Paving the Way to a Sustainable Future: The City of Russell's Transportation Reconstruction Plan

Benefit Cost Analysis Project Technical Memo

USDOT 2018 BUILD Transporation Discretionary Grants

Benefit Cost Analysis Project Summary Matrix

Current Status/Baseline & Problem to be Addressed	Change to Baseline/ Alternatives	Type of Impacts	Population Affected by Impacts	Economic Benefit
Aging pavement Streets dangerous to travel for vehicles, and bicyclists slowing down traffic	Replace existing streets	Reduce wear and tear on vehicles, reduce travel time and make it safer for bicyclists	Number of drivers with reduced wait time & number of accidents & injuries per year	Monetized value of reduced travel times, emissions, and accident costs
Aging pavement or no pavement for Sidewalks, pedestrians walking in the streets, not all sidewalks are ADA Compliant	Replace existing sidewalks and add sidewalks where needed make sidewalks ADA Compliant	Improves accessibility to multimodal travel, jobs, and activity areas for all community members	Number of pedestrians able to walk in a safer environment	Pavement Repair Savings
Travel time delays due to timed cycle length of stop lights	Replace existing stop lights	Reduce Wait time for vehicles	Number of drivers with reduced wait time	Personal time saved
Pedestrian crossings inadequate on Main Street	Add curb extensions	Reduce crossing time for pedestrians and accessibility to multimodal travel, jobs, and activity areas for all community members	Number of pedestrians able to cross in a safer environment	Greater foot traffic into local businesses

Benefit Cost Analysis Summary of Benefits

				Maintenance Cost				VTTS Savings	Accidents	Remaining Capital Value	
Calendar Year	Project Year	Alternative Construction Costs	Discounted Construction costs at 7%	Base Case	Discounted Base Case at 7%	Alternative	Discounted Alternative at 7%	Value of Travel Time Savings Discounted 7%	Discounted Base Case at 7%	Base Case	Alternative
2018	0	$ -	$ -	$ 134,846	$ 130,361	$ -	$ -	$ -	$ -	$ -	$ -
2019	1	$ 1,721,982	$ 1,609,329	$ 2,234,846	$ 2,019,166	$ -	$ -	$ -	$ -	$ -	$ -
2020	2	$ 3,857,241	$ 3,369,064	$ 134,846	$ 113,862	$ -	$ -	$ -	$ -	$ -	$ -
2021	3	$ 3,857,241	$ 3,148,658	$ 134,846	$ 106,413	$ -	$ -	$ -	$ -	$ -	$ -
2022	4	$ 3,857,241	$ 2,942,671	$ 134,846	$ 99,451	$ -	$ -	$ -	$ -	$ -	$ -
2023	5	$ 3,857,241	$ 2,750,160	$ 134,846	$ 92,945	$ -	$ -	$ -	$ -	$ -	$ -
2024	6	$ 3,857,241	$ 2,570,243	$ 134,846	$ 86,865	$ -	$ -	$ 4,064,463	$ 91,870	$ -	$ -
2025	7	$ -	$ -	$ 2,234,846	$ 1,345,455	$ -	$ -	$ 3,802,509	$ 85,860	$ -	$ -
2026	8	$ -	$ -	$ 134,846	$ 75,871	$ -	$ -	$ 3,557,435	$ 80,243	$ -	$ -
2027	9	$ -	$ -	$ 134,846	$ 70,908	$ -	$ -	$ 3,328,152	$ 74,993	$ -	$ -
2028	10	$ -	$ -	$ 134,846	$ 66,269	$ -	$ -	$ 3,113,644	$ 70,087	$ -	$ -
2029	11	$ -	$ -	$ 134,846	$ 61,933	$ -	$ -	$ 2,912,958	$ 65,502	$ -	$ -
2030	12	$ -	$ -	$ 134,846	$ 57,882	$ -	$ -	$ 2,725,204	$ 61,217	$ -	$ -
2031	13	$ -	$ -	$ 2,234,846	$ 896,534	$ -	$ -	$ 2,549,549	$ 57,212	$ -	$ -
2032	14	$ -	$ -	$ 134,846	$ 50,556	$ -	$ -	$ 2,385,214	$ 53,469	$ -	$ -
2033	15	$ -	$ -	$ 134,846	$ 47,249	$ -	$ -	$ 2,231,468	$ 49,971	$ -	$ -
2034	16	$ -	$ -	$ 134,846	$ 44,158	$ -	$ -	$ 2,087,631	$ 46,702	$ -	$ -
2035	17	$ -	$ -	$ 134,846	$ 41,269	$ -	$ -	$ 1,953,063	$ 43,647	$ -	$ -
2036	18	$ -	$ -	$ 134,846	$ 38,569	$ -	$ -	$ 1,827,167	$ 40,791	$ -	$ -
2037	19	$ -	$ -	$ 2,234,846	$ 597,398	$ -	$ -	$ 1,709,385	$ 38,123	$ 542,680	$ 3,705,971
Totals		$ 21,008,187	$ 16,390,123	$ 11,096,920	$ 6,043,112	$ -	$ -	$ 38,247,842	$ 859,685	$ 542,680	$ 3,705,971

	Option 1 <Build>	Option 2 <No Build>
Appraisal period (years)	20	20
Capital Costs	$21,008,187	$0
Whole of Life Costs	$21,277,879	$98,999,030
Cost-benefit analysis of monetary costs and benefits at the Public Sector Discount Rate		
Present Value of Benefits	$39,107,530	$16,251,096
Present Value of Costs	$16,642,316	$43,849,788
Benefit Cost Ratio	2.35	0.37
Net Present Value	$22,465,214	-$27,598,691

Assumptions and Methodology

A baseline of no build was compared to a build scenario. The baseline of no build assumed that repairs would be made each year using the average cost of repairs from 2013 to 2017 and dividing that by the total length of all streets to get a price per foot and multiplying that by the total length of the project. The baseline also assumed that an overlay of the concrete and asphalt streets would occur in 2019 and every five years. The benefits assumed in the baseline, is the cost of not building the roadways and sidewalks.

The build scenario assumed that repairs would take place in 2018 and 2019 until the project started in 2020. The cost of the project was split between six years. The first year, 2019, the cost of the design engineering was calculated and then the cost of construction was split evenly between the next four years. The build assumption included benefits of time savings and accident savings.

Benefit-Cost Analysis Period

For the purpose of this BCA, a 20-year time period that starts from the beginning of construction is used to total benefits and costs associated with Paving the Way to a Sustainable Future: The City of Russell's Transportation Reconstruction Plan. This represents a period in time during which the long-term impacts can be confidently forecasted.

The initial costs of construction are applied over the years construction will take place. Construction is assumed to take up to five years and start in 2020. Project benefits are assumed to take place in 2024 when the project has been completed.

It is expected that the service life of major infrastructure elements will exceed the analysis period and as a conservative measure, a residual value has been calculated based on the service life of twenty-five years for the surface and forty years for the subbase and base.

All costs and benefits were estimated in year 2017 dollars and are based on the recommended values provided in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs. A discount rate of 7 percent was applied to the calculated values.

BCA Spreadsheet Format

Two different spread sheets were used in the Benefit Cost Analysis (BCA). The first BCA Spreadsheet is split into five tabs: Summary, Residual Value, Yearly Cost of Repairs, VTTS (Value of Travel Time Savings), and Accidents.

The summary tab ties the other four tabs together presenting the conclusion of the BCA. The residual value tab calculates the value the project will retain in twenty years. The yearly cost of repairs tab calculates the cost of repairs related to the base case scenario. The value of travel

time savings calculates the value of time saved by drivers and the accident tab calculates the value of an accident.

The second spreadsheet compares a build scenario to a no build scenario. The build scenario takes the cost of construction and compares it with the benefits of the value of travel time savings and the savings form accidents. The no build scenario uses the costs of repairs and overlays as the cost and the cost of the construction of the build scenario as a benefit. The benefit is the cost savings of not building.

Residual Value

The calculation for the residual value to reconstruct the streets and sidewalks assumed that the preliminary engineering, removal of current pavement, engineering and the traffic signals would have no value after twenty years. The surface is projected to have a twenty-five year life. The subbase and base are projected to have a forty year life. The residual value of the reconstruction project at the end of twenty years is projected to be $3,705,970.59.

The residual value for the base case was calculated assuming that an asphalt overlay would take place every five years. In 2037, the last year of the time period projected, an asphalt overlay is projected to be done leaving the residual value to be $542,679.91. This figure was calculated by taking $2,100,000 of the cost of the overlay and discounting it to year twenty with a seven percent discount rate.

Yearly Cost of Repairs

The BCA compares the base case scenario to the reconstruction of the streets. The base case shows repair costs annually, it assumes an overlay of asphalt every five years. The overlay does not include the brick streets. The base case scenario assumes no maintenance of sidewalks from the city, except for a possible cost sharing of replacement of existing sidewalks. The owner of each parcel is ultimately responsible to replace or construct a new sidewalk at their expense in the City's right of way.

The cost of repairs every year is an average of the repairs to the streets done in 2013 through 2017 based on a price per foot and total length of the project. The cost of the overlay was projected by Bartlett & West, the City of Russell's engineers.

The alternate construction scenario is the total reconstruction of streets and sidewalks including replacement of twelve stoplights and twelve curb extensions.

The total repairs and maintenance done assuming the base case scenario is $6,043,112, which is discounted to 7 percent.

The analysis is shown in the table below discounted to 7 percent.

Calendar Year	Project Year	Pavement Maintenance Savings	Discounted to 7%
2018	0	$ 134,846	$ 130,360.55
2019	1	$ 2,234,846	$ 2,019,165.58
2020	2	$ 134,846	$ 113,861.95
2021	3	$ 134,846	$ 106,413.04
2022	4	$ 134,846	$ 99,451.44
2023	5	$ 134,846	$ 92,945.27
2024	6	$ 134,846	$ 86,864.74
2025	7	$ 2,234,846	$ 1,345,455.29
2026	8	$ 134,846	$ 75,871.03
2027	9	$ 134,846	$ 70,907.50
2028	10	$ 134,846	$ 66,268.69
2029	11	$ 134,846	$ 61,933.36
2030	12	$ 134,846	$ 57,881.64
2031	13	$ 2,234,846	$ 896,533.67
2032	14	$ 134,846	$ 50,556.07
2033	15	$ 134,846	$ 47,248.66
2034	16	$ 134,846	$ 44,157.63
2035	17	$ 134,846	$ 41,268.81
2036	18	$ 134,846	$ 38,568.98
2037	19	$ 2,234,846	$ 597,398.24
Total		$ 11,096,920	$ 6,043,112

When completing the residual value for the construct scenario, the surface was projected to last for twenty-five years. With this in mind the cost of maintenance was insignificant and not calculated.

Value of Travel Time Savings Calculation

The value of travel time savings calculation was calculated using the recommended hourly value of travel time savings provided in the Benefit-Cost Analysis Guidance for Discretionary Grant Programs. The amount used was $14.80 per person per hour for private vehicle travel for all purposes.

Elm Street and parts of Lincoln Street are so deteriorated that vehicles cannot safely travel at the posted speed limit of 30 mph. Being conservative, the assumption used for Elm and Lincoln Streets was a safe travel speed of 20 mph which is high for some parts of Elm Street. The 10 mph savings in dollars is $2.52, which is calculated by dividing 10 minutes by 60 minutes and multiplying that figure by $14.80.

Elm Street passes by Ruppenthal Middle School and 30 houses. The assumption used for Elm Street included a calculation of total number students and faculty of 216, times the number of school days, 172, times 2, the number of times student and faculty leave the building. It also included a calculation of 30 households that included 2.75 persons in each household, which was derived from the City of Russell's comprehensive plan, times 2 trips leaving the house a day times 365 days a year. This figure is on the conservative side due to the fact that many people leave their households more than 2 times a day. Also, no other traffic, besides school and household was considered in this figure to be on the conservative side.

Lincoln Street is one of four collectors that connects north Russell from south Russell across the Union Pacific railroad tracks. The assumption used for Lincoln Street included a calculation of 4,506 residents with a growth rate of 5 persons per year, as per the City of Russell's comprehensive plan, times 80 percent of the population using the road minus 11 percent of the population that does not have vehicles according to the 2010 census times 365 days a year times 2 trips a day.

It is concluded that $38,247,842 will be saved in travel time if the City proceeds with the construction scenario instead of the base case scenario. The value of time was discounted at 7 percent. The year of savings started at 2024 when the complete project will be finished.

The table below shows the calculated totals discounted by 7 percent.

Calendar Year	Project Year	Value of Travel Time Savings	Discounted Travel Time Savings at 7%
2024	6	$ 6,099,662.59	$ 4,064,462.73
2025	7	$ 6,105,999.13	$ 3,802,509.38
2026	8	$ 6,112,335.68	$ 3,557,435.02
2027	9	$ 6,118,672.23	$ 3,328,152.28
2028	10	$ 6,125,008.77	$ 3,113,643.87
2029	11	$ 6,131,345.32	$ 2,912,957.99
2030	12	$ 6,137,681.86	$ 2,725,204.15
2031	13	$ 6,144,018.41	$ 2,549,549.21
2032	14	$ 6,150,354.96	$ 2,385,213.69
2033	15	$ 6,156,691.50	$ 2,231,468.33
2034	16	$ 6,163,028.05	$ 2,087,630.83
2035	17	$ 6,169,364.59	$ 1,953,062.84
2036	18	$ 6,175,701.14	$ 1,827,167.13
2037	19	$ 6,182,037.69	$ 1,709,384.93
Total		$ 85,971,901.91	$ 38,247,842.38

Motor Vehicle Accidents

Motor vehicle accident data was calculated for the period of January 1, 2013 through May 8, 2018 and then averaged to come up with an accident rate per year. The value of accidents were calculated using the recommended value from the Benefit-Cost Analysis Guidance for Discretionary Grant Programs. The only type of accidents that occurred on the streets of the project was property damage only accidents and minor injury accidents.

Data was computed by the police department for a 5.5 year time span. The number of accidents that occurred in each category was averaged over the 5.5 year time span. The average amount of accidents then was multiplied by the value recommended in the Benefit-Cost Analysis Guidance. The accident savings was then discounted at 7%. The total number of savings of accidents if the project is completed will be $849,685.

The table below shows the calculated totals.

Calendar Year	Project Year	Accident Savings	Discounted at 7%
2024	6	$ 137,872	$ 91,869.69
2025	7	$ 137,872	$ 85,859.53
2026	8	$ 137,872	$ 80,242.55
2027	9	$ 137,872	$ 74,993.04
2028	10	$ 137,872	$ 70,086.95
2029	11	$ 137,872	$ 65,501.82
2030	12	$ 137,872	$ 61,216.66
2031	13	$ 137,872	$ 57,211.83
2032	14	$ 137,872	$ 53,469.00
2033	15	$ 137,872	$ 49,971.03
2034	16	$ 137,872	$ 46,701.89
2035	17	$ 137,872	$ 43,646.63
2036	18	$ 137,872	$ 40,791.24
2037	19	$ 137,872	$ 38,122.66
Total		$ 1,930,203	$ 859,684.50

Qualitative Benefits

The benefits that are not able to be shown as a quantitative figure include: safer travel of pedestrians, alternative modes of transportation for citizens with no vehicles, safer travel for bicycles, and the cost of maintenance on vehicles due to the road condition.

Constructing new sidewalks will provide safer travel to pedestrians. The base case scenario provides no maintenance of sidewalks. It is up to the parcel owners to provide sidewalks in the City right of way. The City of Russell has a cost sharing program for sidewalk replacement program for existing sidewalks only. The proposed project area is in a low income area where many of the residents cannot afford the cost sharing program. The new sidewalks will provide a means of transportation for the low income individuals whom cannot afford other means of transportation. It will connect them to local businesses schools and health care.

The base case scenario in its current state does not allow for safe travel for all modes of transportation. The sidewalks are uneven, disconnected or do not exist leaving pedestrians to walk in the streets. The streets are cracked or uneven which does not allow for safe travel by bicycle.

Connecting the sidewalks in the main corridor will allow citizens with no vehicles a safe way to travel to school, employment, recreation, and health care. With the base case scenario there is no easy way to travel throughout the main corridor of the city without walking in the streets or through yards. Children who walk to school have no connecting sidewalks and therefore find themselves walking in the streets.

Walking has health benefits that are not quantifiable. By connecting the sidewalks throughout the corridor it will give citizens an alternative to driving to and from work, school and other activities. By walking, citizens will gain a healthier life style that will increase their life expectancy.

The condition of the streets causes many alignment and maintenance problems for vehicles. This costs consumers more money for repairs. By doing nothing in the base case scenario causes vehicle owners a lot of money.

It is rough travel for Bicyclists with in the main corridor. The city is not bicycle friendly due to the condition of the streets. Bicycling is an alternative mode of transportation that focuses on a healthier life style increasing a longer life. Without safe travel for bicyclists throughout the streets many citizens do not travel by bicycle.

Benefit Cost Ratio and Net Present Value

As shown in the summary table below, the Build option has a positive net present value of $22,465,214 and the no build option has a negative net present value of $27,598,691. The benefit cost ratio for the build option is 2.35 and the no build option is .37. This make the build option a much stronger option.

	Option 1 <Build>	Option 2 <No Build>
Appraisal period (years)	20	20
Capital Costs	$21,008,187	$0
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Cost-benefit analysis of monetary costs and benefits at the Public Sector Discount Rate		
Present Value of Benefits	$39,107,530	$16,251,096
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Net Present Value	$22,465,214	-$27,598,691

The assumption used in the build option were, capital costs of $21,008,187 split between six years and repairs for the roads in 2018 and 2019 in the amount of $269,692 before construction is ready to start. These costs were then converted to present value using a 7% discount rate.

The benefits of the build scenario included the value of travel time savings that totaled $85,971,901.91 over a 14 year period starting after construction is complete. This figure was converted to net present value using a 7% discount rate. Also, another benefit used was savings of accident costs. The total savings for 14 years assuming no savings until after the project is complete total $1,930,230 which was converted to net present value using a 7% discount rate.

He no build assumptions used a cost of repairs and asphalt overlays done every five years starting in 2019. The total cost of repairs and overlays amounted to $11,096,920 and then was discounted 7% for 20 years. Benefits in this scenario included the cost savings of the construction cost of $21,008,087, which was also discounted at 7%.

The benefit cost ratio in both scenarios was calculated by taking the present value of benefits and dividing it by the present value of costs.

Conclusion

After evaluating the different costs through the benefit analysis and the existing condition of the pavement, the build option is the best option. The concrete pavement will last considerably longer with less maintenance costs than the asphalt overlay in the no build option. Concrete has a 30-year life span with minimal maintenance costs. There will be minimal maintenance for the next 5-10 years. The local economy will benefit by improved roadways and better access to services. The appearance of the community will greatly improve. During winter, snow removal will be easier with a smother surface; especially since a majority of the roadways in this project are primary snow routes.

With the no build option the current street conditions will continue to worsen at an increasing rate and the future cot of replacement will be more than the current cost of reconstruction now.

Construction costs will continue to increase plus the long that roadway improvements are delayed the worse shape that the subgrade and roadway base will be and will require additional subgrade reconstruction under the roadway.