2021

Transportation Department 2021 Environmental Performance

Sustainability Strategy Division
Transportation, The City of Calgary
June 2022

A sustainable transportation system meets the transportation and other needs of the present without compromising the ability of future generations to meet their needs.

(Transportation Research Board 2004)

EXECUTIVE SUMMARY

This report was prepared in Q1-Q2 2022 by the staff of the Transportation department's Sustainability Strategy division for the information of the Transportation Leadership Team. It also may be of interest to others in City administration, Council and the public. This reporting is presented annually to compile data, analyse trends, and inform leadership of the past year's environmental performance results and emerging issues, challenges and opportunities. It provides information and insight to confirm there is an appropriate alignment of focus and resources across the department and business service lines to meet environmental compliance requirements and organizational goals.

In 2021 the transportation system in Calgary continued to expand, while service delivery was adapted to pandemic-related changes in travel patterns and mobility demand. Environmental performance across the department was strong. Regular audits of operational business units Transportation Infrastructure, Calgary Roads, and Calgary Transit verify that the environmental management systems and processes they have in place are functioning effectively for them to continue to meet legal and policy requirements. The results of internal audits and also external audits performed annually by contracted third parties in 2021 confirm there are good environmental practices and innovations employed in the development and operation of our transportation system, both internal to the organization and throughout the contracted services supply chain. In summary:

- Environmental management systems were confirmed to be well integrated with daily operations and long-term business planning functions within Calgary Roads, Calgary Transit, and Transportation Infrastructure.
- The total energy supply required to operate the transportation system decreased by 8 per cent year-over-year, with reduced public transit service in line with reduced demand/ridership attributable to the pandemic.
- Energy efficiency initiatives helped to minimize transportation system energy use, and combined with The City's renewable energy supply contract they allowed an expanding transportation system to limit greenhouse gas emissions to 87 kilotonnes (down from 97 kt the year prior, and 117 kt in 2019).
- Department-wide efforts in planning, developing, operating – and in 2020-2021, adapting – transportation infrastructure and services enabled a wide range of mobility options for Calgarians, with continued implementation of the cycling strategy, pedestrian strategy, EV strategy, and RouteAhead transit strategy.
- Residents of Calgary and region enjoy good air quality and good water quality in the Bow River, with noted concerns being dust and sediment from land development, construction activities and unpaved surfaces.
- Potential pollutants were well managed through the effective implementation of plans for erosion and sediment control, construction site management, and working in areas of existing soil and groundwater contamination.
- The environmental management of road salts continued to be an area of focus with significant capital investments made in 2021 to minimize the inadvertent release of chlorides to the environment; Calgary Roads benchmarks well against other road authorities nationally in meeting its voluntary compliance targets.
- Waste materials produced from transportation operations, construction and demolition, and in the public realm are mostly diverted from landfill through reuse and recycling.
- Biodiversity conservation measures addressed key habitats, invasive weeds, wild bees, migratory birds and wildlife with 2020/21 marking a pivotal shift for Calgary Roads in "naturalizing" roadside open space.

The year 2021 was notable for being the second year of the global COVID-19 pandemic with related public health measures, significant changes in travel patterns, and corresponding changes in service delivery by The City. While some transportation system development and operational activities were relatively unchanged under this scenario, public transit service demand and corresponding supply were dramatically different than in past years – ridership in 2020 and 2021 was less than half of 2019 levels – and that resulted in significantly reduced energy use in terms of traction power for the light rail transit system and fuel consumption for the bus fleet.

The following dashboard indicates performance trends and current status for each of the operational business units in their continuing implementation of the Calgary Transportation Plan and in alignment with The City's environmental and sustainability policies. More detailed information on these programs and actions, and on select initiatives of the Transportation Planning and Green Line lines of business, are presented in this report under related headings.

Calgary Transit:

Action	2014	2015	2016	2017	2018	2019	2020	2021	Status
Environmental management system	→	→	→	→	→	→	↗	→	●
Energy management	→	↗	↗	→	→	→	→	↗	⊘
Pollution prevention	↗	→	↗	→	→	→	→	→	●
Water management	→	↗	↗	→	↘	↗	→	→	●
Waste management	→	→	↗	→	↗	→	→	→	●
Biodiversity conservation	→	→	→	↘	→	→	→	→	●

Roads:

Action	2014	2015	2016	2017	2018	2019	2020	2021	Status
Environmental management system	↗	→	↗	↗	→	→	→	↗	●
Energy management	↗	↗	→	→	→	→	→	→	●
Pollution prevention	→	↘	→	→	→	↗	→	↗	●
Water management	→	→	→	→	→	→	→	→	●
Waste management	→	→	→	→	↗	→	→	→	●
Biodiversity conservation	→	→	→	→	→	→	↗	↗	●

Transportation Infrastructure:

Action	2014	2015	2016	2017	2018	2019	2020	2021	Status
Environmental management system	↗	↗	↗	→	→	→	→	↗	●
Energy management	→	→	→	→	→	→	→	→	●
Pollution prevention	↗	→	→	→	→	→	→	→	●
Water management	→	→	→	→	→	→	→	→	●
Waste management	→	→	→	→	→	→	→	→	●
Biodiversity conservation	→	→	→	→	→	→	→	→	●

Trend favourable ↗ Trend unfavourable ↘ Trending same → On track ● Issue or Challenge ⊘ On hold ○

CONTENTS

EXECUTIVE SUMMARY i
1. Introduction 1
2. Advancing Environmental Sustainability 2
3. Environmental Management Systems 3
4. Energy Management 4
4.1 Corporate energy strategy and GHG emissions reduction goal 4
4.2 Transportation energy profile 5
4.3 Energy and emissions reductions effort and results 6
4.4 Land use and mobility aspects of energy consumption 12
5. Pollution Prevention 15
5.1 NPRI reporting 15
5.2 Air quality 15
5.3 Soil and groundwater quality 19
5.4 Surface water quality 23
6. Water Management 27
6.1 Water consumption at facilities 27
6.2 Storm water management 28
7. Waste Management 29
7.1 Corporate waste reduction strategy and targets 29
7.2 Waste reduction efforts and results 29
8. Biodiversity Conservation 31
8.1 Habitat management 32
8.2 Control of regulated weeds 33
8.3 Migratory birds protection 34
9. How We Do Our Work 34
10. Benchmarking Against Other Organizations 35

APPENDIX 1 – Transportation Energy Profile

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1. Introduction

This report was prepared by the staff of the Transportation department's Sustainability Strategy division for the information of the Transportation Leadership Team and others in City administration, Council and the public. This information is compiled for reference, planning and decision-making. Reporting with comparable scope and metrics has been presented annually for the past 8 years to inform leadership of environmental performance results and emerging isues, challenges and opportunities. It provides insight to confirm there is an appropriate focus and alignment of resources across business service lines to meet environmental compliance requirements and organizational goals. This report includes summary data from regulatory reporting, and also it presents a roll-up of progress reports that are shared on a regular basis throughout the year with Transportation leadership to provide direct lines-of-sight to operational staff and all programs and activities having environmental aspects (i.e. potential impacts and opportunities).

In the year 2022 this information will be valuable for reference as City administration transitions to a new organizational structure, with associated changes in governance for environmental management.

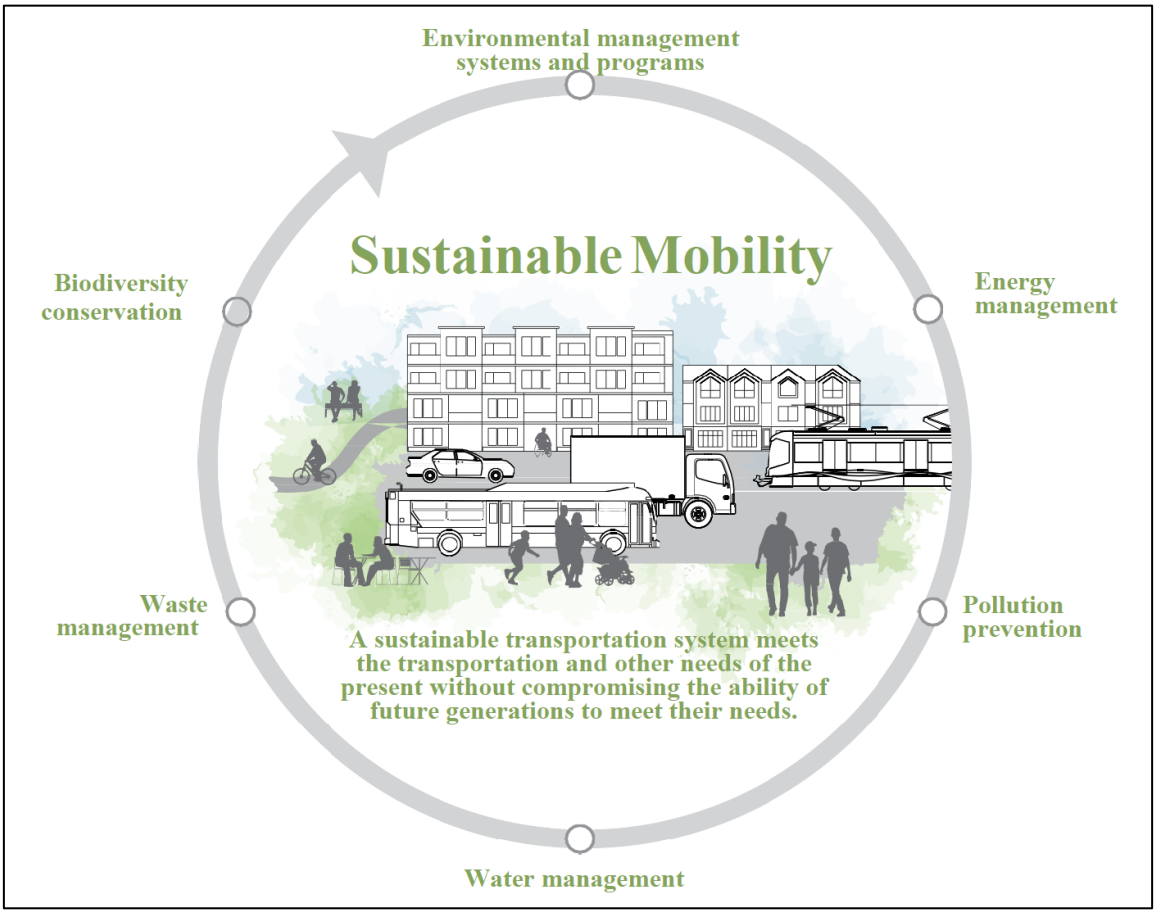
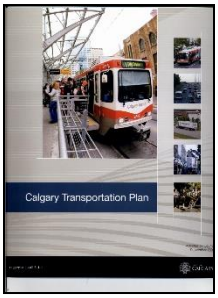


Figure 1:
Environmental sustainability themes selected for performance reporting by the operational business units of City of Calgary Transportation department

With the over-arching goal of the department being to facilitate movement of people and goods, there are several key environmental considerations (Fig.1) for the different Transportation business units and lines of service. The thematic sections of this annual performance report present details on each of these areas of our focus and effort (i.e. what we do, and collectively how well we do it) in advancing environmental sustainability.

The sustainability dashboard presented within the Executive Summary indicates environmental performance trends and current status. It is a qualitative assessment that relies on expert knowledge and professional judgement as supported by performance data and narrative information presented in this report. The dashboard trendlines span successive 3-year and 4-year business plans, so they reflect "best fit" with performance criteria that evolved in step with changes in business plan focus and objectives. Progress updates and select performance results for environmental management and related activities across the department are presented for the year 2021, with reference made to departmental outcomes, strategies, and performance measures outlined in the One Calgary 2019-2022 business plan. Citizen priorities are reflected in Council's strategic direction for "A City That Moves" (having key value dimensions of safety, accessibility, connectivity, responsiveness, and reliability of the transportation system) and "A Healthy and Green City" (key dimensions being climate resilience, water quantity and quality, and green space) being most relevant to this reporting.

2. Advancing Environmental Sustainability



The *Calgary Transportation Plan* (CTP) identifies "Advance environmental sustainability" as one of its seven primary goals, with its supporting objectives more specifically being to "protect **air**, **land**, **water** and **biodiversity** in the planning, design, operation and maintenance of all transportation infrastructure". Consistent with the plan's stated goal and objectives, there are several CTP policies that direct the efforts of the departmental environmental sustainability team in supporting the various Transportation (and broader Corporate) lines of business and service delivery to the citizens of Calgary.

The overall transportation goal presented in the *Municipal Development Plan* (MDP) is:

> *"To **develop an integrated, multi-modal transportation system that** supports land use, provides increased mobility choices for citizens, promotes vibrant connected communities, **protects the natural environment**, and supports a prosperous and competitive economy".*

The *City of Calgary Environmental Policy* states the importance of "The 3 C's" corporately, namely to:

- Comply with legislation;
- Conserve resources and prevent pollution; and
- Continually improve our environmental performance.

The department's three operational business units – Calgary Roads, Calgary Transit, and Transportation Infrastructure (TI) – all have positions filled with qualified environmental staff who provide internal client service on all environmental aspects of the transportation business. The Transportation department has a unique governance and reporting structure having environmental sustainability represented in its leadership, and having direct lines of sight between strategic leadership and tactical effort at the operational level, to better enable the "triple bottom line" (i.e. social, environmental, and financial aspects) being considered in

planning, decision-making, and execution. This report focuses on the efforts and results of work done in the operational business units to advance environmental sustainability.

Also included in this report are updates on select programs and initiatives within the Transportation Planning business unit, being concerned with "sustainability" defined more broadly to address active modes of travel, the shared public realms of roadways, and their integration with other land uses. Transportation planning is closely coordinated with land use planning (as guided by the MDP) to enable transit-oriented development and promote "smart growth". The MDP-CTP monitoring and reporting program, and various other data collection and reporting mechanisms including those within Calgary Transit, are valuable sources of data that are distinct from, and complementary to, the information presented in this report.

3. Environmental Management Systems

For well over a decade the operational business units of Transportation have maintained separate registrations to the International Standards Organization (ISO) program for environmental management systems. Annual audits of these management systems are conducted by an independent third party auditor, and every three years their functional effectiveness is validated for ongoing registration to the ISO 14001 Standard. Each business unit also is subject to an annual ISO/compliance internal audit led by Environmental & Safety Management (ESM). Additionally, Calgary Transit conducts its own facility inspections on a quarterly basis to review hazardous materials storage and labelling, secondary containment and spill release reporting.

In 2021 the three registered business units demonstrated continued satisfactory performance with no "major non-conformance" (indicating a significant deviation from the management system) to the ISO standard. There were several positive audit conclusions related to continuing improvements and sound environmental practices indicating that the management systems promote environmental protection during the construction, operation and ongoing maintenance of our transportation system. The environmental management systems also are demonstrated to be well integrated with daily operations and long-term business planning functions.

Audit results in 2021 confirmed that mature, properly functioning environmental management systems are in place within Transportation, and there is sound stewardship throughout the contracted services supply chain.

The Transportation Planning business unit is not registered to the ISO standard for environmental management, given the non-operational (i.e. primarily office-bound) nature of its work and associated low risk for adverse environmental effects. In 2018 the Green Line Light Rail Transit (LRT) initiative was created as a new, fifth distinct business unit within Transportation (note: as of 2020, the Green Line now operates under a separate governance structure outside the department) that was not anticipated to be ISO registered; instead, in January 2019 the decision was made to pursue certification for Green Line under the "Envision" sustainability rating system as an alternative environmental management guidance system that is suitable for linear infrastructure that will be designed, built and possibly financed by contracted third parties.

4. Energy Management

4.1 Corporate energy strategy and GHG emissions reduction goal

The City of Calgary consumes energy from various renewable and non-renewable sources. Corporate energy use in recent years has increased in step with annual population growth, with energy accounting for approximately 4 per cent of The City's total operating expenses. An integrated Corporate Energy Plan was completed in 2016 that set energy performance targets on specific timelines. In June 2018 a Climate Resilience Strategy was adopted by Council, including an action plan for achieving greenhouse gas (GHG) emission reductions through changes in energy use and supply. Significant work was completed in 2021 to implement the strategy and also to refresh and update the climate mitigation and adaptation action plans.

The combustion of fossil fuels by buses and other fleet vehicles, and natural gas used for heating buildings and facilities, are primary sources of GHG emissions from The City's Transportation business. There are also substantial GHG emissions associated with power generation that is supplied to the provincial electricity grid (Fig.2) although the City's draw from the grid is offset (i.e. considered to have zero emissions) because of it's renewable energy supply contract with ENMAX. Reducing fossil fuel consumption by shifting to lower carbon sources of energy, combined with energy efficiency and conservation measures, are key to reducing GHG emissions. The City previously had established a target to reduce corporate GHG emissions to 20 per cent below 2005 levels by 2020, consistent with commitments made under the 2009 Calgary Climate Change Accord. However, both corporate and city-wide GHG emissions continued to increase between 2009 and 2020. The City of Calgary currently is working toward a "net zero" GHG emissions target for 2050.

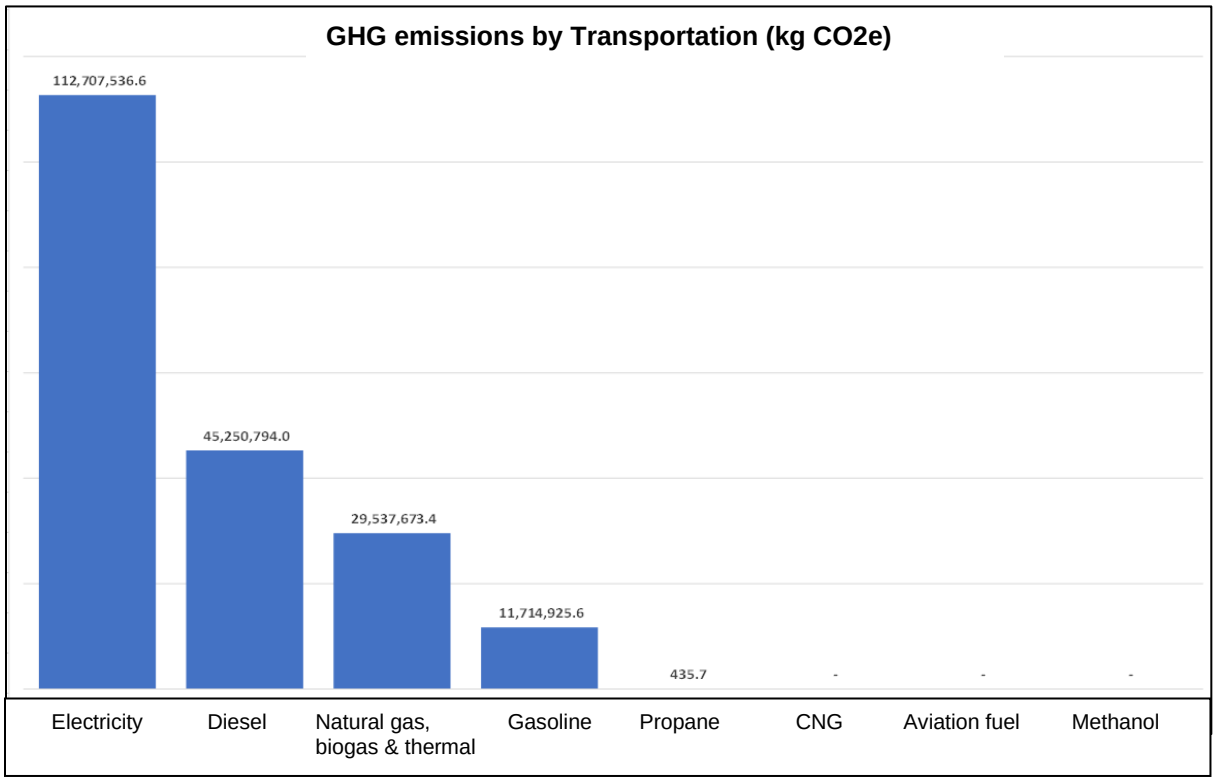


Figure 2: Transportation Department GHG emissions by source, 2021

4.2 Transportation energy profile

The current energy supply mix of the Transportation department comprises mainly electricity, natural gas, diesel fuel and gasoline. There are lesser components of compressed natural gas (CNG), thermal energy from combined heat and power (CHP) systems, solar power, and propane in the energy supply mix (Fig.2).

Data describing energy consumption and associated costs for the department and separately for operational Transportation business units are presented in Appendix 1. The full data set used to produce the charts and performance metrics was collected and compiled for analysis by The City's Energy Management Office.

In summary, in 2021 Transportation had a further 7.7 per cent decrease in energy consumption year-over-year, with total energy consumption from all energy supply sources of 522,180 megawatt hours equivalent (MWHe) at a cost of $60.8 million (Figs. App. 1-1, 1-2). The decreased energy use is primarily attributable to reduced public transit service in line with lower ridership during the Covid-19 pandemic.

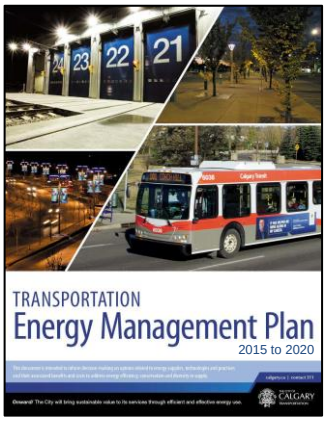
Within the department, Calgary Transit has the highest consumption of fossil fuels for fleet vehicles and facility space heating, accounting for about half of the department's total energy costs and the vast majority of its GHG emissions in a typical year (based on energy reporting for 2017-2019). In 2021 with adjusted bus services Calgary Transit's fossil fuel (diesel, gasoline, and natural gas) costs were 38.7 per cent of the department's total energy costs, while fossil fuel supply for Roads fleet remained the same as the year prior at approximately 6 per cent of departmental energy costs and associated GHG emissions. Unit prices for grid-supplied electricity were up in 2021, with the light rail transit (LRT) traction power system and electricity draw from transit facilities accounting for 31.6 per cent of departmental energy costs, and with the operation by Calgary Roads of street lighting and traffic signal systems being 22.7 per cent of total energy costs in 2021.

4.3 Energy and emissions reductions effort and results

Absolute reductions in Corporate energy consumption are a challenge to achieve in a growing city with an expanding transportation system. However, even with increases in The City's energy consumption needed to grow public transit service and ridership, greater community-wide GHG emissions reductions can be achieved with a significant shift in travel mode-split away from single occupancy vehicles, and toward active modes and public transit which is much more energy efficient. Analysis completed in support of Green Line LRT business case development (Report C2016-0115) reveals that energy efficiency gains are achieved with only 18 passengers riding on CTrain, which is the "break even" point for LRT to save energy compared with 18 automobiles. At maximum capacity, the LRT is 58 times more energy efficient than driving, and similarly transit buses are more energy efficient than automobiles when there are passenger economies of scale.

The following programs and initiatives addressed energy use and GHG emissions in 2021.

Energy management plan implementation



A departmental energy management plan was completed in 2014 to inform decision-making on options related to energy supplies, evolving technologies and practices, and their associated benefits and costs with the aim of improving energy literacy, energy efficiency and conservation, energy supply diversification, and cost control over the longer term. Implementation of the Transportation Energy Management Plan has entailed research, internal engagement, business case development and investigation into funding sources and financing mechanisms for potential capital investments and program changes within Calgary Transit and Roads business units.

One of the most significant initiatives undertaken to date was the conversion of over 80,000 street light fixtures throughout the city, from high pressure sodium to light emitting diode (LED) luminaires, to achieve payback on capital investment in less than 10 years through reduced maintenance effort and reduced energy consumption. With the average wattage per fixture being reduced from 187 Watts to 90 Watts between 2014 and 2019, a 49 per cent reduction in energy use was achieved over 5 years from street lights alone. Additional energy and cost savings were achieved by converting to LED for decorative light fixtures and for lighting at Transit maintenance and public parking facilities.

Several other opportunities identified in the plan have advanced into the realm of execution and operation with some highlights presented below. A refresh of the departmental energy management plan is one component of a pending new corporate-wide energy and emissions plan underway in 2022.

Fleet right-sizing and On Demand service delivery

Calgary Transit has an ongoing program of "right-sizing" the fleet for optimized service, increased fuel efficiency, and reduced GHG emissions. The standard 40-foot diesel-fueled buses have been getting lifecycle replacements on certain routes with gasoline-fueled ARBOC shuttles that are 30 feet in length with seating for 23 passengers, having a modern design that is lighter and more fuel efficient.

Additionally, Calgary Transit has been exploring alternative models of service delivery through two pilot projects undertaken since 2019 to evaluate the use of On Demand transit service. Transit customers in lower ridership areas can use a mobile app to book a trip that suits their schedule rather than rely on fixed-route transit service. On Demand service is constantly optimizing where and when appropriately sized transit vehicles travel to pick-up customers. The pilot project in Springbank Hill demonstrated that On Demand service can reduce vehicle kilometers travelled by 50% compared with fixed route services, with commensurate greenhouse gas emission reductions (reduced from approximately 5,900 kg per week to 3,100 kg per week). Calgary Transit has now adopted On Demand service with the completion of the two pilot projects deemed successful in achieving key metrics in terms of customer satisfaction, wait/travel times, and operating costs.

Shifting to lower carbon fuels

Calgary Transit through involvement with the Canadian Urban Transit Association and other industry networks monitors the evolution of technology and commercial product availability for its fleet. The fleet comprises approximately 1,000 buses and shuttles, mostly fuelled by diesel and gasoline plus a growing number of CNG

buses. Shifting to CNG fuel from diesel was motivated by fuel cost savings and by a commitment to continual improvement in environmental performance. There are significantly reduced tailpipe emissions, including nitrogen oxides (NOx) that contribute to smog formation, and there are also reduced GHG emissions[1]. The Nova CNG buses have electric engine cooling technology that helps reduce fuel consumption and lifecycle costs. The transit bus fleet currently includes 114 CNG buses operating out of the Stoney CNG Transit facility.

With the aim of shifting to lower carbon fuels, between 2017 and 2019 Calgary Transit and Corporate Analytics & Innovation business units worked collaboratively in conducting a comprehensive TBL analysis of potential costs and benefits of electrifying a portion of our transit fleet, and investigating the feasibility and operational aspects of different types of battery charging infrastructure for transit.

In March 2019 The City was awarded $7 million in matching-fund partnership from Emissions Reduction Alberta toward the pilot of battery-powered electric buses ("e-buses"). Planning and procurement for the e-bus pilot project were completed in 2021, with the signing of a contract for the purchase of 14 electric shuttle buses and with work getting underway to install an equal number of charging stations within the Spring Gardens transit vehicle maintenance facility. The e-bus pilot is scheduled to begin in fall 2022 and end in 2024.

On an ongoing basis Calgary Transit also is monitoring the developments at transit agencies in other jurisdictions, including City of Edmonton, who are investing in e-buses on a pilot or limited scale basis. The infrastructure and power supply implications of e-buses scaled up to the level of an entire fleet are not yet well understood.

Within the Roads business unit there have been continued efforts in energy efficiency applied to the street sweeper vehicles used for spring cleaning of city roadways. For the 2021 spring clean-up (SCU) program, of the 31 sweepers used (including rentals) only 11 were the conventional dual engine sweepers. New generation, single-engine sweepers were first used in 2020, and then in 2021 their number increased from 3 to 19 resulting in an approximately 30% reduction in fuel use and associated GHG emissions for those vehicles. This change in equipment resulted in approximately 40,000 L of fuel savings in 2021 resulting in 107.8 tonnes less CO_2 emitted into the atmosphere.

Electric vehicle technology

The Transportation department in 2021 continued to monitor research and pilot applications of shared mobility, mobility-as-a-service, vehicle electrification, and other emerging trends and technologies for advancing environmental sustainability in our transportation system. Further electrification of urban transportation systems will help to drive down GHG emissions with the gradual phase-out of coal-fired generation plants and a corresponding increase of wind, solar and other sources of lower carbon energy supply to the provincial electricity grid. In addition to the e-bus technology described above, The City aims to facilitate

[1] While the actual combustion of CNG fuel has reduced GHG emissions compared with diesel fuel, the compression required for CNG (to boost from 550 psi to 3500 psi) normally may offset the reduction to a degree; however, compression is powered by electricity, and The City has GHG emissions-free electricity supply as described above.

the adoption of electric vehicles (EVs) for its own service fleets, for commercial fleets, and more broadly for personal use by Calgarians. To that end, actions taken in 2021 included the following:

- Partnering with other public and private sector organizations to implement a local and regional EV charging infrastructure system, along with an EV education program for the public and businesses;
- Collaborating with City of Edmonton and Government of Alberta, the local development industry, and utility companies to improve options for home charging of EVs;
- Monitoring and providing input to other orders of government on new EV-specific policies; and
- Streamlining municipal and utility processes to facilitate the uptake of EV projects.

There are more than 100 privately owned "Level 2" charging stations - which can fully charge a vehicle in about 8 hours - operating across Calgary, and also several Direct Current Fast Charging (DCFC) stations located at car dealerships and at least one with public access. Additionally, the Calgary Parking Authority (CPA) has Level 2 charging stations installed across their network of downtown parkades, and additional EV charging stations were installed in 2020 and 2021 at select Calgary Transit park and ride facilities and recreation centres, with funding contributed by Natural Resources Canada and Enmax (at no capital cost to The City). The City is exploring opportunities for other community EV charging infrastructure (e.g. "community charging hubs").

To facilitate trips on a more regional basis, the "Peaks to Prairies" southern Alberta electric vehicle charging network was designed and implemented as a collaboration of The City of Calgary, the Alberta Southwest Regional Economic Development Alliance, SouthGrow Regional Initiative, City of Lethbridge, City of Medicine Hat and Medicine Hat College. There is now a network of DCFC and backup Level 2 stations operating at sites across southern Alberta, including at major entry points to Calgary near the Stoney Trail ring road.

At the policy level, amendments to the Calgary Transportation Plan addressing vehicle electrification were approved by Council in February 2021, including the following new policies in Section 3.12: "(d) The City should participate in and promote initiatives aimed at expanding the availability of publicly accessible electric vehicle charging stations;" (e) "The City should take steps to achieve a transition of the entire fleet of vehicles in Calgary to zero-emissions vehicles by 2050."

Transit fleet GHG emissions intensity

Calgary Transit set a service performance target in the One Calgary service plan of "Bus GHG emissions" intensity of 1260 kg CO_2-equivalent per 1000 km driven, in support of climate action. With CNG buses generating fewer GHG emissions than diesel buses (Fig.3), the introduction of CNG buses to the transit fleet in 2018 and 2019 appeared to be a factor in year-over-year fleet emissions reductions reported for 2019.

In 2021 the actual bus GHG emissions intensity (fleet-wide) was 1281 kg CO_2e per 1000 km driven, which is 2 per cent short of the performance target and a 1 per cent increase in emissions intensity from 2020 (Fig.4).

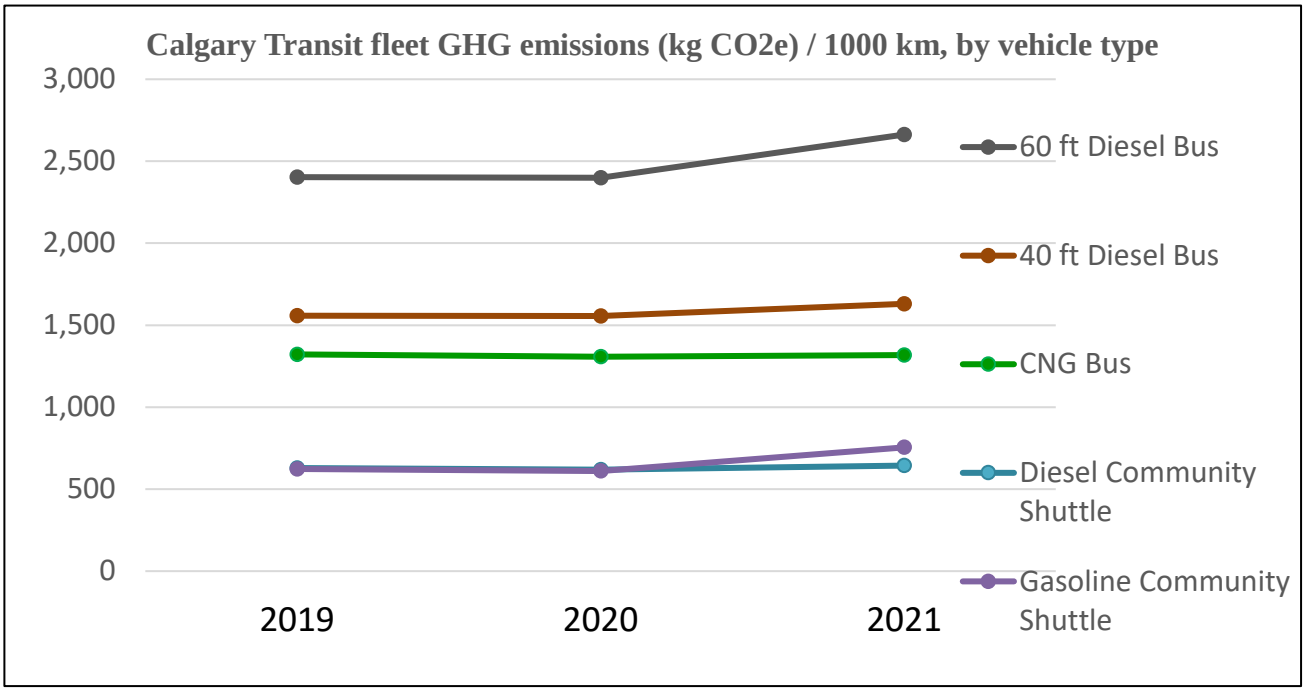


Figure 3: Calgary Transit bus GHG emissions intensity values, by vehicle type, 2019-2021

The upward trend in bus GHG emissions intensity for 2021 showing in Fig. 3 above is most likely attributable to a combination of the CNG buses being less utilized (for reasons of reduced service relative to 2019 and changing demand e.g. peak period service for secondary schools), and the hotter than average summer temperatures and associated increase in fuel consumption to power the air conditioning units of the buses. According to data published by Environment Canada, the number of "cooling degree days" was 30 in 2019, 72 in 2020 and 174 in 2021. Continued monitoring will help to identify other factors that may affect the fuel efficiency and emissions performance of the transit fleet.

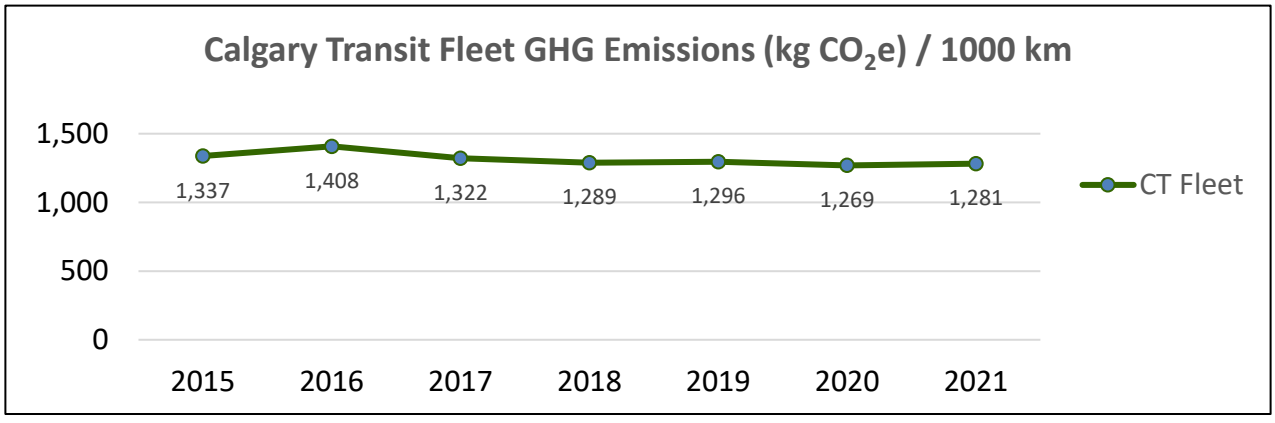


Figure 4: Calgary Transit bus GHG emissions intensity values, fleet-wide, 2015 - 2021

Energy and cost savings from upgraded transit facilities

Calgary Transit largely relies on natural gas for space heating in transit facilities, and tracks the relative energy performance of each facility with measures of natural gas use intensity (i.e. gigajoules per heating degree day per square meter of facility space, or GJ/HDD/m^2). In 2021 there was observed to be a significant (23 per cent) reduction in natural gas use intensity at the Oliver Bowen Maintenance Facility (OBMF) in NE Calgary (Fig.5). This energy efficiency gain was realized by reducing the ambient temperature in the train storage area from 15 to 10 degrees Celsius. A lesser reduction in natural gas use intensity observed at Anderson Garage is primarily attributable to the temporary shut down of the bus maintenance area, and having all the 3-car trains stored indoors. Once 4-car train service is reinstated with increasing service demand (after a significant drop in ridership during the first waves of the pandemic in 2020 and 2021) it is anticipated that natural gas use intensity at Anderson Garage will increase, although a planned future expansion of the garage will allow for indoor storage of 4-car trains and thereby minimize heat loss through open garage doors during cold weather.

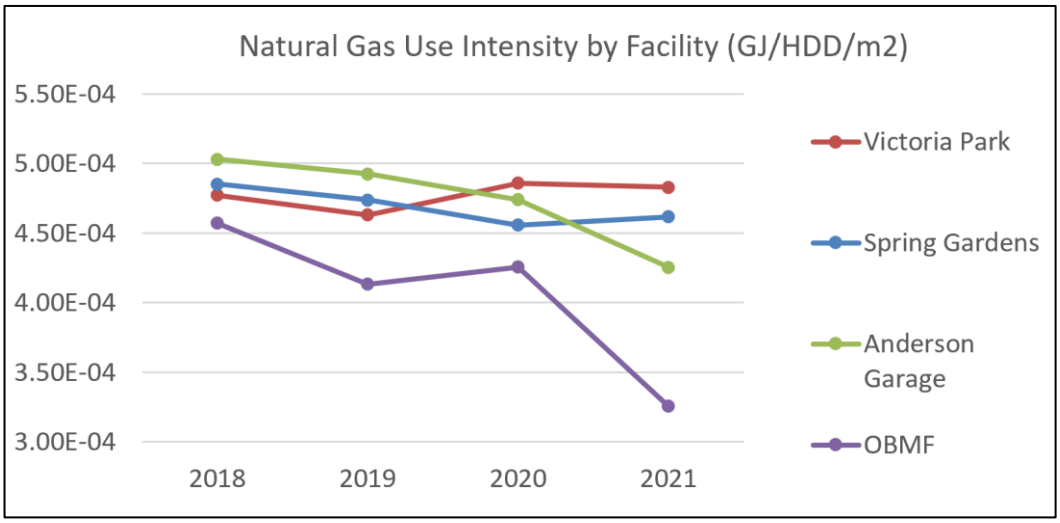


Figure 5: Changes in natural gas use intensity at Transit facilities, 2018-2021

Victoria Park Garage and Spring Gardens Garage were more energy intensive in 2021 compared to the other facilities. Upgrading HVAC systems and replacing energy appliances with more energy efficient models at these two older facilities will improve their energy efficiency as well as reduce operation costs and GHG emissions.

Spring Gardens MUA Upgrade

Make-up air (MUA) units are critical pieces of equipment that provide the primary source of heating for transit maintenance and storage areas, and also a source of fresh air into the facilities (in addition to overhead doors). In 2021 there were 6 MUA gas burners replaced at Spring Gardens Transit Garage, the units having been original to the building (installed in the late 1970s). These MUA burners exceeded their 25-year life expectancy and required increasingly intensive maintenance to keep them running. The worst performing MUA units had been identified and replaced by Calgary Transit maintenance staff. The upgrades to more energy efficient units will significantly improve the heat exchange and indoor air quality of the Spring Gardens transit facility while reducing the costs associated with maintenance and natural gas consumption.

Energy and cost savings from upgraded LRT track & way infrastructure

Track switch heaters are LRT wayside equipment fuelled by natural gas that clear snow from track switches to facilitate their proper functioning during snow events. There are 135 track switch heaters in the LRT network that are operated either manually or remotely. The heaters are often left running for extended periods, even during dry and warmer weather, due to lack of dedicated resources to adjust or remotely monitor switch operations. Calgary Transit Track & Way (T&W) division investigated the possibility of reducing switch heater operational costs and natural gas consumption by installing an automated system of snow detection and rail thermostats to trigger the ON/OFF operation of the gas-fired switch heaters based on inputs from these devices. Following a trial application of the technology completed in 2019, Calgary Transit in 2020 initiated an expanded pilot project in 2020 with the contribution from the Federation of Canadian Municipalities of $300,000 in matching funds to upgrade 11 existing track switch heaters to more efficient models and install 100 units of snow detection and rail thermostat systems (Fig.6). This project, an innovation among Canadian municipalities, was completed in 2021.

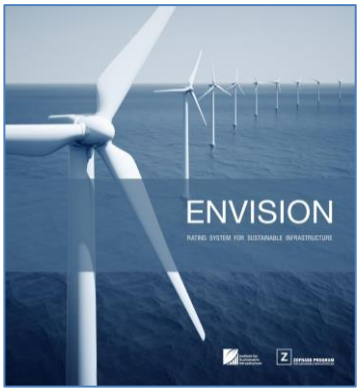
Figure 6: New switch heater with snow sensor in Whitehorn

The LRT track switch heater pilot project promises a range of environmental and economic benefits, which include reducing energy use by approximately 75% (19,500 GJ/year), reducing the LRT system's annual GHG emissions by 1,000 tonnes, and thus reducing exposure to carbon pricing and natural gas fuel price volatility. This project is expected to show operational cost savings of $112,000, achieving payback in less than five years.

Emphasizing the "green" in Green Line LRT infrastructure

Planning, preliminary engineering, land acquisition, utility relocation and procurement continue in support of Green Line LRT (Phase 1) development. The decision was made in 2019 to adopt the "Envision" sustainable infrastructure rating system (consistent with the recently updated Sustainable Building Policy) as guidance for achieving sustainability opportunities in the development and operation of the Green Line. With respect to climate change considerations, use of the Envision framework will assist the project delivery team in optimizing project resilience and sustainability performance. In planning, design and procurement of the project there will be systematic consideration of opportunities to:

- Reduce overall operational energy use throughout the project life
- Reduce GHG and air pollutant emissions
- Meet energy needs through renewable energy sources
- Specify the commissioning and monitoring of energy systems to promote energy efficiency



- Reduce the net embodied carbon of materials used over the life of the project
- Develop a comprehensive climate change vulnerability assessment, and evaluate associated risks
- Support increased project and community resilience to climate change.

With respect to reducing the net embodied carbon of materials, the Sustainability Strategy division since 2018 has attended industry presentations to familiarize with the cement industry association's stated ambition to reduce GHG emissions associated with new construction. We continue to follow developments in the potential for low carbon cements used in concrete, and for CO_2 sequestration in concrete. The potential merits of "CO_2 mineralized concrete" in applications including Green Line and other transportation infrastructure (e.g. bridges, sidewalks) was the subject of ongoing discussion, research and pilot application in 2021.

Lower carbon materials

The pavement rehabilitation and reconstruction of John Laurie Boulevard between Shaganappi Trail and 14 Street NW by the Transportation Infrastructure business unit in 2021 involved curb and gutter reconstruction, and for this project a Portland limestone (GUL) cement-based concrete was used as a trial of the lower carbon material. The GUL cement is produced with relatively less energy than general use (GU) cement, thus having reduced net embodied carbon (i.e. GHG emissions). According to the manufacturer's specifications, a 5 to 10 per cent reduction in GHG emissions can be achieved in substituting GUL cement for GU cement which for this project (approximately 120 tonnes of GUL cement was used) would translate to an emissions reduction of between 6 and 11 tonnes. The structural performance of the concrete will be monitored by TI to inform decision-making on future use of concrete that incorporates GUL cement to achieve GHG emission reductions.

Transportation system operations in 2021 generated a total of approximately 87 kilotonnes of GHGs, or carbon dioxide equivalent (kt CO_2e), based on consumption of 371,862 megawatt hours equivalent (MWHe) of fossil fuels on a department-wide basis. That represents a 9 per cent decrease in GHGs year-over-year.

4.4 Land use and mobility aspects of energy consumption

Passenger vehicles account for a significant portion of GHG emissions in Calgary. The level of GHG emissions from transportation varies considerably based on the mode of transportation used; in developing and implementing plans for a pathway and bikeway network that enables walking, biking, and other forms of wheeling, the City of Calgary is making strides toward reducing community GHG emissions. The City also addresses social equity and inclusion concerns by connecting residents with healthy, affordable transportation options for accessing employment and other needs and amenities. Shifting trips towards walking, biking, and wheeling will also help to reduce levels of air pollution, noise pollution, and traffic congestion.

To help provide a reliable network of pathways and bikeways, the Liveable Streets division of Transportation Planning continued to lead the implementation of Step Forward, Calgary's pedestrian strategy that was approved by Council in 2016. In addition to the pedestrian strategy, the Always Available for All Ages and Abilities (5A) network was approved by Council as part of the 2020 Calgary Transportation Plan. The "5A Network" is a city-wide plan for a system of pathways and bikeways protected from motor vehicle traffic,

designed to meet the needs of people of all ages and abilities as it will provide a consistent, reliable experience through lighting and year-round maintenance. More information on these and related initiatives are presented under sub-headings below.

Cycling strategy implementation

City of Calgary Council approved the Cycling Strategy in 2011 and since then has collected data on its implementation and associated ridership. Implementation of the Cycling Strategy continued in 2021, with the current extent of the city-wide cycling network is summarized below (Fig.7). Various types of on-street cycling infrastructure including both dedicated facilities (e.g. Fig.8) and shared facilities currently comprise 29 per cent of the total 1,807 km cycling network in Calgary, with the balance comprising off-street, multi-use pathways.

Bicycle Facility Type (kilometres)	Baseline (2009)	2015	2016	2017	2018	2019	2020	2021	Target (by 2020)
Total cycling network	1,065	1,213	1,266	1,320	1,319	1,336	**1,515**	1,807	1,500
Pathways (off street)	710	813	866	900	905	**918**	1,022	1,289	900
Bikeways (on street)	355	396	400	414	414	418	493	518	600
• Bike routes	328	345	341	346	344	344	**405**	416	370
• Shared lanes	15	15.1	17.5	18.8	18.8	19.5	**21**	19	20
• Bicycle lanes	12	29.4	33.7	42.5	44.6	46.2	57	57	180
• Cycle track	0	6.6	7.1	7.2	7.2	8.7	12	26	30

Figure 7: Cycling/wheeling infrastructure

The addition of more painted bicycle lanes on roadways is one component of the network that still falls far short of the established target for 2020. And while the extent of dedicated cycle track also still falls short of the target (other facility types were assigned a higher relative priority for investment) that gap was narrowed considerably in 2021. The 1,500 km target for the total network was achieved in 2020, and exceeded in 2021.

Figure 8: Dedicated cycling/wheeling infrastructure on 12th Ave SW

Active and Safe Routes to School program

In 2021, the Active and Safe Routes to School Program (ASRS) continued its third year of collaboration with Ever Active Schools, increasing program participation to 25 schools across the city. Infastructure improvements were completed at 3 schools (e.g. Fig.9), and additional upgrades like curb extensions and missing sidewalks at another 15 schools are scheduled for completion in 2022. Ever Active continued their 'In Residence' education and facilitation at program schools, diversifying their programming to include public transit safety sessions with Calgary Transit and winter cycling skills workshops with Two Wheel View.

Figure 9: Infrastructure improvements and education components of Active and Safe Routes to School Programs

Liveable Streets Division staff also responded to a Council Notice of Motion for an expanded ASRS program that would use The City's GIS data to identify priority schools to be included in the next budget cycle, increasing the area of study around the school and looking at larger scale infrastructure improvements. This planning and prioritization work continues with a related report coming to Council in June 2022.

Transit Network Expansion

Calgary's light rail transit (LRT) network currently comprises a 56 km total line length and 45 stations. The transit network originally focused on moving customers in and out of downtown. From 1996 to 2018 the number of people entering downtown by all modes on a daily basis increased by 21 per cent, while the number of people travelling by transit doubled. As Calgary looks to develop multiple activity centres outside downtown, the transit system is evolving to serve dispersed trips in all corners of Calgary. Implementation of RouteAhead, a 30-year strategic plan for transit service, continued in 2021 with the operation of cross-town bus rapid transit (BRT), advancement of the Green Line LRT (Phase 1) project, ongoing planning for future Blue Line extension further to the northeast plus a transit connection to the airport, and other activities concerned with future capital investments and transit service improvements.

Land use and transit planning are becoming more integrated to influence Calgary's physical form, and to make transit service more viable. Compact urban form supports quality transit, while transit provision can lead development and support intensification. This evolution to match transit and land use increases transit use and mode choice, contributing to environmental sustainability through reduced car dependence.

5. Pollution Prevention

The development and operation of a city-wide transportation system presents many circumstances where pollutants can be inadvertently released to the environment, potentially affecting the quality of air, soil, groundwater and surface water. Pollution prevention measures and substance release reporting and response protocols are well documented both corporately and in environmental management systems. For specific activities, releases and materials there are municipal, provincial and federal regulatory reporting requirements.

5.1 NPRI reporting

The National Pollutant Release Inventory (NPRI) program under the *Canadian Environmental Protection Act, 1999* requires that facilities meeting specified criteria report annually to Environment Canada on the release, transfer or disposal of NPRI substances that are manufactured, processed or used at the facilities. This regulatory requirement applies to the Roads business unit as owner/operator of three facilities:

- The asphalt plant at Manchester yard, for carbon monoxide (CO), fine particulate matter less than 2.5 microns diameter ($PM_{2.5}$), and larger diameter particulate matter (PM_{10});
- The aggregate crushing operation at Spyhill, for $PM_{2.5}$, PM_{10}, and total particulate matter (TPM) which includes the requirement of reporting dust emissions from unpaved roads; and
- The Traffic Field Operations (TFO) sign shop, for toluene used in sign production.

Annual NRPI reporting for these three facilities is due June 01 of each year and as result, the first draft of this performance report prepared in Q1 2022 included data for 2020 only (Fig.10); additional data for 2021 (Fig.11) also has been incorporated in Q2 for this final report. All quantities are calculated estimates.

Substance	Air Emissions (tonnes)		Per cent Change (%)	Recycled (tonnes)		Per cent Change (%)
	2019	2020		2019	2020	
Manchester asphalt plant						
CO	18.833	24.607	30.7	-	-	-
PM_{10}	5.273	6.390	21.2	-	-	-
$PM_{2.5}$	1.607	1.974	22.8	-	-	-
Spyhill aggregate operation						
TPM	25.057	26.938	7.5	-	-	-
PM_{10}	12.029	17.392	44.6	-	-	-
$PM_{2.5}$	2.409	3.827	58.9	-	-	-
Traffic Field Operations (TFO) Sign Shop						
Toluene	0.208	0.260	25.0	4.024	10.274	155.3

Figure 10: National Pollutant Release Inventory (NPRI) Reporting for Calgary Roads, 2019 & 2020

The following operational changes at each of the Roads facilities may help explain changes in emissions between 2019 and 2020 that potentially affected local air quality:

- At Manchester, asphalt production quantities were increased by 30.7 per cent and aggregate handling quantities increased by 20.4 per cent over the previous year;
- At Spyhill, there was a 79.4 per cent increase in aggregate production to meet new landfill cell construction timelines.

Substance	Air Emissions (tonnes)		Per cent Change (%)	Recycled (tonnes)		Per cent Change (%)
	2020	2021		2020	2021	
Manchester asphalt plant						
CO	24.607	20.762	-15.6	-	-	-
PM_{10}	6.390	5.158	-19.3	-	-	-
$PM_{2.5}$	1.974	1.581	-19.9	-	-	-
Spyhill aggregate operation						
TPM	26.938	14.876	-44.8	-	-	-
PM_{10}	17.392	7.106	-59.1	-	-	-
$PM_{2.5}$	3.827	1.433	-62.6	-	-	-
Traffic Field Operations (TFO) Sign Shop						
Toluene	0.260	0.201	-22.6	10.274	2.527	-75.4

Figure 11: National Pollutant Release Inventory (NPRI) Reporting for Calgary Roads, 2020 & 2021

The following operational changes at each of the Roads facilities may help explain certain changes in emissions between 2020 and 2021.

- At Manchester, asphalt production quantities decreased by 15.6 % and aggregate handling decreased by 28.7 %, over the previous year.
- At Spyhill, there was a decrease in aggregate production of 67.6 % as the 2020 push to prepare space for cell construction had been achieved.
- Toluene usage and amount recycled decreased significantly at the TFO in 2021 as operations returned to near normal after 2020 disruptions due to COVID. 2021 data suggests the 2020 results were a one-time event and the anomaly was attributed to the challenges of operating during the pandemic.

5.2 Air quality

Current state and transportation influence

Air pollutants emanate from a wide range of natural, industrial, community and mobile emission sources. The air quality of the Calgary area is monitored by Calgary Region Airshed Zone (CRAZ), a non-profit association with members representing municipal, provincial and federal governments, non-governmental organizations, industries, and the general public. CRAZ employs three continuous monitoring stations - in downtown, NW and SE locations - to analyze meteorological and air quality parameters including those most strongly associated

with transportation: nitrogen oxides (NO_x), ground-level ozone (O_3), carbon monoxide (CO), PM2.5 (primarily associated with very fine dust, pollens, smoke, and combustion engines) and PM10. Transportation sources account for the majority of NO_x and CO emissions. These and other pollutants undergo complex chemical reactions in the atmosphere to form O_3 which contributes to smog. Automated measurements of ambient concentrations for each parameter are made continuously and averaged on an hourly basis. An additional continuous monitoring station located north of Calgary, in Airdrie, began operation (by AEP) in 2017.

There is also a broader network of 40 passive monitoring stations throughout the CRAZ region that rely on simpler technology to sample air quality for a smaller number of parameters on a monthly basis, used to help understand the geographic variation in pollution.

The Air Quality Health Index (AQHI) and the Canadian Ambient Air Quality Standards (CAAQS) are two of the tools used to assess air quality in Alberta, the former as a communications tool and the latter used to monitor and measure long-term trends in air quality and to assign management actions. The AQHI converts hourly measurements for different parameters to a number from 1 to 10, with a higher number indicating a greater health risk, for public information on current or predicted air quality conditions. The CAAQS assessment calculates metrics over three-year periods and excludes exceptional events such as smoke from forest fires, for use in identifying and managing pollutants considering their potential risk to human health and environment.

Canada's Air Pollutant Emission Inventory (APEI) compiles data from various sources for 17 common pollutants and in February 2020 the APEI report summarized information for the 1990-2018 period, indicating that transportation-related pollutant emissions (e.g. NO_x, CO, VOCs) continued a downward trend and were significantly reduced compared to historical levels, with the exception of fine particulate emissions ($PM_{2.5}$) originating from unpaved roads and construction activities (i.e. dust). The downward trend in tailpipe emissions – notable in spite of a considerable increase in the number of passenger vehicles on the road over time - is explained by effective regulations on fuel and engines, according to APEI reporting.

Alberta's annual reporting on the CAAQS summarizes the status for ambient concentrations of fine particulate matter and ground-level ozone, indicating that standards were achieved in the South Saskatchewan air zone based on the data from three ambient monitoring stations including one in Calgary. However, the monitoring results still trigger the need for management planning for PM2.5 and NO_2 under the Air Quality Management Framework established for the South Saskatchewan Regional Plan.

In summary, residents of Calgary and region enjoy good air quality, generally consistent with the air quality objectives established for PM2.5, NO_2, CO, and O_3. Factors affecting air quality are the type and rate of pollutant emissions from various sources, and the ability of the atmosphere to disperse these pollutants by way of wind, temperature, turbulence and the changes in these elements resulting from local topography.

Air quality protection and control efforts

The following Transportation programs and initiatives in 2021 addressed air pollution:

- Minimizing dust from transportation operations facilities;
- Minimizing dust from transportation infrastructure development sites and unpaved surfaces;
- Reducing the fugitive emissions from transit buses;

- Reducing traffic congestion and vehicle idling; and
- Providing additional mobility options.

At Spyhill crushing operation managed by Roads, excavation of fines is the major source of dust generation. Due to the location of these operations, westerly and northwesterly winds can significantly affect dust levels. Roads have standard operational controls in place that involve daily water application on unpaved surfaces for dust suppression during operations, and the use of personal protective equipment by workers on site.

On construction sites (the largest of which are managed by TI, with smaller rehabilitation, maintenance and upgrade projects managed directly by Calgary Transit and Roads), air quality is addressed primarily through the design and application of erosion and sediment control (ESC) measures. Project managers and inspectors in TI are required to demonstrate basic training and competency in ESC. A stated objective of TI's environmental management system is that construction projects meeting certain criteria are to have professionally prepared ESC designs that are acceptable to The City, and implemented appropriately, to minimize dust and prevent pollution of waterbodies with turbid runoff from construction sites. There were 75 customer service requests (CSRs) related to the environment logged for TI projects (11 per cent of total CSRs) in 2021. The specific nature of those CSRs included noise, dust, mud, weeds, vibration, and tree removal concerns. All of the CSRs were addressed and closed with no outstanding requests remaining in Q1 2022.

Calgary Transit's bus fleet comprises a mix of New Flyer Excelsior buses having diesel particulate filters (DPF) and related emissions control technology, gasoline-fuelled community shuttles, and a growing fleet of Nova compressed natural gas (CNG) fuelled buses. The business case for shifting a portion of the fleet to CNG was built on investigations (circa 2012) into the relative operability, operating and maintenance costs, fuel cost, noise, and tailpipe and GHG emissions of diesel and CNG buses. There are signficantly reduced tailpipe emissions, of NO_x (contributing to smog formation) in particular, from CNG buses. As described above in section 4.3 under the heading of "Shifting to lower carbon fuels", Calgary Transit continues to explore emerging technologies like electric battery powered buses to achieve, among other benefits, reduced GHG emissions as well as reduced tailpipe emissions affecting local air quality.

The Roads business unit is supplied by corporate Fleet with equipment such as sanders/plows and both light duty and medium-heavy duty vehicles. In February 2021, Fleet initiated a corporation-wide effort to reduce unnecessary idling. To track progress for the initiative a dashboard was developed to display near-real time idling per fleet vehicle. As indicated below (Fig.12) the idling reduction target for Roads maintenance equipment was met, and significant idling reduction also was achieved for other vehicle types.

The Transportation Planning and Roads business units collaborate in conceiving, implementing and monitoring the results of projects that address traffic congestion through the optimization of traffic signals and the deployment of intelligent transportation systems. The Traffic Engineering group regularly evaluates and adjusts the timing of traffic signals in key travel corridors based on current traffic data and updated models. By improving signal coordination and traffic signal phase timings, this program affects the idling time of hundreds of thousands of vehicles daily; it is influential to both traffic congestion and air quality.

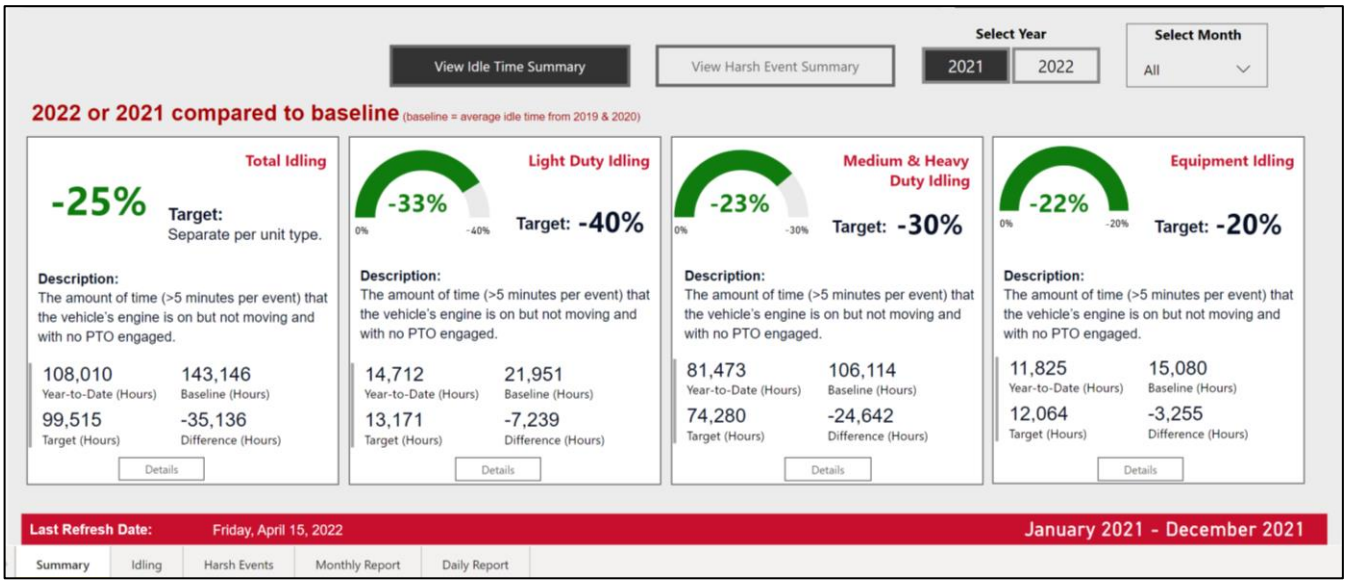


Figure 12: Corporate Fleet idling reduction dashboard for the Calgary Roads business unit for 2021

In 2021 a wide variety of work was continued or initiated to better provide Calgarians with mobility options through expansion of infrastructure and services. Initiatives that promote travel mode-shifting will result in reduced fossil fuel consumption on a community-wide basis and, in turn, reduced emissions of air pollutants and GHGs. These initiatives are described above in section 4.4 under the heading of "Land use and mobility aspects of energy consumption". Many of these and related initiatives are described in still greater detail through the MDP-CTP monitoring and reporting program and Calgary Transit data reporting.

5.3 Soil and groundwater quality

Various activities in the operational business units of Transportation have the potential to affect soil and groundwater quality. The environmental management systems and environmental personnel supporting these business units identify such risks and opportunities, and help to manage them through the implementation of various processes and procedures to maintain regulatory compliance. The specific pollutants and contaminant pathways that are most relevant for soil and groundwater contamination in a transportation context are:

- Hydrocarbon-based substances (e.g. fuel, hydraulic fluid, form oil) released from fleet vehicles, construction equipment, or storage tanks at operational work places and construction sites;
- Hydrocarbon contamination resulting from past land uses, encountered during construction;
- Salt and saline runoff from Roads winter maintenance materials storage facilities and roadways.

Environmental screenings, plans, and results

Through all phases of transportation system planning, development, and operation, efforts are made to ensure any interface of natural environment and environmental processes are understood and considered. These may

include functional planning studies, for example, identifying potential environmental sensitivities like wetlands and contaminated sites that may influence roadway alignment or other planning and design choices. Prior to construction, environmental screening is routinely completed (an internal service provided by the Risk & Liability division of corporate Environmental & Safety Management, ESM) to identify potential soil and groundwater concerns associated with past land uses of a site. External consultant support is retained as required to provide specialist environmental consulting services that include the assessment of environmental risks and impacts, and their mitigation or management.

Environmental Construction Operations (ECO) Plans are developed, implemented, and audited on City projects to minimize adverse environmental effects of construction activities and promote due consideration for environmental protection by contractors, where required as per The City of Calgary's ECO Plan Policy and associated decision criteria. The related ECO Plan Implementation Procedure specifies how these plans are to be submitted to the corporate ESM business unit for review and acceptance prior to construction start. As part of TI's due diligence, the ECO Plans are internally reviewed by TI environmental staff to confirm that environmental aspects are appropriately addressed. Due to the typically very short time frame between award of contract and start of construction, contractors are challenged to provide their inputs to finalize ECO Plans and have ESM review and approval completed prior to construction. TI's internal performance target for ECO Plans, as referenced in their EnviroSystem, is: "100% of TI projects requiring ECO Plans have ECO Plans, reviewed internally by TI environmental specialist and submitted to ESM prior to start of construction".

All 12 of the new TI projects launched in 2021 had ECO Plans submitted to ESM for acceptance prior to construction, and in place to guide construction activities. All 6 of the projects requiring separate ESC Plans (i.e. construction projects with earth-moving activities on a site larger than or equal to 0.4 hectare) had those plans accepted by Water Resources and in place prior to construction.

Transportation Infrastructure's EnviroSystem target of having acceptable plans (ECO Plans and ESC plans, where required) in place at start of construction for 100 per cent of projects was achieved in 2021.

Substance releases affecting soil and groundwater quality

The City of Calgary substance release reporting procedure is followed for all Transportation Infrastructure development projects and for all Roads and Transit operational activites. City staff and project contractors implement procedures for the handling and storage of hazardous materials, and they are required to report all spills, sediment releases and contamination discoveries. A significant investment in time has been made by EnviroSystem coordinators to provide training and guidance to staff and contractors on substance release reporting, with associated improvements in spill reporting being observed as a result.

Calgary Transit substance releases are addressed below under the Surface Water Quality heading, as releases typically are from buses onto roadways with potential discharge to the storm sewer.

Calgary Roads recorded 23 minor releases in 2021, of which 4 were reportable to AEP (vs. 34 minor releases including 7 reportable releases in 2020). There were approximately 30 per cent fewer reported releases year over year, which continues a 3-year downward trend. The substance release distribution was similar with hydraulic oil spills from hose failures continuing to be the majority of releases reported. Of the 4 reportable releases, none were high risk or high consequence. Roads keeps its operational staff well trained to report and

respond to any releases by arranging spill and release response trainings every 3 years, with regular spill drills in between as refresher training to test awareness and capability. There are ongoing soil and groundwater monitoring programs in place for Roads material storage yards and snow dumps, and reporting to AEP for releases to the storm sewer during street sweeping, as described in sections below.

Transportation Infrastructure recorded 16 substance releases and one contamination discovery in 2021, as compared with 29 substance releases in 2020 and 30 the year prior. Of those releases, 12 were releases of turbid runoff to the storm water system as detailed below under the Surface Water Quality heading. None of the other minor releases required reporting to Alberta Environment and Parks (AEP) as having potential to adversely affect soil or groundwater quality.

The downtown flood barrier/public realm improvement project in 2021 provides an example of how TI works with contamination discovery. This project involves upgrading the pathway along the right bank of Bow River from upstream of Peace Bridge (at 7th St. SW) to the start of Riverwalk (in the SE) downstream of Centre Street Bridge, and installation of a sheet pile barrier to protect downtown from a future 1:200-year flood event. Project work includes alterations made to the banks and riparian areas within its footprint. Contaminated soils were encountered during project site investigations for the majority of the proposed disturbance area. A comprehensive soil investigation and sampling program was prepared and executed during project construction to identify various high risk contaminated soil areas, and the soils were managed in accordance with the nature and concentration of the contamination; affected soils were mostly excavated and removed from the project site, with imported clean fill material used to backfill and remediate these areas.

Salt storage and handling at facilities

The storage and handling of salt and salt-treated abrasive materials in the vicinity of Roads maintenance yards present potential risks to soil and groundwater quality, and also to surface water quality (addressed in the following section of this report). Regular monitoring performed at these locations and reported on annually indicates trends of generally increasing, localized concentrations of chlorides in the soil and groundwater.

The salt storage depots and maintenance facilities at Roads are managed in accordance with applicable regulatory requirements, Codes of Practice and BMP guidance documents. Consistent with the best management practices established by Transportation Association of Canada (TAC) to satisfy the Code of Practice for the Environmental Management of Road Salts (established under the *Canadian Environmental Protection Act 1999*), Roads has developed, implemented, and updated annually a “Road Salt Management Plan” to guide its storage, handling and use of chlorides and traction materials. In 2014, Environment Canada issued a set of performance indicators and national targets associated with the Code of Practice after completing a five-year review of progress that indicated the effectiveness of the Code to date in promoting uptake of best practices, and identified actions that could be considered for further improvement.

As a best management practice Roads stores pure road salt (sodium chloride) within structures on impermeable pads for maximum containment at maintenance depots. Historically and in 2021 there has been a combination of indoor and outdoor storage of abrasive materials. For outdoor storage the abrasive materials are mixed with approximately 2 per cent salt to prevent clumping. This stockpiled “pickle” is exposed to weather with the result that salt can be leached from the piles during rain and/or snow melt events and be carried by runoff to water detention ponds or other drainage infrastructure. Custom fitted tarpaulins have

been used successfully in recent years as temporary cover for pickle piles between May and September as an effective and low cost approach to achieve the national targets. Approximately 80 per cent of pickle material stored outdoors was under cover of tarps seasonally, with 100 per cent under cover during the wettest months. All salt and most pickle is routinely stored indoors within permanent structures, as space allows.

Ongoing groundwater monitoring programs continue at the following Roads depots: Confederation Park, Bearspaw, 24th St., Richmond Green, and Manchester; and at the Pumphouse and Highfield snow dumps. The results of ongoing investigations, identified risks and potential concerns are reviewed and discussed annually between the Roads and ESM environmental staff.

In 2021, groundwater monitoring programs were completed at Richmond Green and 24th St. Groundwater chemistry on the sites was found to be generally consistent with recent historical results, with a number of analytes above the applicable guideline. Haddon Rd, 194th, Spring Gardens, Saddelridge and Confederation Park sites will all have groundwater monitoring programs completed in 2022. The Spring Gardens, Pumphouse and Highfield snow dumps have groundwater and snow melt sampled annually.

Conceptual Site Models were developed for Spring Gardens, including the snow dump, as well as Sarcee, Bearspaw and the Highfield snow dump in 2021. Final reports are pending. Richmond Green was evaluated for future site use options given the elevated salinity in soil and groundwater at the site.

The City of Calgary has demonstrated and reported on continual improvements in practices and technologies it employs for road salt management, and it was able to meet all voluntary national compliance targets for 2021.

Roads maintenance facilities requiring capital investment

Implementing the full suite of best management practices at identified point sources of pollution requires capital improvements to be made at Roads depots to minimize salt losses. Calgary Roads and Facilities Management in 2018 had jointly developed the “Roads Strategic Accommodation Master Plan” that assessed current conditions of district assets and presented a prioritized list of capital improvement projects to feed into the budget request process for the 2019-2022 business cycle. Elevated levels of chlorides and total suspended solids (TSS) in storm runoff sampled at Manchester and Haddon Road maintenance yards had identified them as priorities for infrastructure upgrades. Additionally, the Saddleridge storage structure had been condemned and was in need of replacement.

In 2021 there was a complete redevelopment of the Manchester facilities including both salt and pickle storage and site drainage improvements (Fig.13). These state of the art facilities enable all unloading, loading and mixing of chloride products to occur inside the structures. Their design has sanding vehicle travel routes being optimized with new site exits directly to the street, and there are site drainage improvements and stormwater protection features including an underground tank with surge capacity, sediment capture and clean-out access. Also in 2021 at the Saddleridge depot a new structure was built for storage of salt and treated abrasive materials.

Figure 13: New storage facilities for salt (left) and treated abrasives (right) at Manchester in 2021

Haddon Road and Spring Gardens depots are next in line for redevelopment, with planning for upgrades now underway.

5.4 Surface water quality

Water quality in the Bow and Elbow Rivers in the Calgary area is affected by many natural events and anthropogenic sources, including weather systems, snowmelt, land development and various land and water uses across a spectrum of industrial, commercial, residential, and agricultural activities. Control measures and BMPs are employed to reduce total suspended solids (TSS) loading in the Bow River and thereby minimize any significant adverse effects on the receiving environment, consistent with The City's Total Loading Management Plan registered with AEP. Transportation has adopted a general approach to "low impact" development practices including erosion and sediment control BMPs for construction projects, and other controls include use of detention ponds to remove pollutants from storm water runoff. Transportation-related factors affecting surface water quality include any significant volumes of untreated runoff from: transportation infrastructure development sites; unpaved roads, lanes/alleys, and parking lots; facilities such as Roads maintenance depots and processing plants; and paved roadways having snow and ice control materials and residues on them.

Key pollutants affecting waterbodies that are under the control of Transportation staff and contractors are:

- Turbid storm runoff from construction sites and unpaved roads, lanes and parking lots;
- Release of other substances resulting from construction activities and operations; and
- Salt and saline runoff from Roads winter maintenance materials storage facilities and from roadways.

Typical substance releases affecting surface water quality

Transportation Infrastructure initiated 12 new capital projects in 2021 and all were guided by ECO Plans and, where required, ESC plans. There were 2 reported releases of turbid runoff to the storm system, which are

considered unauthorized releases requiring detailed follow-up reporting to the regulator. These sediment releases occurred during significant storm events in July and August 2021. Lessons learned were completed for both releases and shared with TI project managers. There had been 12 such releases the previous year.

Calgary Transit substance releases typically are antifreeze or hydrocarbon releases from buses onto roadways or paved surfaces at transit facilities, some having the potential to discharge to the storm sewer. With buses being the primary source of releases, all bus operators are trained in spill response and all Transit vehicles are equipped with spill kits. In 2021 Calgary Transit recorded 132 substance releases, up 35 per cent from the year prior, with most of the incidents being antifreeze releases onto paved surfaces. The results of initial investigation into this trend in hose failure incidents revealed there may have been quality issues with coolant hoses from a particular supplier. Accordingly, changes in supply were made and monitoring continues.

Spring clean-up of roadways

During the winter snow and ice control (SNIC) season large quantities of abrasive material and salt are applied to roadways for traction and de-icing purposes. Roadways also accumulate sediments that originate from gravel lanes and adjacent areas in addition to leaf fall and other organic matter and debris. The Roads Maintenance spring clean-up (SCU) program involves streets sweepers deployed throughout the city every spring to remove these accumulated materials and associated pollutants (including lead, zinc, and polyaromatic hydrocarbons that bind to finer sediments) from roadways and thereby minimize their transport through storm water infrastructure to local waterways during rain events. Previously completed sediment inventory work and mass balance calculations revealed that the total quantity of materials removed from the roadway during SCU were comparable to the quantity of traction materials applied during SNIC (albeit with significant organics and fine sediment included with the street sweepings), and this information validates that the SCU program meaningfully contributes to downstream water quality and habitat protection. There are turbid releases to the storm sewer during the SCU program as the sweepers are regularly flushed and drained to the storm sewer. Calgary Roads manages its annual SCU program in a strategic manner with these releases (estimates of total volume), and the mitigation measures in place, being reported to the regulator at the conclusion of the program.

Sediments originating from gravel lanes

The Sustainability Strategy division of Transportation has for several years worked closely with management and specialist staff across the Utilities and Environmental Protection department to better understand the generation and movement of sediment through municipal infrastructure to downstream receiving environments. A previous collaborative project had produced a sediment inventory, and in 2020 a related consultant study was completed: the Gravel Lane Total Suspended Solids (TSS) Abatement Study. Storm water measurements and modelling performed by Water Resources had demonstrated that gravel-surfaced lanes in the transportation network are disproportionately large sources of stormwater pollution (i.e. TSS, and sediments in particular); gravel lanes generate up to 11% of the sediment loading to local waterways

from only 1.4 per cent of the municipal land base. The City's Total Loading Management Plan, a requirement of wastewater approvals under the provincial *Environmental Protection and Enhancement Act*, is a planning tool used to derive loading objectives for stormwater infrastructure and wastewater treatment plants and to manage associated water quality impacts on the Bow River.

From an operational perspective, gravel lane maintenance costs have been increasing for Calgary Roads, and similarly Water Resources is facing increasing costs for the maintenance of storm sewer and storm ponds due to accumulations of gravel and finer sediments contributed from gravel lanes.

A robust Triple Bottom Line (TBL) assessment tool was developed and applied as a key component of the consultant study to compare the relative costs, benefits (including but not limited to downstream water quality benefits) and feasibility of conventional and alternative treatments for back lanes, including gravel surfacing, asphalt paving, chip seal, permeable paving stones, and other treatments with the aim of identifying the strongest value proposition for both retrofit solutions and greenfield development. Based on the TBL tool outcomes, pilot sites for three treatment options (including full depth asphalt, chip seal, and quality gravel) were selected and construction specifications developed to test and validate the proposed alternative treatments as a second phase of this study in 2021. The pilots will be underway in 2022.

Saline runoff from roadways to water bodies

Salt applied to roadways throughout the city for winter road maintenance and public safety purposes represents a non-point-source of pollution. Winter road salt application practices used by Calgary Roads are consistent with the national Code of Practice. In 2021 the Roads Maintenance division took the following initiatives to continually improve the environmental management of road salts and minimize increases in salinity of surface water bodies:

- Salt brine (23 per cent salt concentration) use has been increased over pure salt in certain applications with the intent to reduce the total amount of salt required and/or released into the environment.
- Product trials: The trial use of Beet55 brine continues, as an effective (but more costly) alternative to chloride products. Two new products also are in the trial stage: one is made from waste starfish, and the other is a proprietary chloride-free product manufactured in Winnipeg, MN.
- Product application: Historically, limited information has been available to Roads Maintenance on the types and quantities of material that are applied to the roads during a specific snow event. Electronic controllers and remote communication devices that were installed on sanding vehicles over the last couple of years are now ready to provide real-time data on the location and quantity of materials applied. This information will be used over time to track and monitor the quantity of various SNIC products applied in an effort to reduce the overall impact on the environment (further detail below).
- Ongoing participation and sharing of best practices within the national Road Salt Working Group, led by Environment and Climate Change Canada, and Transportation Association of Canada.

Real time data collection on sanding trucks

In 2021, the entire snowplow/sanding vehicle fleet had ground speed-oriented electronic controllers in use to apply salt and sand on roadways in appropriate quantities. Control boxes on sanders are remotely monitored

and adjusted to apply only what is necessary, with pre-determined control gate settings (setting the amount of salt or pickle material per kilometre) based on studies and regular calibrations to minimize over salting or over sanding. Historically, limited information was easily available describing the types and quantities of material applied to roads during a snow event; data was captured by on-board data loggers using a memory stick that had to be manually removed and decoded. By integrating the data logging with the Common Fleet Operating System and Automatic Vehicle Location systems on fleet vehicles Calgary Roads has been developing the capability to view type of material, rate of material application and manual override, coupled with speed, time, location and direction of travel information. This enables an accurate method of real time data collection, also viewing the data in real time and running a dashboard style of report (e.g. by date, route, material type) for any reporting requirements. These upgrades will allow for further refinement to application rates and allow Calgary Roads to optimize the material use.

Water quality monitoring and management by Calgary Roads

Certain operational activities that use or pump water to the storm sewer are required to have analytical testing performed as a condition of annual drainage activity approvals. Discharges from routine maintenance activities undertaken by Calgary Roads in 2021 such as bridge washing, dewatering of excavations, and street sweeper backflushing were sampled and analysed in the field for turbidity and pH to characterize and manage water quality associated with this work.

The five surface water detention ponds at Roads maintenance yards were sampled monthly in 2021. Chloride concentrations were generally within historical ranges. At the 24th St depot 88 per cent of the discharges were below the bylaw limit, which compares favourably with prior years. Spring Gardens remains the largest challenge of the five sites; historically it has had the highest chloride concentrations. Seasonal tarping of the pickle has had a significant positive effect on pond discharge water quality. Similar to 24th St, the majority of the discharges at Spring Gardens occur during the summertime chloride concentration lows.

To further improve the accuracy and value of water quality data, starting in 2021 the sample collection was completed in-house to allow for sampling to occur just before, or at the time of, discharge. Previously samples were collected by a contractor and did not allow for on-demand sampling. This change in sampling method will continue in 2022.

Figure 14: Spring Gardens material storage facilities and surface water retention pond

Spring Gardens (pictured Fig.14) has been operating beyond its capacity for the last two summer seasons to compensate for operational and capacity needs during the site upgrades being made at the Saddleridge and Manchester depots. Those upgrade projects resulted in additional treated pickle being stored at Spring Gardens, and increased operational demands, which have hindered forward progress in chloride management at this site.

In 2015, the Roads and Water business units identified that a temporary exemption from the wastewater bylaw for discharging facility retention ponds to sanitary would enable the redirection of funding to support further investment and implementation of best management practices addressing the point source pollution. These collaborative efforts in general terms have resulted in improved water quality and reduced risk to the downstream environment without noticeably affecting the performance of wastewater treatment processes. The annual discharge monitoring and approval process now is transitioning from a bylaw exemption strategy to an operational risk management strategy. Responding to a changing climate with more frequent and intense rainfall events, Calgary Roads is reliant on the discharge approval to manage pond levels. The several years of monitoring data now available for analysis indicate that water quality at 3 out of 5 sites met the wastewater bylaw criteria at the time of discharge.

6. Water Management

Water management for the purposes of this report refers to the efficient and sustainable use of water, in terms of water quantities and consumption. (Managing water quality is addressed in the previous section). The two major sources of water supply in Calgary are Bow River and Elbow River. The Council priority of "A healthy and green city" is addressed in business plan and budget reporting with various strategies and related performance measures including those relating to water quantity and river withdrawals that apply to the Utilities and Environmental Protection department. While there are no water management targets or performance measures that apply to Transportation, it is noted that "The City must evaluate innovative ways to affordably reduce environmental impact when delivering transportation projects and services"[2] generally.

Sustainable water management is key to operational resilience to climate change and drought preparedness.

Water use management aspects that are most relevant in a transportation context are:

- Water consumption at facilities; and
- Storm water management.

6.1 Water consumption at transit facilities

Calgary Transit continues to explore opportunities to reduce water consumption from operations including bus and train washes, offices, and maintenance facilities in retrofits and new builds. The most significant water use efficiency reductions achieved to date are attributed to the installation (in 2014 and 2015) of wash water recycling systems at Spring Gardens for buses and shuttles, and at Anderson Garage and Oliver Bowen Maintenance Facility (OBMF) for light rail vehicles. Approximately 70 per cent of wash water is reused after each wash. The new Stoney CNG Transit Facility has three automated bus washes that will recycle wash water. The Victoria Park bus maintenance facility does not have such a system. Calgary Transit has been monitoring its water consumption since 2014. Trend data indicates that annual water consumption in 2021 has dropped to the lowest level since 2018 (Fig.15), with significant reductions at least partially attributable to the pandemic; decreases in transit service translated to reduced vehicle washing needs, and a mandatory work-from-home order resulted in much reduced water consumption in office space washrooms, lunchrooms, and kitchens. Water consumption is expected to increase in 2022 with office staff returning to the workplace and with

[2] Action Plan "A healthy and green city" Indicators document.

increased transit service levels. Opportunities to reduce water consumption from transit operations, including bus and train washes, offices, and maintenance facilities in retrofits and new builds, have been identified through audits and inspections in recent years. Pending Council approval of budget asks in the 2023-2026 budget cycle, priority investments would include the installation of additional bus wash water recycling systems at Spring Gardens and increasing the sump capacity at Anderson Garage to enable the operation of the recycling system for the LRV wash water.

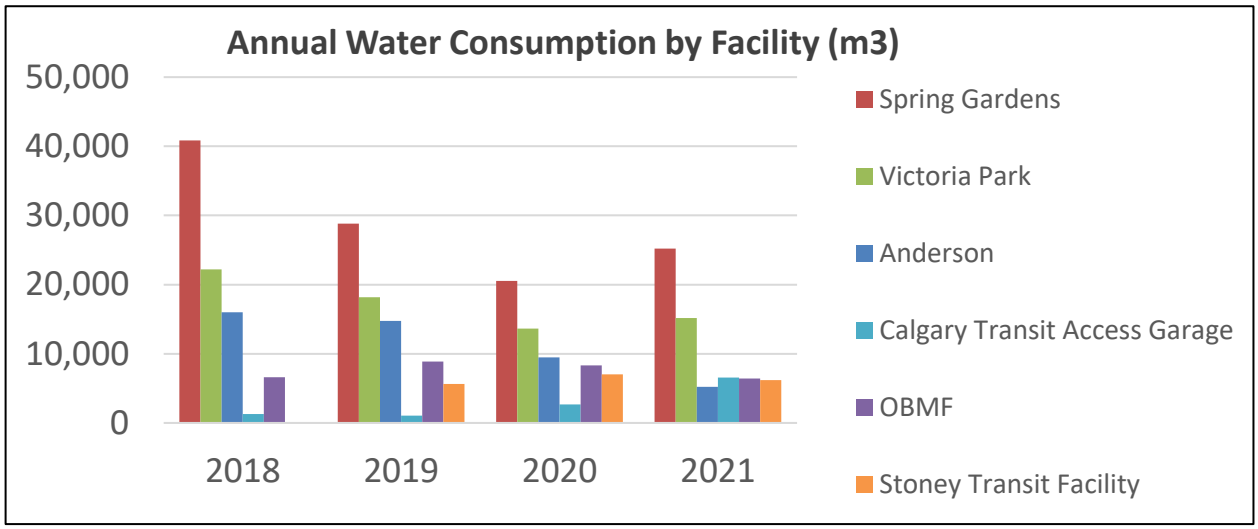


Figure 15: Water consumption at Calgary Transit facilities, 2018-2021

Consideration is being given to upgrading the existing water meters at facilities to automated ones, and also installing vehicle counters on the bus and train wash systems, to: better distinguish between different water uses; further identify possible areas for water cost savings; and expose leakages and possible water-thefts.

6.2 Storm water management

In designing and building transportation infrastructure, the TI business unit routinely works with Water Resources and external partners to develop the necessary storm water management infrastructure. With consideration given to sustainability, innovative stormwater infrastructure and "low impact development" opportunities are pursued where feasible and appropriate[3]. While no such innovations were introduced in 2021, examples of such approaches taken in recent capital projects (detailed in previous annual reporting) include the 17th Ave Reconstruction project where Silva™ cells were installed to allow for more space for tree roots and rainfall infiltration.

Transportation department staff participated in the development by Water Resources of an updated storm water management strategy, and in related work being led by Reslience and Infrastructure Calgary that addresses green storm water infrastructure and other natural assets and ecosystem services.

[3] Lessons learned on the 17th Ave Reconstruction project are that green storm water infrastructure features of the type described are more feasibly installed in greenfield sites than on brownfield reconstruction projects, as there were several utlity conflicts during installation which introduced project schedule delays and negatively affected construction phasing.

7. Waste Management

Waste materials generated from Transportation lines of business can be categorized as: construction and demolition (C&D) waste from construction projects; mixed waste at operational facilities; and waste from office workplaces. The latter two fall into the industrial, commercial and institutional (ICI) sector category.

7.1 Corporate waste reduction strategy and targets

In 2015 The City of Calgary set targets and timelines for the diversion of all waste materials from landfill through a combination of recycling, composting and waste-to-energy technology supported by public and stakeholder education and the provision of blue cart and green cart services. The goal is to achieve 70 per cent waste diversion by year 2025, averaged across all sectors:

- Single family residential - 70 per cent
- Multi-family residential - 65 per cent
- Businesses and organizations (ICI) - 75 per cent
- Construction and demolition (C&D) - 40 per cent.

With existing private sector demand for materials such as concrete, asphalt and scrap metals, plus pricing incentives in place to encourage recycling of other designated materials such as clean wood and cardboard, C&D waste is more readily and cost-effectively recycled than ever before.

7.2 Waste reduction efforts and results

Business unit-specific efforts and results are presented below for the main ICI and/or C&D waste streams.

Calgary Transit operations

The 4-stream waste separation stations installed at transit garages and office buildings are being utilized appropriately. Environmental staff continue to provide waste reduction awareness and reminders through EnviroNews publication, posters and inspections, helping to make waste diversion efforts successful.

With respect to waste materials from service lanes and other operational areas in facilities, unfortunately there is no data available to determine waste diversion results. The Waste & Recycling Services business unit has been unable to provide weigh scale data for waste materials hauled from transit facilities in recent years.

In 2021 the windshield glass recycling program was re-started. Calgary Transit generates a significant amount of broken auto glass waste (up to 30 tonnes per year) with damaged windshields on buses and C-Trains being replaced. Windshield glass has always been a difficult material to recycle and an economic challenge because of its design. A windshield glass recycling program had been initiated in 2016 but was put on hold in 2020 due to lack of processers for this waste material that combines glass and plastic components. The recycled glass can be used for making bottles, concrete blocks, and fiberglass insulation, while the plastic material content can be used for carpet glue and for other applications. The related potential for recycling of broken bus shelter glass is being explored in 2022.

Another re-start in 2021, a program for recycling small batteries was initated by Calgary Transit through partnership with a not-for-profit Canadian organization based in British Columbia. Batteries containing heavy metals such as mercury, lead, zinc, etc. can contaminate soil and groundwater if they are improperly disposed of. Battery-recycling containers were placed at strategic locations at Transit facilities, with environmental staff accepting the responsibility to regularly empty the containers, package the collected batteries, and ship them to the recycler in BC. Valuable materials like metal alloys are retrieved during processing by the recycler, and reused to contribute to a circular economy. These types of materials produce new products such as golf clubs, silverware, bikes, and even new batteries.

Calgary Transit e-waste recycling

On a monthly basis electronic waste (computers, accessories, etc.), as well cables, lead acid batteries, and other recyclable waste materials are collected from Transit facilities and transported to a local drop-off location. In 2021, a total of 6.3 metric tons of these materials were recycled with no direct costs to Transit.

Additionally, on an annual basis the environmental staff of Calgary Transit facilitate the collection of household and office electronic waste (computers, accessories, etc.) from staff for appropriate disposal via the Alberta Recycling Management Authority. Voluntary participation of staff is promoted as the "e-waste roundup".

Calgary Transit's annual e-waste roundup held in fall 2021 resulted 6.3 tonnes of electronic waste collected with the proceeds donated to City of Calgary United Way to support programs that help vulnerable Calgarians.

Calgary Roads Operations

Waste materials generated by Calgary Roads derive from several different construction and rehabilitation activities and sources, and these were managed in 2021 as follows:

- Roads Contract Services division recycled 99.9 per cent of the concrete, asphalt, soil, gravel, and plastic generated during project activities; only 74 tonnes of material, from an annual total of 107,347 tonnes, went directly to landfill for disposal.
- Roads Maintenance Bridge projects division recycled 99.9 per cent of the concrete, wood, cardboard and metal waste materials from the 5th Ave and 16th Ave projects during 2021; only 8.2 tonnes of material, from an annual total of 697.5 tonnes, went directly to landfill for disposal.
- Plants recycled 145 tonnes of asphalt milling chips, all to internal customers (Roads Maintenance and Parks). Market conditions and product location resulted in external customers using alternative suppliers, with no external sales in 2021.

Street sweepings material reuse

A street sweepings material reuse pilot had been underway seasonally at Bearspaw operational workplace centre since 2017, with the aim of diverting this waste stream from landfill in the future. A Trommel SM726 dry screen had been utilized to process 1,000 tonnes of sweepings that had been collected and stockpiled during spring clean up activities. Analytical testing of the screened material showed that all parameters other

than copper were below Residential Tier 1 criteria. The screened sweepings were mixed in with the fresh pickle on a 30:70 ratio, following gradation testing, with 215 tonnes of residual waste material (with organics and other fine materials included) being disposed of at landfill. The recycled sweepings had been applied to roadways on a trial basis, and operations crews reported there was no difference in the effectiveness of mixed aggregate material versus pure pickle. Accordingly, the pilot was extended to the present day.

The street sweeping recycling pilot continued in 2021 with approximately 150 tonnes of sweepings processed through a Trommel SM726 dry screen. Approximately 100 tonnes of usable product was generated. This recycled product will continue to be used to fill the community sandboxes located at Calgary Fire Department stations. Although initial calculations suggest that street sweepings material reuse does not represent a cost savings at current landfill tipping rates, the pilot will continue on a small scale to inform potential process improvements.

Transportation Infrastructure construction & demolition waste

TI has long demonstrated leadership within The City of Calgary for its construction and demolition waste reuse/recycling program, working with contractors to direct and enforce (using contract standard and special conditions) their sorting of waste material streams and tracking of material quantities recycled using standardized reporting tools. It has become standard practice on TI project sites that C&D materials are either sorted on-site, in separate marked bins as space allows, or off-site, for diversion from landfill through reuse and recycling. While the corporate target for C&D waste diversion is 40 per cent, TI has a business unit specific target of 99 per cent diversion. In 2021, TI disposed of 143.8 tonnes of material at landfills and diverted from landfill 105,200 tonnes of C&D materials.

Transportation Infrastructure's waste diversion target of 99 per cent of project construction waste diverted from landfill was exceeded with an actual diversion rate of 99.8 per cent in 2021.

8. Biodiversity Conservation

Biodiversity refers to the variety and complexity of life and habitats that are endemic or native to a given region. Urban development will negatively affect the natural (physical and biological) environment on a local and possibly regional scale, both directly through habitat loss and indirectly through habitat fragmentation and loss of diversity in native plant and animal species over time. With The City of Calgary being signatory to the Durban Commitment: Local Governments for Biodiversity, Council in 2015 approved *Our BiodiverCity, Calgary's 10-year Biodiversity Strategic Plan*. The plan was prepared by Calgary Parks with significant contributions from Corporate partners including Transportation through the General Manager's Office.

Transportation business units play an active role in the conservation of biodiversity during planning, development and operation of the transportation system in Calgary. Long range transportation planning studies are scoped to identify biophysical features and environmentally significant areas with the aim of minimizing the loss of biodiversity through adjustments to route alignment where possible and appropriate mitigation measures applied to design and construction. Environmental construction operations plans guide all work done on the major linear construction projects and facilities, and these plans include guidance on tree

protection, migratory birds, aquatic habitat and water quality protection. Throughout construction and during operation of the transportation system invasive plant species are monitored and controlled by means of mowing, hand-pulling, herbicide application and other approaches through integrated pest management.

8.1 Habitat management

Jaipur Bridge Replacement Project

The Jaipur Bridge project managed by TI in 2021 entailed the removal of an existing bridge (built in 1968) and construction of a new three-span bridge connecting downtown Calgary with Prince's Island Park. This work had potential to negatively affect fish and fish habitat. Fish habitat in the vicinity of the project is suitable for adult and juveniles of all fish species present in the Bow River including rainbow and brown trout.

The Jaipur Bridge is built over a constructed side channel of the Bow River that is referred to as a lagoon. The Prince's Island Lagoon has two flow control structures: there are gated culverts in the causeway upstream of the Jaipur Bridge, and there is a gated weir downstream. There are also both constructed and natural wetlands downstream, near the construction zone on the north side of the 2nd Street Bridge. During the removal of the old bridge and construction of the new bridge, efforts were made to minimize any construction-related impact to the natural habitat and restore any damage to the surrounding natural habitat.

Construction of Jaipur Bridge required closing of the flow control gates and draining of the lagoon. A fish salvage was completed by appropriately qualified personnel before the lagoon was drained, with total of 51,247 fish (14 different species) being captured from the lagoon area and safely released to the mainstem Bow River over a 26-day period.

Road right-of-way as habitat

Roads Maintenance boulevard division, through collaboration with Calgary Parks, the University of Calgary and Mount Royal University over the past several years has performed research and trial applications of roadside landscaping with native plants in support of biodiversity conservation. Building on the techniques and learnings from Calgary's first "bee boulevard", Canyon Meadows Drive SE (between MacLeod Trail and Bow Bottom Trail), and from related habitat restoration work done by Calgary Parks, further collaboration was pursued for a more ambitious and rigorously documented pilot project that could inform a business case for doing more of this work at the city-wide scale, involving potential future changes in landscape design guidelines, road development practices, and roadside maintenance practices. Calgary City Council in February 2020 awarded $450,000 of Council Innovation Funds to Transportation for the design and execution of a 3-year pilot project in "roadside naturalization". With planning, preliminary design and site preparation work completed in 2020, the pilot project was advanced considerably in 2021 through contractor procurement and execution of the pilot treatments over a 10 hectare area plus associated field studies and public engagement.

The project scope involves a reduced mowing treatment of 5 ha of land along both sides of 16th Ave NE west of 52nd St., and the conversion of turfgrass to native urban meadow over a similar 5 ha area east of 52nd St. The project scope also involves assessment of the plant communities, associated pollinator habitat values, and weed control costs of other roadside open space with varying maintenance regimes throughout the city. This pilot project will identify ways in which The City might usefully naturalize more open spaces such as road rights-of-way to create additional habitat for pollinators in general, and in a particular for 3 species of native bees that have been confirmed locally and are listed as threatened (Western bumblebee and Yellow-banded bumblebee) or endangered (Gypsy cuckoo bumblebee). The work is anticipated to stimulate public discussion and further investigation within City administration on the potential for broader application of such methods in lower maintenance landscaping for the purposes of achieving potential cost savings, while at the same time creating value in terms of habitats and biodiversity.

Figure 16: September 2021 appearance of 16th Ave NE

A milestone was reached in August 2021 with initial proof of concept achieved, that being the successful establishment of native grasses and wildflowers throughout the treatment area east of 52nd St. (Fig.16).

In parallel with this pilot project, The City contributed funding and leadership to a pooled-fund project of the Transportation Association of Canada (TAC) which is a compendium of beneficial practices for the management and enhancement of road ecology that is North American in scope. Other jurisdictions, in particular provincial road agencies in BC and Ontario and US State Departments of Transportation, have for many years been leading these emerging areas of practice including mitigating wildlife-vehicle collisions and enhancing pollinator habitats along roads. The final document entitled *Managing and Enhancing Terrestrial Road Ecology* was published in both official languages by TAC in 2021.

8.2 Control of regulated weeds

The three operational business units of Transportation, with support from Parks as needed, conduct weed surveys and control in public land areas under their stewardship. Calgary Roads Boulevard Maintenance division, who work closely with the Parks Integrated Pest Management (IPM) division, perform annual invasive species inspections on City owned land, including roadsides, Roads depots and Spyhill gravel pit. Aggressive weedy species are prone to spread on development sites, on stockpiles and along transportation rights-of-way. The focus of inspections is to target and control regulated weeds on the City lands, therefore limiting off-site transfer of weeds and weeds seeds through transport of gravel and other materials. Inspections are performed following the North American Weed Management Association's guidelines for gravel pit inspections.

In 2021, Calgary Roads seasonal crews hand-pulled, collected and appropriately disposed of 208 large bags of regulated weeds mostly comprising nodding thistle, black henbane, scentless chamomile, and knapweed.

8.3 Migratory birds protection

Migratory birds utilize almost every natural and man-made habitat found in Canada, and they are federally protected during breeding/nesting season. Under the *Migratory Birds Convention Act, 1994*, and its supporting *Regulations* there is an absolute prohibition on the disturbance to nesting migratory birds, their eggs, and their nests; in other words there is no regulatory provision to allow for their incidental take (i.e. no permits or approvals for their disturbance) during activities that support the development, construction, maintenance and operation of transportation facilities. The specific activities having highest potential for interaction with migratory birds include road construction, roadside vegetation management, and bridge maintenance work.

For most capital construction projects managed by TI, trees requiring removal that are identified as potential habitat for migratory birds are removed prior to breeding and nesting periods, typically between April 15 to August 15, with the prior approval of Urban Forestry and Urban Conservation divisions of Calgary Parks. Additionally, bird deterrent methods are applied including advance mowing of grass, cattail, and bushes in the project area to minimize opportunities for migratory birds to establish nests there. These and other measures and site specific guidance may be identified in ECO plans. Bridge washing and maintenance activities conducted by Roads staff and contractors also must planned and executed to prevent disturbance to migratory birds and their nests. An important aspect of migratory bird protection on work sites is the training and awareness of staff, contractors and consultants.

9. How We Do Our Work

The above sections of this annual performance report describe the types of programs and activities that are undertaken to advance environmental sustainability within the Transportation lines of business, and the results achieved from these efforts. Council, citizens and stakeholders expect a high degree of environmental stewardship in City operations, delivered for the best possible value. Accordingly, we seek to optimize, innovate, collaborate, and continually improve.

Our continuing registration to the ISO 14001 Standard for environmental management systems is one important element contributing to a consistent focus and diligence in advancing environmental sustainability, while another may be our unique organizational structure and governance as a Transportation department. Under the recently updated ISO 14001 (2015) Standard, there is increased emphasis on leadership engagement in environmental management activities, and on identifying and addressing both internal and external stakeholder interests in the work we do and how well we do it, among other changes.

Our efforts to advance environmental sustainability within Transportation involve ongoing coordination and collaboration internal to The City, primarily with:

- Water Resources business unit
- Parks business unit
- Environmental and Safety Management business unit

- Energy Management Office, Corporate Analytics and Innovation business unit
- Resilience and Infrastructure Calgary business unit
- Waste and Recycling Services business unit
- Calgary Growth Strategies business unit
- Intergovernmental and Corporate Services
- Law Department
- Corporate Environmental Network.

External to The City, our efforts also involve information sharing and ongoing collaborations with interested parties and networks that include:

- University of Calgary
- The City of Edmonton
- TransLink (Metro Vancouver)
- Alberta Road Builders and Heavy Construction Association
- Transportation Association of Canada (TAC)
- Canadian Urban Transit Association (CUTA)
- Calgary Region Airshed Zone (CRAZ)
- The Miistakis Institute
- Pollinator Partnerships Canada
- Alberta Environment and Parks
- Environment and Climate Change Canada.

Staff of the Sustainability Strategy division and other divisions of the Transportation department also engage in educational and community outreach activities by invite to share information, insights and expertise gained from the work of advancing environmental sustainability in a municipal transportation system.

10. Benchmarking Against Other Organizations

The City of Calgary can reference municipal benchmarks to enable comparison with other Canadian cities on certain aspects of our transportation system, but only for a select few corporate metrics (e.g. Ontario Municipal CAOs Benchmarking Initiative). Currently there are no available data describing environmental management performance that is specific to transportation other than the voluntary performance reporting on the environmental management of road salts that is compiled periodically by Environment & Climate Change Canada (refer to sections 5.3 and 5.4 of this report). Targeted outreach to other municipalities who are members of the Transportation Association of Canada was made between 2015 and 2019, but they report being not currently positioned to track or share such information. Available benchmarking data includes:

- Urban Transportation Indicators (UTI) surveys undertaken every five years, through ongoing work of TAC's Urban Transportation Council since 1994, with data being collected and compiled as indicators of "progress towards sustainable transportation" across 33 census metropolitan areas in Canada.

- The UTI-5 report (Kriger *et al* 2015) presents findings for over 90 indicators including metrics that are reported on for Calgary Transportation Plan implementation monitoring (e.g. travel mode split, land use density).
- Within the specific context of transit (e.g. ridership rates, service hours per capita) Calgary Transit can benchmark against other members of the Canadian Urban Transit Association (CUTA), but that does not enable comparison of key environmental performance results.
- The Federation of Canadian Municipalities (FCM) does not collect and compile such information.

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APPENDIX 1 – TRANSPORTATION ENERGY PROFILE

The information contained in these appendices is compiled from data available as of April 2022. The source for most of the energy consumption and cost data for grid electricity and natural gas supply to The City of Calgary is ENMAX Energy invoice data. Data for district energy use (thermal energy), combined heat and power (CHP) systems, and The City's solar systems are separately metered with energy use and costs being compiled monthly. The values reported here may be adjusted over the next several months as data is finalized by the service providers.

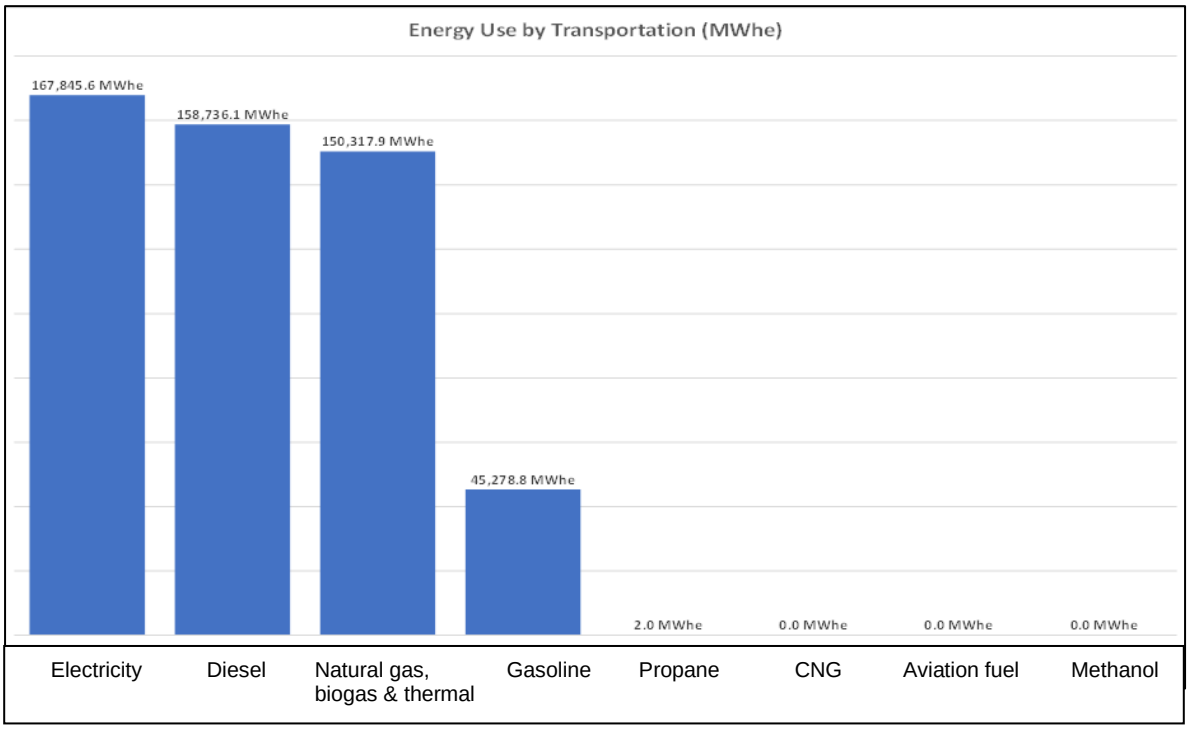
Fuel consumption and cost information is a challenging consolidation of various data sources, from automated database queries, Excel reports and drills on Account Payables, to manual encoding of scanned invoices. Some data quality and encoding issues have been identified, so that there may be some variance of costs with those reported on The City's Peoplesoft system.

The departmental totals (Figs. App. 1-1 and 1-2) include energy use that is attributed to the non-operational business units for construction management (where, for example, Transportation Infrastructure has facilities under their stewardship on a temporary basis) but these values are not presented separately as they are not comparable on an annual basis. Electricity consumption values vary slightly between the charts and data tables as a result of energy transformed by the CHP unit at Spring Gardens and Stoney CNG Transit facility; charts show the energy used by the CHP as natural gas, while the tables show the natural gas input, the electricity produced, and the heat produced. The tables show the complete picture per commodity and the charts show the correct energy balance.

Also note that the energy use profile charts are presented in two ways: 1) with values shown using the typical units for each type of energy supply (e.g. litres of diesel fuel, gigajoules of electricity) which can be cross referenced to the supporting data summaries; and 2) shown in equivalent terms, where values were converted to "megawatt hours equivalent" to enable a visual comparison of relative energy consumption across the different types of energy supply.

APPENDIX 1 – TRANSPORTATION ENERGY PROFILE

Figure App.1-1: Energy Use in 2021 and Trend (2018 to 2021) – Department Total



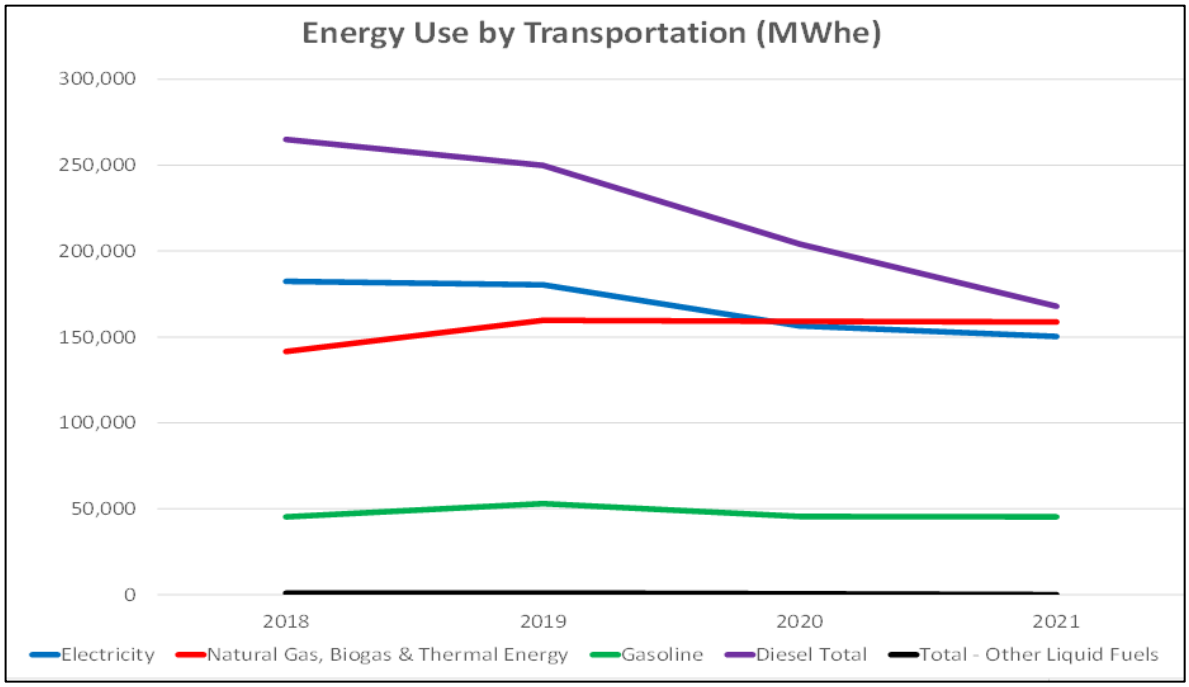
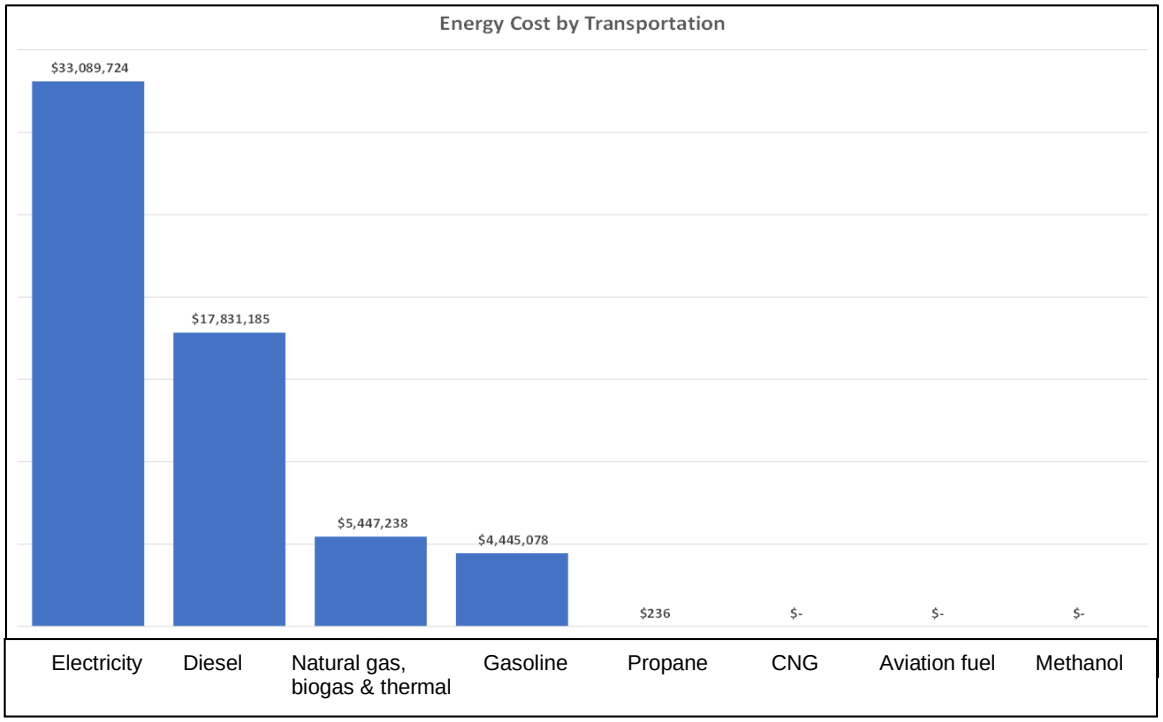


Figure App.1-2: Energy Cost Profile in 2021 and Trend (2018 – 2021) – Department Total (2021)



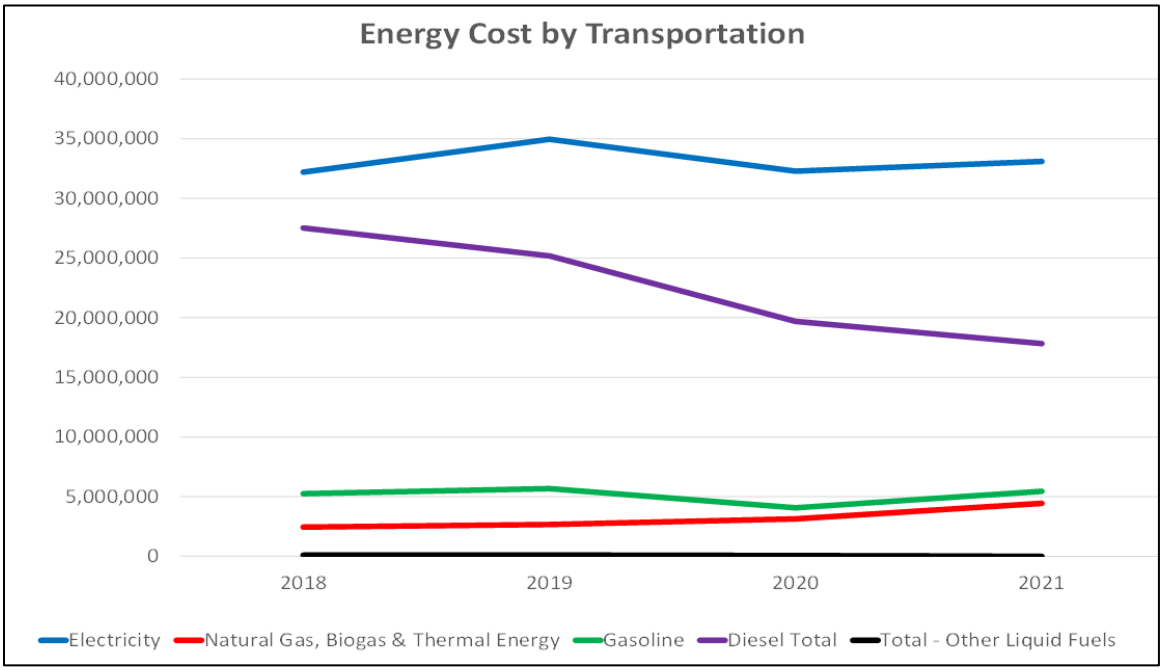
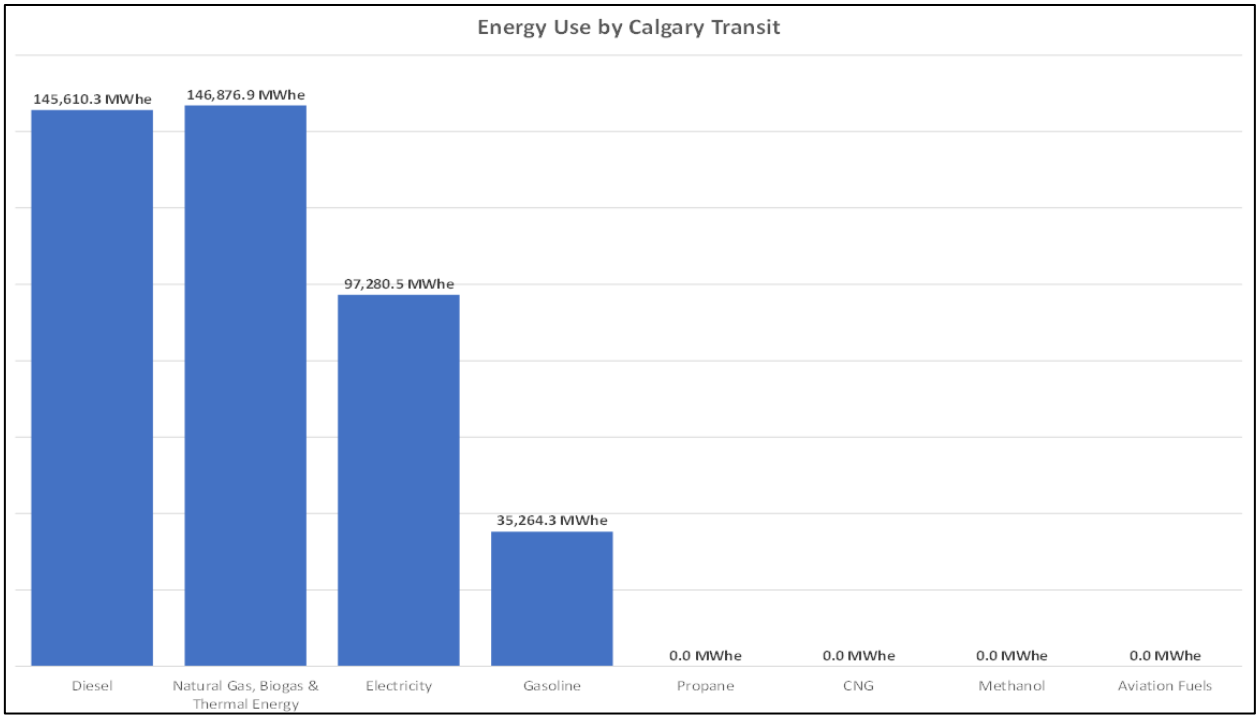


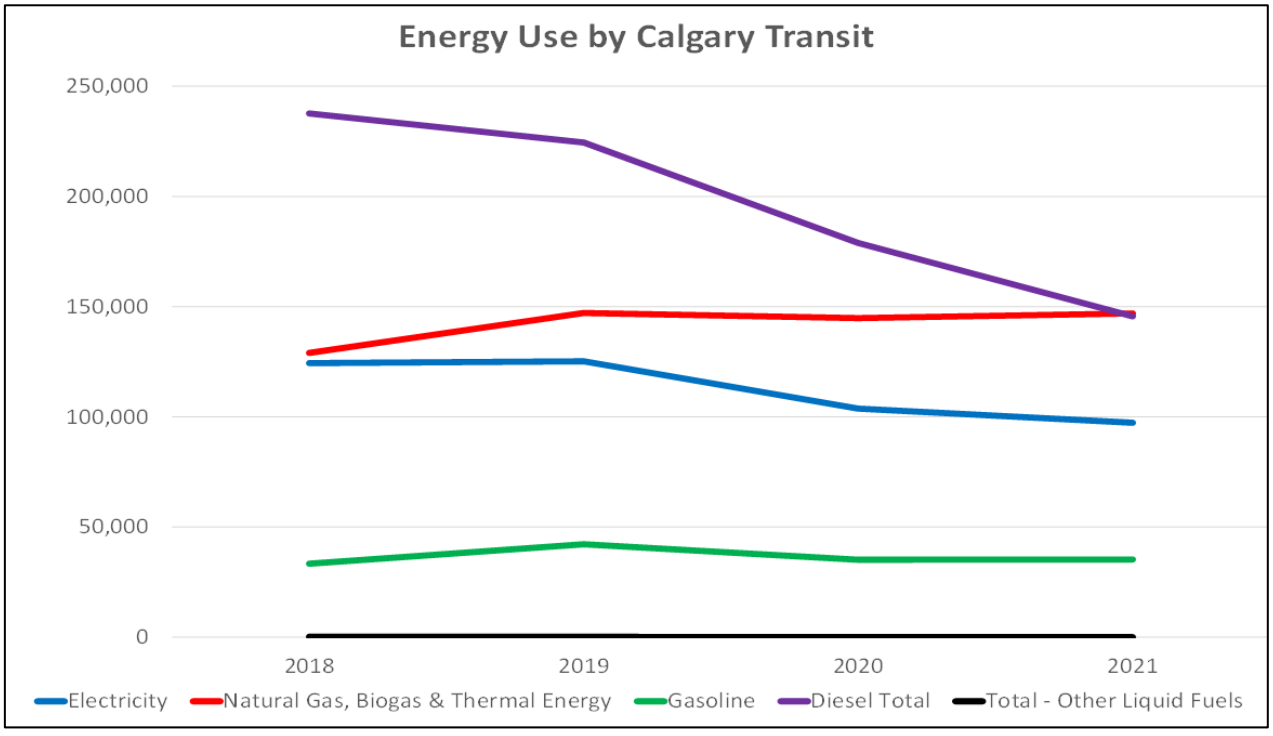
Figure App.1-3: Energy Use and Cost Data – Department Total

Energy Use by Transportation (MWhe)	2018	2019	2020	2021
Diesel	261,037.3	245,902.4	199,519.9	163,100.9
Marked Diesel	3,901.5	3,977.8	4,543.6	4,744.7
Diesel Total	264,938.8	249,880.2	204,063.5	167,845.6
Gasoline	45,275.2	52,968.0	45,567.6	45,278.8
Grid Electricity Purchases	182,324.9	180,286.3	156,420.9	150,276.7
Solar PV	19.5	34.9	41.2	42.2
Solar PV Exports	(0.8)	(1.1)	(2.7)	(1.0)
Electricity	182,343.6	180,320.0	156,459.4	150,317.9
Natural Gas (CHP Use)	3,829.5	5,039.4	6,666.7	9,523.5
Natural Gas (Non CHP Use)	137,703.5	154,666.0	152,491.5	149,212.6
Bio Gas	-	-	-	-
Solar Thermal	-	-	-	-
District Energy	-	-	-	-
Natural Gas, Biogas & Thermal Energy	141,533.0	159,705.4	159,158.2	158,736.1
CNG	195.1	180.0	34.1	-
Av gas 100ll	-	-	-	-
Jet a1	-	-	-	-
Methanol	-	-	-	-
Propane	672.0	768.0	453.6	2.0
Total - Other Liquid Fuels	867.1	948.0	487.7	2.0
Total Energy Use	634,957.6	643,821.7	565,736.3	522,180.3

Energy Cost by Transportation	2018	2019	2020	2021
Diesel	$ 27,088,533	$ 24,793,019	$ 19,349,730	$ 17,362,107
Marked Diesel	$ 430,640	$ 379,328	$ 335,278	$ 469,078
Diesel Total	$ 27,519,173	$ 25,172,347	$ 19,685,008	$ 17,831,185
Gasoline	$ 5,247,898	$ 5,672,758	$ 4,061,125	$ 5,447,238
Grid Electricity Purchases	$ 32,157,387	$ 34,791,391	$ 31,865,561	$ 32,657,598
Solar PV	$ -	$ -	$ -	$ -
Solar PV Exports	$ (118)	$ (80)	$ (150)	$ (96)
CHP Electricity Production	$ 41,602	$ 173,237	$ 424,302	$ 517,746
CHP Electricity Exports	$ -	$ (10,504)	$ (17,507)	$ (85,524)
Electricity	$ 32,198,871	$ 34,954,045	$ 32,272,205	$ 33,089,724
Natural Gas (CHP Use)	$ 69,533	$ 69,110	$ 126,765	$ 251,975
Natural Gas (Non CHP Use)	$ 2,363,534	$ 2,587,472	$ 2,995,229	$ 4,187,166
Bio Gas	$ -	$ -	$ -	$ -
District Energy	$ -	$ -	$ -	$ -
CHP Thermal Purchases	$ 12,242	$ 10,957	$ 6,436	$ 5,937
Solar Thermal	$ -	$ -	$ -	$ -
Natural Gas, Biogas & Thermal Energy	$ 2,445,310	$ 2,667,538	$ 3,128,430	$ 4,445,078
CNG	$ 15,203	$ 14,027	$ 2,657	$ -
Av gas 100ll	$ -	$ -	$ -	$ -
Jet a1	$ -	$ -	$ -	$ -
Methanol	$ -	$ -	$ -	$ -
Propane	$ 80,685	$ 93,384	$ 57,410	$ 236
Total - Other Liquid Fuels	$ 95,888	$ 107,411	$ 60,066	$ 236
Total Energy Use	$ 67,507,141	$ 68,574,099	$ 59,206,835	$ 60,813,461

Figure App.1-4: Energy Consumption in 2021 and Trend (2018 to 2021) – Calgary Transit





APPENDIX 1 – TRANSPORTATION ENERGY PROFILE

Figure App.1-4: Energy Consumption and Cost Data – Calgary Transit

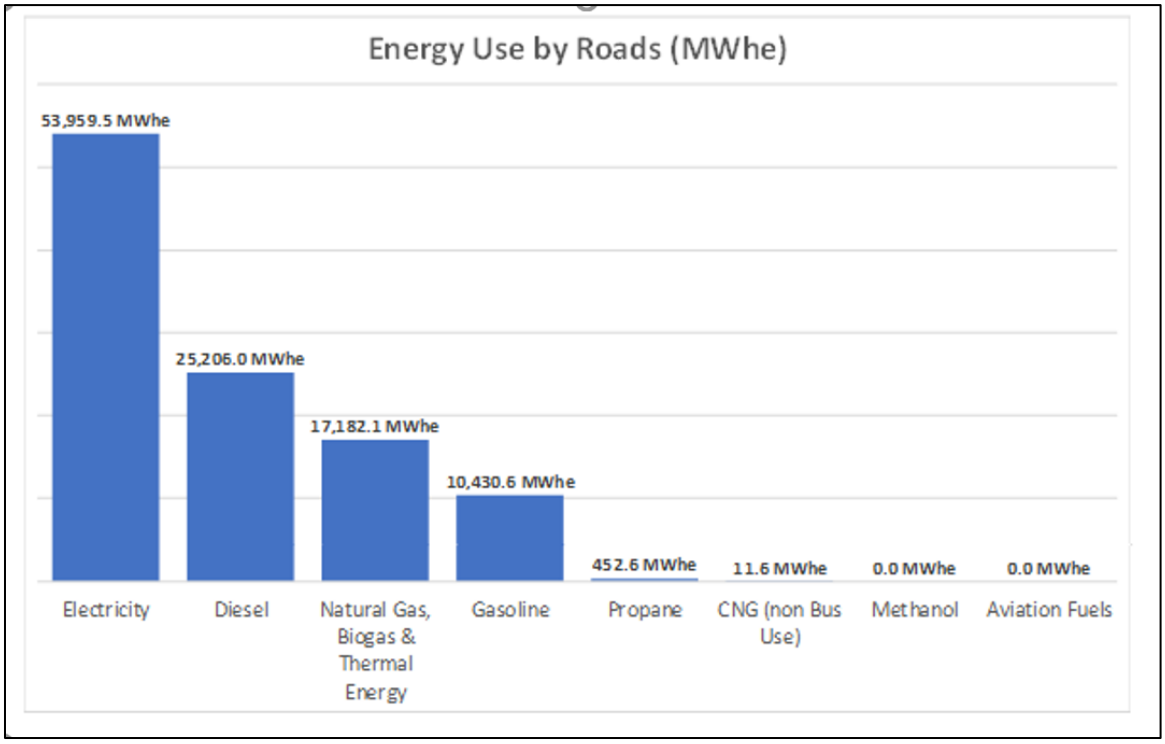
Energy Use by Calgary Transit (MWhe)

	2017	2018	2019	2020
Diesel	259,016.8	237,597.5	224,403.7	178,772.6
Marked Diesel	49.4	29.9	61.8	84.9
Diesel Total	259,066.2	237,627.3	224,465.5	178,857.5
Gasoline	15,551.3	33,389.6	42,190.7	35,104.9
Grid Electricity Purchases	118,201.8	124,308.1	125,116.1	103,435.9
Solar PV	0.4	19.5	34.9	41.2
Solar PV Exports	(0.4)	(0.8)	(1.1)	(2.7)
Electricity	118,201.8	124,326.8	125,149.9	103,474.3
Natural Gas (CHP Use)	6,400.4	3,829.5	5,039.4	6,666.5
Natural Gas (Non CHP Use)	115,342.8	125,205.2	142,051.6	138,370.7
Bio Gas	-	-	-	-
Solar Thermal	-	-	-	-
District Energy	-	-	-	-
Natural Gas, Biogas & Thermal Energy	121,743.2	129,034.7	147,091.0	145,037.1
CNG (non Bus Use)	875.9	195.1	180.0	22.5
Av gas 100ll	-	-	-	-
Jet a1	-	-	-	-
Methanol	-	-	-	-
Propane	8.8	23.8	9.0	1.0
Total - Other Liquid Fuels	884.7	218.9	189.1	23.5
Total Energy Use	515,447.2	524,597.3	539,086.1	462,497.3

Energy Cost by Calgary Transit

	2017	2018	2019	2020
Diesel	$ 23,360,139	$ 23,887,929	$ 22,490,573	$ 17,533,306
Marked Diesel	$ 4,005	$ 3,220	$ 6,007	$ 6,065
Diesel Total	$ 23,364,143	$ 23,891,149	$ 22,496,580	$ 17,539,371
Gasoline	$ 1,639,747	$ 4,123,769	$ 4,398,964	$ 3,065,065
Grid Electricity Purchases	$ 19,870,673	$ 21,827,155	$ 23,413,969	$ 20,569,519
Solar PV	$ -	$ -	$ -	$ -
Solar PV Exports	$ (7)	$ (118)	$ (80)	$ (150)
CHP Electricity Production	$ 73,057	$ 41,602	$ 173,237	$ 424,302
CHP Electricity Exports	$ -	$ -	$ (10,504)	$ (17,511)
Electricity	$ 19,943,723	$ 21,868,639	$ 23,576,623	$ 20,976,160
Natural Gas (CHP Use)	$ 139,207	$ 69,533	$ 69,110	$ 123,385
Natural Gas (Non CHP Use)	$ 2,333,243	$ 2,185,064	$ 2,449,145	$ 2,698,322
Bio Gas	$ -	$ -	$ -	$ -
District Energy	$ -	$ -	$ -	$ -
CHP Thermal Purchases	$ 16,353	$ 12,242	$ 10,957	$ 6,436
Solar Thermal	$ -	$ -	$ -	$ -
Natural Gas, Biogas & Thermal Energy	$ 2,488,803	$ 2,266,840	$ 2,529,211	$ 2,828,143
CNG (non Bus Use)	$ 68,245	$ 15,203	$ 14,027	$ 1,750
Av gas 100ll	$ -	$ -	$ -	$ -
Jet a1	$ -	$ -	$ -	$ -
Methanol	$ -	$ -	$ -	$ -
Propane	$ 1,120	$ 2,841	$ 824	$ 132
Total - Other Liquid Fuels	$ 69,365	$ 18,044	$ 14,851	$ 1,883
Total Energy Use	$ 47,505,781	$ 52,168,441	$ 53,016,229	$ 44,410,621

Figure App.1-5: Energy Consumption and Cost Profiles – Calgary Roads



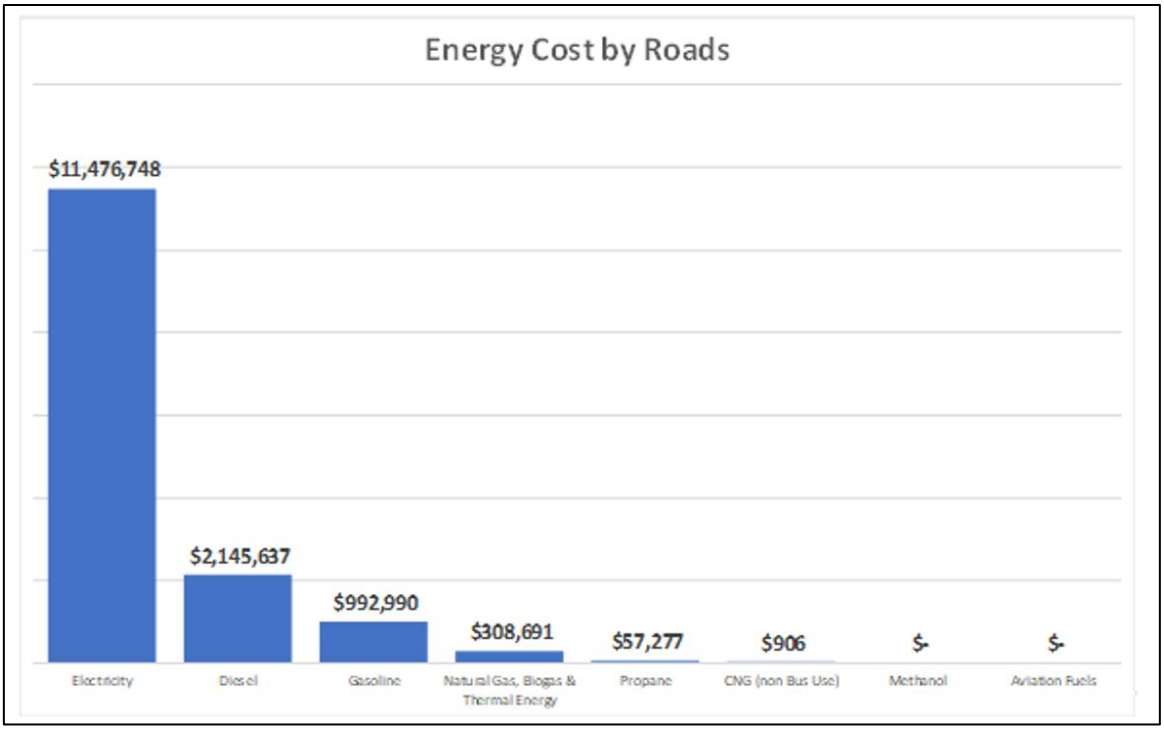


Figure App.1-6: Energy Consumption and Cost Data – Calgary Roads

Energy Use by Roads (MWhe)

	2017	2018	2019	2020
Diesel	22,387.9	23,439.8	21,500.7	20,747.3
Marked Diesel	3,220.6	3,871.6	3,916.0	4,458.7
Diesel Total	25,608.5	27,311.4	25,416.7	25,206.0
Gasoline	12,070.2	11,824.8	10,736.3	10,430.6
Grid Electricity Purchases	65,618.7	59,539.4	56,522.8	53,959.5
Solar PV	-	-	-	-
Solar PV Exports	-	-	-	-
Electricity	65,618.7	59,539.4	56,522.8	53,959.5
Natural Gas (CHP Use)	-	-	-	-
Natural Gas (Non CHP Use)	16,203.7	15,142.8	15,438.9	17,182.1
Bio Gas	-	-	-	-
Solar Thermal	-	-	-	-
District Energy	-	-	-	-
Natural Gas, Biogas & Thermal Energy	16,203.7	15,142.8	15,438.9	17,182.1
CNG (non Bus Use)	-	-	-	11.6
Av gas 100ll	-	-	-	-
Jet a1	-	-	-	-
Methanol	-	-	-	-
Propane	755.8	648.2	759.0	452.6
Total - Other Liquid Fuels	755.8	648.2	759.0	464.2
Total Energy Use	120,257.0	114,466.6	108,873.7	107,242.4

Energy Cost by Roads

	2017	2018	2019	2020
Diesel	$ 2,309,203	$ 2,849,011	$ 2,302,646	$ 1,816,424
Marked Diesel	$ 284,127	$ 427,419	$ 373,321	$ 329,213
Diesel Total	$ 2,593,330	$ 3,276,430	$ 2,675,967	$ 2,145,637
Gasoline	$ 1,275,008	$ 1,468,996	$ 1,269,146	$ 992,990
Grid Electricity Purchases	$ 11,033,753	$ 10,590,712	$ 11,633,721	$ 11,476,748
Solar PV	$ -	$ -	$ -	$ -
Solar PV Exports	$ -	$ -	$ -	$ -
CHP Electricity Production	$ -	$ -	$ -	$ -
CHP Electricity Exports	$ -	$ -	$ -	$ -
Electricity	$ 11,033,753	$ 10,590,712	$ 11,633,721	$ 11,476,748
Natural Gas (CHP Use)	$ -	$ -	$ -	$ -
Natural Gas (Non CHP Use)	$ 292,318	$ 228,975	$ 193,301	$ 308,691
Bio Gas	$ -	$ -	$ -	$ -
District Energy	$ -	$ -	$ -	$ -
CHP Thermal Purchases	$ -	$ -	$ -	$ -
Solar Thermal	$ -	$ -	$ -	$ -
Natural Gas, Biogas & Thermal Energy	$ 292,318	$ 228,975	$ 193,301	$ 308,691
CNG (non Bus Use)	$ -	$ -	$ -	$ 906
Av gas 100ll	$ -	$ -	$ -	$ -
Jet a1	$ -	$ -	$ -	$ -
Methanol	$ -	$ -	$ -	$ -
Propane	$ 99,282	$ 77,844	$ 92,560	$ 57,277
Total - Other Liquid Fuels	$ 99,282	$ 77,844	$ 92,560	$ 58,184
Total Energy Use	$ 15,293,690	$ 15,642,958	$ 15,864,694	$ 14,982,250