Economic Evaluation Complete Report  
Riverbend v2

NOTE: All bounds on uncertainties are given with a 95.0% confidence interval. The number of runs was determined with a 0.1% tolerance.

For Base (Alternative 0) 1000 Monte-Carlo simulations were run.

For Retrofit (Alternative 1) 18000 Monte-Carlo simulations were run.

For New Bridge (Alternative 2) 9000 Monte-Carlo simulations were run.

The random number seed for these runs was 70819614.

# Analysis Base Information

* Number of Alternatives: 2
* Planning Horizon: 50 years
* Discount Rate: 3.0%
* Disaster Rate: Every 25 years
* Uncertainty in Disaster Rate: N/A
* Disaster Magnitude: 6.25% of build cost
* Uncertainty in Disaster Magnitude: N/A
* Risk Preference: neutral
* Statistical Value of a Life: $7500000

# Summary

|  |  |  |  |
| --- | --- | --- | --- |
|  | Base | Retrofit | New Bridge |
| Total Benefits ($) | 0 | 3,795,704 | 8,859,566 |
| (Lower Bound, Upper Bound) ($) | (0; 0) | (2,510,077; 5,078,943) | (6,487,640; 11,024,072) |
| Total Costs ($) | 0 | 3,500,000 | 7,777,368 |
| (Lower Bound, Upper Bound) ($) | (0; 0) | (3,456,450; 4,279,445) | (7,700,214; 8,989,256) |
| Externalities ($) | 0 | 0 | 3,984,762 |
| (Lower Bound, Upper Bound) ($) | (0; 0) | (0; 0) | (3,984,762; 3,984,762) |
| Net with externalities ($) | 0 | 295,704 | 5,066,960 |
| (Lower Bound, Upper Bound) ($) | (0; 0) | (-1,366,659; 1,335,737) | (2,086,003; 6,831,803) |
| SIR with externalities(%) | No Valid SIR | 0.08 | 0.72 |
| (Lower Bound, Upper Bound) ($) | (No Valid SIR; No Valid SIR) | (-0.35; 0.37) | (0.27; 0.94) |
| IRR with externalities (%) | --- | 3.45 | 6.37 |
| (Lower Bound, Upper Bound) ($) | (---; ---) | (0.91; 4.86) | (4.33; 7.31) |
| ROI with externalities (%) | No Valid ROI | 2.17 | 3.30 |
| (Lower Bound, Upper Bound) ($) | (No Valid ROI; No Valid ROI) | (1.30; 2.73) | (2.49; 3.70) |
| Non-Disaster ROI with externalities (%) | No Valid ROI | 0.00% | 1.68% |
| (Lower Bound, Upper Bound) ($) | (No Valid ROI; No Valid ROI) | (0.00; 0.00) | (1.38; 1.71) |
| Net ($) | 0 | 295,704 | 1,082,198 |
| (Lower Bound, Upper Bound) ($) | (0; 0) | (-1,366,659; 1,335,737) | (-1,898,759; 2,847,042) |
| SIR (%) | No Valid SIR | 0.08 | 0.15 |
| (Lower Bound, Upper Bound) ($) | (No Valid SIR; No Valid SIR) | (-0.35; 0.37) | (-0.24; 0.39) |
| IRR (%) | --- | 3.45 | 3.79 |
| (Lower Bound, Upper Bound) ($) | (---; ---) | (0.91; 4.86) | (1.61; 4.95) |
| ROI (%) | No Valid ROI | 2.17 | 2.28 |
| (Lower Bound, Upper Bound) ($) | (No Valid ROI; No Valid ROI) | (1.30; 2.73) | (1.55; 2.71) |
| Non-Disaster ROI (%) | No Valid ROI | 0.00% | 0.66% |
| (Lower Bound, Upper Bound) ($) | (No Valid ROI; No Valid ROI) | (0.00; 0.00) | (0.46; 0.70) |

# Base

### Alternative 0

## Fatalities Averted

Number of Statistical Lives Saved: 0.00

Value of Statistical Lives Saved: $0

## Disaster-Related Benefits

|  |  |  |
| --- | --- | --- |
| Title | Amount ($) | Effective Present Value ($) |
| Response and Recovery Cost Reductions |  | 0 |
| Direct Losses Prevented |  | 0 |
| Indirect Losses Prevented |  | 0 |
| Total |  | 0 |

## Resilience Dividend

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Cost Reductions |  |  |  | 0 |
| Recurring Cost Reductions |  |  |  | 0 |
| Total |  |  |  | 0 |

## Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| Direct Costs |  |  |  | 0 |
| Indirect Costs |  |  |  | 0 |
| OMR Costs: One-Time |  |  |  | 0 |
| OMR Costs: Recurring |  |  |  | 0 |
| Total |  |  |  | 0 |

## Externalities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Positive Externalities |  |  |  | 0 |
| Recurring Positive Externalities |  |  |  | 0 |
| One Time Negative Externalities |  |  |  | 0 |
| Recurring Negative Externalities |  |  |  | 0 |
| Total |  |  |  | 0 |

# Retrofit

### Alternative 1

## Fatalities Averted

Number of Statistical Lives Saved: 0.20

Value of Statistical Lives Saved: $788,581

Description: Estimated reduction in the number of fatalities due to a seismic event with a 25 year return period.

## Disaster-Related Benefits

|  |  |  |
| --- | --- | --- |
| Title | Amount ($) | Effective Present Value ($) |
| Response and Recovery Cost Reductions |  | 630,865 |
| Retrofit Response and Recovery | 600,000 | 630,865 |
| Direct Losses Prevented |  | 273,375 |
| Retrofit Direct Loss Reduction | 260,000 | 273,375 |
| Indirect Losses Prevented |  | 2,102,883 |
| Retrofit Indirect Loss Reduction | 2,000,000 | 2,102,883 |
| Total |  | 3,007,123 |

Retrofit Indirect Loss Reduction: Gaussian distribution with standard deviation of 600000

Retrofit Indirect Loss Reduction: Estimated reduction in indirect losses as a result of a seismic event with a 25 year return period.

Retrofit Response and Recovery: Gaussian distribution with standard deviation of 180000

Retrofit Response and Recovery: Estimated reduction in response in recovery costs for a seismic event with a 25 year return period.

Retrofit Direct Loss Reduction: Estimated reduction in direct losses as a result of a seismic event with a 25 year return period.

## Resilience Dividend

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Cost Reductions |  |  |  | 0 |
| Recurring Cost Reductions |  |  |  | 0 |
| Total |  |  |  | 0 |

## Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| Direct Costs |  |  |  | 3,000,000 |
| Retrofit Direct Cost | Start-Up | N/A | 3,000,000 | 3,000,000 |
| Indirect Costs |  |  |  | 500,000 |
| Retrofit Indirect Cost | Start-Up | N/A | 500,000 | 500,000 |
| OMR Costs: One-Time |  |  |  | 0 |
| OMR Costs: Recurring |  |  |  | 0 |
| Total |  |  |  | 3,500,000 |

Retrofit Indirect Cost: Triangular distribution with a min of 475000 and a max of 750000

Retrofit Indirect Cost: Indirect costs for retrofitting the old bridge. This includes indirect costs of the retrofit actions as well as costs associated with diverted traffic.

Retrofit Direct Cost: Triangular distribution with a min of 2850000 and a max of 3840000

Retrofit Direct Cost: Cost to retrofit the old bridge.

## Externalities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Positive Externalities |  |  |  | 0 |
| Recurring Positive Externalities |  |  |  | 0 |
| One Time Negative Externalities |  |  |  | 0 |
| Recurring Negative Externalities |  |  |  | 0 |
| Total |  |  |  | 0 |

# New Bridge

### Alternative 2

## Fatalities Averted

Number of Statistical Lives Saved: 0.40

Value of Statistical Lives Saved: $1,577,162

Description: Estimated reduction in the number of fatalities due to a seismic event with a 25 year return period.

## Disaster-Related Benefits

|  |  |  |
| --- | --- | --- |
| Title | Amount ($) | Effective Present Value ($) |
| Response and Recovery Cost Reductions |  | 1,051,442 |
| New Bridge Response and Recovery | 1,000,000 | 1,051,442 |
| Direct Losses Prevented |  | 0 |
| Indirect Losses Prevented |  | 3,680,045 |
| New Bridge Indirect Loss Reduction | 3,500,000 | 3,680,045 |
| Total |  | 4,731,487 |

New Bridge Indirect Loss Reduction: Gaussian distribution with standard deviation of 1050000

New Bridge Indirect Loss Reduction: Estimated reduction in indirect losses as a result of a seismic event with a 25 year return period.

New Bridge Response and Recovery: Gaussian distribution with standard deviation of 300000

New Bridge Response and Recovery: Estimated reduction in response in recovery costs for a seismic event with a 25 year return period.

## Resilience Dividend

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Cost Reductions |  |  |  | 0 |
| Recurring Cost Reductions |  |  |  | 2,550,917 |
| Reduced Commute Time | 1 | 1 | 100,000 | 2,550,917 |
| Total |  |  |  | 2,550,917 |

Reduced Commute Time: Triangular distribution with a min of 70000 and a max of 115000

Reduced Commute Time: Estimated benefit incurred due to the reduction of vehicle-hours in traffic as a result of an additional crossing. This benefit is separate from the externalities which focus on community level environmental and social impacts which are not internalized. Instead represent the value of a reduction in travel time itself internalized into the design process.,

## Costs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| Direct Costs |  |  |  | 6,750,000 |
| Additional Roadwork Direct Cost | Start-Up | N/A | 2,500,000 | 2,500,000 |
| Bridge Construction Direct Cost | Start-Up | N/A | 4,250,000 | 4,250,000 |
| Indirect Costs |  |  |  | 295,000 |
| Additional Roadwork Indirect Cost | Start-Up | N/A | 120,000 | 120,000 |
| Bridge Construction Indirect Cost | Start-Up | N/A | 175,000 | 175,000 |
| OMR Costs: One-Time |  |  |  | 0 |
| OMR Costs: Recurring |  |  |  | 732,368 |
| New Bridge OMR | 1 | 1 | 25,000 | 637,729 |
| Additional Roadwork OMR | 1 | 1 | 3,710 | 94,639 |
| Total |  |  |  | 7,777,368 |

New Bridge OMR: Rectangular distribution with a min of 21375 and a max of 30000

New Bridge OMR: Cost of operating and maintaining new bridge. Includes costs of inspection as well as maintenance and deck and superstructure repair.

Additional Roadwork Indirect Cost: Triangular distribution with a min of 114000 and a max of 144000

Additional Roadwork Indirect Cost: Indirect costs to construct and update roadways to accommodate the new bridge.

Bridge Construction Indirect Cost: Triangular distribution with a min of 166250 and a max of 224000

Bridge Construction Indirect Cost: Indirect costs associated with the construction of the new bridge including the costs of an environmental impact study.

Additional Roadwork Direct Cost: Triangular distribution with a min of 2375000 and a max of 3000000

Additional Roadwork Direct Cost: Cost to construct and update roadways to accommodate the new bridge.

Bridge Construction Direct Cost: Triangular distribution with a min of 4037500 and a max of 5440000

Bridge Construction Direct Cost: Cost of new bridge including any right of way or land acquisition costs.

Additional Roadwork OMR: Rectangular distribution with a min of 3500 and a max of 4250

Additional Roadwork OMR: Cost of operations and maintenance for upgraded and newly constructed roads to accommodate the new bridge.

## Externalities

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Title | Start Year | Recurrence (Years) | Amount ($) | Effective Present Value ($) |
| One Time Positive Externalities |  |  |  | 0 |
| Recurring Positive Externalities |  |  |  | 3,984,762 |
| Greenhous Gas Emissions | 1.0 | 1.0 | 77,329 | 1,972,598 |
| Water Pollution | 1.0 | 1.0 | 39,081 | 996,924 |
| Better linking of communities | 1.0 | 1.0 | 39,799 | 1,015,239 |
| One Time Negative Externalities |  |  |  | 0 |
| Recurring Negative Externalities |  |  |  | 0 |
| Total |  |  |  | 3,984,762 |

Greenhous Gas Emissions: The reduction in greenhouse gas emissions incurred due to fewer vehicle-hours in traffic over the year. This assumes that traffic remains at pre-action levels (i.e. a more efficient road network won't attract more motorists).,

Water Pollution: The reduction in water pollution incurred due to fewer vehicle-hours in traffic over the year. This assumes that traffic remains at pre-action levels (i.e. a more efficient road network won't attract more motorists).,

Better linking of communities: More efficient traffic flow and the inclusion of a pedestrian crossing help strengthen the link between communities on the two sides of the river.,