Benefit-Cost Analysis of a Proposed Rail Line Relocation: A Case Study

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ABSTRACT

Although the economic principles associated with conducting a benefit-cost analysis of a proposed rail project have been discussed in the literature, there are few articles that demonstrate these techniques within the context of a practical case study. An attempt is made herein to demonstrate one particular approach that was taken to evaluate the economic feasibility of a proposed rail line relocation. In 1984 the Florida Department of Transportation completed a study of the feasibility of constructing a railroad bypass of the Pensacola-Milton, Florida, urbanized area. This paper is a report on that portion of the study concerned with the benefit-cost analysis. The results of the benefit-cost analysis indicate that, from the standpoint of pure economic efficiency, the project is not desirable. The benefit-cost analysis reveals that only between 69 and 83 percent of project costs are offset by quantified benefits. In addition, an evaluation of the distribution of present value benefits demonstrated that the Seaboard System Railroad would be the prime beneficiary of the project.

Section 5 of the Department of Transportation Act of 1966, as amended by the Local Rail Service Assistance Act of 1978, requires states to include a benefit-cost methodology, to be used in evaluating rail projects, in their State Rail Plans. Benefit-cost guidelines, which were intended to suggest how a state might conduct such an economic analysis, were produced by the Federal Railroad Administration (FRA) (1). A subsequent article (2) was written to further aid the analyst in estimating the true economic benefits and costs of proposed state rail projects. Although both of these publications focus on the difficult theoretical issues associated with conducting a benefit-cost analysis, there are few articles that demonstrate these techniques within the context of a practical case study. Aside from the theoretical complexities of such an analysis, there are also difficult measurement problems that must be overcome. According to the FRA (2), branch-line benefit-cost studies submitted to its Office of State Assistance by state transportation agencies have been filled with analytical flaws that have produced misleading results. This paper is an attempt to illustrate, through a case study, one particular approach that was taken to evaluating the economic feasibility of a proposed rail line relocation. In addition, the application of benefit-cost analysis under realistic (and less than ideal) conditions of incomplete information is demonstrated. Time and budgeting constraints did not allow the environmental effects of the project to be addressed. Nevertheless, every reasonable effort was made, including the use of a special train performance calculator and a grade crossing delay computer program, to consider all significant effects of the project.

BACKGROUND

In 1979 the Florida Department of Transportation (FDOT) completed a study (3) to evaluate the possibility of establishing a main-track bypass of the urbanized areas of Escambia and Santa Rosa Counties in Florida. The document contained several alternative alignments for a main-track bypass of the urban area and a recommendation that one alignment be implemented. This alignment, however, was not well received by the public and implementation was not pursued.

In early 1983 the Seaboard System Railroad (SBD) notified the FDOT that it was initiating steps to replace its Escambia Bay trestle and inquired about the status of the bypass. Implementation of the bypass would eliminate the need for the trestle and the SBD would avoid the expense of a replacement structure estimated to cost $23 million.

Subsequently, the Pensacola Urbanized Area Metropolitan Planning Organization requested the FDOT to reexamine the feasibility of a railroad bypass of the Pensacola-Milton, Florida, urbanized area. Although there are a number of problems or issues presented by the location of the existing SBD main track in the urbanized area, these issues principally relate to the dense population along the route and associated vehicular delay and safety considerations at local rail-roadway grade crossings and the transportation of hazardous material.

Preliminary investigations were made to determine if the potential existed for a corridor that had not previously been examined and that would permit the location of a main-line railroad operation with minimum interference with existing and planned development in the two-county area. The 1979 effort failed in large part because of citizen concern over the recommended location, which was close to existing and potential population centers. A new corridor was identified (Figure 1), which offered the best possibility of meeting the criteria necessary for community acceptance and was adopted for this evaluation. In 1984 FDOT completed a study (4) on the economic feasibility of the proposed project. This paper is a report on that portion of the study concerned with the benefit-cost analysis.

Included in this paper is a description of the economic principles considered, analytical techniques used, and primary conclusions reached in evaluating

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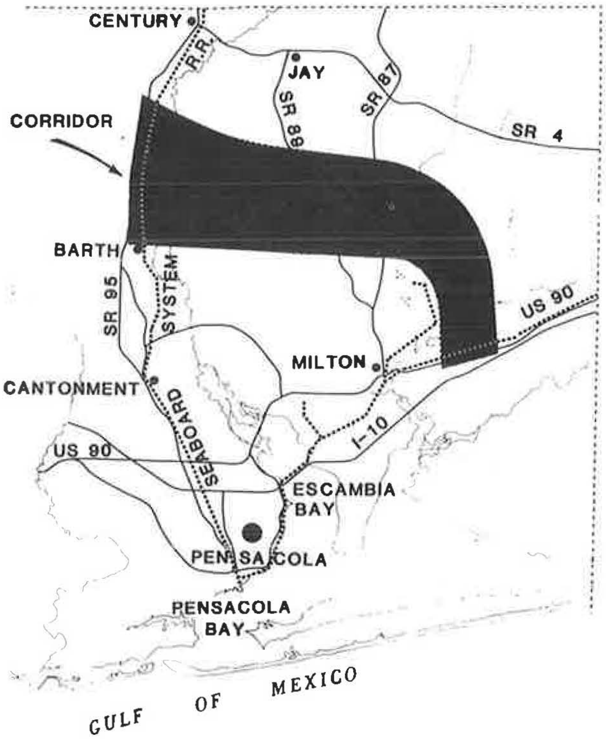

FIGURE 1 Study corridor.

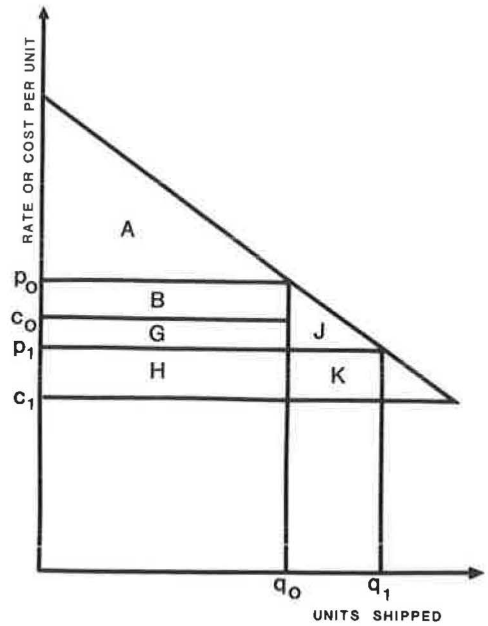

FIGURE 2 Demand curve for freight transportation (from U.S. Department of Transportation).

the project. Even though other factors may also be important, maximizing economic efficiency was the primary decision criterion used in the analysis. The analytical framework proposed by the FRA (1) was used as a point of departure in the study. Although these FRA guidelines were primarily produced to aid in the evaluation of railroad branch-line projects, most of the economic principles and techniques are equally relevant to this proposed main-line relocation. The benefits derived from changes in transport rates and cost as a result of the proposed project are best illustrated with the aid of Figure 2, a demand curve for freight transportation, and the following formula:

$$(B_1 - B_0)_t = Q_0(C_0 - C_1) + 1/2(P_0 - P_1)(q_1 - q_0) + (P_1 - C_1)(q_1 - q_0) \qquad (1)$$

where

- P = unit rate,
- C = unit cost,
- q = quantity shipped,
- $(B_1 - B_0)_t$ = gain in economic benefits associated with implementation of the proposed project (Alternative 1) over the null alternative of no action (Alternative 0),
- $q_0(C_0 - C_1)$ = cost reduction on existing traffic (Areas G + H),
- $1/2(P_0 - P_1)(q_1 - q_0)$ = consumer surplus on new traffic (Area J), and
- $(P_1 - C_1)(q_1 - q_0)$ = producer surplus on new traffic (Area K).

Consumer surplus, in the illustration, is the difference between what a consumer is willing to pay for some quantity of a product, as defined by his demand curve, and what he has to pay as defined by the price he pays for that amount. Producer surplus is the excess of total revenue over total avoidable cost that accrues to a seller as economic profit. Areas A and B in Figure 2 represent consumer and producer surpluses for the null alternative of no action.

Areas G, H, J, and K show the increase in producer and consumer surpluses that result from implementation of the project. According to the FRA analytical framework, the benefits of a project can be divided into three subcategories: first, actual resources saved or costs avoided on existing traffic (Areas G and H); second, consumer surplus on new traffic (Area J); and, finally, producer surplus (economic profit) on new traffic (Area K).

PRESENT VALUE ANALYSIS

Benefits and costs will occur at different times during the life of the project; consequently, a discount rate was used to convert all benefits and costs to a present value. The authors believe that the appropriate discount rate is the average rate of return that is expected on private investment before taxes and after inflation. Those funds expended for a government project are not funds that would otherwise stand idle. They are obtained by the government from the private sector, either by taxation or by borrowing, or from the government itself by diverting funds from other purposes. If left in the private sector, the funds would be put to use there and would earn a return that measures the value society places on the use of the funds. If the funds are diverted to government use, the true cost of the diversion is the return that would otherwise have been earned. This cost is the opportunity cost of capital and is the correct discount rate to use in benefit-cost analysis.

In recognition that discount rates may reflect both the effects of inflation and the true opportunity cost of money, all costs and benefits were expressed in constant 1983 dollars and the real discount rate reflecting only opportunity costs was used in the analysis. It is believed that the true social opportunity cost of capital, before taxes and after inflation, is approximately 7 percent and this is the correct discount rate to use in an economic analysis. Predictably, the selection of a discount rate has generated a diversity of opinion, although 4 and 10 percent real discount rates appear to represent the extreme upper and lower range of current professional opinion (5,pp.14-15; 6-9). Because the results of the benefit-cost analysis may be sensitive to the discount rate used, calculations were also performed at discount rates of 4 and 10 percent for comparative purposes.

The net present value (NPV) criterion was used to evaluate the stream of costs and benefits over time:

$$NPV_k = \sum_{t=1}^{n} (B_{kt} - C_{kt})/(1 + r)^t \quad (2)$$

where

NPV_k = net present value of project k,
B_{kt} = benefits from project k in year t,
C_{kt} = costs of project k in year t, and
$1/(1 + r)^t$ = present value discount factor at rate of discount r for t years.

The proposed rail line relocation project would be considered desirable from an economic efficiently standpoint if the present value of all project-related benefits exceeded the present value of all project-related costs.

ANALYSIS PERIOD

The benefit-cost analysis was performed for a period of 32 years beginning in 1983 when the study commenced and ending in 2015, 25 years beyond the estimated date the bypass would be available for operations. The interim period represents the elapsed time to arrange for funding, perform detailed engineering, obtain the necessary approvals and permits, and complete construction of the bypass. The 25-year period beyond project completion was selected as a representative project life. Although many components of the project have an economic life well beyond this period of time, cross-ties used in the bypass main track will have reached the end of their useful life and will require replacement. In addition, the mathematics of discounting to arrive at present worth are such that a longer period of time should not produce any significant difference in net present value.

IMPLEMENTATION COSTS

A preliminary bypass route was located within the corridor defined in Figure 1. This route was established following the same general criteria that were used in selecting the corridor itself, minimizing population and activity conflicts, while following sound railroad engineering practices to minimize railroad operating costs.

The bypass route selected extends 29.9 mi from the vicinity of Bogia in Escambia County to the vicinity of Harold in Santa Rosa County. A description of the bypass is given and the manner in which it was selected and designed are fully discussed in the complete study (4). The implementation cost of the bypass project was estimated to be $64,098,446 in 1983 dollars and is summarized by work item for all components in Table 1.

In addition to the cost of construction, there were other costs that the railroad would have to incur because of the project. The condition of the existing Escambia Bay trestle dictates constant maintenance on the part of SBD, which is estimated by the railroad to approximate $1 million per year. These costs will continue to be incurred by the SBD as long as the structure is required for railroad operations (i.e., until the new structure is completed or the bypass implemented). The SBD plans to build a new structure, which could be completed by November 1986, in order to avoid these costs. Thus the $1 million per year must be considered as an additional cost to the SBD for any action that requires continued use and maintenance of the existing trestle beyond the estimated completion date of the new bridge (1986) and before the bypass can be implemented (1990).

TABLE 1 Summary of Estimated Project Costs by Work Item (1983 dollars)

Work Item	Cost ($)
Right-of-way	1,240,000
Grading, drainage, and erosion control	13,869,500
Bridges and grade separations	21,060,000
Track construction	17,860,756
Crossings and crossing protection	98,625
Utility adjustments	323,900
Shops, scales, office, and other yard facilities	1,285,000
Subtotal	55,737,781
Engineering and contingencies at 15 percent	8,360,665
Total estimated cost	64,098,446

DERIVATION OF BENEFITS

Implementation of the project would result in benefits accruing to both the railroad and the public. An examination of potential categories revealed that many benefits of an economic nature could be quantified following the principles related to the freight transportation demand curve shown in Figure 2. Others could not, however, given time and budget constraints. Reductions in transport costs in the form of railroad savings on existing traffic as well as public savings, which would accrue from alteration of use of the railroad main track, were expected.

Railroad savings were found to result from reductions in operations, derailments, and capital expenditures with additional benefits derived from liquidation of facilities no longer needed. Public benefits were related to decreased exposure to railroad operations, consumer and producer surplus on new rail traffic, and residual value of the project's assets. These benefit categories and their derivation are more fully described in the following sections.

BYPASS BENEFITS--RAILROAD

The proposed bypass would result in positive benefits for the SBD based on a revised operating scheme and removal of the Escambia Bay trestle. Figure 3 shows the existing main track and related facilities as well as the proposed bypass.

Operating Impacts

A forecast of anticipated traffic levels, based on historical trends, and the revised operating scheme were used to estimate the impact of the bypass on SBD operating factors. The analysis was performed, in large part, using a train performance calculator,

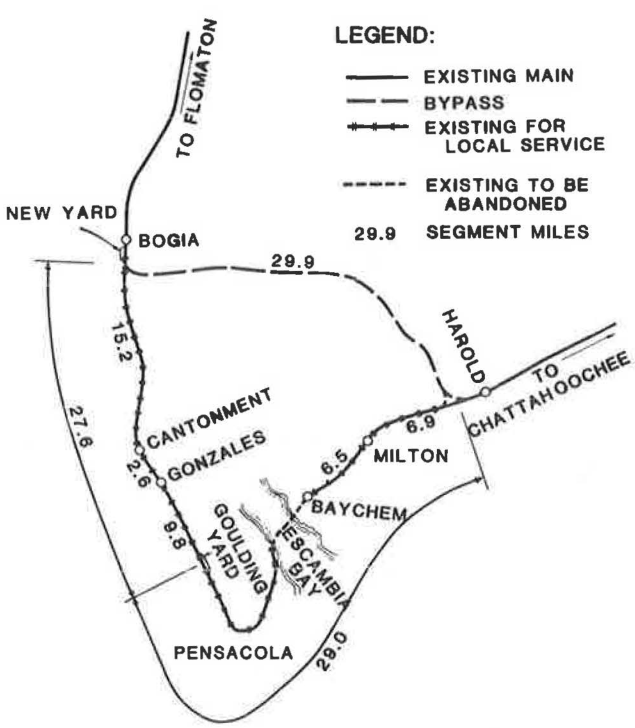

FIGURE 3 Proposed bypass and existing main track.

a computer model that simulates train operations (10). The configuration of the trains and the track alignment and gradients were used as input. In this manner train operations in and through the two-county area were simulated for both the existing main track and the bypass.

A number of operating factors were considered in the analysis. Time and fuel consumption factors were determined using the train performance calculator. Mileage impacts--cars, trains, and locomotive units--were determined from calculations using local traffic origins and destinations and through-car counts. In general, the operating factors examined and quantified on an annual basis increased for local train operations with the revised operating scheme but declined significantly for through and way trains. The latter train categories benefit from the reduction in main-track mileage and improved track geometry. Details on SBD operating impacts are provided in the complete study (4).

The operating impacts that would result from implementation of the bypass and Bogia yard equate to $970,847 in estimated annual SBD savings. These savings are comprised of cost reductions--freight car miles, fuel consumption, and locomotive repair and maintenance--that can be directly attributed to the reductions in operating factors previously discussed and given in Table 2.

Although time savings would be produced with implementation of the bypass, these savings cannot be directly translated into reductions in expenses. Because of local work rules, time savings for train crews cannot be readily converted into wage changes; thus there would be no reduction in each crew's assignment. Time savings for equipment, locomotives and freight cars, will not equate to savings unless there is an improvement in utilization of the equipment. Unless the time savings can be shown to actually improve utilization, such as making a connection with another train at a distant terminal that could not have been made otherwise, the time saved cannot be viewed as an economic benefit. Although there might be some improvement in utilization somewhere on the SBD, it would be difficult to ascertain and quantify.

TABLE 2 Annual SBD Operating Savings with Bypass Implementation

Item	Quantity	Unit Cost[a]	Annual Savings ($)
Fuel	523,400 gal	0.92 per gallon[b]	481,528
Car-miles	3,543,600	0.0848[c] per car-mile	300,497
Locomotive repair	21,753,680 locomotive gross ton-miles	0.00868[d] per locomotive gross ton-mile	188,822
Total			970,847

[a] 1983 dollars.
[b] Average cost including labor over last 4 years based on Louisville and Nashville Railroad 1982 costs and the American Association of Railroads (AAR) fuel index.
[c] SBD unit costs for 1981 based on typical car types used or transported through the study area and AAR Railroad Cost Recovery Index.
[d] SBD unit cost for 1981 and AAR Railroad Cost Recovery Index.

Derailment Impacts

Another factor to be considered in relation to SBD main-line operations is the reduced potential for derailments if the bypass route were used. This consideration involves not only the number of derailments but the consequences of those that do occur. Derailments affect both the railroad and the public and pose the potential for the severest consequences of all factors considered. This discussion therefore covers benefits that are attributable to both the railroad and the public and is further developed later in the section on public benefits.

Between 1975 and August 1983, 31 derailments occurred in the two counties on lines of the SBD. Of the total number recorded, 15 occurred on the existing main line within the limits affected by the proposed bypass route. The derailments, which comprised all of the injuries and fatalities reported, resulted in 11 injuries and 2 fatalities.

Railroad derailments usually result from problems related to one of three major factors--track, equipment, or human error. Relating these factors to estimated reductions in railroad operational measures (track, main-line mileage; equipment, car- and locomotive-miles; human error, operating hours and train-miles) indicates that a 39 percent weighted reduction in derailments could reasonably be expected as a result of the reduced exposure. The calculations on which the weighted reduction in derailments was based, are provided in the complete study (4).

Main-line derailments reported in the area resulted in estimated costs to the railroad (property damage and clearing wrecks) ranging between $7,830 and $861,212 per occurrence. The costs do not include some perhaps more far-reaching costs such as settlement of lawsuits. The average cost per derailment was $178,932 in 1983 dollars. Based on the frequency of occurrence of 1.7 derailments per year over the main-line segment affected by the bypass, the reduction in derailment potential of 39 percent, described previously, and the average historical cost of derailments, annual SBD savings of $118,632 ($178,932 x 1.7 x 0.39) could be anticipated with use of the bypass.

Liquidation of Assets

The revised scheme of operations resulting from use of the proposed bypass would enable SBD to liquidate some of its assets that would no longer be needed. The new yard at Bogia would render approximately 77 acres of land at Goulding yard available for use for purposes other than railroad operations. With removal of the Escambia Bay trestle, a section of the existing main line (Figure 3) would no longer be needed for train operations because of the elimination of through trains and the absence of rail users. On the basis of the market and net liquidated values of the properties and track materials, resources equal to $957,100 would be available for other uses.

Escambia Bay Trestle

The largest benefit of the bypass to the SBD is the expenditure saved by avoiding the need to construct a new trestle across Escambia Bay. The new trestle is estimated to cost $23 million.

BYPASS BENEFITS--COMMUNITY

There are community benefits associated with the proposed project that include the residual value of the project's assets and costs avoided by reducing derailments, grade crossing delays and accidents, and the community's vulnerability to hazardous material transported in and through the urban area.

Residual Value

It is estimated that the residual value of the project's assets, primarily right-of-way, rail, and structures, will have a market value of $14,922,000 in the last year of the analysis period (2015).

Derailment Impacts

Injuries and fatalities associated with derailments occurred at the rate of 1.25 and 0.23 per year, respectively, from 1975 to 1983. The reduction in derailment potential of 39 percent, described earlier, can be equated to lowering the annual injury and fatality rate to 0.49 and 0.09, respectively.

The National Safety Council (NSC) estimates that the average cost per injury was $8,000 in 1983 (11). The problem of placing a value on human life has been extensively addressed in the literature (12-14). Some economists have argued that the relevant benefit measure of an endeavor that affects human life should be based on an individual's willingness to pay for a marginal change in the probability of survival (13). Thaler and Rosen (15) analyzed a sample of individuals and, using risk compensating wage differences to estimate risk premiums, estimated the value of life in 1983 dollars at $612,627. Using these estimates, the total value to be placed on lowering the annual injury and fatality rate is $59,056 per year. These calculations are given in Table 3.

TABLE 3 Calculation of Community Derailment Impact Savings with Bypass Implementation

Item	Description	Value
a	NSC average cost per injury ($)	8,000.00
b	Thaler and Rosen estimated value of a life ($)	612,627.00
c	Injuries per year 1975 to 1983 in the study area	1.25
d	Fatalities per year 1975 to 1983 in the study area	0.25
e	Reduction in injuries per year = 39 percent reduction in derailments x c	0.49
f	Reduction in fatalities per year = 39 percent reduction in derailments x d	0.09
g	Value to be placed on lowering annual injury rate = (a x e) ($)	3,920.00
h	Value to be placed on lowering annual fatality rate = (b x f) ($)	55,136.00
i	Total value of reduced injuries and fatalities per year = (g + h) ($)	59,056.00

Impacts of Grade Crossings

From a public viewpoint, elimination of through and way train operations from the existing main line, leaving only local trains and switch engines whose operation is limited to local service, results in a tremendous reduction in potential grade crossing conflicts. Although the existing crossings would remain, the majority of them would only be subjected to a few train movements per day if the bypass were implemented. This reduction in train movements would decrease person and vehicular traffic delay at the crossings, reduce the potential for vehicle-train accidents at the crossings, and reduce the need for additional crossing signal protection and grade separations. Because the proposed bypass alignment would be grade separated at all arterials, no significant adverse impacts would be generated along the new main-line route.

Delays at Grade Crossings

The cost savings (benefits) associated with the reduction of train movements at the crossings affected by the bypass were estimated using a grade crossing delay computer program (16) in association with the train performance calculator. The two-step procedure consists of, first, estimating the times and durations of grade crossing blockages due to train operations and, second, calculating the highway vehicle delays that would occur as a result of these crossing blockages.

The crossing blockage records produced by the train performance calculator and individual grade crossing average daily traffic and number of roadway lanes are then used by the Grade Crossing Delay Model to calculate the vehicle and person delay resulting from train operations. Average daily traffic was distributed by hour of day using generalized daily traffic hourly percentages. Standard queueing formulas were then used to calculate the vehicles stopped, queue lengths, and total vehicle delay arising from each train blockage. Person delay was calculated using assumed vehicle occupancy rates.

Total person and vehicle delay was calculated by summing the delays resulting from all crossing blockages throughout the travel day. Local wage rates and family income were then used along with the procedures available in the AASHTO publication, A Manual on User Benefit Analysis for Highway and Bus-Transit Improvements (17), to determine average unit costs. A detailed presentation of all calculations is provided in the complete study (4). The results of the analysis indicate that savings with an estimated value of $220,460 would be achieved annually with the revised operating scheme resulting from use of the bypass. These savings are comprised of $87,600 in annual vehicle stop and idle costs and $132,860 in annual person delay.

Accidents at Grade Crossings

The reduction in train movements also reduces the potential for train-vehicle accidents at area grade crossings. The grade crossings of the existing main track, within the limits being evaluated for the bypass, comprise 79 percent of the main-track crossings in the two counties and handle 74 percent of the vehicular average annual daily traffic (AADT). A weighted value based on train movements over these crossings, with and without the bypass, indicates that the probability of a main-track grade crossing accident should be reduced by 54.6 percent. Recent grade crossing statistics equate to 10.5 accidents, 1.4 injuries, and 0.34 fatalities per year. FRA data indicate that the average property damage per grade crossing accident was $1,892 for automobiles and $5,143 for trucks (18). Based on these incident rates, the reduced probability of main-track grade crossing accidents, and the associated costs per incident (accident costs are proportioned from the percentage of the AADT comprised of trucks), grade crossing accident cost savings are $133,474 per year as given in Table 4.

Protection of Grade Crossings

Although the number of grade crossing protection devices currently in use could conceivably be reduced with the reduction in train movements, this is not envisioned. Grade crossing protection upgrading, however, is planned by the FDOT for 14 crossings in the area during the next 5 years. These improvements will require a total expenditure of $578,000, which could be avoided if the bypass were implemented. Also avoided would be maintenance costs associated with these protective devices. Maintenance costs are estimated to total $21,000 per year after installation of all of the devices.

Transportation of Hazardous Materials

The transportation of hazardous materials over the SBD main line through the urbanized areas is a major safety concern of local citizens. Although increases in regulations and technical improvements in railroad tank cars have mitigated the risk and consequences associated with derailments involving hazardous materials, the potential for a major disaster in the urbanized area still exists. A major criterion in selecting the bypass route was a reduction in community vulnerability to hazardous material accidents through decreased exposure of population and property.

Six of the 31 derailments previously discussed required the evacuation of an estimated 3,505 people because of the release of hazardous material. Of the six, five occurred on the existing main line within the limits affected by the bypass. Injuries and fatalities resulting from these derailments were discussed and quantified under railroad derailments. Public costs such as emergency service (overtime), lodging and food, rental equipment, time lost by residents, and volunteer help were not. Although precise information of this type was difficult to obtain, the data available from a variety of sources did indicate that time lost by residents and public emergency service costs that might be avoided by reducing the population exposed to potential derailments amount to $19,285 per year. A much more comprehensive discussion of these estimates may be found in the complete study (4).

The savings do not include consideration of property exposure. Given the improvements and investments in some of the developed property, derailments involving fire or explosions, or both, could prove to have large consequences in the urban areas. Needless to say, the factors that were quantified are at best rough estimates and, if anything, reflect the lower range of potential community savings resulting from reduced exposure.

So far, the economic benefits attributed to the proposed project have been based on actual resources saved or costs avoided on existing traffic (Areas G and H). A summary of the benefits is given in Table 5. The analytical framework proposed by the FRA also suggests that, if possible, the benefits attributed to consumer and producer surpluses on new traffic be addressed. There are, however, significant problems associated with these concepts.

Consumer and Producer Surplus on New Traffic

It is reasonable to consider the possibility that railroad cost savings may lead to lower freight rates, which would then generate new traffic. Consumer surplus on new traffic is the familiar welfare triangle shown in Figure 2 (Area J) and part of Equation 1, which, for simplicity, may be recast as

$$w = 1/2 \Delta P \Delta Q \quad (2)$$

where

w = consumer surplus on new traffic,
$\Delta P = (P_0 - P_1)$, and
$\Delta Q = (q_1 - q_0)$.

Unfortunately, it is difficult to estimate ΔP and ΔQ directly, so a crude approximation will be used and then checked to see how sensitive the results are to any change in assumptions. It has been assumed that all of the railroad's annualized cost savings of $2,205,737 (SBD cost savings in this example were taken from Table 5 and annualized using a 7 percent discount rate) will be passed through to

TABLE 4 Calculation of Grade Crossing Accident Cost Savings

Item	Description	Value
a	NSC average cost per injury ($)	8,000.00
b	Thaler and Rosen estimated value of a life ($)	612,627.00
c	FRA average property damage per grade crossing accident for automobiles ($)	1,892.00
d	FRA average property damage per grade crossing accident for trucks ($)	5,143.00
e	Estimated reduction in grade crossing accidents	0.546
f	Total accidents per year 1975 to 1983 in the study area	10.50
g	15 percent of AADT is trucks, thus truck accidents per year = 15 percent x f	1.58
h	85 percent of AADT is automobiles, thus automobile accidents per year = 85 percent x f	8.93
i	Injuries per year 1975 to 1983 in the study area	1.40
j	Fatalities per year 1975 to 1983 in the study area	0.34
k	Value to be placed on lowering annual truck accidents (property damage) per year = (d x g x e) ($)	4,437.00
l	Value to be placed on lowering annual automobile accidents (property damage) per year = (c x h x e) ($)	9,225.00
m	Value to be placed on lowering annual injury rate = (a x i x e) ($)	6,115.00
n	Value to be placed on lowering annual fatality rate = (b x j x e) ($)	113,728.00
o	Total value of reduced property damage, injuries, and fatalities per year = (k + l + m + n) ($)	133,505.00

TABLE 5 Summary of Benefits Based on Costs Avoided on Existing Traffic with Implementation of Project

Benefit	Amount ($)	Occurrence
SBD		
Operating savings	970,847	Annual
Derailment cost reduction	118,632	Annual
Asset liquidation	957,100	1991-1994
New Escambia Bay bridge construction avoidance	23,000,000	1985-1986
Public		
Derailment injury and fatality reduction	59,056	Annual
Grade crossing delay reduction	220,460	Annual
Grade crossing accident reduction	133,505	Annual
Grade crossing protection installation and	578,000	1984-1988
maintenance avoidance	21,000	Annual
Hazardous materials derailment reduction	19,285	Annual
Residual value of project's assets	14,922,000	2015

shippers in the form of lower freight rates. Although this is an unlikely assumption in a market in which there are so many captive shippers, it should give an upper bound on the estimate. Given the average number of rail cars that has recently either originated or terminated in Pensacola, Florida, each year (34,650), this amounts to a price reduction of $64 per year or approximately 9 percent of the average freight rate per car on the SBD system.

George Wilson (19,pp.15-19) has estimated the aggregate price elasticity of rail transport demand at -0.696. This means that a 9 percent decline in price will lead to a 6 percent increase in quantity demanded or 2,079 cars per year. With ΔP and ΔQ now available, the consumer surplus on new traffic can be estimated at $66,528 per year (1/2 x $64 x 2,079). When the railroad's cost savings in Table 5 are annualized at 4 and 10 percent, the consumer surplus on new traffic is $48,524 and $87,336 per year, respectively.

There are theoretical problems associated with the use of producers' surplus as an economic benefit in this study. Producers' surplus (Figure 2, Area K), the excess of total revenue over total avoidable cost that accrues to a seller as profit in the short run, is transformed into a cost, or otherwise eliminated, in the long run. Therefore, even if there were excess factor payments generated by the proposed project, their value as an economic benefit would only extend over a comparatively short period of time relative to the anticipated life of the project. Mishan (20,pp.55-64) and Anderson and Settle (12) have argued forcefully that the concept of producers' surplus in an increasing-cost industry is not applicable in the long run. For these reasons, estimates of producer surplus have not been included in this study.

BENEFIT-COST RESULTS

Estimated benefits and costs take place at various points in time and must be appropriately discounted to evaluate the relative merits of the proposal. The results of the present value calculations are given in Table 6.

The proposed project would be considered desirable from an economic efficiency standpoint if the present value of project-related benefits exceeded the present value of project-related costs. Clearly this is not the case because discounted costs exceed discounted benefits at all three discount rates. The results of the benefit-cost analysis indicate that from the standpoint of pure economic efficiency the project is not desirable. The benefit-to-cost ratios reveal that only between 69 and 83 percent of project costs are offset by quantified benefits.

TABLE 6 Project's Net Present Values ($000s) and Benefit-to-Cost Ratios at Various Discount Rates

	Discount Rate (%)		
Item	4	7	10
Benefits	45,568	34,273	27,820
Costs	54,691	46,707	40,102
Net present value	-9,123	-12,434	-12,282
Benefit-to-cost ratio	0.83	0.73	0.69

In estimating consumer surplus, it was assumed that all of the railroad's annualized cost saving would be passed through to shippers in the form of lower freight rates. Although this was a fragile assumption, it did provide a useful upper bound on the estimate. Clearly, because the cost of the proposed project far exceeds its benefits, the conclusions are not affected by a change in this particular assumption, which would only reduce the benefit-to-cost ratio.

DISTRIBUTIONAL CONSIDERATION

Benefit-cost analysis, as described here, focuses on the economic efficiency aspects of the proposed rail line relocation. However, policy makers are often as interested in the distributional aspects of a project. Because funding sources have not been identified, it is not possible to determine how the project's cost would be distributed. Nevertheless, a distribution of present value benefits is given in Table 7 and demonstrates that, depending on the discount rate used, the SBD is the beneficiary of between 76 and 85 percent of the quantified benefits.

TABLE 7 Distribution of Present Value Benefits ($000s)

Beneficiary and Benefits	Discount Rates (%)		
	4	7	10
SBD			
Operations	11,525.5	7,045.7	4,522.2
Derailments	1,408.3	860.9	522.6
Asset liquidation	654.4	497.7	382.1
Bridge construction	22,893.0	19,491.7	18,222.8
Subtotal	34,481.2	27,896.0	23,679.7
Public			
Grade crossings			
Delays	2,617.7	1,600.2	1,027.1
Accidents	1,584.8	968.8	621.8
Protection	832.4	685.6	587.5
Derailments			
Hazardous materials evacuations	229.1	140.1	89.9
Injuries and fatalities	701.1	428.6	275.1
Project residual value	4,253.7	1,712.2	706.7
Consumer surplus	867.5	841.4	832.0
Subtotal	11,086.3	6,376.9	4,140.1
Quantified total	45,567.5	34,272.9	27,819.8

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