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FUEL TAX REBATES FOR NEWLY TOLLED INTERSTATES: A QUANTITATIVE ASSESSMENT

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November 2021

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PART 1

INTRODUCTION

The Interstates, America's most important highways, are aging and most will need reconstruction and modernization over the next two decades. A growing number of states are considering toll-financed reconstruction, but over 90% of all Interstates are currently not tolled. Elected officials are wary of motorist and trucking industry resistance to "adding tolls to existing highways," even though a rebuilt Interstate costing several billion dollars would be a new highway, except for the right of way.

One way to address this problem would be for the state government to offer rebates of the fuel taxes attributable to the miles driven on the replacement Interstates, partly offsetting the cost of the new tolls. This would address the long-standing concern about "double taxation" on existing toll roads, in which highway users pay existing fuel taxes in addition to the tolls, even though the toll rates are intended to fully cover the capital and operating costs of the toll roads.

State departments of transportation (DOTs) may well be concerned about the loss of needed fuel tax revenue if they provide such fuel tax rebates. Due to ever-increasing federal corporate average fuel economy (CAFE) requirements on new vehicles and the growing market penetration of electric vehicles (EVs), state DOTs might oppose providing rebates, which would reduce the amount of state highway funds they have available to maintain and modernize their state highway systems.

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The purpose of this policy study is to assess the feasibility of providing fuel tax rebates for miles driven on reconstructed Interstates financed by toll revenues. To do this, the author built and analyzed a hypothetical but realistic model of a toll-financed rural Interstate reconstruction program that includes state fuel tax rebates. The final numbers compare the amount of state fuel tax revenues devoted to the rebates and the amount of toll revenue generated from the newly tolled corridors. The toll rates used were set so as to cover both the reconstruction and lane addition costs and the ongoing operating and maintenance costs of the rebuilt Interstates. Hence, in exchange for devoting a portion of its future fuel tax revenue to rebates, the state would no longer have to use any of its fuel tax money for the long-distance Interstate highways in its state. Their capital and operating costs going forward would be covered by the toll revenues, freeing the remaining fuel tax revenues for all of the DOT's other roads.

PART 2

RATIONALE

In the FAST Act legislation of 2015, Congress asked the Transportation Research Board (of the National Academies of Sciences, Engineering, and Medicine) to convene an expert committee to analyze the future of the Interstate Highway System and make recommendations. The consensus study report, published in January 2019,[1] concluded that most of the system had exceeded or would soon exceed its original design life and that much of it would need "full-depth pavement reconstruction." Some corridors would also need widening to cope with conservative estimates of future traffic demand, especially in truck freight. It estimated the cost of reconstruction and modernization at $1 trillion over a 20-year period. Although the report acknowledged the advantages of up-front financing via toll revenue bonds, it instead recommended a massive increase in federal fuel taxes in an effort to replicate the original 1956 pay-as-you-go annual funding on a 90% federal/10% state basis.

Unfortunately, neither Congress, nor the Trump administration, nor the Biden administration has taken the report or its recommendations seriously. The huge infrastructure spending bills debated in summer 2021 ignored the need to reconstruct and modernize the Interstates. Consequently, it will be up to states (as the owner/operators of the Interstates) to address this major investment need themselves. In recent years, four

1 *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future*, Transportation Research Board Special Report 329, The National Academies Press, 2019, https://nap.edu/catalog/25334/renewing-the-national-commitment-to-the-interstate-highway-system-a-foundation-for-the-future.

states have funded large-scale studies of toll-financed Interstate reconstruction: Connecticut, Indiana, Michigan, and Wisconsin. Legislative and/or state DOT interest in projects to rebuild or replace individual corridors or major bridges has manifested in Alabama (I-10 bridge), Colorado (I-70), Louisiana (two I-10 bridges), Missouri (I-70), North Carolina (I-95), Oregon (I-5 and I-205), South Carolina (I-95), Virginia (I-81 and I-95), and Wyoming (I-80).

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As of this writing, none of these projects has been implemented, generally due to concerns about tolling the replacement capacity (though Louisiana is under way on developing the first of its two I-10 bridge replacements as a toll-financed public-private partnership).[2] Rhode Island implemented tolling of only heavy trucks to help fund replacement of deficient bridges on Interstates and some other highways.[3]

The author of this policy brief has published several reports suggesting the need for *customer-friendly* tolling policy.[4] The idea is to address highway user groups' main concerns about tolling, creating a better value proposition for those who will benefit from much better Interstates going forward.

2 Eugene Gilligan, "Louisiana Shortlists Four Teams for Bridge P3," *Inframation News*, 15 July 2021.

3 "Rhode Works," Rhode Island Department of Transportation, n.d., https://dot.ri.gov/rhodeworks/index.php.

4 Robert W. Poole, Jr., "Can Interstate Tolling Be Politically Feasible? A Customer-Friendly Approach," Policy Brief, Reason Foundation, March 2018.

Here are the principal concerns raised by highway user groups, and proposed customer-friendly policies:

- **Concern #1: Toll Roads as Cash Cows**
- ***Solution**:* Provide legal protection of new toll revenues to be used solely for the capital and operating costs of the newly tolled corridors.

- **Concern #2: High Cost of Toll Collection Compared with Fuel Taxes**
- ***Solution**:* Employ all-electronic toll collection with strong incentives for prepaid transponder accounts.

- **Concern #3: No Value Added for Highway Users**
- ***Solution**:* Begin charging tolls only after replacement capacity is opened for use.

- **Concern #4: Double Taxation (i.e., paying both tolls and fuel taxes on the same highway)**
- ***Solution**:* Provide rebates of fuel taxes attributable to the miles driven on newly tolled corridor.

The main focus of this policy study is the fourth of these, but the analytical approach assumes the other three policies as well.

PART 3

STUDY APPROACH

During 2011–2012 the author of this study carried out a 50-state feasibility study of toll-financed reconstruction and widening of the entire Interstate Highway System.[5] It used data from the Federal Highway Administration (FHWA) Highway Economic Requirements System (HERS) on the unit costs per lane-mile for rural and urban Interstate reconstruction and lane additions. The study used toll rates comparable to 2010 rates on existing long-distance tolled Interstates, with the model adjusting them each year by an estimated Consumer Price Index (CPI). For urban Interstates, it used higher toll rates with peak and off-peak differentials. The study took into account estimates for each state of the fraction of lane-miles in flat, rolling, or mountainous terrain (in order to use the appropriate HERS unit cost figures).

The study's main finding was that, given the assumptions made, toll-financed reconstruction and selective widening would be financially feasible in all but five states (with low traffic, low population, and/or high construction costs—e.g., Vermont). A shorter version of the study passed TRB peer review and was presented at the 2014 TRB Annual Meeting.[6] A slightly different version passed academic peer review for publication in a

[5] Robert W. Poole, Jr., "Interstate 2.0," Policy Study, Reason Foundation, 2013, https://reason.org/policy_study/modernizing-the-interstate-highway.

[6] Robert W. Poole, Jr., "Modernizing the U.S. Interstate Highway System via Toll Finance," Paper No. 14-0716, TRB 2014 Annual Meeting, January 2014.

transportation journal.[7] Two such peer reviews provide some assurance that the methodology used was reasonable.

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For this policy study, the purpose is much simpler: to use realistic current numbers to compare the expected toll revenue with the cost to a state DOT of state fuel tax rebates on the rebuilt corridors. Rather than selecting a single state, the concept creates a generic mid-size state with Interstate characteristics that are a composite of 10 such states. To simplify the model, only two-digit long-distance (rural) Interstates were included.

As shown in Table 1, 10 states were selected from the middle range of the 2020 Census Bureau state population table, encompassing various portions of the country. Data on rural Interstate route-miles, lane-miles, and 2019 vehicle-miles of travel (VMT) were assembled from various FHWA highway statistics tables. As shown by Table 1, these states average out to a 2020 population of 6.9 million, 629 route-miles of rural Interstate constituting 2,595 lane-miles, giving an average of 4.1 lanes per corridor (which was simplified to four lanes in subsequent calculations), with a composite 2019 VMT of 6698 million. In addition, the average number of rural Interstate routes was four.

7 Robert W. Poole, Jr., "The Feasibility of Modernizing the Interstate Highway System via Toll Finance," *Research in Transportation Economics*, Vol. 44, June 2014.

TABLE 1: DATA FOR THE COMPOSITE GENERIC MID-SIZE STATE

State	2020 pop. (M)	Rural Int. Rt.-Mi.	Rural Int. Ln.-Mi.	Avg. # Lanes	2019 VMT (M)	% Lt. Veh	% Comb. Trucks	LT Veh VMT M	HV VMT M	# of Inter-states	List of Rural Interstates
Arizona	7.2	916	3,725	4.1	7,158	74.4%	17.9%	5,325	1,282	5	I-8, I-10, I-17, I-19, I-40
Colorado	5.8	648	2,628	4.1	4,935	85.0%	12.5%	4,194	617	3	I-25, I-70,I-76
Michigan	10.1	562	2,355	4.2	5,784	82.0%	15.4%	4,742	888	4	I-69, I-75, I-94, I-96
Minnesota	5.7	588	2,358	4.0	3,985	77.5%	15.3%	3,089	610	3	I-35, I-90, I-94
Missouri	6.2	842	3,426	4.1	7,115	66.2%	26.7%	4,713	1,900	5	I-29, I-35, I-44, I-55, I-70
S. Carolina	5.1	546	2,240	4.1	8,569	82.9%	12.9%	7,104	1,105	5	I-20. I-26, I-77, I-85, I-95
Tennessee	6.9	645	2,640	4.1	8,726	75.7%	20.9%	6,601	1,821	4	I-24, I-40, I-65, I-75
Virginia	8.6	598	2,508	4.2	9,496	80.4%	17.0%	7,634	1,611	6	I-64, I-66, I-77, I-81, I-85, I-95
Washington	7.7	429	1,924	4.5	5,000	86.0%	10.4%	4,298	521	3	I-5, I-82, I-90
Wisconsin	5.9	513	2,147	4.2	6,207	83.0%	13.1%	5,151	811	5	I-39, I-41, I-43, I-90, I-94
Average	**6.9**	**629**	**2,595**	**4.1**	**6,698**			**5,285**	**1,117**	**4.3**	

Sources: Census, HM-15, HM-60, VM-2, VM-4, VM-4

For the hypothetical modeling exercise, since no detailed data could exist for the generic state to be modeled, it was assumed that:

- All four corridors in the generic state would be of the same length and initial lane configuration.
- Two of the four corridors needed one additional lane in each direction, added at the same time as reconstruction.
- The reconstruction projects would be staggered, with construction beginning, respectively, in 2025, 2028, 2031, and 2034.
- Tolling would begin as each project was completed, in 2030, 2033, 2036, and 2039.

The next sections detail the assumptions made in the reconstruction and widening, the projection of traffic and revenue, and the calculation of fuel tax rebates paid to tolled-Interstate customers. Also, to address expenditures, revenues, and rebates occurring at different future points in time, this model calculates the net present value (NPV) of all those annual numbers, and compares the NPV of toll revenues with the NPV of construction costs, and to compare the NPV of toll revenue with the NPV of fuel tax rebates. The construction and revenue/rebate spreadsheets extend to 2060; projecting various parameters longer than 40 years did not seem credible.

PART 4

RECONSTRUCTION AND WIDENING COSTS

It was essential to have up-to-date unit construction and widening costs from FHWA's HERS database, such as those the author had used in the 2013 Interstate 2.0 study. The most recent numbers will appear in the 24th edition of U.S. DOT's periodic *Conditions & Performance Report*, which had not been released during the time this policy study was being prepared. Fortunately, the relevant unit cost data pages were made available to the author.[8] FHWA provided unit costs as of 2016, along with instructions on how to update them to 2019, using FHWA's National Highway Construction Cost Index (NHCCI). Since construction costs have been increasing at a much faster rate than consumer prices, the construction cost spreadsheet for this project used the recent NHCCI average annual increase of 5.22% to estimate unit construction costs for each future year in the spreadsheet. This may over-estimate future construction costs, but there was no basis for using a different inflation figure such as the CPI, which does not reflect construction costs. Also, the wide variations in construction costs between 2002 and 2019 averaged a slightly higher 5.72% per year.[9]

8 U.S. DOT, *24th Conditions & Performance Repor*t, pages "TypRurPvmtCostsPerLM_2018-07-26" and "TypRurCapcCostsPer LM_2018-09-28," not yet released.

9 "Construction Cost Trends for Highways, " Federal Highway Administration, undated, https://www.fhwa.dot.gov/policy/otps/nhcci/pt1.cfm (30 August 2021).

HERS provides an array of unit costs, depending on the nature of the terrain—flat, rolling, or mountainous—and also whether the reconstruction is “typical” or “total” (the latter means starting at the sub-grade). For the mid-size states in Table 1, it was assumed that 50% of the lane-miles were in flat terrain and 50% in rolling terrain. It was also assumed that 50% of the reconstruction was “typical” and the rest the more costly “total.” For “typical” reconstruction, HERS provides unit costs of $1.160 million/lane-mile for flat terrain and $1.372 million/lane-mile for rolling terrain, so at a 50/50 split “typical” reconstruction will average $1.266 million/lane-mile. For “total” reconstruction, the comparable HERS numbers are $1.604 million for flat terrain and $1.890 million for rolling, so the 50/50 split gives us an average of $1.747 million/lane-mile. By the assumption that 50% is typical and 50% is total, the average of the two unit costs ($1.266 and $1.747) gives an overall reconstruction cost of $1.506 million per lane-mile.

As noted previously, we assume that two of the four long-distance corridors would need additional lanes (one each direction) to be carried out at the same time as reconstruction. For lane additions, HERS provides an array of unit costs—a basic “normal” (no obstacles) case and seven different alternatives, cases A through G, identified as follows (but with no further explanation), with a different unit cost for each:

A. Dense development
B. Better transportation facility
C. Other public facility
D. Terrain restoration
E. Historic and archeological site
F. Environmental section
G. Parkland

Rather than arbitrarily selecting one of these, the average of all seven-unit costs was calculated, yielding $5.773 million/lane-mile for flat terrain and $7.838 million/lane-mile for rolling terrain, hence averaging $6.805 million/lane-mile. Since we are modeling rural Interstates and these special situations are assumed to be uncommon, an additional assumption was made that this alternative higher-cost treatment would occur in 10% of the added lane-miles, while 90% would have normal costs. Taking into account, again, the 50/50 split between flat and rolling terrain, we have an average normal lane addition cost of $1.604 million/lane-mile for flat and $1.890 million/lane-mile for rolling terrain, averaging $1.747 million/lane-mile. And for the special cases, we have an average of

$6.805 million/lane-mile for the combined flat and rolling terrain. Hence with 90% at $1.747 and 10% at $6.805, overall average cost of lane additions in these corridors is $2.253 million/lane-mile.

All the above costs from HERS were in 2016 dollars, so for the construction cost spreadsheet, they were first converted to 2019 dollars using the NHCCI discussed previously. Hence, the spreadsheet begins with 2019 reconstruction costs of $1.742 million/lane-mile and lane-addition costs of $2.606 million/lane-mile.

Each of the four rural Interstates was assumed to be 157.25 miles long, with 629 lane-miles needing to be reconstructed. Two of the corridors would need an additional 314.5 lane-miles to be added, at the higher unit cost for lane additions.

On the assumption of all-electronic toll (AET) collection, a construction cost estimate for the required gantries and equipment was obtained from electronic tolling consultant Daryl Fleming, a pioneer in all-electronic tolling dating back to the Highway 407 ETR in Ontario, Canada—the world's first all-electronic toll road. Fleming is also the author of a study on the cost-reduction potential of AET systems designed from scratch to make use of transponders and prepaid accounts to minimize the cost of collection.[10] Fleming's assessment of 2021 cost was $350,000 per lane-mile, on the assumption that a significant construction cost inflation factor would be used.

As noted above, the HERS 2016 unit costs were adjusted using DOT's NHCCI to 2019 levels, and an annual rate of construction cost inflation based on that (5.22%/year) was assumed for all the construction costs in Table 2. For the four corridors to be rebuilt, in each case a five-year period of construction was assumed for the entire corridor, with construction starting dates of 2025, 2028, 2031, and 2034. The corridors with lane additions were assumed to be the first and third of these.

10 Daryl F. Fleming, et al., "Dispelling the Myths: Toll and Fuel Tax Collection Costs in the 21st Century," Reason Foundation, October 2012, https://policy-study/myths-toll-road-and-gas-tax-collection .

TABLE 2: RECONSTRUCTION AND WIDENING COSTS FOR FOUR RURAL INTERSTATES

Year	Route-Miles	Lane-Miles	FHWA Const. Cost Factor	Recon. Unit Cost ($M)	Lane-Miles Added	Lane Add. Unit Cost ($M)	Reconst. Cost ($M)	Lane Addition Cost ($M)	ETC Capital Cost ($M)/ Lane-Mi.	ETC Capital Cost	6% NPV Factor	Total Cost ($M)	NPV Total Cost ($M)
2019			1.0000	1.742		2.606					1.0000		
2020			1.0522	1.833		2.742					0.9434		
2021			1.1071	1.929		2.885			0.350		0.8900		
2022			1.1649	2.029		3.036			0.368		0.8396		
2023			1.2257	2.135		3.194			0.387		0.7921		
2024			1.2897	2.247		3.361			0.408		0.7473		
2025	157.25	629	1.3570	2.364	314.5	3.536	1487	1112.2	0.429	404.8	0.7050	$3,004	$2,118
2026			1.4279	2.487		3.721	0		0.451		0.6651		
2027			1.5024	2.617		3.915	0		0.475		0.6274		
2028	157.25	629	1.5808	2.754	0	4.120	1732		0.500	314.3	0.5919	$2,046	$1,211
2029			1.6633	2.898		4.335	0		0.526		0.5584		
2030			1.7502	3.049		4.561	0		0.553		0.5268		
2031	157.25	629	1.8415	3.208	314.5	4.799	2018	1509.3	0.582	549.3	0.4970	$4,076	$2,026
2032			1.9377	3.375		5.050	0		0.613		0.4689		
2033			2.0388	3.552		5.313			0.645		0.4423		
2034	157.25	629	2.1452	3.737	0.0	5.590	2351		0.678	639.9	0.4173	$2,990	$1,248
Totals	**629**	**2516**			**629**		**$7,587.4**	**$2,621.5**		**$1,908.3**		**$12,117.2**	**$6,602.9**

The next-to-last column in Table 2 provides the total cost in then-year dollars for each project. The final column provides the net present value (NPV) of those costs as of 2019. This number will be compared with the NPV of toll revenue and the NPV of fuel tax rebates in the subsequent sections.

PART 5

TRAFFIC AND REVENUE ESTIMATION

The traffic and revenue modeling followed the approach used in the author's 2013 "Interstate 2.0" study. The basic data requirements were as follows:

- Estimated annual vehicle-miles of travel (VMT), 2020 through 2060;
- CPI-indexed toll rates for the same period;
- Toll diversion rates for light vehicles and heavy trucks;
- Starting year for tolling for each rebuilt corridor.

Since light vehicles and heavy trucks are expected to have different VMT growth rates, as well as significantly different toll rates, their traffic and revenue must be calculated separately, and then added together for each year that tolling is in operation.

A U.S. DOT traffic modeling expert provided a table showing 20-year annual VMT growth rates, 2018–2038 for each of the 50 states. Table 3 extracts those growth rates for the 10 states that comprise our composite state. The light vehicle segment includes pickup trucks and SUVs, while heavy vehicle growth rates are for combination trucks. The 10-state average is used as the starting point for the traffic and revenue spreadsheets.

TABLE 3: ANNUAL VMT GROWTH RATES FOR THE 10 MID-SIZE STATES

State	Light Vehicle VMT Growth Rate	Heavy Vehicle VMT Growth Rate
Arizona	1.4%	2.8%
Colorado	1.1%	2.2%
Michigan	0.4%	1.2%
Minnesota	0.9%	1.9%
Missouri	0.7%	1.8%
South Carolina	1.4%	2.0%
Tennessee	0.8%	2.5%
Virginia	0.9%	1.9%
Washington	1.0%	2.3%
Wisconsin	0.5%	1.4%
Average	**0.91%**	**2.0%**

Source: FHWA

Long-distance toll rates were obtained from CDM Smith's proprietary "Toll Database 2020." The average rate per mile for the 13 tolled long-distance turnpikes was $0.07 for cars and $0.308 for 5-axle trucks. The heavy truck average was significantly skewed by the $0.554 rate of the Illinois Tollway. The ratio of truck toll/car toll was 4.35 with Illinois Tollway included but only 3.64 without that toll system (which is partly urban and partly rural). The author settled on a midpoint truck toll to car toll ratio of 4.0, which gave an initial toll rate for heavy trucks of $0.28/mile and a light-vehicle rate of $0.07/mi. Since toll rates in a growing number of toll facilities are now indexed to the CPI (not the construction cost index), CPI indexing was applied to the toll rates in the traffic and revenue spreadsheets. A CPI of 1.75% per year was used as a plausible average consumer price inflation rate going forward.

Traffic and revenue (T&R) studies recognize that, historically, a limited-access highway will attract less traffic if it is tolled than if it is non-tolled. Highway user tax rebates for toll-road users are uncommon. To the author's knowledge, as of 2021 such rebates are available only for heavy trucks using the Massachusetts Turnpike and the New York Thruway. T&R modelers appear to be unaware of those rebate programs. Those modelers do take into account that the higher the toll rate, the larger the fraction of travelers that will divert to parallel non-tolled routes. This suggests that a newly tolled highway *with fuel-tax rebates* could be modeled as if its "effective" toll rate/mile were the posted per-mile toll rate minus the fuel tax rate per mile.

It is also generally accepted in T&R studies that the diversion rate is higher for commercial vehicles (including heavy trucks) than for personal vehicles. Therefore, for purposes of this planning-level assessment, diversion rates of 10% for light vehicles and 20% for heavy vehicles were assumed. Those diversion rates were applied to the VMT estimates to provide net (tolled) VMT on the rebuilt corridors.

Another feature borrowed from the Interstate 2.0 study is the assumption that 15% of the gross toll revenue is used for operating and maintenance costs of the rebuilt, tolled corridor. For purposes of assessing toll feasibility (i.e., will toll revenue cover the cost of reconstruction and widening?) the relevant number is the *net* toll revenue (i.e., the gross toll revenue minus the 15% taken off the top to cover ongoing operating and maintenance costs). On the other hand, for comparison of toll revenue with fuel tax revenue that is lost to the state DOT due to rebates, the relevant comparison is gross toll revenue versus the amount of fuel tax revenue used for rebates. Hence, the T&R spreadsheets must provide the NPV of gross toll revenue and the NPV of net toll revenue for these two different purposes.

"Finally, consistent with the customer-friendly tolling principles in Part 2, toll collection is modeled as beginning when each rebuilt corridor opens to traffic (although in practice this would likely occur as each segment of a corridor is completed)."

Finally, consistent with the customer-friendly tolling principles in Part 2, toll collection is modeled as beginning when each rebuilt corridor opens to traffic (although in practice this would likely occur as each segment of a corridor is completed). Hence, for each of the four corridors, tolling begins in the fifth year—in 2030 for corridor 1, in 2033 for corridor 2, in 2036 for corridor 3, and in 2039 for corridor 4. Table A1 in this study's Appendix is the T&R projection for corridor 1, the first one to be rebuilt (and widened). Table 4 summarizes the results for all four corridors.

TABLE 4: SUMMARY OF TRAFFIC & REVENUE ($M), ALL FOUR CORRIDORS

Corridor	Gross Toll Revenue	NPV Gross Revenue	Net Toll Revenue	NPV Net Revenue
#1	$10,646	$2,312	$9,049	$1,966
#2	$10,010	$1,997	$8,509	$1,697
#3	$9,312	$1,705	$7,915	$1,449
#4	$8,544	$1,436	$7,262	$1,221
Totals	**$38,512**	**$7,450**	**$32,735**	**$6,333**

These four corridors' spreadsheets demonstrate that this set of Interstate reconstruction and widening projects is toll-feasible, on a sketch-level-assessment basis.

These four corridors' spreadsheets demonstrate that this set of Interstate reconstruction and widening projects is toll-feasible, on a sketch-level-assessment basis. The inflation-adjusted toll rates for light and heavy vehicles yield a net present value of net toll revenues of $6.333 billion. Net toll revenue (gross revenue minus 15% for operations and maintenance) is used for this calculation since this is the revenue available for debt service to cover the construction costs. From the construction cost spreadsheet (Table 2) we saw that the NPV of construction costs was $6.603 billion, which is within 4% of the NPV of net revenue. A far more detailed traffic and revenue study (in addition to a far more detailed cost assessment) would be needed to assess the actual toll feasibility of a corridor to be rebuilt, but this calculation shows that this model is in the right ballpark for toll feasibility.

PART 6

FUEL TAX REBATE ESTIMATION

The data requirements to model the amount of gasoline and diesel tax rebates include the following:

- State gasoline and diesel tax rates during the period to 2060;
- Light vehicle and heavy vehicle fuel economy projections; and,
- Electric vehicle (EV) share of light vehicle and heavy-vehicle fleets.

As with the construction costs and the T&R projections, projecting these factors requires making a number of assumptions.

To begin with, 2020 state fuel tax rates were obtained for the 10 states making up the generic mid-size state.[11] Table 5 presents these rates, with the average state gas tax rate being $0.269/gallon and the average diesel tax rate at $0.273/gal.

[11] "Gas Tax by State for 2020," Igentax.com, https://igentax.com/gas-tax-state/#table (accessed 9 June 2021).

TABLE 5: 2020 STATE FUEL TAX RATES FOR THE 10 MID-SIZE STATES ($/GALLON)

State	Gasoline Tax Rate	Diesel Tax Rate
Arizona	$0.240	$0.2575
Colorado	$0.2325	$0.20625
Michigan	$0.263	$0.263
Minnesota	$0.268	$0.268
Missouri	$0.1742	$0.1742
South Carolina	$0.2275	$0.2275
Tennessee	$0.274	$0.284
Virginia	$0.162	$0.202
Washington	$0.519952	$0.519952
Wisconsin	$0.329	$0.329
Average	**$0.269**	**$0.273**

Source: "Gas Tax by State for 2020," Igentax.com, https://igentax.com/gas-tax-state/#table (accessed 9 June 2021).

Since some states index fuel taxes for inflation but others do not, in the spreadsheet calculations the 2020 rates were assumed to remain unchanged through 2024, increased by 5% in 2025 and kept constant through 2029. As of 2030, both gasoline and diesel tax rates were increased annually by the assumed CPI rate used for toll rates: 1.75% per year. A complication not quantified in this study is that five of the 10 states in Table 5 divert some portion of their fuel tax revenue to non-highway uses, but in only one (Michigan) is this a significant fraction.[12] This would have to be taken into account in any real-world implementation of fuel tax revenue on newly tolled highways.

Projections of fleetwide miles/gallon (mpg) for light vehicles and heavy vehicles were developed by Ed Regan of transportation consulting firm CDM Smith for this project and several projects dealing with mileage-based user fees.[13] They are taken from worksheets developed by Regan for projecting national and state changes in fuel tax revenue from the

12 Baruch Feigenbaum and Joe Hillman, "How Much Gas Tax Money States Divert Away from Roads," Policy Brief, Reason Foundation, 30June 2020. https://reason.org/policy-brief/how-much-gas-tax-money-states-divert-away-from-roads.

13 Ed Regan, "Calculating Rebates on Tolled Corridors," email to Robert Poole, with spreadsheets, 4 August 2021.

present through 2050. The projections of fleetwide average fuel economy were based on the 2021 Energy Information Administration (EIA) light vehicle and heavy vehicle stock forecasts.[14] These figures represent not the annual sales of new vehicles, but the fleetwide average, since it takes 15–20 years for old vehicles to be retired and replaced by newer vehicles. The 2021 EIA numbers are based on the reduced near-term mpg targets enacted by the Trump administration, which the Biden administration is in the process of increasing. In creating alternative fuel efficiency scenarios, Regan revised the EIA numbers to reflect a broad estimate of what may result from the Biden revision.

Regan and this author consider the EIA forecasts of electric vehicle (EV) market penetration to be on the low side, not reflecting recent announcements by U.S. and overseas auto manufacturers of plans to convert new vehicle production entirely to non-petroleum-fueled personal vehicles by target dates between 2030 and 2040. They also do not reflect the large projected increases in federal efforts to jump-start vehicle electrification via policy changes and subsidies. Regan instead created a third "high-EV" scenario adapted from recent global EV forecasts developed by Bloomberg New Energy Finance (BNEF),[15] which is more consistent with industry, congressional, and Biden administration EV policies. Regan's EV scenario focused on light vehicles. Hence, the author introduced further assumptions on EV penetration in the heavy vehicle market. Heavy vehicle EVs would constitute 1% of that fleet by 2030 and increase by 0.5% per year through 2040. Thereafter, their share would increase by 1% per year through 2060. Regan's mpg and light vehicle EV share projections extend only to 2050, so the author of this paper extended them to 2060.

Table A2 in the Appendix is the fuel tax rebates spreadsheet for the first of the four corridors. Similar spreadsheets were prepared for the other three corridors, as was done for the traffic and revenue spreadsheets. Separately for light vehicles and heavy vehicles, the table shows the increases in mpg and EV share of the fleet as estimated from 2030 to 2060. State gasoline and diesel tax rates are shown from 2020 to 2060, as discussed above. These numbers permit, for each of the two vehicle categories, calculations for the fuel tax rebates, using the following procedure:

- VMT divided by mpg = gallons consumed
- Gallons times tax rate = gross rebate amount
- Gross rebate times fraction paying fuel taxes = net rebate amount

14 "Light Vehicle Stock Forecast," Energy Information Administration, February 2021.

15 "Electric Vehicle Outlook 2020." Bloomberg New Energy Finance, 2020, https://About.bnef.com/electric-vehicle-outlook.

Hence the spreadsheet uses the equation (VMT/mpg) x (tax rate) x (1- EV share). The separate annual totals of gas tax rebates and diesel tax rebates are added to equal total fuel tax rebate. The NPV of the rebates is then calculated, for comparison with the NPV of gross toll revenue, to measure how the rebate amount compares with the toll revenues collected during the same time period. For corridor 1 (the earliest one to be rebuilt and re-opened to traffic), the NPV of fuel tax rebates is 8.0% of the NPV of gross toll revenue. Table A2 in the Appendix shows the complete spreadsheet for corridor 1. The other three corridor spreadsheets are similar, but start at later years, consistent with the traffic and revenue spreadsheets presented in Part 5. The results of all four corridors are summarized in Table 6.

TABLE 6: SUMMARY OF FUEL TAX REBATES ($M), ALL FOUR CORRIDORS

Corridor	Total Fuel Tax Rebates	NPV of Fuel Tax Rebates
#1	$733.32	$185.34
#2	$583.36	$132.39
#3	$517.92	$105.04
#4	$453.16	$82.33
Totals:	**$2,287.76**	**$505.09**

Finally, Table 7 compares the gross toll revenue and the NPV of gross toll revenue with the total fuel tax rebates and the NPV of those rebates.

TABLE 7: COMPARISON OF TOLL REVENUES AND FUEL TAX REBATES ($M)

Corridor	Nominal Gross Toll Revenue ($M)	NPV of Gross Toll Revenue ($M)	Nominal Fuel Tax Rebates ($M)	NPV of Fuel Tax Rebates ($M)
1	$10,646	$2,312	$733.3	$185.3
2	$10,010	$1,997	$583.4	$132.4
3	$9,312	$1,705	$517.9	$105.0
4	$8,544	$1,436	$453.2	$82.3
Totals:	**$38,512**	**$7,450**	**$2,287.8**	**$505.0**

Comparing the NPV of fuel tax rebates with the NPV of gross toll revenue shows that the rebates account for only 6.8% of the toll revenue. By using that small portion of its state fuel tax revenues to remove the "double-taxation" objection to tolling, the state DOT can shift the major investments needed to rebuild and modernize its long-distance rural Interstates from the fuel tax to tolls, while also covering the tolled Interstates' operating and maintenance costs out of the toll revenue. This will free up the state's other fuel tax funds for all other state highways.

PART 7

CONCLUSIONS

This policy study set out to estimate the impact on state fuel tax revenue that would result from a policy decision to use toll financing with fuel tax rebates to rebuild and modernize a mid-size state's long-distance (rural) Interstate highways. The primary conclusion of the analysis, assuming the assumptions made are reasonable, is that the fuel tax rebates paid out would be less than 7% of the new toll revenue, would only begin to occur as of 2030, and would decrease over time.

"The primary conclusion of the analysis, assuming the assumptions made are reasonable, is that the fuel tax rebates paid out would be less than 7% of the new toll revenue, would only begin to occur as of 2030, and would decrease over time."

There are several reasons for this result. First, the toll rates were selected to be consistent with those on other tolled long-distance Interstates and to be sufficient to cover the capital and operating costs of the rebuilt and modernized Interstates. The per-mile toll rates are higher than the average state fuel tax collected per mile from both cars and trucks. Second, fuel tax revenues will be declining during the period modeled (2030 to 2060) for two reasons: the ongoing increase in vehicle fuel economy (more miles driven per gallon used) and the increasing fraction of electric vehicles that use no gasoline or diesel fuel. Those changes occur much sooner for cars than for heavy trucks.

Because the reconstruction of the four corridors is assumed to take place at different times, and the toll revenues and fuel tax rebates also take place at different times over a 30-year period, the only way to make a fair comparison is by using the net present value of all future costs and revenues, as was done in all the tables.

By removing a large obstacle to toll-financed Interstate reconstruction, the fuel tax rebate provision would enable a state to accomplish the very costly task of rebuilding its Interstates using only a modest fraction of its state fuel tax revenue for rebates.

By removing a large obstacle to toll-financed Interstate reconstruction, the fuel tax rebate provision would enable a state to accomplish the very costly task of rebuilding its Interstates using only a modest fraction of its state fuel tax revenue for rebates. The avoided costs of Interstate reconstruction and widening would be the $6.6 billion (net present value) in construction cost plus the ongoing operating and maintenance costs, all of which would be covered by the toll revenues. This would leave the remaining fuel tax revenue (after rebates) for maintaining and improving all the other roads for which the state DOT has responsibility.

This should be a positive result for any state DOT that is interested in using toll financing to reconstruct and selectively widen its long-distance Interstates. One of the largest political obstacles to gaining legislative and highway-user support for such tolling is the objection to “double taxation”—paying both tolls and fuel taxes on the same highway. Providing rebates of gasoline and diesel taxes for all miles driven on the rebuilt and modernized Interstate corridors would eliminate that concern, while using only a small fraction of state fuel tax revenue for the rebates.

ABOUT THE AUTHOR

Robert W. Poole, Jr. is director of transportation policy and the Searle Freedom Trust Transportation Fellow at Reason Foundation, a national public policy think tank based in Los Angeles.

His 1988 policy paper proposing supplemental privately financed toll lanes as congestion relievers directly inspired California's landmark private tollway law (AB 680), which authorized four pilot projects including the highly successful 91 Express Lanes in Orange County. Over two dozen other states have enacted similar public-private partnership legislation. In 1993 Poole oversaw a study that introduced the term HOT (high-occupancy/toll) Lane, a concept which has become widely accepted since then.

Poole has advised the Federal Highway Administration, the Federal Transit Administration, the White House Office of Policy Development and National Economic Council, the Government Accountability Office (GAO), and the California, Florida, Georgia, Indiana, Texas, Utah, Virginia, and Washington State Departments of Transportation. He served 18 months on the Caltrans Privatization Advisory Steering Committee, helping oversee the implementation of AB 680. He was appointed by Gov. Pete Wilson as a member of California's Commission on Transportation Investment in 1995-96.

Poole is a member of the board of the Public-Private Partnerships (P3) division of ARTBA and an emeritus member of the Transportation Research Board's Managed Lanes

Committee. From 2003 to 2005, he was a member of the TRB's special committee on the long-term viability of the fuel tax for highway funding. In 2008 he was a member of the Study Committee on Private Participation in Toll Roads, appointed by Texas Gov. Rick Perry. In 2010 he was a member of the Washington State DOT's Expert Review Panel on the proposed Eastside Managed Lanes Corridor. Also in 2010, he served as a transportation policy advisor on the transition team of Florida Gov. Rick Scott.

Poole is the author of dozens of policy studies and journal articles on transportation issues. His book, *Rethinking America's Highways*, was published by the University of Chicago Press in 2018. Poole's popular writings have appeared in national newspapers, including *The New York Times* and *The Wall Street Journal*; he has also been a guest on such programs as "Crossfire," "Good Morning America," and "Huffington Post," as well as ABC, CBS and NBC News, NPR, and PBS. He produces the monthly e-newsletter *Surface Transportation Innovations*. *The New York Times* has called him "the chief theorist for private solutions to gridlock."

Poole received his B.S. and M.S. in mechanical engineering at MIT and did graduate work in operations research at NYU.

APPENDIX

TABLE A1: TRAFFIC AND REVENUE ($M) PROJECTIONS FOR CORRIDOR 1

Year	Light Veh Annual VMT (M)	Net Lt Veh VMT (M)	Lt Veh Toll Rate per mi.	Gross Annual Lt Veh Rev ($M)	Net Annual Lt Veh Toll Rev ($M)	Annual Truck VMT (M)	Net Truck VMT (M)	Truck Toll Rate per mi.	Gross Annual Truck Toll Rev. ($M)	Net Annual Truck Toll Rev. ($M)	Total Annual Gross Revenue ($M)	Total Annual Net Revenue ($M)	6% NPV Factor	NPV Gross Revenue ($M)	NPV Net Revenue ($M)
2019	1,321	1321	0.0700	0	0	279	279	0.2800	0	0	0	0	1.0000	0	0
2020	1,333	1333	0.0712	0	0	285	285	0.2849	0	0	0	0	0.9434	0	0
2021	1,345	1345	0.0725	0	0	290	290	0.2899	0	0	0	0	0.8900	0	0
2022	1,357	1357	0.0737	0	0	296	296	0.2950	0	0	0	0	0.8396	0	0
2023	1,370	1370	0.0750	0	0	302	302	0.3001	0	0	0	0	0.7921	0	0
2024	1,382	1382	0.0763	0	0	308	308	0.3054	0	0	0	0	0.7473	0	0
2025	1,395	1395	0.0777	0	0	314	314	0.3107	0	0	0	0	0.7050	0	0
2026	1,407	1407	0.0790	0	0	320	320	0.3162	0	0	0	0	0.6651	0	0
2027	1,420	1420	0.0804	0	0	327	327	0.3217	0	0	0	0	0.6274	0	0
2028	1,433	1433	0.0818	0	0	333	333	0.3273	0	0	0	0	0.5919	0	0
2029	1,446	1446	0.0833	0	0	340	340	0.3330	0	0	0	0	0.5584	0	0
2030	1,459	1313	0.0847	$111.3	$94.6	347	278	0.3389	$94.0	$79.9	$205.3	$174.5	0.5268	$108.2	$91.94
2031	1,473	1325	0.0862	$114.3	$97.1	354	283	0.3448	$97.6	$83.0	$211.9	$180.1	0.4970	$105.3	$89.50
2032	1,486	1337	0.0877	$117.3	$99.7	361	289	0.3508	$101.3	$86.1	$218.6	$185.8	0.4689	$102.5	$87.13
2033	1,500	1350	0.0892	$120.4	$102.4	368	295	0.3570	$105.1	$89.4	$225.6	$191.7	0.4423	$99.8	$84.81
2034	1,513	1362	0.0908	$123.7	$105.1	375	300	0.3632	$109.1	$92.7	$232.8	$197.9	0.4173	$97.1	$82.57
2035	1,527	1374	0.0924	$127.0	$107.9	383	306	0.3696	$113.2	$96.3	$240.2	$204.2	0.3937	$94.6	$80.39
2036	1,541	1387	0.0940	$130.4	$110.8	391	313	0.3760	$117.5	$99.9	$247.9	$210.7	0.3714	$92.1	$78.26
2037	1,555	1399	0.0957	$133.9	$113.8	398	319	0.3826	$122.0	$103.7	$255.8	$217.5	0.3504	$89.6	$76.20
2038	1,569	1412	0.0973	$137.5	$116.8	406	325	0.3893	$126.6	$107.6	$264.0	$224.4	0.3305	$87.3	$74.18
2039	1,583	1425	0.0990	$141.1	$120.0	415	332	0.3961	$131.4	$111.7	$272.5	$231.6	0.3118	$85.0	$72.22
2040	1,598	1438	0.1008	$144.9	$123.2	423	338	0.4031	$136.4	$115.9	$281.3	$239.1	0.2942	$82.7	$70.34
2041	1,612	1451	0.1025	$148.8	$126.5	431	345	0.4101	$141.5	$120.3	$290.3	$246.8	0.2775	$80.6	$68.47
2042	1,627	1464	0.1043	$152.8	$129.8	440	352	0.4173	$146.9	$124.8	$299.6	$254.7	0.2618	$78.4	$66.68
2043	1,642	1478	0.1062	$156.9	$133.3	449	359	0.4246	$152.4	$129.6	$309.3	$262.9	0.2470	$76.4	$64.93
2044	1,657	1491	0.1080	$161.0	$136.9	458	366	0.4320	$158.2	$134.5	$319.3	$271.4	0.2330	$74.4	$63.23
2045	1,672	1505	0.1099	$165.4	$140.6	467	374	0.4396	$164.2	$139.6	$329.6	$280.1	0.2198	$72.4	$61.57
2046	1,687	1518	0.1118	$169.8	$144.3	476	381	0.4473	$170.4	$144.8	$340.2	$289.2	0.2074	$70.6	$59.97
2047	1,702	1532	0.1138	$174.3	$148.2	486	389	0.4551	$176.9	$150.3	$351.2	$298.5	0.1957	$68.7	$58.42
2048	1,718	1546	0.1158	$179.0	$152.1	495	396	0.4631	$183.6	$156.0	$362.5	$308.2	0.1846	$66.9	$56.89
2049	1,734	1560	0.1178	$183.8	$156.2	505	404	0.4712	$190.5	$161.9	$374.3	$318.1	0.1741	$65.2	$55.39
2050	1,749	1574	0.1199	$188.7	$160.4	515	412	0.4794	$197.7	$168.1	$386.4	$328.4	0.1643	$63.5	$53.96
2051	1,765	1589	0.1220	$193.7	$164.7	526	421	0.4878	$205.2	$174.4	$398.9	$339.1	0.1550	$61.8	$52.56
2052	1,781	1603	0.1241	$198.9	$169.1	536	429	0.4964	$213.0	$181.0	$411.9	$350.1	0.1462	$60.2	$51.19
2053	1,797	1618	0.1263	$204.3	$173.6	547	438	0.5050	$221.0	$187.9	$425.3	$361.5	0.1379	$58.6	$49.85
2054	1,814	1632	0.1285	$209.7	$178.3	558	446	0.5139	$229.4	$195.0	$439.1	$373.2	0.1301	$57.1	$48.56
2055	1,830	1647	0.1307	$215.3	$183.0	569	455	0.5229	$238.1	$202.4	$453.4	$385.4	0.1228	$55.7	$47.33
2056	1,847	1662	0.1330	$221.1	$187.9	581	464	0.5320	$247.1	$210.0	$468.2	$397.9	0.1158	$54.2	$46.08
2057	1,864	1677	0.1353	$227.0	$193.0	592	474	0.5413	$256.4	$218.0	$483.4	$410.9	0.1093	$52.8	$44.91
2058	1,881	1693	0.1377	$233.1	$198.1	604	483	0.5508	$266.1	$226.2	$499.2	$424.3	0.1031	$51.5	$43.75
2059	1,898	1708	0.1401	$239.3	$203.4	616	493	0.5604	$276.2	$234.8	$515.5	$438.2	0.0972	$50.1	$42.59
2060	1,915	1724	0.1426	$245.7	$208.9	628	503	0.5703	$286.7	$243.7	$532.4	$452.5	0.0923	$49.1	$41.77
TOTALS											**$10,646.0**	**$9,049.1**		**$2,312.5**	**$1,965.6**

TABLE A2: FUEL TAX REBATES, CORRIDOR 1

Year	Net Lt Veh VMT (M)	Net Truck VMT (M)	6% NPV Factor	Lt. Veh. Mpg	Hvy Veh. Mpg	Lt Veh. EV share	Est. Hvy Veh EV share	State Gas Tax $/gal	State Diesel Tax $/gal	Lt Veh. Gas Tax Rebate ($M)	Hvy Veh. Diesel Tax Rebate ($M)	Total Fuel Tax Rebates ($M)	NPV Rebates ($M)
2019	1321	279	1.0000										
2020	1333	285	0.9434					0.269	0.273				
2021	1345	290	0.8900					0.269	0.273				
2022	1357	296	0.8396					0.269	0.273				
2023	1370	302	0.7921					0.269	0.273				
2024	1382	308	0.7473					0.269	0.273				
2025	1395	314	0.7050					0.282	0.287				
2026	1407	320	0.6651					0.282	0.287				
2027	1420	327	0.6274					0.282	0.287				
2028	1433	333	0.5919					0.282	0.287				
2029	1446	340	0.5584					0.282	0.287				
2030	1313	347	0.5268	30.0	8.4	0.045	0.01	0.287	0.292	$11.99	$11.94	$23.94	$12.61
2031	1325	354	0.4970	30.5	8.6	0.054	0.02	0.292	0.297	$12.00	$11.99	$23.98	$11.92
2032	1337	361	0.4689	31	8.7	0.063	0.03	0.297	0.302	$12.00	$12.17	$24.17	$11.34
2033	1350	368	0.4423	31.5	8.8	0.075	0.04	0.302	0.308	$11.98	$12.35	$24.33	$10.76
2034	1362	375	0.4173	31.9	9	0.095	0.05	0.308	0.313	$11.88	$12.39	$24.27	$10.13
2035	1374	383	0.3937	32.3	9.1	0.12	0.06	0.313	0.318	$11.71	$12.60	$24.31	$9.57
2036	1387	391	0.3714	32.7	9.2	0.153	0.07	0.318	0.324	$11.44	$12.81	$24.25	$9.01
2037	1399	398	0.3504	33	9.3	0.1845	0.08	0.324	0.330	$11.20	$12.98	$24.18	$8.47
2038	1412	406	0.3305	33.4	9.4	0.216	0.09	0.330	0.335	$10.93	$13.19	$24.11	$7.97
2039	1425	415	0.3118	33.7	9.5	0.2475	0.1	0.335	0.341	$10.67	$13.42	$24.09	$7.51
2040	1438	423	0.2942	33.9	9.5	0.279	0.12	0.341	0.347	$10.44	$13.61	$24.05	$7.07
2041	1451	431	0.2775	34.2	9.6	0.315	0.14	0.347	0.353	$10.09	$13.65	$23.74	$6.59
2042	1464	440	0.2618	34.4	9.7	0.358	0.16	0.353	0.360	$9.65	$13.70	$23.36	$6.11
2043	1478	449	0.2470	34.5	9.7	0.387	0.18	0.360	0.366	$9.44	$13.89	$23.33	$5.76
2044	1491	458	0.2330	34.7	9.8	0.408	0.2	0.366	0.372	$9.31	$13.92	$23.23	$5.41
2045	1505	467	0.2198	34.9	9.8	0.426	0.22	0.372	0.379	$9.21	$14.08	$23.29	$5.12
2046	1518	476	0.2074	35	9.8	0.444	0.24	0.379	0.385	$9.13	$14.23	$23.36	$4.85
2047	1532	486	0.1957	35.1	9.9	0.46	0.26	0.385	0.392	$9.08	$14.25	$23.33	$4.57
2048	1546	495	0.1846	35.2	9.9	0.473	0.28	0.392	0.399	$9.08	$14.37	$23.44	$4.33
2049	1560	505	0.1741	35.3	10	0.485	0.3	0.399	0.406	$9.08	$14.35	$23.43	$4.08
2050	1574	515	0.1643	35.4	10	0.497	0.32	0.406	0.413	$9.08	$14.47	$23.55	$3.87
2051	1589	526	0.1550	35.5	10.1	0.509	0.34	0.413	0.420	$9.08	$14.45	$23.53	$3.65
2052	1603	536	0.1462	35.6	10.1	0.521	0.36	0.420	0.428	$9.06	$14.53	$23.59	$3.45
2053	1618	547	0.1379	35.7	10.2	0.533	0.38	0.428	0.435	$9.05	$14.47	$23.52	$3.24
2054	1632	558	0.1301	35.8	10.2	0.545	0.4	0.435	0.443	$9.03	$14.54	$23.56	$3.07
2055	1674	569	0.1228	35.9	10.3	0.557	0.42	0.443	0.451	$9.15	$14.44	$23.58	$2.90
2056	1662	581	0.1158	36	10.3	0.569	0.44	0.450	0.458	$8.96	$14.48	$23.45	$2.72
2057	1677	592	0.1093	36.1	10.4	0.581	0.46	0.458	0.466	$8.92	$14.34	$23.26	$2.54
2058	1693	604	0.1031	36.2	10.4	0.593	0.48	0.466	0.475	$8.88	$14.33	$23.21	$2.39
2059	1708	616	0.0972	36.3	10.5	0.605	0.5	0.475	0.483	$8.82	$14.17	$22.99	$2.23
2060	1724	628	0.0923	36.4	10.5	0.617	0.52	0.483	0.491	$8.76	$14.11	$22.87	$2.11
TOTALS												**$733.32**	**$185.34**