APPENDIX P

BENEFIT-COST ANALYSIS

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CHICAGO TO COUNCIL BLUFFS - OMAHA

HIGH-SPEED INTERCITY PASSENGER RAIL (HSIPR) PROGRAM

BENEFIT-COST ANALYSIS OF THE CHICAGO TO COUNCIL BLUFFS-OMAHA HIGH-SPEED INTERCITY PASSENGER RAIL PROGRAM

APRIL 16, 2013

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1 Project Overview

The Iowa Department of Transportation (IowaDOT), in conjunction with the Federal Railroad Administration (FRA), is evaluating alternatives for the expansion of High-Speed Intercity Passenger Rail (HSIPR) service from Chicago, IL to Council Bluffs, IA and Omaha, NE. The FRA has agreed to a phased implementation approach for the Chicago to Iowa City corridor. Illinois DOT is proceeding with the Tier 2 studies for the portion of the corridor extending from Chicago to Quad Cities with a terminus in Moline, IL. While the Chicago to Iowa City and Chicago to Council Bluffs-Omaha service may use the same corridor, there may be different levels of service on the corridor and as a result a separate Cost-Benefit Analysis is required to evaluate potential impacts. The Chicago to Council Bluffs-Omaha corridor project is expected to be constructed in five phases as shown in Table 1.

Table 1. Chicago to Council Bluffs – Omaha Project Construction, Level of Service, and Ridership Forecasts

Phase	Construction Start Year	Construction End Year	Opening Year	Round Trips Per Day	Initial Ridership (In Opening Year)
Phase 1 - Chicago to Moline (Base Case)	2014	2015	2015	2	120,009
Phase 2 - Chicago to Iowa City (Build Case)	2015	2016	2017	2	186,109
Phase 3 - Chicago to Des Moines (Build Case)	2020	2021	2022	2	346,973
Phase 4 - Chicago to Des Moines (Build Case)	2024	2024	2025	4	547,624
Phase 5 - Chicago to Council Bluffs (Build Case)	2028	2029	2030	4	737,492

2 Cost Benefit Analysis (CBA) Framework

The Cost Benefit Analysis (CBA) framework is a comparison of values – the cost to build and operate the HSIPR measured as the forgone value of the investment in the project (which could alternatively be directed elsewhere) and the benefits of the project, assessed as the improvement in social welfare due to the project. To be deemed economically feasible, projects must pass one or more value benchmarks: the total benefits must exceed the total costs of the project on a present value basis and/or the rate of return on the funds invested should exceed the cost of raising capital, often defined as the long-term treasury rate or the social discount rate.

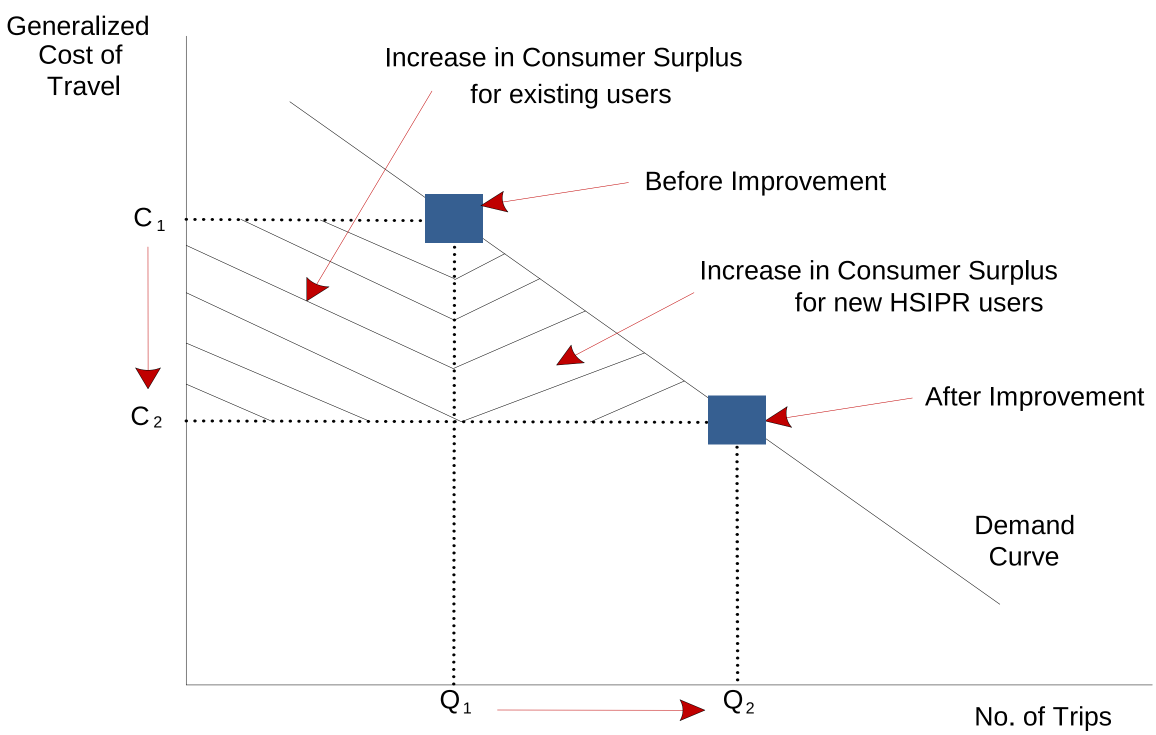
Benefits are estimated for current and future users on an incremental basis - as the change in welfare that consumers and, more generally, society derive from the access to the new passenger rail service in comparison to an estimated 'no build' situation. As with most transportation projects, the benefits derived from implementation are actually a reduction in the costs associated with transportation activities. However, the reduction of costs due to the rail service affects users differently depending on their preferences and the way the project changes their specific transportation options and costs. These cost reductions may come in the form of time saved by users, travel cost savings, reduced costs of unreliability, reduction of pollution and accidents, or more generally, a combination of these effects.

In general, benefits primarily represent the creation of economic value from changes in the quantity of final uses and the quality (time spent, reliability, among other factors) of the services provided to affected travelers.

3 Methodology

In general, the economic benefits of transportation investments can be illustrated with a simple graph relating the generalized cost of travel to the demand for travel. The demand for travel is measured as the total number of trips per time period, while the generalized cost of travel includes the value of travel time under different service levels, the costs of unreliability, and any out-of-pocket expenses such as fares for transit (for car users the generalized costs include fuel, oil and depreciation costs). This relationship, the travel demand curve, is illustrated in Figure 1, below.

Figure 1: The Demand for Travel and Consumer Surplus from Lowered Costs



The travel demand curve, in the diagram above where the number of trips is represented on the horizontal axis and the generalized cost of travel on the vertical axis, is downward sloping: as the generalized cost of travel decreases, the number of trips increases. Investment in new rail systems, or new routes, can be evaluated by estimating the change in the generalized price of travel brought about by the investment, and the associated change in trip making.

Riders on the improved HSIPR may experience travel time savings compared to their previous travel mode; or they can be motivated by changes in the comfort and reliability of the system, or reductions in their trip expenses. In addition, the availability of transportation at a more affordable price will encourage users to travel more, increasing the total number of trips.

Highway users will also benefit from the improved intercity passenger rail, or IPR, system, as trip diversion from auto to rail frees up some capacity on the highways. Benefits to highway users will include benefits to both existing and new highway users, as the reduction in highway congestion (due to trip diversion) reduces the generalized cost of highway travel (travel time, fuel and oil consumption, accident costs, etc.)

The benefits of the passenger rail service could therefore be evaluated by considering the travel cost savings accruing to travelers switching from other modes. This is accomplished using the consumer surplus methodology, which compares transportation costs per trip between the base case and the implementation case (see Figure 1).[1] The social cost of a trip on a congested road includes travel time, vehicle operating cost, safety cost, and emission costs.

The availability of rail service can result in social cost savings as well, benefits in addition to direct travel trip savings. These can include vehicle operating cost savings, emission cost savings, and accident cost savings. In compliance with the HSIPR application guidelines, the following sections discuss each category of benefits within the context of the evaluation criteria set forth by the HSIPR program.

4 Principles

The following principles guide the estimation of benefits and costs for this study:

- Only incremental benefits and costs are measured
    - Incremental in this situation means that only net additions in costs to the current situation will be considered. Any investments or operating costs required for the operation of the existing track are not considered costs associated with this project. The Chicago to Council Bluffs-Omaha project consists of five phases. It is assumed that Phase 1 is included in the Base Case for the purposes of the evaluation, since it will occur with or without the extension to Council Bluffs. Additional ridership, capital cost, and operating costs incurred from Phases 2-5 define the Build Case or Alternative Case against which the Base Case is evaluated.

[1] The consumer surplus in this case is estimated by valuing the cost saved for each trip – the difference between the new price and the old price.

- The incremental benefits of the project include the transportation cost savings for the users of the service as a result of the implementation of the transportation improvements.

- The incremental costs of implementation of the project include initial and recurring costs. Initial costs refer to the capital costs incurred for design and construction of a list of enhancements designed to increase the maximum speed limit on the existing tracks. Recurring costs include incremental operating costs, and additional administration and marketing expenses. Only additions in cost to the current operations and planned investments are considered as costs of the project.

- Benefits and costs are valued at their opportunity costs: The benefits stemming from the implementation of the transportation improvement are those above and beyond the benefits that could be obtained from the best existing transportation alternative. For instance, the transportation costs savings for users are measured relative to the next best existing option, which may be the highway or the existing bus service, depending on the type of user. The benefit is the net cost saving in transportation costs relative to the best alternative.

The costs of the project will only include those incremental costs that represent an opportunity costs to the funding entities. Expenditures are considered foregone opportunities to invest in the next-best alternative.

5 Guidance

U.S. Department of Transportation's (USDOT) Federal Railroad Administration (FRA) guidance (CFR Vol. 74 No. 119 Docket No. FRA-2009-0045) indicates three main assessment categories, 1) public return on investment, 2) project success factors and 3) other attributes.

Metrics for the measurement of the first category, public return on investment, include service reliability, schedule and capacity, and transportation in passenger miles, including diversion from other modes as well as induced ridership. Within this category, benefits are divided into three main evaluation criteria: transportation benefits, economic recovery benefits and other public benefits.

The transportation benefits criterion relates to improved intercity passenger rail service, as well as transportation network integration, including intermodal connections and transportation safety benefits. Meanwhile, economic recovery relates to preserving and creating jobs, particularly in economically distressed areas. The final criterion, other public benefits focuses on measuring environmental quality, energy efficiency and livable communities. Table 2 below summarizes benefits metrics.

In order to quantify the metrics listed, monetizing factors of project performance (e.g. accident costs per vehicle mile traveled (VMT)) are included in the analysis. However, in the absence of quantitative measures, other categories and measures of benefits are used, including qualitative assessments of potential benefits. Furthermore, in compliance with the Office of Management and Budget (OMB) circulars, A-4 and A -94, sensitivity analyses, for discount rates and other assumptions are conducted to provide for a complete perspective on the range of potential value for the project.

Table 2: Potential Benefits by Evaluation Criteria

Criteria	Criteria Description	Benefit Category
Transportation Benefits	Improved intercity passenger rail service, transportation network integration (including intermodal connections, transportation safety benefits)	User Cost Savings (existing and diverted riders) – Vehicle Operating Costs, Travel Time
		User Cost Savings to Remaining Roadway Users – Congestion Costs
		Improved Safety
		Pavement Maintenance Savings
Other Public Benefits	Environmental quality, energy efficiency; and livable communities	Reductions in Environmental Emissions and Noise Pollution Savings

All benefits and costs are estimated in 2013 dollars. The benefits are valued using a number of assumptions that are required to produce monetized values for all these non-pecuniary benefits. The different components of time, for instance, are monetized using a "value of time" assumed to be equivalent to the user's willingness to pay for time savings in transit. Premiums on the value of time are also considered in association with reliability, comfort and other characteristics associated with the quality of the trip. Other estimates used in the monetization of benefits include the cost of operating a vehicle, including maintenance, repair, and depreciation, and the cost per ton of pollution, among other elements. Assumptions and inputs are discussed in greater detail below.

6 General Assumptions

The methodology makes several important assumptions and seeks to avoid overestimation of benefits and underestimation of costs. Specifically:

- The methodology assumes that the number of users of the rail service will increase as a result of its implementation. In other words, the implementation of the project will result in induced demand, producing more riders in the system than the existing alternatives.

- Congestion relief benefits derived by current and future users of other transportation alternatives are accounted for in the analysis.

- Average improvements in welfare are estimated for those riders who are expected to switch from other modes of transportation. Welfare improvements are approximated by the change in the average generalized transportation cost for those who switch.

- Input prices are inflated to 2013 dollars.

7 Input Categories

Input values used in this analysis are taken from the United States Department of Transportation (USDOT) guidance on the preparation of Cost Benefit Analyses, including the published guidelines for the HSIPR program and TIGER Grant applications. Where USDOT has not provided valuation guidance or a reference to guidance, standard industry practice has been applied.

Estimates used in the monetization of benefits include the cost of operating a vehicle, including maintenance, repair, and depreciation. Table 3 below lists input variables used in this analysis, adjusted for 2013 dollars. As part of calculating diversion benefits the number of vehicles that would be taken off the road due to the improved rail service is calculated. The expected increase in ridership is used in conjunction with the average vehicle occupancy (1.6 persons/vehicle) to estimate the reduction in the number of vehicles.

Benefits resulting from the reduction in the number of vehicles are based on values for congestion cost, pavement maintenance, noise pollution as well as accident costs, all in dollars per vehicle miles. Internal costs include those for fuel, both for vehicles as well as train miles, in addition to estimates for fare per passenger mile as well vehicle operating cost per car mile.

Meanwhile, emission costs are expressed as dollars per ton and are based on the benefits associated with recently-adopted regulations that limit emissions of air pollutants from passenger cars.

Table 3: Input Variables used in the Cost Benefit Analysis

Parameter	Units	Values
General Assumptions		
Discount Rates	%	7% and 3%
Period of Study (life-cycle)	Years	2013 - 2037
Vehicle occupancy - normal (HSIPR)	Persons / Vehicle	1.6
External Costs - Vehicles		

Parameter	Units	Values
Congestion cost per vehicle mile	$ / Vehicle mile	0.09
Pavement maintenance cost per vehicle mile	$ / Vehicle mile	0.014
Noise pollution cost per vehicle mile	$ / Vehicle mile	0.003
Accident cost per vehicle mile	$ / Vehicle mile	0.08
Internal costs - Bus, Train, Air, Vehicle		
Fare per HSIPR passenger mile	$ / passenger mile	0.07 – 0.11
Vehicle operating cost per car mile	$ / Vehicle mile	0.46 – 0.50
Air Fare	$/one way	350 – 439
Bus Fare	$/one way	35 - 72
Average Daily Airport Parking	$/day	20
Value of time[2]		
Value of travel time (per hour) - Air	$ / Hour	45
Value of travel time (per hour) - Auto	$ / Hour	19
Value of travel time (per hour) - Bus	$ / Hour	19
Value of travel time (per hour) - HSIPR	$ / Hour	19
Emissions Costs per Ton		
NO_X	$ / ton	6,677
PM	$ / ton	365,646
VOC	$ / ton	1,636
CO_2	$/ton	28 – 56

8 Results

The benefits of the rail service are evaluated in this analysis based on the HSIPR funding evaluation criteria published in CFR Vol. 74 No. 119 Docket No. FRA-2009-0045. Additional guidance is provided in section D of the FRA application forms.

[2] Transportation Economics & Management Systems, Inc. 2004. Midwest Regional Rail Initiative Project Notebook. Note: HDR used the Illinois value of time (Exhibi 4-5; Page 4-9) and adjusted it from 2002 to 2009 dollars using the real increase in wages (Increase in Wages: BLS Series Id. CIS1020000000000I (C); Increase in Consumer Prices: BLS Series Id. CUSR0000SA0).

8.1 Operational and Ridership Benefits Metrics

Ridership estimates were developed for each of the five project phases. The ridership forecast values for the opening year of each project phase are shown in Table 1. It was assumed there would be an annual growth rate in ridership of 2.00% in subsequent years after opening.

Table 4 below shows the estimated average annual level of ridership for the HSR passenger service from Chicago to Council Bluffs over the 21 year analysis period. In addition, the table shows how many HSR passengers are diverted from other modes (auto, air and bus) or represent newly induced trips.

Table 4: Incremental Ridership by Source

	Value
Average Annual Level of HSR Ridership	505,439
Average Annual Trips Diverted from Auto	338,644
Average Annual Trips Diverted from Air Travel	5,054
Average Annual Trips Diverted from Bus	116,251
Average Annual Induced Trips	31,693

As a result of the above-mentioned diversion of trips from auto to HSIPR, Table 5 below shows the total amount of auto trips diverted throughout the study period and estimated average annual reduction in vehicle miles traveled (VMT). Induced trips are not included in these calculations, since induced users previously made no trips at all.

Table 5: VMT and Auto Reduction

	Value
Total Auto Trips Reduced	3,797,840
Average Annual vehicle miles traveled (VMT) Reduced	66,941,081

A result of the diversion from auto usage to the HSIPR, Table 6 below show the total VMT avoided over 21 years in addition to the pavement maintenance cost savings.

Table 6: VMT Reduction and Pavement Maintenance Savings

	Value
Total VMT Avoided	1,673,527,015
Pavement Maintenance Savings ($M)	$7.5

Note: Monetary values were discounted using a 7 percent rate.

In terms of Vehicle Operating Cost savings, Table 7 below illustrates the net Vehicle Operating Cost savings, in addition to the induced demand benefits for new HSIPR users. Induced demand benefits accrue to users who were not making the trip between Chicago and Council Bluffs using the available modes of transportation prior to the project, and are now using the rail service for the trip.

Table 7: Vehicle Operating Cost Net Savings to New Users and Induced Demand Benefits

	Value
Net Vehicle Operating Cost Savings ($M)	$254.5
Induced Demand Benefits ($M)	$0.0

Note: Monetary values were discounted using a 7 percent rate.

Benefits to remaining highway users include average annual VMT reduction, which results in a reduced cost of congestion and reduced accident costs (from fewer accidents). Table 7 below shows these benefits.

Table 7: Benefits to Remaining Highway Users and Safety Benefits

	Value
Average Annual VMT Reduced	66,941,081
Reduced Cost of Congestion ($M)	$46.0
Reduced Accident Costs ($M)	$40.2

Note: Monetary values were discounted using a 7 percent rate.

8.2 Environmental Benefits

Environmental benefits are calculated by: (1) estimating the reduction in vehicle emission from trips being diverted to rail; and, (2) estimating the increase in emission from introducing new passenger rail service. Table 8 indicates the total life-cycle emission reduction for the project.

Table 8: Environmental Reduction

	Value
Reduced Gallons of Fuel	7,261,530
Reduced NO_x Emissions (tons)	467
Reduced PM Emissions (tons)	20.1
Reduced VOC Emissions (tons)	533
Reduced CO_2 Emissions (tons)	676,862

Meanwhile, Table 9 below shows the net emission savings over the 21 year analysis period.

Table 9: Emission Cost Savings

	Value
Environmental Benefits ($M)	$12.1
NO_x Cost Savings ($M)	$1.0
PM Cost Savings ($M)	$2.3
VOC Cost Savings ($M)	$0.3
CO_2 Cost Savings ($M)	$8.5
Noise Emission Savings ($M)	$1.7

Note: Monetary values were discounted using a 7 percent rate.

8.3 Findings and Overall Results

The table below summarizes the CBA findings. Annual costs and benefits are computed over a long-run planning horizon and summarized over the life-cycle of the project. The project time horizon has a study period of 21 years used in the analysis. Construction is expected to be completed in phases as shown in Table 1, but operating costs continue through the whole horizon of the project. Benefits also accrue during the full operation of the project.

At a 7% discount rate, a $709 million investment (capital and O&M) results in fully $728 million of benefits. This yields a benefit to cost ratio of approximately 1.03. At a 3% discount rate, a $1,064 million investment (capital and O&M) results in fully $1,408 million of benefits. This yields a benefit to cost ratio of approximately 1.32.

Table 10: Overall Results of the Cost

CHI-OMA Benefit Cost Analysis Results	7% Discount Rate	3% Discount Rate	Undiscounted
Total Construction Capital Cost ($ millions)	$517	$711	$931
Average Annual O&M Cost ($ millions)	$8	$15	$25
Total O&M Cost ($ millions)	$192	$353	$581
Total Costs ($ millions)	$709	$1,064	$1,512
Total Benefits ($ millions)	$728	$1,408	$2,398
Benefit - Cost Ratio	**1.03**	**1.32**	**1.59**
Net Present Value ($ millions)	**$20**	**$344**	**$885**

Table 11: Detailed Results of the Cost Benefit Analysis

Summary of Primary Selection Criteria - Long Term Outcomes	7% Discount Rate	3% Discount Rate
Transportation Benefits		
Benefits to High Speed Rail Users		
Total Increased Ridership	7,394,977	7,394,977
Average Annual Increased Ridership	352,142	352,142
Average Annual Reduction in VMT	66,941,081	66,941,081
Transportation Cost Savings to New Users ($ millions)	$548.5	$1,066.1
Induced Demand Benefits ($ millions)	$0.0	$0.0
Revenues ($ millions)	$72.6	$136.4
Benefits to Traffic		
Congestion Cost Savings ($ millions)	$46.0	$87.8
Accident Cost Savings ($ millions)	$40.2	$76.8
Pavement Maintenance Savings ($ millions)	$7.5	$14.3
Economic Recovery Benefits		
Additional Employment (No. of Jobs)		
Direct Employment		
Indirect Employment		
Induced Employment		
Short-Term Employment Benefits ($ millions)		
Environmental Benefits		

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Summary of Primary Selection Criteria - Long Term Outcomes	7% Discount Rate	3% Discount Rate
Emissions Benefits		
Reduced Emissions (tons)	677,882	677,882
NOx	467	467
PM	20	20
VOC	533	533
CO2	676,862	676,862
Environmental Benefits ($ millions)	$12.0	$23.1
NOx	$1.0	$1.9
PM	$2.3	$4.3
VOC	$0.3	$0.5
CO2	$8.5	$16.4
Other Environmental Benefits		
Gallons of Gasoline Avoided	7,261,530	7,261,530
Noise Pollution Savings ($ million)	$1.7	$3.3
Benefit Cost Analysis Results		
Benefit Cost Analysis Results		
Total Discounted Benefits ($ millions)	$728.5	$1,407.8
Total Discounted Costs ($ millions)	$708.8	$1,063.8
Benefit - Cost Ratio	1.03	1.32
Net Present Value ($ millions)	$19.7	$344.0
Internal Rate of Return	7.43%	7.43%

9 Sensitivity Analysis

A sensitivity analysis was conducted to determine the impact a decrease or increase in forecasted ridership would have on the project Benefit-Cost Ratio and Net Present Value. The forecasted ridership was varied +/- 10% for each project phase. Tables 12 and 13 provide the sensitivity analysis results for a decrease and increase in forecasted ridership respectively. At a 10% decrease in forecasted ridership the project NPV becomes negative when evaluating at a 7% discount rate, while for a 10% increase in forecasted ridership the NPV increases from a value of $20 million to a value of $106 million when evaluating at a 7% discount rate.

Table 12: Sensitivity Analysis of 10% Decrease in Forecasted Ridership

CHI-OMA Benefit Cost Analysis Results	7% Discount Rate	3% Discount Rate	Undiscounted
Total Construction Capital Cost ($ millions)	$517	$711	$931
Average Annual O&M Cost ($ millions)	$8	$15	$25
Total O&M Cost ($ millions)	$192	$353	$581
Total Costs ($ millions)	$709	$1,064	$1,512
Total Benefits ($ millions)	$642	$1,244	$2,123
Benefit - Cost Ratio	**0.91**	**1.17**	**1.40**
Net Present Value ($ millions)	**-$67**	**$180**	**$611**

Table 13: Sensitivity Analysis of 10% Increase in Forecasted Ridership

CHI-OMA Benefit Cost Analysis Results	7% Discount Rate	3% Discount Rate	Undiscounted
Total Construction Capital Cost ($ millions)	$517	$711	$931
Average Annual O&M Cost ($ millions)	$8	$15	$25
Total O&M Cost ($ millions)	$192	$353	$581
Total Costs ($ millions)	$709	$1,064	$1,512
Total Benefits ($ millions)	$815	$1,571	$2,671
Benefit - Cost Ratio	**1.15**	**1.48**	**1.77**
Net Present Value ($ millions)	**$106**	**$507**	**$1,159**