**Parkway Corridor Class EA**
**Benefit Cost Assessment of Alternatives**
**Assumptions and Approach**

## Introduction

For the purpose of the Environmental Assessment process, the Benefit-Cost analysis is being used as one of a number of criteria to compare the advantages and disadvantages of various network improvement alternatives. At this stage of the project, the planning level cost estimates, preliminary analysis results, and assumptions used to date are not intended, and should not be portrayed as the final conclusion for the study or the final result for any one alternative.

As the project progresses, the preliminary design for the preferred alternative will be developed to a greater level of detail and the capital construction and property costs will be able to be estimated with greater confidence. The implementation plan for the preferred alternative may also influence the assumptions related to timing of the costs and benefits. Different assumptions for implementation or how the costs and benefits have been estimated could be argued, but for the purpose of comparison, any changes would change the results for each alternative equally.

Table 1 presents a summary of the Benefit-Cost analysis results presented at PIC #2 in support of the evaluation of network alternatives for the north and south ends of the study area. The costs and benefits of the Jackson Park Valley Alternatives are not included in this analysis and will be incorporated in subsequent versions of the analysis to support the Step 3 evaluation process.

**Table 1 – Summary of Benefit –Cost Results**

| | Present Value Costs $ | Present Value Benefits $ | Benefit-Cost Ratio |
|---|---|---|---|
| **South Alternatives** | | | |
| 1 - Parkway Corridor | $20,555,800 | $21,630,800 | 1.05 |
| 2 - Parkway - Goodfellow - Clonsilla | $25,703,200 | $19,056,800 | 0.74 |
| 3- Clonsilla Widening | $27,591,000 | $18,985,800 | 0.69 |
| 4 - Parkway Corridor - Revised Alignment | $20,555,800 | $21,630,800 | 1.05 |
| | | | |
| **North Alternatives** | | | |
| 1 - Parkway Corridor | $20,555,800 | $21,630,800 | 1.05 |
| 2- Fairbairn St / 3rd Line widening | $30,203,400 | $10,553,800 | 0.53 |
| 3- Parkhill Rd / Water St widening | $40,582,800 | $17,860,300 | 0.44 |

The intent of this working paper is to provide the technical methodology and assumptions used to generate the inputs and outputs of the benefit-cost analysis. At the end of this discussion paper, a summary of the key differences in methodology has been presented to explain the differences between these results and the previous Benefit-Cost analysis completed by Morrison Hershfield in 2003.

## General Approach

The Benefit-Cost Assessment (BCA) used travel time savings and vehicle operating cost savings as the primary measures of reliable and quantifiable benefits associated with the various alternatives. These measures were extracted from the updated transportation model developed for use as part of the 2012 Comprehensive Transportation Master Plan completed by Morrison Hershfield. This model was updated using the most recent (2006) Transportation Tomorrow Survey travel data for the Peterborough area and was recalibrated to better estimate speeds and travel times compared to the older model that was used in the previous 2002 Transportation Master Plan. Documentation of the model development and calibration work can be found in the 2012 Comprehensive Transportation Master Plan report on the City of Peterborough website at the following link.

http://www.peterborough.ca/Living/City_Services/Transportation.htm

Collision costs are often used in BCA, and collision reduction can also represent a significant cost savings for projects that provide measurable safety benefits. Given the network wide approach to the estimation of the other benefits, and the lack of reliable network wide statistics on collision patterns within the City of Peterborough, it is difficult to estimate a network wide collision reduction benefit with any degree of certainty. It is noted however, that the potential collision performance of a semi-controlled access Parkway Route (semi-controlled because there are very few direct driveways and minor sideroads that intersect with the route) is expected to offer significant safety performance benefits (i.e. reduced collision experience) compared to a widening of Fairbairn Street or Parkhill Road to 4 lanes and a widening of Clonsilla Avenue to 6-7 lanes due to the numerous direct driveways and minor sideroads that intersect with these roads. From this perspective, the estimated benefits can be considered as conservative to the low side.

## How the Model Works

The model area is divided into a series of traffic zones which generate and attract trip making activity based on projected population and employment within each zone. The model uses existing observed origin-destination information to forecast future travel demand patterns based on where new growth in population and employment will be located in the city and the surrounding rural communities.

The routing of vehicles through the transportation network is undertaken using a macro modelling approach where vehicle speeds are estimated as a function of existing free flow speeds, and the volume to capacity ratio on the link. As the volume-capacity ratio increases and approaches 1.0, the speeds are reduced to reflect slower operating speeds associated with congestion.

The model uses an iterative approach to determine the best routes to use between each origin and destination and the number of vehicles that will be assigned to each road link by comparing the travel times of the various routes and assigning vehicles to the routes that provide the best travel time. As the most attractive routes approach their capacity, the next iteration will reroute trips to paths with better travel times, and so on. We use 100 iterations in each model run. When the trips cannot change their route to save time, the model has reached equilibrium which is viewed to represent an approximation of how motorists drive in real life. (i.e. everyone knows the best route to use to get to a destination accounting for distance and traffic and ultimately travel time).

When a new road link is added to the model, the same traffic assignment process is used to determine how many trips will use this route for part or their entire journey. By definition, any trips that the model assigns to use a new road corridor will save some travel time compared to the route they would have used without the corridor in place. This point is fundamental to consider in viewing the results of this study and past studies.

All of the 2031 network scenarios used the same travel demands and there are 31,810 vehicle trips that are loaded into the model road network, with about 1400 of these representing external traffic passing through the area (i.e. from Highway 7 East or Highway 28 north to Highway 115 south). External traffic demands were estimated from MTO Origin-destination surveys completed in 2007 on Highway 7, Highway 28, and Highway 115 in the Peterborough Area. From the model run with the Parkway Corridor in place, there are about 3,975 trips that would use at least one portion of the Parkway corridor in the PM peak hour between Cumberland Avenue and Lansdowne Street (including Medical Drive) but the volume of traffic varies by segment. This represents about 12.5% of the total trips in the model area.

After the model is run, travel time estimates for the entire road network are extracted to determine the benefits of each of the alternatives. These benefits reflect the fact that vehicles which shift to the new or improved route will (by definition) experience some time savings, and other road users may also experience savings due to lower traffic levels and improved travel times on the competing roads. Some roads that experience higher volumes will experience increased travel times and this impact is accounted for in the calculations. The same network approach to quantifying travel time benefits was used for the recent 2012 Transportation Plan and the previous West Side Corridor Study and subsequent 2003 Benefit-Cost Study.

**Estimating Travel Time Savings**

Using the transportation model, PM peak hour network wide travel times were estimated for each network scenario for the 2031 horizon year. The travel time savings were estimated by comparing the network wide travel times for the Base Case scenario to the various network alternatives, with the difference representing time savings expressed in veh-hrs. The model runs assumed population and employment growth based on the City Official Plan and the 2012 Comprehensive Transportation Master Plan (herein referred to as the 2012 TMP).

The model runs also assumed that the transit use would increase from 4% of peak hour trips to 6% by 2031 and that non-auto trips (walking and cycling) would increase from 6% to 8% of peak hour trips by 2031. These assumptions are consistent with the policy recommendations contained in the 2012 TMP and result in a reduction in auto demand of approximately 900 vehicles per hr (based on internal trips only) from what one would normally expect if current trends continued in the future. All of the network scenarios tested also assumed the full implementation of all other road improvement projects included in the 2012 TMP.

Peak hour travel time savings estimated by the model were expanded to annual veh-hrs of time savings by applying a factor of 2600 (representing 10% of daily demand in the peak hour x 260 weekdays per year). Data from the 2006 Transportation Tomorrow survey shows that PM peak hour trip making in the City of Peterborough currently represents 9.8% of the daily demand.

*Since our Public Meeting held March 2012 we received a number of requests from members of the public to provide information on the potential time savings associated with the preliminary recommended network in the north and south ends of the study area.*

*We have undertaken some further review and verification of the travel times produced by the model compared to actual travel times during the afternoon peak period. This review is not yet finished, however early observations suggest that the model may be underestimating actual travel times by 15-20% on some routes that feature a number of turns at intersections. Since the city-wide model does not explicitly simulate the operation of intersections and any delays associated with traffic signals or stop signs, the link performance functions used by the model are set during the calibration stage of model development to approximate this additional time. Based on these early findings, there is potential that the travel time savings that have been reported for all of the alternatives are also conservative to the low side.*

*The need for more detailed simulation modelling work was identified as part of our next stage of work to verify the operational performance of various intersection configuration options. This additional detailed modelling work will also incorporate the time spent by vehicles at intersections or in roundabouts and we will look to update our assessment with these results once they are available.*

**Travel Time Benefits Not Included in Benefit-Cost Assessment**

**Saturdays -** Additional time savings for Saturdays were not included as the model is not designed to forecast Saturday or Sunday travel conditions, although in many areas of the City the Saturday peak period exhibits worse congestion than the traditional weekday pm peak period. Since the value of travel time savings are also not as high on weekends due to the lower share of work related trip making, these benefits have been excluded to be conservative in the estimation.

*Metrolinx (the Regional Planning Agency for the GTA) uses a factor of 3000 in Benefit-Cost calculations for transportation investment projects to convert peak hour model results to annual figures. This represents 10% of daily traffic in the peak hour and 300 days per year. The use of the 300 factor to convert daily savings to annual savings recognizes that time savings would also be experienced on weekends, and these are estimated at roughly half of the savings generated on weekdays. To be conservative our approach has been to exclude these additional benefits.*

**Trucks -** Travel time savings for truck traffic has also not been included in the analysis. The City transportation model does not contain detailed origin-destination information for truck traffic. On many of the major arterial roads in the city, truck traffic represents 2-3% of peak hour demands based on traffic count data collected by the City. Truck traffic may benefit from the improved capacity offered by each of the alternatives, however, since detailed data on truck movements and future truck movement demands in the City are not available, it is not possible to provide reliable estimates of the specific benefits to truck traffic for each alternative, other than an approach based on the auto travel time savings.

The Value of Time typically used for commercial vehicle traffic is $50 / hr, based on values used by the Ontario Ministry of Transportation. Assuming a generic peak hour truck percentage of 3% across the city, the estimated value of the travel time savings could be in the order of $90,000 – $120,000 per year across the range of alternatives (approximately 7% of the auto travel time savings), but this assumes a uniform distribution of truck traffic which may not necessarily be correct. Some road corridors may experience higher truck use than the 3% average and others may see very little truck use. Given this uncertainty we have excluded these benefits from the BCA calculations as well, but it is important to recognize that they do exist to some degree.

As a result, the travel time savings estimates and resulting benefits can also be considered as somewhat conservative for all alternatives.

**Converting Time Savings to Economic Benefits**

The annual travel time savings were monetized assuming an average auto occupancy of 1.27 persons / vehicle (consistent with the mode share assumptions used in the 2012 TMP) and average value of time of $15.75 per hour in 2031. This is consistent with the equivalent hourly wage rate from the 2006 Census expressed in 2031 dollars assuming a 1% annual inflation rate. If the median earnings of full time employees were to be considered, a more appropriate wage rate would be $25.00 per hour. Given that the model is based on pm peak hour conditions, where the travel demands include work trips by full and part time employees plus those not employed, we felt the lower rate was more appropriate. The combination of these two factors results in Value of Time of about $20 / veh-hr of travel time savings.

Vehicle operating costs savings were also estimated from the transportation model based on the total network-wide veh-km of travel estimated for each model run scenario, again compared to the base case scenario. The same peak hour to annual expansion factors were used and the total annual veh-km travel savings were assigned a value using a cost of $0.17 per km which is based on the Average Annual Vehicle Operating Costs for 2012 published by CAA. Given the range in vehicle operating costs, from a low of 12.9 cents/ km for a Honda Civic to the 16.68 cents per km used for the Toyota Camry, these values were not inflated to 2031 dollars.

**Combining North and South End Benefits**

Since network wide delay savings estimates were generated from the model it did not make sense to separate the travel time or vehicle operating cost savings between the north and south ends of the study area, since these benefits are not mutually exclusive. For the south end network scenarios, the model was run for each south end alternative, assuming the 2 lane arterial road in the Parkway corridor between Fairbairn Street and Cumberland Avenue, as per the 2012 TMP. For the north end network alternatives, each scenario was run with the recommended south end alternative from this study established in Step 1 of the evaluation (the new 2 lane arterial in the Parkway corridor between Sherbrooke Street and The Parkway / Clonsilla Avenue intersection). For this reason, the South End Alternative 1 and North End Alternative 1 have the same travel time benefits and same costs as illustrated in Table 1, below. The costs and benefits for the combination of improvements was used to estimate the benefit-cost ratios presented in our results.

The estimated annual travel time savings and vehicle operating cost savings for each network alternative are presented in **Table 2**.

**Table 2 – Annual Travel Time / Vehicle Operating Cost Savings**

| | 2031 Travel Time Savings<br>Annual veh-hrs | 2031 Travel Time Savings<br>Annual $ | 2031 Vehicle Travel Savings<br>Annual veh-km | 2031 Vehicle Operating Cost Savings<br>Annual $ |
|---|---|---|---|---|
| **South Alternatives** | | | | |
| 1 - Parkway Corridor | 80,860 | $1,620,000 | 2,115,900 | $359,700 |
| 2 - Parkway - Goodfellow - Clonsilla | 73,060 | $1,459,000 | 1,656,600 | $281,600 |
| 3- Clonsilla Widening | 69,420 | $1,390,000 | 2,046,700 | $347,900 |
| 4 - Parkway Corridor - Revised Alignment | 80,860 | $1,620,000 | 2,115,900 | $359,700 |
| **North Alternatives** | | | | |
| 1 - Parkway Corridor | 80,860 | $1,620,000 | 2,115,900 | $359,700 |
| 2- Fairbairn St / 3rd Line widening | 60,320 | $1,206,000 | (1,422,588) | ($241,800) |
| 3- Parkhill Rd / Water St widening | 67,100 | $1,340,000 | 1,714,153 | $241,400 |

Notes -

South Alternatives modelled with North Alt 1 in place per TMP recommendation
North Alternatives modelled with recommended South Alt 4 in place
No difference in model results between South Alternatives 1 and 4
Fairbairn Alternative 2 results higher vehicle operating costs compared to base case due to increased out of way travel, resulting in negative benefits

## Induced Demand

The travel demand forecasting work did not include any induced demand. The same overall demand for travel was used in the modelling of each scenario, including the Do Nothing scenario (without the Parkway Corridor in place). In this approach drivers may change their route as result of road network improvements that reduce travel times but no new demand is generated. As a result of the shift in route choice, higher traffic volumes would be experienced on portions of the network, however this would be offset by traffic volume reductions in other areas of the network.

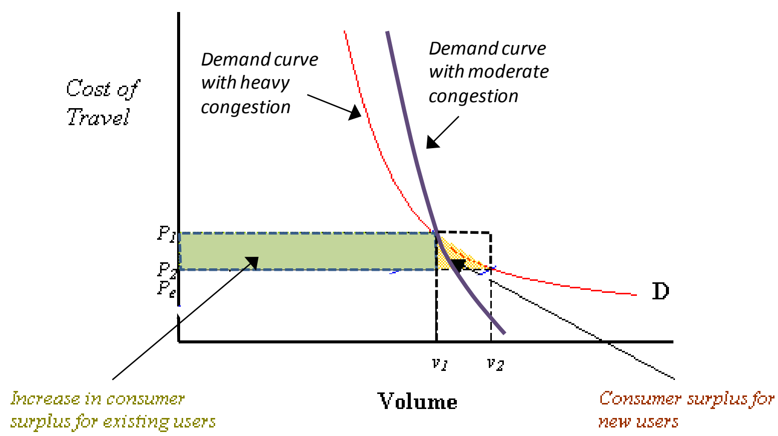
The issue of induced traffic is complex. In a heavily congested network (such as the Toronto area) some travelers choose to defer making trips, some travel outside of peak periods, and others shift to travel by other modes (such as transit) to avoid traffic congestion. In these cases, the addition of road network capacity may improve peak period auto travel times enough to "induce" these users to change their trip making and revert back to travel by auto during the peak periods. Even these are not necessarily new trips – they are just trips added to the peak periods instead of other periods of the day or other travel modes. Generally, a corresponding reduction in demand would occur in the off peak periods or in the number of trips made by other modes as a result. In BCA these shifts are treated as new demand and the travel time benefits are reduced by 50% using the consumer surplus theory.

*What is Consumer Surplus?* - Each user of a transportation facility is willing to pay a certain price (in terms of time, accident risk, vehicle operating costs, tolls, etc.) to travel on that facility. This amount will differ from user to user. However, every user typically incurs the same travel time costs. The difference between what a group of users is willing to pay in terms of travel costs (travel time, etc.) and what they actually pay is called consumer surplus. In a benefit cost analysis the travel time benefits of the project are generated by the change in consumer surplus attributable to a transportation improvement. For existing users the consumer surplus is the simply the difference in travel time before and after the improvement.

The new users who did not previously make a trip, did not travel by automobile, or did not travel during the peak time period are considered as new or "induced" trips. They do not have a previous cost of travel, but since the cost of travel is reduced, they change their travel behavior to take advantage of the implied cost savings. Their change in consumer surplus can be estimated by finding the area below the demand curve and above the horizontal line at the new travel cost P2 and between v1 and v2. See **Figure 1**.

The shape of the demand curve depends on the level of congestion in the transportation network and the degree to which this congestion influences travel behaviour. In heavily congested networks, such as the GTA, the change in demand can be quite noticeable when the cost of travel is reduced, as travelers shift to travel by a more desirable mode of travel or time period. In networks with moderate congestion, the change in demand is not overly sensitive to the cost of travel and the curve is closer to a vertical line. If the change in the cost of travel or change in demand is relatively small, the curve can be assumed linear, thereby making the calculations simple with the area under the curve representing half of the area of the "square". For these "induced" users the travel time savings are approximately 50% of the time savings attributed to existing users.

**Figure 1 : Change in consumer surplus due to a transportation facility improvement**




The extent of peak period congestion in Peterborough is not expected to be so significant by 2031 to suppress trip making, or force drivers to travel outside of peak times or by other modes of travel simply to avoid congestion. The demand curve is more representative of a network with moderate congestion. That being said, there is clear evidence to show that motorists are already diverting to use other routes to avoid congestion or delays within the City (i.e. the continued growth in traffic on University Road and Television Road on the east side of the City to access new development areas in the north end of the City). Given the expected shift in trip making is expected to be small, the consumer surplus approach was not utilized to discount the travel time benefits, as there is no assumed shift in modes and no "new" demand generated by the capacity provided for any of the alternatives.

The other case where induced traffic can be found is for a new highway or rail project that links two communities and reduces travel times between them significantly. In this case new inter-city travel may be induced; however this is often traffic that would have traveled within each community or to other communities prior to the improvement. This would be similar to the widening of Highway 35/115 which contributed to increased commuting between the Peterborough Area and Durham Region, for example. This condition also does not apply in the context of the Parkway Corridor study as the majority of traffic is internal to the City and the new road capacity provided does not fundamentally change travel times between adjacent communities.

**Cost Estimation**

The cost side of the benefit-cost calculation included planning level estimates of capital costs, property acquisition costs, and annual maintenance costs. As with the transportation benefits noted above, the costs for the south end alternatives also include the costs for the Parkway Alternative in the north end (as this was the TMP recommendation). For the north end alternatives the costs include the costs for the recommended south end alternative #4 – the Parkway corridor with the revised alignment.

The capital costs were estimated using unit (per km) rates for typical widening and new road construction projects. The unit cost rates are based on the average capital costs experienced on a range of similar projects in Peterborough and across southern Ontario which include the basic road construction costs and many of the additional features that would be implemented on a project of this nature (storm sewers, storm water management ponds, noise walls, earth work, paving, structures and culverts, etc).

A separate cost for major intersections have also been added based on the number of major intersections along each route, to account for turning lanes, traffic lights or roundabouts, etc. At this stage of the project detailed designs have not been developed for each of the alternatives to provide more project specific cost estimates, and many elements of the final design have not yet been established (i.e. amount of earth to be moved, number and size of stormwater ponds, intersection treatments, locations and details of noise mitigation treatments, etc). This level of detail will be developed for the preferred alternative and the final preliminary design and the final project cost estimate will include these project specific treatments. Accordingly, the unit cost estimates have been estimated on a conservative basis, likely to the high side.

For example, for typical road widening cost we have used a rate of $4.5 million per km and a new two lane arterial road has used a unit cost of $3.25 million / km. Costs for minor intersections are added to these unit costs at the rate $300,000 for a minor intersection and $450,000 for a major intersection to account for typical turning lanes and traffic controls (signals, roundabouts, etc). By comparison the bid price for phase 1 of the new Medical Drive was $6,900,000 for a 2.8 km segment of new two lane arterial with a large stormwater pond, 4 traffic lights (one is a partial signal for pedestrian crossing), storm sewers and noise walls, etc. This translates into a unit cost of just under $2.5 million per km.

At this stage in the analysis the costs associated with the Jackson Creek Valley Alternatives have not been included in the Benefit-Cost Analysis and the benefits associates with these alternatives have also not been included in the assessment. Our intent is to treat these as incremental costs and incremental benefits once this portion of the evaluation has progressed. The costs for these alternatives have been presented as a range and can vary depending on the specifics of each alternative (approach to widening Parkhill Road and Fairbairn Street, the use of roundabouts versus signalized intersections, the use of a long span versus short span bridge, etc).

- For a new roadway and bridge across the Jackson Creek Valley the costs have been estimated at $20-30 Million, depending on the choice of long span versus short span design concepts.
- For the widening of Fairbairn Street and Parkhill Road to go around the Valley and avoid the new bridge, the estimated cost is between $15-17 Million (including a rough estimate of the cost to acquire properties).

These preliminary cost estimates will be refined as part of the evaluation of these alternatives.

**Property Costs**

For property acquisition, the cost estimates we have developed are order of magnitude costs based on the potential property purchase needed for the new right-of way limit and average property costs for residential and commercial properties. Once a preferred corridor is selected, the preliminary design process will look at different design treatments with a view to minimizing the extent of property that would actually be required for the project considering grading needs, roadway alignment and the treatments used at intersections. Of course the actual costs can still vary by quite a bit, depending on the specific properties being acquired and the appraised values of these properties. This level of certainty is not available until detailed design has been completed and property appraisals have been undertaken. For the purpose of planning level cost estimates, the following assumptions were used based on city experience on other projects:

- Commercial property = $161.50 / m2
- Residential property = $ 33.50 / m2
- Full Residential Displacement = $220,000 (average)
- Full Commercial Property Displacement = varies by type of commercial property impacted (i.e. $450,000 for sole proprietor type of business, up to $950,000 for strip commercial businesses)

It should be noted that even these estimates are preliminary in nature since the preliminary design would attempt to minimize property impacts as part of the design process. This level of design would only be undertaken for the preferred alternative in the final phase of the EA study. It is important to note that the final costs would be determined through specific property appraisals during the detailed design stage of the project. It should also be noted that commercial property costs noted above do not include any costs associated with additional business related impacts (i.e. loss of parking, loss of business claims, etc).

*Sensitivity Analysis*

*Subsequent to this completion of the initial analysis, more up to date data on the costs for partial property acquisition in the City suggests that residential property costs used in this initial analysis may be significantly understated. Recent costs for partial residential properties acquired on other recent projects suggests that the average cost may be as high as $550 / m2 rather than the $33.50 / m2 used in the original analysis. The average cost for full property acquisition may also be too low based on the average City of Peterborough residential house price of $258,000[1] published by Canadian Mortgage and Housing Corporation (CHMC). If these higher costs were to be used, they would impact all of the alternatives in a similar manner, although alternatives with higher full and partial property impacts would see a larger increase in costs. Sensitivity analysis using the updated figures yield the following results illustrated in Table 3.*

[1] *A 2012 article in Money Sense entitled Best Places to Live" noted average home prices in Peterborough of $257,400*

| *Table 3 –Benefit –Cost Results – Impact of Higher Property Cost Assumptions* | | | |
|---|---|---|---|
| | *Present Value Costs $* | *Present Value Benefits $* | *Benefit-Cost Ratio* |
| ***South Alternatives*** | | | |
| *1 - Parkway Corridor* | *$24,150,200* | *$21,630,800* | *(1.05)* ***0.90*** |
| *2 - Parkway - Goodfellow - Clonsilla* | *$30,072,300* | *$19,056,800* | *(0.74)* ***0.63*** |
| *3- Clonsilla Widening* | *$31,264,900* | *$18,985,800* | *(0.69)* ***0.61*** |
| *4 - Parkway Corridor - Revised Alignment* | *$24,150,200* | *$21,630,800* | *(1.05)* ***0.90*** |
| ***North Alternatives*** | | | |
| *1 - Parkway Corridor* | *$24,150,200* | *$21,630,800* | *(1.05)* ***0.90*** |
| *2- Fairbairn St / 3rd Line widening* | *$36,885,600* | *$10,553,800* | *(0.53)* ***0.29*** |
| *3- Parkhill Rd / Water St widening* | *$52,959,300* | *$17,860,300* | *(0.44)* ***0.34*** |

(X.XX) - result presented at PIC 2

The higher property cost assumptions reduce the benefit-cost ratio of all alternatives to some degree as noted in Table 3 above. In the south end, the Parkway alternative is reduced the most as the Clonsilla and Goodfellow alternatives impact more commercial properties, which aren't impacted by the change in property costs used in this sensitivity analysis. In the north end, the Fairbairn Street / 3rd Line alternative is impacted the most due to the extensive residential property requirements for this alternative.

### Annual Maintenance Costs

The annual maintenance costs have been estimated for each alternative to account for the increased costs related to snow removal, pavement maintenance, grass cutting, line painting, sidewalk clearing, storm sewer maintenance, etc. Costs from the 2013 City budget were used to develop a unit cost for these activities on a per lane-km basis based on the existing network in place. The following unit costs summarized in Table 4 were used:

**Table 4 – Annual Maintenance – Unit Costs**

| 2013 Budget | Cost | Quantity | Unit | Unit Cost |
|---|---|---|---|---|
| Winter Control - Roads | $ 1,907,438.00 | 931 | lane-km | $ 2,048.81 |
| Winter Control - Sidewalks | $ 389,565.00 | 368 | km | $ 1,058.60 |
| Pavement | $ 434,760.00 | | | |
| Street Cleaning | $ 642,721.00 | | | |
| Right-of-Way | $ 278,218.00 | | | |
| Surface Drainage | $ 232,054.00 | | | |
| **Total Surface Maintenance** | **$ 1,587,753.00** | 931 | lane-km | $ 1,705.43 |
| Storm Sewer Maintenance | $ 405,675.00 | 319 | km | $ 1,271.71 |

**Table 5** summarizes the segment-by-segment estimated maintenance costs and the combined maintenance costs for the north and south portions of the corridor for each alternative.

### Table 5 –Maintenance Costs[1]

| | Length New (km) | Length Widening (km) | Total Lane-km[4] | New Sidewalk / Path[2] (km) | New Storm Sewer[3] (km) | Annual Maintenance Cost |
|---|---|---|---|---|---|---|
| **South Alternatives** | | | | | | |
| 1 - Parkway Corridor | 1.25 | 0.00 | 2.5 | 2.5 | 1.25 | $ 13,600.00 |
| 2 - Parkway - Goodfellow - Clonsilla | 0.56 | 0.79 | 2.69 | 1.12 | 0.56 | $ 12,700.00 |
| 3- Clonsilla Widening | 0.26 | 1.01 | 2.54 | 0.52 | 0.26 | $ 10,400.00 |
| 4 - Parkway Corridor - Revised Alignment | 1.25 | 0.00 | 2.5 | 2.5 | 1.25 | $ 13,600.00 |
| | | | | | | |
| **North Alternatives** | | | | | | |
| 1 - Parkway Corridor | 3.3 | 1 | 8.6 | 6.6 | 3.3 | $ 43,500.00 |
| 2- Fairbairn St / 3rd Line widening | 4.35 | 1.15 | 11 | 8.7 | 4.35 | $ 47,400.00 |
| 3- Parkhill Rd / Water St widening | 0 | 4.2 | 6.2[5] | 4.2 | 0 | $ 20,600.00 |

**Combined Annual Maintenance Cost**

| | South Portion | North Portion | Total |
|---|---|---|---|
| **South Alternatives** | | | |
| 1 - Parkway Corridor | $ 13,600.00 | $ 43,500.00 | $ 57,100.00 |
| 2 - Parkway - Goodfellow - Clonsilla | $ 12,700.00 | $ 43,500.00 | $ 56,200.00 |
| 3- Clonsilla Widening | $ 10,400.00 | $ 43,500.00 | $ 53,900.00 |
| 4 - Parkway Corridor - Revised Alignment | $ 13,600.00 | $ 43,500.00 | $ 57,100.00 |
| | | | |
| **North Alternatives** | | | |
| 1 - Parkway Corridor | $ 13,600.00 | $ 43,500.00 | $ 57,100.00 |
| 2- Fairbairn St / 3rd Line widening | $ 13,600.00 | $ 47,400.00 | $ 61,000.00 |
| 3- Parkhill Rd / Water St widening | $ 13,600.00 | $ 20,600.00 | $ 34,200.00 |

**Notes:**

1. Maintenance costs represent costs to maintain new facilities only - over and above what exists today. Therefore costs for maintaining existing road surface and sidewalks on alternatives that include widening are not included in calculations unless these facilities do not currently exist (i.e. Fairbairn Street north has no storm sewers or sidewalks so these represent new costs). It is assumed that the City would assume Fairbairn Street north / 3rd Line / County Road 19 for the purposes of maintenance and hence these are considered new costs.
2. Sidewalks / Paths assumed on both sides of all new / upgraded arterial roads per City policy.
3. Storm sewer required on one side of road only. For new road segments the cost of maintaining new storm sewer is included. For widening of existing urbanized roads, storm sewers exist and would not require new maintenance.
4. Lane-km is derived by multiplying length by number of new lanes (i.e. a 1km section of new 2 lane road = 2 lane-km)
5. Parkhill Road widening to 4 lanes (1.5km) plus new sidewalk on one side, Water Street widening is only for centre turn lane (2.7km) – new sidewalk / path on one side

### Summary of Costs

Table 6 summarizes the combined north and south end costs for each alternative.

**Table 6 – Summary Costs for Each Alternative**

| | Capital Cost 2013 $ | Property Cost 2013 $ | Maintenance Cost in Year 1 2013 $ |
|---|---|---|---|
| **South Alternatives** | | | |
| 1 - Parkway Corridor | $23,600,000 | $1,400,000 | $57,100 |
| 2 - Parkway - Goodfellow - Clonsilla | $26,300,000 | $5,100,000 | $56,200 |
| 3- Clonsilla Widening | $28,100,000 | $5,700,000 | $53,900 |
| 4 - Parkway Corridor - Revised Alignment | $23,600,000 | $1,400,000 | $57,100 |
| | | | |
| **North Alternatives** | | | |
| 1 - Parkway Corridor | $23,600,000 | $1,400,000 | $57,100 |
| 2- Fairbairn St / 3rd Line widening | $26,600,000 | $10,200,000 | $61,000 |
| 3- Parkhill Rd / Water St widening | $25,800,000 | $24,000,000 | $34,240 |

Note - all cost exclude costs associated with Jackson Creek Valley Alternatives

### Timing Assumptions

To account for the costs and benefits over the life of the project assumptions are required for when costs will be incurred and when benefits will begin to accrue. The following assumptions were used for all alternatives:

- Construction Capital Costs occur in 2020 with the improvements open and ready for traffic in 2021. This was based on the timing suggested for the new 2 lane road in the north end of the study area from the TMP (in reality the project would likely be phased over a number of years which could influence the results to the upside or downside). Recommendations on the timing and implementation plan for the recommended improvements will be developed towards the end of the study once the preferred route and design have been established.
- Property costs are incurred in 2019 – one year in advance of construction
- Annual maintenance costs begin in 2021 and are escalated 2% per year over the life cycle over and above the rate of inflation
- Travel Time and Vehicle Operating Cost savings are based on 2031 modeled values. Between 2021 and 2031, these benefits are reduced by 1% per year, or slightly higher than the forecast population growth rate. Beyond 2031 the benefits accrue at 1% per year allowing for continued growth in travel demand for the "do nothing" and the "do project" scenarios, since the benefits represent the difference.
- A life cycle of 20 years has been used for all alternatives, with benefits and ongoing maintenance costs accruing to 2041 (of course additional costs and benefits would continue to accrue beyond this period but the 20 year horizon would represent the initial life cycle before major pavement and structure rehabilitation would be required). A longer life cycle would tend to increase the benefit-cost ratio as the project benefits continue to accrue and the Present Value of the up-front capital investment reduces.
- Project Costs and Benefits were expressed in Present Value terms using a 4% discount rate. *Use of a 5% discount rate would reduce the benefit-cost ratio for the north and south end alternatives in the Class EA study from 1.05 to 0.96. All other alternatives would also see similar reductions*.

**What is Present Value?**

Present Value (PV) is a formula used in Finance that calculates the present day value of an amount that is received or a cost that is incurred at a future date. The premise is that there is "time value of money". Essentially, receiving something today is worth more than receiving the same item at a future date after you account for inflation and interest that you could earn if you had the money today. Similarly, it is better to defer an expenditure to a future date as inflation and the interest you can earn on your money makes the expenditure cheaper in the future.

**Intent of Benefit-Cost Analysis**

At this stage of the project, it is important to remember that the Benefit-Cost analysis is being used as one of a number of criteria to compare the advantages and disadvantages of various network improvement alternatives. As such, the planning level cost estimates, preliminary analysis results, and assumptions used to date are not intended, and should not be portrayed as the final conclusion for the study or the final result for any one alternative.

As the project progresses, the preliminary design for the preferred alternative will be developed to a greater level of detail and the capital construction and property costs will be able to be estimated with greater confidence. The implementation plan for the preferred alternative may also influence the assumptions related to timing of the costs and benefits. Different assumptions for implementation or how the costs and benefits have been estimated could be argued, but for the purpose of comparison, any changes would change the results for each alternative.

A summary of the preliminary results for each alternative is provided in Table 7 below. A detailed cash flow summary for each alternative is provided in Attachments A and B.

**Table 7 – Summary of Benefit –Cost Results**

| | Present Value Costs $ | Present Value Benefits $ | Benefit-Cost Ratio |
|---|---|---|---|
| **South Alternatives** | | | |
| 1 - Parkway Corridor | $20,555,800 | $21,630,800 | 1.05 |
| 2 - Parkway - Goodfellow - Clonsilla | $25,703,200 | $19,056,800 | 0.74 |
| 3- Clonsilla Widening | $27,591,000 | $18,985,800 | 0.69 |
| 4 - Parkway Corridor - Revised Alignment | $20,555,800 | $21,630,800 | 1.05 |
| | | | |
| **North Alternatives** | | | |
| 1 - Parkway Corridor | $20,555,800 | $21,630,800 | 1.05 |
| 2- Fairbairn St / 3rd Line widening | $30,203,400 | $10,553,800 | 0.53 |
| 3- Parkhill Rd / Water St widening | $40,582,800 | $17,860,300 | 0.44 |

Notes -

South Alternatives include costs and benefits of North Alt 1 (per TMP recommendation)

North Alternatives include costs and benefits of recommended South Alt 4

No difference in planning level costs or benefits between South Alternatives 1 and 4

All Benefits exclude the benefits of the Jackson Creek Valley Alternatives

## Attachment A – South End Alternatives

**Parkway Corridor - Preliminary Cost-Benefit Analysis**

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Maintenance Escalation Cost | 2% | | | | | | | | | | | | | | |
| Discount Rate | 4% | | | | | | | | | | | | | | |
| Annual Traffic Growth Rate | 1% | | | | | | | | | | | | | | |
| | | Year | | | | | | | | | | | | | |
| | Net Present Value | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
| **South - Parkway Alternative** | | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 23,600,000 | | | | | | | | |
| Maintenance Cost | | | | | | | | $ 57,092 | $ 58,233 | $ 59,398 | $ 60,586 | $ 61,798 | $ 63,034 | $ 64,294 | $ 65,580 |
| Property Cost | | | | | | $ 1,397,782 | | | | | | | | | |
| Total Cost | $20,555,779 | $ - | $ - | $ - | $ - | $ 1,397,782 | $ 23,600,000 | $ 57,092 | $ 58,233 | $ 59,398 | $ 60,586 | $ 61,798 | $ 63,034 | $ 64,294 | $ 65,580 |
| Travel Time Savings | | | | | | | | $ (1,461,626) | $ (1,476,390) | $ (1,491,303) | $ (1,506,367) | $ (1,521,583) | $ (1,536,952) | $ (1,552,477) | $ (1,568,158) |
| Auto Operating Cost Savings | | | | | | | | $ (325,310) | $ (328,596) | $ (331,915) | $ (335,268) | $ (338,654) | $ (342,075) | $ (345,530) | $ (349,020) |
| Other Benefits | | | | | | | | | | | | | | | |
| Total Benefits | ($21,630,769) | $ - | $ - | $ - | $ - | $ - | $ - | $ (1,786,936) | $ (1,804,986) | $ (1,823,218) | $ (1,841,634) | $ (1,860,237) | $ (1,879,027) | $ (1,898,007) | $ (1,917,179) |
| **Benefit/Cost** | **1.05** | | | | | | | | | | | | | | |
| **South - Parkway -Goodfellow Alternative** | | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 26,300,000 | | | | | | | | |
| Maintenance Cost | | | | | | | | $ 56,200 | $ 57,324 | $ 58,470 | $ 59,640 | $ 60,832 | $ 62,049 | $ 63,290 | $ 64,556 |
| Property Cost | | | | | | $ 5,078,617 | | | | | | | | | |
| Total Cost | $25,703,207 | $ - | $ - | $ - | $ - | $ 5,078,617 | $ 26,300,000 | $ 56,200 | $ 57,324 | $ 58,470 | $ 59,640 | $ 60,832 | $ 62,049 | $ 63,290 | $ 64,556 |
| Travel Time Savings | | | | | | | | $ (1,319,602) | $ (1,332,931) | $ (1,346,395) | $ (1,359,995) | $ (1,373,733) | $ (1,387,609) | $ (1,401,625) | $ (1,415,783) |
| Auto Operating Cost Savings | | | | | | | | $ (254,692) | $ (257,265) | $ (259,864) | $ (262,489) | $ (265,140) | $ (267,818) | $ (270,523) | $ (273,256) |
| Other Benefits | | | | | | | | | | | | | | | |
| Total Benefits | ($19,056,752) | $ - | $ - | $ - | $ - | $ - | $ - | $ (1,574,294) | $ (1,590,196) | $ (1,606,259) | $ (1,622,484) | $ (1,638,872) | $ (1,655,427) | $ (1,672,148) | $ (1,689,039) |
| **Benefit/Cost** | **0.74** | | | | | | | | | | | | | | |
| **South - Clonsilla Alternative** | | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 28,100,000 | | | | | | | | |
| Maintenance Cost | | | | | | | | $ 53,853 | $ 54,930 | $ 56,028 | $ 57,149 | $ 58,292 | $ 59,458 | $ 60,647 | $ 61,860 |
| Property Cost | | | | | | $ 5,682,432 | | | | | | | | | |
| Total Cost | $27,591,004 | $ - | $ - | $ - | $ - | $ 5,682,432 | $ 28,100,000 | $ 53,853 | $ 54,930 | $ 56,028 | $ 57,149 | $ 58,292 | $ 59,458 | $ 60,647 | $ 61,860 |
| Travel Time Savings | | | | | | | | $ (1,253,763) | $ (1,266,427) | $ (1,279,219) | $ (1,292,141) | $ (1,305,193) | $ (1,318,377) | $ (1,331,693) | $ (1,345,145) |
| Auto Operating Cost Savings | | | | | | | | $ (314,669) | $ (317,847) | $ (321,058) | $ (324,301) | $ (327,577) | $ (330,886) | $ (334,228) | $ (337,604) |
| Other Benefits | | | | | | | | | | | | | | | |
| Total Benefits | ($18,985,787) | $ - | $ - | $ - | $ - | $ - | $ - | $ (1,568,432) | $ (1,584,275) | $ (1,600,277) | $ (1,616,442) | $ (1,632,769) | $ (1,649,262) | $ (1,665,921) | $ (1,682,749) |
| **Benefit/Cost** | **0.69** | | | | | | | | | | | | | | |

| | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **South - Parkway Alternative** | | | | | | | | | | | | | |
| Capital Cost | | | | | | | | | | | | | |
| Maintenance Cost | $ 66,892 | $ 68,230 | $ 69,594 | $ 70,986 | $ 72,406 | $ 73,854 | $ 75,331 | $ 76,838 | $ 78,374 | $ 79,942 | $ 81,541 | $ 83,172 | $ 84,835 |
| Property Cost | | | | | | | | | | | | | |
| Total Cost | $ 66,892 | $ 68,230 | $ 69,594 | $ 70,986 | $ 72,406 | $ 73,854 | $ 75,331 | $ 76,838 | $ 78,374 | $ 79,942 | $ 81,541 | $ 83,172 | $ 84,835 |
| Travel Time Savings | $ (1,583,998) | $ (1,599,998) | $ (1,616,160) | $ (1,632,322) | $ (1,648,645) | $ (1,665,131) | $ (1,681,783) | $ (1,698,600) | $ (1,715,586) | $ (1,732,742) | $ (1,750,070) | $ (1,767,570) | $ (1,785,246) |
| Auto Operating Cost Savings | $ (352,546) | $ (356,107) | $ (359,704) | $ (363,301) | $ (366,934) | $ (370,603) | $ (374,309) | $ (378,053) | $ (381,833) | $ (385,651) | $ (389,508) | $ (393,403) | $ (397,337) |
| Other Benefits | | | | | | | | | | | | | |
| Total Benefits | $ (1,936,544) | $ (1,956,105) | $ (1,975,864) | $ (1,995,623) | $ (2,015,579) | $ (2,035,735) | $ (2,056,092) | $ (2,076,653) | $ (2,097,419) | $ (2,118,394) | $ (2,139,578) | $ (2,160,973) | $ (2,182,583) |
| **Benefit/Cost** | | | | | | | | | | | | | |
| **South - Parkway -Goodfellow Alternative** | | | | | | | | | | | | | |
| Capital Cost | | | | | | | | | | | | | |
| Maintenance Cost | $ 65,847 | $ 67,164 | $ 68,507 | $ 69,877 | $ 71,275 | $ 72,700 | $ 74,154 | $ 75,638 | $ 77,150 | $ 78,693 | $ 80,267 | $ 81,873 | $ 83,510 |
| Property Cost | | | | | | | | | | | | | |
| Total Cost | $ 65,847 | $ 67,164 | $ 68,507 | $ 69,877 | $ 71,275 | $ 72,700 | $ 74,154 | $ 75,638 | $ 77,150 | $ 78,693 | $ 80,267 | $ 81,873 | $ 83,510 |
| Travel Time Savings | $ (1,430,084) | $ (1,444,529) | $ (1,459,120) | $ (1,473,711) | $ (1,488,448) | $ (1,503,333) | $ (1,518,366) | $ (1,533,550) | $ (1,548,885) | $ (1,564,374) | $ (1,580,018) | $ (1,595,818) | $ (1,611,776) |
| Auto Operating Cost Savings | $ (276,016) | $ (278,804) | $ (281,620) | $ (284,437) | $ (287,281) | $ (290,154) | $ (293,055) | $ (295,986) | $ (298,946) | $ (301,935) | $ (304,954) | $ (308,004) | $ (311,084) |
| Other Benefits | | | | | | | | | | | | | |
| Total Benefits | $ (1,706,100) | $ (1,723,333) | $ (1,740,740) | $ (1,758,148) | $ (1,775,729) | $ (1,793,486) | $ (1,811,421) | $ (1,829,536) | $ (1,847,831) | $ (1,866,309) | $ (1,884,972) | $ (1,903,822) | $ (1,922,860) |
| **Benefit/Cost** | | | | | | | | | | | | | |
| **South - Clonsilla Alternative** | | | | | | | | | | | | | |
| Capital Cost | | | | | | | | | | | | | |
| Maintenance Cost | $ 63,097 | $ 64,359 | $ 65,646 | $ 66,959 | $ 68,298 | $ 69,664 | $ 71,057 | $ 72,478 | $ 73,928 | $ 75,407 | $ 76,915 | $ 78,453 | $ 80,022 |
| Property Cost | | | | | | | | | | | | | |
| Total Cost | $ 63,097 | $ 64,359 | $ 65,646 | $ 66,959 | $ 68,298 | $ 69,664 | $ 71,057 | $ 72,478 | $ 73,928 | $ 75,407 | $ 76,915 | $ 78,453 | $ 80,022 |
| Travel Time Savings | $ (1,358,732) | $ (1,372,457) | $ (1,386,320) | $ (1,400,183) | $ (1,414,185) | $ (1,428,327) | $ (1,442,610) | $ (1,457,036) | $ (1,471,607) | $ (1,486,323) | $ (1,501,186) | $ (1,516,198) | $ (1,531,360) |
| Auto Operating Cost Savings | $ (341,014) | $ (344,459) | $ (347,938) | $ (351,417) | $ (354,932) | $ (358,481) | $ (362,066) | $ (365,686) | $ (369,343) | $ (373,037) | $ (376,767) | $ (380,535) | $ (384,340) |
| Other Benefits | | | | | | | | | | | | | |
| Total Benefits | $ (1,699,746) | $ (1,716,915) | $ (1,734,258) | $ (1,751,601) | $ (1,769,117) | $ (1,786,808) | $ (1,804,676) | $ (1,822,723) | $ (1,840,950) | $ (1,859,359) | $ (1,877,953) | $ (1,896,732) | $ (1,915,700) |
| **Benefit/Cost** | | | | | | | | | | | | | |

## Attachment B – North End Alternatives

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Parkway Corridor - Preliminary Cost-Benefit Analysis** | | | | | | | |
| Maintenance Escalation Cost | 2% | | | | | | | | | | | | | |
| Discount Rate | 4% | | | | | | | | | | | | | |
| Annual Traffic Growth Rate | 1% | | | | | | | | | | | | | |
| | | Year | | | | | | | | | | | | |
| | Net Present Value | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **North - Parkway Alternative** | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 23,600,000 | | | | | | | |
| Maintenance Cost | | | | | | | | $ 57,092 | $ 58,233 | $ 59,398 | $ 60,586 | $ 61,798 | $ 63,034 | $ 64,294 |
| Property Cost | | | | | | $ 1,397,782 | | | | | | | | |
| Total Cost | $20,555,779 | $ - | $ - | $ - | $ - | $ 1,397,782 | $ 23,600,000 | $ 57,092 | $ 58,233 | $ 59,398 | $ 60,586 | $ 61,798 | $ 63,034 | $ 64,294 |
| Travel Time Savings | | | | | | | | $ (1,461,626) | $ (1,476,390) | $ (1,491,303) | $ (1,506,367) | $ (1,521,583) | $ (1,536,952) | $ (1,552,477) |
| Auto Operating Cost Savings | | | | | | | | $ (325,310) | $ (328,596) | $ (331,915) | $ (335,268) | $ (338,654) | $ (342,075) | $ (345,530) |
| Other Benefits | | | | | | | | | | | | | | |
| Total Benefits | ($21,630,769) | $ - | $ - | $ - | $ - | $ - | $ - | $ (1,786,936) | $ (1,804,986) | $ (1,823,218) | $ (1,841,634) | $ (1,860,237) | $ (1,879,027) | $ (1,898,007) |
| **Benefit/Cost** | **1.05** | | | | | | | | | | | | | |
| **North - Fairbairn Alternative** | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 26,600,000 | | | | | | | |
| Maintenance Cost | | | | | | | | $ 61,025 | $ 62,246 | $ 63,491 | $ 64,761 | $ 66,056 | $ 67,377 | $ 68,724 |
| Property Cost | | | | | | $ 10,187,643 | | | | | | | | |
| Total Cost | $30,203,403 | $ - | $ - | $ - | $ - | $ 10,187,643 | $ 26,600,000 | $ 61,025 | $ 62,246 | $ 63,491 | $ 64,761 | $ 66,056 | $ 67,377 | $ 68,724 |
| Travel Time Savings | | | | | | | | $ (1,090,576) | $ (1,101,592) | $ (1,112,719) | $ (1,123,959) | $ (1,135,312) | $ (1,146,780) | $ (1,158,364) |
| Auto Operating Cost Savings | | | | | | | | $ 218,716 | $ 220,925 | $ 223,157 | $ 225,411 | $ 227,688 | $ 229,988 | $ 232,311 |
| Other Benefits | | | | | | | | | | | | | | |
| Total Benefits | ($10,553,823) | $ - | $ - | $ - | $ - | $ - | $ - | $ (871,860) | $ (880,667) | $ (889,563) | $ (898,548) | $ (907,624) | $ (916,792) | $ (926,053) |
| **Benefit/Cost** | **0.35** | | | | | | | | | | | | | |
| **North - Parkhill Alternative** | | | | | | | | | | | | | | |
| Capital Cost | | | | | | | $ 25,800,000 | | | | | | | |
| Maintenance Cost | | | | | | | | $ 34,181 | $ 34,865 | $ 35,562 | $ 36,273 | $ 36,999 | $ 37,739 | $ 38,494 |
| Property Cost | | | | | | $ 24,016,238 | | | | | | | | |
| Total Cost | $40,582,027 | $ - | $ - | $ - | $ - | $ 24,016,238 | $ 25,800,000 | $ 34,181 | $ 34,865 | $ 35,562 | $ 36,273 | $ 36,999 | $ 37,739 | $ 38,494 |
| Travel Time Savings | | | | | | | | $ (1,211,908) | $ (1,224,150) | $ (1,236,515) | $ (1,249,005) | $ (1,261,621) | $ (1,274,365) | $ (1,287,237) |
| Auto Operating Cost Savings | | | | | | | | $ (263,543) | $ (266,205) | $ (268,894) | $ (271,610) | $ (274,353) | $ (277,124) | $ (279,924) |
| Other Benefits | | | | | | | | | | | | | | |
| Total Benefits | ($17,860,255) | $ - | $ - | $ - | $ - | $ - | $ - | $ (1,475,451) | $ (1,490,354) | $ (1,505,408) | $ (1,520,614) | $ (1,535,974) | $ (1,551,489) | $ (1,567,161) |
| **Benefit/Cost** | **0.44** | | | | | | | | | | | | | |

| | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 | 2040 | 2041 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **North - Parkway Alternative** | | | | | | | | | | | | | | |
| Maintenance Cost | $ 65,580 | $ 66,892 | $ 68,230 | $ 69,594 | $ 70,986 | $ 72,406 | $ 73,854 | $ 75,331 | $ 76,838 | $ 78,374 | $ 79,942 | $ 81,541 | $ 83,172 | $ 84,835 |
| Total Cost | $ 65,580 | $ 66,892 | $ 68,230 | $ 69,594 | $ 70,986 | $ 72,406 | $ 73,854 | $ 75,331 | $ 76,838 | $ 78,374 | $ 79,942 | $ 81,541 | $ 83,172 | $ 84,835 |
| Travel Time Savings | $ (1,568,158) | $ (1,583,998) | $ (1,599,998) | $ (1,616,160) | $ (1,632,322) | $ (1,648,645) | $ (1,665,131) | $ (1,681,783) | $ (1,698,600) | $ (1,715,586) | $ (1,732,742) | $ (1,750,070) | $ (1,767,570) | $ (1,785,246) |
| Auto Operating Cost Savings | $ (349,020) | $ (352,546) | $ (356,107) | $ (359,704) | $ (363,301) | $ (366,934) | $ (370,603) | $ (374,309) | $ (378,053) | $ (381,833) | $ (385,651) | $ (389,508) | $ (393,403) | $ (397,337) |
| Total Benefits | $ (1,917,179) | $ (1,936,544) | $ (1,956,105) | $ (1,975,864) | $ (1,995,623) | $ (2,015,579) | $ (2,035,735) | $ (2,056,092) | $ (2,076,653) | $ (2,097,419) | $ (2,118,394) | $ (2,139,578) | $ (2,160,973) | $ (2,182,583) |
| **North - Fairbairn Alternative** | | | | | | | | | | | | | | |
| Maintenance Cost | $ 70,099 | $ 71,501 | $ 72,931 | $ 74,390 | $ 75,877 | $ 77,395 | $ 78,943 | $ 80,522 | $ 82,132 | $ 83,775 | $ 85,450 | $ 87,159 | $ 88,902 | $ 90,680 |
| Total Cost | $ 70,099 | $ 71,501 | $ 72,931 | $ 74,390 | $ 75,877 | $ 77,395 | $ 78,943 | $ 80,522 | $ 82,132 | $ 83,775 | $ 85,450 | $ 87,159 | $ 88,902 | $ 90,680 |
| Travel Time Savings | $ (1,170,064) | $ (1,181,883) | $ (1,193,821) | $ (1,205,880) | $ (1,217,939) | $ (1,230,118) | $ (1,242,419) | $ (1,254,844) | $ (1,267,392) | $ (1,280,066) | $ (1,292,867) | $ (1,305,795) | $ (1,318,853) | $ (1,332,042) |
| Auto Operating Cost Savings | $ 234,657 | $ 237,028 | $ 239,422 | $ 241,840 | $ 244,259 | $ 246,701 | $ 249,168 | $ 251,660 | $ 254,177 | $ 256,718 | $ 259,286 | $ 261,878 | $ 264,497 | $ 267,142 |
| Total Benefits | $ (935,407) | $ (944,855) | $ (954,399) | $ (964,040) | $ (973,680) | $ (983,417) | $ (993,251) | $ (1,003,184) | $ (1,013,215) | $ (1,023,348) | $ (1,033,581) | $ (1,043,917) | $ (1,054,356) | $ (1,064,900) |
| **North - Parkhill Alternative** | | | | | | | | | | | | | | |
| Maintenance Cost | $ 39,264 | $ 40,049 | $ 40,850 | $ 41,667 | $ 42,500 | $ 43,350 | $ 44,217 | $ 45,101 | $ 46,004 | $ 46,924 | $ 47,862 | $ 48,819 | $ 49,796 | $ 50,792 |
| Total Cost | $ 39,264 | $ 40,049 | $ 40,850 | $ 41,667 | $ 42,500 | $ 43,350 | $ 44,217 | $ 45,101 | $ 46,004 | $ 46,924 | $ 47,862 | $ 48,819 | $ 49,796 | $ 50,792 |
| Travel Time Savings | $ (1,300,239) | $ (1,313,373) | $ (1,326,640) | $ (1,340,040) | $ (1,353,440) | $ (1,366,975) | $ (1,380,645) | $ (1,394,451) | $ (1,408,396) | $ (1,422,479) | $ (1,436,704) | $ (1,451,071) | $ (1,465,582) | $ (1,480,238) |
| Auto Operating Cost Savings | $ (282,751) | $ (285,607) | $ (288,492) | $ (291,406) | $ (294,320) | $ (297,263) | $ (300,236) | $ (303,238) | $ (306,271) | $ (309,334) | $ (312,427) | $ (315,551) | $ (318,707) | $ (321,894) |
| Total Benefits | $ (1,582,991) | $ (1,598,980) | $ (1,615,132) | $ (1,631,446) | $ (1,647,761) | $ (1,664,238) | $ (1,680,881) | $ (1,697,689) | $ (1,714,666) | $ (1,731,813) | $ (1,749,131) | $ (1,766,622) | $ (1,784,289) | $ (1,802,132) |

**Differences between Previous Benefit Cost Assessment Study (2003)**

Many members of the public have raised questions regarding the differences between this most recent Benefit-Cost Assessment and the study completed by Morrison Hershfield in 2003. The following summarizes some of the major differences between the approaches and the impact of these changes.

**Updated Model** - As noted in the final 2012 TMP report, the model was updated from the previous model used for the 2002 Transportation Plan Review and West Side Corridor Study with the latest (2006) travel survey information. The original model was developed and calibrated to predict traffic volumes and routings of future traffic through the network but it was not initially designed or calibrated to provide accurate travel times. This was noted in the text of West Side Corridor Study Report. During the recent model update for the 2012 TMP, completed by the Morrison Hershfield team, a special speed calibration exercise was undertaken to improve the reliability of the model for predicting travel times. This is documented in their final report that can be viewed at the link below.

http://www.peterborough.ca/Living/City_Services/Transportation.htm

In comparing the results of the previous studies the following additional differences in base assumptions are noted:

- **Implementation Timing -** The 2003 Cost Benefit Assessment (BCA) assumed full implementation of the Partial Parkway Alternative in 2006 (and concluded that perhaps this level of improvement was not needed this early in the planning horizon). The implementation timing in our analysis was assumed for 2021 in accordance with the recommended timing recommendations in the 2012 TMP for the 2 lane arterial in the north section. Had the original analysis assumed a 2021 implementation, this would have reduced the Present Value (PV) of the capital cost from the $30.3M used in their Appendix C to about $8.9M. Even a 5 year deferral to 2011 would reduce the PV of the Capital Costs to $19.1M from $30.3M.

- **Capital Cost Escalation** - The Costs in the 2003 CBA are not consistent between Table 1 in the report and Appendix C where the financial analysis is summarized – for example Table 1 (pg 5) shows the Capital Cost of $22.3M in 2001 dollars (includes property) yet these costs are shown as $30.3M in 2005 in Appendix C. The report does not provide any reference for the reason for the cost escalation which equates to $8M or about 8% compounded per year, although this is clearly higher than the prevailing inflation rate of 1-2%.

- **Operating Costs and Cost Escalation** - The 2003 CBA study assumes an extremely high Operating Cost for annual maintenance and this represents a PV of over $10M in the report. Upon further review, it became clear that there are two or three compounding errors in these figures.
    - The first error is in the West Side Corridor Study Report which estimated the annual maintenance costs for each alternative. The report took the total city maintenance budget and divided it by the lane-km *in the City model* (which only included 260 lane-km of major arterial and collector roads) to come up with a unit cost of $20,000 per lane-km. In actual fact the city has over 900 lane-km of roadways it maintains (per their 2013 Operating Budget). When you exclude the costs related to Parks and Playgrounds and other non-road maintenance that is also in the Maintenance budget our estimated annual road maintenance cost is about $5,450 per lane-km (as documented in **Table 4**, above.

    - The second issue is the fact that the Maintenance Costs in the 2003 CBA are not consistent between Table 1 in the report and Appendix C where the financial analysis is summarized. For example Table 1 (pg 5) shows the Operating and Maintenance Costs of $375,000 in 2001 dollars yet these costs are shown as $550,998 in 2005 in Appendix C. The report does not reference the reason for the cost escalation which equates to $176,000 or about 10% compounded per year, although this is clearly higher than the prevailing inflation rate of 1-2%.

- The third error is the escalation in operating and maintenance costs over the life cycle of the project. The 2003 report notes that all costs are treated in constant 2005 dollars yet the annual maintenance costs are escalated at an 8% annual rate, clearly higher than the prevailing inflation rate and contrary to the stated methodology. Our approach used a 2% annual cost escalation in real terms (i.e. over the rate of inflation) to provide a conservative estimate of future maintenance costs, but this is nowhere near the 8% used in the 2003 study.

*If one were to correct for these 3 errors the annual maintenance costs would be about $134,660 per year in 2005 dollars (assuming 2% inflation over the past 8 years) and this one change would reduce the PV of these O&M costs from $10.2M (from the 2003 BCA report) to $1.3M (AECOM calculations). This one change alone would increase the B/C ratio from 0.18 to 0.23 on its own.*

- **Quantification of Travel Time Savings** – There are a number of differences in the approach to estimating the annual value of travel time savings between the 2003 CBA report and the preliminary BCA work described above. These differences do not include any differences due to the use of the updated model, noted previously.

  - **Value of Time -** The value of time used in the 2003 BCA is $10 /hr and the report notes that this is consistent with Transport Canada guidance. The values used are referred to in the 1994 publication, "Guide to Benefit-Cost Analysis in Transport Canada" which suggested a weighted average rate of $9.10 / hr for auto travelers in 1990 dollars. In today's dollars these costs equate to $14.43. (The AECOM analysis has used $15.75 based on the rationale noted earlier in this document).

  - **Auto Occupancy Rate** – Recognizing that many vehicles contain more than one person, the previous 2003 study used an average vehicle occupancy rate of 1.15. The updated analysis has used an average vehicle occupancy rate 1.27 person/vehicle based on the mode share targets established in the 2012 TMP and the policy to encourage increased carpooling (which also reduces auto demands).

*The combined effect of these two differences in the Value of Time is significant and would increase the travel time savings reported in the 2003 study by a factor of 1.74. This in turn would increase the PV of their reported benefits from $6.9M to $12.1M. This one change would increase the B/C ratio to 0.31 from 0.18 (irrespective of the other points raised).*

  - **Peak Hour to Annual Expansion Factors -** The expansion factor used to convert peak hour travel time savings to annual savings is quite different between the two studies:

    - **Peak Hour to Daily Factor -** In the 2003 study used a factor of 1000, representing 4 hours per day x 250 days per year. The rationalization for this was that the peak hours only represent 4 hours per day (1 hour in the AM peak and 3 hours in the PM). Travel time savings for all other periods of the day are not included. The hourly to daily factor assumption was based on the peak hours being the only hours of congestion, which may be true to some extent. However, it is noted that the model run results quoted in the report show travel time savings for the 2006 horizon year that are about 6 times higher for the Partial Parkway alternative compared to the other alternatives examined, yet the recent 2012 TMP noted relatively modest levels of congestion in the 2006 base year.

- The extent of the differences between alternatives in 2006 suggests that a portion of the time savings are attributable to the more direct routing and improved operating speeds (compared to base conditions) offered by the partial Parkway Alternative as opposed to pure congestion relief. It is our view that this suggests that some of the travel time benefits should also accrue at other times of the day. Our peak hour – daily factor assumption uses a factor of 10 to expand pm peak hour results to daily results based on the share of daily trips that occur in the pm peak period (based on data from the 2006 TTS survey).

- **Daily to Annual Expansion Factor** - The 2003 study used 250 days (5 days x 50 weeks) to expand daily travel time savings to annual. Our updated work used 260 (5 days x 52 weeks). The use of the 250 days factor assumes a two week period where no weekday travel time savings are acknowledged. The report does not rationalize the reason for this assumption but it may be based on the belief that nobody travels during the 2 week Christmas period or that most employees get 2 week's vacation per year and therefore don't value travel during this period. As noted previously, Metrolinx (the Regional Planning Agency for the GTA) uses an annualization factor of 3000 (10% of daily traffic in the peak hour and 300 days per year). We are comfortable that our figure of 260 days per year is appropriate for the Peterborough market.

*The combined impact of the different peak hour to annual expansion factors is also very significant. If you modify the reported annual time savings in the 2003 report to reflect our 2600 annualization factor, the PV of the benefits improves to $18.2M from $6.9M and improves the C/B ratio to 0.46 from 0.18 (irrespective of the other points raised).*

- **Use of Consumer Surplus Approach** – While the 2003 BCA report showed results for the "traditional" and the "consumer surplus" method, there are a number of concerns with the use of the Consumer Surplus Approach in this application as noted previously:

    - The Consumer Surplus approach is intended to be used where new traffic demand is induced by an improvement, as discussed above. The model is using the same demand to test each alternative and there is no "new demand" being generated.

    - The 2003 BCA report talks about diverted traffic being treated as a Consumer Surplus as if this traffic is new traffic. In fact the graph used to illustrate this concept shows a line sloping downwards to the right implying an increase in travel demand as a result of the reduced generalized costs. In reality the diverted traffic is traffic that has already decided to drive and is simply shifting their route to save time, and is not new. The literature on this topic treats diversion as a diversion *from a different mode* due to the improvement in generalized costs resulting from the improvement.

      For example, improving road capacity in a heavily congested urban centre, like the GTA, may shift some trips from transit to drive again. In this context it can be treated as "new demand" and the consumer surplus "rule of half" is only applied to the travel time savings of new users. There is no new auto demand being created in the previous study or our updated study either. Unlike the GTA or other large metropolitan centres where congestion levels are extreme, there is no evidence that motorists in Peterborough are shifting to transit due to congestion on the road network.

- **Vehicle Operating Cost Savings** –There are also some differences in the approach used for vehicle operating cost savings. The 2003 BCA study only attributed fuel cost savings using an average cost of $0.35 per litre of gasoline, which they noted was the cost net of federal and provincial taxes). The report rationalized the use of the net cost figure since tax revenues collected from the fuel are returned to government where it is put to use for the benefit of society. This raises a couple of questions: one, the taxes don't really fully accrue to the local government level that is making the investment and two; the full fuel costs certainly represent an after tax expense to the travelling public that they would put to a better use if they had the money left in their possession.

    - That being said, it is hard to compare the assumptions to our methodology since we use a $0.17 /km cost per vehicle-km travelled instead of a savings in fuel consumption. Our costs are expressed in 2012 dollars based on the published Canadian Automobile Association average vehicle operating costs and are not inflated to 2031.

    - The figures used in the EA study are comparable with those used by Metrolinx (the Regional Planning Agency for the GTA) in undertaking their Benefits Case studies for transportation investments. Metrolinx have used $0.15/km (expressed in 2008 dollars) which represents about $0.16 /km in 2012 dollars. Since the 2003 CBA report did not provide veh-km savings for the various alternatives we have not been able to determine if these different assumptions are significant or not.

- **Discount Rate** - Modern Benefit Cost studies are using discount rates between 3% and 7% with a figure of 5% being used as the mid-point value (Metrolinx). The 2003 study used 8% discount rate which was generally appropriate at the time. We have used 4% discount rate reflecting the low interest rates that prevail today which are reflected in borrowing costs and inflation rates currently being experienced. *Use of a 5% discount rate would reduce the benefit-cost ratio for the north and south end alternatives in the Class EA study from 1.05 to 0.96. All other alternatives would also see similar reductions.*

**Conclusion**

Based on the above review we have completed a re-analysis of the 2003 BCA Study results using the base figures reported in the 2003 BCA study. The cost and benefit figures have been modified to reflect the differences in non-model related assumptions between the two approaches, as follows:

- Deferral of project implementation by 5 years from 2005 to 2011 – with benefits accruing from 2012 to 2031
- Reduced Capital cost to $22.3M per Table 1 of 2003 study
- Revised Operation and Maintenance Costs from $550,998 per year to $134,660 per year – with cost escalation at 2% /yr in real terms (above inflation). Thus in year 2012 the maintenance cost is $151,649 and these continue to escalate at 2% per yr to 2031.
- Updated Travel Time Savings
  - Value of time increased from $10 /hr to $15.75/hr
  - Vehicle occupancy increased from 1.15 to 1.27
  - Annualization factor of 2600 versus 1000
  - Travel Time savings begin in 2012 and continue to 2031
- No change to Fuel Cost Savings – savings begin in 2012 and continue to 2031

The combined effect of these differences improves the B/C ratio in the original 2003 BCA study from **0.18** to **2.03** for the Partial Parkway alternative using the traditional (non consumer surplus) method.

This does not include any changes due to the improvement in the model to better predict travel times, as noted above. With the change to a 4% discount rate the B/C ratio is more conservative and reduces to **1.84** in the revised calculation. **Table 6** below illustrates the revised cost and benefit streams that support this analysis.

Despite our reservation with the use of the Consumer Surplus Approach in this application, the use of the revised assumptions on the original travel time savings reported in the 2003 BCA report (Appendix C) would still yield a **1.37** B/C ratio using an 8% discount rate (**1.23** with a 4% rate).

Based on the above analysis the differences in a few key assumptions used in the 2003 study can significantly change the findings and the conclusions that one would draw from the results without considering any changes from use of the updated and improved model that we are currently using.

AECOM is comfortable that all of our assumptions are defendable and can be rationalized using up to date information, data, and industry standards used in modern benefit-cost calculations. We are also comfortable that our analysis is conservative on a number of fronts as noted above with respect to the estimation of project costs and benefits. Given our selective review of observed travel times in the city compared to base year results from the model (which suggest that even the improved model may be underestimating the delays at intersections) we are also confident that our estimated travel time savings are conservative to the low side as well.

Again, it should be stressed that our use of the Benefit-Cost calculation in the Class EA study is intended to compare between a series of alternatives, and the B/C ratio is being used as one of a number of evaluation criteria. One may debate the finer points of particular assumptions, however in the context of an EA evaluation approach, the important factor is the relative comparison between all reasonable alternatives.

## Table 5 - Reanalysis of 2003 BCA Study Results with Revised Assumptions – Traditional Method

| | Original TT Savings (2003 Study) | Updated TT Savings | Original Fuel Cost Savings | Original Capital + Property Costs | Original Maintenance Costs | Updated Maintenance Costs |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| 2005 | | | | | | |
| 2006 | $ 640,659.00 | $ 2,897,254.98 | $ 28,210.00 | $ - | $ 550,998.00 | $ 134,660.00 |
| 2007 | $ 661,677.00 | $ 2,992,304.77 | $ 29,043.00 | $ - | $ 595,078.00 | $ 137,353.20 |
| 2008 | $ 682,695.00 | $ 3,087,354.57 | $ 29,876.00 | $ - | $ 642,684.00 | $ 140,100.26 |
| 2009 | $ 703,713.00 | $ 3,182,404.36 | $ 30,709.00 | $ - | $ 694,099.00 | $ 142,902.27 |
| 2010 | $ 724,731.00 | $ 3,277,454.15 | $ 31,542.00 | $ - | $ 749,627.00 | $ 145,760.31 |
| 2011 | $ 745,749.00 | $ 3,372,503.95 | $ 32,375.00 | $ 22,338,904.00 | $ 809,597.00 | $ 148,675.52 |
| 2012 | $ 744,528.00 | $ 3,366,982.21 | $ 31,542.00 | $ - | $ 874,365.00 | $ 151,649.03 |
| 2013 | $ 743,308.00 | $ 3,361,465.00 | $ 30,709.00 | $ - | $ 944,314.00 | $ 154,682.01 |
| 2014 | $ 742,087.00 | $ 3,355,943.27 | $ 29,876.00 | $ - | $ 1,019,859.00 | $ 157,775.65 |
| 2015 | $ 740,866.00 | $ 3,350,421.53 | $ 29,043.00 | $ - | $ 1,101,448.00 | $ 160,931.17 |
| 2016 | $ 739,646.00 | $ 3,344,904.32 | $ 28,210.00 | $ - | $ 1,189,563.00 | $ 164,149.79 |
| 2017 | $ 738,425.00 | $ 3,339,382.59 | $ 27,377.00 | $ - | $ 1,284,728.00 | $ 167,432.78 |
| 2018 | $ 737,205.00 | $ 3,333,865.38 | $ 26,544.00 | $ - | $ 1,387,507.00 | $ 170,781.44 |
| 2019 | $ 735,984.00 | $ 3,328,343.64 | $ 25,711.00 | $ - | $ 1,498,507.00 | $ 174,197.07 |
| 2020 | $ 734,763.00 | $ 3,322,821.91 | $ 24,878.00 | $ - | $ 1,618,388.00 | $ 177,681.01 |
| 2021 | $ 733,543.00 | $ 3,317,304.70 | $ 24,045.00 | $ - | $ 1,747,859.00 | $ 181,234.63 |
| 2022 | $ 719,402.00 | $ 3,253,354.79 | $ 26,526.00 | $ - | $ 1,887,688.00 | $ 184,859.32 |
| 2023 | $ 705,261.00 | $ 3,189,404.89 | $ 29,006.00 | $ - | $ 2,038,703.00 | $ 188,556.51 |
| 2024 | $ 691,120.00 | $ 3,125,454.98 | $ 31,487.00 | $ - | $ 2,201,799.00 | $ 192,327.64 |
| 2025 | $ 676,979.00 | $ 3,061,505.08 | $ 33,968.00 | $ - | $ 2,377,943.00 | $ 196,174.19 |
| 2026 | $ 662,838.00 | $ 2,997,555.17 | $ 36,448.00 | $ - | $ 2,568,178.00 | $ 200,097.68 |
| 2027 | $ 648,697.00 | $ 2,933,605.26 | $ 38,929.00 | $ - | $ 2,773,632.00 | $ 204,099.63 |
| 2028 | $ 634,556.00 | $ 2,869,655.36 | $ 41,409.00 | $ - | $ 2,995,523.00 | $ 208,181.62 |
| 2029 | $ 620,415.00 | $ 2,805,705.45 | $ 43,890.00 | $ - | $ 3,235,165.00 | $ 212,345.25 |
| 2030 | $ 606,274.00 | $ 2,741,755.55 | $ 46,371.00 | $ - | $ 3,493,978.00 | $ 216,592.16 |
| 2031 | $ 592,133.00 | $ 2,677,805.64 | $ 48,851.00 | $ - | $ 3,773,496.00 | $ 220,924.00 |
| **PV - 8% discount rate** | | | | | | |
| | **$7,029,937.67** | **$31,791,517.67** | **$302,301.95** | **$14,077,298.80** | **$10,203,668.07** | **$1,721,703.43** |
| **PV - 4% discount rate** | | | | | | |
| | $9,615,674.62 | $43,485,007.16 | $429,735.51 | $21,479,715.38 | $24,639,595.49 | $2,440,283.18 |

| | | | | |
|---|---|---|---|---|
| | Original B/C Ratio | **0.18** | | - 2005 construction / 2006 implementation |
| 8% discount rate | Original B/C Ratio* | **0.30** | (A+C) / (D+E) | * modified to assume 2012- 2031 implementation |
| 8% discount rate | Revised B/C Ratio | **2.03** | (B+C) / (D+F) | - assumes 2012- 2031 implementation |
| 4% discount rate | Revised B/C Ratio | **1.84** | | |

Benefits and Costs for 2006-2011 ignored in calculation but shown for comparison