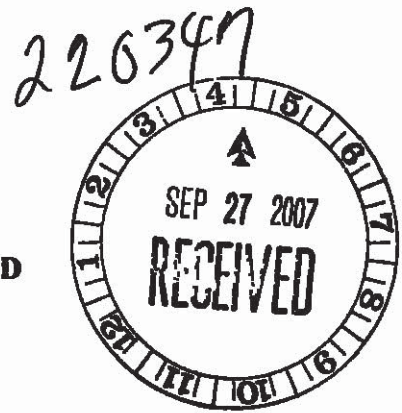


**BEFORE THE
SURFACE TRANSPORTATION BOARD**



METHODODOLOGY TO BE EMPLOYED IN
DETERMINING THE RAILROAD INDUSTRY'S
COST OF CAPITAL

Ex Parte No 664

ORIGINAL

**COMMENTS OF THE
ASSOCIATION OF AMERICAN RAILROADS**

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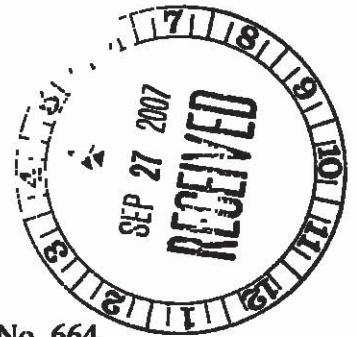
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September 27, 2007

**BEFORE THE
SURFACE TRANSPORTATION BOARD**



METHODOLOGY TO BE EMPLOYED IN
DETERMINING THE RAILROAD INDUSTRY'S
COST OF CAPITAL

Ex Parte No 664

**COMMENTS OF THE
ASSOCIATION OF AMERICAN RAILROADS**

Pursuant to the revised schedule established by the Board's decision served August 31, 2007, the Association of American Railroads ("AAR") and its members respectfully submit these Comments in response to the Notice served in this proceeding on August 20, 2007 ("Notice").¹ AAR also submits in support of these Comments

- (1) a Verified Statement of R Glenn Hubbard, Dean, Columbia School of Business, and Bruce E Stangle, Chairman, Analysis Group, Inc ("Hubbard-Stangle V S "),
- (2) a Verified Statement of Stewart C Myers, Robert C Merton (1970) Professor of Financial Economics at MIT Sloan School of Management ("Myers V S "), and
- (3) a report to AAR prepared by Cambridge Systematics, Inc , *National Rail Freight Infrastructure Capacity and Investment Study* (September 2007)

¹ On August 20, 2007, six days after service of the original Notice, the Board issued a "Corrected Decision" which incorporated changes to the original Notice made in a separate decision served on August 14, 2007, and made corrections to Tables 1 and 2 of the original Notice. See STB Ex Parte No 664, Corrected Decision served August 20, 2007. Unless otherwise noted, all references to the Board's Notice in this proceeding will be to the Corrected Decision served on August 20, 2007.

INTRODUCTION AND SUMMARY

The Notice proposes a radical change in the cost of capital methodology that—as the Board acknowledges—both it and its predecessor, the Interstate Commerce Commission (“ICC”), have used for more than a quarter of a century, and a radical downward reduction in the resulting cost of capital value. See Notice at 2 (acknowledging that ICC settled upon the discounted cash flow (“DCF”) model in 1982 “[a]fter considerable public discourse”) There is no basis for such a dramatic change.

The Board’s Notice proposes to abandon its (and the ICC’s) longstanding reliance on the DCF model and, instead, adopt the Capital Asset Pricing Model (“CAPM”) to determine the cost of equity. Such an approach, if adopted with the particular input values that the Board also proposes, would have resulted in a reduction in Board’s calculation of the railroad industry’s estimated cost of equity for 2005 of approximately 45 percent, and a reduction in the weighted average cost of capital for 2005 of approximately 39 percent. Indeed, under the Board’s proposal, the cost of equity would be even lower than the level that the shipper participants in this proceeding have been advocating. If the Board’s proposed new cost of capital methodology had been in effect for the past few years, *several of the major U.S. railroads would have been found revenue adequate for one or more years*, and the others would appear to be well on their way.

One would have expected that a change of course so far-reaching and unprecedented would be supported by transparent and readily auditable calculations and workpapers, and a thorough analysis of its economic justification and consequences. This is particularly true now, given the potential effect of the Board’s proposal on future revenue adequacy determinations, and the enormous stakes for the American economy in the financial health of the railroad industry. A finding of revenue adequacy is not merely an academic

conclusion Railroads found consistently to be revenue adequate over a sustained period are subject to greater regulatory constraints over pricing² Adoption of an erroneously low cost of capital therefore could have major implications for the railroads' financial health As the ICC found in 1981,

investments earning less than the cost of capital will, in general, not maintain existing funding nor obtain new funding because investors will have sufficient opportunities to invest their funds elsewhere at a higher rate of return It is extremely important to add, however, that this is true of funds generated internally as well Railroad management has little incentive to reinvest funds generated by ratepayers in continued rail uses if greater returns are available elsewhere Railroads are private companies whose stockholders would not permit such reinvestment Thus, even retained earnings will not be invested in the company if they cannot earn a rate of return equal to the cost of capital

Ex Parte No 393, *Standards for Railroad Revenue Adequacy*, 364 I C C 803, 810 (1981), *aff'd sub nom Bessemer & Lake Erie R Co v United States*, 691 F 2d 1104 (3d Cir 1982), *cert denied*, 462 U S 1110 (1983) And damage to the railroad industry's financial health would threaten the American economy as a whole, given the amounts that the industry must invest in infrastructure expansion to keep up with projected growth in freight traffic volume over the next 30 years

The Notice, however, fails even to acknowledge these issues Moreover, as explained in more detail below and the supporting statements of Dean Hubbard/Dr Stangle and

² The cost of capital is also an important input to the Board's regulatory costing system for railroads, the Uniform Rail Costing System ("URCS") A dramatic reduction in the weighted average cost of capital would decrease the variable costs calculated by URCS This in turn would thrust above the jurisdictional threshold a number of freight movements now below the 180 percent revenue-to-variable cost ratio, and therefore outside the Board's jurisdiction A major reduction in the weighted average cost of capital would also increase the reported revenue/variable cost ratios of traffic that is already above the 180 percent threshold This would increase the amount of traffic subject to rate cases and the size of the rate relief the Board could order in rate cases

Professor Myers, it is not fully clear, even to such experts, how the Board derived some of the values underlying its proposed cost of equity and resulting cost of capital calculations

Analysis of the best method for estimating the cost of capital (particularly the cost of equity) for railroads must begin with two fundamental realities. First, all available methods of modeling the railroads' cost of equity are simplifications of reality, and inherently imprecise and uncertain. The return demanded by equity investors cannot be observed directly, and can only be approximated by inference from historical or other indirect evidence. Second, the harms of underestimating the railroad industry's actual cost of capital are likely to be large. Meeting the growing demand for rail transportation of freight is estimated to require about \$150 billion in investment in network infrastructure over the next 30 years. Cambridge Systematics, Inc., *National Rail Freight Infrastructure Capacity and Investment Study* (Sept. 2007) ("Systematics Report")(appended hereto). Without earnings sufficient to cover the industry's full cost of capital, much or most of the necessary investment will not be made.

The generally accepted method of estimating the cost of capital is to consider a range of probative data, reject the extreme values at either end, and adopt a point value within the resulting range. When, as here, the regulated firms need to make large capital investments on additional infrastructure to meet anticipated growth in demand, the point estimate should be above the median of the range.

The attached verified statements of Dean Hubbard/Dr. Stangle and Professor Myers explain how these principles could be applied for two illustrative years, 2005 and 2007. Both the CAPM and the DCF, when run with generally accepted and economically sensible input values, produce equity cost estimates for the four largest United States railroads in the range of 8.8 to 13.1 percent for December 2005, and 10.5 to 16.6 percent for September 2007. Given (1) the inherent imprecision of both the CAPM and DCF models, (2) the massive investment in

additional network infrastructure that the railroad industry must make to meet expected growth in demand in the next three decades, (3) the directive of Congress to the Board to ensure revenues that are adequate to attract and retain needed investment capital, and (4) the potential harms to shippers and consumers if the railroads were prevented by regulation from recovering their cost of capital, the appropriate cost of equity for these two years (or any other years) would be between the midpoint and the upper end of the range produced by the CAPM and DCF models when run with appropriate inputs. *Hubbard/Stangle V S*, ¶¶ 8-12, *Myers V S* at 3-4, 7-8, 14-15.

Regrettably, far from adhering to the above approach, the Board has proposed a methodology that is both unsupported and overly restrictive. First, despite the suggestion in the Notice that the underlying bases for the Board's calculations of the cost of equity and cost of capital in Tables 1 and 2 can be found in the workpapers the Board has made available, that does not appear to be so. For example, the workpapers fail to describe the formula and data that the Board used to calculate the market risk premium – a critical element of its CAPM calculations. Moreover, the workpapers are not fully functional and do not properly indicate the sources of their inputs. The incomplete and inadequate nature of the workpapers is inconsistent not only with the Administrative Procedure Act, but also with the Board's own standards.

Second, even the incomplete information disclosed about the inputs and assumptions underlying the Board's proposed model makes clear that they almost certainly understate the railroads' actual cost of capital. Rather than adopt a point estimate within the range of estimates produced by running the model with standard input values, the Board has adopted outliers. For each key input variable of the CAPM, the Board appears to have systematically chosen an input value at the low end, or below the low end, of the reasonable range. In particular

- The Board has used one value for the constant term for risk-free return, and a different value to subtract from stock market returns in determining the market risk premium. This is a mismatch and an inconsistency. The same risk-free return should be used in both places.
- The Board's CAPM calculations assume a 50-year period for purposes of determining a market risk premium, contrary to the standard approach of using a time period that goes back as far as possible in order to minimize measurement error in the estimates. Consistent with the standard economic approach, the Board should use a time period that goes back as far in time as possible – for example, beginning in 1926 to the present, which is the approach used in the Ibbotson calculation of long-term equity risk premium (on which WCTL's witness relied in his previous testimony). When such a time period is used, a reasonable estimate of the market risk premium falls within the range of seven to eight percent.
- The ten-year period used by the Board to calculate beta is contrary to the standard economic approach of using five years of weekly or monthly data, in order to reflect the fact that betas change. Thus, the Board should use a five-year period. This would produce a reasonable estimate of beta for the railroad industry falling within the range of 1.0 or more, not 0.8.

The resulting cost of equity and weighted average cost of capital estimates derived by the Board from its analysis are far below any reasonable estimate of the cost of equity using *either* the CAPM *or* the DCF methodology. Indeed, the values obtained by the Board are below even the low end of the range of values proposed by shipper groups, such as the Western Coal Traffic League ("WCTL"), in their 2006 comments in this proceeding. For example, the Board's calculations of cost of equity and cost of capital for 2005 under the CAPM were 8.4 percent and 7.5 percent, respectively—both of which figures are lower than the 10.41 percent cost of equity and 8.87 percent cost of capital that the WCTL calculated using the CAPM. Compare Notice at 7-8 (Tables 1 and 2) with Reply Comments of WCTL filed April 28, 2006, in Ex Parte No. 558 (Sub-No. 9), at 2.

Moreover, the Board has eliminated an obvious reality check on the CAPM results by arbitrarily excluding any consideration of the results of DCF estimates of the cost of equity. The reasons offered by the Board for refusing to consider the DCF do not withstand

scrutiny, and are at odds with the mainstream of current cost of capital analysis. The Board's refusal to consider DCF results is particularly indefensible in view of the evidence that, if the DCF and CAPM methods are done properly, the results of the two methods should be roughly equivalent – as participants in this proceeding have acknowledged. Unsurprisingly, multiple-stage DCF models, when run with generally accepted input values, also produce equity cost estimates that are consistent with the range of values that the CAPM produces with proper inputs. *Hubbard/Stangle V S* ¶¶ 8, 45, *Myers V S* at 12-13.

Given the serious concerns identified with the Board's proposals, and the importance of a proper determination of the cost of capital to the railroad industry's health and ability to fund needed investments, "getting it right" is critical. Accordingly, AAR requests that once Reply Comments have been filed, the Board hold a hearing to consider the views of all parties and to hear directly from the experts who have commented on the proposals.

ARGUMENT

I. THE BOARD'S STANDARDS FOR ESTIMATING THE COST OF EQUITY CAPITAL SHOULD ACCOUNT FOR BOTH THE IMPRECISION OF AVAILABLE COST OF CAPITAL MODELS AND THE SIGNIFICANT HARMS LIKELY TO RESULT FROM UNDERSTATING THE RAILROAD INDUSTRY'S ACTUAL COST OF CAPITAL.

A. All Available Methods Of Modeling The Railroads' Cost Of Equity Are Inherently Uncertain And Imprecise.

In principle, the task before the Board in estimating the cost of equity of the railroad industry is straightforward – to estimate the forward-looking returns on equity that investors currently demand for investments of comparable risk. *FPC v Hope Natural Gas Co.*, 320 U.S. 591, 603 (1944) (“[T]he return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks”), *Petal Gas Storage*,

L.I.C. v. FERC, ___ F.3d ___ (No. 04-1166) (D.C. Cir. Aug. 7, 2007), slip op. at 5 (quoting *Canadian Assn. of Petroleum Producers v. FERC*, 254 F.3d 289, 293-94 (D.C. Cir. 2001) (“the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks”))

In practice, however, estimating the returns demanded by investors is inherently judgmental and uncertain. The fundamental problem is that the minimum return on investment needed to attract and retain adequate equity investment cannot be observed directly, and can only be inferred from circumstantial evidence. *Myers v. S.* at 2. The DCF methodology infers the minimum return demanded by equity investors by projecting the future stream of dividends from an equity investment, and determining the discount rate needed to reduce that stream of future cash flows to a present value equal to the current market price of the stock. *Id.* at 4. By contrast, the CAPM methodology calculates the return demanded by equity investors as the return demanded by investors for risk-free investments plus the risk premium for the particular equity investment. *Id.* at 5. The latter is calculated “by comparing the *expected* return on that investment with the *expected* return on the entire stock market.” Robert S. Pindyck and Daniel L. Rubinfeld, *Microeconomics* (6th ed. 2005). See Notice at 2-3.

Although both DCF and CAPM are widely accepted methods of estimating the cost of equity, both models—like all cost of equity models—are simplifications of reality, and should not be assumed to be more precise and reliable than they actually are. *Hubbard-Stangle v. S.* ¶¶ 13-19, *Myers v. S.* at 3, 5-8. The Board has emphasized in its Notice that, when the short-term growth in earnings projected by analysts exceeds the long-run growth rate of the economy, an analyst using the DCF method must make assumptions about the path at which investors expect the former to converge to the latter. Since this convergence, by definition, will

not occur until a number of years into the future, the predictive nature of this assumption injects uncertainty into DCF estimates *See* Notice at 4-5

But the assumptions underlying the CAPM involve at least as much judgment and uncertainty as those underlying the DCF model *See id.* at 6 (“we must make judgment calls whether we use a multi-stage DCF or CAPM model”) The Board recognized in its Notice that although the theory underlying CAPM may be “simple and intuitive,” the actual development of a particular CAPM model “can be complex and still requires the exercise of judgment ” *Id.* at 2 As detailed below, the CAPM model proposed by the Notice makes a number of subjective, and unrealistic or unprovable, assumptions regarding the inputs for the model, including assumptions regarding the appropriate time periods for determining the market risk premium and beta Available estimates of beta often have standard errors equal to 60 percent or more of the estimated values Academics have described the market risk premium as a “big guess ” Many of the assumptions about investor and market behavior underlying CAPM are simplistic or unproven And the empirical track record of CAPM in predicting actual stock prices is poor *See generally* Section IV, *infra*, Hubbard-Stangle V S ¶¶ 14-19, Myers V S at 3, 5-8

B. The Consequences Of Underestimating The Railroads’ Cost Of Capital Are Especially Severe Now Because Meeting The Anticipated Growth In Demand For Freight Transportation Will Require Nearly \$150 Billion of Investment In Network Infrastructure Over The Next 30 Years.

About \$148 billion must be invested to expand the Nation’s freight railroad infrastructure over the next three decades to provide capacity adequate to meet future demand This amount is *in addition to* the approximately \$5 billion needed to replace existing assets as they wear out Cambridge Systematics, Inc , *National Rail Freight Infrastructure Capacity and Investment Study* (Sept 2007) (“Systematics Report”), ch 7 and 8 Demand for rail freight transportation, measured in tonnage, is expected to increase 88 percent by 2035 *Id.* , *passim* “Without this investment, 30 percent of the rail miles in the primary railroad corridors will be

operating above capacity by 2035, causing severe congestion that will affect every region of the country and potentially shift freight to an already heavily congested highway system ” *Id* at ES-2

Studies by the Department of Transportation and others have reached similar conclusions. The DOT has predicted that demand for rail freight transportation will increase 55 percent by the year 2020, and the American Association of State Highway and Transportation Officials (“AASHTO”) projects that freight tonnage will grow by almost 57 percent by that time.³ Most Class I railroads have undertaken substantial capacity expansion and improvement projects in response to this growth in demand for rail service – and they will be called upon to make increasing investments in facilities in the coming years.⁴ In addition, the increasing volume of rail traffic is resulting in more rapid deterioration of, and need to replace, existing rail facilities.

Moreover, if railroad capacity falls short of demand, other modes of transportation are unlikely to pick up the slack. Railroads are the only transportation industry investing heavily in growing freight capacity. Truckers are not building or repairing roads to handle traffic. Overnight air express carriers are not building runways to handle their aircraft. And federal transportation funds are woefully insufficient to pave our collective way out of the transportation crunch. As Undersecretary of Transportation Shane has testified before the Board, there will not be a second “Eisenhower highway plan” like the massive interstate highway

³ Federal Highway Administration, *Freight Analysis Framework* (Oct 2002), FHWA-OP-03-006 (R), available at www.ops.fhwa.dot.gov/freight/documents/fafa_overview.pdf, American Association of State Highway and Transportation Officials, *Freight-Rail Bottom Line Report*, at 2 (2003).

⁴ See, e.g., “Rails Say Capital on Track,” *Traffic World*, March 27, 2006, at 31 (“The nation’s biggest rail carriers will expand their capital spending 21 percent [in 2006], investing \$8 billion on rail cars, track and facilities to keep up record volume growth and improve service”)

program that Congress enacted in the 1950's⁵ In this environment, regulators need to take care to avoid creating disincentives to rail transportation investment by the private sector As the Board has stated, "Government action that would discourage private investment in infrastructure without providing alternative funding would degrade rather than improve service, and plainly would be irresponsible"⁶

⁵ See Testimony of Jeffrey N. Shane, Under Secretary of Transportation For Policy, at April 11, 2007, hearing in Ex Parte No. 671, *Rail Capacity and Infrastructure Requirements*. See also Statement of Jeffrey N. Shane Before the Committee on Transportation and Infrastructure, Subcommittee on Highways and Transit, U.S. House of Representatives, Jan. 24, 2007 (available at <http://testimony.ost.dot.gov/tcst/shane1.htm>) ("How will our transportation system handle these demands? We certainly do not plan to more than double the number of lanes-miles of highways. Lane-miles of highways have increased by only 5.3 percent over the past 24 years, and an extrapolation to 2050 suggests that highway capacity will only increase by 10 percent by that year")

⁶ *Joint Petition For Service Order*, STB Service Order No. 1518, 3 S.T.B. 28 (1998), 1998 WL 63520 (S.T.B.), at *4 (rejecting proposal to force UP/SP to transfer various yards and track to Tex. Mex. and a switching railroad, because proposal would "plainly act as a disincentive to UP/SP's investment in the Houston area") See also, e.g., *Arkansas and Missouri R.R. Co. v. Missouri Pacific R.R. Co.*, 8 I.C.C. 2d 567, 578 (1992) (rejecting proposal to deny a return on sunk investment, because such denial "would discourage future investment"), *Adequacy of Railroad Revenue (1978 Determination)*, 362 I.C.C. 199, 226 (1979) (rejecting "status quo capitalization rate" as a rate-of-return benchmark, because it would "discourage the making of new investments. In this time of concern with the adequacy of rail revenue, we find it difficult to understand how the maintenance of rail earnings at the status quo level could be an appropriate goal"), *Car Service Compensation – Basic Per Diem Charges – Formula Revision In Accordance With the Railroad Revitalization and Regulatory Reform Act of 1976*, 361 I.C.C. 189, 191 (1979) (rejecting "vintage approach" for calculation of cost of debt, because "it could create a disincentive for new investment and efficient utilization"), *Car Service Compensation – Basic Per Diem Charges – Formula Revision In Accordance With the Railroad Revitalization and Regulatory Reform Act of 1976*, 358 I.C.C. 716, 761 (1977) (using inflated dollar growth for calculating cost of equity because using only a real growth rate would fail to recognize investors' opportunities to obtain returns elsewhere that reflect inflationary conditions and expectations, thus creating disincentives to freight car investment), *Eric Boulevard Hydropower, L.P.*, 120 FERC ¶ 61,267 (Sept. 21, 2007), at para. 91, 2007 WL 2758913 (F.E.R.C.), at *22 (denying request to include a condition in renewed license, because doing so would undercut licensee's certainty as to viability of project, "would consequently discourage investment in renewable hydropower, and would be bad policy"), *In the Matter of Petition of Quest Corporation For Forbearance Pursuant To 47 U.S.C. § 160(c) In the Omaha Metropolitan Statistical Area*, 20 FCC Red. 19415, 19468 & n.265 (FCC allowed "forbearance" from "unbundling" requirements of Telecommunications Act with respect to broadband, because requirements

The progress of the railroad industry toward financial recovery since 1980 understandably may have caused memories to fade about the consequences of regulation-induced revenue inadequacy. The historical record, however, is clear. Chronic revenue inadequacy in the decades before 1980 ultimately caused two major Midwestern railroads (the Rock Island and the Milwaukee) to go bankrupt, and the railroad industry in the Northeastern United States (including the Penn Central, the Erie Lackawanna and the Reading) to experience "total collapse." See, e.g., *Bessemer & Lake Erie R R Co v ICC*, 691 F.2d 1104, 1107-1108 (3d Cir. 1982), cert. denied, 462 U.S. 1110-1111 (1983).⁷ Industry-wide rates of return remained under 2 percent.⁸

To prevent such situations from recurring, Congress enacted the Railroad Revitalization and Regulatory Reform Act of 1976 ("4-R Act") and the Staggers Rail Act of 1980. Both statutes substantially reduced the then-extensive jurisdiction of the ICC over railroad rates – which Congress found to be a major source of the railroads' financial problems. Equally important, both statutes required the ICC to ensure that railroads earned revenues "that are adequate, under honest, economical, and efficient management, to cover total operating expenses plus a reasonable and economic profit and return (or both) on capital employed in the business." See, 49 U.S.C. § 10704(a)(2) (emphasis added), see also *Bessemer & Lake Erie R R Co v ICC*, 691 F.2d at 1107-1109.⁹

would have created disincentives for Bell Operating Companies to make substantial investments in new fiber technologies)

⁷ See also, e.g., H.R. Rep. No. 96-1035, 96th Cong., 2d Sess. 87, 99 (1980), H.R. Rep. No. 94-725, 94th Cong., 1st Sess. 54 (1975).

⁸ S. Rep. No. 96-470, 96th Cong., 1st Sess. 3-4 (1979).

⁹ See also, e.g., S. Rep. No. 94-595, 94th Cong., 2d Sess. 134 (1976) (Conference Report on 4-R Act) (stating that Congress was enacting the 4-R Act "to provide for an extensive overhaul of railroad rate regulation by the Interstate Commerce Commission"), S. Rep. No. 94-499, 94th Cong., 1st Sess. 10 (1975) (stating that this "extensive overhaul" was necessary because

As the Commission noted in 1981, denying a railroad "the pricing flexibility needed to obtain long-term revenue adequacy simply because that railroad was making some progress toward achieving that goal would be assigning the railroads the Sisyphean task of working toward revenue adequacy, and every time it came close robbing it of the very means it had used to get there " Ex Parte No. 393, *Standards for Railroad Revenue Adequacy*, 364 I C C 803, 809 (1981), *aff'd sub nom Bessemer & Lake Erie R Co v United States*, 691 F 2d 1104 (3d Cir 1982), *cert denied*, 462 U S 1110 (1983) This point bears reemphasis now, when the industry must invest approximately \$148 billion for infrastructure expansion over the next 28 years to meet projected growth in demand An unrealistically low measure of the cost of equity increases the odds that one or more railroads will be found to be revenue adequate, and thus the likelihood that regulation will constrain the railroads' earnings below the level needed to cover the railroads' cost of capital, and thus the ability of the railroads to attract and retain the investment capital needed to build the additional infrastructure required to meet the expected growth in demand over the next 30 years

C. Given The Limitations Of Available Cost Of Capital Models, The Board Should Consider A Range Of Estimates Of The Cost Of Equity, And Adopt A Point Estimate Each Year Within The Middle To Upper Portion Of That Range.

The limitations and shortcomings of both the CAPM and DCF methodologies do not mean that the Board should reject either model, the CAPM and DCF appear to be the best equity cost models now available But the Board should treat the results of both methodologies with caution, and without attributing a false degree of precision to either. As a responsible regulator, the Board should (1) consider the results of all reasonable methods of estimating the cost of capital, without arbitrarily excluding any relevant data points, (2) run each model with

"[r]ailroad regulation has failed to assure adequate industry profits and rates of return and has retarded the industry's ability to compete with competitors")

economically sensible inputs, and (3) base the values ultimately prescribed on a point estimate selected from the middle to upper end of the range of reasonable estimates. *Hubbard-Stangle V S*, ¶¶ 8-12, 40, 46, *Myers V S* at 3-4, 8, 14-15

Regulatory precedent supports this approach. See, e.g., *Composition of Proxy Groups for Determining Gas and Oil Pipeline Return on Equity*, 120 FERC ¶ 61,068 (July 19, 2007), 2007 WL 2064673 (F E R C), at *1 n 3 (FERC “generally sets pipelines’ return at the median of the range” of average risk), *Kern River Gas Transmission Co* , 117 FERC ¶ 61,077, para 170 (“Although parties may present evidence to support any return on equity that is within the zone of reasonableness, [u]nless a party makes a very persuasive case in support of the need for an adjustment and the level of the adjustment proposed, the Commission will set the pipelines’ return at the median of the range of reasonable returns”), *Refinement of Procedures and Methodologies for Represcribing Interstate Rates of Return for AT&T Communications and Local Exchange Carriers*, 5 F C C Rcd 197, 198 (1989) (allowing parties to “submit cost of equity analyses using any reasonable method, provided they include all underlying assumptions”), *Adequacy of Railroad Revenue (1978 Determination)*, 361 I C C 79, 94 (1978) (determining the current cost of equity capital for the Nation’s railroads by “[c]hoosing the approximate midpoint” of the results of the market value studies presented) ¹⁰

Shippers have also agreed that the Board should consider all available data in determining the cost of capital. At the Board’s February 15, 2007, hearing, for example, WCTL’s witness, James Hodder, an economist offered as an expert on cost of capital methodologies, suggested using multiple methodologies to calculate the cost of capital ¹¹. See

¹⁰ See also, e.g., *Devon Power Co* , 104 FERC ¶ 61, 123, at p 61,419 (2003) (FERC “as a general policy employs the midpoint of the zone of reasonableness as the appropriate rate of return” in calculating cost of equity)

¹¹ See Transcript of February 15, 2007, Hearing in Ex Parte No 664, at 95 (testimony of James E Hodder) (“I would suggest you mandate a multi-phase DCF model”), *Id* at 96 (“I would

also Thomas Crowley V S in Ex Parte No 558 (Sub-No 9), *Railroad Cost of Capital – 2005* (“Crowley V S ”), at 3 (“A railroad industry COE using the CAPM can be easily calculated using publicly available data from reputable sources. That result can be vetted against railroad industry cost of equity prepared by independent sources”)

Moreover, when the regulated firm needs to make large investments in additional infrastructure, the prudent course for a regulator is to adopt a point towards the upper end, not the midpoint, of that range ¹²

suggest that you mandate a second estimation methodology based on some asset pricing model,” including either CAPM, Fama-French, or arbitrage pricing theory “The basic idea here is that all three of these models are similar in the sense that they focus on first, a risk-free return, which includes both a real return and an inflation adjustment [I]n the end, you should get out similar estimates”), *id* at 97 (“The models are estimating [the cost of equity] imperfectly But they should converge”), *id* at 98 (“if the inputs used across the various models are consistent with each other, [the] difference [in the cost of capital estimates] should be modest”)

¹² See, e.g., Myers V S at 3-4, 8, 14-15, *American Electric Power Service Corp*, Order on Rehearing, 118 FERC ¶ 61,041 (2007), 2007 WL 178590 (F E R C), at *9 (finding, as part of decision to approve incentive rate treatment for utility, that return on equity at upper end of zone of reasonableness is appropriate to attract investment, since length, scope, and multi-state nature of proposed project presents substantial risks), *Promoting Transmission Investment Through Pricing Reform*, Order No 679, 116 FERC ¶ 61,057 (2006), 2006 WL 2039629 (F E R C), at *22 (establishing policy of allowing, when justified, an incentive-based ROE to all public utilities for new investments in transmission facilities that benefit consumers by ensuring reliability or reducing cost of delivered power by reducing transmission congestion, and holding that FERC will approve an ROE at upper end of zone of reasonableness for new infrastructure investments that otherwise meet requirements of new energy statute), *In the Matter of Tele-Media Co of Virginia*, Appeal of Local Rate Order, 15 F C C Rcd 4351, 4358 (2000) (in determining rates for cable operators, FCC has identified a zone of reasonableness for cost of capital and set rate of return of 11.25%, at the upper end of the range, so that operators could attract capital needed to provide regulated cable service and expand their regulated offerings), *Implementation of Sections of the Cable Television Consumer Protection and Competition Act of 1992 Rate Regulation*, Report and Order and Further Notice of Proposed Rulemaking, 9 F C C Rcd 4527, (1994) (same, citing FCC’s “desire to encourage infrastructure development” as reason for prescribing return toward upper end of zone of reasonableness), *Enstar Gas Co*, Regulatory Commission of Alaska, Order No 12 dated August 8, 2002, 2002 WL 32166739, at *15 (prescribing return on equity that is at upper end of range proposed in the record, “to reflect confidence in ENSTAR’s management practices and to assure an incentive for capital investment in the company”), *Green Mountain Power Corp*, Vermont Public Service Board Docket No

II. THE BOARD HAS FAILED TO PROVIDE A CLEAR AND TRANSPARENT METHOD FOR DETERMINING THE COST OF EQUITY.

The Board has stated that one of its primary objectives in revisiting its calculation of the cost of capital is “to adopt a fixed and transparent methodology upon which railroads and the public can rely” Notice at 8, *id.* at 6 (CAPM model applied by Federal Reserve Board is “simple and transparent”) The STB’s CAPM calculations, however, are far from transparent

Although the Notice suggests that the underlying bases for the Board’s calculations of the cost of equity and the cost of capital in Tables 1 and 2 can be found in the workpapers it has made available (*see* Notice at 7 n 14), that does not appear to be the case For example, the formula and data used to calculate the market risk premium do not appear in the Board’s electronic workpapers, as produced to the AAR on August 20, 2007 In particular, the Board has not fully explained or provided any supporting data underlying its assumed market risk premium of 5.2 percent Although the text of the Appendix (at 11) indicates that the 5.2 percent value is based on “monthly New York Stock Exchange (NYSE) data over a 50-year period,” the STB’s electronic workpaper entitled “COC CAPM workpaper.xls,” Sheet 1, contains only a hard-coded entry of “5.2” for each year in the analysis, with no indication of how that figure was derived ¹³ Likewise, the value of beta proposed by the Board also lacks proper workpaper support While the Board provided the results of the regression analyses, the source data used to run the regressions were missing Despite requests from the AAR for additional

5983, Order dated February 27, 1998, 1998 WL 216535 (Vt. P.S.B.) (adopting cost of equity at upper end of range provided, which accounts for investment risk)

¹³ The AAR’s expert witnesses, including leading authorities on the cost of capital, believe that they have been able to replicate, or come close to replicating, most if not all of the Board’s calculations But they were able to do so only through informed speculation and through the AAR’s purchase of costly proprietary data that are not readily available to the public Parties lacking access to these proprietary data will not be able to reproduce, or even fully understand, the Board’s CAPM calculations

data, the Board's Staff has indicated that no additional workpapers or related information will be provided beyond that set forth in the workpapers

The failure of the Board to provide complete workpapers is contrary to its obligation under the Administrative Procedure Act to provide adequate notice and "give interested persons an opportunity to participate in the rule making through submission of written data, views, or arguments." See 5 U.S.C. § 553(c). The D.C. Circuit recently has reiterated that an "[i]ntegral" part of the APA's requirements "is the agency's duty 'to identify and make available technical studies and data that it has employed in reaching the decisions to propose particular rules'."¹⁴ As the D.C. Circuit stated, an "agency commits serious procedural error when it fails to reveal portions of the technical basis for a proposed rule in time to allow for meaningful commentary."¹⁵ Hence, the APA forbids an agency from basing a rule on data "that, [in] critical degree, is known only to the agency" itself.¹⁶ The Board's derivation of the market risk premium is a critical element of its CAPM calculation, and the Board's failure to explain that derivation and provide the underlying data (or at least make it available for review by interested parties) is a critical flaw in the Board's decision.

¹⁴ *Owner-Operator Independent Drivers Ass'n, Inc. v. Federal Motor Carrier Safety Admin.*, 494 F.3d 188, 199 (D.C. Cir. 2007) ("*OOIDA*"), quoting *Solite Corp. v. EPA*, 952 F.2d 473, 484 (D.C. Cir. 1991), (and cases cited therein).

¹⁵ *Id.*, quoting *Connecticut Light & Power Co. v. NRC*, 673 F.2d 525, 530-31 (D.C. Cir. 1982), see *Chamber of Commerce v. SEC*, 443 F.3d 890, 899 (D.C. Cir. 2006), see also *Air Transp. Ass'n of Am. v. FAA*, 169 F.3d 1, 7 (D.C. Cir. 1999) (the "most critical factual material that is used to support the agency's position on review must have been made public in the proceeding and exposed to refutation") (quoting *Association of Data Processing Serv. Orgs. v. Bd. of Governors of the Fed. Reserve Sys.*, 745 F.2d 677, 684 (D.C. Cir. 1984)). Accord, *OOIDA*, 494 F.3d at 204 ("[w]hen an agency uses a computer model, it must 'explain the assumptions and methodology used in preparing the model'") (quoting *U.S. Air Tour Ass'n v. FAA*, 298 F.3d 997, 1008 (D.C. Cir. 2002) and *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 535 (D.C. Cir. 1983)).

¹⁶ *Time Warner Entertainment Co., L.P. v. FCC*, 240 F.3d 1126, 1140 (D.C. Cir. 2001), quoting *Community Nutrition Institute v. Block*, 749 F.2d 50, 57 (D.C. Cir. 1984) and *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 393 (D.C. Cir. 1973).

Here, the Board's brief description of its implementation of the CAPM model (Notice at 10-11) fails to satisfy its own standards governing evidentiary submissions by parties. The Board has admonished parties appearing before it in rate cases that if an "evidentiary presentation relies on supporting materials (workpapers or electronic spreadsheets), references to those materials must be included in the textual presentation with sufficient specificity to allow quick access to the referenced materials. Unreferenced supporting materials (or broad, general references to the workpapers) will not be considered." STB Ex Parte No. 347 (Sub-No. 3), *General Procedures For Presenting Evidence In Stand-Alone Cost Rate Cases*, slip op. at 4 (served March 12, 2001). But the Board's Notice in this case contains only one fleeting reference, in a footnote, to the spreadsheets containing its proposed implementation of CAPM.

Moreover, the workpapers provided by the Board are not fully functional and do not properly indicate the sources of their inputs. These spreadsheets would not be regarded as acceptable workpapers in an evidentiary submission by a party. The Board has reminded parties before it that "in order to fully evaluate the evidence, we must be able to access and manipulate all spreadsheets. If a spreadsheet does not function (e.g., will not recalculate), the party filing the defective spreadsheet runs the risk that its evidentiary presentation will be treated as incomplete and ultimately unpersuasive. We emphasize the importance of spreadsheet links being functional and documented." *General Procedures For Presenting Evidence In Stand-Alone Cost Rate Cases*, slip op. at 4-5, *see also* STB Docket No. 42072, *Carolina Power & Light Co. v. Norfolk Southern Ry. Co.*, slip op. at 77-78, 121, 130 (served Dec. 23, 2003) (disregarding electronic spreadsheets containing only hard-coded figures that could not be verified, accepting only costing formulas that could be replicated and verified), STB Docket No. 42069, *Duke Energy Corp. v. Norfolk Southern Ry. Co.*, slip op. at 59 n.71, 90 (served Nov. 6, 2003) (same,

stating that “the Board must be able to verify the procedures used to develop such [electronic] evidence”)

Finally, the Board has stated, “the source of all values in a spreadsheet must be readily apparent. If a source is not identified parties run the risk that we will assume that the value is unsupported.” *General Procedures For Presenting Evidence In Stand-Alone Cost Rate Cases*, slip op. at 5 (footnote omitted). In this case, as noted above, no source is shown in the workpapers for the Board’s assumed market risk premium of 5.2 percent, and its calculation is not fully explained in the Notice or Appendix.

The Board’s incomplete and inadequate workpapers are also inconsistent with the Board’s own information quality standards. See STB Ex Parte No. 587, *Information Quality Guidelines* (served Oct. 1, 2002). Those Guidelines state that scientific or statistical information disseminated by the Board “should be presented with supporting data and models to allow intended users or qualified third parties to assess the objectivity of information sources.” *Id.* at 3. When that is not possible (for example, because of trade secrets or privacy concerns), “the STB will apply especially rigorous robustness checks, and at a minimum, *indicate specific data sources, quantitative methods, and assumptions used*.” *Id.* (emphasis added).

Most importantly, the Guidelines provide that when the Board disseminates analytical results that are “likely to be influential” (i.e., likely to have an important effect on governmental or private policies, or have important consequences for specific industries or firms), such results “*must be capable of being substantially reproduced*.” *Id.* (emphasis added). Without the proprietary data described above, the Board’s CAPM calculations cannot be reproduced.

In this regard, the Board’s reliance on undisclosed proprietary data underlying its CAPM model bears an uncanny resemblance to the circumstances that caused the ICC to refuse

to rely on a similar CAPM model in Ex Parte No 436, *Railroad Cost of Capital--1982*, 367 I C C 662, 670 (1983). In that case, the AAR's cost of capital witness, Professor Robert Litzenberger, sponsored a CAPM model based on 51 years of data drawn from "a data base provided by the Center for Research in Security Prices [CRSP] at the University of Chicago " *Id* at n 27 Finding that many of the assumptions underlying Dr Litzenberger's study "could not be thoroughly analyzed in this proceeding because of lack of access to underlying data," the ICC held that "we do not believe that the CAPM study can be used as the primary means of determining the railroads' cost of equity " *Id* , 367 I C C at 670 Except for the identity of the entity seeking to rely on the undisclosed data, the circumstances here are essentially identical

III. THE BOARD HAS DERIVED AN UNREASONABLY LOW COST OF CAPITAL ESTIMATE FROM THE CAPM MODEL BY USING UNREALISTICALLY LOW INPUT VALUES.

Although most parties and the public will be unable to replicate or fully understand the Board's calculations, the limited and incomplete workpapers produced by the Board make clear that the Board's CAPM analysis is based on extremely (and arbitrarily) low input assumptions, as described in the following sections

Although the Notice finds that the CAPM is "superior" to the DCF model as a financial model and will address the Board's concerns regarding the accuracy of results produced by the DCF model (Notice at 4-5), the Board's calculations under the CAPM are unreliable, because the input values that it uses in the model are unrealistic As a result, the estimates of cost of capital under the CAPM that the Board has calculated in Table 2 of the Notice are unreasonably low

A. Risk-Free Return

The Board's CAPM calculations purportedly assume a risk-free return of 4.25 percent for 2005, based on the 10-year T Bond rate. See Notice at 10 (Appendix), STB workpaper entitled "COC CAPM workpaper.xls," Sheet 1. The Board justifies this ten-year term on the ground that the "10-year is the longest Treasury Bond that has been continually issued." *Id.* While this may be an acceptable approach, it is certainly not the only one. Other reasonable proxies for the risk free rate include the short-term T-Bill and long-term T-Bond. Hubbard-Stangle V.S. ¶ 31. The Board should, at a minimum, compare those three benchmarks and make a reasoned determination as to which appears to be most appropriate. A reasonable estimate of the risk-free return, based on data for December 2005, is about 4.6 percent. Hubbard-Stangle V.S., Exh. 3a.

B. Market Risk Premium

The inputs used in the Board's calculations of the market risk premium under CAPM are also flawed. First, the Board assumes a market risk premium of 5.2 percent for 2005. See STB workpaper entitled "COC CAPM workpaper.xls," Sheet 1. The Board states that it calculated the 5.2 percent value using "monthly New York Stock Exchange (NYSE) data over a 50-year period." Notice at 11 (Appendix), Hubbard-Stangle V.S. ¶ 32, Myers V.S. at 10-11. This approach is unreasonable for several reasons.

First, the workpapers made public by the Board do not support the 5.2 percent figure. As previously discussed, despite the assurances of the Notice that all figures that the Board used can be derived from the workpapers it has made available, the 5.2 percent figure cannot be replicated from those workpapers without the use of data which must be obtained from third-party vendors. Rather, the figure appears to be hard-wired into the workpapers,

without any underlying cells in the workpapers that would enable interested parties to test or replicate the value ¹⁷

It is clear, however, the time period used by the Board to estimate the market risk premium is too short, an error that biases its estimated value downward. *Hubbard-Stangle V S* ¶¶ 34, 37-38, *Myers V S* at 9-10. The standard economic approach is to use a time period that goes back as far back in time as possible – for example, to 1926 or even earlier, if reliable data for those time frames are available. *Hubbard-Stangle V S* ¶¶ 34-37, *Myers V S* at 9-10 ¹⁸. This approach minimizes the effect of measurement error in the estimates – a result that the Board states that it wishes to achieve. Notice at 11 (Appendix), *accord*, *Myers V S.* at 9-10, *Virginia Arbitration Order*, 18 F C C Rcd at 17756 (use of longest period for which reliable data are available “minimiz[es] the impact of any short-term fluctuation from long-term trend[s]”)

The issue of the proper time period to be used in calculating the market risk premium is particularly important because risk premiums during the past few years have been abnormally low. Including data from recent years, when risk premiums have been abnormally low, while excluding data from years before 1955, when market risk premiums were much higher, arbitrarily skews downward the overall estimate of the equity risk premium. *Hubbard-Stangle V S* ¶¶ 38 & Exh. 2. For example, merely restoring the ten years of data for the period from 1947 through 1956 to the time series raises the estimated equity risk premium from 5.2 percent (for 1957-2006) to 7.1 percent (for 1947-2006). *Hubbard-Stangle V S* ¶¶ 38 & Exh. 2

¹⁷ The number also appears to be for 2006, not 2005. See *Hubbard-Stangle V S*, Exh. 2 (value for 1957-2006 estimation period)

¹⁸ *Accord*, *In the Matter of Petition of WorldCom, Inc. Pursuant To Section 252(c)(5) of the Communications Act For Preemption of the Jurisdiction of the Virginia State Corporation Commission Regarding Interconnection Disputes With Verizon Virginia Inc., and For Expedited Arbitration*, 18 F C C Rcd 17722, 17759-17760 (2003) (“*Virginia Arbitration Order*”) (“the market risk premium should be based on the average excess of the market rate of return over the risk-free rate over the longest period for which reliable data are available”) (emphasis added)

Other sources confirm that use of the proposed 50-year period would result in risk premiums that are too low. See Myers V S at Table 3 (reporting market risk premiums from several widely used sources). Ibbotson's estimate of the long-term equity risk premium as of 2005 and 2006 is 7.1 percent, nearly two percentage points higher than the Board's 5.2 percent figure. See *Risk Premium over Time Report 2006*, Ibbotson Associates (2006), Table A-1, at 2 (attached as Exhibit 2 to Crowley V S), Verified Statement of Thomas D. Crowley and Daniel L. Fapp submitted July 25, 2007, in Ex Parte No. 664, at 11 ("Crowley/Fapp V S ") (stating that Ibbotson's estimate of long-term equity risk premium for 2006 was 7.1 percent). Significantly, WCTL's own witness, Thomas Crowley, used the Ibbotson estimate (which was based on data for years beginning in 1926) in his own CAPM calculations in the testimony that he submitted in the recent Ex Parte No. 558 (Sub-No. 9) proceeding and in the verified statement that he and Mr. Fapp submitted in this proceeding last month. See Crowley V S at 16, Crowley/Fapp V S at 11. Mr. Crowley testified that the "Ibbotson calculation of the equity risk premium is widely considered the best estimate of the equity risk premium available." Crowley V S at 11-12 & n 15 (citing S. P. Pratt, *Cost of Capital: Estimations and Applications* (2d ed., 2002), at 116). Crowley/Fapp V.S. at 6 & n 2 (citing S. P. Pratt, *supra*, at 113).¹⁹

The foregoing analysis also sheds light on whether the Board should adopt a fixed estimate of the market risk premium rather than recalculating it each year. Notice at 10 (Appendix). The issue has little practical importance if the Board adopts a sufficiently long data

¹⁹ See also, e.g., *Estate of Hendrickson*, 78 T.C.M. (CCH) 322, 335 (1999) (Ibbotson's long-term equity risk premium "is widely used in calculating a cost of capital under CAPM"), *Virginia Arbitration Order*, 18 F.C.C. Rcd. at 17759-17760 (adopting Ibbotson's long-term risk premium for the period 1926-1999 as the "historical" risk premium, i.e., the risk premium for the 20-year Treasury bond, in determining rates for unbundled network elements, or "UNEs"), *AT&T Communications of California*, Application Nos. 01-02-024, et al., California PUC Opinion issued September 23, 2004, 2004 WL 2327932 (Cal. P.U.C.), at **76-77 (adopting, as risk premium for purposes of determining UNE rates, Ibbotson's long-term market risk premium for the period 1926-2001, as the "most reasonable" to use in PUC's CAPM analysis).

series (e.g., beginning 1926 or earlier), since the resulting average should change only slightly from year to year. The Board, however, most definitely should not adopt a fixed estimate based on data limited to the last 50 years, or any other arbitrarily truncated period. Doing so would merely lock in place a misleading short-run estimate of the long-run underlying value.

The Board's methodology suffers from a second and independent error beyond the use of a too-short time series of data. Although the Board states that it used returns on 10-year Treasury Bonds as a proxy for the measure of riskless return that is deducted from the total equity market return to estimate the market risk premium, the Board actually used returns on long-term debt portfolios, with an average maturity considerably longer than 10 years, as proxy for riskless returns. Notice at 10, Myers v. S. at 10. The problem is that, changes in the current market price of a bond over its life represent a larger share of the expected total return on the bond as the period to maturity of the bond becomes longer. Returns caused by increases in the market price of a government bond held by an investor (primarily as a result of changes in expected interest rates) are clearly not risk-free in the context of CAPM. Hubbard-Stangle v. S. ¶ 36. This error alone understates the risk premium by approximately 0.5 percentage points.

Further, and in any event, the same risk-free return value should be used for the constant term for risk-free return and in calculating the market risk premium. Hubbard-Stangle v. S. ¶ 31 & n. 20. The Board has used inconsistent values for two tasks. "This is a mismatch and an inconsistency." Myers v. S. at 9.

Finally, if the Commission adheres to its proposal to use the annual average yield to maturity on ten-year Treasuries as the constant term risk-free return, then the market risk premium must be defined as the average spread between rates of return on the stock market and rates of return on Treasuries of the *same ten-year maturity*. Calculating the historical market risk premium as the difference between the income return (current yields, not yields to maturity) on

20-year Treasuries, as the Board apparently did, is a mismatch. This mismatch results in an understatement of the market risk premium because 20-year Treasuries have, on average, generated higher rates of return than have 10-year issues. *Myers V S* at 9-10.

C. Beta

The workpapers provided by the Board show that the Board used a beta in the range of 0.8 for 2005. The calculation was based on 10 years of monthly data. *See* STB workpaper entitled "COC CAPM workpaper.xls," Sheet 1; Notice at 10 (Appendix) (stating that, to calculate the beta for each carrier, the Board proposes to use that carrier's monthly, merger-adjusted stock return data for the prior 10 years in a "standard equation"). After computing the total return month-by-month, the Board then subtracted yield-to-maturity rates from 10-year government bonds. Notice at 10 (Appendix). The intercept term used in the regression was constrained to zero. *See id.* at 11 (inviting comments on whether an intercept term should be used).

This approach is erroneous in a number of respects. First, the Board computed monthly risk premiums by comparing the monthly returns on investment in the stocks listed on the NYSE Index with ten-year interest rates, not short-term interest rates. This is "illogical and inconsistent." *Myers V S* at 10.

Second, the Board appears to have obtained its beta estimates through a least-square regression equation that has no constant term (i.e., that assumes a zero intercept). This is not standard practice. "A constant term should have been included to capture other factors affecting returns and risk premiums." *Myers V S* at 10.

Third, the use of a ten-year data series is inappropriate. *Hubbard/Stangle V S* ¶¶ 20-26, *Myers V S* at 10-11. Betas should be determined with recent data, because betas change with the market conditions and risks of an industry. When an industry undergoes major

structural changes like those experienced by the railroad industry in recent years, an overly long estimation period for beta can generate significant bias in the estimate Hubbard-Stangle V S ¶¶ 22-26 Accordingly, the use of a five year (or even shorter) time series has far greater acceptance than the use of a ten-year time series The standard approach is to use five years of weekly or monthly data Hubbard-Stangle V S ¶¶ 23-25

The Board's own calculations illustrate the bias that can result from overly long estimation periods The ten-year data series used by the Board in its CAPM calculations includes the "high-tech bubble" period of the late 1990's and the collapse of the "bubble" in 2000-2002 Including these gyrations in the overall measure of market volatility give an artificial impression of stability to other companies Hubbard-Stangle V S ¶¶ 23-26

For three of the four largest railroads, substituting five years for ten years of data would produce a higher beta For two of the railroads, many of the current (August 2007) betas are substantially above 1.0 Hubbard-Stangle V S , Exhibits 1a through 1d Other estimates of beta for the railroads are even higher, some are as high as 2.2 or 2.5 See Summary of Presentation of AAR, filed February 12, 2007, at 26 (Figure 2).

The Board also has raised the question of whether it would be reasonable to assume that beta equals 1 (thereby eliminating the need to estimate beta), because "[f]inance theory predicts that beta will move towards 1 over time, and this has proved true for banks and other firms that provide payment processing services" Notice at 11 (Appendix) (citing Transcript of February 15, 2007, Hearing at 25) While it is true that betas tend over the long run to converge on 1.0, not all betas do so Betas for intrinsically risky businesses can remain above 1.0 for long periods, and betas for firms in low-risk industries can remain below 1.0 indefinitely

Moreover, and in any event, the notion that a risk factor should be disregarded in estimating the cost of capital if the factor tends to regress to the mean over the long run is

illogical. There are accepted statistical techniques for estimating the degree of regression toward the mean that is likely to occur in beta values over a specified short-run period. Hubbard-Stangle V S ¶¶ 27-28. Assuming that the short-run risk factors have no effect from the outset on the returns demanded for investors, however, is a non sequitur. Many phenomena that tend to dissipate in the long run nonetheless have a substantial influence on investor behavior: corporate earnings growth rates tend to converge on the long-run growth rate of the economy, returns on equity tend to converge on the industry average, the price-earnings ratios of individual securities tend to converge on the industry average, and, in the words of Lord Keynes, "in the long run, we are all dead."²⁰ If a long-run tendency to regress to the mean were an adequate justification for ignoring factors that affect the returns demanded by investors for holding the equity stock of individual firms and industries, then the price/earnings ratios of all publicly traded stocks should be identical. That they vary is proof that investment decisions are affected by risk factors that deviate from the average in the short run.

* * *

When the Board's estimates of using the CAPM model are restated by using more realistic estimates of riskless returns, market risk premiums and beta, the estimated cost of equity and cost of capital increase dramatically. For example, the median estimated cost of equity for the four major railroads as of December 2005 ranges from approximately 8.3 percent to approximately 11.1 percent, according to CAPM calculations sponsored by Dean Hubbard and Dr. Stangle. Hubbard-Stangle V S ¶¶ 9, 39-42 and Exh. 3a and 3b. For September 2007, the same CAPM approach produces equity cost estimates with a median value of approximately 12.4 percent. *Id.*

²⁰ John M. Keynes, *A Tract on Monetary Reform* (1923).

IV. IGNORING THE ESTIMATES OFFERED BY THE DCF MODEL IS ARBITRARY AND IRRATIONAL.

In its Notice, the Board has proposed to jettison the DCF model, the model relied on by the Board and the ICC to estimate the cost of capital since the early 1980's, on the ground that the DCF model tends to overstate the cost of equity when the projected 5-year growth rate exceeds the long-term growth of the economy Notice at 4 Although the Board concedes that it could update its current approach by using a two-stage DCF method, the Board proposes not to adopt the latter approach because "it would be difficult to select a particular [2-stage DCF] approach in a non-arbitrary fashion," given the absence of any "sound theoretical basis to prefer one multi-stage DCF over another " *Id* at 5 The CAPM, the Board also contends, "provides an alternative to DCF that commands greater respect in the regulatory and academic community and dominates the private sector " *Id* at 6 The Board describes CAPM as "the industry norm" that "is widely considered to be the superior financial model " *Id* This reasoning does not withstand scrutiny The multi-stage DCF is at least as conceptually sound and reliable as the CAPM, and the equity cost estimates generated by multi-stage DCF models provide a valuable cross check on the reasonableness of the estimates produced by the CAPM Hubbard-Stangle V S ¶ 52, Myers V S at 4, 13-14

A. The Board Has Overstated the Shortcomings of the DCF Model.

The Board has exaggerated the purported shortcomings of the DCF While the precise path of the convergence of earnings growth rates and long-term economic growth rates used by multi-stage DCFs can only be projected, neither the Board nor any participating party has challenged the conceptual predicate for adoption of multiple stages—that earnings growth rates tend to converge with the long-run rate of growth of the overall economy Estimates of the cost of equity produced by generally accepted multi-stage DCF models are comparable to those produced by the CAPM when run with appropriate inputs Ibbotson Associates' estimate of the

median cost of capital for line haul operating railroads, based on a three-stage DCF model, was 11.5 percent for March 2006 and 11.4 percent for March 2007. Hubbard-Stangle V.S. ¶ 49

B. The Board Has Overlooked the Major Shortcomings of the CAPM and Overstated Its Acceptance Among Reputable Analysts.

The Board's proposed decision to accept the CAPM as the "superior financial model" (Notice at 6) overlooks the shortcomings of the CAPM, while overstating its virtues. Moreover, the Board exaggerates the acceptance of the CAPM in the regulatory, academic, and financial sectors.

1. The CAPM Is As "Arbitrary" and "Subjective" As the DCF.

Although the Board proposes to reject the DCF method because of the arbitrariness of its inputs, the key growth assumptions of the CAPM are at least as subjective and uncertain as those of the DCF. Myers V.S. at 3, 5-8, 13; Hubbard/Stangle V.S. ¶¶ 13-19. As Professors Myers and Hubbard, and Dr. Stangle all testify in their verified statements accompanying these Comments, the return expected by equity investors is conceptually forward-looking – i.e., the return that investors demand *today*. That expectation, however, cannot be observed or measured. As a result, analysts must combine forward-looking returns demanded by investors in risk-free debt investments (which returns can be observed) with backward-looking market risk premiums to estimate the forward-looking expected returns demanded by equity investors. Many of the simplifying assumptions required for such an analysis are simplistic, counterfactual, or inherently unverifiable. Hubbard-Stangle V.S. ¶¶ 13-19.

Moreover, the market risk premium, which has been described as "one of the most important but elusive parameters in finance,"²¹ varies greatly with the time period observed and the analytical method used. Hubbard-Stangle V.S. ¶ 14. A risk premium based on a

²¹ See Pablo Fernandez, IESE Business School, Market Risk Premium: Required, Historical and Expected, <http://ideas.repec.org/p/ebg/iesewp/d-0574.html> (Oct. 17, 2004).

relatively short-run time series of data may have very large measurement error *Id* ; Myers V S at 6, 9-10

Similarly, the range of beta estimates can and does vary widely, because there is no consensus as to precisely how beta should be estimated Myers V S at 6 & Table 1 The value obtained by the analyst is highly sensitive to, *inter alia*, the period over which beta is estimated, the frequency of data that is used to estimate beta (*e.g.* daily, weekly, or monthly), and the proxy that is used to measure overall market performance Hubbard-Stangle V S ¶ 14 As illustration, the permutations generated by the alternative values offered by WCTL witness Crowley earlier in this case for only three variables affecting beta generated 16 different estimation methodologies, producing betas that ranged from 0.7 to almost 2.5 See Summary of Presentation of the AAR, filed February 12, 2007, at 26 Further, the standard errors and confidence intervals for betas are very large, a fact that should “dispel any view that betas can be estimated with close accuracy” Myers V S at 10-11 & Table 4

Finally, empirical studies have failed to confirm that the CAPM has any significant predictive value Some empirical analyses have shown a low correlation between actual returns on equity and beta – and a much higher correlation with other explanatory variables such as market capitalization (small cap stocks historically earn higher returns), price/earnings (“P/E”) ratios (equities with lower P/E ratios tend to earn higher returns), and book-to-market ratios (firms with lower ratios tend to generate higher returns) Hubbard-Stangle V S ¶ 17, Myers V S at 5-6²²

²² *Accord*, Eugene F. Fama and Kenneth R. French, “The Cross-Section of Expected Stock Returns,” 47 *Journal of Finance* 427-466 (1992), Eugene F. Fama and Kenneth R. French, “Common Risk Factors in the Returns on Stocks and Bonds,” 17 *J. of Financial Economics* 3-56 (1993)

In sum, the range of arbitrariness and subjectivity in the CAPM is at least as great as that in the DCF model. As the Commission found almost 30 years ago, the CAPM, "like other types of cost of capital evidence, has its weakness. For example, our analysis shows that this data is sensitive to the choice of dates for study periods, and that the calculated betas do not fully explain changes in railroad returns compared to changes in market returns." Ex Parte No 338, *Adequacy of Railroad Revenue (1978 Determination)*, 361 I C C 79, 92, 116-18 (1978). Those observations remain as valid today as they were then.

2. The Board Exaggerates the Extent To Which the CAPM Has Displaced the DCF Among Reputable Analysts.

The Board has also exaggerated the acceptance of CAPM as the preferred method among regulators, academics, and the financial sector. Regulators in many jurisdictions, for example, continue to use the DCF model, either as the primary measure of the cost of equity or in tandem with the CAPM. *Myers V S* at 7, *Hubbard-Stangle V S* ¶ 17, *Hubbard V S* (December 8, 2006) at 5. Similarly, many in the academic and financial communities still regard the DCF model to be at least as reliable as the CAPM. See *Hubbard-Stangle V S* ¶ 47, *Myers V S* at 14 (Board should consider both CAPM and DCF results).

Even many of the shipper participants in this proceeding have recognized that CAPM is not the "preferred method," and instead have advocated the use of DCF, either alone or in combination with CAPM. During most of the past quarter century, shippers were generally at least as supportive of the DCF as the CAPM. See, e.g., *Railroad Cost of Capital—1982*, 367 I C C 662, 670 (1983) (noting support of shippers for DCF rather than CAPM). As late as last February, WCTL argued in this docket that the Board should adopt *either* the multi-stage DCF model *or* a CAPM-based approach, because "Both approaches, properly employed, should yield similar results, and both approaches should be considered and any differences reconciled." Summary of Hearing Testimony of WCTL, filed February 12, 2007, at 2. Shipper witness

Charles King likewise has argued in this docket that the Board should continue to use the DCF methodology—which, he stated, “has been acknowledged fairly universally as the best available technique for estimating the cost of equity”—using the two-step procedure used by FERC to identify the growth factor in the DCF formula. *King V S*, filed December 8, 2006, at 5, 10, 12-13, 19, *see also* February 15, 2007, Hearing Transcript at 114-119 (King testimony)

C. A Multi-Stage DCF, When Run With Appropriate Inputs, Produces A Significantly Higher Cost of Equity Than The Board Calculated.

DCF models, when run with appropriate inputs, produce equity cost estimates that are much higher than the estimate derived by the Board from the CAPM, and much closer to the estimates produced by more mainstream CAPM approaches. The Board’s own two-stage DCF analysis is a good example. When corrected for several obvious errors, it produces weighted average cost of capital (“WACC”) values for that are substantially higher than the values derived by the Board from the CAPM. *See Myers V S* at 12-13.

First, the Board has erroneously (and apparently inadvertently) discounted the stream of dividends after year 21 *twice* in the Board’s spreadsheet. The magnitude of this error is equivalent to assuming the payment of no dividends at all from years 21 through 40, with second-stage dividends not beginning until year 41. Correcting this error alone increases the two-stage DCF cost of equity by about 2.5%—from 7.24% to 9.76%. *Myers V S* at 12-13.

Second, the Board’s DCF estimate is biased downward by its use of the Social Security Administration’s estimate of the long-run growth rate of U.S. economy (4.6%). *See* Notice at 7 n 14. This estimate is too low. More reasonable estimates are the 5.9% value calculated by Ibbotson Associates, and Blue Chip estimate of 5.5%. *Morningstar, Inc., Stocks, Bonds, Bills and Inflation, Market Results for 1926-2006, 2007 Yearbook*, Valuation Edition, p 70, *Myers V S* at 13 & n 15 (citing *Blue Chip Economic Indicators*, October 10, 2005, p 15).

Other commonly used multi-stage DCF models also produce significantly higher cost of equity estimates. As noted above, Ibbotson Associates' estimate of the median cost of capital for line haul operating railroads, based on a three-stage DCF model, was 11.5 percent for March 2006 and 11.4 percent for March 2007. *Hubbard-Stangle V.S.* ¶¶ 11, 49.

In short, the Board's proposed refusal to consider DCF results is arbitrary, particularly given the recognition of such participants as WCTL that CAPM and DCF methods, if done properly, should generate roughly equivalent results. See Summary of Hearing Testimony of WCTL filed February 12, 2007, in Ex Parte No. 664, at 2.

CONCLUSION

For the foregoing reasons, the Board should reconsider its proposal to use the CAPM as the exclusive method of determining the cost of equity. Instead, the Board should consider the results of both the CAPM and multi-stage DCF models.

Second, regardless of whether the Board ultimately decides to give weight to DCF results, it is essential that the Board run its models with generally accepted and economically sensible input values. Doing so produces equity cost estimates that are considerably higher than are produced by the idiosyncratic inputs proposed by the Board. As illustration, running the CAPM with generally accepted input values for the three key variables—risk free return, market risk premium and beta—yields equity cost estimates ranging from 8.8 to 13.1 percent for the four largest United States railroads as of December 2005, and 10.5 to 16.6 percent as of September 2007. Widely used multi-stage DCF models, when run with appropriate inputs, yield results that also fall within this range. It is absolutely clear that the Board's proposed inputs to the CAPM methodology must be corrected. In the words of Professor Myers, "Taken together, it's clear that the Board's proposed CAPM calculations are inconsistent and idiosyncratic. They do not follow

standard practice. The calculations would generate downward-biased estimates of the cost of equity capital.” Myers V.S. at 11.

Third, given (1) the inherent imprecision of both the CAPM and DCF models, (2) the massive investment in additional network infrastructure that the railroad industry must make to meet expected growth in demand in the next three decades, (3) the directive of Congress to the Board to ensure revenues that are adequate to attract and retain needed investment capital, and (4) the potential harms to shippers and consumers if the railroads were prevented by regulation from recovering their cost of capital, the Board should adopt an annual cost of equity toward the upper end of the range of individual cost of equity estimates generated by the above procedure

The AAR asks that the Board schedule a full hearing on the Board’s proposal after the submission of reply comments on October 29, 2007. The far-reaching implications of the proposal for the railroad industry, its customers and the public, and major issues raised by the Board’s proposed method of implementing the CAPM model—some of which have already been acknowledged by the Board itself—warrant full and careful examination. The Board should take the opportunity to understand the comments and criticisms offered by interested parties and permit all parties, including experts who have submitted statements addressing the proposal, to be heard in a public forum.

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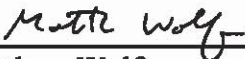
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September 27, 2007

CERTIFICATE OF SERVICE

I hereby certify that on this 26th day of September, 2007, I caused a copy of the foregoing Comments of the Association of American Railroads in Ex Parte No 664, "Methodology to be Employed in Determining the Railroad Industry's Cost of Capital," to be served on all parties of record in this proceeding by first class mail, postage prepaid or more expeditious method of delivery.



Matthew Wolfe

**BEFORE THE
SURFACE TRANSPORTATION BOARD**

METHODOLOGY TO BE EMPLOYED IN	)	
DETERMINING THE RAILROAD INDUSTRY'S	)	Ex Parte No. 664
COST OF CAPITAL	)	

**VERIFIED STATEMENT
OF
R. GLENN HUBBARD
DEAN, COLUMBIA BUSINESS SCHOOL
AND
BRUCE E. STANGLE
CHAIRMAN, ANALYSIS GROUP, INC.
ON BEHALF OF
ASSOCIATION OF AMERICAN RAILROADS**

September 27, 2007

I. INTRODUCTION

A. Qualifications

1. My name is R. Glenn Hubbard. I am the Dean of the Graduate School of Business of Columbia University, where I hold the Russell L. Carson Professorship in Finance and Economics. In addition, I am a Professor of Economics in the Department of Economics of the Faculty of Arts and Sciences. At the National Bureau of Economic Research, I am a research associate in programs on corporate finance, public economics, industrial organization, monetary economics, and economic fluctuations and growth. I am also a visiting scholar at the American Enterprise Institute in programs on tax policy and financial markets. Prior to joining the Columbia faculty as Professor of Economics and Finance in 1988, I taught in the Department of Economics at Northwestern University. I have also served as Visiting Professor of Business Administration at Harvard Business School, John M. Olin Visiting Professor at the University of Chicago, Visiting Professor and Research Fellow of the Energy and Environmental Policy Center at the John F. Kennedy School of Government and John M. Olin Fellow at the National Bureau of Economic Research. I hold A.M. and Ph.D. degrees in economics from Harvard University, and B.A. and B.S. degrees in economics from the University of Central Florida, *summa cum laude*.
2. My professional work has centered on problems in corporate finance, public economics, industrial organization, monetary economics, and natural resource economics. I have authored more than 100 research articles, edited a number of books, and authored a leading textbook on money and financial markets (*Money, the Financial System, and the Economy*, 6th ed., 2007) and a textbook on principles of economics. In my own work, I have used various methodologies for calculating the cost of capital of firms and industries, including the Discounted Cash Flow ("DCF") model, the Capital Asset Pricing Model ("CAPM") and variations of each of these models.

- 3 I have been an advisor or consultant to the Board of Governors of the Federal Reserve System, Congressional Budget Office, Federal Reserve Bank of New York, Internal Revenue Service, International Trade Commission, National Science Foundation, U.S. Department of Energy, and U.S. Department of the Treasury. From 1991 to 1993, I served as Deputy Assistant Secretary (Tax Analysis) of the U.S. Department of the Treasury, where I was responsible for economic analysis of tax policy, the administration's revenue estimates, and health care policy issues. From 2001 to 2003, I served as Chairman of the President's Council of Economic Advisers, over that time period, I also served as Chair of the Economic Policy Committee for the Organization for Economic Co-operation and Development (OECD) in Paris.
4. My name is Bruce E. Stangle. I am an economist with over 25 years of experience with issues relating to antitrust, regulation, intellectual property and securities matters, and other areas of economic analysis. I am Chairman and a co-founder of Analysis Group, Inc., a national economic consulting firm with over 300 professional consultants in ten offices in North America. Over the course of my career, I have provided testimony on a number of topics including antitrust, market definition, entry conditions, competitive effects, security valuation, and damages. I am a member of the American Economic Association, the Board of Trustees of Bates College, the Visiting Committee for the Economics Department at the Massachusetts Institute of Technology, and the Board of Directors of Wellington Trust Company, NA, a money management firm. I have a B.A. from Bates College, and an M.S. in Management and a Ph.D. in Applied Economics from the Sloan School of Management at Massachusetts Institute of Technology.

B. Purpose of Testimony

5. We have been asked by counsel for the Association of American Railroads ("AAR") to comment on the August 14, 2007 proposal (corrected August 20, 2007) of the Surface Transportation Board ("STB") "to revise its method for

calculating the railroad industry's cost of capital by computing the cost of equity using a capital asset pricing model."¹

6. We have previously filed statements on December 8, 2006 and February 12, 2007 regarding the methodology we believe is appropriate for estimating the cost of capital in this industry, including our rationale for the continued use of the DCF model. In this statement, however, we focus primarily on the STB's proposed implementation of the CAPM. As we make clear, however, we still believe the DCF framework could have a useful role to play in the STB's decision-making process.
7. In evaluating the STB's proposed methodology, our concern is to help ensure that the regulation does not create inefficient investment incentives. This objective is particularly important in an industry as capital-intensive as the railroads. If the estimated regulated cost of capital is set too low, investment will be deterred, and both the quantity and quality of rail service provided will suffer. Similarly, adverse and inefficient consequences may arise if the estimated regulated cost of capital is set too high. We are also concerned that long-term investments may be "stranded" if a new approach reduces revenues from existing investments that were made based on expectations informed by the prior regulatory environment.

C. Summary of Conclusions

8. The STB has ignored a body of evidence that both the DCF model and the CAPM require the STB to make significant judgments regarding the appropriate implementation of each model. Furthermore, the STB has not presented compelling reasons to reject the use of one method in favor of the other. Either model is capable of giving a flawed estimate if key inputs are chosen poorly. Neither model is inherently superior to the other, and ideally, both models

¹ Surface Transportation Board Decision STB Ex Parte 664, Methodology to be Employed in Determining the Railroad Industry's Cost of Capital, August 14, 2007 ("STB Decision"), p. 1

should yield comparable results. The STB's implementation of the CAPM, however, is clearly at odds with common practice.

9. We find that after a more realistic estimate of the market risk premium is used in the CAPM, along with some widely used beta estimates produced by well-known financial data providers, the cost of equity as of December 2005 for the four major railroads ranges from 8.8 percent to 13.1 percent, with a median value of 11.1 percent. In contrast, the STB's estimates (7.8 percent to 8.7 percent) fall completely below this range. In our view, this comparison leaves no doubt that the specific implementation of the CAPM proposed by the STB in its workpapers yields a cost of equity estimate that is much too low. If adopted for regulatory purposes, the inappropriately low cost of capital generated by the STB's proposed methodology would have a significant adverse impact on important investment decisions facing the railroad industry.
10. When the CAPM inputs are updated to September 2007 values, we find that the cost of equity for the four major railroads increases further, with the new range being 10.5 percent to 16.6 percent, with a median value of 12.4 percent.
11. While the STB clearly needs to revise its implementation of the CAPM, we also continue to believe that it would be valuable for the STB to use a multi-stage DCF model as a cross check on the distribution of results obtained from the CAPM. A version of the multi-stage DCF model published by Ibbotson Associates estimates the cost of equity for the median railroad in March 2007 to be 11.4 percent, which is squarely within the range of values we found using alternative inputs to the CAPM.
12. Whatever methods are ultimately employed by the STB, we believe the approach must be transparent and the results must be reproducible by all parties. In addition, any final point estimate of the cost of capital used for regulatory purposes should give weight to the entire range of plausible estimates, not just the low end of the range.

II. PROBLEMS WITH THE PROPOSED IMPLEMENTATION OF THE CAPM

A. Basic Principles of Estimation

13. In evaluating the STB's proposed methodology, it is crucial to recognize that all cost of equity models, including DCF and CAPM, are simplifications of reality, and should not be assumed to have greater precision and reliability than they actually possess.

14. Each of the key inputs is measured with error, the result being that any one point estimate of the cost of equity is really associated with an entire distribution of values. For example, as Professor Stephen Penman has noted:

The CAPM requires estimates of firms' betas, but these estimates typically have errors. A beta estimated as 1.3 may, with significant probability, be somewhere between 1.0 and 1.6. With a market risk premium of 6.0 percent, an error in beta of 0.1 produces an error of 0.6 percent in the required return.

Penman continues:

The market risk premium is a big guess. Research papers and textbooks estimate it in the range of 4.5 percent to 9.2 percent. . . . With a beta of 1.3, the difference between a required return for a market risk premium of 4.5 percent and one for a market risk premium of 9.2 percent is 6.11 percent.²

15. Given the inherent imprecision in this process, the STB should consider the sensitivity of results to alternative values of key inputs, as well as alternative methodologies, including the DCF model.

16. Instead, the STB proposes to replace, rather than supplement, the DCF model with the CAPM. While the STB recognizes that "the actual development of a particular [CAPM] model can be complex and still requires the exercise of judgment,"³ we do not think that the STB recognizes the full extent to which the

² Stephen H. Penman, *Financial Statement Analysis and Security Valuation*, McGraw-Hill Irwin, 2001, p. 691.

³ STB Decision, p. 2.

CAPM is sensitive to arbitrary choices made in the estimation and implementation process.

- 17 For example, we are puzzled by the STB's citation of the paper by Professors Graham and Harvey to support the Board's position that "CAPM provides an alternative to DCF that commands greater respect in the regulatory and academic community and dominates the private sector."⁴ In fact, Graham and Harvey reach quite a different conclusion from the STB:

While the CAPM is popular, we show later that it is not clear that the model is applied properly in practice. Of course, even if it is applied properly, it is not clear that the CAPM is a very good model (see Fama and French, 1992).⁵

B. Key Inputs to the CAPM

18. Key inputs used in the implementation of the CAPM are inherently subjective and imprecise. Application of the CAPM requires judgment regarding.

- Model type (e.g., single-factor versus multi-factor);
- Risk-free rate (e.g., short-term versus long-term),
- Market risk premium (e.g., the appropriate market index, period of measurement over which the premium is calculated, method of measurement [arithmetic versus geometric mean]);
- Beta estimate (estimation period, frequency of data); and
- Peer group (e.g., in the case of a private company, the CAPM must be estimated using data for comparable public companies).

19. As we will discuss in more detail below, the cost of equity estimates resulting from the STB's implementation of the CAPM (as described in the STB's proposal, including the Appendix and workpapers), are highly sensitive to alternative approaches for estimating beta, the risk-free rate, and the market risk

⁴ STB Decision, p. 6

⁵ John R. Graham and Campbell R. Harvey, "The Theory and Practice of Corporate Finance: Evidence from the Field," *Journal of Financial Economics*, vol. 60 (2001), p. 201

premium. Our findings are consistent with previous studies that have explored the sensitivity of CAPM estimates to various methodological issues.⁶

C. Estimates of Beta

20. The STB proposes estimating beta for each carrier using monthly stock returns over the prior 10 years. The STB decision notes:

In selecting a 10-year time period to estimate Beta, we seek to balance the desire to eliminate statistical noise and achieve stability in the estimate, while allowing for the fact that Beta may change over time. Using earlier data might cause results to be skewed by events that are no longer important.⁷

21. The STB also invited comments on the use of 25-year or 5-year windows over which to estimate beta, noting that “anything less than 5 years appears to add too much noise to the estimate.”⁸

22. A 10-year beta is quite long, particularly given the evolution of railroad betas during the past decade -- a period over which beta has clearly been rising.⁹ Beta is a lagging indicator of the appropriate cost of equity. When an industry is undergoing economic changes, as the railroad industry has been over the past decade, using too long an estimation period for beta can introduce significant bias into the estimate.

⁶ See, for example, Eugene F. Fama and Kenneth R. French, “The Capital Asset Pricing Model: Theory and Evidence,” *Journal of Economic Perspectives*, vol. 18, no. 3 (Summer 2004), pp. 25-46, and Robert F. Bruner, Kenneth M. Fades, Robert S. Harris, and Robert C. Higgins, “Best Practices in Estimating the Cost of Capital: Survey and Synthesis,” *Financial Practice and Education*, (Spring/Summer 1998), pp. 13-28, cited in “Reply Comments of the Western Coal Traffic League,” Surface Transportation Board, Ex Parte No. 558 (Sub-No. 9), Railroad Cost of Capital-2005, April 28, 2006 (“WCTL Comments”).

⁷ STB Decision, p. 11.

⁸ STB Decision, p. 11. In the Appendix to its proposed decision, the STB invited comments “on the inclusion of an intercept term in the [beta] regression.” We do not believe the STB should produce its own estimates of beta, but if the STB continues to do so, we would prefer to see the regressions estimated with an intercept. Omitting the intercept imposes a theoretical restriction that may not be supported by the data.

⁹ See February 12, 2007 testimony of Bruce E. Stangle, in Summary of the Presentation of the American Association of Railroads, Surface Transportation Board Decision, STB Ex Parte 664, Methodology to be Employed in Determining the Railroad Industry’s Cost of Capital, pp. 17-18.

23 Furthermore, a 10-year estimation window is not commonly used by researchers or practitioners in economics and finance. Although there is no hard and fast rule, the practice of using 5 years of historical data to estimate beta appears to be much more common.¹⁰ For example, Ibbotson Associates, *Stocks, Bonds, Bills and Inflation 2007 Yearbook, Valuation Edition* ("SBBI") notes:

The amount of history included in beta calculations done by commercial beta services is fairly consistent at five years. Using five years of data is a rather arbitrary decision that attempts to use as much data as possible without including irrelevant historical data. Using five years of data would ideally cover a number of different economic scenarios such as an expansion and contraction in the economy.¹¹

24 Citing the significance of the events of September 11, 2001 for the airline industry, the SBBI also notes that it might be appropriate to estimate beta over a time period even shorter than 5 years.

An example of a company-specific event is a change in the way a company conducts business. After September 11, 2001, Southwest Airlines, together with other airlines, was forced to cope with reduced airline travel, the implementation of new safety and security measures, restructuring, and other changes. Measuring the beta of Southwest Airlines using a longer time period may not be appropriate due to differences in the risk characteristics of the company pre- and post-September 11, 2001. The beta of Southwest Airlines was 0.85 when using 5 years of monthly data, and 1.31 when using two years of monthly data both through September 2003. Southwest Airlines serves as an example of a company changing the way it conducts business and the relevance of measuring beta over a shorter time period.¹²

¹⁰ See Fisher Black, Michael Jensen, and Myron Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in *Studies in The Theory of Capital Markets*, Michael Jensen, ed., Praeger, 1972, pp. 79-121, where a five-year historical window is the rule of thumb, and Gordon J. Alexander and Norman L. Chervany, "On the Estimation and Stability of Beta," *Journal of Financial and Quantitative Analysis*, vol. 15, no. 1 (March 1980), p. 136, who found that periods between 4 and 6 years were optimal.

¹¹ *Stocks, Bonds, Bills and Inflation, Market Results for 1926-2006, 2007 Yearbook, Valuation Edition*, Morningstar, Inc., p. 106.

¹² SBBI, p. 107.

25. Research in financial economics therefore indicates that using five years of historical data to estimate beta is a more defensible methodology. The 10-year window proposed by the STB would capture too much irrelevant information and the proposed 25-year window would not make any economic sense. The STB's position cited above that "anything less than five years appears to add too much noise to the estimate" fails to recognize that recent economic events and decisions play a crucial role in determining the extent of nondiversifiable risk associated with a particular stock. In fact, where there is strong evidence of changing industry dynamics, an estimation period shorter than five years may be justified.
26. Exhibits 1a-1d clearly illustrate the bias that is created in the beta estimates over time when the estimation window is too long. Despite the changing economic conditions in the industry, the 10-year window proposed by the STB yields a very stable -- but also unusually low -- estimate of beta for three out of the four major railroads.
27. The STB also considers assuming a beta of one under the notion that finance theory predicts that "beta will move toward 1 over time," and because of the recent decision by the Board of Governors of the Federal Reserve System to use the CAPM to impute "the costs that would have been incurred and profits that would have been earned had the Federal Reserve Banks' priced services been provided by a private firm."¹³ We note that finance research has shown in a portfolio setting that betas may revert to unity over time.¹⁴ To account for this possible tendency, financial data providers such as Ibbotson, Value Line, and

¹³ Federal Reserve System, Federal Reserve Bank Services Private Sector Adjustment Factor, Notice with request for comments ("Federal Reserve Notice"), Federal Register, vol. 70, no. 98 (May 23, 2005), p. 29512.

¹⁴ See, for example, Marshall Blume, "On the Assessment of Risk," *The Journal of Finance*, vol. 26, no. 1 (March 1971), pp. 1-10; Marshall Blume, "Betas and Their Regression Tendencies," *The Journal of Finance*, vol. 30, no. 3 (June 1975), pp. 785-795; Pieter Elgers, James R. Haltiner, and William H. Hawthorne, "Beta Regression Tendencies: Statistical and Real Causes," *The Journal of Finance*, vol. 34, no. 1 (March 1979), pp. 261-263.

Bloomberg also offer "adjusted beta" estimates.¹⁵ We believe it would be a mistake simply to assume a beta of unity for the railroad industry -- and ignore the existence of these alternative estimates of beta -- many of which differ significantly from 1.0

28. Furthermore, the decision of the Federal Reserve to adopt a fixed beta of 1.0 rested in large part on considerations that are absent here. The Federal Reserve faced a unique problem in implementing the CAPM -- identifying a relevant peer group. The Federal Reserve assumed a beta of 1.0 in part to allow it to avoid having to choose a peer group and calculate the historical beta specific to that group.¹⁶

29. Lastly, because the cost of equity selected by the Federal Reserve does not affect its investment in the priced services it provides, it makes sense for the Federal Reserve to focus on methods that are "simple to understand, administer, and monitor."¹⁷ The STB's decisions, however, directly influence railroads' investment decisions, with potentially significant consequences. Thus, the stakes for the value of the regulated firm associated with the estimation process are fundamentally different in the case of the recommendations by the Federal Reserve and the STB.

D. The Risk Free Rate of Return

30. The STB proposes using a 10-year Treasury Bond rate as a proxy for the risk-free rate in its implementation of the CAPM. The STB's proposed proxy for the risk free rate is generally consistent with the rate advocated in the academic

¹⁵ For example, Bloomberg adjusts its beta as follows: $(1.0)/(0.33) = (\beta)/(0.67)$. For further research on adjustment methodologies, see Marshall Blume, "Betas and Their Regression Tendencies," *The Journal of Finance*, vol. 30, no. 3 (June 1975), pp. 785-795, Oldrich A. Vasicek, "A Note on Using Cross-Sectional Information in Bayesian Estimation of Security Betas," *The Journal of Finance*, vol. 28, no. 5 (December 1973), pp. 1233-1239, and Martin Lally, "An Examination of Blume and Vasicek Betas," *The Financial Review*, vol. 33 (1998), pp. 183-197.

¹⁶ Federal Reserve Notice, Federal Register, vol. 70, no. 199 (October 17, 2005), p. 60346.

¹⁷ Federal Reserve Notice, Federal Register, vol. 70, no. 199 (October 17, 2005), p. 60346.

literature, although some potentially useful alternatives exist.¹⁸ The medium-term rate is generally accepted because the duration of the 10-year Treasury Bond tends to match the investment horizon of the typical project being evaluated.

31. Other reasonable proxies for the risk-free rate include the yield on the short-term Treasury Bill and the long-term Treasury Bond. Ibbotson's proxy for the risk-free rate is the yield on the 20-year Treasury Bond.¹⁹ Whatever risk-free rate is used, the market risk premium should be constructed in a consistent manner. For example, if the long-term Treasury Bond rate is used as the risk-free rate, then the market risk premium should be based on the difference in the returns between the market and the long-term Treasury Bond.²⁰

E. The Market Risk Premium

- 32 The STB proposes estimating the market risk premium using monthly NYSE data over a 50-year time period, and invites comments on the choice of the appropriate time period as well as the use of a fixed market risk premium rather than one which varies each year.²¹
- 33 We note that the market risk premium is subject to wide variation depending on one's approach. As noted previously (by Professor Penman), estimates in financial research range from 4.5 percent to 9.2 percent. In its workpapers the STB has estimated a market risk premium of 5.2 percent, which is at the low end of the plausible range. There is no inherent justification for the STB's

¹⁸ See Richard A. Brealey, Stewart C. Myers, and Franklin Allen, *Principles of Corporate Finance*, 8th ed., McGraw-Hill Irwin, 2006, pp. 147-49; Krishna G. Palepu, Paul M. Healy, and Victor L. Bernard, *Business Analysis and Valuation Using Financial Statements*, 2nd ed., 2000, pp. 12-22-12-23; Stephen H. Penman, *Financial Statement Analysis and Security Valuation*, McGraw-Hill Irwin, 2001, p. 75; Tim Koller, Marc Goedhart, and David Wessels, *Valuation: Measuring and Managing the Value of Companies*, 4th ed., McKinsey & Company, p. 296; Shannon P. Pratt, *Cost of Capital, Estimation and Applications*, 2nd ed., Wiley, 2002, p. 83.

¹⁹ SBBI, p. 59.

²⁰ Richard A. Brealey, Stewart C. Myers, and Franklin Allen, *Principles of Corporate Finance*, 8th ed., McGraw-Hill Irwin, 2006, p. 222, footnote 8.

²¹ STB Decision, p. 10.

approach, and yet this estimate fundamentally determines the outcome. Even the WCTL's expert, Mr. Crowley, estimated a much higher market risk premium of 7.1 percent in his earlier report.²²

34. While the level of the equity risk premium is the subject of considerable debate among researchers in finance, practitioners often rely on long-horizon risk premium estimates because such estimates tend to reduce the estimation error.²³ As such, the 50-year time period proposed by the STB strikes us as too short by industry standards
35. Furthermore, the STB should be aware of the complexity of estimating the expected equity risk premium. For example, the SBBI, a well-known source for these data, reports new equity risk premium data each year, and provides detailed notes on its choice of market proxy (S&P 500), the estimation period (1926-present), and the risk-free rate (20-year Treasury Bonds).²⁴ In addition, there is no support in the financial literature for the use of a fixed equity risk premium, as it ignores pertinent information about changes in the economic landscape that occur over time
36. An example of the complexity of the exercise is illustrated by the methodology for computing the historical risk-free rate. While the yield to maturity of a long-term Treasury Bond is an appropriate measure of the *forward-looking* risk-free rate, the SBBI notes that when a researcher collects *historical* government bond return data in the context of estimating the CAPM, some portion of the reported return is attributable to changes in the *price* of the government bond (which rises and falls in response to general economic conditions and is therefore not risk-free). Therefore, only that portion of the return associated with the default

²² Verified Statement of Thomas D. Crowley, April 28, 2006, p. 16, in WCTL Comments

²³ See Tim Koller, Marc Goedhart, and David Wessels, *Valuation: Measuring and Managing the Value of Companies*, 4th ed., McKinsey & Company, p. 298, which advocates using "the longest period possible," and the SBBI, pp. 82-83, which notes that, "[U]sing a longer historical period provides a more stable estimate of the equity risk premium." See also Shannon P. Pratt, *Cost of Capital: Estimation and Applications*, 2nd ed., Wiley, 2002, p. 61, which contains a section titled "Ibbotson Associates Is the Primary Source of Historical Risk Premium Data."

²⁴ SBBI, Chapter 5

risk on the coupon payment, and not the interest rate risk, can be considered truly risk-free. For example, the SBBI reports that the total return on a long-term government bond in 1971 was 13.23 percent. Of this return, roughly half (6.32 percent) was attributable to the coupon payments and roughly half (6.61 percent) was attributable to changes in the price of the bond. Only the former can be considered risk-free in the context of the CAPM. The SBBI adjusts its computation of the historical risk premium accordingly.²⁵

37 We also note that the time period used by the SBBI begins with 1926, and so the SBBI includes many years of data that the STB proposal would ignore. We would favor starting at least with 1926, if not earlier, and relying on a standard source such as the SBBI, rather than relying on a unique risk premium calculated by the STB.

38 As shown in Exhibit 2, the time period used by the researcher has a significant impact on the estimate of the market risk premium. The STB's chosen estimation period does not make use of all the available historical data. By ignoring these additional data, the STB significantly reduces the expected equity risk premium by up to 1.9 percentage points (7.1 percent – 5.2 percent).

F. Summary of Alternatives to the Proposed Implementation of the CAPM

39 To the extent that the STB will use the CAPM going forward, we believe it is critically important that key inputs to the CAPM *not* be estimated in the manner proposed by the STB. All of the key inputs to the CAPM are available through highly reputable financial data providers using methodologies that are superior to those proposed by the STB. The use of these commercially available estimates would be a cost-effective way to make the process more open and transparent.

40 While these sources will result in a range of estimates for the key inputs, we believe the STB should consider the entire range of cost of equity estimates that

²⁵ SBBI, pp. 75-77. Bond return data are from pp. 239-243.

result from these inputs. To do otherwise would create an impression of false precision that we believe is detrimental to the regulatory process. When faced with a range of estimates, we believe the STB should adjust the cost of equity it actually employs in regulatory decisions only when the central tendency of the estimates points to a higher or lower rate than was used in the past.

41. Exhibits 3a and 3b show the cost of equity estimates as of December 2005 and September 2007, respectively, that result from using inputs provided by three well-respected financial data providers. In order to isolate the effect of beta on the cost of equity estimates, the risk-free rate proxy and the market risk premium (from the SBBI) are held constant in each of the bottom three panels. As Exhibits 3a and 3b show, the differences in betas among the financial data providers generate significantly different cost of equity estimates. For example, the cost of equity estimate in Exhibit 3a for Burlington Northern using Ibbotson betas is 9.13 percent, while the estimate increases to 11.33 percent using Value Line betas.
42. When comparing the cost of equity estimates that result from the different data sources, Exhibit 3a shows that for every railroad the STB estimates are the lowest -- in many cases by a considerable amount. Exhibit 3a shows that the STB estimates as of December 2005 (7.8 percent to 8.7 percent) fall completely below the range we find using more appropriate CAPM inputs from commercial data providers (8.8 percent to 13.1 percent, with a median value of 11.1 percent). When the CAPM inputs are updated to September 2007 values, Exhibit 3b indicates that the cost of equity estimates increase further, with the new range being 10.5 percent to 16.6 percent, with a median value of 12.4 percent.
43. Given the description of the STB's proposed CAPM implementation in its August 14, 2007 decision, at least some of the methodological differences between the STB's CAPM inputs and those of the commercial providers are known. A major contributor to why the STB's cost of equity estimates are unduly low is the market risk premium discussed earlier in connection with

Exhibit 2 In addition, the STB uses 10 years of monthly returns to estimate betas, whereas the commercial providers use 5 years of monthly data or between 2 and 5 years of weekly data. The STB uses NYSE data to estimate beta while some commercial providers use the S&P 500 as an alternative market proxy. Finally, we used a 20-year Treasury Bond rate as a measure of the risk-free rate to be consistent with the methodology used to compute the market risk premium. In contrast, the STB's risk-free rate appears to be based on the 10-year Treasury Bond rate.

III. THE STB HAS NOT JUSTIFIED ITS EXCLUSION OF THE DCF MODEL

A. The STB's Position Regarding the DCF Model

44. The STB proposes to ignore the DCF model going forward on grounds that a one-stage DCF model is unrealistic and the definition of the multi-stage DCF model is "arbitrary."²⁶
45. The relative rankings of estimates generated by different cost of equity models are difficult to predict. We do not believe that the CAPM is more straightforward than the DCF or more reliant on objective facts. As noted above, both models require judgment in order to be properly applied. Neither method should produce consistently higher or lower estimates of the cost of equity than the other.
46. The STB should continue giving weight to the results of a DCF model, in combination with the CAPM approach described above.

B. The Multi-Stage DCF Model

47. While we understand the reluctance of the STB to rely on a single-stage DCF model, multi-stage DCF models are widely accepted by economists and regulators. For example, we understand that FERC continues to use a two-stage

²⁶ STB Decision, pp. 5-6

DCF model in some of its deliberations.²⁷ A significant point in favor of the DCF model is that it is forward-looking in nature, thus focusing on the industry's future capital needs. In contrast, the CAPM, as discussed previously, relies entirely on historical data.

48. We believe that a three-stage DCF model would be a useful cross check for the STB. Estimates from a three-stage DCF model are published annually in the Ibbotson Associates *Cost of Capital Yearbook*, and so these estimates represent a readily available alternative to the CAPM that does not require any additional resources on the part of the STB or the parties involved.
49. Ibbotson reports that the median cost of capital for SIC 4011 (Railroads, Line Haul Operating) generated by the three-stage DCF model was 11.5 percent in March 2006 and 11.4 percent in March 2007. In contrast, Ibbotson reports the median cost of equity generated by the CAPM was 12.1 percent in March 2006 and 11.0 percent in March 2007.²⁸ These results illustrate that, when properly implemented, alternative approaches may serve as a useful cross check without generating an unworkably wide range of estimates.
50. While the Ibbotson methodology reflects specific choices and judgments made by that organization, we believe these choices are sensible from an economic perspective. In the three-stage model, each firm's earnings growth rate during the first five years is taken to be the consensus estimate of industry analysts. The firm's growth rate during years 6 through 10 is the average of the consensus analysts' estimates for the earnings growth of the industry as a whole. Starting in year 11, the firm's growth rate is taken to be the long-run growth rate of the aggregate economy.²⁹

²⁷ See, for example, Federal Energy Regulatory Commission, *Cost-of-Service Rates Manual*, Washington, D.C., June 1999, 68 FERC ¶ 61,032, Order Affirming in Part and Reversing in Part Initial Decision, Ozark Gas Transmission System, Docket Nos. RP94-105-002 (Phase I) and RP94-105-003, July 7, 1994, and 117 FERC ¶ 61,077, Opinion No. 486, Kern River Gas Transmission Company, Docket RP04-274-000, Opinion and Order on Initial Decision, October 19, 2006.

²⁸ Ibbotson Associates, *Cost of Capital Yearbook*, 2006, p. 4-4, and 2007, p. 4-4.

²⁹ SBBI, p. 68.

51 The Ibbotson three-stage approach is attractive because it is consistent with various life-cycle valuation models based on company and industry growth. The first growth rate allows for the integration of any exceptional near-term growth potential perceived by the financial community. The second rate allows for competitive forces that tend to equalize returns across firms in an industry over time, while still allowing for differences in performance across industries. Finally, the third rate reflects the fact that any barriers to competition across industries tend to break down over time, which contributes to bringing industry growth rates into line with the growth of the aggregate economy.³⁰

52 The use of a multi-stage DCF model as a cross check on the CAPM results would also help to ensure a degree of consistency with prior STB decisions. As we indicated in our earlier filings, in regulating an industry, great care must be taken to avoid creating inefficient investment incentives and to avoid abruptly and significantly changing the regulatory environment that influenced past investment decisions.

³⁰ SBBI, p. 68

VERIFICATION

I, R. Glenn Hubbard, declare under penalty of perjury that the foregoing is true and correct.

Executed on September 27, 2007

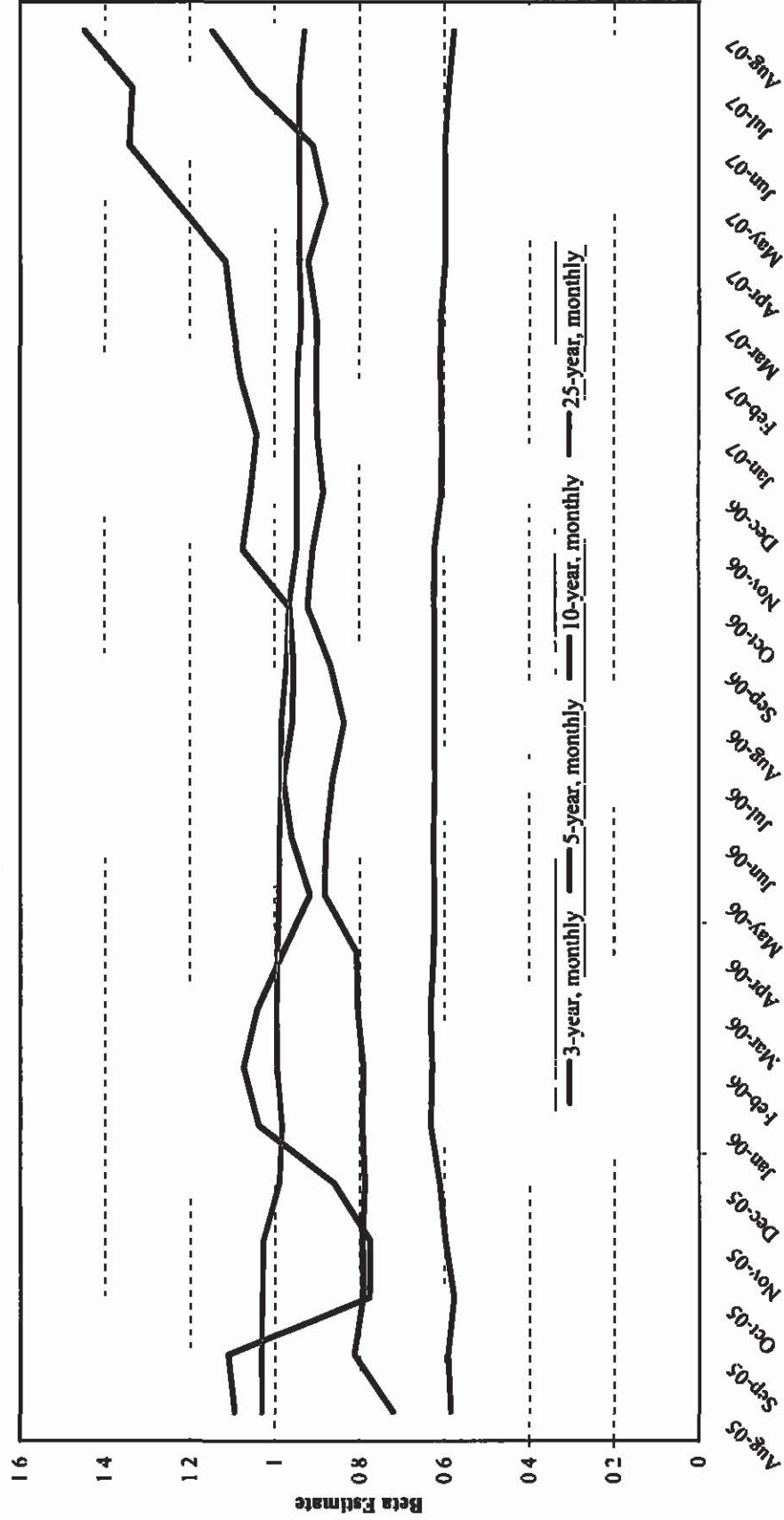
R. Glenn Hubbard
R. Glenn Hubbard

I, Bruce E. Stangle, declare under penalty of perjury that the foregoing is true and correct.

Executed on September 27, 2007

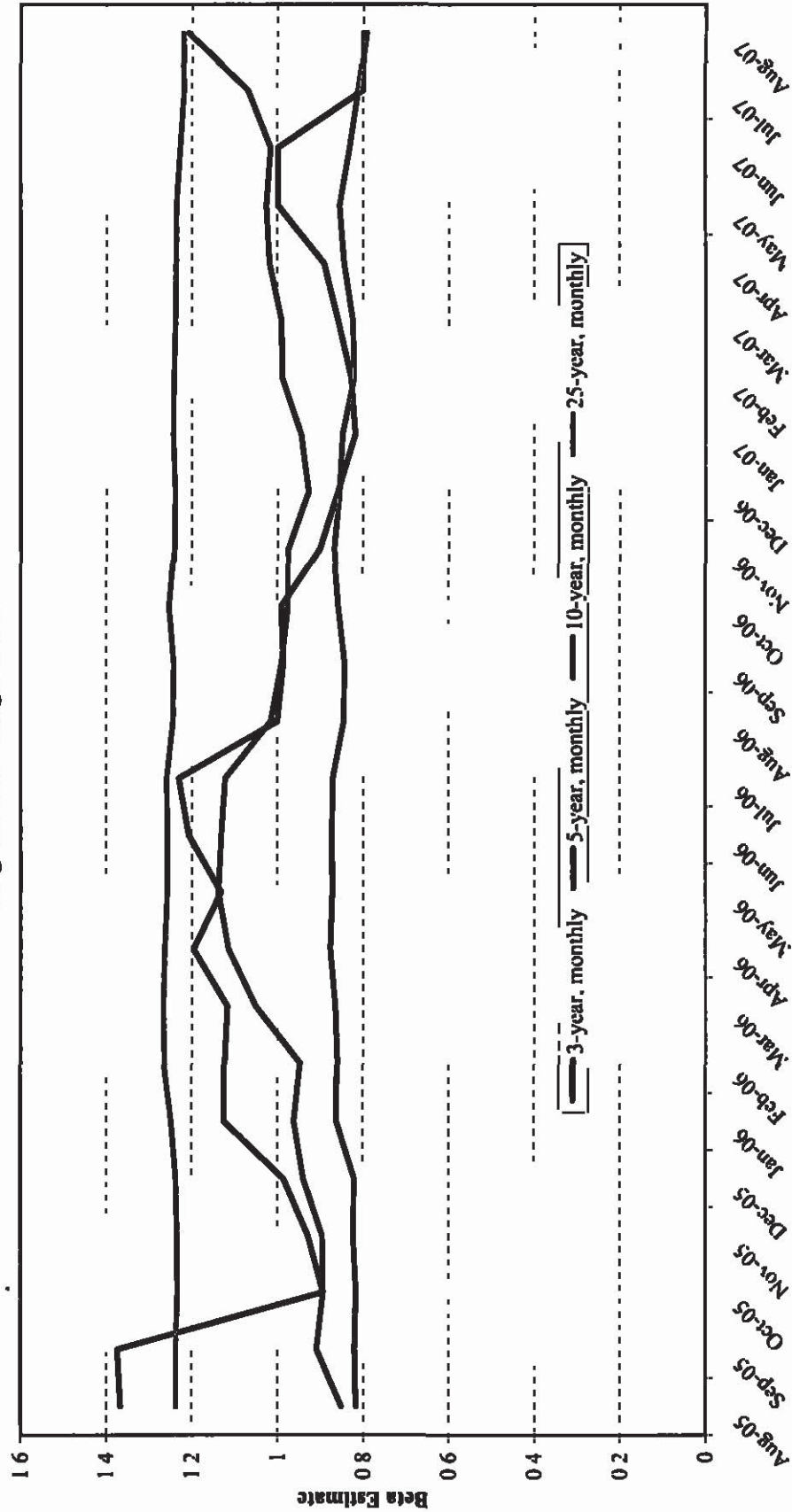
Bruce E. Stangle
Bruce E. Stangle

Exhibit 1a
Burlington Northern Santa Fe Beta Estimates by Estimation Period
August 2005 - August 2007



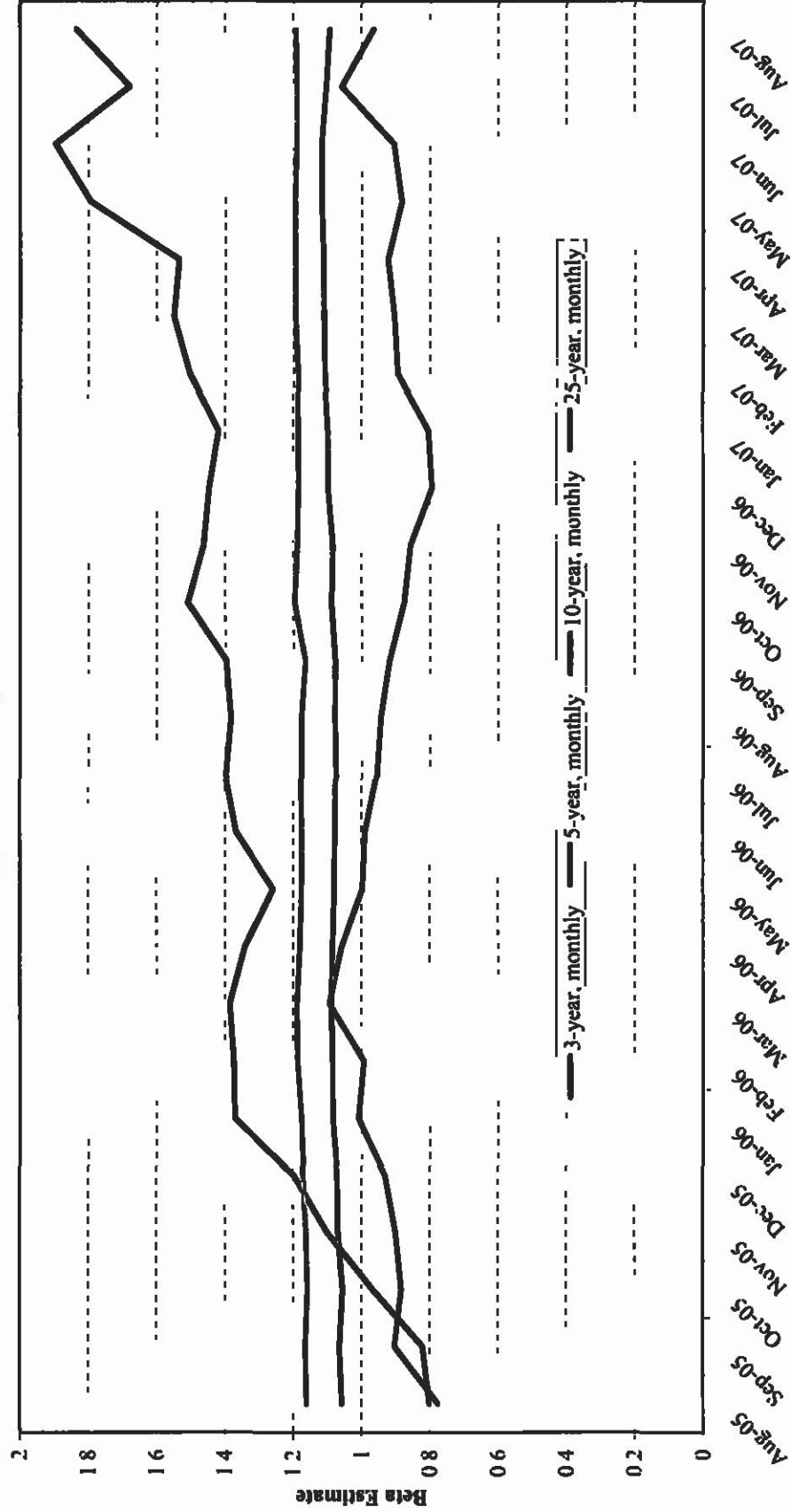
Notes and Sources Beta estimates were obtained by regressing monthly returns of the railroad's stock on monthly returns of the NYSE Composite Index, using the specified estimation window Railroad and NYSE price data are from Bloomberg The time period is restricted to August 2005 - August 2007 due to data availability, as 25 years of data are required to compute the first 25-year beta estimate

Exhibit 1b
CSX Beta Estimates by Estimation Period
August 2005 - August 2007



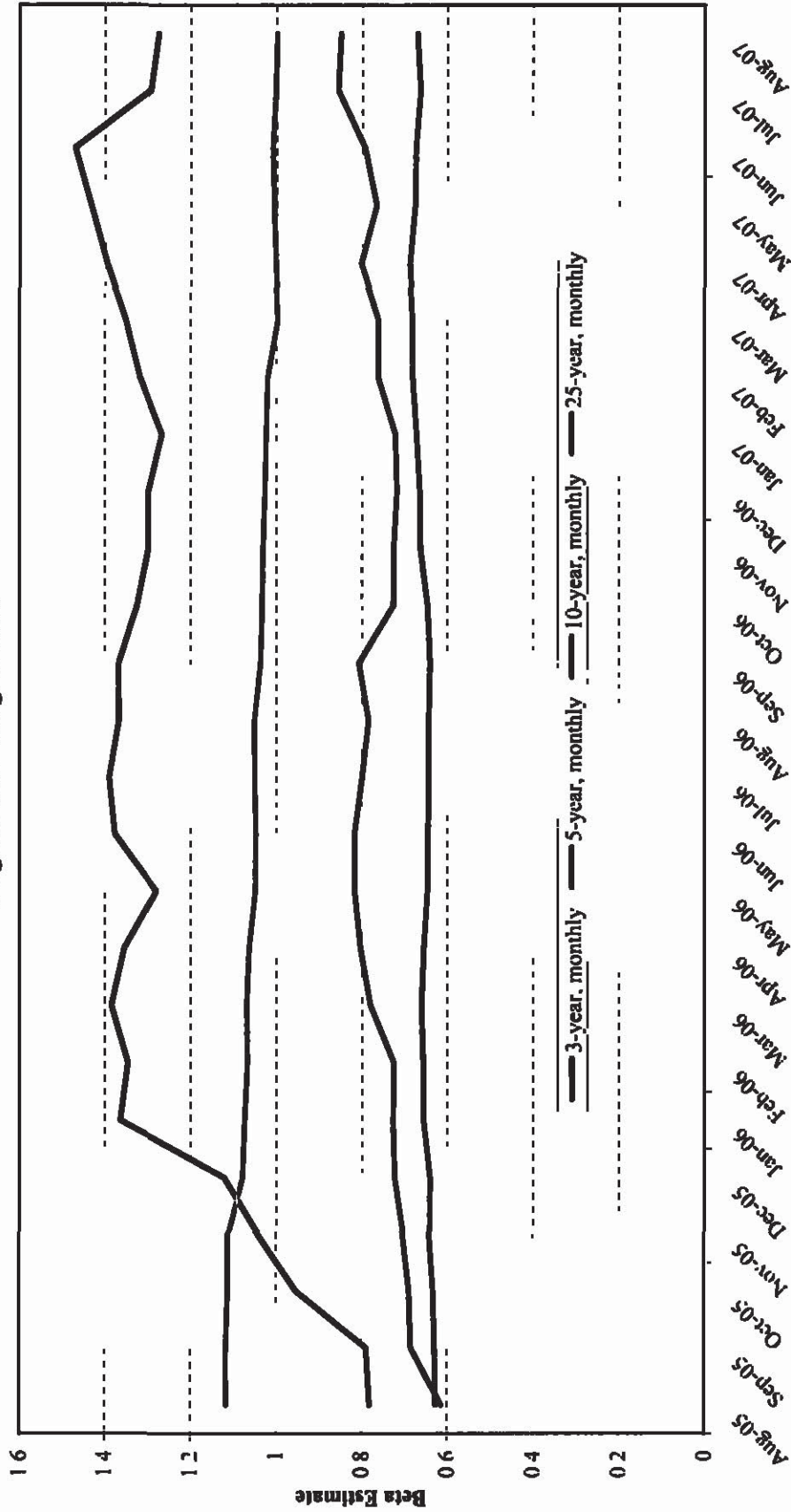
Notes and Sources: Beta estimates were obtained by regressing monthly returns of the railroad's stock on monthly returns of the NYSE Composite Index, using the specified estimation window. Railroad and NYSE price data are from Bloomberg. The time period is restricted to August 2005 - August 2007 due to data availability, as 25 years of data are required to compute the first 25-year beta estimate.

Exhibit 1c
Norfolk Southern Beta Estimates by Estimation Period
August 2005 - August 2007



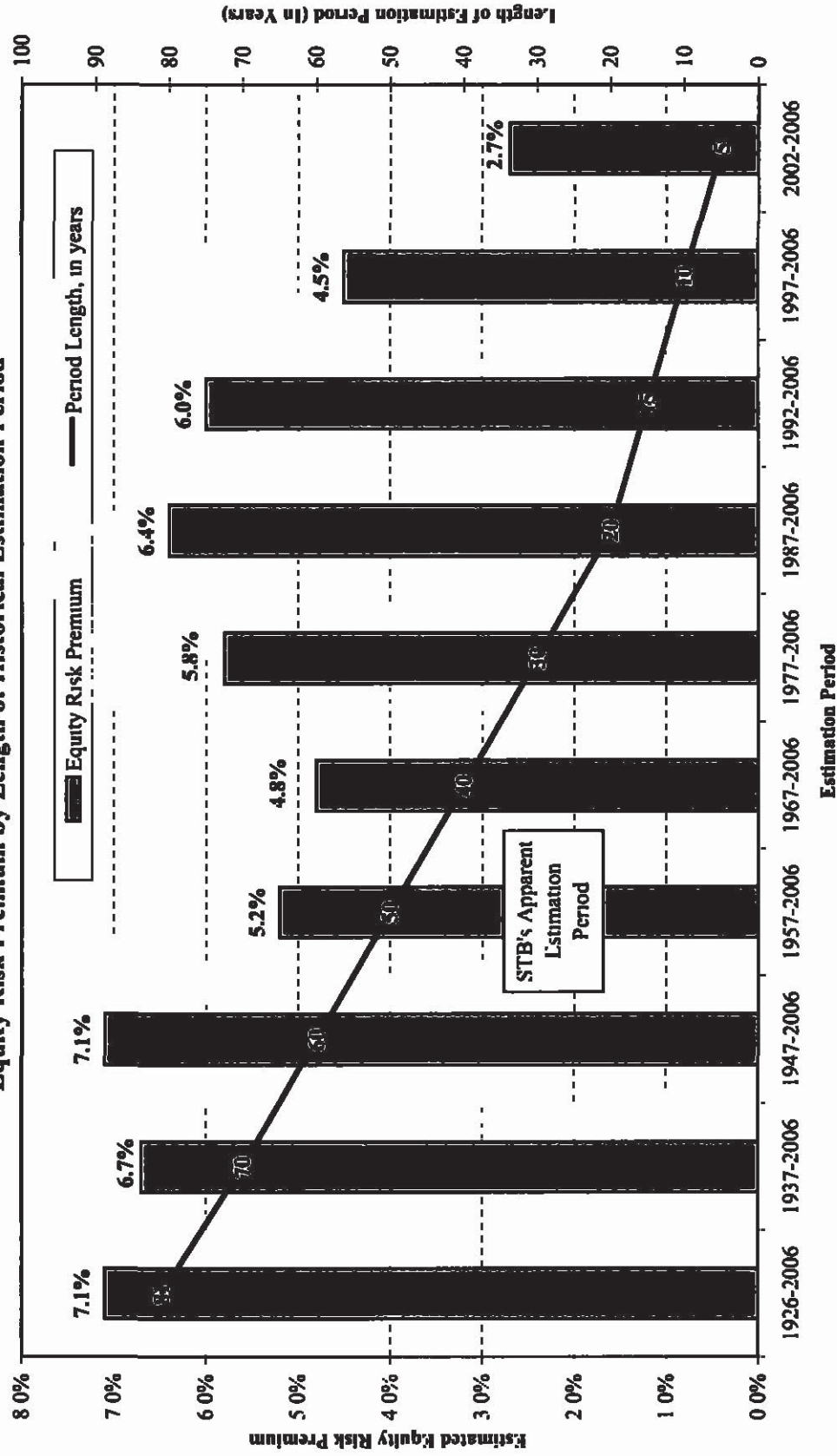
Notes and Sources Beta estimates were obtained by regressing monthly returns of the railroad's stock on monthly returns of the NYSE Composite Index, using the specified estimation window Railroad and NYSE price data are from Bloomberg The time period is restricted to August 2005 - August 2007 due to data availability, as 25 years of data are required to compute the first 25-year beta estimate

Exhibit 1d
Union Pacific Beta Estimates by Estimation Period
August 2005 - August 2007



Notes and Sources: Beta estimates were obtained by regressing monthly returns of the railroad's stock on monthly returns of the NYSE Composite Index, using the specified estimation window. Railroad and NYSE price data are from Bloomberg. The time period is restricted to August 2005 - August 2007 due to data availability, as 25 years of data are required to compute the first 25-year beta estimate.

Exhibit 2
Equity Risk Premium by Length of Historical Estimation Period



Notes and Sources Data are from *Stocks, Bonds, Bills and Inflation, Market Results for 1926-2006, 2007 Yearbook, Valuation Edition*, Morningstar, Inc. Table 5-5, p. 83. The stock market proxy used here is the S&P 500 and the government bond used here is the 20-year Treasury Bond (pp. 72-75). Ibbotson notes "[T]he equity risk premium is calculated by subtracting the arithmetic mean of the government bond income return from the arithmetic mean of the stock market total return" (p. 72).

Exhibit 3a
CAPM Inputs and Implied Cost of Equity According to the STB and Professional Providers
2005

STB Estimates, as of December 2005

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.25%	0.85	5.20%	8.69%
CSX Corp	4.25%	0.83	5.20%	8.57%
Norfolk Southern Corp	4.25%	0.85	5.20%	8.69%
Union Pacific Corp	4.25%	0.68	5.20%	7.78%

Ibbotson 5-Year Monthly Estimates, as of December 2005

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.60%	0.64	7.08%	9.13%
CSX Corp	4.60%	0.83	7.08%	10.48%
Norfolk Southern Corp	4.60%	0.89	7.08%	10.90%
Union Pacific Corp	4.60%	0.59	7.08%	8.78%

Value Line 5-Year Weekly Estimates, as of December 2005

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.60%	0.95	7.08%	11.33%
CSX Corp	4.60%	1.00	7.08%	11.68%
Norfolk Southern Corp	4.60%	1.00	7.08%	11.68%
Union Pacific Corp	4.60%	0.85	7.08%	10.62%

Bloomberg 2-Year Weekly Estimates, as of December 2005

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.60%	0.94	7.08%	11.23%
CSX Corp	4.60%	1.20	7.08%	13.07%
Norfolk Southern Corp	4.60%	1.19	7.08%	13.01%
Union Pacific Corp	4.60%	0.81	7.08%	10.32%

Median (Non-STB Estimates)

11.06%

Notes and Sources

- [1] Cost of Equity = [Risk-Free Rate] + [Beta]*[Risk Premium]
- [2] STB risk-free rate, beta, and risk premium estimates are from STB workpapers
- [3] The risk-free rate and risk premium used with the Ibbotson, Value Line, and Bloomberg estimates are from *Stocks, Bonds, Bills and Inflation, Market Results for 1926-2006, 2006 Yearbook, Valuation Edition*, Ibbotson, pp. 59 and 72. The risk-free rate represents the yield on the 20-year U.S. Treasury Bond as of December 31, 2005. The risk premium is measured over the period 1926-2005.
- [4] Ibbotson betas are unadjusted OLS betas from the Ibbotson Beta Book, First Edition 2006 (Data through December 2005). Ibbotson also provides adjusted betas.
- [5] Value Line betas are from Value Line; risk-free rate and equity risk premium are from SBBI, see note [3]. Value Line provides only adjusted betas, which are shown here.
- [6] Bloomberg betas are unadjusted OLS betas from Bloomberg; risk-free rate and equity risk premium are from SBBI, see note [3]. Bloomberg also provides adjusted betas.

Exhibit 3b
CAPM Inputs and Implied Cost of Equity According to Professional Providers
2007

Ibbotson 5-Year Monthly Estimates, as of September 2007

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.90%	1.09	7.13%	12.65%
CSX Corp.	4.90%	1.06	7.13%	12.46%
Norfolk Southern Corp	4.90%	0.85	7.13%	10.95%
Union Pacific Corp	4.90%	0.79	7.13%	10.53%

Value Line 5-Year Weekly Estimates, as of September 2007

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.90%	1.00	7.13%	12.03%
CSX Corp	4.90%	1.05	7.13%	12.39%
Norfolk Southern Corp	4.90%	1.05	7.13%	12.39%
Union Pacific Corp	4.90%	0.95	7.13%	11.67%

Bloomberg 2-Year Weekly Estimates, as of September 2007

Railroad	Risk-Free Rate	Beta	Risk Premium	Cost of Equity
Burlington Northern Santa Fe Corp	4.90%	1.50	7.13%	15.61%
CSX Corp	4.90%	1.02	7.13%	12.14%
Norfolk Southern Corp	4.90%	1.64	7.13%	16.62%
Union Pacific Corp	4.90%	1.40	7.13%	14.91%

Median **12.39%**

Notes and Sources

- [1] Cost of Equity = [Risk-free Rate] + [Beta]*[Risk Premium]
- [2] The risk premium used with the above estimates is from *Stocks, Bonds, Bills and Inflation, Market Results for 1926-2006, 2007 Yearbook, Valuation Edition*, Morningstar, Inc., p. 72. The risk premium is measured over the period 1926-2006.
- [3] The risk-free rate represents the yield on the 20-year U.S. Treasury Bond as of August 31, 2007, and is from http://www.federalreserve.gov/releases/h15/data/Weekly_Friday_11115_TCMNOM_Y20.txt, accessed on September 20, 2007.
- [4] Due to the absence of recently published estimates, Ibbotson betas are obtained by regressing 5 years of monthly returns of each railroad stock on 5 years of monthly returns of the S&P 500, which is the method used by Ibbotson.
- [5] Value Line betas are from Value Line; risk-free rate and equity risk premium are from Ibbotson; see notes [2] and [3]. Value Line provides only adjusted betas, which are shown here.
- [6] Bloomberg betas are from Bloomberg; risk-free rate and equity risk premium are from Ibbotson; see notes [2] and [3]. Bloomberg also provides adjusted betas.

VERIFIED STATEMENT OF STEWART C. MYERS

1. INTRODUCTION

I am the Robert C. Merton (1970) Professor of Finance at MIT's Sloan School of Management, a Research Associate of the National Bureau of Economic Research and a Principal of The Brattle Group, Inc. I am past President of the American Finance Association and co-author, with Richard Brealey and Franklin Allen, of *Principles of Corporate Finance*, now in its 8th edition. A more detailed statement of my qualifications is attached as Appendix A.

Most of my research and teaching focuses on corporate investment and financing decisions, including capital investment decisions, the choice between debt and equity financing and the measurement and use of the cost of capital. I have consulted in several industries, including the energy, mining, software, banking and pharmaceutical industries. I have served as expert witness in major cases and regulatory proceedings in several industries, including oil pipelines, telecommunications and railroads. I have prepared and submitted verified statements to the Surface Transportation Board (the Board or the STB) on three previous occasions. These statements dealt with railroad revenue requirements, the risks of railroad investment and the revenues required to support new capital investment.¹

Counsel for the Association of American Railroads (AAR) have asked me to review and evaluate the recent Board decision on the methodology for determining the cost of capital for the U.S. railroad industry (the Proposed Methodology).² The Board proposes to adopt the capital

¹ Verified Statements of Stewart C. Myers in *FMC Corporation v. Union Pacific Railroad Company*, Docket No. 42022, 1999; *Wisconsin Power and Light Company v. Union Pacific Railroad Company*, Docket No. 42051, 2000, and *PPL Montana v. Burlington Northern and Santa Fe Railway Company*, Docket No. 42054, 2001.

² "Methodology to be Employed in Determining the Railroad Industry's Cost of Capital," STB Ex Parte No. 664, August 14, 2007. A two-page supplement correcting errors in two tables

asset pricing model (CAPM) formula to compute the railroad industry's cost of equity capital. It proposes to discard a discounted cash flow (DCF) formula that it has used for many years for this purpose

The cost of equity is the key input to the industry's weighted average cost of capital (WACC). The cost of equity is also the most difficult input to estimate. It is not a contractual obligation like the cost of debt. It is the expected rate of return required by investors in the common stocks of the major railroad companies.

The Board's most recent cost of capital decision was issued in September 2006 for the year 2005.³ The decision used the DCF formula to get a cost of equity of 15.18%, which was blended with other inputs to get an overall weighted average cost of capital (WACC) of 12.2%. The WACC calculation was:

$$\begin{aligned} \text{WACC} &= \text{Cost of debt} \times \text{Debt weight} + \text{Cost of equity} \times \text{Equity weight} \\ &= .0536 \times .3041 + .1518 \times .6959 = .1219, \text{ rounded to } 12.2\% \end{aligned}$$

This WACC was a blend of a 5.36% interest rate on railroad industry debt with the industry cost of equity of 15.18%. The weights were the fractions of debt and equity in the industry's market-value capital structure. Using market values, the industry was about 30% debt financed and 70% equity financed.

The Board's new proposal uses the CAPM formula to get an estimated 8.4% cost of equity, reducing the industry WACC for 2005 to

$$\begin{aligned} \text{WACC} &= \text{Cost of debt} \times \text{Debt weight} + \text{Cost of equity} \times \text{Equity weight} \\ &= .0536 \times .3041 + .084 \times .6959 = .075 \text{ or } 7.5\% \end{aligned}$$

The proposed cost of equity and WACC are dramatically less than the Board previously

was issued on August 20, 2007. I also reviewed work papers for the calculations in these tables.

³ "Railroad Cost of Capital – 2005," STB Ex Parte No. 558 (Sub-No. 9), September 15, 2006.

calculated. The Board's Proposed Methodology would have cut the estimated cost of equity for 2005 almost in half, from 15.2% to 8.4%.

Getting the cost of capital right is important. Railroads that consistently earn at least their cost of capital are "revenue adequate." Railroads have not been revenue-adequate under the Board's previous cost of capital methodology, but the new CAPM methodology would make them appear so. I understand that railroads deemed revenue-adequate could face limits on what they can charge for transportation. Such limits could also limit profitability and undercut the incentive to invest, slowing the pace of modernization and expansion of capacity in the railroad industry.

My report is organized as follows. Section 2 surveys the issues encountered in estimating the cost of equity by the CAPM. Section 3 evaluates the specific numerical and statistical procedures chosen by the Board in its proposed implementation of the CAPM. Section 4 covers a two-stage DCF model considered and rejected by the board, and also discusses such models generally. Section 5 restates my conclusions and notes some broader issues that will need the Board's further attention.

Preview of conclusions

The Board's Proposed Methodology overstates the validity and accuracy of the CAPM. The CAPM is very useful, particularly for unregulated companies, but the CAPM does not give definite answers. There are no consensus inputs to the CAPM, and therefore no consensus output. The CAPM generates a range of cost-of-equity estimates. The Board should take care that its CAPM estimates are in the heart of the range and not near or below its lower boundary.

Given the CAPM's imprecision and imperfections, the Board should not rely on it exclusively. It should not ignore evidence from DCF models. These models are at very least a useful check on the CAPM.

The Board's proposed CAPM calculations are inconsistent and idiosyncratic. They do not follow standard practice. The calculations would generate downward-biased estimates of the cost of equity capital.

The Board should weigh the costs of underestimating the true cost of equity against the

costs of overestimating it. Underestimates are generally more costly. They deter capital investment, for example. If the Board wants to encourage the railroad industry to modernize and expand capacity, it is better off settling on a higher cost of equity than a lower one.

2. ESTIMATING THE COST OF EQUITY

The Board has estimated the railroad cost of capital annually since 1982, using the following DCF formula:

$$\text{Cost of equity} = D/P + g = \text{Dividend yield} + \text{expected growth rate},$$

where D is the average dividend over the next year,⁴ P is the current stock price and g is the forecasted long-term growth rate of earnings and dividends.

This formula assumes that the growth rate g is constant for the very long run, strictly speaking in perpetuity. The Board has estimated the growth rate by averaging security analysts' forecasts for earnings growth. These forecasts look out at most five years. If the forecasts are temporarily high – higher than the railroads can sustain in the long run – then the DCF formula will overstate the cost of equity.

The Board's cost of capital decision for 2005 used an average industry growth rate of $g = 13.66\%$, based on an average of contemporaneous analysts' forecasts. These forecasts were probably reasonable for the following few years, but no company can grow by more than 13% per year in perpetuity.

There are alternatives to the constant-growth DCF formula. Two-stage DCF formulas distinguish near-term from long-term growth. Analysts' forecasts can be used for the first stage and a moderate, sustainable growth rate substituted for the long term. The Board's Proposed Methodology presents a two-stage DCF model and results, but rejects this model in favor of the CAPM. I review this two-stage model in Section 4.

⁴ The average dividend includes one-half year's growth, that is, the current annual dividend rate multiplied by $1 + g/2$.

The Capital Asset Pricing Model

The CAPM says that each firm's cost of equity depends on the risk of its common stock, measured by beta (β). The formula is.

$$\text{Cost of equity} = R = \text{Risk-free interest rate} + \beta \times \text{Market risk premium}$$

$$R = R_F + \beta(R_M - R_F) = R_F + \beta \times \text{MRP}$$

The risk-free interest rate R_F is typically a Treasury rate. The market risk premium (MRP) is the expected future difference between returns on the overall stock market and returns on investment in Treasury bills, notes or bonds. Beta is the future market risk of the stock, which depends on its volatility and its correlation with the market return. An average-risk stock has a beta of 1.0. Betas estimated from past returns range mostly from 0.4 or 0.5 (relatively low risk) to 1.5 or above (high risk).

The CAPM formula looks easy to use, and it is widely used in practice by corporations that estimate or update their cost of capital. The CAPM can be unreliable, however, for two broad reasons.

First, the CAPM is an economic hypothesis that should explain differences in average returns on common stocks. If the CAPM were true, then low-beta stocks would (on average and over the long run) deliver lower rates of return than high-beta stocks. Average rates of return on portfolios of low- or high-beta stocks should be proportional to the portfolio betas times the market risk premium. This prediction is not true. Average rates of return do increase with beta, but not by as much as the CAPM predicts. The relationship between beta and average returns is particularly weak over the last few decades.⁵ Thus the CAPM understates average returns on

⁵ See Fig 8.10 at p. 195 in R. A. Brealey, S. C. Myers and F. Allen, *Principles of Corporate Finance*, 8th ed., McGraw-Hill Irwin, 2006. Chapter 8 of this book reviews the evidence pro and con the CAPM. See also E. F. Fama and K. R. French, "The Capital Asset Pricing Model: Theory and Evidence," *Journal of Economic Perspectives* 18 (Summer 2004), 25-46.

low-beta stocks and overstates average returns on high-beta stocks. In addition, stocks with small market capitalizations have done better than the CAPM predicts and growth stocks (stocks with high ratios of stock price to book value per share) have done worse. The CAPM's recent empirical performance has not been impressive.

Perhaps this adverse evidence is spurious. Perhaps the CAPM will work fine in future decades. But the evidence to date suggests that the CAPM theory is at best incomplete.

Second, the CAPM is not easy to use even if the CAPM theory is accepted as true. Difficulties include the following.

Forecasting beta. The CAPM is used to estimate expected future rates of return. It requires forecasted *future* betas. Betas are estimated from past returns, but betas can change and beta estimates are liable to statistical noise and error. Beta estimates depend on the period chosen and on the estimation method.

Betas estimated from past returns can be acceptable forecasts of future betas when the estimates have been reasonably stable. But betas cannot be pinned down precisely. There is no consensus beta, as Table 1 illustrates. The table contains estimates of railroad betas from several public sources. Panel A of the table reports recent estimates. Panel B reports estimates through the end of 2005. Note the variation, for example the difference between the Value Line betas and the Yahoo Finance 36-month betas in Panel A. The Yahoo estimates suggest that some railroad betas have increased recently.

The market risk premium. The CAPM calls for investors' current forecast of the average difference between the return on the overall stock market and the return on risk-free Treasuries. There is no consensus MRP. Historical MRPs can be used to forecast future MRPs, but good statistical estimates of the past average MRP require very long periods of time. The most commonly cited averages run from 1900 or 1926 to date, although estimates that exclude the Great Depression and World War II are also useful. Average MRPs for shorter periods are less precise. MRPs averaged over decades or 20- or 30-year periods are useless -- there is too much statistical noise in the estimates.⁶

⁶ Betas are easier to estimate than MRPs. Useful (but not precise) estimates of past betas can usually be obtained from five years of monthly or weekly returns.

Investment horizon. The CAPM is a short-term model. It assumes that investors set portfolio strategy for the current period and rebalance at the end of the period. The length of the period is usually taken as one year or less. But the railroad cost of capital is a longer-term return, because railroads hold long-lived assets. Thus a long-term cost of equity has to be generated from the short-term CAPM. The CAPM will give different answers depending on the method used.

These difficulties mean that the CAPM cannot be used mechanically. The CAPM formula generates a specific number for the cost of equity, but that number is not a precise measurement. There is no consensus beta and no consensus MRP. There are different methods for generating a long-term cost of capital. Therefore there is no consensus CAPM result. A CAPM cost of equity is one point in a range of possible estimates.

The Board says that the "CAPM is widely considered to be the superior financial model and is now the dominant model used by companies and investors in the marketplace" (Proposed Methodology, p. 6) This statement is broadly true if the use is estimating the cost of capital for unregulated public companies. DCF models are poor fits to many unregulated firms, particularly growth firms with low or zero dividend yields. Unregulated firms have turned to the CAPM, despite its shortcomings, because it is a simple and logical formula and because there is no better practical alternative. Also, these firms are estimating a discount or hurdle rate for internal use, not in a contested public setting. In my experience they do not apply the CAPM mechanically. For example, they smooth over implausible fluctuations in beta and use judgment to set a reasonable MRP. They can round up or down if the CAPM formula gives unreasonably low or high numbers.

The CAPM may be a "superior financial model" for unregulated firms, but it is not the only useful model for regulated firms. For example, the Federal Energy Regulatory Commission (FERC) uses a version of the DCF formula with adjustments to attenuate analysts' forecasts of earnings growth. The FERC also gives explicit ranges for the cost of equity, recognizing the inevitable imprecision in cost of equity estimates, regardless of whether CAPM, DCF or both methods are used.

I am not recommending that the Board reject the CAPM model and return to sole reliance

on the constant-growth DCF formula. But it should not take the CAPM as literally true, and it should recognize that the CAPM generates a range of cost of equity estimates, not a precise measurement. The Board should take care that its CAPM estimates are in the heart of the range and not at the lower end of it.

Given the CAPM's imprecision and imperfections, the Board should not rely on it exclusively. It should not ignore evidence from other sources, including DCF models. These models are at very least a useful check on the CAPM.

3. CALCULATING THE COST OF EQUITY FROM THE CAPM

Section 2 covered the DCF and CAPM models generally. I now turn to the specific procedures that the Board proposes to follow. Recall the CAPM formula:

$$\text{Cost of equity} - R = \text{Risk-free interest rate} + \text{beta} \times \text{Market risk premium}$$

$$R = RF + \beta(RM - RF) = RF + \beta \times MRP$$

I have replicated the Board's calculations in the Proposed Methodology to close tolerances.⁷ For example, the calculation for Burlington Northern in 2005 was

$$R = RF + \beta \times MRP = .04251 + 0.853 \times .052 = 0.0869 \text{ or } 8.67\%,$$

The Board used a risk-free rate of 4.251%, a market risk premium of 5.2% and a beta for Burlington Northern of 0.853.

Table 2 summarizes how the Proposed Methodology would calculate CAPM cost-of-equity estimates. My discussion follows.

⁷ The Board's description of its Proposed Methodology lacks detail. I assume that the ability to replicate the Board's numerical results reveals the detail. I stand ready to review additional information about the Board's assumptions and procedures.

Risk-free rate. The risk-free interest rate appears twice in the CAPM, first as the constant term RF and also in the MRP (The MRP is defined as the expected spread (difference) between the return on the market and the return on risk-free investments.) The same risk-free rate should be used in both places.

The Board proposes to use the annual average yield to maturity on ten-year Treasuries as the constant term RF. If this rate is used, then the MRP should be defined as the average spread between rates of return on the stock market, defined as the New York Stock Exchange (NYSE) Index,⁸ and rates of return on Treasuries of the same ten-year maturity. Instead the historical MRP was apparently calculated using income returns (current yields, not yields to maturity) on long-term, 20-year Treasuries. This is a mismatch and inconsistency. In addition, use of long- instead of medium-term interest rates will reduce the MRP, since long-term Treasuries have, on average, generated higher rates of return than shorter-maturity issues.

Market risk premium. The MRP used in the Board's CAPM calculation is a 50-year average. The MRP from 1956 to 2005 is 5.2%.

Fifty years is a long time for many purposes, but not for measuring the MRP. The noise created by stock-market volatility makes it difficult to pin down the true average. The sample-average MRP, which incorporates the market's random volatility, can be very different from the MRP that investors expected. A statistician's confidence limit around the 5.2% average MRP for 1956 to 2005 spans a range of about $\pm 4.5\%$, from 0.7% to 9.7%.⁹

Given this imprecision, standard sources for historical-average MRPs have turned to longer, not shorter time periods. Table 3 gives average MRPs vs long- and short-term Treasury returns for three longer periods, including 1947-2005, a period that captures almost all postwar

⁸ I do not understand why the Board used the NYSE Index, which for long time series requires data from the Center for Research in Security Prices (CRSP) data base. The most widely used index is the Standard & Poor's (S&P) Composite Index. Returns on the S&P index are widely available.

⁹ The standard deviation of annual risk premiums from 1956 to 2005 was 15.96%. The standard error equals the standard deviation divided by the square root of the 50 observations, that is, by 7.07%. Thus the standard error is $15.96/7.07 = 2.26\%$. The confidence limit is $\pm 2 \times 2.26 = 4.52\%$.

experience. The Board's proposed 5.2% MRP is lower than any of these longer-term averages.¹⁰

The Board's MRP is calculated from the NYSE Index. This index is not as widely used as the Standard & Poor's Composite Index, the "S&P 500." Table 3 also includes risk premiums for the S&P index.

Beta. The Proposed Methodology for beta uses ten years of monthly data for each railroad stock and the NYSE Index. The index is a proxy for returns on the overall stock market. Each month the rates of return on the railroad stock and the market are recorded and a risk-free interest rate is subtracted from each. Thus the beta estimates are based on monthly risk premiums, not on total returns. That is OK, except that monthly risk premiums should be computed with short-term interest rates. Instead the Proposed Methodology uses ten-year interest rates, that is, the yield to maturity on ten-year Treasuries.¹¹ This is illogical and inconsistent.¹² Using a ten-year yield to maturity as a short-term interest rate makes no sense at all.

Ten years is not the standard estimation period. Most standard sources use five years of monthly or weekly returns. Experienced practitioners do look at longer periods to check the stability of betas over time, but they do so by examining a series of five-year beta estimates reaching back 15 or 20 years. They do not just run one ten-year estimate. (The Board's sole reliance on ten-year betas is particularly questionable because the sample periods include the dot.com boom of the late 1990s.)

Experienced practitioners also understand the statistical noise in estimated betas. Table 4 reports standard errors and confidence limits for the Board's proposed beta estimates for 2005. The standard error measures the lack of precision in the estimates. The confidence limit,

¹⁰ Some research argues that the expected future MRP is probably less than historical averages. For example, see E. Dimson, P. R. Marsh and M. Staunton, *Triumph of the Optimists: 101 Years of Investment Returns*, Princeton University Press, 2002. But the Board's Proposed Methodology relies solely on historical data.

¹¹ The Board's procedure requires an interest rate for each month to calculate a monthly risk premium. It appears that they used the ten-year yield to maturity for each month, converted to a monthly rather than annual rate.

¹² In addition, the Proposed Methodology does not allow a constant term in the least-squares regression used to estimate beta. This is not standard practice. A constant term should have been included to capture other factors affecting returns and risk premiums.

following standard statistical practice, adds and subtracts two standard errors. The confidence limits should dispel any view that betas can be estimated with close accuracy.¹³

The difficulty of estimating betas precisely explains why there are no consensus betas, and why betas from standard sources often differ.

Taken together, it's clear that the Board's proposed CAPM calculations are inconsistent and idiosyncratic. They do not follow standard practice. The calculations would generate downward-biased estimates of the cost of equity capital.

Example of standard practice

An example of standard practice may be helpful. I start with the yield to maturity on long-term Treasuries at the end of 2005, which was 4.7%. I use a MRP of 6.6%, which is the historical average from 1900 of the difference between returns on the stock market and returns on long-maturity Treasuries. (See Table 3.) Thus long-term Treasury returns are used for both the constant (RF) and the MRP in the CAPM formula. Then I use 2005 Value Line betas. (Value line is a standard source that is usually reliable.) The result for Burlington Northern is:

$$R = RF + \beta \times MRP = .047 + .95 \times .066 = .1097, \text{ about } 11\%$$

The weighted-average cost of equity for the four major railroads changes from 8.4% in the Proposed Methodology to 10.9% using this standard procedure.

Of course this is an illustration, not a consensus estimate. It is one point in a range of estimates that could be generated by different sources for betas (or different methods for estimating betas), by different estimates of the future MRP or by moving from long- to shorter-maturity interest rates. Specifying the most reasonable range for the cost of equity will require

¹³ Accuracy can be improved by estimating betas from returns on a portfolio of railroad stocks and by looking to other information, for example betas estimated from prior periods. But precise beta estimates for individual stocks or industries are almost always impossible.

further exploration of these choices. Nevertheless, I believe that my illustration will be comfortably within the range boundaries when the boundaries are eventually set. The Board's proposed cost of equity calculations will be close to the bottom of the range and possibly below its lower boundary.

4. IMPLEMENTING THE TWO-STAGE DCF MODEL

The Board's decision on methodology considered a two-stage DCF model as an alternative or supplement to the constant-growth DCF model that it has used since 1982. The Board rejected the two-stage model, however, citing its "flexibility" and the need for judgment in applying it. The Board worried that "... parties could advocate a variety of outcomes by manipulating [stage] lengths and [the] phase down [from short- to long-term growth]." (Proposed Methodology, p. 5) Of course the same worries about advocacy attend the CAPM. The CAPM formula is rigid, but there is ample room for disagreement about inputs.

The Board's Proposed Methodology offers a table comparing cost of equity estimates for the constant-growth DCF, a two-stage DCF and the CAPM. The table (as corrected) reports two-stage DCF estimates that are consistently below the Board's CAPM estimates. This may leave the impression that the two-stage model is inaccurate or downward-biased. Closer examination reveals that the Board's two-stage DCF return was not calculated correctly.

Figure 1 explains the error. The Board's two-stage model assumed dividends growing at a first-stage rate for 20 years. Growth was to decline to a long-run, second-stage rate starting in year 21. The first-stage growth rate was based on analysts' forecasts of earnings growth. The second-stage rate was set at a long-term GDP growth rate estimated by the Social Security Administration.

The resulting growth path is plotted in Figure 1. Initial dividends grow at a constant compound rate until year 21, when growth slows down. The dividend growth path should be continuous, as shown by the higher line at the right of the figure. The bottom line at the right of the figure shows the dividends actually projected after year 20 in the Board's two-stage model. Note the discontinuity: the dividend in year 21 is far below the dividend in year 20. The reason is that the dividend in year 21 is discounted *twice* in the Board's spreadsheet. That is, the dividend

for year 21 is given an arbitrary haircut by discounting it for an extra 20 years. All subsequent dividends are projected from the (discounted) dividend in year 21, so these later dividends are given the same haircut ¹⁴

Reversing this haircut increases the two-stage DCF cost of equity by about 2.5%, from 7.24% to 9.76%.

There are other issues with the Board's two-stage model. Practitioners would not normally use a 20-year horizon for the first stage. Five or ten years is more common. Also, the choice of the long-term GDP growth rate deserves more careful attention, because the cost of equity estimate is sensitive to this input. The Board used a growth rate from the Social Security Administration (SSA), which has been the lowest of several common choices, at least over the past few years. For example, the Blue Chip forecast of long-term GDP growth for 2005 is 5.5%, 0.9% higher than the SSA forecast of 4.6%.¹⁵ Switching to an average of the SSA and Blue-Chip forecasts increases the cost of equity estimate from the two-stage DCF model by 0.2% to 9.96%. Other forecasts could of course be included in this average.

The extra haircut is doubtless just an inadvertent error that is easily corrected. The choice of the one relatively low, long-term GDP growth rate is probably an oversight. It seems clear, however, that the Board did not adequately consider multi-stage DCF models as alternatives or supplements to the CAPM.

Two-stage DCF models do not have to be arbitrary or excessively flexible. The two growth rates and the duration of the first stage should be derived from a deeper understanding of the industry. For example, it's important to distinguish earnings growth generated by increasing profitability from growth from capital investment and expansion. The length of the first stage of the DCF model may be set by limits on profitability or by longer-term requirements for capital investment. Also, cash available for payout to investors should increase when investment slows down. A well-designed two-stage DCF model should be consistent with underlying trends or changes in profitability, capital investment and payout.

¹⁴ It's as if the second-stage dividends started in year 41, not year 21, with zero dividends in the interim.

¹⁵ *Blue Chip Economic Indicators*, October 10, 2005, p. 15.

5. CONCLUSIONS

The Board should revisit its assumptions and procedures for implementing the CAPM and the two-stage DCF model, correcting the inconsistencies and mistakes that I have identified. It should use longer spans of historical returns to calculate the average MRP. It should bring its CAPM calculations closer to standard practice.

The CAPM is a useful model, but Board should not take the model as literally true and complete. The Board should not rely exclusively on the CAPM. It should not discard other useful information, particularly from DCF methods. The Board's traditional, constant-growth DCF model may have given upward-biased estimates in 2005, but that model could work again in the future. In the meantime, useful two-stage DCF models can be developed.

The Board should recognize that the CAPM generates a range of cost-of-equity estimates, not a precise measurement. The Board should seek to identify reasonable boundaries for the range and take care that its cost of equity numbers are not at the bottom of the range or below it. (DCF models could help to identify the boundaries)

Of course the Board must in the end reach specific numbers for the cost of equity. The midpoint of the range is one starting point for this determination. The midpoint is in most cases not the best answer, however

The midpoint of a range for the cost of equity may under- or overstate the true cost of equity. Some imprecision is inevitable. Given the imprecision, the Board should weigh the costs of underestimating the true cost of equity against the costs of overestimating it. Underestimates are generally more costly. They deter capital investment. If the Board wants to encourage the railroad industry to modernize and expand capacity, it is better off settling on a higher cost of equity than a lower one.

Setting a higher cost of equity may also give railroads a cushion to offset asymmetric risk. Railroads face asymmetric risk when competition or regulation limits upside profitability, with no offsetting downside protection. I discussed asymmetric risk extensively in earlier

Verified Statements submitted to the Board.¹⁶

¹⁶ Citations are given in fn. 1 See also J. Hausman and S. C. Myers, "Regulating U.S. Railroads: The Effects of Sunk Costs and Asymmetric Risk," *Journal of Regulatory Economics*, 22 (November 2002), 287-310.

Table 1
Beta Estimates for 2007 and 2005

1A. Estimates for 2007

Company	Bloomberg 5-year Weekly Beta (Adjusted) [1]	Bloomberg 5-year Monthly Beta (Adjusted) [2]	Value Line Beta [3]	MSN MoneyCentral Beta [4]	Yahoo Finance 36-month Beta [5]
Burlington Northern Santa Fe Corp	1.02 (1.01)	1.07 (1.04)	1.00	0.90	1.64
CSX Corp	1.23 (1.16)	1.14 (1.10)	1.05	0.80	1.03
Norfolk Southern Corp	1.11 (1.08)	0.88 (.92)	1.05	1.01	2.00
Union Pacific Corp	0.90 (.93)	0.81 (.87)	0.95	0.90	1.49

Source and Notes:

[1], [2] Bloomberg, September 25, 2007 5-year weekly betas are calculated from September 20, 2002 to September 14, 2007 5-year monthly betas are calculated from August 30, 2002 to August 31, 2007

[3] Value Line, September 7, 2007

[4] Money Central, MSN, September 21, 2007

[5] Yahoo Finance, September 21, 2007

Adjusted betas are shifted towards 1.0 Low (high) estimated betas tend to increase (decrease) when estimated in later periods

Table 1
Beta Estimates for 2007 and 2005

1B. Estimates for 2005

Company	Bloomberg 5-year Weekly Beta (Adjusted*) [1]	Bloomberg 5-year Monthly Beta (Adjusted*) [2]	Value Line Beta [3]	SIFB Proposed Beta [4]
Burlington Northern Santa Fe Corp	0.76 (.84)	0.65 (.77)	0.95	0.85
CSX Corp	1.09 (1.06)	0.84 (.90)	1.00	0.83
Norfolk Southern Corp	1.02 (1.01)	0.90 (.93)	1.00	0.85
Union Pacific Corp	0.67 (.78)	0.60 (.73)	0.85	0.68

Source and Notes

[1], [2] Bloomberg, September 25, 2007 5-year weekly betas are calculated from January 05, 2001 to December 30, 2005 5-year monthly betas are calculated from December 29, 2000 to December 30, 2005

[3] Value Line, December 9, 2005

[4] SIFB CAPM work paper

Adjusted betas are shifted towards 1.0. Low (high) estimated betas tend to increase (decrease) when estimated in later periods

Table 2
Proposed STB CAPM Implementation

Formula: $R = RF + \beta \times MRP$		
Inputs for 2005		
RF	4.251%	Average of monthly yields to maturity on 10-year Treasury notes or bonds
MRP	5.2%	Average of annual market risk premiums for 1956-2005. The market is the NYSE index. Annual risk premiums are calculated by subtracting the annual income returns on 20-year Treasuries from the NYSE index total returns.
β	See Table 3	R = merger-adjusted monthly stock return for the railroad. RF = monthly yield to maturity on 10-year Treasury notes or bonds, RM = monthly total return on the NYSE and ϵ = random error term
R is calculated from ten years of monthly returns on each railroad stock and the NYSE index. The risk-free rate RF is the yield to maturity in each month on 10-year Treasuries, converted to a monthly return. Fitted by ordinary least squares regression with the intercept coefficient forced to zero		

Sources and Notes:

STB Decision dated August 14, 2007 (STB Ex Parte 664) and correction dated August 20, 2007. STB CAPM work paper. Monthly NYSE total returns and the monthly yield to maturity on the 10-year Treasury bond are from The Center for Research in Security Prices (CRSP) database. Annual income returns for the long term (20-year) Treasury bond are from Ibbotson Associates, *Stocks Bonds Bills and Inflation (S&B/I)*, monthly reports

Table 3
Market Risk Premiums

	NYSE Long Term MRP [1]	NYSE Short Term MRP [2]	S&P Long Term MRP [3]	S&P Short Term MRP [4]	US Long Term MRP [5]	US Short Term MRP [6]
1900-2006	-	-	-	-	6.60%	7.40%
1926-2005	6.81%	8.27%	7.10%	8.50%	-	-
1947-2005	6.83%	8.18%	7.00%	8.40%	-	-
1956-2005	5.20%	6.55%	5.00%	6.40%	-	-

Sources and Notes:

[1] - [2]: NYSE Returns from CRSP Interest Rates from Ibbotson Associates, *Stocks Bonds Bills and Inflation (S&BI)* monthly reports
[3] - [4]: Ibbotson Associates, *S&BI 2006 Yearbook, Valuation Edition*, Tables A-1 and A-3. S&P refers to Standard & Poor 500 Index.
[5] - [6]: Dimson, Marsh and Staunton, *Global Investment Returns Yearbook 2007*, p. 44.

Long-term MRPs are average spreads between market returns and income or total returns on long-term Treasuries Short-term MRPs are spreads vs. Treasury bill rates

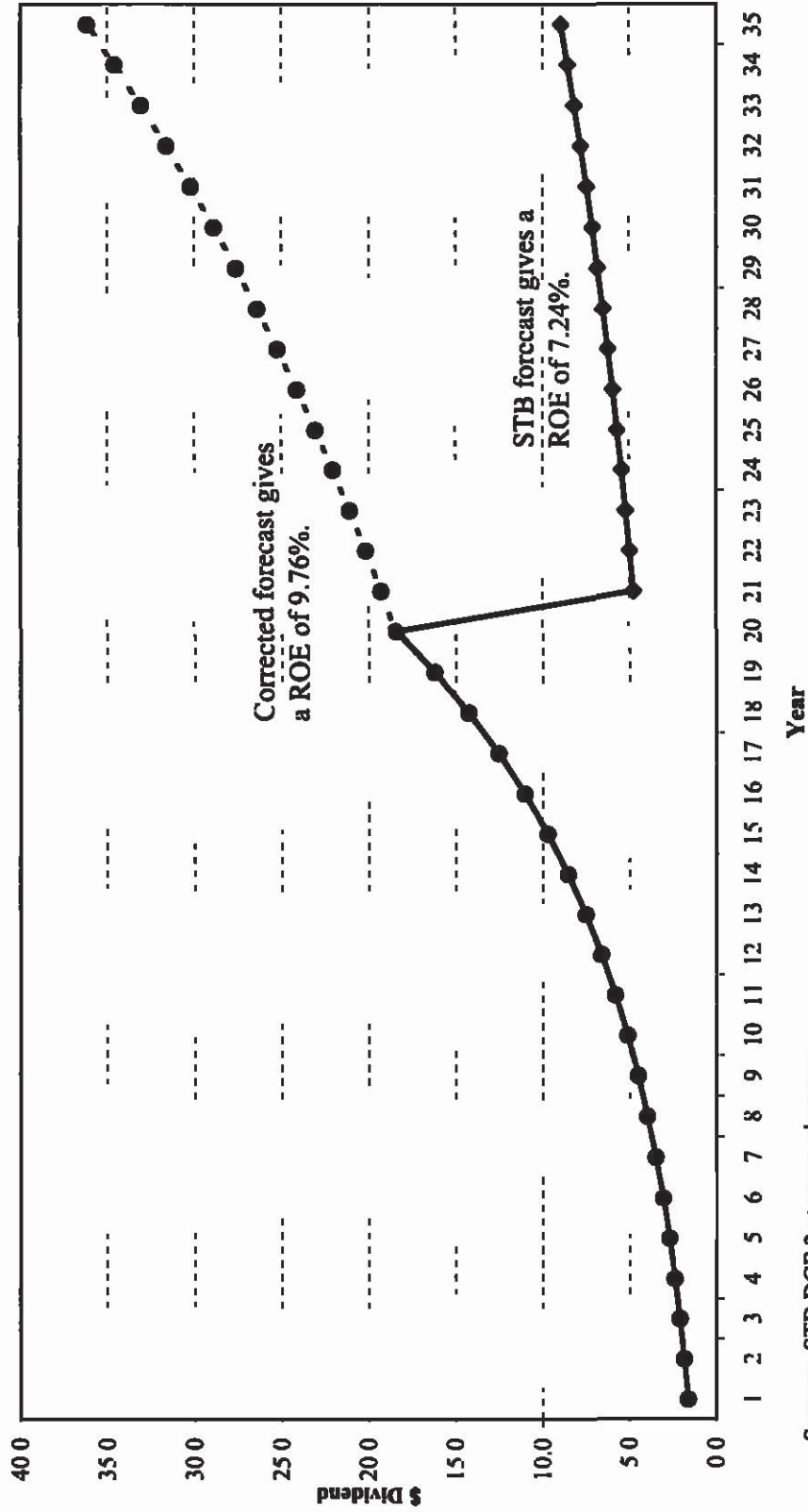
Table 4
STB Proposed Betas for 2005

	<u>Beta</u>	<u>Standard Error</u>	<u>Confidence Interval</u>	
			Lower Bound	Upper Bound
Burlington Northern	0.85	0.14	0.58	1.13
CSX	0.83	0.16	0.50	1.16
Northern Suffolk	0.85	0.19	0.48	1.23
Union Pacific	0.68	0.14	0.39	0.97

Sources and Notes:

STB CAPM work paper, matched by regressing monthly risk premiums on railroad stocks on risk premiums for the NYSE Index. Risk-free rates are monthly yields to maturity on 10-year Treasuries. The estimation period is 1996 to 2005.

Figure 1
STB Two-Stage DCF Implementation



Sources STB DCF 2-stage work paper

VERIFICATION

I, Stewart C. Myers, declare under penalty of perjury, that the foregoing statement is true and correct and that I am qualified and authorized to file this statement

Executed on September 17, 2007


Stewart C. Myers

APPENDIX A

STEWART C. MYERS

Principal

Stewart C. Myers is the Robert C. Merton (1970) Professor of Finance at the MIT Sloan School of Management. He is past President and Director of the American Finance Association and co-author of the leading graduate-level textbook on corporate finance. His research is primarily concerned with the valuation of real and financial assets, corporate financial policy and financial aspects of government regulation of business. He is a Research Associate of the National Bureau of Economic Research and is active as a financial consultant.

Degrees: A.B., Williams College, 1962
 M.B.A., Stanford University, 1964
 Ph.D., Stanford University, 1967

 Doctor Honoris Causa, Free University of Brussels, 1997
 D.Sc., Honorary, London Business School and University of London, 2000

Field: Financial Economics

PROFESSIONAL EXPERIENCE

1966-69	Assistant Professor, MIT Sloan School of Management
1969-76	Associate Professor, MIT Sloan School of Management
1975, 1987-88	Visiting Professor, London Business School
1976-84	Professor, MIT Sloan School of Management
1978-	Research Associate, National Bureau of Economic Research
1984-2006	Gordon Y. Billard Professor of Finance, MIT Sloan School of Management
1982-87, 2001-2003	Area Head for Economics, Finance and Accounting, MIT Sloan School of Management
1988-95	Director, International Financial Services Research Center, MIT
2006-	Robert C. Merton (1970) Professor of Financial Economics, MIT Sloan School of Management

HONORARY AND PROFESSIONAL SOCIETIES

American Finance Association.
 President, 1983
 Vice President, 1982
 Director, 1984-1985, 1975-1977
 Fellow, 2000
American Economic Association
Financial Management Association
 Fellow, 2005

APPENDIX A

STEWART C. MYERS

Principal

OTHER PROFESSIONAL ACTIVITIES

Associate Editor, *Journal of Finance* (1971-1983), *Journal of Financial Economics* (1974-1988), *Journal of Financial and Quantitative Analysis* (1970-1975), *Journal of Financial Research* (1981-1990), *Financial Management* (1993-); member of Editorial Board, *Midland Corporate Finance Journal* (1983-1988); *Journal of Applied Corporate Finance* (1989-); Advisory Editor, *North Holland Handbooks of Finance* (2000-).

Director, Putnam, Hayes and Bartlett, Inc., 1989-1991.

Principal and Director, *The Brattle Group*, 1991-

Director, CAT Ltd., 1993-1998.

Trustee, MIT Retirement Plan, 1995-2001.

Board of Managers, Cambridge Endowment for Research in Finance, 2001 -

DISSERTATION

"Effects of Uncertainty on the Valuation of Securities and the Financial Decisions of the Firm," Stanford University, 1967 Received the 1967 award of the Program for Study of the Modern Corporation, Columbia University, for the best dissertation in management.

PUBLICATIONS

Optimal Financing Decisions (with A. A. Robichek), Englewood Cliffs, NJ: Prentice-Hall, Inc., 1965.

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STEWART C. MYERS

Principal

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STEWART C. MYERS

Principal

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STEWART C. MYERS

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WORKING PAPERS

"Discounting Rules for Risky Assets" (with R. Ruback), July 1988.

"Signaling Models of Accrual Accounting," June 1988.

"Measuring Profitability in the Credit Card Business" (with C. Lapucerta), January 1997

"Taxing Mutual and Stock Life Insurance Companies" (with A. L. Kolbe), March 1998

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"Debt and Managerial Rents in a Real-Options Model of the Firm" (with B. Lambrecht), *Journal of Financial Economics*, forthcoming.

TEACHING

Primary teaching responsibility at MIT is in the area of finance theory and corporate financial management. Faculty head of MIT's Financial Engineering Track (1999-2003).

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ORAL AND OTHER NON-PUBLISHED PRESENTATIONS (Partial List)

"Applicability of Finance Theory to Public Utility Rate Cases," Dartmouth College, September 1970.

"Comments on Public Utility Regulation Under Uncertainty," Michigan State University, February 1971; Stanford University, June 1971.

"What Was AT&T's Cost of Capital in Early 1971?" Financial Management Association, 1971.

"A Linear Programming Approach to Corporate Financial Management," Rochester Chapter of the Institute of Management Sciences, April 1972; Operations Research Society, 1973.

"Real Determinants of Market Risk Measures," AT&T Conference on Risk and Return, Vail, Colorado, August 1973.

"Determinants of Corporate Debt Capacity," Faculte Universitaire Catholique de Mons and the European Institute for Advanced Studies in Management, Mons, Belgium, June 1975.

"Rate of Return Regulation: A Critical Appraisal," FCC Future Planning Conference, Washington, D. C., July 1976.

"Why Firms Need Financial Slack," Indiana University, April 1978

"Estimating Return to Equity," Lincoln Institute of Land Policy, Phoenix, Arizona, February 1979

"Stock Issues and Investment Policy When Firms Have Information Investors Do Not Have," University of Washington and the University of British Columbia, October 1979; also presented at New York University, Ohio State University, University of Toronto, University of Chicago, UCLA, and the National Bureau of Economic Research.

"Overview and Critique of Comparable Earnings and Market Value Methodologies for Fair Rate of Return," Conference on Rate of Return/Earnings Regulation, Washington, D. C., November 1980

"The Impact of Inflation on Regulated Industries," Seminar on Earnings Regulation, Washington, D. C., November 1980.

"The Search for Optimal Capital Structure," Chase Financial Policy, Chicago, June 1982.

"The Evaluation of a Merger Target," Berkeley Program in Finance, March 1983

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"The State of the Art in Capital Investment Analysis," MIT Center for Energy Policy Research, Conference on Energy Project Evaluation, Boston, April 1983

"Applications of Option Pricing Theory to Corporate Investment Decisions," New York University, May 1983.

"The Capital Structure Puzzle," Presidential Address, American Finance Association, San Francisco, December 1983.

"Options, Taxes and Regulation," Edison Electric Institute (at MIT), June 1984

"Information Asymmetry and Corporate Financial Behavior," Investment Technology Association, New York, February 1985.

"Tax Explanations of Corporate Financial Behavior," NBER, July 1985.

"Applications of Option Valuation Techniques to Real Assets," MIT Center for Energy Policy Research, October 1985.

"Tax Asymmetries and Corporate Income Tax Reform," Carleton University and Canadian Ministry of Finance, Ottawa, April 1986.

"Discounting Rules for Risky Assets," American Finance Association, New Orleans, September 1986; also presented at Baruch College, City University of New York; Northwestern University; Tuck School, Dartmouth College; London Business School; Erasmus University, Rotterdam, HEC-CESA, Paris; London School of Economics; Stockholm School of Economics.

"Development and Application of Capital Investment Theory," address at the inauguration of the Tinbergen Institute, Rotterdam, June 1987

"Signaling Models of Accrual Accounting," presented at London Business School, INSEAD, University of Groningen, University of Bristol, University of Strathclyde, Indiana University, University of Colorado

"Still Searching for Optimal Capital Structure," Federal Reserve Bank of Boston, October 1989, revised and expanded version presented as keynote address at the International Conference on Finance, Groupe IIEC and the French Finance Association, Jouy-en-Josas, France, June 1990.

"Testing Static Tradeoff vs. Pecking Order Theories of Capital Structure," presented at the Banca D'Italia, Boston College, NBER, Ohio State University, UCLA, and the Whittemore Conference, Tuck School, Dartmouth College

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"The Paradox of Liquidity," London Treasurers' Club, March 1993, Nobel Symposium on Corporate Governance, Stockholm, August 1995; also presented at American Finance Association, NBER and University of Chicago

"The Five Most Important Ideas in Finance," Financial Management Association, Toronto, October 1993

"Estimating WACC," Financial Management Association, Toronto, October 1993.

"Capital Structure and the Cost of Capital for Regulated Companies," Society of Rate of Return Analysts, Philadelphia, March 1994.

"New Developments in International Corporate Finance – Risk Management," MIT, for the EPOCH Foundation, April 1994.

"Corporate Finance for Financial Corporations," MIT Alumni Convocation, New York, November 1994.

"Risk and Return in R&D-Intensive Companies," AIMR, Washington, DC, January 1995, Keynote Address, American Society of Appraisers, Boston, MA, November 1995. Edited text reprinted in *Corporate Financial Decision Making and Equity Analysis*, AIMR, Charlottesville, VA, 1995.

"The Future of Finance in Pharmaceutical R&D," MIT Program on the Pharmaceutical Industry, The Future of the Pharmaceutical Industry, Cambridge, MA, December 1997.

"Valuing Investments in R & D," Erasmus University, Rotterdam, October 1996; Free University of Brussels, February 1997.

"A Financial Model of Investment in R & D," Distinguished Speaker Series, DePaul University, Chicago, April 1998.

"Outside Equity Financing," NBER; Duke University and University of North Carolina, November 1997; American Finance Association, January 1998; University of Alabama, February 1999; New York University, April 1999.

"Financial Structure," Foro Desarrollo Productivo, Santiago, Chile, May 1998; Financial Executives Institute, June 1998; Keynote Address, European Financial Management Association, Lisbon, Portugal, June 1998; Keynote Address, Conference on Finance, Economics and Accounting, New York University, November 1998

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Roundtable on "The Capital Structure Puzzle," Vanderbilt University, April 1998. Edited transcript published in *The Journal of Applied Corporate Finance*, Spring 1998.

"Real Options and Pharmaceutical R&D," Conference on Real Options Valuation in the New Economy, New York, March 2000.

"Value to Investors," Lean Aircraft Initiative Conference, MIT, March 2000

"Finance at the GSB," Stanford Graduate School of Business 75th Anniversary Celebration, May 2000.

"Capital Structure: Some Legal and Policy Issues," OECD Conference on Company Law Reform, Stockholm, December 2000.

"Capital Allocation for Insurance Companies," Wharton School, November 1999; NBER, February 2000, IIEC (Montreal), April 2002; Casualty Actuarial Society (Marco Island, FL), May 2003

"Financial Architecture," AIMR, New York, February 2000; Q-Group, Tampa, FL, April 2001

"Normative Research in Corporate Finance," Keynote address, Northern Finance Association, Halifax, N. S., September 2001, Financial Management Association, New Orleans, October 2004.

"Economic Evaluation of Arbitration Claims," American Arbitration Association, New York, November 2001.

"Real Options After 25 Years," Keynote address, Real Options Symposium, University of Maryland, April 2002.

"Financing Strategy - Trends, Risks and Opportunities," SEB/Enskilda Securities, Stockholm, November 2002.

"Valuing R&D," MIT Conference on Driving Innovation through Technology, May 2003; ChevronTexaco Distinguished Speakers Series, November 2003

"R² Around the World," Tulane University, November 2003; Duke University and University of North Carolina, April 2004, Harvard Business School, April 2004; Boston College, June 2004, American Finance Association, Philadelphia, January 2005. FAME (Geneva), November 2005; Royal Institute of Technology, Stockholm, November 2005; Q-Group, Santa Barbara CA, October 2006

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"Venture Capital: An Experiment in Computational Corporate Finance," Stockholm Institute for Financial Research, August 2003; American Finance Association, Philadelphia, January 2005.

"Real Options After 27 Years," Keynote Address, Real Options Conference, Montreal, June 2004.

"Corporate Finance and the Life Cycle of the Firm," WIU Campus for Finance, Vallendar, Germany, January 2004; Keynote Address, China International Conference in Finance, Shanghai, July 2004.

"A Theory of Takeovers and Disinvestment," London Business School and Australian Graduate School of Management, November 2005, Australian Graduate School of Management, November 2005.

"Real and Financial Economics," Royal Institute of Technology, Stockholm, November 2005.

"Debt and Managerial Rents in a Real-Options Model of the Firm," Australian Graduate School of Management, December 2005; Financial Management Association, October 2006; NBER, November 2006.

"University Capital Structure," Forum for the Future of Higher Education, Aspen Institute, September 2006.

"Corporate Governance and Corporate Finance," keynote address, Financial Management Association, October 2006.

CONSULTING (Partial List)

Office of Economics, Federal Power Comm.
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Brunswick Corporation
Digital Equipment Corporation
Federal Energy Regulatory Commission LOOP, Inc
Georgia Pacific Corporation
Chase Manhattan Bank

Palladian Software, Inc
Merck & Co , Inc.
Marriott Corp.
Pfizer, Inc
Phillips Petroleum Corp
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TESTIMONY (Partial List)

"Texas Eastern Transmission Corporation--Cost of Equity Capital Study " FPC Docket RP69-13, 1969.

"AT&T Cost of Capital Study " FCC Docket 19129, 1971

"A Study of the Risk of Comsat Common Stock." FCC Docket 16070, 1974

Testimony before the U. S. Senate Special Subcommittee on Integrated Oil Operations, February 1974, and before the Subcommittee on Antitrust and Monopoly of the Senate Committee on the Judiciary, August 1974.

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The AAR's steering committee provided invaluable information and advice to the consultant team throughout the study. Their time and effort were very much appreciated.

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Executive Summary

This study is an assessment of the long-term capacity expansion needs of the continental U.S. freight railroads. It provides a first approximation of the rail freight infrastructure improvements and investments needed to meet the U.S. Department of Transportation's (U.S. DOT) projected demand for rail freight transportation in 2035. The U.S. DOT estimates that the demand for rail freight transportation – measured in tonnage – will increase 88 percent by 2035.

The study was commissioned by the Association of American Railroads (AAR) at the request of the National Surface Transportation Policy and Revenue Study Commission. The Commission is charged by Congress to develop a plan of improvements to the nation's surface transportation systems that will meet the needs of the United States for the 21st century.

The study focuses on 52,340 miles of primary rail freight corridors, which carry the preponderance of rail freight traffic.¹ These corridors, which constitute about one-third of all continental U.S. rail freight miles, are expected to absorb the bulk of the forecast traffic and nearly all of the investment to expand capacity.

The study estimates the need for new tracks, signals, bridges, tunnels, terminals, and service facilities in the primary corridors. The study does not estimate the cost of acquiring additional land, locomotives, and freight cars, or the cost of replacing and updating existing track, facilities, locomotives, and freight cars. The study assumes no shift in modal tonnage shares among rail, truck, and water beyond those projected by the U.S. DOT.

The study does not forecast passenger rail demand or estimate future passenger rail capacity needs; however, capacity is provided for the long-distance Amtrak and local commuter passenger rail services that are currently operated over rail freight lines. Additional investment, beyond that projected in this report, will be needed if the freight railroads host increased levels of passenger rail service. The Commission has convened a passenger rail committee that is studying the need for improvements and investments to support passenger rail demand through 2035. The findings of that committee will be reported separately.

This study estimates that an investment of \$148 billion (in 2007 dollars) for infrastructure expansion over the next 28 years is required to keep pace with economic growth and meet the U.S. DOT's forecast demand. Of this amount, the Class I freight railroads' share is projected to be \$135 billion and the short line

¹ Nearly all of these primary corridor miles are owned and operated by the seven Class I freight railroads: BNSF Railway, Canadian National (Grand Trunk Corporation), Canadian Pacific (Soo Line), CSX Transportation, Kansas City Southern, Norfolk Southern, and Union Pacific. There are more than 550 short line and regional freight railroads.

and regional freight railroads' share is projected to be \$13 billion. Without this investment, 30 percent of the rail miles in the primary corridors will be operating above capacity by 2035, causing severe congestion that will affect every region of the country and potentially shift freight to an already heavily congested highway system

The investment requirement is driven by three factors: demand, current system capacity, and infrastructure expansion costs. The U.S. DOT estimates that population growth, economic development, and trade will almost double the demand for rail freight transportation by 2035. The projected rate of growth over the next 30 years is not extraordinary, but it comes after two decades of growth in rail freight tonnage that has absorbed much of the excess capacity in the existing rail freight system. Most of the moderate-cost capacity expansions have already been made, future capacity expansions will be purchased at a higher cost because they will require expensive new bridges and tunnels and more track and larger terminals in developed areas.

Meeting the U.S. DOT's forecast demand will require the Class I freight railroads to increase their investment in infrastructure expansion. The Class I railroads anticipate that they will be able to generate approximately \$96 billion of their \$135 billion share through increased earnings from revenue growth, higher volumes, and productivity improvements, while continuing to renew existing infrastructure and equipment. This would leave a balance for the Class I freight railroads of \$39 billion or about \$1.4 billion per year to be funded from railroad investment tax incentives, public-private partnerships, or other sources.

These investment projections assume that the market will support rail freight prices sufficient to sustain long-term capital investments. If regulatory changes or unfunded legislative mandates reduce railroad earnings and productivity, investment and capacity expansion will be slower and the freight railroads will be less able to meet the U.S. DOT's forecast demand.

The findings of this study provide a starting point for assessing future rail freight capacity and investment requirements. The findings outline the improvements and investments required for the railroads to carry the freight tonnage forecast by the U.S. DOT. Additional work is needed to determine how much more capacity and investment would be needed for the railroads to increase their share of freight tonnage and reduce the rate of growth in truck traffic on highways. Finally, the forecasts and improvement estimates in this study do not fully anticipate future changes in markets, technology, regulation, and the business plans of shippers and carriers. Each could significantly reshape freight transportation demand, freight flow patterns, and railroad productivity, and, thus, rail freight infrastructure investment needs.

In summary, the findings point clearly to the need for more investment in rail freight infrastructure and a national strategy that supports rail capacity expansion and investment.

1.0 Objective

The objective of this study is to identify rail freight infrastructure improvements and investments in the continental U.S. rail network that will allow the freight railroads to meet the U.S. Department of Transportation's (U.S. DOT) projected demand for rail freight transportation in 2035. The U.S. DOT estimates that the demand for rail freight transportation—measured in tonnage—will increase 88 percent by 2035. This projected rate of growth over the next 30 years is not extraordinary, but it comes after two decades of growth in rail freight tonnage that has absorbed much of the excess capacity in the existing rail freight system. The study assumes no shift in modal tonnage shares among rail, truck, and water beyond those projected by the U.S. DOT.

The study looks at infrastructure improvements that expand the capacity of rail lines, bridges, tunnels, terminals, and service facilities along the 52,340 miles of primary rail corridors within the U.S. owned and operated primarily by the seven Class I railroads—BNSF Railway, Canadian National (Grand Trunk Corporation), Canadian Pacific (Soo Line), CSX Transportation, Kansas City Southern, Norfolk Southern, and Union Pacific. These primary corridors constitute about one-third of all U.S. rail miles and carry the preponderance of rail freight traffic.

The investment estimates include capital costs for expansion only; that is, the cost of the new rail lines and support facilities needed to accommodate future demand. The estimates do not include costs to maintain and operate the new rail lines and support facilities, acquire additional locomotives and railcars to provide services; or operate, maintain, and replace existing rail lines and facilities. Finally, the study does not include the costs to rail shippers to accommodate growth in rail traffic volumes at their facilities. The study does include a general estimate of the investment required to bring the weight-bearing capacity of Class I branch lines and short line and regional railroad lines up to current standards.

The findings of this study provide a starting point for assessing future rail freight capacity and investment requirements. The findings outline the improvements and investments required for the railroads to carry the freight tonnage forecast by the U.S. DOT. Additional work is needed to determine how much more capacity and investment would be needed for the railroads to increase their share of freight tonnage and reduce the rate of growth in truck traffic on highways. Finally, the forecasts and improvement estimates in this study do not fully anticipate future changes in markets, technology, regulation, and the business plans of shippers and carriers. Each could significantly reshape freight transportation demand, freight flow patterns, and railroad productivity, and, thus, rail freight infrastructure investment needs.

2.0 Background

The study was done at the request of the National Surface Transportation Policy and Revenue Study Commission. The Commission was established by Congress in 2005 to provide a national vision and recommendations that will “preserve and enhance the surface transportation system to meet the needs of the United States for the 21st century.”² The Commission is charged with completing a comprehensive study of the national surface transportation system and the Highway Trust Fund, then developing a conceptual plan with alternative approaches to ensure that the system continues to serve the needs of the United States

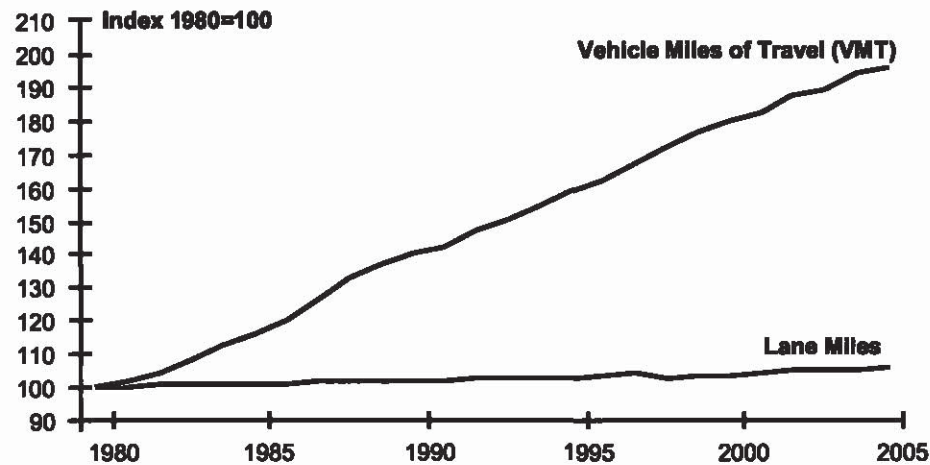
Since May 2006, the Commission has met regularly to hear about the challenges facing America’s surface transportation network. The Commissioners have heard testimony from national transportation advocates, policymakers, industry, labor, and the general public. Congress is actively following the activities of the Commission, and the Commission’s report (anticipated in December 2007) is expected to provide information that will be helpful to Congress as it considers reauthorization of the Federal surface transportation programs in 2009.

Over the course of its hearings, the Commission has expressed concern about the capacity and future of the nation’s freight transportation systems. Freight transportation is vitally important to domestic economic productivity, the international competitiveness of American businesses, and the economic well-being of all Americans.

The demand for transportation is pressing the capacity of the nation’s transportation systems, especially its critical highway and rail freight transportation infrastructure. On the highway system, vehicle-miles of travel grew by 96 percent between 1980 and 2005, while lane miles of road increased by only 5.7 percent. Figure 2.1, based on Federal Highway Administration (FHWA) statistics, illustrates the widening gap between vehicle-miles of travel and roadway capacity.

² See Section 1909 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU)

**Figure 2.1 Vehicle Miles of Travel and Lane Miles
1980 to 2005**



Source Federal Highway Administration, *Highway Statistics*

The result has been increasing highway congestion. The Texas Transportation Institute reports that over the decade between 1993 and 2003, the cost of highway congestion in the nation's urban areas increased from \$39.4 billion to \$63.1 billion, an increase of 60.2 percent.³ The U.S. DOT estimates that the cost of congestion across all modes of transportation could be three times as high—approaching \$200 billion per year—if productivity losses, costs associated with cargo delays, and other economic impacts are included. These include losses accruing to auto drivers, freight carriers, businesses, consumers, and the general public.⁴

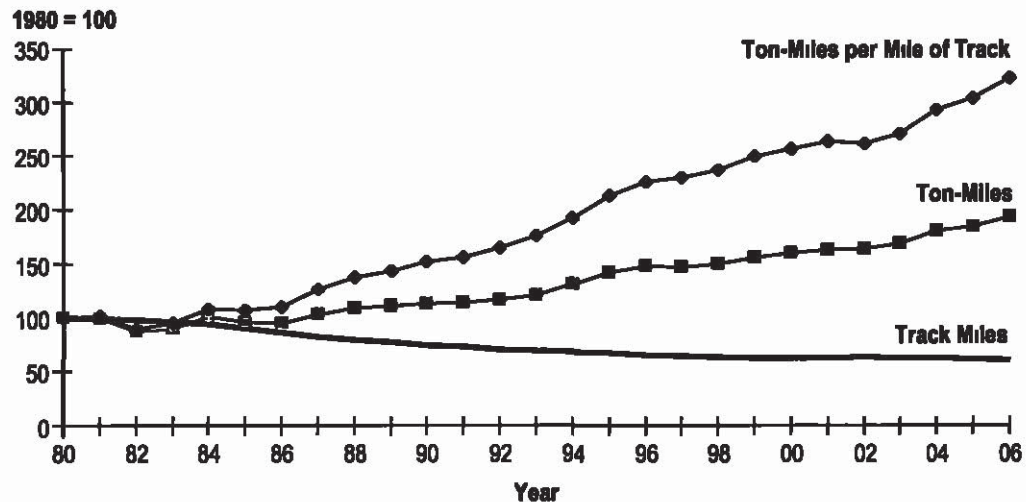
As the cost of highway congestion has increased, public policy-makers at all levels of government have started looking to the railroads to carry more freight to relieve truck and highway congestion, and to help conserve energy, reduce engine emissions, and improve safety. Shippers, too, have started looking to railroads to carry more longer-distance shipments, especially as the costs of truck fuel and labor have increased.

³ David Schrank and Tim Lomax, *The 2005 Urban Mobility Report*, Texas Transportation Institute, May 2005, available at <http://mobility.tamu.edu>

⁴ U.S. Department of Transportation, *National Strategy to Reduce Congestion on America's Transportation Network*, Washington, D.C., March 2007
See <http://www.fightgridlocknow.gov/docs/conginitoverview070301.htm>

However, the growing demand for freight transportation is also pressing the capacity of the nation's rail freight system. Ton-miles of rail freight (one ton of freight moved one mile counts as one ton-mile) carried over the national rail system have doubled since 1980, and the density of train traffic—measured in ton-miles per mile of track—has tripled since 1980. Figure 2.2 illustrates the widening gap between ton-miles of rail travel and track miles.⁵

Figure 2.2 Rail Freight Ton-Miles and Track Miles
Class I Railroads, 1980 to 2006

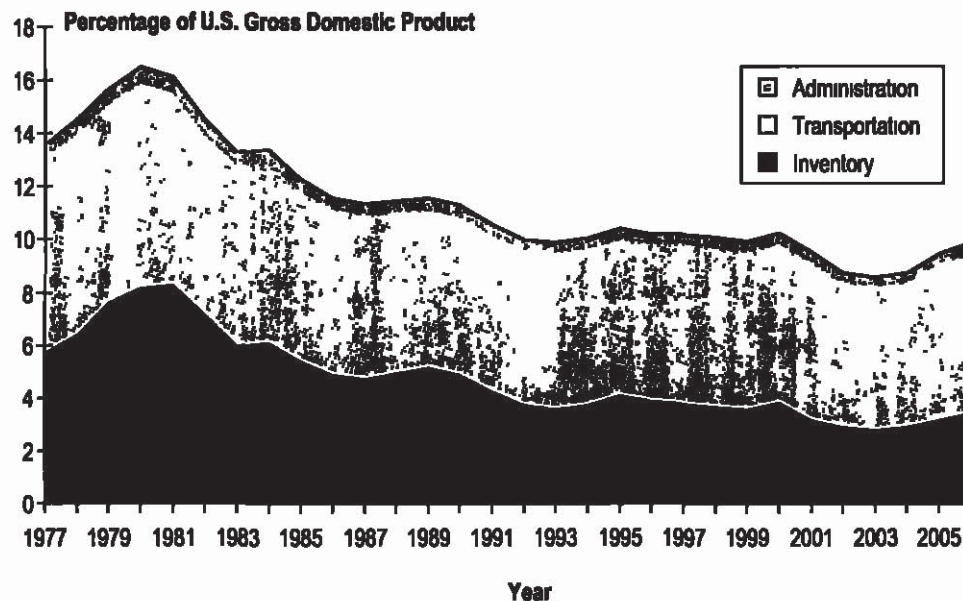


Source: AAR and Annual Report Form R-1

The tightening of system capacity across all modes of freight transportation has likely contributed to the first notable increase in total logistics cost in over 25 years. Total logistics cost is the cost of managing, moving, and storing goods. Figure 2.3 shows the total logistics cost as a percentage of the U.S. gross domestic product (GDP).

⁵ Association of American Railroads data and Annual Report Form R-1.

**Figure 2.3 Total Logistics Cost
Percentage of Gross Domestic Product**



Source: *State of Logistics Report*, Council of Supply Chain Management Professionals, 2006

Logistics costs rose through the 1970s to a high of about 16 percent of GDP in 1980, reflecting rising fuel prices, increasing interest rates, and deteriorating productivity across the freight transportation system. Renewed investment in highways, economic deregulation of the freight transportation industry in the early 1980s, adoption of new technologies, and lower interest rates drove down the costs of truck, rail, air, and water freight transportation. The total logistics cost declined through the 1980s and 1990s to a low of about 8.6 percent of GDP in 2003. Businesses and consumers benefited because lower transportation costs resulted in lower-cost goods and better access to global markets.

But the total logistics cost is rising again. In 2006, the total logistics cost was 9.9 percent of GDP.⁶ The change reflects recent increases in fuel prices and increases in congestion on the nation's highways and rail lines and at its international trade gateways and ports. Freight shippers and carriers are worried that the productivity of the nation's freight systems may continue to drop and that logistics costs may rise further, undermining future domestic economic productivity, international competitiveness, and economic growth.

⁶ Rosalyn A. Wilson, *State of Logistics Report*, Council of Supply Chain Management Professionals, 2006 and 2007.

Freight shippers and carriers are especially concerned about the future capacity and productivity of the freight system because the demand for freight transportation is projected to nearly double by 2035. The U.S. DOT Freight Analysis Framework (FAF Version 2.2) estimates that the demand for freight transportation will grow from 19.3 billion tons today to 37.2 billion tons in 2035, an increase of about 93 percent.⁷

To absorb this growth and maintain their existing shares of the freight transportation market, the nation's truck and rail freight systems must increase their capacity and productivity substantially. Trucks and the highway system must add capacity to handle 98 percent more tonnage. And railroads must add capacity to handle 88 percent more tonnage. The U.S. DOT estimates assume no shift in modal tonnage shares among rail and truck beyond those created by structural changes in the economy (i.e., different growth rates across freight-generating industries).

The anticipated rates of growth for the U.S. economy and freight transportation demand are about the same as those experienced over the last 30 years; however, much of the capacity existing or created over those years has been filled, leaving the nation with a need to provide new capacity through expanded infrastructure and improved productivity.⁸

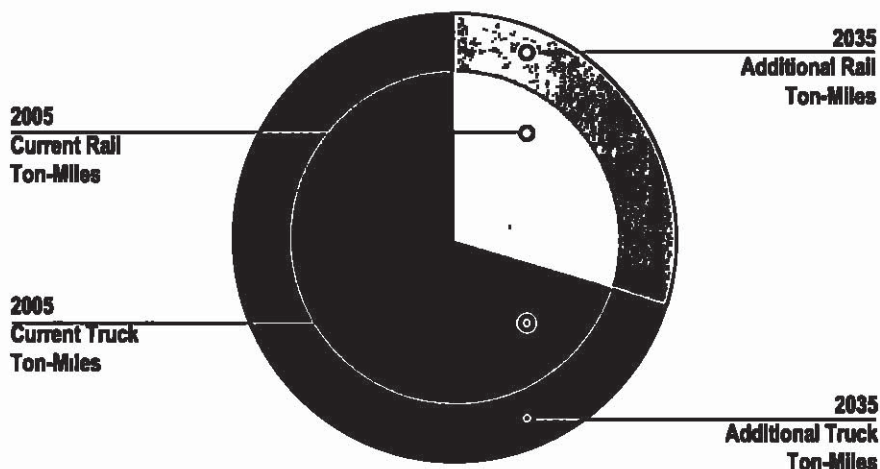
Figure 2.4 shows the relative shares of freight—measured in ton-miles—carried by truck and rail in 2005.⁹ If railroads cannot carry their share in 2035, then freight will be shed to trucks and an already heavily congested highway system. Conversely, if trucks cannot carry their share in 2035, then freight must be shifted to rail and the capacity of the rail system expanded even more than currently forecast.

⁷ See U.S. Department of Transportation, Freight Analysis Framework, *Freight Facts and Figures* at <http://www.ops.fhwa.dot.gov/freight/>. This study uses the current Freight Analysis Framework (FAF Version 2.2) forecasts.

⁸ Global Insight, Inc. forecasts that the U.S. economy will grow at a compound annual rate of about 2.8 percent over the next 30 years. Source: Global Insight, Inc. in *Freight Demand and Logistics Bottom Line Report* prepared by Cambridge Systematics, Inc. for the American Association of State Highway and Transportation Officials (AASHTO), (forthcoming, 2007).

⁹ Ton-miles estimated by Global Insight for the AASHTO *Freight Demand and Logistics Bottom Line Report*.

**Figure 2.4 Truck and Rail Market Shares in Ton-Miles
2005 and 2035**



Source: Cambridge Systematics, Inc., based on Global Insight, Inc. freight demand forecasts

In response to these projections and concerns, the Commission asked the Association of American Railroads (AAR) to assess the capacity of the nation's rail system to accommodate the estimated increase in freight-rail traffic. The AAR, supported by the four largest Class I railroads—the BNSF Railway, CSX Transportation, the Norfolk Southern Corporation, and the Union Pacific Railroad—undertook this study to estimate the additional rail freight capacity and investment required to meet the U.S. DOT forecast.

This study is a hallmark study, the first effort of its kind. The U.S. DOT and the Federal Highway Administration (FHWA) have developed national infrastructure needs and cost estimates for the publicly owned highway systems, but no comparable, long-term, national estimates have been developed for the rail system. The railroads are publicly traded or privately owned companies, and the planning horizons for railroad capital projects typically do not extend out 30 years. And neither the U.S. DOT nor individual state DOTs have comprehensive rail infrastructure databases suitable for long-term planning. This study is the first collective assessment by the major freight railroads of their long-term capacity expansion and investment needs.

3.0 Methodology

This study provides a first approximation of the rail freight infrastructure improvements and investments in the continental U.S. rail network that will allow the freight railroads to meet the U.S. DOT's projected demand for rail freight transportation in 2035. It addresses two major rail freight infrastructure elements:

- Line expansion:
 - Upgrades to the Class I railroad system mainline tracks and signal control systems;
 - Improvements to significant rail bridges and tunnels,¹⁰
 - Upgrades to Class I railroad secondary mainlines and branch lines to accommodate 286,000-pound freight cars, and
 - Upgrades to short line and regional railroad tracks and bridges to accommodate 286,000-pound freight cars.¹¹
- Facility expansion:
 - Expansion of carload terminals, intermodal yards, and international gateway facilities owned by railroads, and
 - Expansion of Class I railroad service and support facilities such as fueling stations and maintenance facilities.

¹⁰Included in this category are expansions of major bridges and tunnels (or construction of new parallel bridges and tunnels) to add rail capacity along a corridor, and corridor overhead clearance projects, which typically involve raising dozens of highway bridges crossing a rail line to permit the movement of double-stacked intermodal container trains.

¹¹Most Class I railroad tracks and bridges have been designed or reconstructed to carry railcars weighing 286,000 pounds, and some Class I lines accommodate railcars weighing up to 315,000 pounds. Older rail lines, including some Class I railroad secondary mainlines and branch lines and about half of the short line and regional railroad tracks and bridges, were designed and constructed to carry railcars weighing up to 263,000 pounds. The heavier, "standard," 286,000-pound cars can be operated over many lines designed for lighter cars, but usually at very low speeds.

The study includes the cost of designing and constructing these improvements, but does not include the cost of acquiring real estate to accommodate new rail lines and terminals ¹² This is consistent with the approach used in national highway system needs and investment studies, which do not estimate the cost of acquiring real estate for widening or adding highways. The study does not include the cost of capital depreciation or the cost of buying additional locomotives and rail cars to expand service. Railroad maintenance and operating costs are not included, for either existing or expanded lines and facilities.

The study assumes that capacity is provided for long-distance Amtrak and local commuter passenger rail services that are currently operated over rail freight lines, but the study does not forecast the need for new passenger rail services or the necessary capacity to support passenger rail growth. The Commission has convened a passenger rail committee that is studying the need for improvements and investments to support passenger-rail demand through 2035. The findings of that committee will be reported separately.

This study estimates rail line capacity and investment requirements by:

- Dividing the continental U.S. Class I railroad network into primary corridors,
- Establishing current corridor volume in freight and passenger trains per day for each primary corridor, based on 2005 Surface Transportation Board Carload Waybill data, the most recent comprehensive information available,
- Estimating current corridor capacity in trains per day for each primary corridor, based on current information;
- Comparing current corridor volume to current corridor capacity,
- Estimating future corridor volume in trains per day, using U.S. DOT's Freight Analysis Framework Version 2.2 forecasts of rail freight demand in 2035 by type of commodity and by the origin and destination locations of shipments moving within the U.S. and through international land and port gateways;
- Comparing the future corridor volume to current corridor capacity;

¹²Current capital expenditures by the Class I railroads for expansion of lines and terminals (as reported in Section 4.5) include the cost of acquiring real estate. However, with the exception of land acquired for new or expanded intermodal terminals, the cost of real estate acquisition has been a small part of current capital expenditures because most new rail lines have been constructed within existing railroad-owned rights-of-way. As the space in existing rights-of-way is used up, the cost of acquiring real estate for new lines is expected to be a larger percentage of capital expenditures for expansion. The real estate costs will be in addition to the infrastructure costs estimated in this study.

- Determining the additional capacity needed to accommodate future train volumes at an acceptable level of service reliability;
- Identifying the rail line and signal control system improvements required to provide the additional capacity, and
- Estimating the costs of the improvements

The study estimates the need for expansion of Class I railroad carload terminals, intermodal yards, and railroad-owned international gateway facilities by analyzing the projected increases in the number of railcars and intermodal units (containers and truck trailers) handled at major facilities and comparing them to current handling capacity. Expansion costs are estimated using unit costs per railcar or intermodal container, or estimated using recent and comparable terminal expansion project costs. Estimates of the cost of expanding service and support facilities such as fueling stations were provided by the railroads based on the anticipated changes in the number and type of trains.

Finally, the study estimates the capacity and investment requirements for secondary mainlines, branch lines, and short line and regional railroads by updating information from a prior study of short line system investment needs commissioned by the American Short Line and Regional Railroad Association¹³

Wherever possible, the analysis is based upon existing and publicly available data sources. The key sources of data are the following:

- Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis' Rail Network (Version 5-5) is used to develop a primary corridor network model and identify the key corridor characteristics such as the number of tracks and type of signal system;
- The U.S. DOT Surface Transportation Board's (STB) 2005 Carload Waybill Sample is used to estimate current corridor volumes based on 2005 loaded-car movements,
- Data from the Surface Transportation Board's Uniform Rail Costing System (URCS) on empty-return ratios by railroad, car type, and car ownership are used to estimate empty car movements,
- The U.S. DOT's Freight Analysis Framework (FAF Version 2.2) forecast is used to establish rail freight traffic growth by type of train service (e.g., intermodal train, manifest/carload train, auto train, and bulk train) from 2005 to 2035;

¹³Zeta-Tech Associates, Inc., *An Estimation of the Investment in Track and Structures Needed to Handle 286,000-Pound Rail Cars*, prepared for the American Short Line and Regional Railroad Association, May 26, 2000

- Data from the railroads and the AAR are used to estimate the capacity in trains per day for archetypical rail corridors representing different combinations of number of tracks and signal types. The capacities of the archetypical rail corridors are used to identify the improvements needed to accommodate future train volumes.
- Data from the Class I railroads, the AAR, and published construction industry information are used to estimate the cost of adding tracks, upgrading signal systems, expanding terminals, and adding rail-support facilities.

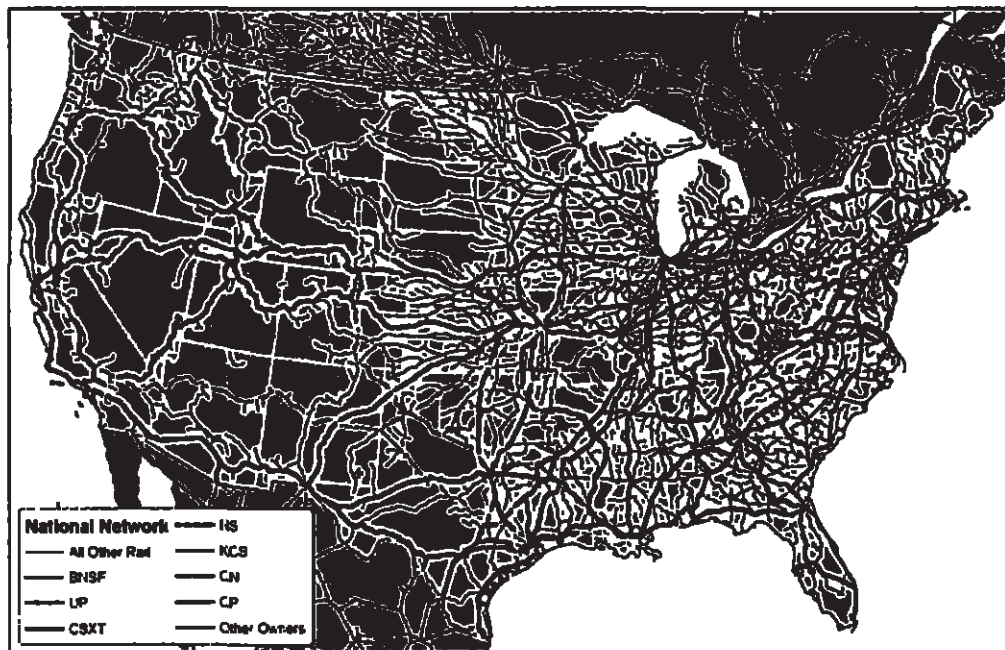
Appendix A describes the technical methodology in more detail.

4.0 Current Train Volumes and Capacity

4.1 PRIMARY CORRIDORS

The study focuses on the primary rail corridors within the national rail freight system. Figure 4.1 shows the national rail network. The primary corridors for each of the seven Class I railroads are shown in color, all other rail lines are shown in gray.

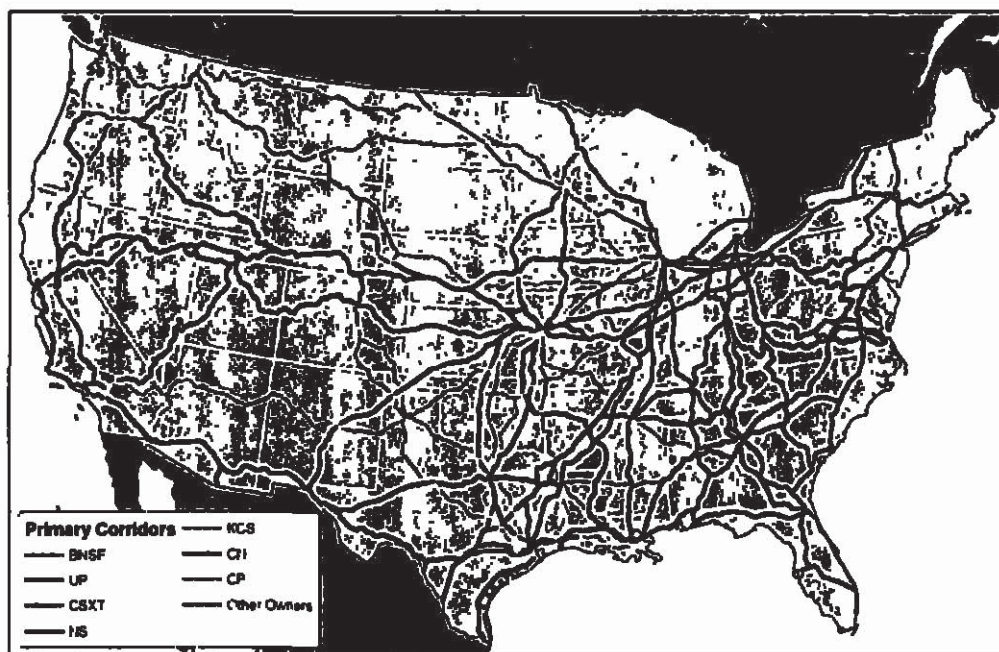
Figure 4.1 National Rail Freight Network and Primary Rail Freight Corridors



Source: Cambridge Systematics, Inc

Figure 4.2 shows just the primary corridors used for this study of rail freight capacity. The primary corridors were designated by the Class I railroads for this study. The primary corridors represent the higher-volume corridors for rail freight. The primary corridors total about 52,340 miles of road (or centerline miles), representing about half of all Class I-operated miles in the U.S. and about one-third of the 140,810 miles in the U.S. rail freight network. For comparison, the Interstate Highway System comprises about 47,000 route miles, and the National Highway System, which adds other major U.S. and state freight highways, comprises about 162,000 route miles.

Figure 4.2 Primary Rail Freight Corridors



Source. Cambridge Systematics, Inc

4.2 CURRENT VOLUMES

Current corridor volumes in trains per day were established for each primary corridor using data from the Surface Transportation Board's 2005 Carload Waybill Sample. The Waybill Sample is an annual survey of railcar movements on the national rail network. The survey collects information from a sample of loaded, revenue-producing railcar movements. The data include information about the commodity shipped, the type of railcar used, the origin and destination station of the shipment, any interchanges between railroads, and the names of railroads handling the shipment. The sample data are statistically expanded to represent 100 percent of the loaded revenue railcar moves in a year. The Waybill Sample is used in many regulatory proceedings and is generally considered an accurate reflection of U.S. railroad shipments. The 2005 Waybill Sample is the most recent comprehensive data available.

The Waybill Sample does not collect information about empty, non-revenue-producing railcar movements. These were estimated using information from the Uniform Rail Costing System (URCS) on empty-return ratios by railroad, car type, and car ownership. The number of empty, non-revenue-producing railcar movements were added to the number of loaded, revenue-producing railcar movements to estimate total railcar movements.

The number of carloads moving on the rail system varies daily, weekly, and seasonally. To select a representative day, the distribution of the number of carload movements for each day in 2005 was examined and the volume for the 85th percentile day was selected for analysis. This approach is consistent with the analysis procedures for highway needs studies.

The carload volumes were then allocated among four types of train service based on the commodity being carried and the type of operation.

1. **Auto Train Service** – For assembled automobiles, vans, and trucks moving in multilevel cars,
2. **Bulk Train Service** – For grain, coal, and similar bulk commodities moving in unit trains;
3. **Intermodal Train Service** – For commodities moving in containers or truck trailers on flat cars or specialized intermodal cars; and
4. **General-Merchandise Train Service** – Everything else, including commodities moved in box cars and tank cars.

The number of trains of each type needed to move the cars were estimated using information on the typical number of cars hauled by train service type, as summarized in Table 4.1. The number of intermodal trains needed is based on the number of intermodal units (e.g., container-on-flat-car [COFC] units and trailer-on-flat-car [TOFC] units). Separate calculations were made for Eastern and Western Class I railroads because differences in regional geography and topography allow Western railroads to operate longer trains.¹⁴

Table 4.1 Typical Number of Cars or Intermodal Units by Train Service Type

Type of Train Service	Eastern Railroads	Western Railroads
Auto	57.0	63.9
Bulk	86.0	112.4
General Merchandise	82.0	80.7
Intermodal (TOFC/COFC count)	110.7	164.3

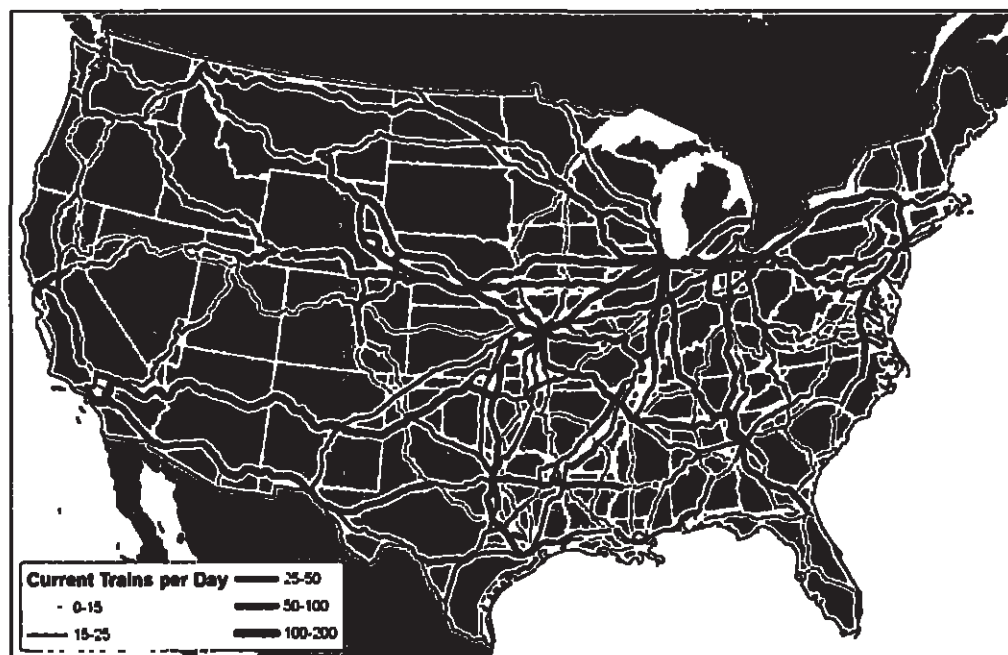
Source: Class I railroad data.

¹⁴For details, see Appendix A.

Finally, the number of long-distance Amtrak and local commuter passenger rail trains operating over the primary rail freight corridors was added to the number of freight trains to calculate the total number of trains per day per corridor. The number of passenger trains was estimated from published information on Amtrak and commuter passenger rail schedules for 2007.

Figure 4.3 maps the current corridor volumes in trains per day for the primary rail freight corridors. The number of trains per day is indicated by the width of the corridor line. The thinnest line indicates that a corridor carries up to 15 trains per day; the widest line indicates that a corridor carries between 100 and 200 trains per day.

Figure 4.3 Current Corridor Volumes by Primary Rail Freight Corridor
2005 Freight Trains and 2007 Passenger Trains per Day



Source Cambridge Systematics, Inc

Note Volumes are for the 85th percentile day

4.3 CURRENT CAPACITY

To determine whether a corridor is congested, current volume was compared to current capacity. Three variables were used to estimate the current capacity of the primary corridors: the number of tracks, the type of control system, and the mix of train types ¹⁵

- **Tracks** – Most sections of the national rail freight system are single-tracked with multiple sidings for trains to meet and pass each other, and a significant portion of the heaviest-volume corridors are double-tracked. A limited number of sections have three or four tracks.
- **Control System** – The type of control system affects capacity by maintaining a safe spacing between trains meeting and passing on the same track. There are three major types of signal systems:
 - **Automatic Block Signaling (ABS)** is a signal system that controls when a train can advance into the next track block. A block is a section of track with traffic control signals at each end. The length of the block is based on the length of a typical train and the distance needed to stop the train in a safe manner. When a train exits a block, the signal changes to yellow, indicating to the engineer of a following train that the block is now empty, but that the following train should be prepared to stop before entering the next block (currently occupied by the train ahead). Automatic block signaling is governed by block occupancy and cannot be controlled by a railroad dispatcher from a remote location.
 - **Centralized Traffic Control (CTC) and Traffic Control System (TCS)** are systems that use electrical circuits in the tracks to monitor the location of trains, allowing railroad dispatchers to control train movements from a remote location, typically a central dispatching office. CTC and TCS increase capacity by detecting track occupancy and allowing dispatchers to safely decrease the spacing between trains because the signal systems automatically prevent trains from entering sections of track already occupied by other trains.
 - **No Signal (N/S) and Track Warrant Control (TWC)** are basic train control systems that require the train crew to obtain permission or warrants

¹⁵The capacity of rail corridors is determined by a large number of factors, including the number of tracks, the frequency and length of sidings, the capacity of the yards and terminals along a corridor to receive the traffic, the type of control systems, the terrain, the mix of train types, the power of the locomotives, track speed, and individual railroad operating practices. Complete, consistent, and current information on all these factors was not available for the study, so the capacity of the primary corridors was estimated using only the three dominant factors (e.g., number of tracks, type of signal system, and mix of train types).

before entering a section of track. Crews receive track warrants by radio, phone, or electronic transmission from dispatcher. TWC is used on low-volume track instead of more expensive ABS or CTC/TCS systems.

- **Train Types** – The mix of train types determines the speed and spacing of trains on a track. Different types of trains operate at different speeds and have different braking capabilities. A corridor that serves a single type of train will usually accommodate more trains per day than a corridor that serves a mix of train types. Trains of the single type can be operated at similar speeds and with more uniform spacing between the trains because they have similar braking capabilities. This increases the total number of trains that can traverse the corridor per day. When trains of different types—each with different length, speed, and braking characteristics—use a corridor, greater spacing is required to ensure safe braking distances. As a result, the average speed drops, reducing the total number of trains that can traverse the corridor per day. For the study, trains were grouped into three train-type groups based on their operating characteristics.
 - **Train-Type Group 1** – includes merchandise/carload trains and bulk coal and grain trains. These trains tend to haul heavier, bulkier commodities such as coal, grain, gravel, and phosphates, and operate at slower speeds.
 - **Train-Type Group 2** – includes intermodal trains and multilevel auto carriers hauling assembled automobiles. These trains tend to operate at higher speeds because they are lighter than merchandise and bulk trains and are run to more exacting schedules.
 - **Train-Type Group 3** – includes passenger trains such as Amtrak's long-distance trains and local commuter rail trains. Passenger trains operate at high speeds and on fixed schedules, similar to the speeds and schedules of intermodal trains. They require close control to ensure safe operation and stopping distances, especially when operating along corridors carrying merchandise trains or a mix of merchandise and intermodal trains. By law, Amtrak passenger trains operating over rail freight lines must be given priority; this means that when Amtrak trains meet or overtake freight trains, the freight trains are shunted to sidings or parallel lines until the passenger train has passed.

There are eight combinations of number of tracks and type of signal system that are in common use across the primary corridors today. Table 4.2 lists the combinations, along with five- and six-track corridor types, which are used in this study to accommodate future demand. The first column lists the number of tracks, and the second column lists the type of control system. For each combination of number of tracks and type of control system, the maximum number of trains that can typically be accommodated is determined by the mix of train types operating along the corridor. The third column in the table lists the maximum practical capacity in trains per day that can be accommodated if multiple train types (e.g., merchandise, bulk, and passenger trains) use the corridor. The

rightmost column lists the maximum practical capacity in trains per day that can be accommodated if a single train type (e.g., all intermodal trains) uses the corridor

Table 4.2 Average Capacities of Typical Rail-Freight Corridors
Trains per Day

Number of Tracks	Type of Control	Trains per Day	
		Practical Maximum If Multiple Train Types Use Corridor*	Practical Maximum If Single Train Type Uses Corridor**
1	N/S or TWC	16	20
1	ABS	18	25
2	N/S or TWC	28	35
1	CTC or TCS	30	48
2	ABS	53	80
2	CTC or TCS	75	100
3	CTC or TCS	133	163
4	CTC or TCS	173	230
5	CTC or TCS	248	340
6	CTC or TCS	360	415

Key N/S-TWC – No Signal/Track Warrant Control
ABS – Automatic Block Signaling
CTC-TCS – Centralized Traffic Control/Traffic Control System

Notes * For example, a mix of merchandise, intermodal, and passenger trains
** For example, all intermodal trains

The table presents average capacities for typical rail freight corridors. The actual capacities of the corridors were estimated using railroad-specific capacity tables. At the request of the railroads, these detailed capacity tables were not included in this report to protect confidential railroad business information.

Source: Class I railroad data aggregated by Cambridge Systematics, Inc.

Typically, a corridor serving multiple train types will have a lower capacity than a corridor serving a single train type. For example, a railroad corridor with two tracks, a centralized traffic control (CTC) system, and a mix of merchandise/bulk trains, intermodal/auto trains, and passenger trains would typically operate at a capacity of about 75 trains per day. The same corridor, serving all merchandise trains, would typically operate at a capacity of about 100 trains per day.

For the study, each primary corridor in the national rail network was assigned a capacity based its actual number of tracks, type of control system, and mix of train types. The calculated capacity of each corridor was reviewed with the railroads. The railroads made adjustments to update network information and better represent their actual corridor train volumes and capacities.

4.4 CURRENT VOLUMES COMPARED TO CURRENT CAPACITY

Current corridor volumes were compared to current corridor capacity to assess congestion levels. This was done by calculating a volume-to-capacity ratio expressed as a level of service (LOS) grade. The LOS grades are listed in Table 4.3

Table 4.3 Volume-to-Capacity Ratios and Level of Service (LOS) Grades

LOS Grade	Description	Volume/Capacity Ratio
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents
B		0.0 to 0.2
C		0.2 to 0.4
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents
F	Above Capacity	Unstable flows, service breakdown conditions
		0.4 to 0.7
		0.7 to 0.8
		0.8 to 1.0
		> 1.00

Source: Cambridge Systematics, Inc.

Rail corridors operating at LOS A, B, or C are operating below capacity; they carry train flows with sufficient unused capacity to accommodate maintenance work and recover quickly from incidents such as weather delays, equipment failures, and minor accidents. Corridors operating at LOS D are operating near capacity; they carry heavy train flows with only moderate capacity to accommodate maintenance and recover from incidents. Corridors operating at LOS E are operating at capacity; they carry very heavy train flows and have very limited capacity to accommodate maintenance and recover from incidents without substantial service delays. Corridors operating at LOS F are operating above capacity; train flows are unstable, and congestion and service delays are persistent and substantial. The LOS grades and descriptions correspond generally to the LOS grades used in highway system capacity and investment requirements studies.

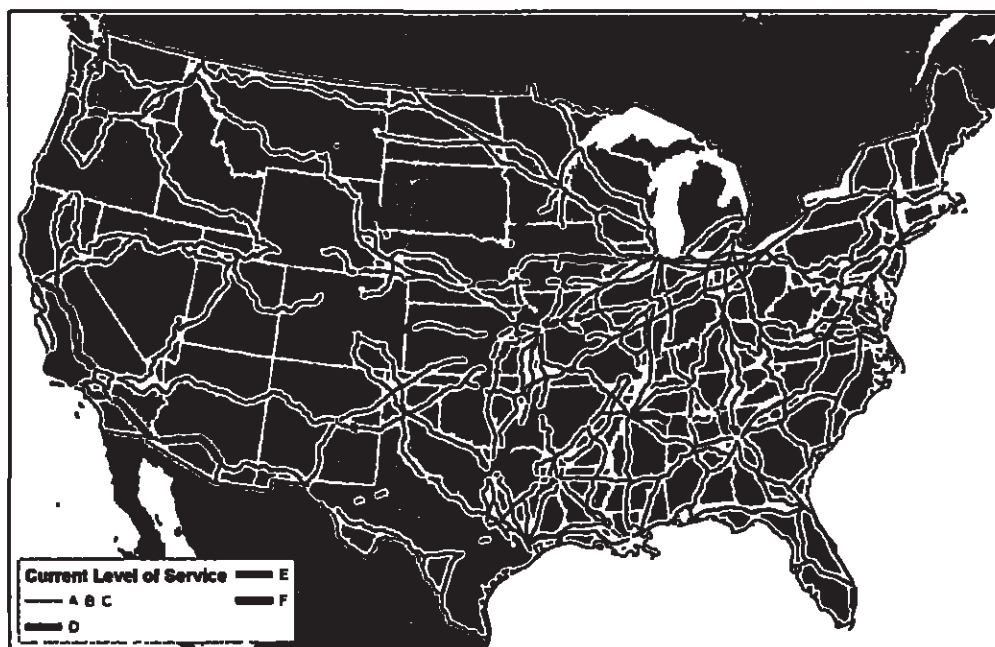
A rail corridor that is operating at a volume-to-capacity ratio of 0.7 (the boundary between LOS C and LOS D), is operating at 70 percent of its theoretical maximum capacity. This is considered to be the corridor's practical capacity because a portion of the theoretical maximum capacity is lost to maintenance, weather delays, equipment failures, and other factors. A corridor operating at LOS C will have stable train flows, ensuring that schedules can be met reliably and safely, and permitting timely recovery from service disruptions. At LOS D, a corridor will have stable operations under normal conditions, but service can quickly become unstable with unplanned and unanticipated disruptions. At volume-to-capacity ratios significantly greater than 0.8 (e.g., at LOS E or F), train flow rates and schedule reliability deteriorate and it takes longer and longer to recover from disruptions. To provide acceptable and competitive service to shippers and receivers, railroads typically aim to operate rail corridors at LOS C/D or better.

Figure 4.4 maps the volume-to-capacity ratios, expressed as LOS grades, for each primary rail corridor, based on current train volumes and current capacity.¹⁶ For legibility, rail corridors operating at LOS A, B and C (below practical capacity) have been mapped in green. Corridors operating at LOS D (near practical capacity) have been mapped in yellow, and corridors operating at LOS E (at practical capacity) have been mapped in orange. Rail corridors operating at LOS F (above capacity) have been mapped in red.

Analysis of the current levels of service, summarized in Table 4.4, shows that 88 percent of today's primary corridor mileage is operating below practical capacity (LOS A/B/C), 12 percent is near or at practical capacity (LOS D/E), and less than 1 percent is operating above capacity (LOS F).

¹⁶Current volumes are based primarily on shipment volumes reported in the 2005 STB Carload Waybill Sample. These volumes do not reflect fully recent increases in coal shipments moving from Western coal fields (e.g., Powder River Basin) to Eastern utilities nor the recent increases in intermodal containers delivered by water to East Coast ports and transferred to rail for inland delivery. Current capacity is based on 2007 information.

Figure 4.4 Current Train Volumes Compared to Current Train Capacity



Source Cambridge Systematics, Inc

Note Volumes are for the 85th percentile day

Table 4.4 Primary Rail Corridor Mileage by Current Level of Service Grade
Current Volumes and Current Capacity

LOS Grade	Total Mileage	Percentage
A	9,719	19%
B	15,417	30%
C	20,683	39%
D	4,952	9%
E	1,461	3%
F	108	<1%
Totals	52,340	100%

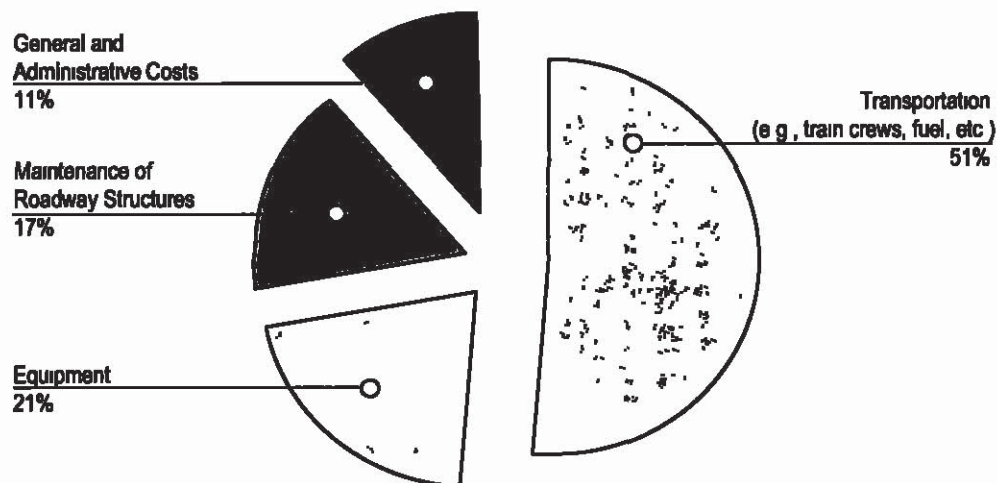
Source Cambridge Systematics, Inc

4.5 CURRENT RAILROAD INVESTMENT IN CAPACITY

The Class I railroads generated \$52.2 billion in revenue in 2006 and incurred \$41 billion in operating expenses.¹⁷ After deducting interest charges, taxes and other miscellaneous items, the Class I railroads earned a net income of \$6.5 billion in 2006.

Of the \$41 billion in expenses, \$21.1 billion (40 percent of revenue) was spent on transportation, which includes the costs of train crews and fuel; \$8.5 billion (16 percent of revenue) on equipment; \$6.8 billion (13 percent of revenue) on maintenance of roadway (e.g., rails, ties, ballast and substructure) and structures (e.g., bridges, tunnels, service building, etc.); and \$4.6 billion (9 percent of revenue) on general and administrative costs. A breakdown of the operating expenditures is shown in Figure 4.5.

Figure 4.5 Class I Railroad Operating Expenditures 2006



Source: American Association of Railroads

In 2006, the Class I railroads' capital expenditures totaled \$8.5 billion. Of this, \$1.5 billion (about 18 percent) was spent on equipment, and \$7.0 billion (about

¹⁷In 2006, the operations and maintenance (O&M) cost for Class I railroads was \$210,380 per mile of track and \$359,097 per mile of road. This O&M cost is a fully burdened cost including transportation, equipment maintenance, G&A (but not maintenance of way and structures), and capital expenditures for equipment (but not way and structures). Depreciation is deducted to avoid double-counting. The calculations are based on 162,056 miles of operated track and 94,942 miles of road, less miles operated under trackage rights to avoid double-counting. This information is for the seven Class I railroads, U.S. operations only.

82 percent) on roadway and structures.¹⁸ These capital expenditures include amounts for renewal of the existing roadway, structures, and equipment, as well as expenditures for expansion to serve additional traffic.

Combining operating and capital spending and adjusting for depreciation, 40 percent of the Class I railroads' revenue is spent on maintenance, replacement, or expansion of their track, structures, and equipment.¹⁹ In 2006, the Class I railroads spent \$10.6 billion maintaining and improving their infrastructure, and another \$8.7 billion on equipment.²⁰

The AAR estimates that the Class I railroads will spend approximately \$1.9 billion in 2007 for expansion of capacity through the construction of new roadway and structures. This is the highest level of investment for expansion in recent years and reflects a steady increase in investment in expansion of roadway and structures. The Class I railroads invested \$1.1 billion in expansion of roadway and structures in 2005. The Class I railroads invested \$1.4 billion in infrastructure expansion in 2006. This was in addition to an expenditure of \$17.9 billion for renewal of roadway, structures, and equipment and additions to locomotives and freight cars. The average annual investment in infrastructure expansion over the three year period from 2005 to 2006 was \$1.5 billion per year.²¹

As these numbers demonstrate, rail transportation is capital intensive, requiring high levels of spending on infrastructure such as track, bridges, and signals; locomotives, freight cars, and maintenance equipment; and information technology. From 1996 through 2005, Class I railroad capital expenditures averaged 17 percent of revenue. (The comparable figure for the average U.S. manufacturer was 3 percent of revenue.) Railroad capital expenditures for ties alone have exceeded \$1 billion every year since 2003, and spending for rail has been even higher.

Even though the railroads must invest heavily in infrastructure, the railroads have had substantial surplus capacity in the rail network for many years. This has enabled them to absorb traffic growth with relatively modest additional capital commitments to expand infrastructure. With this surplus capacity largely absorbed by two decades of growth and with major traffic increases in the past few years, an increasing portion of the capital investment in roadway and structures has been devoted to capacity expansion. And with traffic growth through 2035 expected to be significant, increasing amounts of capital will need to be devoted to expansion.

¹⁸These capital expenditures do not include some equipment that was acquired under operating leases.

¹⁹Capital expenditures plus operating expenses for infrastructure and equipment, minus depreciation to avoid double-counting capital spending.

²⁰Association of American Railroads economists estimate that each \$1 billion of investment in rail infrastructure generates over 20,000 jobs.

²¹Association of American Railroads data.

5.0 Future Train Volumes and Capacity

5.1 FUTURE VOLUMES

2035 train volumes were projected using economic growth and commodity forecasts from the U.S. DOT's Freight Analysis Framework (FAF Version 2.2). The FAF forecasts are national freight transportation estimates covering all types of shipments by truck, rail, water, pipeline, and air. The U.S. DOT and the Federal Highway Administration use the FAF forecasts to analyze truck freight demand and help estimate highway capacity needs and investment requirements.

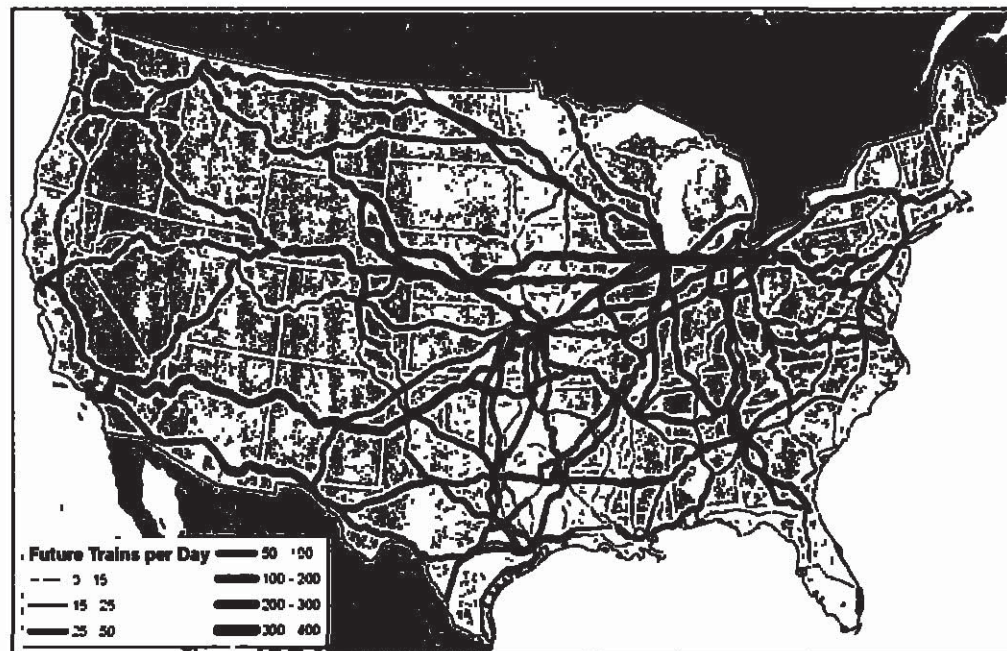
The FAF forecasts consider growth in population, the economy, and international trade. Forecasts of the demand for freight transportation are derived by examining production, consumption, and trade by major industry sector and economic region in the U.S., North America, and the rest of the world. The rail freight forecasts cover over 40 categories of commodities and estimate the volume of each type of commodity moving among 138 economic zones (114 zones representing economic areas and international trade gateways within the U.S., and 24 zones representing economic areas in Canada, Mexico, and overseas).

The forecasts are driven by demand only; they are not constrained by supply. This means that if an industry grows and the industry currently ships and receives a commodity by rail, then the industry will ship and receive more of that commodity by rail in the future. Conversely, if an industry declines and the industry currently ships and receives a commodity by rail, then the industry will ship and receive less by rail in the future. The forecasts assume that the rail system (and other freight modes) will have the capacity to meet the future demand. The forecasts also do not attempt to presuppose how markets and demand will change in response to future, but unknown, changes in technology, regulation, and politics. The forecasts are a starting point for consideration of the effect of future demand on infrastructure capacity and investment requirements, but are not comprehensive in their estimation of future freight demand.

The FAF Version 2.2 2035 commodity forecasts were used to develop weighted growth rates for the four types of train services—auto train service (for finished automobiles), bulk train service (for grain, coal, and similar bulk commodities), intermodal train service (for commodities moving in containers or truck trailer on flat cars or specialized intermodal cars), and general-merchandise train service (for everything else, including commodities moved in box cars and tank cars). The growth rates were applied to the number of 2005 trains to approximate the number of 2035 trains. The number of passenger trains was held at 2007 levels and added to the estimated number of freight trains in 2035.

Figure 5.1 maps the future corridor volumes in trains per day for the primary rail freight corridors. The number of trains per day is indicated by the width of the corridor line. The thinnest line indicates that a corridor carries up to 15 trains per day; the widest line indicates that a corridor carries between 300 and 400 trains per day.

Figure 5.1 Future Corridor Volumes by Primary Rail Freight Corridor
2035 Freight Trains and 2007 Passenger Trains per Day

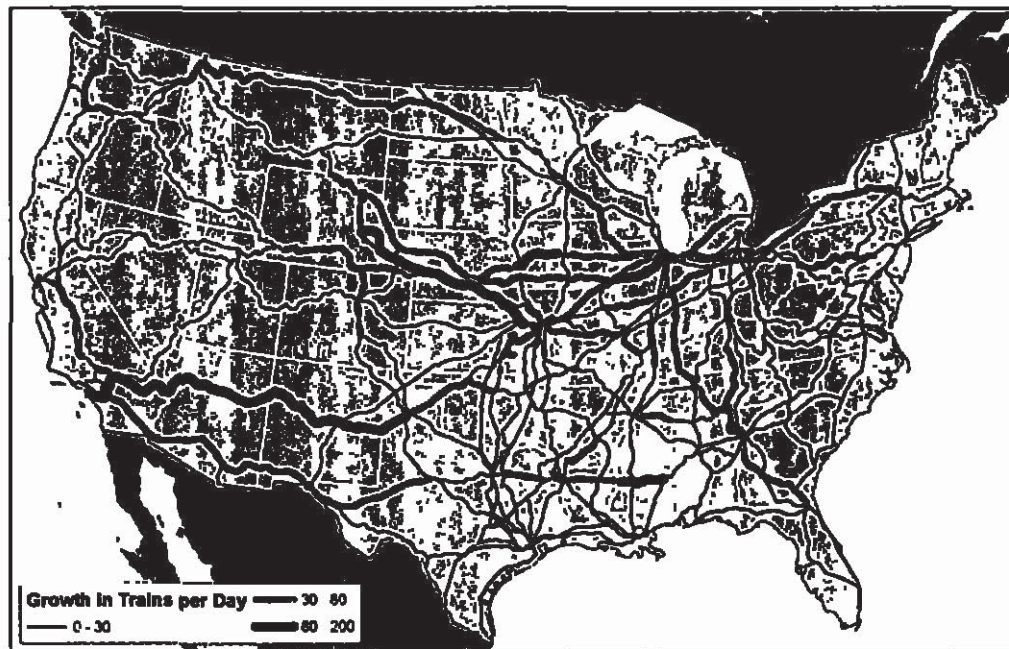


Source Cambridge Systematics, Inc

Note. Volumes are for the 85th percentile day

Figure 5.2 compares current and future volumes by primary corridor. The figure shows the growth in trains per day between the 2005 volumes and the 2035 volumes. The growth is indicated by the width and color of the corridor line. A thin black line indicates that a corridor will carry up to 30 additional trains per day by 2035; a green line indicates that a corridor will carry between 30 and 80 additional trains per day, and a thick black line indicates that a corridor will carry between 80 and 200 additional trains per day.

Figure 5.2 Growth in Trains per Day from 2005 to 2035 by Primary Rail Corridor

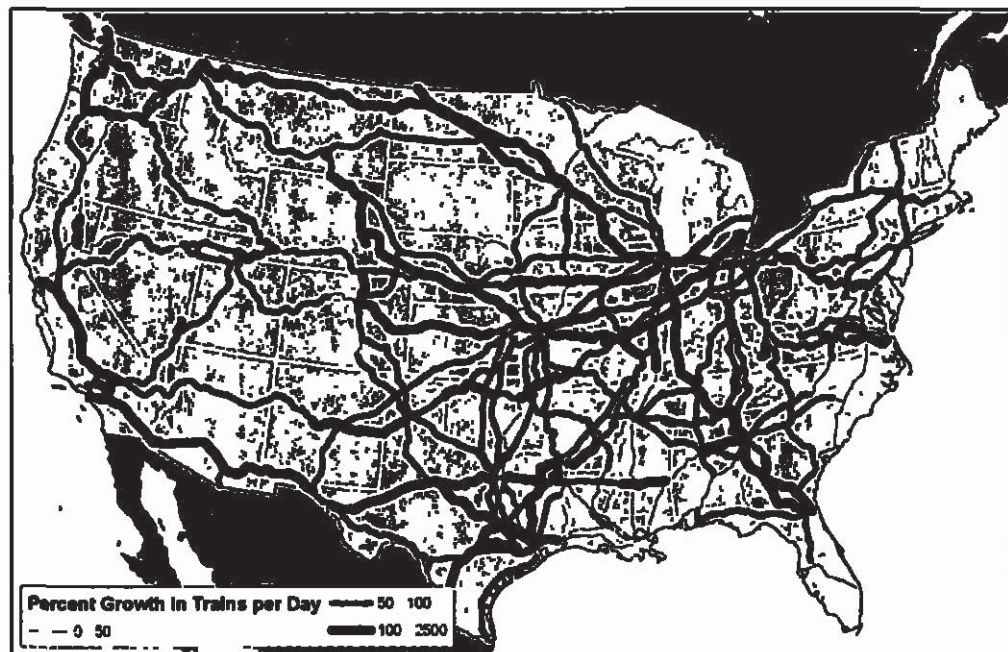


Source: Cambridge Systematics, Inc.

Note: Volumes are for the 85th percentile day

Figure 5.3 also compares current and future volumes by primary corridor, but the figure shows the percentage growth in trains per day from 2005 to 2035. The percentage growth is indicated by the width and color of the corridor line. A thin black line indicates that a corridor will carry up to 50 percent more trains per day by 2035; a blue line indicates that a corridor will carry between 50 and 100 percent more trains per day, and a thick black line indicates that a corridor will carry over 100 percent more trains per day.

Figure 5.3 Percentage Growth in Trains per Day from 2005 to 2035 by Primary Rail Corridor



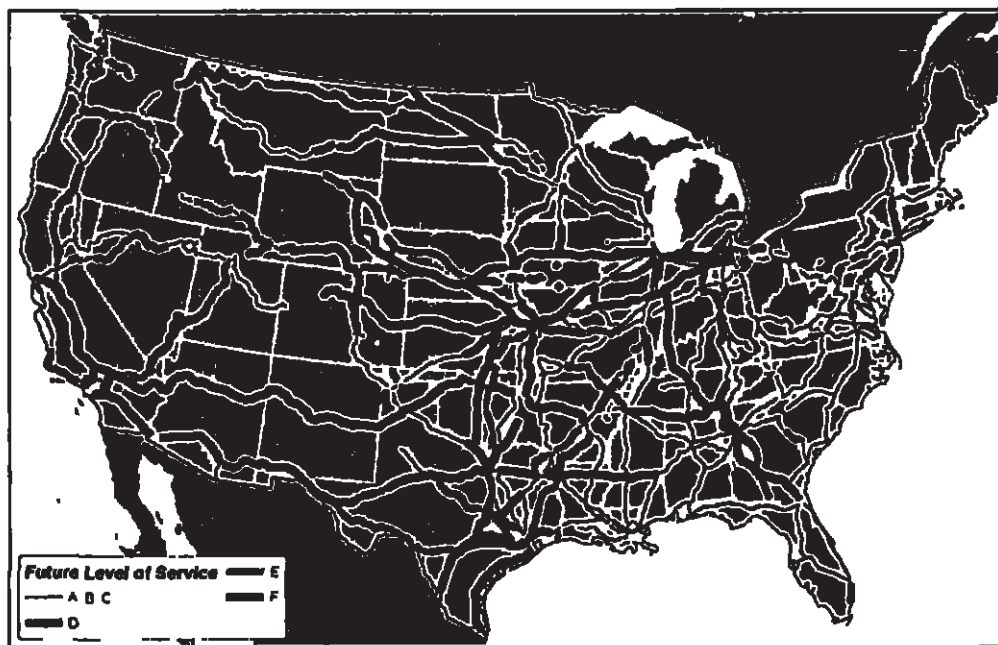
Source Cambridge Systematics, Inc

Note Volumes are for the 85th percentile day

5.2 FUTURE VOLUMES COMPARED TO CURRENT CAPACITY

Future volumes were compared to current capacity to estimate future volume-to-capacity ratios. This information was used to determine where demand will exceed capacity and where improvements will be required to avoid congestion. Figure 5.4 compares 2035 volumes in trains per day to current corridor capacity. The volume-to-capacity ratios are expressed as LOS grades for each primary rail corridor. Again, for legibility, rail corridors operating at LOS A, B, and C (below practical capacity) have been mapped in green. Corridors operating at LOS D (near practical capacity) have been mapped in yellow, and corridors operating at LOS E (at practical capacity) have been mapped in orange. Rail corridors operating at LOS F (above capacity) have been mapped in red.

Figure 5.4 Future Corridor Volumes Compared to Current Corridor Capacity 2035 without Improvements



Source: Cambridge Systematics, Inc.

Note: Volumes are for the 85th percentile day.

Analysis of the 2035 levels of service, summarized in Table 5.1, shows that—without improvements—45 percent of primary corridor mileage will be operating below capacity (LOS A/B/C), 25 percent will be operating near or at capacity (LOS D/E), and 30 percent will be operating above capacity (LOS F). The resulting level of congestion would affect nearly every region of the country and would likely shut down the national rail network.

Table 5.1 Primary Rail Corridor Mileage by Future Level of Service Grade 2035 without Improvements

LOS Grade	Total Mileage	Percentage
A	4,895	9%
B	6,626	13%
C	11,708	23%
D	5,353	10%
E	7,980	15%
F	15,778	30%
Totals	52,340	100%

Source: Cambridge Systematics, Inc.

6.0 Rail Capacity Improvements

6.1 CAPACITY IMPROVEMENTS

Rail improvements were determined by comparing the current capacity in each primary corridor to the capacity needed to accommodate future train volumes. Capacities estimates were based on the capacities of typical rail corridor combinations of tracks, controls, and mix of train types as shown in Table 6.1. (This table was described in Section 4.0 and is repeated here for reference.)

Table 6.1 Average Capacities of Typical Rail-Freight Corridors
Trains per Day

Number of Tracks	Type of Control	Trains per Day	
		Practical Maximum If Multiple Train Types Use Corridor*	Practical Maximum If Single Train Type Uses Corridor**
1	N/S or TWC	16	20
1	ABS	18	25
2	N/S or TWC	28	35
1	CTC or TCS	30	48
2	ABS	53	80
2	CTC or TCS	75	100
3	CTC or TCS	133	163
4	CTC or TCS	173	230
5	CTC or TCS	248	340
6	CTC or TCS	360	415

Key N/S-TWC – No Signal/Track Warrant Control.
ABS – Automatic Block Signaling
CTC-TCS – Centralized Traffic Control/Traffic Control System

Notes * For example, merchandise, intermodal, and passenger trains.
** For example, all intermodal trains

The table presents average capacities for typical rail freight corridors. The actual capacities of the corridors were estimated using railroad-specific capacity tables. At the request of the railroads, these detailed capacity tables were not included in this report to protect confidential railroad business information.

Source Class I railroad data aggregated by Cambridge Systematics, Inc

For example, if a corridor with “one track and N/S-TWC control,” which today accommodates 15 trains per day, must accommodate 35 trains per day in 2035, it is upgraded to “one track with CTC-TCS control,” which accommodates 30 to 48 trains per day, depending on the mix of train types operating in the corridor

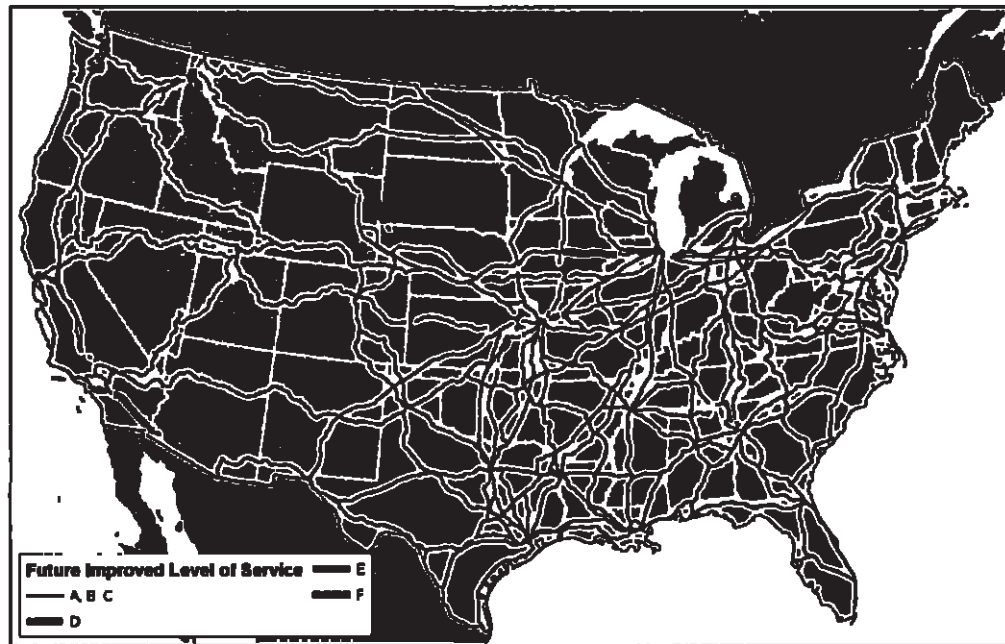
To avoid double-counting improvements that are currently programmed or underway, new improvements were selected to accommodate only forecast demand, not to correct current capacity shortfalls. If a corridor is at or above capacity today and needs additional capacity to accommodate future demand, improvements were programmed to bring the volume-to-capacity ratio back to the current ratio. For example, if the current volume-to-capacity ratio of a corridor is 0.85 and the future volume-to-capacity ratio without improvements is estimated to be 1.6, improvements were made to bring the volume-to-capacity ratio back to 0.85, not to 0.70. If a corridor is below capacity today and needs additional capacity to accommodate future demand, improvements were selected to bring the volume-to-capacity ratio up to a maximum of 0.70.

6.2 FUTURE VOLUMES COMPARED TO FUTURE CAPACITY

Figure 6.1 compares projected future corridor volumes in trains per day to projected future corridor capacity assuming that the necessary improvements are made. The volume-to-capacity ratios are expressed as LOS grades for each primary rail corridor. Again, rail corridors operating at LOS A, B and C (below practical capacity) have been mapped in green. Corridors operating at LOS D (near practical capacity) have been mapped in yellow, and corridors operating at LOS E (at practical capacity) have been mapped in orange. Rail corridors operating at LOS F (above capacity) have been mapped in red.

Analysis of the 2035 levels of service, summarized in Table 6.2, shows that—with improvements—97 percent of primary corridor mileage will be operating below capacity (LOS A/B/C), 2 percent will be near or at capacity (LOS D/E), and less than 1 percent will be operating above capacity (LOS F).

**Figure 6.1 Future Train Volumes Compared to Future Train Capacity
2035 with Improvements**



Source Cambridge Systematics, Inc

Note Volumes are for the 85th percentile day

**Table 6.2 Primary Rail Corridor Mileage by Future Level of Service Grade
2035 with Improvements**

LOS Grade	Total Mileage	Percentage
A	4,895	9%
B	15,198	29%
C	31,036	59%
D	608	1%
E	597	1%
F	6	<1%
Totals	52,340	100%

Source. Cambridge Systematics, Inc

7.0 Investment Requirements

7.1 COST OF IMPROVEMENTS

The cost of improvements needed to accommodate rail freight demand in 2035 is estimated at \$148 billion (in 2007 dollars). The Class I freight railroads' share of this cost is projected to be \$135 billion; the short line and regional freight railroads' share is projected to be \$13 billion. The cost estimates cover:

- Line expansion
 - Upgrades to mainline tracks and signal control systems;
 - Improvements to significant rail bridges and tunnels,
 - Upgrades to Class I railroad secondary mainlines and branch lines to accommodate 286,000-pound freight cars, and
 - Upgrades to short line and regional railroad tracks and bridges to accommodate 286,000-pound freight cars.
- Facility expansion.
 - Expansion of carload terminals, intermodal yards, and international gateway facilities owned by railroads, and
 - Expansion of Class I railroad service and support facilities such as fueling stations and maintenance facilities

Table 7.1 summarizes the investments required by type of improvement for the Class I and the short line and regional railroads.

Table 7.1 Cost of Rail Freight Infrastructure Improvements
Millions of 2007 Dollars

	Class I Freight Railroads	Short Line and Regional Freight Railroads	Totals
Line Haul Expansion	\$94,750	\$320	\$95,070
Major Bridges, Tunnels, and Clearance	\$19,400	\$5,000	\$24,400
Branch Line Upgrades	\$2,390	\$7,230	\$9,620
Intermodal Terminal Expansion	\$9,320		\$9,320
Carload Terminal Expansion	\$6,620		\$6,620
Service Facilities	\$2,550		\$2,550
Totals	\$135,030	\$12,550	\$147,580

Source Cambridge Systematics, Inc

Notes All estimates exclude real estate acquisition costs, consistent with national highway needs analysis study practices

Line expansion costs for short line and regional railroads are only for segments used to connect the primary corridors, not the entire system

The category Major Bridges, Tunnels, and Clearance covers very large projects such as expansion of major bridges and tunnels (or construction of new parallel bridges and tunnels) and corridor overhead clearance projects that are not adequately accounted for by per mile unit costs

The category Branch Line Upgrades covers upgrades to secondary main and branch lines to meet 286,000-pound weight-limit standards for the Class I railroads. A preliminary analysis shows limited need to upgrade the capacity of secondary mainlines and branch lines.

Line expansion cost estimates were based on per mile construction costs to upgrade from one level of corridor capacity to another. Table 7.2 lists the average construction cost per mile for each set of upgrades. For example, upgrading a corridor from "one track and N/S-TWC control" to "one track with CTC-TCS control" would cost \$700,000 per mile. All costs are reported in current (2007) dollars.

Table 7.2 Average Unit Costs

From		To		Construction Cost (per mile)
Tracks	Control	Tracks	Control	
1	N/S-TWC	1	CTC-TCS	\$700,000
2	NS-TWC	2	CTC-TCS	\$700,000
1	ABS	1	CTC-TCS	\$500,000
2	ABS	2	CTC-TCS	\$600,000
1	CTC-TCS	2	CTC-TCS	\$3,800,000
2	CTC-TCS	3	CTC-TCS	\$4,400,000
3	CTC-TCS	4	CTC-TCS	\$4,400,000
4	CTC-TCS	5	CTC-TCS	\$4,400,000
5	CTC-TCS	6	CTC-TCS	\$4,400,000

Key. N/S-TWC – No Signal/Track Warrant Control
 ABS – Automatic Block Signaling
 CTC-TCS – Centralized Traffic Control/Traffic Control System

Note The table presents average costs for typical rail freight corridors. The actual costs of the corridors were estimated using railroad-specific capacity tables. Per mile construction costs for Eastern rail corridors were higher than the averages presented in the table because of the number of urbanized areas, hilly terrain, and numerous river crossings. Conversely, per mile construction costs for Western rail corridors in non-urban areas were lower than the averages presented in the table because of the prevalence of flatter, non-urbanized areas along some Western railroad primary corridors. At the request of the railroads, the railroad-specific cost tables were not included in this report to protect confidential railroad business information.

Source Cambridge Systematics based on Association of American Railroads and Class I railroads' data

Expansion costs for major bridges and tunnels were estimated separately for each facility based on the cost of recent and comparable projects. Expansion costs for facilities such as intermodal yards, carload terminals, fueling stations, and maintenance facilities were estimated using the anticipated number of intermodal units, cars, and trains operating in the corridor.

The estimates do not include all line expansion costs on short line and regional railroads, nor the cost of expanding tunnels, bridges, and service facilities on the short lines and regionals. Neither the Class I nor the short line and regional railroad estimates include the cost of additional real estate, the cost to maintain or replace existing rail lines and facilities, or the cost to acquire additional locomotives and railcars.

Appendix A provides more information on the cost estimating methods.

7.2 COST SAVINGS FROM PRODUCTIVITY IMPROVEMENTS

The recommended improvements and the cost estimates assume that the future demand for rail freight transportation will be met by using current technology and existing rail corridors. The analysis also assumes that there will be no shift in freight traffic among modes (i.e., rail, truck, water), and no significant changes in regulation or other factors that could change the demand for or supply of rail freight services.

However, there are alternative futures that could, and eventually should, be examined. These include futures that assume significant changes in rail technology, major shifts in markets or trade patterns, and new innovations in railroad operations. A full examination of these alternative futures was not attempted for this first approximation study. However, a preliminary estimate was made of the potential cost savings from productivity improvements.

The railroads anticipate that they can improve train productivity by up to 0.5 percent per year over the 28-year period from 2007 to 2035. The productivity would be gained by carrying more freight over each primary rail corridor. This would be done by increasing the number of trains, hauling more cars per train, and loading railcars more efficiently to make better use of the 286,000-pound capacity of current railcars. These improvements would allow the railroads to carry the same amount of rail freight in 2035, but carry it with fewer trains.

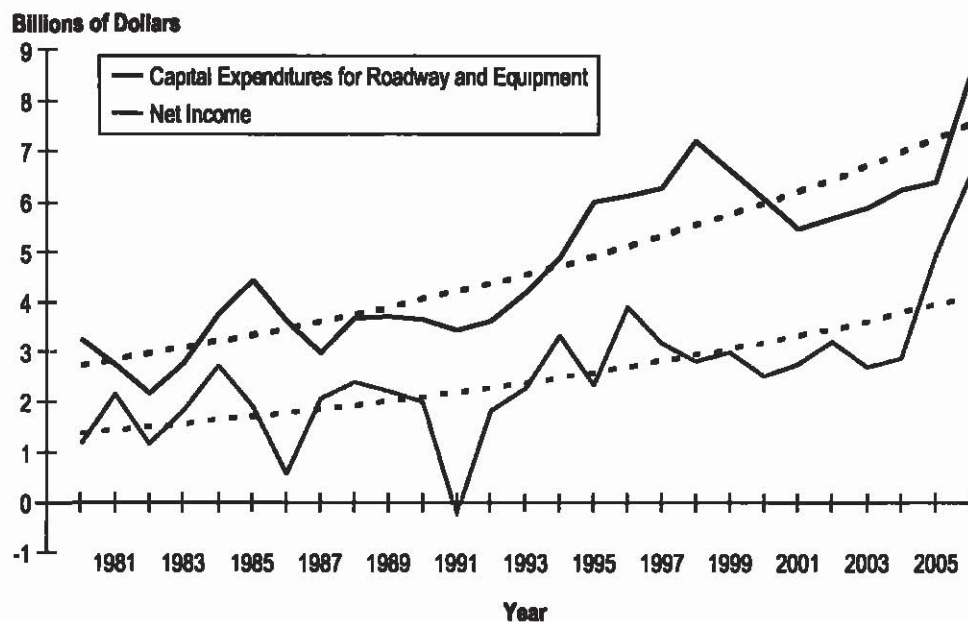
A 0.5 percent productivity improvement would reduce the number of trains to about 87 percent of the initial 2035 forecast number of trains. This would reduce capacity expansion needs in many corridors, reducing the cost of line expansion across all railroads from \$148 billion to about \$121 billion.²² The Class I freight railroads' share for infrastructure expansion would be reduced from \$135 billion to \$109 billion, a savings of \$26 billion. The short line and regional freight railroads' share of capital expenditures would be reduced from \$12.6 billion to \$12.3 billion, a savings of about \$0.3 billion.

²²Productivity improvements are only applied to line costs, not to terminals, yards, facilities, etc.

7.3 RAILROAD INVESTMENT CAPACITY

In general, Class I railroad capital expenditures have tracked income, as shown in Figure 7.1, increasing consistently (in current dollars) since the economic deregulation of the railroad industry in 1980. Class I capital expenditures for infrastructure expansion totaled \$1.1 billion in 2005 and \$1.4 billion in 2006. The AAR estimates that Class I capital expenditures for infrastructure expansion will total \$1.9 billion in 2007.

Figure 7.1 Capital Investment and Income
Class I Railroads, 1981 to 2006, in Current Dollars



Source: American Association of Railroads data

If rail revenues grow proportionally to rail tonnage, currently forecast to increase by 88 percent by 2035, and if the railroads maintain their current level of effort for expansion, then the Class I railroads will invest cumulatively about \$70 billion over the 28-year period.

7.4 INVESTMENT REQUIREMENTS FOR CLASS I RAILROADS

The estimated cost of the improvements needed to accommodate rail freight demand in 2035 is \$148 billion. Of this amount, the Class I freight railroads' share is projected to be \$135 billion.

The Class I railroads anticipate that they will be able to generate approximately \$96 billion of their \$135 billion share through increased earnings from revenue growth, higher volumes, and productivity improvements, while continuing to renew existing infrastructure and equipment. If revenue and capital expenditures for expansion follow the growth in rail tonnage, as the railroads expect, the Class I railroads could realize about \$70 billion of the \$135 billion from growth. And if the Class I railroads can continue to achieve train productivity gains of up to 0.5 percent per year, the railroads could realize savings of \$26 billion in reduced capital expenditures. This would leave a balance for the Class I freight railroads of \$39 billion or about \$1.4 billion per year to be funded from railroad investment tax incentives, public-private partnerships, or other sources.

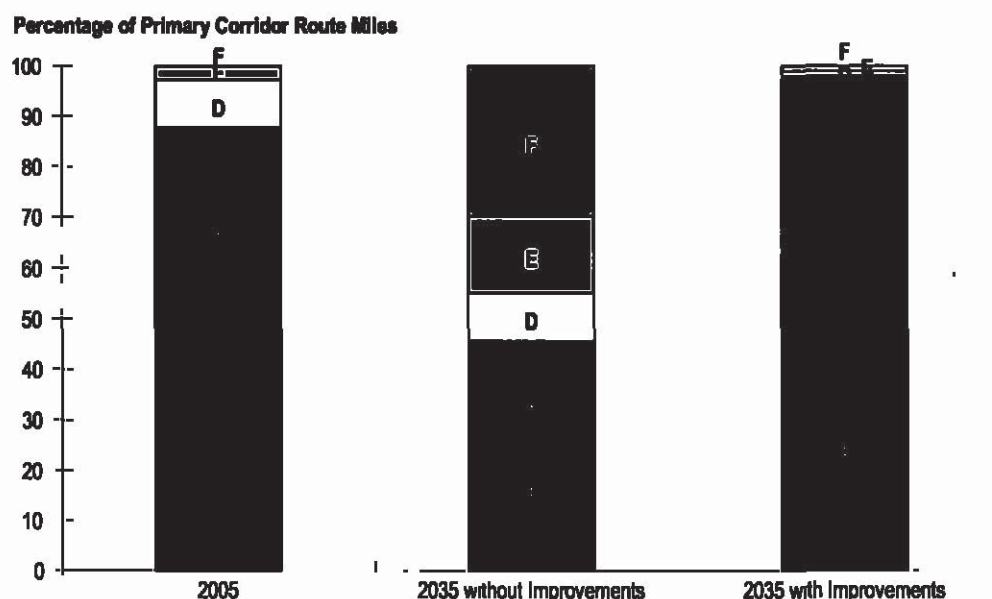
These investment projections assume that the market will support rail freight prices sufficient to sustain long-term capital investments. If regulatory changes or unfunded legislative mandates reduce railroad earnings and productivity, investment and capacity expansion will be slower and the freight railroads may not be able to meet the U.S. DOT's forecast demand.

8.0 Conclusions

On first approximation, the investment in the continental U.S. rail network required to allow the freight railroads to meet the U.S. DOT's projected demand for rail freight transportation is \$148 billion (in 2007 dollars). This level of investment would enable the freight railroads to keep pace with economic growth and meet the U.S. DOT's forecast demand for rail freight transportation in 2035.

The impact of the investment is illustrated in Figure 8.1, which compares the percentage of primary rail freight corridor miles by LOS grade and year.

Figure 8.1 Percentage of Rail-Freight Primary Corridor Route Miles by Level of Service Grade in 2005, 2035 without Capacity Improvements, and 2035 with Capacity Improvements



Source: Cambridge Systematics, Inc.

The left column shows the percentage of miles by LOS grade for the current rail system (2005 train volumes on the 85th percentile day compared to 2007 capacity). Red indicates the percentage of miles operating above capacity, yellow and orange the percentage of miles near or at capacity, and green, the percentage of miles below capacity. The center column shows the percentage of miles by LOS grade for the primary corridors in 2035 without improvements. Thirty percent of the rail miles in the primary corridors will be operating above capacity, causing severe congestion that will affect every region of the country and potentially shift freight to an already heavily congested highway system. Finally, the right column shows the estimated LOS grades in 2035 with improvements. The

improvements sharply reduce the number of primary corridor miles operating above capacity.

Meeting the U.S. DOT's forecast demand will require the Class I freight railroads to increase their investment in infrastructure expansion. The AAR estimates that between 2005 and 2007, Class I freight railroad capital expenditures for infrastructure expansion averaged \$1.5 billion per year. To meet the U.S. DOT's forecast demand for 2035, the Class I freight railroads must invest \$135 billion over the next 28 years or about \$4.8 billion per year.

The Class I freight railroads anticipate that they will be able to meet most of this increase in investment through growth and productivity gains. If revenue and capital expenditures for expansion follow the growth in rail tonnage, the Class I railroads could realize about \$70 billion of the \$135 billion from growth. And if the Class I railroads can continue to achieve train productivity gains of up to 0.5 percent per year, the railroads could realize savings of \$26 billion in reduced capital expenditures. This would leave a balance for the Class I freight railroads of \$39 billion or about \$1.4 billion per year to be funded from railroad investment tax incentives, public-private partnerships, or other sources.

These investment projections assume that the market will support rail freight prices sufficient to sustain long-term capital investments. If regulatory changes or unfunded legislative mandates reduce railroad earnings and productivity, investment and capacity expansion will be slower and the freight railroads may not be able to meet the U.S. DOT's forecast demand.

The findings of this study provide a starting point for assessing future rail freight capacity and investment requirements. The findings outline the improvements and investments required for the railroads to carry the freight tonnage forecast by the U.S. DOT. Additional work is needed to determine how much more capacity and investment would be needed for the railroads to increase their share of freight tonnage and reduce the rate of growth in truck traffic on highways. Finally, the forecasts and improvement estimates in this study do not fully anticipate future changes in markets, technology, regulation, and the business plans of shippers and carriers. Each could significantly reshape freight transportation demand, freight flow patterns, and railroad productivity, and, thus, rail freight infrastructure investment needs.

In summary, the findings point clearly to the need for more investment in rail freight infrastructure and a national strategy that supports rail capacity expansion and investment.

A. National Rail Freight Infrastructure Capacity and Investment Study: Methodology

A.1 INTRODUCTION

The objective of this study is to identify rail freight infrastructure improvements and investments in the continental U.S. rail network that will allow the freight railroads to meet the U.S. Department of Transportation's (DOT) projected demand for rail-freight transportation in 2035. This requires an understanding of the current and forecasted demand for rail services and the current and projected capacity of the rail network. The study encompasses the continental United States rail system

The general approach was to divide the continental U.S. Class I railroad network into primary corridors; establish the volume of trains in 2005 and 2035, compare those volumes to current capacity; determine the additional capacity needed to accommodate 2035 volumes; identify the types of improvements warranted; and estimate the investment needed for these improvements. The improvements can be divided into line expansion and facility expansion, each with multiple components.

- Line expansion includes:
 - Upgrades to the Class I system mainlines control systems and/or number of tracks,
 - Improvements to significant bridges, tunnels, clearances, and other items above average costs;
 - Upgrades to Class I railroad secondary mainlines and branch lines to accommodate 286,000-pound freight cars; and
 - Upgrades to short line and regional railroad track and bridges to accommodate 286,000-pound freight cars
- Facility expansion includes:
 - Expansion of capacity at Class I railroad-owned intermodal facilities, including terminals, ports and gateways;
 - Expansion of capacity at carload terminals (e.g., classification yards); and
 - Expansion of capacity at Class I railroad-owned service facilities (e.g., fueling stations, maintenance facilities)

A.2 LINE CAPACITY EXPANSION

The work steps to estimate the cost of expanding line capacity along primary Class I railroad corridors to meet U.S. DOT projected demand was as follows:

1. Divide the continental U.S. Class I railroad network into primary corridors;²³
2. Establish the number of freight trains for a day representing the 85th percentile of the maximum trains per day from the 2005 Surface Transportation Board (STB) Carload Waybill Sample (Waybill);
3. Establish the number of scheduled passenger trains for a current average weekday, and combine with the freight trains;
4. Estimate the number of freight trains per day in 2035 by applying forecast rates from the Freight Analysis Framework Version 2.2 to the 2005 STB Waybill. Passenger train volumes were held constant,
5. Estimate the current capacity on the nation's primary rail corridors in trains per day based on current track configurations,
6. Compare the 2005 and 2035 freight and passenger trains per day to the current capacity, and identify the types of improvements necessary to maintain reliable rail service in 2035;
7. Estimate the construction costs of the improvement lines,
8. Estimate the cost of significant bridges, tunnels, clearance projects, etc ; and
9. Estimate the cost to upgrade all Class I branch lines and all short line and regional lines that are currently below 286,000-pound weight standards to the current standard

Each of these is described in more detail in the following sections

Divide the Continental U.S. Class I Railroad Network into Primary Corridors

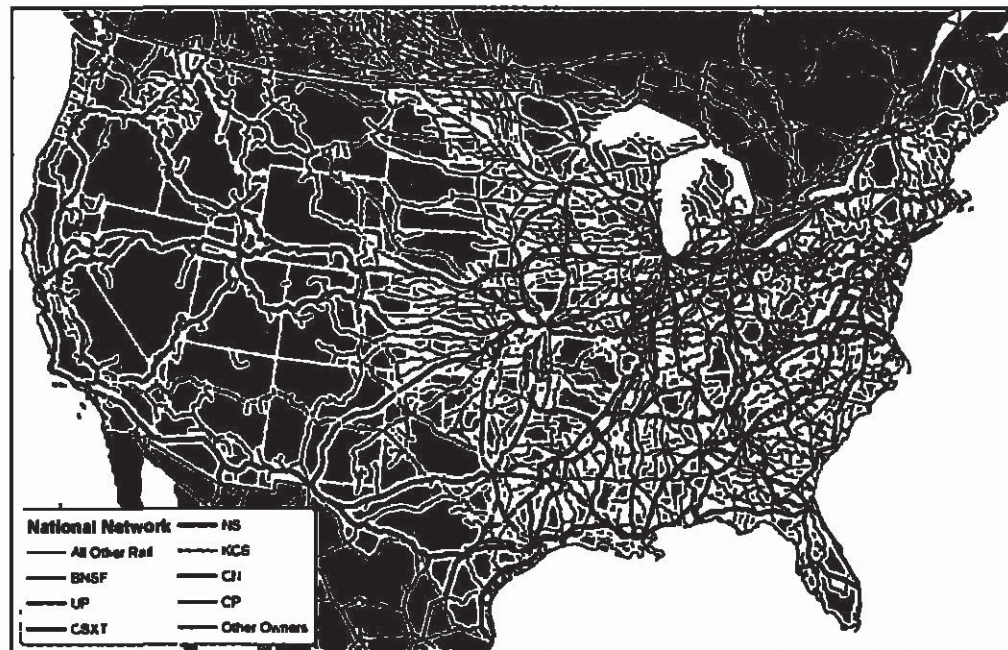
The initial work step was to divide the continental U.S. Class I railroad network into primary corridors. The corridors are mainline track and represent the lanes that haul the majority of the freight rail traffic. A corridor is roughly homogeneous with respect to traffic mix and type of infrastructure (i.e., number of tracks and control system)

²³The Class I railroads covered in this study are BNSF, CN (U.S. operations), CP (U.S. operations), CSX, KCS, NS, and UP

The beginnings and ends of the corridors are major urban areas corresponding with the U.S. Department of Transportation Freight Analysis Framework Version 2.2 (FAF²²) zones, major rail traffic generators such as the Powder River Basin coal fields, port complexes, and major rail traffic junctions

Each of the Class I railroads participating in the study provided to Cambridge Systematics (CS) a map of their recommended primary corridors. CS aggregated this information into a national network of primary corridors for use in this study.

Figure A.1 National Rail Network and Primary Rail Corridors



Source. Cambridge Systematics, Inc

The primary corridors were then mapped to a network combining the Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis Rail Network Version 5-5 containing infrastructure attributes, with a network developed for the Tennessee Department of Transportation that assigns rail flows using minimum distance paths. In the course of this project the TDOT network was revised to include missing links with information from the ORNL network. The mapping was done in TransCAD, a commercially available transportation network modeling program.

Establish the Number of Freight Trains Operating on an 85th Percentile Day along Each Corridor in 2005

Data from the 2005 Surface Transportation Board Carload Waybill Sample was used to establish the total number of trains operating in each corridor with the following caveats.²⁴

- Northbound Canadian traffic and southbound Mexican traffic will not be accounted for fully in this study because much of this traffic is absent from the Waybill Sample. Traffic terminating in Canada and Mexico (both U.S. originations and pass-through NAFTA traffic) often is waybilled to the U.S. border crossing, but much of the northbound Canadian traffic and southbound Mexican traffic is not reported.
- The Waybill Sample will not provide a complete picture of rail shipments end-to-end. The Waybill Sample is subject to "re-waybiling" (Rule 11 traffic) at key junctions such as Chicago. For example, one waybill may be written to cover a shipment from Los Angeles to Chicago, and a second waybill written to cover the same shipment as it moves on from Chicago to New York. This reporting practice makes it difficult to trace the entire route of some rail shipment. This issue did not affect the estimate of the number of trains operating in each corridor, and no effort was made to "link" these movements.

The Waybill Sample, which represents loaded revenue movements on the railroads, was adjusted to account for empty rail car moves. To estimate the empty car movements, empty return ratios were supplied by the AAR from the Uniform Rail Costing System (URCS), as shown in Table A.1. CS matched the empty return ratios to the Waybill data based on origin railroad, car type, and the car ownership flag. Table A.1 represents averaged empty return ratios for all cars ownerships - railroad, private, and leased. For a car ownership flag in the STB Waybill of "railroad" or "Trailer Train," specific ratios for railroad-owned cars were used. For a car ownership flag of "private," the privately owned car ratios were used. When the loaded car originated on a Class I carrier, the ratios for that carrier were applied. When a short line or regional railroad originated the load, the empty ratio was based on the East or West average, depending on whether the load originated east or west of the Mississippi River.

The carloads and intermodal units in the Waybill Sample were multiplied by the appropriate empty return ratio, reverse routed to represent the return movement from destination to origin, and then appended to the loaded cars in the Waybill. The assumption of reverse routing of the empties does not accurately reflect railroad operations, but it does place the correct amount of empty car miles on the network and it offers a reasonable approximation for this analysis.

²⁴The Waybill Sample is expanded to represent 100 percent of the movements on U.S. railroads.

Table A.1 Empty Return Ratios Used in the STB's URCS Phase 3 and Waybill Costing Programs
All Cars, 2005 Ratios

URCS CT Number	Car Type	BNSF	CN (U.S.)	CP (U.S.)	CSX	KCS	NS	UP	East	West
1	Box - 40-foot	133	172	175	159	152	172	138	165	138
2	Box - 50-foot	133	172	175	159	152	172	138	165	138
3	Box - Equipped	169	189	186	187	176	199	176	192	174
4	Gondola - Plain	196	186	231	194	197	191	236	192	226
5	Gondola - Equipped	185	211	198	183	200	189	189	186	188
6	Hopper - Covered	177	198	182	194	202	204	201	199	190
7	Hopper - Open Top General	194	192	214	195	194	196	209	195	205
8	Hopper - Open Top Special	196	203	211	195	200	201	213	198	209
9	Reefer - Mechanical	173	173	136	177	151	193	175	179	174
10	Reefer - Nonmechanical	158	235	188	193	542	181	186	190	172
11	Flat - Intermodal	115	118	110	115	105	109	115	112	115
12	Flat - Multilevel	127	145	138	154	119	159	145	155	141
13	Flat - General	241	247	224	179	194	266	201	229	216
14	Flat - Other	174	203	194	184	190	205	188	195	182
15	Tank < 22,000 Gallons	147	170	616	197	201	201	208	198	180
16	Tank >= 22,000 Gallons	154	188	230	201	206	203	204	202	183
17	All Other Freight Cars	134	170	256	194	204	152	203	169	159
18	Average Freight Car	151	185	159	175	183	170	182	174	169

Note Empty Return Ratio defined as total miles divided by loaded miles. Ratios in spreadsheet are available to six significant digits - only three shown above. Ratios for 40-foot Box Cars use same value as 50-foot Box Car as a default. URCS Phase 3 and Waybill costing use ratios for All Other Freight Cars as defaults for railroad-owned tank cars.

Source AAR, from the Uniform Rail Costing System

Annual cars were then converted into average daily cars. This was done by first summarizing the Waybill Sample by waybill date and number of cars. The volume from the day representing the 85th percentile (based on volume of cars) was used to scale the annual volume to a daily volume. The 85th percentile threshold is consistent with highway capacity analysis methods.²⁵ This multiplier to convert annual cars and intermodal units in the Waybill Sample to an 85th percentile day was 0.00357. An 85th percentile day has 9.9 percent more cars than a 50th percentile day in the 2005 Waybill Sample.

The cars were subdivided into four service types – intermodal, bulk, general merchandise, and auto – the same four defined in the Waybill Sample. For each service type, the number of daily cars was converted into daily trains based on average train lengths supplied by BNSF, CSX, NS and UP. For the other railroads, CS estimated the train lengths. Table A.2 contains the average values used for eastern and western railroads. Intermodal unit train conversions were based on TOFC/COFC counts rather than cars. Adjustments were made in some corridors (e.g., Powder River Basin) to reflect actual operations of significantly longer trains.

**Table A.2 Average Train Length
Number of Cars**

Type of Service	Eastern Railroads	Western Railroads
Auto	57.0	63.9
Bulk	86.0	112.4
General Merchandise	82.0	80.7
Intermodal (TOFC/COFC count)	110.7	164.3

Source: Class I Railroad data averaged by Cambridge Systematics, Inc.

The next step was to unlink the trips. The Waybill Sample has records with a junction frequency up to six, indicating that seven railroads participated in the move (six junctions). The unlinked records break these apart so that each “trip” is only for a single railroad. The geographic endpoints of the trip can either be the origin and destination, or the junction location. These are generically referred to as the on-point and off-point. The Waybill does not have information on internal routings and classifications on an individual railroad.

The final step was to assign the train estimates to the ORNL rail network, using an all or nothing assignment in TransCAD. After combining the freight and

²⁵This method of scaling the annual volume based on the 85th percentile is preferred over simply selecting the traffic on the day representing the 85th percentile. Scaling the annual volume will provide a more robust distribution of traffic over the rail lines that accounts for seasonality, instead of a snapshot of traffic for a single day.

passenger trains (see next section), density maps were developed and provided to BNSF, CSX, NS, and UP for review. The AAR reviewed the traffic density maps for CN, CP, and KCS. Corrections were made to the assignments and volumes when needed, and new maps were generated for further review.

As in all cases with this study, care was taken not to distribute confidential data about one railroad to the other railroads. Only the AAR and CS had access to the full information.

Establish the Current Number of Passenger Trains per Day

In addition to the total number of freight trains, the number of passenger trains operating on the network was determined. This includes estimates of Amtrak service, and commuter services such as the Virginia Railway Express and the Southeastern Pennsylvania Transportation Agency that make significant use of freight railroad lines. Not every commuter service was included, only those operating on the primary corridor network.

Most of the train information was obtained from available published schedules. Although the term "train" is used, it should more appropriately be called a "trip." A train that goes out and back was counted as two "trains." An average day was considered to be a weekday, not a weekend or holiday.

The passenger train estimates were assigned directly to the ORNL rail network using TransCAD, rather than applying a traffic assignment algorithm. Passenger train maps were generated and distributed to the study participants for review and comment.

The final step was to add the daily passenger train counts directly to the freight trains that had been assigned to the network.

Establish the Forecasted Number of Train Equivalents Operating Along Each Corridor for the Year 2035

The U.S. Department of Transportation's Freight Analysis Framework Version 2.2 (FAF^{2.2}) provides an estimate of all freight traffic moving in the U.S. by origin, destination, commodity, and mode. It has a 2002 base year and forecasts from 2010 to 2035 in five-year increments. The geography is based on 138 zones, with 114 zones in the U.S. It includes domestic traffic, North American traffic (Canada and Mexico border crossings, with the gateway location), and international traffic (by foreign region and U.S. zone, with an intermediate port). FAF^{2.2} contains seven different modes of transportation: air and truck, other intermodal, pipeline and unknown, rail, truck, truck-rail, and water.

CS used the FAF^{2.2} forecasts for 2035 for the rail and truck-rail modes by origin, destination, and commodity. The rail and truck-rail modes were combined into a single set of forecasts rates. The Waybill data was geographically matched to the FAF^{2.2} zones by using a translation table mapping county to zone. Since the Waybill "starts" and "stops" trips at ports, the international forecasts were

included in the forecast rates based on the location of the port. For example, a move from Europe to the Atlanta zone with a port of Charleston, was considered a Charleston – Atlanta move and the forecasts rates were blended with the domestic forecast rates for other Charleston – Atlanta traffic by commodity. Rates by commodity for both Canadian and Mexican traffic were developed, and applied to Waybill data originating or terminating in those countries.

FAF²² uses Standard Classification of Transported Goods (SCTG) codes. CS developed weighted averages of the forecast growth rates to establish growth factors for the general merchandise, intermodal, bulk and auto service types, based on the assignments in Table A.3. Weighted forecast growth rates for each service type were calculated for each FAF²² origin-destination zone.

Table A.3 FAF²² Commodity Assignment to Rail Service Type for Establishing Forecast Growth Rates

Auto	Bulk	Intermodal	Merchandise
Motorized vehicles	- Animal feed - Cereal grains - Coal - Coal-n e c - Metallic ores - Gravel - Nonmetallic minerals	- Alcoholic beverages - Electronics - Furniture - Machinery - Meat/seafood - Miscellaneous manufactured products - Mixed freight - Pharmaceuticals - Plastics/rubber - Precision instruments - Printed products - Textiles/leather - Tobacco products - Transport equipment	- Articles-base metal - Base metals - Basic chemicals - Building stone - Chemical products - Crude petroleum - Fertilizers - Fuel oils - Gasoline - Live animals/fish - Logs - Milled grain products - Natural sands - Nonmetal mineral products - Other agriculture products - Other foodstuffs - Unknown - Waste/scrap - Wood products - Newsprint/paper - Paper articles

The 2035 forecast growth rates were applied to the 2005 base-year loaded and empty cars by FAF²² origin-destination zone and railroad service type. (The rates were adjusted to reflect the difference between the FAF²² 2002 base year the Waybill 2005 survey year) This makes the assumption that empty return ratios will be the same in 2035 as they were in 2005. For empty cars, the forecast rate was based on the last commodity hauled. The forecast number of loaded and empty cars were converted into average trains per day, using the same conversion factors established for the 2005 data (i.e., average train lengths were held constant).

The number of passenger trains was held at current levels. This study did not attempt to forecast 2035 passenger rail demand and service. A separate study is being conducted to develop passenger rail needs for presentation to the Commission.

The forecasted 2035 freight trains were then assigned to the ORNL rail network using an all or nothing assignment based on minimum distances, adjusted to reflect current rail road operating restrictions validated against existing volumes. Current passenger trains were added directly to the network to provide the complete 2035 year volumes. The results were mapped and sent to the railroads for review.

Estimate the Current Capacity for Each of the Primary Corridors

The capacity of the primary rail corridors was determined by defining a set of archetypical corridors, based on track and type of control, and then defining the capacity in terms of trains per day. Readily available information was supplied by the railroads participating in this study drawing from previously performed simulation studies. The information ranged from generic data to simulation results of specific corridors and general knowledge of operations.

CS used this information to identify a set of archetypical corridors that represented the various track and control combinations present along the corridors. The number of tracks was 1, 2, 3, or 4 and the type of controls included no signal or track warrant control (N/S-TWC), automated block signal (ABS), and centralized traffic control or train control system (CTC-TCS). To accommodate future demand, archetypical corridors of 5 and 6 tracks were added.

Comparison of the capacity information from each railroad yielded a range of values. One reason for this range was the mix of trains on the line. Lines with a nearly homogenous train mix have a higher capacity than lines with a mixture of train types. To adjust for this, each archetype was assigned a lower and an upper bound for the maximum number of trains. The lower bound was defined as the maximum number of trains per day, assuming an equal mix of merchandise-bulk, intermodal-auto, and passenger trains (one-third each). The upper bound was defined as the maximum number of trains per day, assuming 100 percent one type, and 0 percent of the other two types (complete homogeneity). To move between the lower bound and the upper bound, the standard deviation of the

train mix was used to scale the range between the bounds. For a train mix of 33 percent, 33 percent, and 33 percent for each of the three types, the standard deviation is zero; therefore a zero adjustment is added to the lower bound. A train mix of 100 percent, 0 percent, and 0 percent yields a standard deviation of 0.47, which was scaled to produce a factor that added to the lower bound equaled the upper bound.^{2a} A standard deviation falling between the minimum of zero and the maximum of 0.47 produced a capacity somewhere between the lower and upper bounds. Table A.4 contains the archetypes used in this study, along with the lower and upper capacity bounds.

Another reason for differences in capacity is due to differences in geography and topography. For similar types of track, a region with longer runs and greater distances between urban areas can achieve higher speeds and greater throughput than areas with short runs and more closely spaced urban areas. Therefore, different capacity tables were developed based on regional variations. Table A.4 contains the average lower and upper maximum capacity bounds for the archetypes used in this study.

Rail capacity can take two forms. The "theoretical capacity" is the maximum number of trains assuming perfect conditions. The "practical capacity" considers factors such as possible disruptions, maintenance, human decisions, weather, possible equipment failures, supply and demand imbalances, and seasonal demand. Practical capacity is about 70 percent of the theoretical capacity and provides reliable service; it is similar to a highway level of service of C or D (described in the next section). At higher percentages, rail congestion increases and service reliability begins to deteriorate. The values established in Table A.4 represent practical capacity.

Using the number of tracks and the control system information from the ORNL rail network, CS developed a series of maps of track characteristics that were reviewed by the railroads. The track characteristics information was updated using feedback from the railroads, and then each of the primary rail corridors was assigned to one of the archetypes in Table A.4. Using the capacity for each archetype, and adjusting between the lower and upper bounds based on the standard deviation of the train mix, a practical capacity in trains per day was assigned to each of the primary corridors.

^{2a}The population standard deviation, not the sample standard deviation, was used since the three data points representing the percent mix of merchandise/bulk, intermodal/auto, and passenger encompasses the entire population.

Table A.4 Average Capacities of Archetypical Rail Corridors
Trains per Day

Number of Tracks	Type of Control	Trains per Day	
		Practical Maximum If Multiple Train Types Use Corridor*	Practical Maximum If Single Train Type Uses Corridor**
1	N/S or TWC	16	20
1	ABS	18	25
2	N/S or TWC	28	35
1	CTC or TCS	30	48
2	ABS	53	80
2	CTC or TCS	75	100
3	CTC or TCS	133	163
4	CTC or TCS	173	230
5	CTC or TCS	248	340
6	CTC or TCS	360	415

Key N/S-TWC – No Signal/Track Warrant Control
ABS – Automatic Block Signaling
CTC-TCS – Centralized Traffic Control/Traffic Control System

Notes * For example, a mix of merchandise, intermodal, and passenger trains.
** For example, all intermodal trains

Source. Class I railroads' data aggregated by Cambridge Systematics, Inc

Compare the 2005 and 2035 Train Volumes to the Current Capacity, and Identify the Types of Improvements Needed to Maintain Reliable Rail Service in 2035

Current corridor volumes were compared to current corridor capacity to assess congestion levels. This was done by calculating a volume-to-capacity ratio expressed as a level of service (LOS) grade. The LOS grades are listed in Table A.5. The LOS designations and descriptions correspond to the LOS designations used in highway system capacity and investment requirements studies.

Table A.5 Volume-to-Capacity Ratios and Level of Service (LOS) Grades

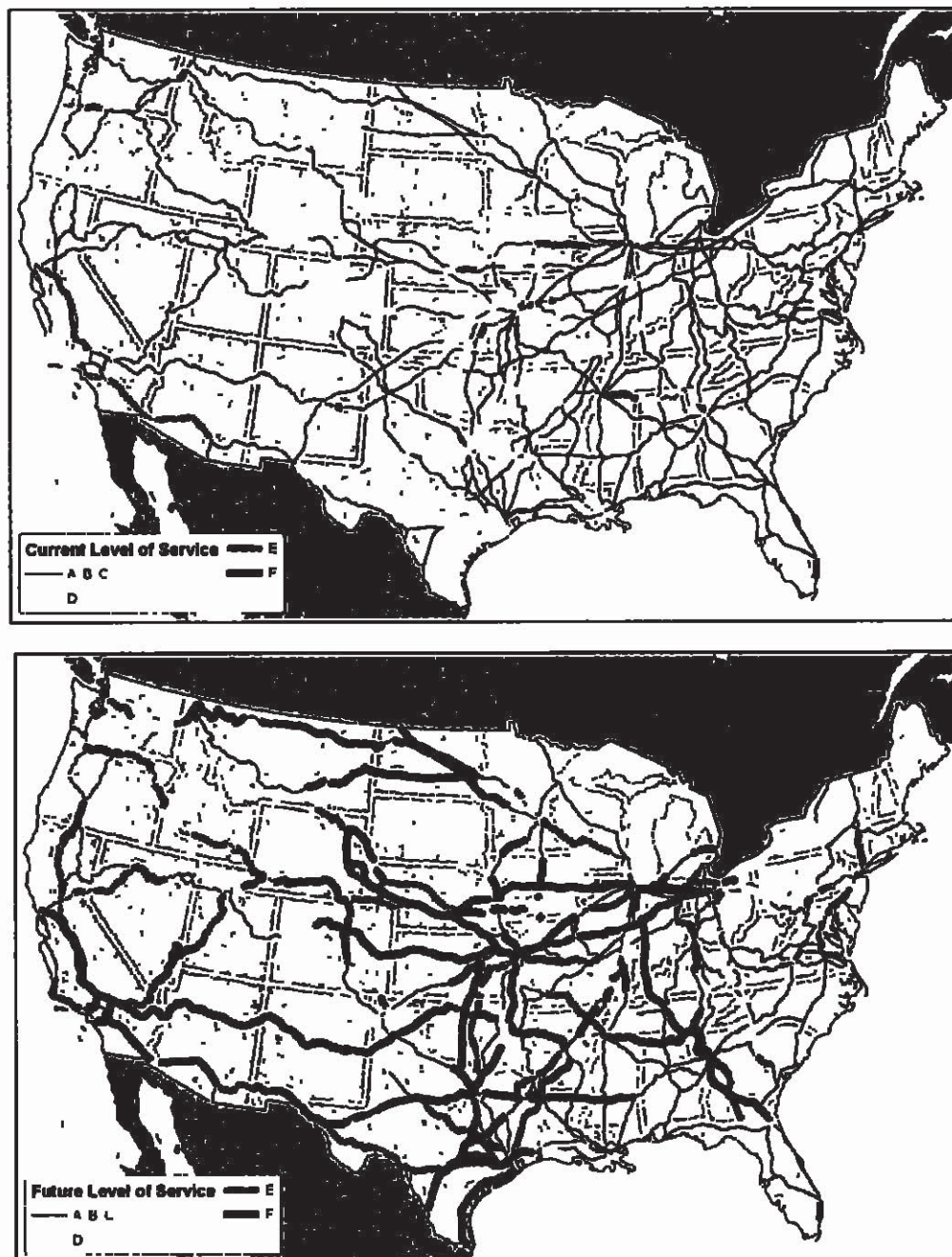
LOS Grade	Description	Volume/Capacity Ratio
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents
B		0.0 to 0.2
C		0.2 to 0.4
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents
E	At Capacity	Very heavy train flow with very limited capacity to accommodate maintenance and recover from incidents
F	Above Capacity	Unstable flows, service break-down conditions
		0.4 to 0.7
		0.7 to 0.8
		0.8 to 1.0
		> 1.00

Source: Cambridge Systematics, Inc.

Rail corridors operating at LOS A, B or C are operating below capacity; they carry light to moderate train flows with sufficient unused capacity to accommodate maintenance work and recover quickly from incidents such as weather delays, equipment failures, and minor accidents. Corridors operating at LOS D are operating near capacity; they carry heavy train flows with moderate capacity to accommodate maintenance and recover from incidents. Corridors operating at LOS E are operating at capacity; they carry very heavy train flows and have very limited capacity to accommodate maintenance and recover from incidents without substantial service delays. Corridors operating at LOS F are operating above capacity; train flows are unstable, and congestion and service delays are persistent and substantial. The LOS grades and descriptions correspond generally to the LOS grades used in highway system capacity and investment requirements studies.

Maps of the volume-to-capacity ratios, expressed as LOS classes, for the primary rail corridors are shown in Figure A.2. Rail corridors operating under capacity (at LOS A, B, or C) have been mapped in green, corridors operating near capacity (LOS D) have been mapped in yellow, rail corridors operating at capacity (LOS E) have been mapped in orange, and rail corridors operating over capacity (LOS F) have been mapped in red. Current volumes are those reported in the 2005 STB Waybill Sample (factored for empties and using an 85th percentile day). These volumes do not reflect fully recent trends, such as the increase in coal shipments moving from the Powder River Basin in Wyoming and Montana to Eastern utilities, nor the recent increase in intermodal containers delivered to East Coast marine ports and transferred to rail for inland delivery. Current capacity is the capacity as of 2007, and does not represent planned expansion.

Figure A.2 2005 and 2035 Train Volumes Compared to Current Train Capacity



Source Cambridge Systematics, Inc

Rail capacity line expansion improvements were estimated by identifying the upgrades to current capacity needed to accommodate future train volumes. To avoid double-counting improvements that are currently programmed or

underway, new improvements were selected to accommodate only forecast demand, not to correct current capacity shortfalls. If a corridor is below capacity today and needs additional capacity to accommodate future demand, improvements were selected to bring the volume-to-capacity ratio up to a maximum of 0.70. If a corridor is at or above capacity today and needs additional capacity to accommodate future demand, improvements were programmed to bring the volume-to-capacity ratio back to the current ratio. For example, if the current volume-to-capacity ratio of a corridor is 0.85 and the future volume-to-capacity ratio without improvements is estimated to be 1.6, improvements were made to bring the volume-to-capacity ratio back to 0.85, not to 0.70.

The hierarchy of corridor upgrades is shown in Table A.6. This hierarchy was used to expand from one archetypical corridor to another, until the capacity of the corridor could accommodate the forecasted 2035 volumes at a LOS of C or at current LOS if already operating at LOS D, E, or F. For example, if a corridor with "one track and N/S-TWC control" that today accommodates 16 to 20 trains per day needs to accommodate 35 trains per day in 2035, it would be upgraded to "one track with CTC-TCS control." As a rule, upgrades were selected to provide the appropriate level of service at the least cost. For the primary corridors under consideration, it was determined that any new construction would at a minimum involve a one-track CTC system (e.g., no expansion of lines operating on track warrants or with ABS on the primary corridors).

Table A.6 Hierarchy of Archetypical Rail-Freight Corridors
Practical Capacity in Trains per Day

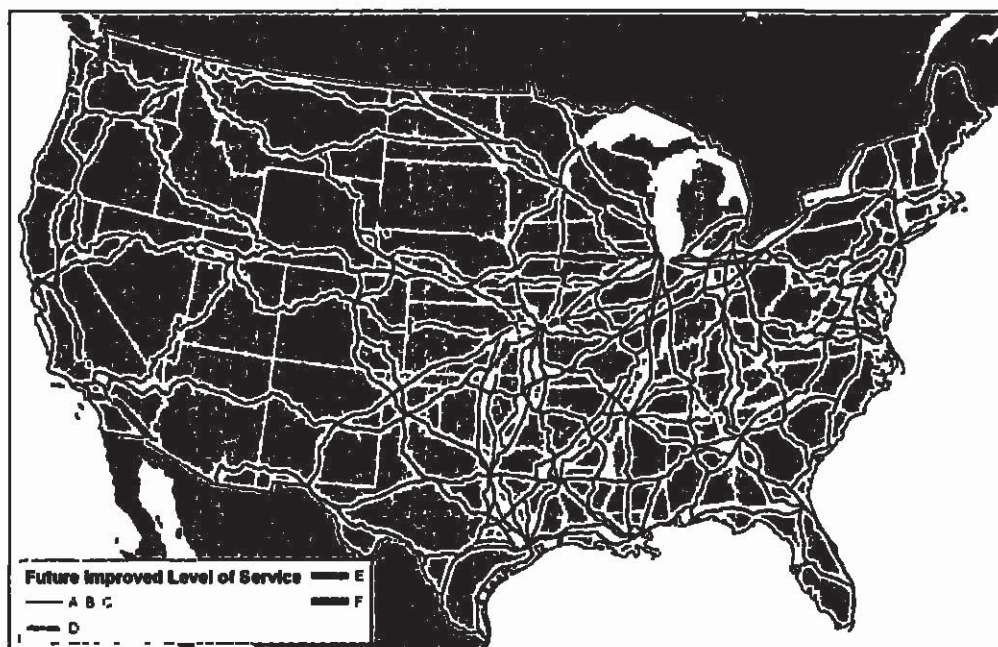
From				To			
Number of Tracks	Control	Lower Bound	Upper Bound	Number of Tracks	Control	Lower Bound	Upper Bound
1	NS-TWC	16	20	1	CTC-TCS	30	48
2	NS-TWC	28	35	2	CTC-TCS	75	100
1	ABS	18	25	1	CTC-TCS	30	48
2	ABS	53	80	2	CTC-TCS	75	100
1	CTC-TCS	30	48	2	CTC-TCS	75	100
2	CTC-TCS	75	100	3	CTC-TCS	133	163
3	CTC-TCS	133	163	4	CTC-TCS	173	230
4	CTC-TCS	173	230	5	CTC-TCS	248	340
5	CTC-TCS	248	340	6	CTC-TCS	360	415

Source: Class I railroads' data aggregated by Cambridge Systematics, Inc.

Note: N/S-TWC is No Signal and Track Warrant Control. ABS is Automatic Block Signaling. CTC-TCS is Centralized Traffic Control and Traffic Control System.

Figure A.3 compares future corridor volumes in trains per day to future corridor capacity assuming the necessary improvements are made. The volume-to-capacity ratios are expressed as LOS classes for each primary rail corridor. This map should look similar to the 2005 map in Figure A.2, since the goal was not to improve a corridor beyond the current level of service. This is not entirely possible due to the step-function nature of adding capacity. Adding an additional track can cause the LOS to drop several levels.

**Figure A.3 Future Train Volumes Compared to Future Train Capacity
2035 with Improvements**



Source: Cambridge Systematics, Inc.

Estimate the Construction Costs of the Improvement Lines

The costs to upgrade from one level of corridor capacity to another are listed in Table A.7. The costs are in unit costs per mile for construction. All costs are reported in current (2007) dollars. In the example cited above, upgrading a corridor from "one track and N/S-TWC control" to "one track with CTC-TCS control" would cost \$700,000 per mile for construction. This is inclusive of design, engineering, and installation expenses. It is exclusive of any real estate costs.

Table A.7 presents average costs for typical rail freight corridors. The actual costs of the corridors were estimated using railroad-specific capacity tables. Per mile construction costs for Eastern rail corridors were about 25 percent higher than the averages presented in the table because of the number of urbanized areas, hilly terrain, and numerous river crossings. At the request of the railroads, the railroad-specific cost tables were not included in this report to protect confidential railroad business information.

**Table A.7 Hierarchy of Archetypical Rail-Freight Corridors
Unit Cost to Upgrade Lines**

From		To		Average Construction Cost Per Mile
Number of Tracks	Control	Number of Tracks	Control	
1	NS-TWC	1	CTC-TCS	\$700,000
2	NS-TWC	2	CTC-TCS	\$700,000
1	ABS	1	CTC-TCS	\$500,000
2	ABS	2	CTC-TCS	\$600,000
1	CTC-TCS	2	CTC-TCS	\$3,800,000
2	CTC-TCS	3	CTC-TCS	\$4,400,000
3	CTC-TCS	4	CTC-TCS	\$4,400,000
4	CTC-TCS	5	CTC-TCS	\$4,400,000
5	CTC-TCS	6	CTC-TCS	\$4,400,000

Source AAR and Class I railroads' data aggregated by Cambridge Systematics, Inc

The costs in Table A.7 are additive. To expand from a one track CTC to a three track CTC would cost \$8.2 million per mile (\$3.8 million plus \$4.4 million). The lower cost to go from one to two tracks (as opposed to 2 to 3 and 3 to 4) reflects cost savings from connecting existing sidings, less need to upgrade drainage, and other savings. The costs to maintain this additional track is not included in the total.

Estimate the Cost of Significant Bridges, Tunnels, Clearance Projects, etc.

Significant projects that are well outside the average unit cost in Table A 7, such as bridges spanning the Mississippi or Ohio River or expensive new or expanded tunnels and clearances, were included as additional costs in this study. The railroads, using maps provided by CS of where and how much capacity would be needed in 2035, individually provided estimates for significant structures.

It should be noted that these estimates are not based on detailed engineering studies, and therefore only provide a rough approximation. In most cases, the estimates were based on averages ranging from \$200 to \$300 million per structure. A detailed list of these projects is not contained in the report, since the cost estimates are average and should not be attributed to a specific project.

A significant structures cost estimate was developed for CN, CP, and KCS by prorating the total significant structures cost by the ratio of the line haul expansion cost for these three railroads to the total line haul expansion cost.

Estimate the Cost to Upgrade Class I Branch Lines and Short Line and Regional Railroad Lines Currently Below 286,000-Pound Standards to Current Standards

The American Short Line and Regional Railroad Association (ASLRRA) released a report in 2000 that identified \$6.9 billion in costs (1999 dollars) to upgrade the track of America's short line and regional railroads to accommodate the current standard weight of 286,000-pounds. This estimate was updated as part of this study. The update involved:

- The cost was inflated to represent 2007 dollars based on a construction price index developed from the U.S. Bureau of Labor statistics. This raised the cost from \$6.9 billion to \$10.8 billion.
- The cost of upgrading bridges was removed, and an ASLRRA provided estimate of \$5 billion was included as a significant structures costs for short line and regional railroads.
- The AAR provided an estimate 898 route miles that has been upgraded between 2004 and 2007, an average of 299 miles per year. Using this ratio, an estimate of 2,395 miles were assumed to be upgraded to 286,000-pound standards between 1999 and 2007.
- The inflated cost to upgrade was reduced to reflect track already upgraded.

The final estimate for upgrading short line and regional railroad track to accommodate 286,000-pound loads is \$7.2 billion (in 2007 dollars). The calculations are contained in Table A.8.

For the Class I railroad's branch lines, an average cost to upgrade was calculated at \$300,000 per mile using the revised estimates from the ASLRRA. The miles of track not 286,000-pound ready was provided by BNSF, CSXT, NS, and UP. For CN, CP, and KCS, the estimated cost was prorated from the ratio of line expansion costs for those three railroads to the total line expansion costs.

Table A.8 Estimation of Cost to Upgrade Short Line and Regional Railroads to 286,000-Pound Weight Standard

Year	Inflation	Cost (Millions)	Cost Less Bridges (Millions)	Total Miles	Miles/Year Upgraded (2005 to 2007)	Estimated Miles Upgraded (1999 to 2007)	Assume 50 Percent Not 286,000- Ready (2007)	Estimated Percent Upgraded Since 1999	Estimated Cost to Upgrade (Millions)	Cost/Mile to Use for Class I (Millions)
1999	N/A	\$6,861	\$5,100	49,985	N/A	N/A	N/A	N/A	N/A	N/A
2007	0.575	\$10,806	\$8,033	48,194	299	2,395	24,097	9.94%	\$7,234	\$0.300

Source 1999 Information from ASLRRRA An Estimation of the Investment in Track and Structures Needed to Handle 286,000-pound Rail Cars

Note Assumption of 50 percent not 286,000 ready provided by AAR Based on 22,256 miles (46 percent) not 286,000 ready in 2004 less 898 miles upgraded between 2004 and 2007 Exact percentage unavailable since 10 percent of track has unknown weight limit

A.3 INTERMODAL AND CARLOAD TERMINALS, AND SERVICE FACILITY CAPACITY EXPANSION

The work steps to estimate the cost of expanding terminal and facility capacity necessary for the Class I railroads to meet U.S. DOT projected demand was as follows:

- Expansion of capacity at Class I railroad-owned intermodal facilities, including terminals, ports and gateways,
- Expansion of capacity at carload terminals, and
- Expansion of capacity at Class I railroad-owned service (e.g., fueling stations, maintenance facilities)

Expand Capacity at Class I Railroad-Owned Intermodal Facilities, Including Terminals, Ports and Gateways

The cost of expanding intermodal facilities, whether they are intermodal yards, railroad-owned port facilities, or international gateways, was provided by the railroads. CS provided to each study participant a table of on-point and off-point volumes by county and railroad service type for 2005 and 2035. The railroads individually provided cost estimates for expanding the largest and most important intermodal facilities to accommodate the projected growth between 2005 and 2035. Consistent with other parts of this study, real estate costs were excluded.

It should be noted that these estimates are not based on detailed engineering studies, and therefore only provide a rough approximation. A detailed list of these projects is not contained in the report, since the cost estimates are average and should not be attributed to a specific project.

An intermodal facility cost estimate was developed for CN, CP, and KCS by prorating the total intermodal facility expansion cost by the ratio of the line haul expansion cost for these three railroads to the total line haul expansion cost.

Additional maintenance costs for these new and expanded intermodal facilities are not included.

Expand Capacity at Carload Terminals

The cost of expanding carload facilities (e.g., classification yards) was provided by the railroads. CS provided to each study participant a table of on-point and off-point volumes by county and railroad service type for 2005 and 2035. The railroads individually provided cost estimates for expanding the largest and most important carload facilities to accommodate the projected growth between 2005 and 2035. Consistent with other parts of this study, real estate costs were excluded.

It should be noted that these estimates are not based on detailed engineering studies, and therefore only provide a rough approximation. A detailed list of these projects is not contained in the report, since the cost estimates are average and should not be attributed to a specific project

A carload facility cost estimate was developed for CN, CP, and KCS by prorating the total carload facility expansion cost by the ratio of the line haul expansion cost for these three railroads to the total line haul expansion cost

Additional maintenance costs for these new and expanded carload facilities are not included

Expand Capacity at Class I Railroad-Owned Service Facilities

The cost of expanding service facilities (e.g., fueling, car shops) was provided by the railroads. CS provided to each study participant a table of on-point and off-point volumes by county and railroad service type for 2005 and 2035, and a series of maps showing traffic volumes by corridor for 2035. The railroads individually provided costs estimates for expanding service facilities to accommodate the projected growth between 2005 and 2035. Consistent with other parts of this study, real estate costs were excluded.

It should be noted that these estimates are not based on detailed engineering studies, and therefore only provide a rough approximation. A detailed list of these projects is not contained in the report, since the cost estimates are average and should not be attributed to a specific project

A service facility cost estimate was developed for CN, CP, and KCS by prorating the total service facility expansion cost by the ratio of the line haul expansion cost for these three railroads to the total line haul expansion cost.

Additional maintenance costs for these new and expanded service facilities are not included