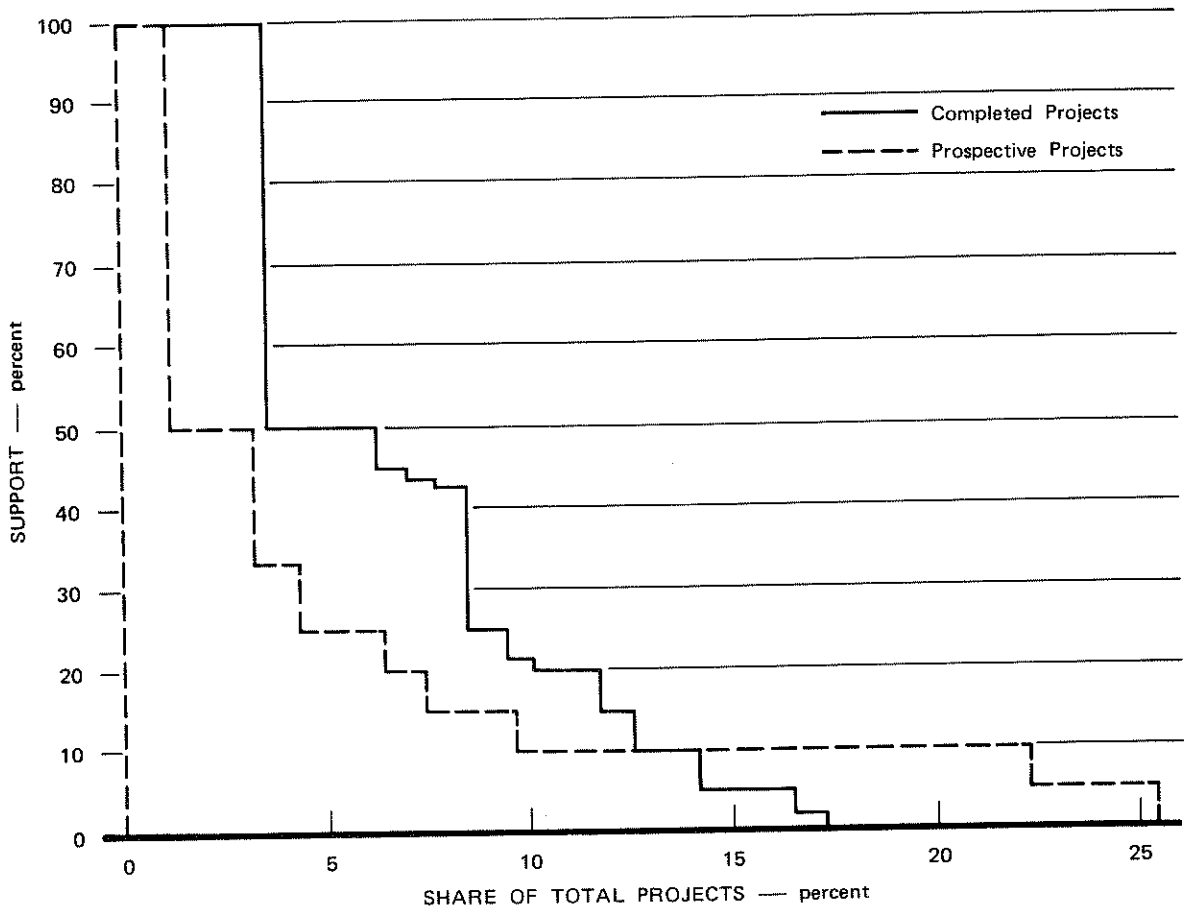


FIGURE 11 CUMULATIVE DISTRIBUTION OF LOCAL SOURCES FOR 73 COMPLETED PROJECTS AND 38 PROSPECTIVE PROJECTS BY SHARE OF SUPPORT

- A high federal support level of 80 percent to 90 percent for justifiable projects.
- A moderate federal support level, say 70 percent, with provision for state support of 50 percent or more of the balance.
- A variable federal support level, say between 70 percent and 90 percent, depending on a city's ability to pay and a state's ability to offer partial support.

The third policy, while perhaps more equitable and more likely to conserve federal funds, would be difficult to administer and has the disadvantage of presenting an added uncertainty to cities in the planning stages of the project as to the level of federal support that might eventually be authorized.

Authorizing the use of highway funds for railroad relocation under present methods of allocating urban system funds by population would probably lead to few starts for new relocation projects because the other transportation needs of nearly all cities are too urgent to permit setting aside or accumulating sufficient funds to finance relocation projects. Committing urban system highway funds against payments for railroad relocation bonds would be feasible in principle but probably too risky in practice for most cities. The alternative, creating a special fund for discretionary relocation grants similar to capital grants for transit systems, is not an easy or inexpensive path but appears necessary if there is a significant national interest in facilitating urban railroad relocations.

We find nothing in the principles of revenue sharing or of, say, the single transportation fund recently advocated by the ACIR that would contradict the creation of a special fund for railroad relocation assistance. Similarly, in discussions with the National League of Cities, there is no lack of support for discretionary federal funding of special programs in areas such as this where needs vary considerably between cities and where a high degree of intergovernmental and public/private cooperation is desirable in the planning stages.

The justification for federal funding is that the federal government should: support projects that provide benefits to highway users, maintain and improve the national resource represented by the railroad network, compensate communities for the environmental degradation they suffer in maintaining the natural resource of the railroads, and support a national commitment to improving the quality of life in American cities.

It is also apparent, from this study, that incentives are required if a sizable volume of railroad relocation projects are to be undertaken. The cost of relocation projects generally places them beyond the financial capability of communities. Federal or state funding should be provided in amounts that will induce a community to try harder to gather funding that is within the local capability.

The extent to which federal financing should be utilized should be determined in harmony with similar federal programs. For highway benefits, there is justification for a split ranging from 95 percent to 100 percent federal funding permitted for the elimination of railroad highway grade crossing, to the 70 percent used for most Federal Aid Highway projects. Federal support of community objectives and needs should similarly be commensurate with the levels of support inherent in other federally managed, community oriented programs, such as those of the Department of Housing and Urban Development and the Department of Health, Education and Welfare.

Similarly, incentives may be offered to the railroads. The railroads can argue that their own operating benefits will not, in most cases, justifiy a large contribution to railroad relocation projects. In the projects we have examined, railroads benefit on the average only slightly in reduced operating costs from relocation and sometimes incur higher costs. But there are large railroad benefits from relocation in a few cases. This argues that the degree of railroad participation in financing relocation might be worked out with individual cities on a case-by-case basis rather than being included in any federal criteria or cost-sharing formulas. As an alternative, considering the national rail network as similar to the national highway network in importance and public benefits, levels of funding equivalent to those for highway projects could be justified. For example, in its action to subsidize rail lines that are clearly committed to local service, the Congress through the Regional Rail Reorganization Act of 1973 has stipulated a 70-percent federal/30-percent nonfederal division of subsidy funds.

Determination of the railroad share also should recognize both the high minimum attractive return on investment for expenditure of railroad funds (typically two or three times the ten-percent discount rate used in evaluating public projects) and the associated difficulty of raising railroad investment capital. In the case of highway users, highway trust funds contributed by users are available. For railroads, a user-financed source of funds is not available, and given the rail industry's poor access to external sources of capital, federal loans or loan guarantees would be essential in many cases when railroads participate in project funding, even if the results of the project itself will generate the operating cost savings necessary to finance the railroad share.

Appendix A

STATISTICAL ANALYSIS

Appendix A

STATISTICAL ANALYSIS

This appendix presents estimates of the uncertainty in the estimates of the number of places with railroad conflicts, and then describes the methods for estimating the number of places, program cost, program benefit and the uncertainty of each.

Number of Places with Railroad Conflict

The number of places with an urban railroad conflict is estimated by scoring a sample of smaller communities and by a questionnaire sent to larger entities. The sampling is stratified by region and by population group. Uncertainties arise from sampling effects and scoring errors. The uncertainty due to sampling is a function of the sample size and the proportion of the population in the sample; this uncertainty will be considered first.

Variance is a convenient way of expressing the amount of uncertainty. A group of scattered values can be described as having a mean or center of the group that is the sum of all the values divided by the number of values. The variance is the sum of squares of the difference between each value and the group mean. Standard deviation, sometimes also used to measure the size of uncertainty, is the square root of the variance.

The estimate of the number of places with railroad conflict is the mean fraction of the places in this sample having conflicts, multiplied by the total number of places in the size and regional strata.

Variance of the sample estimate can be expressed as

$$\sigma_e^2 = n_p^2 \frac{p(1 - p)}{n_s} \left(1 - \frac{n_s}{n_p}\right) \quad ,$$

where:

σ_e^2 is the variance of the estimate

p is the proportion of the sample with the characteristic (problem with the railroad)

n_s is the number of observations in the sample

n_p is the number of places in the region and population group.

The equation indicates that increasing the number of observations in the sample will decrease the variance of the estimate. Table A-1 presents the variance and standard deviations of the estimates of number of places that are expected to have a conflict with the railroad in each region and population group. Places with 1970 populations greater than 100,000 were analyzed by a questionnaire and were not stratified by region.

The second source of uncertainty is in the scoring of the attributes that indicate that there is a substantial railroad problem.

Comparison of scores by two observers indicates that the standard deviation of the differences in scoring between the observers is about three percent. This value is squared and applied to the number of places with railroads estimated from the map analysis to produce the scoring variance reported on Table A-2. The total variance of the estimate of number of places is the sum of the scoring variance and the sampling variance. These values are also reported on Table A-2.

Analysis of Programs Based on Benefits and Costs

The project team developed a method for analyzing programs that are defined by a specified minimum benefit-cost ratio for each project. The analysis determines the fraction of projects that would qualify in each population range, considering the mean cost and benefit of projects in those places and the uncertainty in the cost and benefit. In addition, the method allows computation of the mean cost and benefit of the acceptable projects and the variance of cost and benefit of accepted projects.

The analysis in Section IV, illustrated by Figure 6, indicated that benefits of relocation or consolidation projects in a city are partially explained by a city's population in the form:

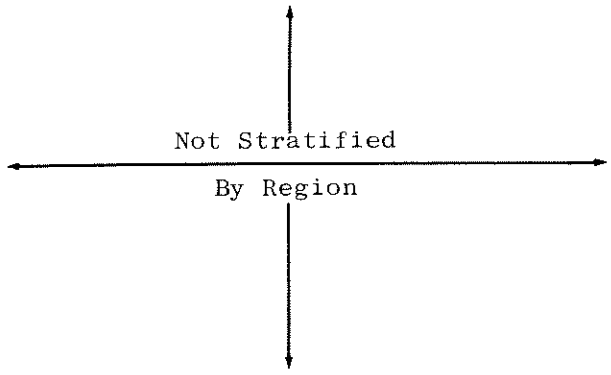
$$\ln(\text{benefit}) = A + B \ln(\text{population}) + e_b \quad ,$$

where ln is the natural logarithmic function, A and B are constants, and

Table A-1

VARIANCE AND STANDARD DEVIATION DUE TO SAMPLE SIZE
FOR ESTIMATES OF RAILROAD PROBLEM OCCURRENCE

Population Range (Thousands)	Region				
	NE	SE	CENT	WEST	TOTAL
5-10	96	77	37	20	
	41%	18%	27%	55%	
	1431.4	273.7	566.2	855.0	3125.9
	37.8	16.5	23.7	29.2	55.9
10-25	103	57	31	17	
	37%	14%	19%	76%	
	685.3	127.8	290.8	610.1	1714.0
	26.1	11.3	17.0	24.7	41.4
25-50	30	20	17	3	
	37%	25%	29%	100%	
	338.0	62.1	73.8	982.6*	1456.5
	18.3	7.8	8.5	31.3	38.1
50-100	11	8	2	2	
	73%	25%	0%*	50%	
	180.5	16.7	124.7*	527.2*	849.1
	13.4	4.0	11.2	23.0	29.1
100-250					3.7
					1.9
250-500					1.5
					1.2
500-1000					0.8
					0.9
Over 1000					0.5
					0.7



Note: Sequence of numbers in each cell:
Number of places in sample
Percent with scored railroad conflict
Variance of estimate of number of places with conflict
Standard deviation of estimate of number of places with conflict.

*Variance computed from row averages of percentages.

Table A-2

SCORING AND TOTAL VARIANCE FOR ESTIMATES
OF RAILROAD PROBLEM OCCURRENCE

Population Range (thousands)	Estimated Number Railroad Problems	Variance			Total Standard Deviation
		Scoring	Sample	Total	
5-10	645	832.6	3125.9	3958.5	62.9
10-25	500	665.8	1714.0	2379.8	48.7
25-50	248	123.0	1456.5	1579.5	39.7
50-100	118	18.1	849.1	867.2	29.4
100-250	90	--	3.7	3.7	1.9
250-500	27	--	1.5	1.5	1.2
500-1000	18	--	0.8	0.8	0.8
Over 1000	5	--	0.5	0.5	0.7

e_b is the residual value, or uncertainty in the estimate. Analysis shows that e_b has a probability distribution that is appropriately described by the normal, or gaussian function, with mean = 0. The variance of e_b is the variance of the estimate of benefit.

Similarly, the cost function, determined from about 30 points, illustrated by Figure 4, indicates that the expected cost of a project is related to population in such a way that

$$\ln (\text{cost}) = A_c + B_c \ln (\text{population}) + e_c \quad .$$

The residual value, e_c, is assumed to have a probability density distribution that is described by the normal, or gaussian function, with mean = 0 and variance from Table 11.

Figure A-1 will help illustrate the analysis as it continues. In the figure, the mean cost and benefit (on a logarithmic scale) are determined from the equations relating cost and benefit to population.

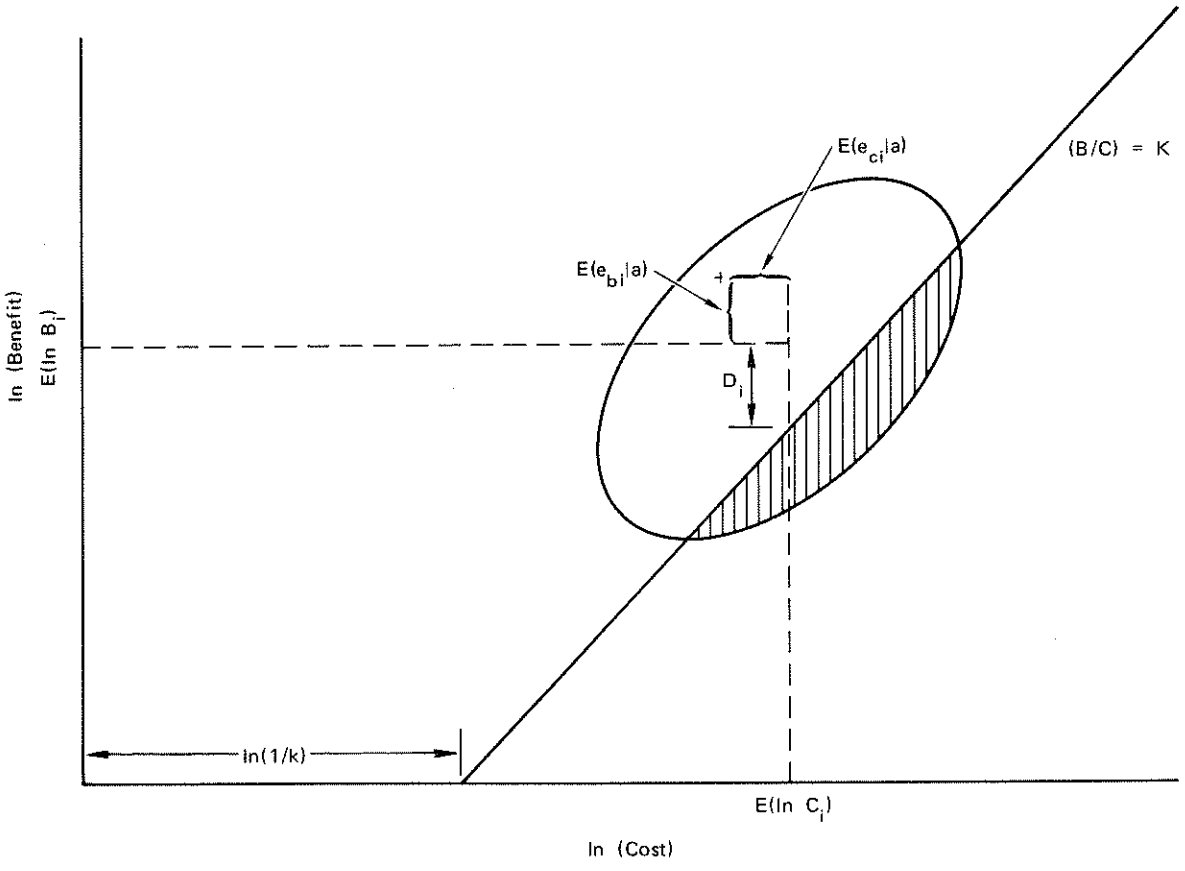


FIGURE A-1 ILLUSTRATION OF UNCERTAINTY IN ESTIMATES OF COSTS AND BENEFITS

Denoting by E(X) the mean or expected value of a random variable X, and calling P_i the representative population size (geometric mean) of the ith population group, we obtain from the regression equations:

$$E\ (\ln C_i) = A_c + B_c \ln P_i$$

$$E\ (\ln B_i) = A_b + B_b \ln P_i$$

The uncertainty of the estimates of benefit and cost are indicated by the ellipse around the mean cost and benefit for a particular population size group. The ellipse is a contour representing a constant probability density. The deviations from the mean values are the residual values e_c and e_b described above. That is, the cost and benefit of a particular project from the population group could be represented by $\ln (C_i) = E(\ln C_i) + e_c$ and $\ln (B_i) = E(\ln B_i) + e_b$, where e_c and e_b are random variables with mean = 0, standard deviation σ_c and σ_b, respectively, and coefficient of correlation, ρ.

The diagonal line on the figure represents the minimum benefit/cost ratio defined by the program. If the project cost and benefit, when plotted on the figure, fall below the diagonal line, the project is rejected; if above, the project is acceptable. The shaded area of the ellipse indicates the proportion of unacceptable projects; the unshaded portion, the proportion of acceptable projects.

The probability that a project from population group i will be accepted, under a program characterized by a benefit/cost ratio equal to K can be computed as a function of the parameter D_i (see Figure A-1) where:

$$D_i = E(\ln C_i) - E(\ln B_i) + \ln K \quad .$$

The probability of acceptance, P_a is computed

$$P_{ai} = \frac{1}{2}\left[1 - \phi\left(\frac{D_i}{\sqrt{2}\,\sigma_d}\right)\right] \quad ,$$

where $\phi(x)$ is the error function defined by

$$\int_o^x \frac{2}{\sqrt{\pi}} e^{-t^2} dt \quad ,$$

and σ_d is a constant computed as follows:

$$\sigma_d^2 = \sigma_c^2 - 2\rho\sigma_c\sigma_b + \sigma_b^2 \quad .$$

Because the projects rejected are those that have lower benefits and higher costs, the mean cost and benefit of the acceptable projects will shift, as indicated on Figure A-1. Call $(e_c|a)$ and $(e_b|a)$ the error terms on ln (cost) and ln (benefit) conditional upon acceptance of the project. The means and variances of these conditional variables are computed as follows:

$$E(e_{ci}|a) = \frac{k_c\sigma_c}{\sqrt{2\pi}\ P_{ai}} \exp\left[-\frac{1}{2}\left(\frac{D_i}{\sigma_d}\right)^2\right]$$

$$E(e_{bi}|a) = \frac{k_b\sigma_b}{\sqrt{2\pi}\ P_{ai}} \exp\left[-\frac{1}{2}\left(\frac{D_i}{\sigma_d}\right)^2\right] \quad ,$$

where

$$k_c = \frac{\sigma_c^2}{\sigma_d^2}\left(\rho\frac{\sigma_b}{\sigma_c} - 1\right)$$

$$k_b = k_c + 1$$

and

$$\sigma^2(e_{ci}|a) = \sigma_c^2 + E(e_{ci}|a)[k_c D_i - E(e_{ci}|a)]$$

$$\sigma^2(e_{bi}|a) = \sigma_b^2 + E(e_{bi}|a)[k_b D_i - E(e_{bi}|a)] \quad .$$

The mean values and variances of ln (cost) and ln (benefit) conditional upon project acceptance are therefore:

$$E[\ln (C_i|a)] = E(\ln C_i) + E(e_{ci}|a)$$

$$E[\ln (B_i|a)] = E(\ln B_i) + E(e_{bi}|a)$$

$$\sigma^2[\ln (C_i|a)] = \sigma^2(e_{ci}|a)$$

$$\sigma^2[\ln (B_i|a)] = \sigma^2(e_{bi}|a) \quad .$$

These mean values and variances correspond to cost and benefit still defined on a logarithmic scale. The conversion to a linear scale can be done using the second order relationships:

$$E(X) = \left[1 + \frac{1}{2}\sigma^2(\ln X)\right] \exp\left[E(\ln X)\right]$$

$$\sigma(X) = \sigma(\ln X) \exp\left[E(\ln X)\right] \quad .$$

The above relationships are only approximate but do not require assumptions about the form of probability distributions.

The cost and benefit of the program defined by the minimum benefit/cost ratio, K, are determined from the number of places with a probable conflict in each population group, N_i, the probability of acceptance of these projects, P_{ai}, and the cost and benefit of those projects conditional upon acceptance. The mean values are:

$$\text{Mean Program Cost} = \sum_{i=1}^{n} E(N_i)P_{ai}E(C_i|a) \quad ;$$

$$\text{Mean Program Benefit} = \sum_{i=1}^{n} E(N_i)P_{ai}E(B_i|a) \quad ;$$

where i is the index associated with the group size and n is the total number of group sizes.

The variances of the program cost and benefit are likewise determined from the preceding quantities and the formulas

$$\text{Program Cost Variance} = \sum_{i=1}^{n} E(N_i)P_{ai}\sigma^2(C_i|a) + E^2(C_i|a)\left[E(N_i)P_{ai}(1 - P_{ai}) + \sigma^2(N_i)\right]$$

$$\text{Program Benefit Variance} = \sum_{i=1}^{n} E(N_i)P_{ai}\sigma^2(B_i|a) + E^2(B_i|a)\left[E(N_i)P_{ai}(1 - P_{ai}) + \sigma^2(N_i)\right] .$$

Appendix B

REPORT OF A SURVEY OF RAILROAD PROBLEMS IN URBAN AREAS*

*A study report by Karyn Kleiman, SRI, originally submitted 27 July 1973.

Appendix B

REPORT OF A SURVEY OF RAILROAD PROBLEMS IN URBAN AREAS

Introduction

In an interim report on the nature and magnitude of urban railroad relocation problems published and submitted to the Federal Railroad Administration by Stanford Research Institute in November 1972, it was reported that reviews made of railroad studies in over 60 cities, 34 of which were relocation plans, as well as other related materials and maps, identified three types of urban railroad problems:

- Type I--Conflict with community travel and environment
- Type II--Inefficient use of community land resources
- Type III--Inefficient railroad facilities.

The interim report also reported on a review of topographical maps of over 200 communities, with the conclusion that almost every city in America with a population of over 100,000 had a problem of conflict between the railroad and community travel and environment. It was estimated that there are 6329 miles of railroad in these problem locations and that the cost of relocating all of the railroad mileage in these cities would exceed $60 billion. Also, an estimated 30 percent of all railroad yards in the United States, or 181 yards, was said to warrant relocation based on conversion of their land to a higher and better use.

To obtain a closer estimation of the magnitude of these problems, a survey was designed to obtain more specific information from each city.* The SRI Urban Railroad Location Survey was sent to the planning directors of each city in the contiguous United States having a population of 100,000 or more according to the 1970 U.S. Census, excluding San Jose and Oakland, California, which served as pilots for the survey, and Denver, Colorado, and Beaumont, Texas, which had been previously studied during recent field trips by the project leader. Data for Denver, Beaumont,

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*See Appendix C.

San Jose, and Oakland are included in the survey results as responses received.

Survey Results

Of the 152 surveys sent, 94 were completed and returned. Of the 94 received, 26 were from the Northeast, 27 from the Southeast, 21 from the Central Region, and 20 from the West. The number of responses from each region is fairly evenly distributed. However, of the 152 surveys sent, 55 were to the Northeast, 36 to the Southeast, 30 to the Central Region, and 31 to the West. Therefore, although there are about as many responses from the Northeast as from other regions, the percentage response from that region is considerably smaller than for the others. The distribution of responses is shown in Table B-1.

As shown in Table B-1, there are far fewer cities in the largest group than in the smallest, so of course fewer surveys were returned from large cities than from smaller ones. Because of this, it is invalid to use these population groups to draw correlations between size of place and the characteristics surveyed. The few responses received from the larger cities showed no apparent differences from the characteristics of smaller cities. Therefore we reduced the number of groups to be analyzed to five: the four regions plus all regions together.

It had been hypothesized that planners of cities with railroad problems would more likely respond to the survey than those who were unconcerned with railroads. We found that 93 percent of the completed surveys indicated at least one railroad problem. However, by selecting nine nonrespondents at random, and telephoning them, we were unable to prove our hypothesis. Planners' responses indicated that failure to respond was due to not receiving the survey, not having the requested information and therefore forwarding the survey to another department, or insufficient time and staff. It was not evident that allotting time and staff to the survey correlated with having a railroad problem. Of the nine nonrespondents telephoned, three had requested information from another city department and were awaiting an answer before returning the survey to us (we later received one of these), two still had the survey and said they intended to respond to it, three claimed never to have received a survey but willingly answered a few of the briefer survey questions on the phone (despite the claim, we later received one of these in the mail), and one survey had been misdirected to the wrong department. Contrary to our hypothesis, the results indicate that information obtained from our 94 respondents should be generalized to the entire sample.

Table B-1

SURVEY RESPONSE BY REGION AND POPULATION GROUP

City Population	Region				Total
	Northeast	Southeast	Central	West	
100,000 - 250,000					
Number of cities in group	38	25	15	19	97
Number of responses	20	21	9	11	61
Percent response in group	53%	84%	60%	58%	63%
Percent of total response	21%	22%	10%	12%	65%
250,001 - 500,000					
Number of cities in group	7	7	9	6	29
Number of responses	1	4	6	6	17
Percent response in group	14%	57%	67%	100%	59%
Percent of total response	1%	4%	6%	6%	18%
500,001 - 1,000,000					
Number of cities in group	6	4	5	5	20
Number of responses	4	2	5	3	14
Percent response in group	67%	50%	100%	60%	70%
Percent of total response	4%	2%	5%	3%	15%
Over 1,000,000					
Number of cities in group	4	0	1	1	6
Number of responses	1	0	1	0	2
Percent response in group	25%	-	100%	-	33%
Percent of total response	1%	-	1%	-	2%
All Population Groups					
Number of Cities in group	55	36	30	31	152
Number of responses	26	27	21	20	94
Percent response in group	47%	75%	70%	65%	62%
Percent of total response	28%	29%	22%	21%	100%

Source: SRI

Discussion

From the survey we hoped to develop reasonable estimates on the severity of nationwide railroad problems, how cities feel about these problems, what cities thought might be done to alleviate the problems, and how much, if any, revenue might be generated locally to finance projects related to resolution of all the railroad problems discussed in the survey.

Part I of the survey dealt with conflict and environment problems related to the railroad. The planner was asked to indicate as many kinds of conflicts as existed in his city. Of the 94 respondents, 87 (93 percent) had at least one of these problems. Types of conflicts reported and the distribution of responses is shown in Table B-2.

The planner was asked to describe briefly the location of sections of railroad that have any of the significant conflicts outlined in Table B-2. He was then asked to rate the severity of the problem on each section in comparison to all other community concerns on a scale from one (minor concern) to five (major concern). A middle score of three is clearly both the mean and the mode for these responses. It is interesting to note in Table B-3 that even in comparison to all other community concerns, 13 percent of the respondent cities found their conflict and environment problems to be of major concern.

Costs to motorists at grade crossings are an indication of the intensity of the conflict between the railroad and the highway. Grade crossing and traffic data were collected for the sections the planner defined as having problems of conflict with the environment. If the planner could not estimate for each problem section the number of miles of railroad right of way, the number of grade crossings, the number of trains per day, and the total average daily highway traffic for those grade crossings, he was asked to provide us with the name and address of the person within his jurisdiction who might be able to.

These grade crossing and traffic data have been computer-analyzed for benefits and costs and are shown in Table B-4. It is important to note that the number of grade crossings used to calculate the costs to motorists is the total number of grade crossings along all problem sections rather than the number of grade crossings that represent a significant conflict with highway traffic (although we may assume that that number is a subset of the total number of crossings given).

There exist 534.2 miles of railroad right of way in the 51 cities that reported mileage of railroad lines in their city causing a significant

Table B-2

SIGNIFICANT CONFLICTS WITH CITY ENVIRONMENT
CAUSED BY RAILROAD LINES

Significant Conflict	Respondents Having This Conflict in at Least One Section of the City	
	Number	Percent of Respondents
Interference with highway traffic	74	79%
Division of the community because of barrier effects	54	57
Undesirable environmental effects (i.e., noise, unsightliness, danger to pedestrians, incompatible land use, etc).	67	71
Others:		
Denies riverfront access	4	4
Lack of maintenance on right of way	4	4
At least one significant conflict	87	93

Note: Figures add to more than totals because of multiple responses.
Source: SRI Urban Railroad Location Survey

Table B-3

SEVERITY OF RAILROAD CONFLICT PROBLEMS IN CITIES

Problem Severity		Sections of Railroad Classified		Average Problem Rating* for Each Respondent City	
Score	Definition	Number	Percent	Number	Percent
5	"Major"	49	19%	10	13%
4		41	15	12	16
3		78	30	28	36
2		44	17	18	23
1	"Minor"	49	19	9	12
Total		261	100%	77	100%

*Ratings for each section in a city were totaled and then divided by the number of sections rated.

Source: SRI Urban Railroad Location Survey

Table B-4

COST TO MOTORISTS AT GRADE CROSSINGS
IN PROBLEM SECTIONS
(in cities over 100,000 population)

	Total 48 Contiguous States
Survey Responses	
Number of cities completing Questions I-8, I-9, I-10	54
Total Costs to Motorists	$31,228,150.00
Mean per city answering	578,299.07
95 percent confidence interval: Mean ±	188,704.80
Estimated National Problem in Cities over 100,000 Population	
Number of cities with conflict or environment problem (see page B-4)	141
Total Costs to Motorists	$81,540,168.87

conflict and environment problem. Within right-of-way mileages with problems, the 55 cities reporting numbers of grade crossings have 1054 grade crossings: means are 10.47 miles of railroad right of way and 19.16 grade crossings per reporting city. Within 95 percent confidence intervals these means are 10.47 ± 3.02 and 19.16 ± 6.72 respectively. Since 93 percent of the respondents cited at least one section with problems (Table B-2), we assumed that the same percent of the 152 cities surveyed, or 141 cities, have at least one section of railroad with at least one of these problems. Therefore, there is an estimated total of 1476 miles of railroad right of way, containing 2702 grade crossings,* that have at least one kind of conflict and environment problem within U.S. cities of 100,000 population or greater.

To alleviate the railroad conflict and environment problems in their cities if there were no restrictions other than financial, many planners would grade separate some or all of their present grade crossings. Of those who had a conflict and environment problem, 52 percent suggested grade separation (two percent of these designated depressing the tracks) as at least one possible solution. Table B-5 lists the various suggestions given to solve railroad conflict problems.

Part II of the survey dealt with land use of railroad yard and/or shop areas. As shown in Table B-6, 61 percent of those responding had at least one yard and/or shop area that might be better utilized. Clearly, the West reported the fewest of these problems yard/shop areas. Of the 88 yard/shop areas reported that might be better utilized, 33 percent had alternative uses stated in a city plan. Sixty-three percent did not have alternative uses stated in a city plan and four percent did not respond to the question. The planner was asked to state all uses that were preferable for each area regardless of whether or not any of these alternatives were stated in a plan. It is interesting to note that the planners indicated that nearly half the present yard/shop areas would be better utilized as an industrial area, which indicates that although these areas are under-utilized, they are most likely compatible with surrounding land uses. The distribution of responses of alternative uses is shown in Table B-7.

After stating the number of yard/shop areas that might be better utilized and possible alternative uses in his city, the planner was asked to estimate the acreage of the yard/shop area and its land value per acre both before and after redevelopment. The 44 planners that complete these questions gave widely varying estimates of acreage. Estimation of acreage

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*Mean multiplied by the estimated number of cities that have at least one section of railroad with at least one problem.

Table B-5

SOLUTIONS SUGGESTED FOR RAILROAD CONFLICT PROBLEMS

Solution Suggested	Number of Times Mentioned	Percent of All Cities Reporting a Problem
Grade separation	45	52%
Relocation of railroad line	27	31
Consolidation of railroad lines	14	16
Sight and/or noise screening along right of way	6	7
Improved land use control along right of way	4	5
Closing streets	3	3
All cities reporting a railroad conflict problem	87	100%

Note: Figures do not add to totals because of multiple responses.
Source: SRI Urban Railroad Location Survey

Table B-6

DISTRIBUTION OF YARD AND SHOP AREAS
THAT MIGHT BE BETTER UTILIZED
(in cities over 100,000 population)

Survey Responses	Region				Total
	Northeast	Southeast	Central	West	48 Contiguous States
Number answering Question II-1	25	26	18	20	89
Number of cities that might better use yard/shop area (s)	20	13	11	10	54
Percent of those answering that might better use at least one yard/shop area	80%	50%	61%	50%	61%
Number answering Question II-2	19	12	11	8	50
Number of yard/shop areas that might be better used	36	18	22	12	88
Mean number of yard/shop areas per city with problem	1.9	1.5	2.0	1.5	1.8
95% confidence interval : Mean	$\pm$.5	$\pm$.5	$\pm$.7	$\pm$.7	$\pm$.3
Estimated National Problem in Cities Over 100,000 Population					
Total Number of Cities	55	36	30	31	152
Number of Cities with yard/ shop area problem	44	18	18	16	93
Number of yard/shop areas that might be better used	84	27	37	24	167

Source: SRI Urban Railroad Location Survey

Table B-7

BETTER USES SUGGESTED FOR AREAS OCCUPIED
BY RAILROAD YARDS AND SHOPS

Suggested Alternative Uses	Areas that Would Be Better Utilized by this Alternative: Number of Times Mentioned	Areas that Would Be Better Utilized by this Alternative: Percent of all Under-utilized Areas
Park or recreation area	25	28
Residential area	19	22
Extension of central business district	24	27
Industrial area	43	49
Alternative transportation facilities	11	13
Public facilities (museum, convention, or cultural center)	7	8
Government services (school, manpower training center, fire station)	3	3
Number of areas that might be better utilized	88	100%

Note: Figures do not add to totals because of multiple responses.
Source: SRI Urban Railroad Location Survey

by regions gave meaningless results because of the wide variations and the small group sizes. Therefore, data are shown only for the entire sample in Table B-8.

Estimation of land values before and after redevelopment received the least response of all questions of the survey. Only planners in 19 cities attempted those estimates. Therefore, even more so than was true for acreage estimation, it is impossible to draw any conclusions about particular regions. Total land value per area was obtained by multiplying the number of acres in an area by the land value per acre. More than twice as many respondents estimated the number of acres per area (see Table B-8) than land values before and after redevelopment. Nevertheless, those for which land values were given reasonably represent the entire sample on the basis of acreage, which is an important factor. The mean acreage of yard/shop areas that might be better utilized per city is 132.3 (see Table B-8) for all responses to that question, and 127.8 for only those who also estimated land values. Table B-9 shows the data and estimates made of land values before and after redevelopment for the 48 contiguous states.

As was done for the conflict and environment problems in Part I of the survey, the planner was asked to rank the severity of the land use problems for each yard or shop area in comparison with all other community concerns on a one (minor concern) to five (major concern) scale. Here, the ratings tended to be a bit lower than those for the conflict and environment problems. The overall mean rating for cities is 2.6. Whereas 12 percent found their conflict and environment problems of major concern, only four percent found the yard/shop land use problems of similar concern.

Part III of the survey requested that the planner describe any other railroad problem not already stated. For the most part, planners took this opportunity to elaborate on problems already indicated. Most other problems were unique to their particular city; however, a few responses were given several times. Six of the 94 respondents felt that the railroad had more land than it should. This varied from railroad ownership of between 10 and 15 percent of the city's land (and in several cases refusing to sell it for what the city felt was a reasonable price) to having a considerably wider right of way than the city deemed appropriate at this time. Seven respondents complained of insufficient or no passenger service. Four complained of insufficient clearance under railroad bridges, and another five cited a lack of communication with the railroads.

Part IV of the survey requested that the planner estimate how much, if any, revenue might be generated locally to help alleviate the problems

Table B-8

ACREAGE OF YARD AND SHOP AREAS
THAT MIGHT BE BETTER UTILIZED
(in cities over 100,000 population)

Survey Responses	Total 48 Contiguous States
Number of cities answering question	44
Number of yard/shop areas for which acreage is given	73
Total acreage	5818.9
Mean per city answering	132.25
95% confidence interval	± 42.56
Estimated National Problem in Cities Over 100,000 Population	
Number of cities with yard/shop area problem (see Table B-6)	93
Acreage of yard/shop areas that might be better used	1229.3

Sources: SRI Survey of Urban Railroad Location; Table B-6

Table B-9

LAND VALUE OF YARD AND SHOP AREAS
THAT MIGHT BE BETTER UTILIZED
(in cities over 100,000 population)

Survey Responses	Total 48 Contiguous States
Number of cities answering question	19
Number of yard/shop areas for which values are given	33
Total value before redevelopment (millions)	$139.7
Mean per city answering (millions)	$7.4
95% confidence interval (millions)	$7.4 ± $4.8
Mean per area (millions)	$4.2
95% confidence interval (millions)	$4.2 ± $2.6
Total value anticipated after redevelopment (millions)	$355.3
Mean per city answering (millions)	$18.7
95% confidence interval (millions)	$18.7 ± $15.1
Mean per area (millions)	$10.8
95% confidence interval (millions)	$10.8 ± 8.5
Estimated National Values of Under-Utilized Yard/Shop Area in Cities over 100,000 Population	
Number of cities with yard/shop area problem (see Table B-6)	93
Value of yard/shop areas that might be better used based upon mean per city (millions)	
Before redevelopment	$683.6
After redevelopment	$1739.2
Number of yard/shop areas which might be better utilized (see Table B-6)	167
Value of yard/shop areas that might be better used based upon mean per area (millions)	
Before redevelopment	$706.7
After redevelopment	$1,798.1

Sources: SRI Survey of Urban Railroad Location; Table B-6

indicated. Six percent did not respond to the question. Of the 87 respondents who have a problem, 48 percent stated that they believed they could not generate any local funds to finance projects related to resolution of any of the problems stated in the survey; 43 percent of the respondents felt they could generate local funds: 13 percent estimated that they could generate under $1 million, another 11 percent estimated $1 million to $5 million, and six percent estimated over $5 million; 13 percent felt they could generate funds but did not venture an estimate of how much.

Prior to the survey no estimates of dollar amounts that might be generated to finance projects had been made. Planners were not asked specifically how much could be generated, but rather they were asked to choose between the three ranges outlined. Even so, many of the planners who ventured an estimate commented that the amount would vary greatly depending upon the exact project proposed.

Other estimates made prior to the survey have been refined by it and in some cases are reasonably close to the originals. The previous estimate that almost all cities of 100,000 population or greater have conflict and environment problems was held but refined to a 93 percentage. Also close was the estimate of the number of railroad yard and/or shop areas occupying land that could be better utilized. The originally estimated 181 yard/shop areas in the United States is somewhat higher than the 167 areas estimated from the survey, but it must be pointed out that the 181 yard/shop area estimate was for the entire United States, whereas the survey estimate is solely for places of 100,000 population or greater. Together these estimates indicate that most of the yard/shop areas that might be better utilized are located in the larger cities.

One estimation made previously that was reduced greatly by the survey was the number of miles of railroad right of way that cause significant conflict and environment problems. The survey estimate of 1476 miles is far more optimistic than the original estimate of 6329 miles in the larger cities, which was based on the assumption that all rail mileage in larger cities was a problem. Specific problem areas within cities were pointed out by the planners and only these mileages recorded in the survey. It is, of course, apparent that to alleviate the problems within these defined areas considerably more mileage would have to be involved. Nevertheless, the original estimate of the length of right of way in large cities causing a problem appears to be about four times the actual mileage.

Appendix C

QUESTIONNAIRES AND TRANSMITTAL LETTERS

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA 94025
(415) 326-6200

Dear Sir:

Stanford Research Institute is conducting a study of urban railroad problems for the Federal Railroad Administration, an agency of the U.S. Department of Transportation. As I am sure you are aware, railroad facilities in many cities are still in locations which they occupied when they were built many years ago to serve passengers, whereas their customers now are primarily industrial concerns which do not require mainline rail routes through town. Consequently, railroads unnecessarily interfere with street traffic, divide the community, and occupy land that might be used for some higher and better purpose.

We are asking the cooperation of planners in the 150 largest cities in the country to provide information on railroad location problems in their communities. We will use the information that we collect to estimate the number of cities that are encountering these problems and the severity of the problems to the communities.

There are four kinds of information that we need from you or from someone in your department about your city;

I. Problems related to conflict between train movements and street traffic and other environmental problems.

II. Yard and shop areas that might be used for higher and better purposes.

III. Railroad location problems that do not fit comfortably into either of the above classes.

IV. Estimated amount of community financial support that could be raised to help solve the railroad problems.

If you do not have detailed data in either the planning department or other city departments to complete the questionnaire, we would appreciate your answers based on your best judgment.

CABLE: STANRES, MENLO PARK / TWX 910-373-1246

If you would like a tabulation of responses to this survey, there is a box to check at the end of the questionnaire. Please include your address. If you have any questions, please call me at (415) 326-6200, extension 4892. Because of project scheduling demands, we would appreciate your response within a week's time if at all possible. Thank you.

Sincerely,

Albert E. Moon
Project Leader
Railroad Relocation Project

STANFORD RESEARCH INSTITUTE URBAN RAILROAD LOCATION SURVEY

Directions:
- Please answer the following questions with the best estimates available.
- If additional space is required for any question(s), please attach additional sheets.

PART I: CONFLICT AND ENVIRONMENT

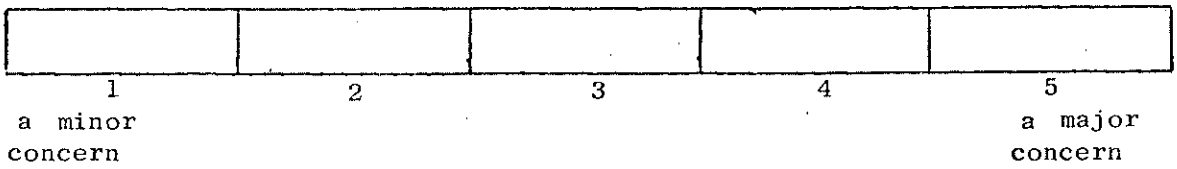
I-1. Does your city have a significant conflict with a railroad because of (check all that apply)

- ☐ A. Interference of the railroad with highway traffic?
- ☐ B. Division of the community because of railroad barrier effects?
- ☐ C. Undesirable environmental effects (i.e., noise, unsightliness, danger to pedestrians, incompatible land use, etc.) caused by railroad lines?
- ☐ D. Other environmental railroad problems? Describe _____
- ☐ E. If none of the above, skip to Part II.

I-2. Describe location of sections of railroad right-of-way which cause any of the above-stated problems. (Enclose map if possible)

ALONG (street, river, etc)	FROM (street crossing)	TO (street crossing)	Section No.
			= S1
			= S2
			= S3
			= S4
			= S5

I-3. In comparison to all other community concerns, how would you rank the conflict problems related to each segment? Place appropriate symbols S1, S2, etc. in appropriate boxes.



I-4. If there were no restrictions other than financial, what would you like to do to alleviate the problem(s) described above?

_____

_____

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Please complete the following table for each section of right-of-way described.

		Section of right-of-way causing a problem				
	QUESTION	S1	S2	S3	S4	S5
I-5.	Name of railroads using the section (abbreviate)					
I-6.	Miles of railroad right-of-way					
I-7.	Number of sets of tracks					
I-8.	Number of trains per day					
I-9.	Number of grade crossings in section					
I-10.	Total average daily highway traffic over all grade crossing in section					

The information for the above table may or may not be within the realm of your planning department. Frequently this information is found with either the city engineer or the traffic engineer; however, we have found that this varies from city to city. If you cannot complete the table, please give us the name and address of the party within your jurisdiction who may have the answers to these questions.

_____
name and title of official

_____
city department

_____
street address

_____
city state zip code

_____
area code telephone number

PART II: LAND USE

II-1. Are there railroad yards or railroad shop areas within your city's limits that might be better used for some other purpose?

Yes ☐

No ☐ Skip to Part III on next page.

II-2. Describe the location of the railroad yard or shop areas that might be better used for some other purpose (indicate on map if possible).

Part of Town	Area No.
	= A1
	= A2
	= A3

II-3. For each yard or shop area located in II-2, please check the appropriate cells in the following table.

	Areas		
Alternatives uses are: (check one or the other)	A1	A2	A3
(1) included in an existing plan	☐	☐	☐
(2) desirable but not in an existing plan	☐	☐	☐
Alternative uses: (check all that apply)			
Park or recreation area	☐	☐	☐
Residential Area	☐	☐	☐
Extension of business district	☐	☐	☐
Industrial area	☐	☐	☐
Other (please elaborate)	☐	☐	☐

Please complete the following table.

		AREA		
		A1	A2	A3
II-4	Initials of railroads using yards or shops			
II-5	Acreage of yard or shop area (estimate)			
II-6	Estimate current land value per acre of property adjacent to areas			
II-7	Estimate anticipated land value per acre after redevelopment			

II-8 In comparison to all other community concerns, how would you rank the land use problem in each of the yard and/or shop areas listed? Place symbols A1, A2, etc., in appropriate boxes.

1	2	3	4	5
a minor concern				a major concern

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PART III: OTHER PROBLEMS

III-1. Please describe any other railroad related problem not already stated.

PART IV: FINANCIAL SUPPORT

VI-1. Do you believe that local funds could be generated to finance projects related to resolution of any of the railroad problems discussed in this questionnaire?

☐ Yes. Estimation of dollar amount:
- ☐ Under $1,000,000
- ☐ $1,000,000 - $5,000,000
- ☐ over $5,000,000

☐ No

Name of respondent _____

Address _____

Telephone number _____
area code extension

Our department ☐ is

☐ is not interested in obtaining the results of this survey.

THANK YOU!

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA 94025
(415) 326-6200

The Federal Railroad Administration, of the U. S. Department of Transportation has asked Stanford Research Institute to help them determine the nature and extent of urban railroad location problems in the U.S.

We need your help in determining the magnitude of railroad grade crossing problems in cities. At the top of the next page of this survey is a list of sections of railroad that are considered a problem, or part of a problem by your city's planning department. For each of these railroad segments, please complete the table on the bottom half of that page with the best estimates available. If no estimates are available, please use your best judgment. We will use your response together with those from other cities to estimate how much it would cost to alleviate conflicts between the railroad and street traffic and what benefits could be derived from relocation of the railroads.

Your thoughtful responses will enable us to give the Federal Railroad Administration a realistic picture of the extent of the problems. This survey has been sent to 150 major cities in the country. If you would like a copy of the survey tabulation, check the appropriate box at the end of the survey. If you have any questions, please call me at (415)326-6200, extension 4892. Because of project scheduling demands, we would appreciate your response within a week's time if at all possible. Thank you.

Sincerely,

Albert E. Moon
Project Leader
Railroad Relocation Project

CABLE: STANRES, MENLO PARK / TWX 910-373-1246

STANFORD RESEARCH INSTITUTE URBAN RAILROAD LOCATION SURVEY

The list of sections of railroad right-of-way shown below has been given to us by the city planner of your city. The sections described here are those for which we need grade crossing and traffic data.

Location of railroad sections

ALONG (street, river, etc.)	FROM (street crossing)	TO (street crossing)	SECTION NO.
			= S1
			= S2
			= S3
			= S4
			= S5

Directions: Please complete the following table for each section located above with the best estimates available. Precise answers are preferred but not necessary.

QUESTION	SECTION S1	S2	S3	S4	S5
Name of railroads using the sections (abbreviate)					
Miles of railroad right-of-way					
Number of sets of tracks					
Number of trains per day					
Number of grade crossings					
Total average daily highway traffic over all grade crossings in section (sum of ADTS)					

Name of respondent _____

Address _____

Telephone number _____
Area code extension

Our department ☐ is interested in obtaining the tabulations of this survey
☐ is not

THANK YOU!

O.M.B. No. 04-573009

Appendix D

URBAN RAILROAD RELOCATION IN WISCONSIN
(Letter Report to the Stanford Research Institute)

URBAN RAILROAD RELOCATION IN WISCONSIN
---Letter Report to the Stanford Research Institute---

I. Wisconsin Railroad Relocation Projects - Increasing Priority

a) Increasing Interest in Railroad Related Activities

Significant sentiment for giving urban railroad related studies and projects (including relocation possibilities) a higher priority among statewide transportation considerations is quite evident in Wisconsin. Many legislators, state and local officials, planners, and citizen groups have shown an increased interest in urban railroad related activities in Wisconsin within the last year.

A number of reasons can be pinpointed for the increasing interest in and higher priority of State railroad related activities. The Wisconsin Department of Transportation's vigorous promotion of all-mode transportation planning and development throughout the State can be cited as one key reason. The present and past involvement of the Department in various critical railroad related activities such as the ongoing National Railroad-Highway Crossing Inventory (Section 203, 1973 Federal-Aid Highway Act), playing an active role in railroad and rail ferry abandonment cases around the state, and the ongoing State Rail Plan project is an additional important reason.

The WDOT has detected a rather high degree of interest in railroad related matters among local officials and citizens around the State. Many appear to have a real concern for the retention and improvement of rail service in Wisconsin communities. Some local officials also feel that in certain instances the relocation of specific rail lines should be given consideration. This interest has been specifically voiced at area public conferences held in various areas of the state in conjunction with preparation of the all-mode State Transportation Plan.

Other indicators of the increased interest in and higher priority of urban railroad related activities (including relocation) within the State are: the investigative hearings of the Highway Committee of the Wisconsin Legislative Council; the strong viewpoint of the Department of Local Affairs and Development (DLAD) on railroad-community land-use conflicts;[1/] increased federal activities, legislation, and funding possibilities; and the increased interest and concerns of the railroad companies regarding the financial impacts and benefits of relocation, and other matters such as local restrictions on train operations and highway grade crossings, which have surfaced in informal staff discussions with rail officials.

1/ Statement to Legislative Council Highway Subcommittee, Department of Local Affairs and Development, November 8, 1974.