Next 20: State of the City
Supplemental Report: Potential Cost Savings of a Balanced Growth Pattern

July 15, 2020

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Potential Cost Savings of a Balanced Growth Pattern

2020 June 10

1 Summary

In 2009, IBI Group completed a study titled "Implications of Alternative Growth Patterns on Infrastructure Costs" for the Plan It Calgary process. It is more generally referred to as the "Cost of Growth" study.

The 2009 Cost of Growth study identified that the current Municipal Development Plan (MDP) and Calgary Transportation Plan (CTP) would result in societal savings of $11 billion in capital costs over 60 years, and an annual operating cost savings of $130 million at the final year of the original study. This is relative to the "Dispersed Scenario" which reflected current policy and trends in 2009. Through the MDP Scenario these savings would be shared by multiple parties including The City, Province, School Boards and private developers. These savings were due to the reduced amount of linear and spatial infrastructure that would be required from a smaller city footprint.

Linear and spatial infrastructure refer to infrastructure that supports the expansion of Calgary's urban footprint. It includes things like new roads, road upgrades, and water pipes.

Administration, using the methodology from the 2009 study, updated the analysis using information from 2019, except in a few cases where only 2018 data was available. Storm water infrastructure was not included in the 2009 study, but was added to this analysis. The revised cost of growth for capital infrastructure is shown in Table 1. Table 2 contains a summary of the incremental operating costs expected 60 years from now.

Table 1: Summary of Capital Infrastructure Costs to Support Growth ($ Billions)

Infrastructure Type	Dispersed Scenario	MDP Scenario	Potential Savings	% Difference
Roads	$21.96	$15.76	$6.20	28%
Transit	$19.88	$19.11	$0.77	4%
Water Services	$15.58	$9.15	$6.42	41%
Fire Stations	$0.90	$0.56	$0.34	38%
Parks	$1.78	$0.98	$0.80	45%
Schools	$4.82	$3.17	$1.65	34%
Total Capital Costs	**$64.91**	**$48.73**	**$16.18**	**25%**

Table 2: Estimate Incremental Operating Cost Increase in Horizon Year ($ Billions)

Infrastructure Type	Dispersed Scenario	MDP Scenario	Potential Savings	% Difference
Roads	$0.06	$0.04	$0.02	36%
Transit	$0.28	$0.15	$0.13	45%
Water Services	$0.08	$0.04	$0.04	45%
Fire Stations	$0.22	$0.13	$0.10	43%
Parks	$0.25	$0.14	$0.11	45%
Total Annual Operating Costs	**$0.88**	**$0.49**	**$0.39**	**44%**

There are some important caveats that should be noted with respect to the updated analysis. Environmental and social benefits, beyond these cost savings, are not included in the calculation. The time period continues to look out over the next 60 years, so the updated calculations do not account for infrastructure costs and savings prior to 2019. The calculations look at how the city would grow spatially under different scenarios and use linear and area unit costs to determine overall savings. This analysis is not a full operating cost model and includes municipal as well as non-City costs. The methodology, used to support decisions on the MDP/CTP in 2009, is not comparable to a City of Calgary analysis of capital and operating investments to support growth decisions today. The work of the city-wide growth strategy and off-site levy review will identify City project-specific capital and operating costs at a more detailed level, so some differences in overall costs are to be expected.

While the analysis continues to confirm that progress on a more compact urban form can have tangible savings, it is acknowledged that there are many costs to achieving a more compact city that are not reflected in the methodology. These include, but are not limited to, increased risk and timelines for project approval, increased land prices in central locations, and utility upgrade complications and risks. The work of the Established Areas Growth and Change Strategy, Main Streets, Downtown Strategy and related initiatives must continue to seek to address these factors if the full spectrum of savings is to be achieved.

What does "final year" mean?

Both the MDP and the CTP are planning for a point about 60 years in the future, however for analysis purposes this point needs to be specifically defined. The original study only referenced "60 years in the future." The current analysis assumes the final year is 2076 as it aligns with other long range forecasts in the city.

CAPITAL & OPERATING COSTS

Capital costs are the costs associated with building new infrastructure or purchasing new equipment. This includes building new LRT lines, roadways, water pipes, or purchasing fire equipment. Most of these costs are one-time costs, and once construction or the purchase is complete, the infrastructure is then available for use.

Operation and maintenance costs are the costs to operate any equipment or maintain physical infrastructure. They are ongoing costs that are paid every year.

The incremental costs discussed in this report are the different in operating costs between today and the final horizon year in 2076.

2 Introduction

2.1 Background

In 2009, Plan It Calgary commissioned a study to assist the development of an integrated plan for land use and transportation. It examined the difference in infrastructure requirements, and the potential savings, between two scenarios. The first scenario, the "Dispersed Scenario" assumed growth would follow the trends (where most growth was allocated to the developing areas of Calgary) and city policies that were in place at that time.

The second scenario was called the "Recommended Direction" which intensified jobs and population in specific areas of Calgary and linked them with high quality transit service. The original study investigated infrastructure related to transportation (roads and transit), water and waste-water services, police, fire, parks, recreation centres, and schools. The study found a significant savings in infrastructure costs if Calgary were to grow towards the balanced growth pattern in the Recommended Direction. There were also cost savings in operating costs associated with a more balanced approach to growth pattern.

The "Recommended Direction" was approved in 2009 and adopted in the Municipal Development Plan (MDP) and renamed the MDP Scenario.

2.2 Study Purpose and Scope

The Next 20 project reviewed the MDP and CTP and included a review and update of potential savings that could be realized with a balanced growth pattern. While there are other costs associated with growth, this study is intended to give a broad indication of the savings between different growth patterns and is not intended to be exhaustive or to be used as a project or budget estimating tool. The original study considered the potential savings over a 60 year period and most of the initial conditions in the study were based on data from 2006. The updated study refreshed the current day assumptions and looked at potential savings as Calgary grows from today to 2076, a little less than 60 years in the future. This was to align with other long range forecasting activities in Calgary. Over the study time period, Calgary is expected to add over 900,000 more people. It was also assumed that if Calgary were to follow the growth pattern in the Dispersed Scenario, then the existing city limits would likely expand to incorporate this growth. The MDP Scenario would not see a change to the city limits.

This analysis focused on savings that are location dependent and included providing new transportation, water and fire services, as well as new parks and schools. Savings from location independent services, such as police or other community services, were not specifically evaluated as there would be no differences between the scenarios. Lastly, life cycle and maintenance costs of existing infrastructure were also excluded from the study as these costs would need to be accommodated in both scenarios. This analysis was conducted in constant 2019 dollars.

This study considered potential savings from two categories:

1. Capital Investments

Capital costs are the costs associated with building new infrastructure or purchasing new equipment. This includes building new LRT lines, roadways, water pipes, or purchasing fire equipment. Most of these costs are one-time costs, and once construction or the purchase is complete the infrastructure is then available for use.

The capital costs in this report refer the total cost to provide infrastructure to support growth in Calgary over the next 60 years. It should be noted that in most costs, the cost estimated does not include the cost to purchase land.

2. Operation and Maintenance Costs

Once the capital infrastructure has been constructed, there are costs associated with operating and maintaining infrastructure. This would include operators for new LRT services, snow clearing on roadways, repairing water mains, maintaining parks and operating recreation centres. These costs are on-going and are paid every year to operate facilities and maintain infrastructure.

This analysis determined the incremental annual operating cost in the horizon year, 2076. It is the additional amount of operating and maintenance funding needed to support capital infrastructure investments for each scenario. It does not reflect an operating budget.

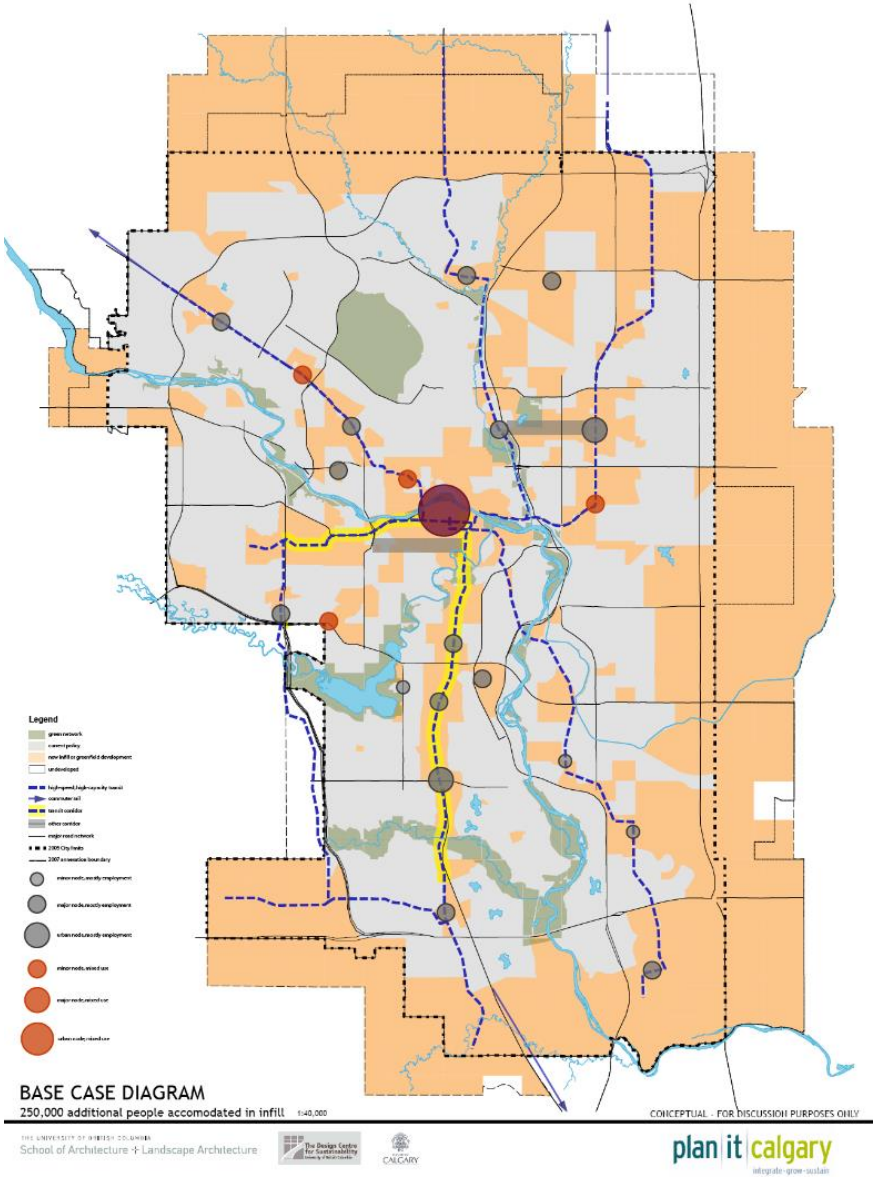
2.3 Funding Partners

Providing infrastructure services to Calgarians is a partnership between the City, private developers, other orders of government, and external partners. Partners contribute to the funding for capital projects and includes grants, levies, debt, reserves and Pay-As-You-Go. This analysis considered the whole cost of growth, regardless of the funding source, and all partners would benefit from savings that would be realized.

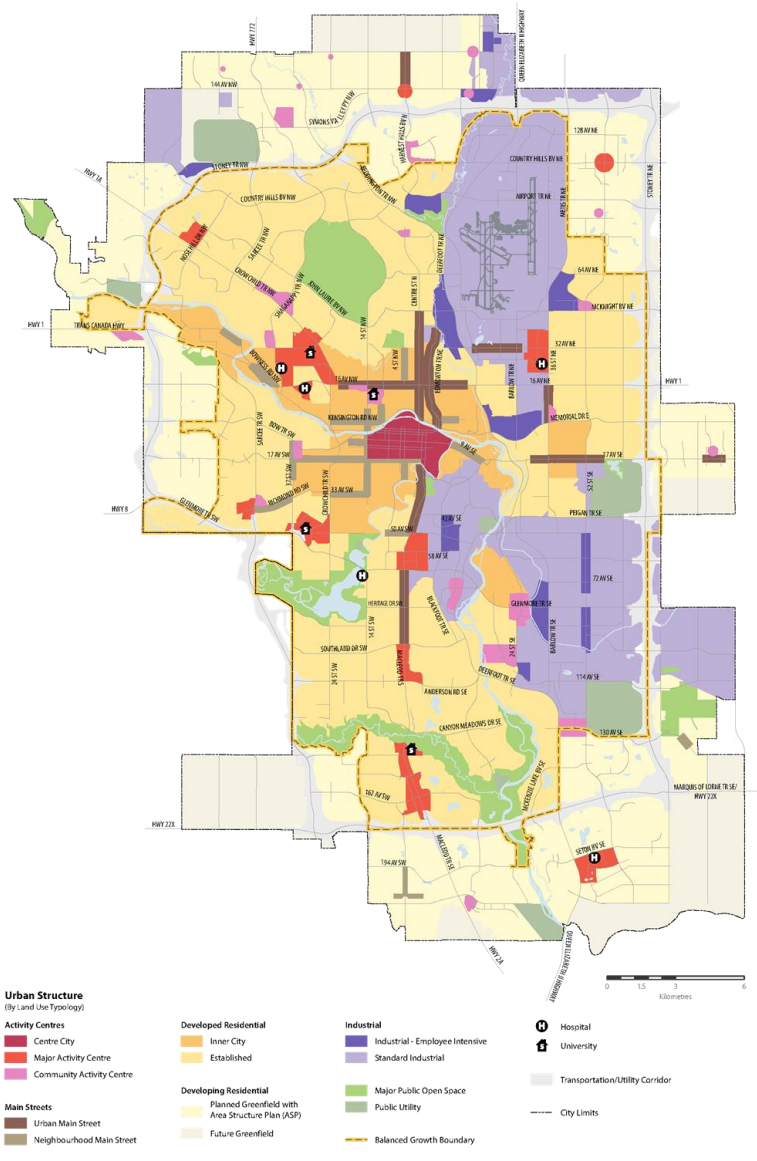
3 Scenario Descriptions

In 2009, developed areas were losing population and new growth was accommodated along the outer edges of Calgary. Under the Dispersed Scenario, it was expected that some growth would be accommodated within the developed areas of the city, but most would be located around the outer edges. In this scenario, the urban footprint of Calgary was expected to more the double over a 60 year timeframe. The MDP Scenario saw a shift towards an increase in redevelopment with the intention to accommodate half of Calgary's growth over 60 years within the developed areas of Calgary. The scenario would see the urban footprint of Calgary expand by only 50% over the same time period. Figure 1 shows the different development patterns and urban footprints of both scenarios.

Figure 1: Dispersed and MDP Scenario 60 Year Urban Footprint



Dispersed Scenario
Urban Footprint: 101,300 hectares



MDP Scenario
Urban Footprint: 78,720 hectares

Population and employment assumptions remained consistent between the two scenarios. However, growth projections have been updated to reflect changes since the MDP and CTP were approved. Over the next 60 years, Calgary's population is expected to increase by about 75% and employment is expected to almost double. This means over a million more people coming to live and work in Calgary over the next 60 years. Table 3 shows the expected growth in population and intensification within the developed areas of Calgary. Table 4 shows the expected growth in employment in Calgary.

Table 3: Calgary Population Forecast

	2006	2019	Dispersed Scenario	MDP Scenario
Population	956,000	1,267,000	2,217,000	2,217,000
Pop in Developed Area	841,000	878,000	1,181,000	1,471,000
Pop in Developing Area	115,000	389,000	1,035,000	745,000
Intensification Ratio	12%	12%	27%	50%

Table 4: Calgary Employment Forecast

	2006	2019	Dispersed Scenario	MDP Scenario
Total Employment	608,500	781,400	1,345,400	1,345,400
Jobs in Established Area	519,500	560,200	1,076,700	1,151,900
Jobs in Greenfield Area	89,000	221,200	268,700	193,400

4 Potential Infrastructure Cost Savings

When new communities are built, there is very little infrastructure in place to support the growing community. As the city grows, additional infrastructure is needed so people can go about their daily lives. This includes building new roads to connect homes to the places people need to go, providing water services so people have drinking water, and ensuring there are enough parks and recreation facilites for people to enjoy. Most of this new infrastructure is required when new communities are built on bare land with no services. However, in the MDP Scenario there additional improvements that may be needed to support increased densities along activity centres and corridors. This would include increasing transit services, upgrading water and waste-water piping, and upgrading or expanding parks and recreation facilities.

The types of infrastructure examined in this study mirrored the original 2009 study and included:

- Building new roads of all scales
- Increasing transit service
- Building new water and waste-water pipes
- Providing new fire stations and equipment
- Constructing or upgrading recreation facilities
- Developing new regional parks
- Building new schools.

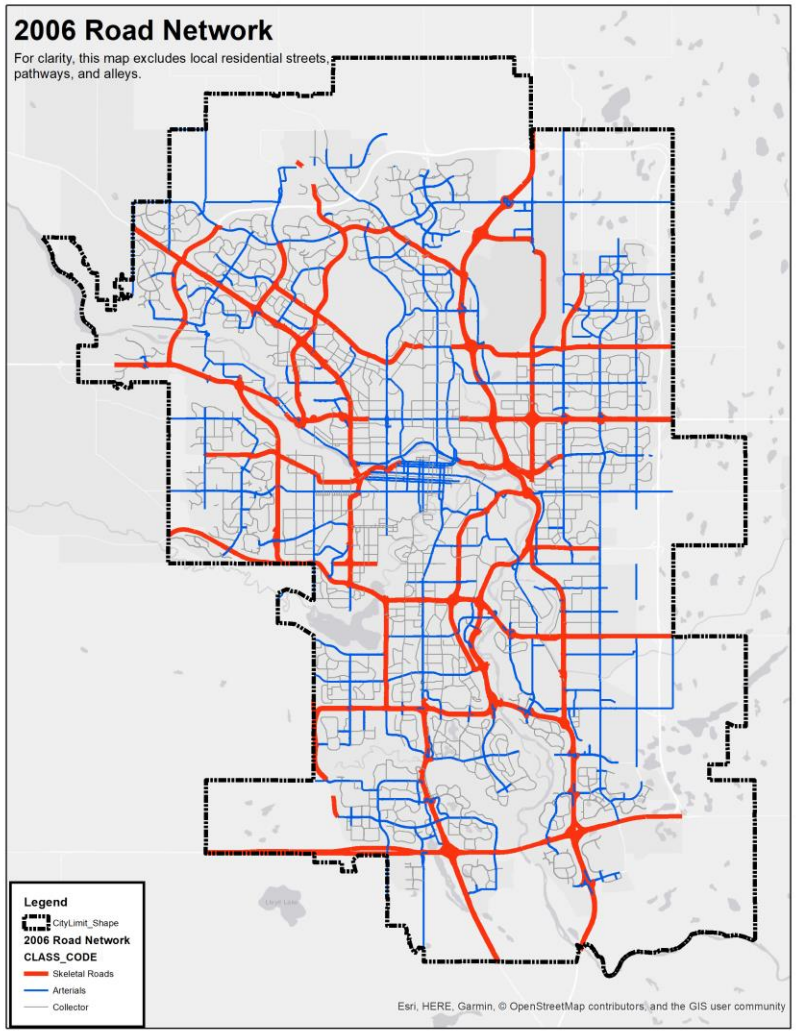
Although schools are a provincial responsibility, they were included in the original study, so it was included in this analysis to ensure the results would be comparable. The analysis was expanded to include storm water services as they support the health of Calgary's watershed. There may be other costs associated with growth, however, the scope of this analysis was limited to ensure the results would be comparable.

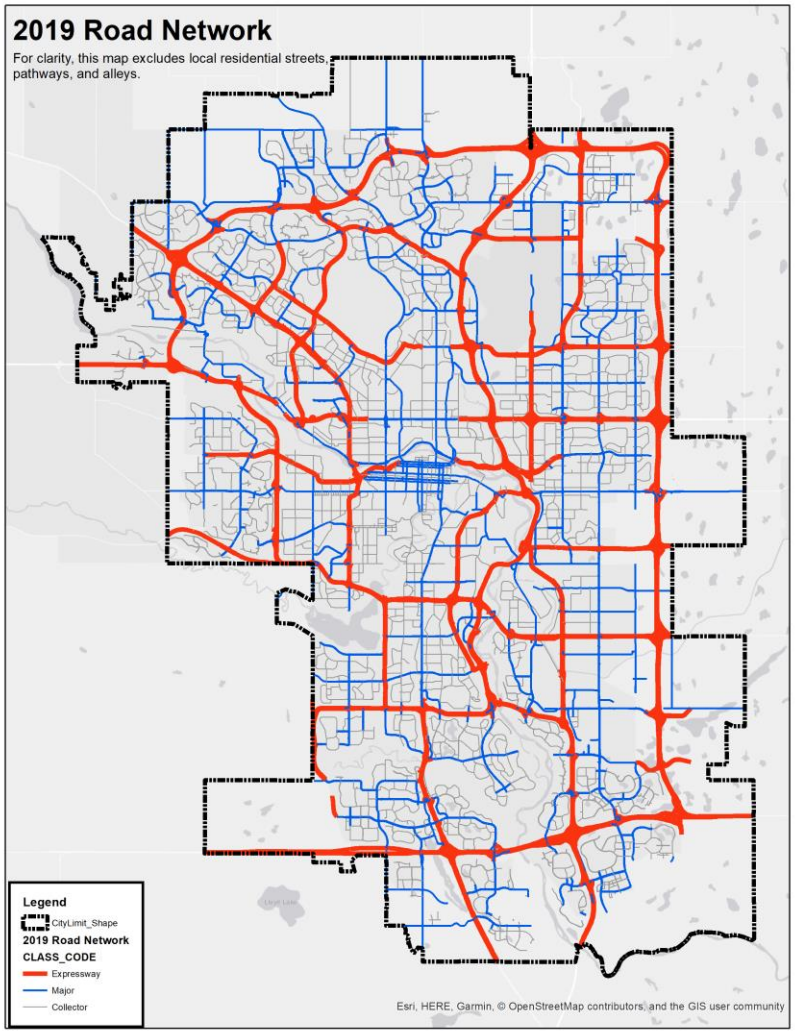
4.1 Road Infrastructure

In the Dispersed Scenario, new residential and collector roads are needed to connect new communities to the rest of the transportation network. It also will require upgrading parts of the existing transportation network to accommodate the additional demand. Under the MDP Scenario, some new roads are necessary to connect new communities, and some upgrades along major corridors may be needed to accommodate growth. However, the MDP Scenario relies on a significant investment in transit to reduce the need for additional road infrastructure. Other infrastructure upgrades in this scenario include upgrading roads to parkway and boulevard standards and providing infrastructure to support transit. The costs to support transit are considered in the Transit section. Investment in road infrastructure leads to increases in operating costs as these new roads will need to be maintained.

Since the plans were approved in 2009, the road network has been expanded both to support new communities and improve the skeletal road system. Figure 2 shows the expansion of the road network since 2006, the base year used in the original analysis.

Figure 2: Comparison of 2006 and 2019 Road Networks





4.1.1 Estimating future road supply

Estimating potential savings from changes to the future road network requires estimating the length of roadway needed to support growth. Road construction costs differ depending on the road classification, as skeletal roadways cost more to build than local roads. This analysis considered the following road classes and facilities:

- Skeletal roads
- Arterial streets
- Boulevard/Parkway Upgrades
- Collectors
- Local roads
- Interchanges

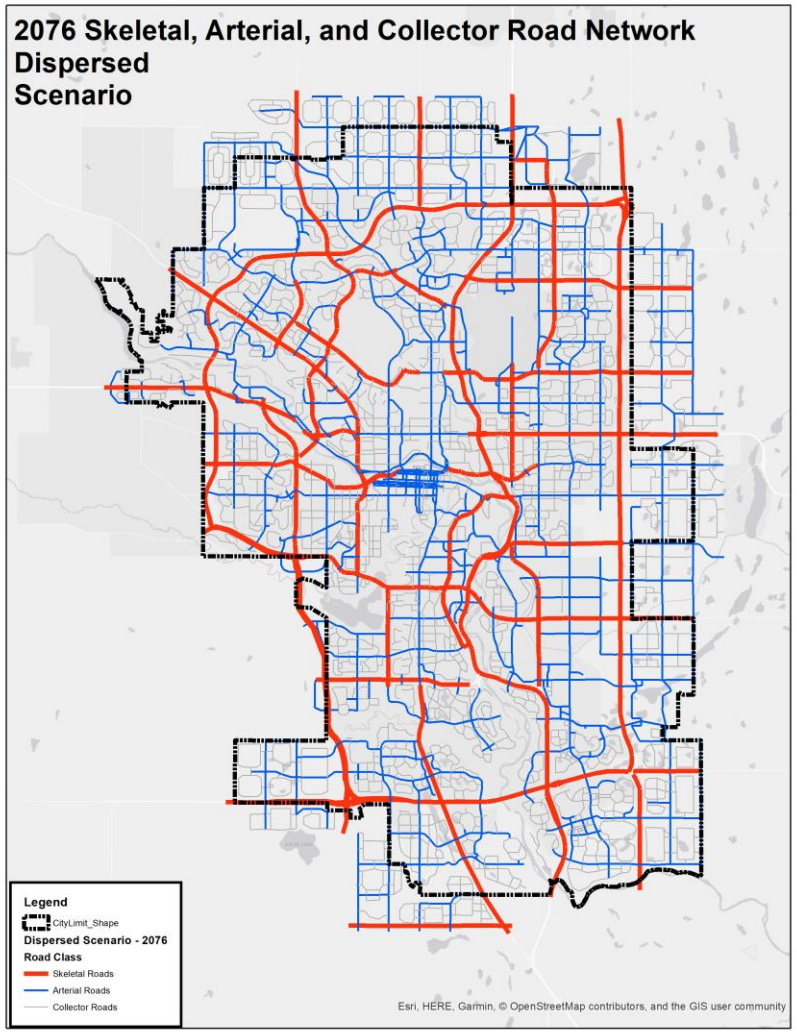
Estimating the skeletal and arterial road supply used information from forecast scenarios developed using the Calgary Regional Transportation Model (RTM). The Dispersed Scenario was based on a long-range network from a series of forecasts developed using scenarios from the RTM in 2008. This scenario assumed a growth pattern similar to the Dispersed Scenario. The skeletal and arterial network supply for the MDP Scenario was estimated using the long range horizon from the 2015 MDP/CTP Scenario Series as it aligned with the CTP road network. The base networks were updated to reflect conditions in 2019. The difference between current conditions and these future scenarios was used to estimate the additional length of road required. Table 5 shows the estimated length of skeletal and arterial roadways to support different development forms.

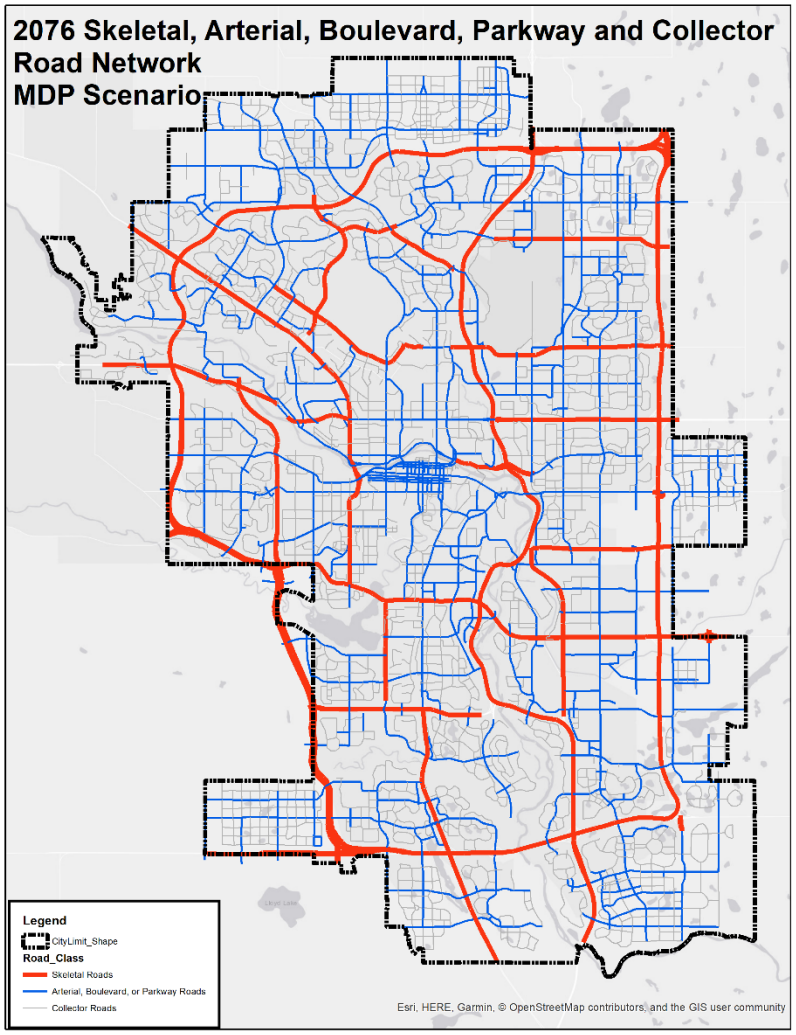
Table 5: Estimated Skeletal and Arterial Road Supply (Lane-km)

Road Class	Base (2019)	Additional Lane-km (2076)		Total Lane-km (2076)	
		Dispersed Scenario	MDP Scenario	Dispersed Scenario	MDP Scenario
Skeletal	1200	1500	1000	2700	2200
Arterial	2100	1500	700	3600	2800
Total	**3300**	**3000**	**1700**	**6300**	**4900**

It should be noted that this increase in road infrastructure is due to both the construction of new roads in new communities and widening existing roads to support demand. Figure 3 shows the potential future networks for each scenario.

Figure 3: Potential Future Road Networks (2076)





When the original analysis was conducted, there were no road classifications for boulevards and parkways so it made some assumptions about the length of road in these classifications. With the adoption of the MDP and CTP in 2009 and approval of the Complete Streets Policy in 2014, roads in Calgary were reclassified according to the road classes in these documents, this included reclassifying a number of roads to boulevards and parkways. These can be existing roads that have been upgraded or new roads that have been built to meet the boulevard and parkway standards in these documents. The length of roads classified as boulevards and parkways in the current analysis was estimated using street network spatial data. It was found that the length of these roads was higher in 2019 than originally estimated in the 60 year horizon. The MDP Scenario estimated the length of boulevards and pathways using the long-range scenario from the 2015 MDP/CTP Scenario Series as the classifications were consistent with CTP road classifications. For the Dispersed Scenario the length of parkways was assumed to be the same as the MDP Scenario. Also, the length of additional boulevards required in the Dispersed Scenario was assumed to be half the length of new boulevards in the MDP Scenario. These two assumptions were consistent with assumptions in the original analysis. The resulting length of boulevards and parkways are shown in Table 6.

Table 6: Estimated Boulevard and Parkway Road Supply (Lane-km)

Road Class	Base (2019)	Additional Lane-km		Total Lane-km	
		Dispersed Scenario	MDP Scenario	Dispersed Scenario	MDP Scenario
Boulevards	271	73	147	345	418
Parkways	109	34	34	143	143

The length of collector and local roads required a different estimation method as the RTM does not have sufficient detail to measure the road supply directly. However, they can be estimated using the population differences between the two scenarios. The original report surveyed a cross section of residential areas and determined that approximately 9 lane-m of roadway per resident were needed for all road classes. This length of new roadway included skeletal and arterial roads. The original analysis determined that 50% of these roads were residential and 20% were collector while the remaining 30% would be skeletal and arterial roads. The length of new collector and local roads in the updated analysis can be estimated by applying these assumptions to updated population forecasts. Table 7 shows the resulting estimate of local and collector roads in each scenario.

Table 7: Estimated Collector and Local Road Supply (Lane-km)

Road Class	Base (2019)	Additional Lane-km		Total Lane-km	
		Dispersed Scenario	MDP Scenario	Dispersed Scenario	MDP Scenario
Collector Roads	2,100	1,300	900	3,400	2,100
Local Roads	4,900	3,100	2,200	8,000	5,300
Total	**7,000**	**4,400**	**3,000**	**11,400**	**7,400**

Lastly, the number of interchanges needed to accommodate the flow of future traffic needs to be estimated for each scenario. The network assumptions in both the 2006 and 2015 scenario series from the RTM were reviewed and the number of new interchanges estimated for each horizon. The resulting totals are shown in Table 8.

Table 8: Estimated Number of Interchanges

	Dispersed Scenario	MDP Scenario
Number of Interchanges	113	101

4.1.2 Estimating potential savings to the road network

Potential savings were estimated using the network supply information and the unit costs to build different roadway facilities provided by Calgary Roads and Transportation Infrastructure. The skeletal and arterial road and interchange construction costs were estimated using a series of recent projects completed by Transportation Infrastructure. The collector, local, boulevard and parkway costs were provided by Calgary Roads. The potential costs and savings of the future road network is shown in Table 9 below.

Table 9: Estimate Capital Costs of Road Supply ($ Billion)

Road Type	Dispersed Scenario	MDP Scenario	Potential Savings
Skeletal	$4.09	$2.57	$1.52
Arterial	$3.26	$1.49	$1.76
Boulevard/Parkway Upgrades	$0.19	$0.39	-$0.20
Collector	$2.18	$1.49	$0.69
Local	$5.35	$3.66	$1.69
Total New Roads	$15.07	$9.60	$5.46
Interchanges	$6.90	$6.20	$0.70
Total Costs	**$21.97**	**$15.80**	**$6.16**

The savings in operating expenses are based on the length of roadway that needs to be maintained. This can be estimated using the road supply estimates above. Currently The City spends approximately $129 million per year to maintain Calgary's current roadway system, and this is expected to increase as more roads are added to the network. The balanced growth scenario would lead to fewer roads to maintain which could see up to $20 million in savings annually by 2076. Table 10 summarizes the operating costs associated with maintaining Calgary's roadway system. Please note that these costs are average maintenance cost estimates across all road types.

Table 10: Estimate of Road Operating Costs ($ Billion)

	Base (2019)	Dispersed Scenario	MDP Scenario	Potential Savings
Total Lane-km	16,636	27,310	24,640	2,670
Lane-km Added		10,674	8,004	2,670
Average Lane-km added per year		184	138	46
Total Cost Operating Budget ($ Billion)	$0.130	$0.213	$0.192	$0.02
Incremental Operations and Maintenance Cost ($ Billion)		$0.06	$0.04	$0.02

4.1.3 Changes Since 2009

The original analysis used unit costs from the Canada Mortgage and Housing Corporation's (CMHC) 2008 Lifecycle Costing Tool for Community Infrastructure. Since the original analysis was completed, Calgary Roads launched an asset management program and began tracking costs associated with infrastructure. In the updated analysis, the costs reflect current costs experienced by The City of Calgary for building and maintaining infrastructure. Further, there were inconsistencies in the original report when it came to reporting operating costs. In some cases, like with Roads and Transit, the total operating cost in the horizon year was estimated and for others the incremental cost to support the new infrastructure was determined. This report is reporting the incremental cost to support the new infrastructure for all services. This difference is why some values are lower than reported in 2009.

4.2 Transit Infrastructure

Since the MDP and CTP were approved in 2009, Calgary Transit developed Route Ahead, a comprehensive long range transit plan for Calgary. It recommended the construction of new light rail lines, extensions to existing light rail, and transitways to support Bus Rapid Transit (BRT) routes. The capital investment outlined in Route Ahead was approved in 2012, an update is planned for late 2020. The investments approved in the plan are likely to continue regardless of the growth pattern in Calgary. However, there are some differences between the Dispersed and MDP Scenarios.

If Calgary follows a dispersed growth pattern, then the existing city limits will likely change. Route Ahead recommended LRT extensions up to Calgary's existing city limits. In the Dispersed Scenario, some existing LRT lines may need to extend outside the current city limit to provide service to the population living in these areas. The MDP Scenario would see almost the same level of capital investment over time, however, the operating hours of transit service would be larger. The MDP Scenario assumes that both the CTP mode split and transit service hours per capita targets are met.

4.2.1 Estimating future transit supply

Future transit use is a combination of the physical infrastructure required to provide transit service and the number of hours of service that are provided. Capital costs include the construction of new infrastructure such as LRT lines and maintenance buildings, as well vehicles to provide transit service.

The physical infrastructure was separated into four categories:

- Construction of additional light rail lines, including the extension of existing lines.
- Construction of transitways, which are separated bus lanes used to improve transit travel time and reliability.
- Purchase of new transit vehicles including light rail vehicles (LRVs) and buses.
- Construction of new maintenance facilities to support the increase in transit fleet vehicles.

The expansion of the light rail system is detailed in Route Ahead, Calgary Transit's 30-year plan for transit investment. It is expected that this plan would be followed regardless of Calgary's growth pattern so there are minimal differences between the two scenarios when it comes to light rail infrastructure. The length of the LRT system for the MDP Scenario was estimated using the long-range scenario from the 2015 MDP/CTP Scenario Series. This scenario was developed using the approved plans in Route Ahead and the CTP. The Dispersed Scenario LRT line expansions were estimated by looking at the LRT terminals in the MDP Scenario and estimating potential extensions to those lines to support the additional population. These extensions may extend beyond the current city limits, but it is likely that if Calgary were to develop in a dispersed pattern that land would need to be annexed to support that growth and these extensions would likely fall within future city limits.

Calgary Transit completed the 17 Avenue S.E. Transitway and the Southwest Transitway in 2019. Route Ahead called for the construction of transitways along the Green Line corridor, but it is more likely that this corridor will be constructed as a light rail line and will skip the transitway stages. The other major transitway proposed in Route Ahead is the 162 Avenue S.W. Transitway with extensions to the community of Providence. The length of this transitway was estimated using the long-range scenario in the 2015 MDP/CTP Scenario Series and is assumed to be the same in both scenarios. The length of LRT and transitway facilities estimated in this analysis are shown in Table 11.

Table 11: Transit LRT and Transitway Infrastructure Estimates (Line-km)

Line Name	2006 Line Distance	2019 Line Distance	Route Ahead Line Distance	Dispersed Scenario New Line Distance (km)	Dispersed Scenario Total Line Distance (km)	MDP Scenario Total Line Distance (km)
LRT - Red Line	27	34	38	4	42	38
LRT - Blue Line	12	25	38	2	39	38
LRT - Green Line	0	0	43	4	47	43
LRT – 17 S.E. Avenue Upgrade	0	0	15	2	17	15
LRT - Airport Line	0	0	10	0	10	10
Transitway - 162 Avenue S.W.	0	0	9	0	9	9

The number of new vehicles needed to provide transit service was estimated based on the average service hours per vehicle. This information was obtained from Calgary Transit, who provided the number of service hours for light rail vehicles and buses in 2018 along with the number of each type of vehicle.

Estimating the future service hours used estimates of transit service hours per capita and the forecast population. Under the Dispersed Scenario it was assumed that transit service hours per capita would remain similar to 2009 conditions or about 2.5 service hours per capita. These assumptions were used for the updated analysis. However it should be noted that the service hours per capita in 2018 had fallen to 2.2 hours per capita due to reductions in transit service. The MDP Scenario assumes investment in transit service and the service hours are increased to 3.7 service hours per capita. These service hour estimates and the forecast population were used to estimate the annual service hours for each scenario, and from there, the number of transit vehicles required to provide that service. Table 12 shows the estimated number of transit vehicles needed for each scenario.

Table 12: Estimate of future transit vehicles

Transit Vehicle Type	Vehicles (2018)	Service Hours per Vehicle	Service Hours			New Vehicles	
			Current (2018)	Dispersed Scenario	MDP Scenario	Dispersed Scenario	MDP Scenario
Number of LRV	225	923	208,000	536,000	525,000	356	343
Number of Buses	930	2738	2,546,000	5,005,000	7,677,000	898	1874

Lastly, additional maintenance facilities are required to maintain the new vehicles for an expanded transit system. Route Ahead provided information on the number of vehicles that each new facility could service and this information was used to estimate the number of new facilities needed. Both scenarios required the same number of facilities for light rail vehicle maintenance as the difference in the LRT network is not substantial between the two scenarios. However, much of the additional service hours in the MDP Scenario are provided by bus, so more bus maintenance facilities are needed. The results are shown in Table 13.

Table 13: Estimated Future Transit Maintenance Facilities

	Dispersed Scenario	MDP Scenario
New LRV Maintenance Facilities	3	3
New Bus Maintenance Facilities	3	5

4.2.2 Estimating potential savings to the transit system

Potential savings in transit infrastructure were estimated using a variety of sources. Construction estimates for light rail lines were based on publically available Green Line cost information. Transitway and maintenance facility construction were estimated on published information and estimates from Route Ahead that were adjusted for inflation. Route Ahead is scheduled for an update later in 2020, at which point a review of this work should be done to ensure the broad assumptions made in this analysis are still valid. Vehicle purchase estimates were provided by Calgary Transit. Table 14 summarizes the capital costs associated with transit service.

Table 14: Potential Savings to Transit Capital Costs ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
LRT			
Cost of LRT Line Extensions	$16.05	$14.37	$1.68
Cost of Additional LRVs	$2.03	$1.96	$0.07
LRV Maintenance Facilities	$0.52	$0.52	$0.00
Total LRV Infrastructure Costs	$18.60	$16.85	$1.75
Bus			
Cost of Transitways	$0.18	$0.18	$0.00
Cost of Buses	$0.58	$1.22	-$0.63
Additional Maintenance Facilities	$0.52	$0.87	-$0.35

Total Bus Infrastructure Costs	$1.28	$2.26	-$0.98
Total Transit Capital Costs	**$19.88**	**$19.11**	**$0.77**

Operating costs for Calgary Transit depend on the services hours provided and are offset by the revenue generated. The analysis in this update considered both revenues and expenses. The original analysis assumed that all increases in operating cost would be offset by increases in fare collection. However, the updated analysis found this was not the case if transit fares remain consistent with inflation. Tables 15 shows a summary of the service hours in each scenario, the cost to provide that service and the potential revenues that may be generated by additional passengers.

Table 15: Potential Savings in Transit Operating Costs ($ Billion)

	Current (2018)	Dispersed Scenario	MDP Scenario	Potential Savings
Annual Operating Hours	2,753,742	5,541,500	8,201,420	
Operation Hours Per Capita	2.2	2.5	3.7	
Annual system revenue ($ Billions)	$0.17	$0.31	$0.83	
Total system costs ($ Billions)	$0.41	$0.83	$1.22	
Total Operation Costs ($ Billions)	$0.24	$0.52	$0.39	$0.13
Incremental Operating Cost ($ Billion)	**$0.00**	**$0.28**	**$0.15**	**$0.13**

4.2.3 Changes Since 2009

In 2009, Calgary's investment in Transit was limited to the expansion of the existing light rail lines. The original analysis assumed a cost of approximately $50 million per km of LRT track, while current estimates from published Green Line reports suggest that costs for above ground LRT line construction are about three times that amount. This has a significant impact on the costs associated with light rail expansion. This increase in cost, and the approval of Route Ahead, which identified significant investment in transit services, resulted in a capital cost that is different than what was estimated in 2009. Further, it was assumed that operating costs would be the same between the two scenarios, that is unlikely given the difference in transit services hours provided between the scenarios. The updated analysis captures the difference in operating costs and capital costs.

4.3 Water Distribution Services

Providing water services to Calgary homes and businesses requires piped services and treatment facilities to distribute and treat water. Water service infrastructure includes piped services to distribute water, waste-water, and storm water as well as treatment plant capacity to treat both drinking water and waste-water.

Currently Calgary has two water treatment plants to clean water for consumption. Over time the water treatment capacity of Calgary will need to increase as the population grows. The demand for treated water is the same in both the Dispersed and MDP Scenarios so the costs associated with increasing water treatment capacity were not included in this work. The same is true for waste-water plant capacity in Calgary.

New piped infrastructure for water and waste-water services is required to support the development of new communities in Calgary. Potential savings may be realized in the MDP Scenario as this scenario has a smaller urban footprint. These savings may be offset by additional investment in the developed areas of the city to support redevelopment.

There are costs associated with operating and maintaining the water distribution system. This work assumed that the savings in operating costs in the developed area was minimal and that most of the potential savings are due to the reduced pipe infrastructure in the developing areas of Calgary.

4.3.1 Estimating Water Services supply

The number of pipes needed to support the developing areas of the city is based on the new urban footprint of the city. The larger the urban footprint, the more pipes are required to support growth. Calgary has grown since 2009, so the new area needing water services would exclude expansions to the urban footprint since 2009. Table 16 contains the urban footprint assumptions used for the developing areas of Calgary.

Table 16: Urban Footprint Assumptions for Water Services (Hectares)

	Base (2019)	Dispersed Scenario	MDP Scenario
Total Urban Footprint	51,209	101,300	78,720
Developing Area	1,209	51,300	28,720
Additional Area to be Serviced		50,091	27,511

For the developed areas of Calgary, the savings from the reduction in pipes to new communities is somewhat offset by the need to upgrade existing water infrastructure in the developed areas. This is to support the additional population and employment that would be living in those areas. Table 17 shows the population and employment assumptions used for this analysis.

Table 17: Developed Area Population and Employment Assumptions for Water Services

	Base (2019)	Dispersed Scenario	MDP Scenario
Total Population	1,267,000	2,217,000	2,217,000
Developed Area Population	878,000	1,181,000	1,471,000
Additional Population		303,000	593,000
Total Employment	781,400	1,345,400	1,345,400
Developed Area Employment	560,200	1,076,700	1,151,900
Additional Employment		516,500	591,700

4.3.2 Potential savings to water services

For the developing areas, potential savings were estimated using per hectare costs from Water Resources. These were estimated on a per hectare basis and included the cost to provide water, waste-water and storm water pipelines to new communities. These estimates were based on the business cases submitted for new communities approved in 2018. In the developed areas Calgary, potential savings were estimated based on the population and employment in the developed area. The costs per person and job were estimated by Water Resources after reviewing several new developments as case studies. This analysis only included water and waste-water services, so it was assumed that the cost to provide storm sewer services would be comparable to the cost for waste-water services. The potential savings to water service infrastructure is shown in Table 18.

Table 18: Potential Savings in Water Services Capital Investment ($ Billion)

Capital Costs	Dispersed Scenario	MDP Scenario	Potential Savings
Developing Area	$14.93	$8.20	$6.73
Developed Area	$0.65	$0.95	($0.31)
Total Capital Cost	**$15.58**	**$9.15**	**$6.42**

The potential in savings for operations and maintenance are related to providing water services and was calculated for the new pipes servicing the developing areas of Calgary. It was not anticipated that the additional demand in the developed areas would have significant operating and maintenance savings. Table 19 shows the incremental savings to operation and maintenance costs as a result of growth in the developing areas of Calgary.

Table 19: Water Services - Incremental Operating and Maintenance Costs ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
Incremental Operating and Maintenance Costs	$0.08	$0.04	$0.04

4.3.3 Changes Since 2009

Two significant changes to the cost assumptions were made in the updated analysis. The first was to include the provision of storm water infrastructure in the cost estimates as they are essential for managing water runoff. This protects Calgary's watershed health as well as homes and businesses from flooding. The second change was around capital cost investments in the developed areas of Calgary. The original analysis assumed that pipes would be replaced as part of normal lifecycle maintenance. However, Water Services has technology which enables them to extend the life of pipes that reduces the need for pipe replacement. As a result, fewer pipes are being replaced as part of life cycle maintenance and more would need to be built to support the increased densities in the MDP Scenario.

4.4 Fire Service Infrastructure

Fire station locations are planned to deliver minimum response times based on regulatory requirements. As Calgary expands, additional fire stations and equipment are needed to ensure the fire responders can respond to emergencies in a reasonable amount of time. In the Dispersed Scenario this involves the construction of additional fire stations to support new communities and the purchase of equipment for each station. The MDP Scenario has fewer new stations but would need additional equipment in the developed areas of Calgary to support the increase in population.

4.4.1 Estimating future fire service infrastructure

The number of new fire stations needed to support development are estimated based on the size of the developing area of Calgary. The provision of equipment to service the fire stations is based on population. Table 20 shows the number of new fire stations and new equipment that are required to support growth in Calgary.

Table 20: Estimated Fire Service Infrastructure

	Current	Dispersed Scenario	MDP Scenario
Urban Footprint	51,209	101,300	78,720
Developed Area	50,000	50,000	50,000
Developing Area	1,209	51,300	28,720
Fire Stations	41	84	66
Equipment	132	229	229

4.4.2 Potential savings to fire service

Savings in Fire Services are realized through building fewer stations and needing to purchase fewer pieces of equipment. Information on the cost to provide fire services, build new fire stations and purchase new equipment were provided by Fire Services and used to estimate the savings. A summary of these savings is shown in Table 21.

Table 21: Potential Savings to Fire Services Capital Investment ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
New Fire Stations	$0.78	$0.44	$0.34
New Equipment	$0.12	$0.12	$0.00
Total Capital Cost	**$0.90**	**$0.56**	**$0.34**

Savings in operating and maintenance costs were estimated based on the number of stations and was adjusted based on the additional equipment required to service the developed areas of Calgary. Table 22 shows the potential incremental operational savings for Fire Services.

Table 22: Potential Incremental Operational Savings to Fire Services ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
Incremental Operating and Maintenance Costs	$0.22	$0.13	$0.10

4.4.3 Changes Since 2009

The methodology to estimate the potential savings in providing fire services did not change significantly since 2009. Information was updated based on current data from Fire Services and One Calgary, The City's strategic plan for 2019-2022.

4.5 Recreation Infrastructure

As Calgary grows, there is a need to provide additional recreation facilities. The amount of recreation space needed is based on Calgary's population, so the amount of space needed to the same between the two scenarios. The Dispersed Scenario would require more facilities in the developing areas of Calgary, while the MDP Scenario may require upgrading or replacing existing facilities in the developed areas. The constructions costs, excluding land and demolitions costs, are also largely similar between the two scenarios so overall the capital costs are similar. However, the land costs can vary widely across the city and will impact overall costs.

4.5.1 Estimating future recreation service supply

The amount of space required to provide recreation services to citizens is based on the population of the area to be serviced. The estimate of future recreation space needed to support growth is shown in Table 23.

Table 23: Future Recreation Space Estimate (Square Feet)

Recreation Space	Dispersed Scenario	MDP Scenario
New Developing Area Recreation Space	1,267,000	688,000
New Developed Area Recreation Space	681,000	1,261,000
Total New Recreation Space	**1,948,000**	**1,948,000**

4.5.2 Potential savings for future recreation services

Potential savings for capital investment in recreation services are estimated based on the square footage of space required on a population basis. It is expected that the amount of space required for the two scenarios is the same as the population does not change. However, these estimates do not include demolition of existing facilities or the estimates to purchase land to build recreation space. This will vary significantly across the city depending on where the facilities are located. Some attempts were made to quantify the difference in land use value across the city, but the variation depends on a many variables that cannot be forecast. As a result the land use costs remain excluded, although they would impact the cost to construct new recreation spaces. Table 24 contains the capital cost estimates for recreation facilities.

Table 24: Potential Savings to Recreation Services ($ Billion)

Capital Cost	Dispersed Scenario	MDP Scenario	Potential Savings
Developing Areas	$0.72	$0.39	$0.33
Developed Areas	$0.34	$0.67	-$0.33
Total Recreation Capital Cost	**$1.07**	**$1.07**	**$0.00**

Recreation services operating and maintenance costs are not expected to be different between the scenarios as they are based on the total population. These were excluded from this analysis and not evaluated.

4.5.3 Changes Since 2009

The methodology used to estimate recreation space was not described in enough detail to replicate in this analysis. The new methodology was developed in consultation with Recreation Services based on current practices for recreation planning.

4.6 Parks Infrastructure

As Calgary grows, some natural areas are lost to support population growth. One of the goals of the MDP is to preserve the natural landscape around Calgary by protecting environmentally sensitive areas and supporting biodiverse vegetation, wild life species and natural prairie landscapes. To offset the loss of natural areas due to growth, The City has different ways to protect and preserve natural areas. In new developments, land is designated as a municipal reserve and developed into community and neighbourhood parks. The City also dedicates a portion of lands as environmental reserves to protect environmentally sensitive areas around Calgary. Also, with partners, The City can dedicate large pieces of land for regional park space, like Nose Hill Park or Ralph Klein Park. Regional parks are larger spaces where the natural area is preserved for people to enjoy.

The MDP Scenario focuses on more a balanced approach to growth that reduces the growth of Calgary's urban footprint. This allows for more natural environments to be preserved and less space needs to be protected through municipal or environmental reserves. In the Dispersed Scenario, more of the natural environment is disrupted to build houses, roads, and other structures in new communities so more land needs to be dedicated to reserves.

4.6.1 Estimating supply of future parks

Three different types of land are used for park spaces. A municipal reserve is used for neighbourhood and community parks, an environmental reserve preserves natural areas in Calgary, and larger scale regional parks serve multiple communities. The future municipal reserve can be estimated based on the requirements of the Municipal Government Act which requires 10% of land in subdivisions to be

dedicated for park space. For ease of estimation, this 10% reserve was applied to Calgary's future urban footprint. The environmental reserve was estimated by reviewing the amount of land set aside for environmental reserve over the past ten years. The average rate from this review was applied to the urban footprint of Calgary to estimate future park needs. The amount of space needed for regional parks in the future was estimated using Parks data to determine the proportion of land in Calgary that is currently allocated to a regional park and then assuming that this proportion would remain consistent over time. Table 25 shows the new supply of park space required to support growth in Calgary.

Table 25: Estimate future park space (hectares)

Park Type	% of Urban Footprint	Total Park Space Dispersed Scenario	Total Park Space MDP Scenario
Municipal Reserve	10%	10,130	7,872
Environmental Reserve	22%	22,504	17,488
Regional Parks	6%	6,008	4,669

4.6.2 Potential cost savings to parks supply

Potentials savings to park capital investments were estimated using information provided by Parks. It considered the investment needed to build regional parks that serve multiple communities and does not include estimates to purchase land. Potential savings in capital infrastructure are shown in Table 26 below.

Table 26: Parks Estimate of Capital Costs ($ Billions)

	Dispersed Scenario	MDP Scenario	Potential Savings
Parks Capital Costs	$1.78	$0.98	$0.80

Potential operating and maintenance savings were estimated using information from Parks and were based on the size of park space to be maintained. This would include park space allocated to municipal and environmental reserves. The potential incremental savings for the operation and maintenance of Calgary parks is shown in Table 27.

Table 27: Potential Incremental Savings to Park Service ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
Incremental Operating and Maintenance Costs	$0.25	$0.14	$0.11

4.6.3 Changes Since 2009

Similarly to Recreation Services, the methodology used in the original study was not detailed enough to replicate. Parks was consulted and a new methodology was developed to produce the estimates for this analysis.

4.7 School Infrastructure

Over the next 60 years, Calgary's population is expected to increase by over one million people. That includes over 100,000 new children who will need to attend school. When communities first start to grow, students are bussed to schools with excess capacity until the community has enough population to support a school. Once a school is built, demand increases as many of the new homes are occupied by young families. As the community continues to age, the demand for schools remains high for about 20 years when the children graduate and leave the school system. At that point the demand for schools begins to decrease. There may still be new families moving to the community, but the demand for schools tends to drop to about half of the initial demand. The Province of Alberta is responsible for and pays for schools, but schools were included in this analysis to be consistent with the original study.

In the Dispersed Scenario, more schools are required to support the additional students living in the developing areas of Calgary. Under the MDP Scenario, fewer new schools will be needed in the developing areas of Calgary and students living within the developed areas will be accommodated within existing schools. Although the number of students will increase as Calgary grows, declining birth rates will lead to the school age population growing slower than the rest of the population and it is reasonable to assume these students can be accommodated within existing infrastructure.

4.7.1 Estimating future school requirements

The provision of new schools is based on population in the developing areas of Calgary. The first stage of the analysis estimated the population based on density and determined the number of new schools that would be required to support growth in the developing areas. The original analysis included a lag that reduced the number of schools required. It is not clear from the original work what the lag was, but it likely referred to a delay between when schools are needed and when they are built. The lag was included in the update to ensure the results were comparable.

The second stage of the analysis looked at the utilization rates based on the estimated number of new schools. In both scenarios, the utilization rates were less than 100% indicating that there will be enough capacity to support the new students. New schools in developing areas of Calgary may lead to lower school utilization rates in developed areas although this depends on distance to schools, amenities offered at schools, and the capacity of new schools. This analysis focused on the number of schools needed for students in the Calgary Board of Education. The Calgary Board of Education information was used as it was the most complete, represented the largest number of students, and would be available to any child in the system. It is difficult to forecast how many students may attend other school board, particularly if they have lower enrollment. The costs will be factored to include the other school divisions. Table 28 shows the new schools required to support growth in the Calgary Board of Education in each scenario.

Table 28: Estimates of New Schools for Calgary Board of Education

	Dispersed Scenario	MDP Scenario
Elementary Schools	79	50
Junior High Schools	52	37
Senior High Schools	17	12

4.7.2 Potential savings to education

Potential savings were estimated using the Calgary Board of Education Three-Year School Capital Plan for 2019-2022. This report contained the current estimates to build elementary, junior and senior high schools in Calgary. This information was used to estimate the capital investment needed to provide schools for the Calgary Board of Education. The potential savings estimated in this analysis were factored to include the provision of schools for other school boards based on relative school enrollment. Table 29 contains the potential cost savings in capital investment provide schools to future Calgary students. These facilities are provided by the Province of Alberta, so they would benefit from these savings.

Table 29: Potential Savings for education ($ Billion)

	Dispersed Scenario	MDP Scenario	Potential Savings
Total Capital Cost	$4.82	$3.17	$1.65

4.7.3 Changes Since 2009

The same methodology used in 2009 was also used to update the savings in the current analysis. The primary difference is the number of senior high schools expected to be constructed. The original analysis did not detail how the number of senior high schools was determined, the current analysis was updated to reflect senior high school provision based on current Calgary Board of Education reports.

5 Appendix A - Acknowledgements

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6 Appendix B – Original 2009 Study

This appendix contains the original costing study completed in 2009.

Implications of Alternative Growth Patterns on Infrastructure Costs - 2009 IBI Report