Coquitlam

October 31, 2018

E-filed

British Columbia Utilities Commission
Sixth Floor, 900 Howe Street
Vancouver, BC V6C 2N3

Attention: Patrick Wruck, Commission Secretary

Re: City of Coquitlam ("City") Evidence for Phase Two
FortisBC Energy Inc. ("FEI") - Application for Use of Lands under Sections 32 and 33 of the *Utilities Commission Act* in the City of Coquitlam for the Lower Mainland Intermediate Pressure System Upgrade ("LMIPSU") Project
Project No. 1598963

Dear Mr. Wruck:

Further to the regulatory timetable established by the British Columbia Utilities Commission in Order G-190-18, I am writing to submit the City's evidence for Phase Two of this proceeding.

I am the Manager of Design and Construction in the City of Coquitlam's Engineering and Public Works Department and have held that position for 12 years. Previously I held the position of Traffic Operations Engineer at the City for six years. My responsibilities at the City, and in particular in relation to FEI's Project, include:

- Managing the staff who coordinate the review of applications from third-party utility companies.
- Managing the City's Contract Administrator and Senior Inspector who will be working with FEI and its contractors during construction of the LMIPSU Project in Coquitlam, as well as the Customer Service Supervisor and other staff who will be needed to support the LMIPSU Project.
- Review and approval of noise exemption permits, such as those anticipated from FEI's contractor.

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- Reporting to senior staff and City Council on the status of major third-party utility projects, such as the LMIPSU Project.

This evidence is submitted in support of the City's position that 1) the entire 5.5km section of the NPS 20 Pipeline must be removed by FEI once the new NPS 30 Pipeline is in service; and 2) FEI must complete curb-to-curb repaving of Como Lake Avenue to repair the damage that will be caused by its Project.

The Project

As part of the LMIPSU Project, FEI is upgrading its infrastructure under Como Lake Avenue in the City. FEI's Project within the City will include construction of a new NPS 30 Pipeline and decommissioning of the existing 60-year-old NPS 20 Pipeline along an approximately 5.5 kilometre section of Como Lake Avenue from Mariner Way to the Burnaby border.

Summary of Coquitlam's Position

There are two issues remaining to be considered in Phase Two of this proceeding.

Issue 4: Removal of the decommissioned NPS 20 Pipeline

The City's position is that the preferred and most cost-effective approach is for FEI to remove the entire 5.5km of NPS 20 Pipeline underneath Como Lake Avenue as soon as possible (i.e., when the NPS 30 Pipeline is in service), rather than fill it with concrete and then remove it separately in the future.

The NPS 20 Pipeline is occupying space that is needed now or will be needed in the future. The most urgent need for space currently occupied by the NPS 20 Pipeline is the 380m section of the NPS 20 Pipeline between North Road and Clarke Road. This space is needed by the City for the installation of its new 250mm water main and 450mm sanitary sewer, which the City has deferred the installation of to avoid having to relocate the NPS 20 Pipeline while it remains in service. The space occupied by the remaining section of the decommissioned NPS 20 Pipeline will be needed in the near future because the projected and planned growth of the City will require new utilities to be installed in the already congested corridor under Como Lake Avenue.

Issue 5: Repair and repaving of damage to Como Lake Avenue caused by the Project

The City's position is that FEI must repair and repave the whole of the 5.5km section of Como Lake Avenue, curb-to-curb, to return it to an acceptable standard at the end of the Project. FEI's proposal to pave only the middle lanes of Como Lake Avenue will not abide by the terms of the 1957 Operating Agreement as all four lanes will be extensively damaged by the Project.

The Project will result in substantial damage to Como Lake Avenue. The centre two lanes will be fully involved in the Project. The curb lanes will also be damaged by numerous lateral cuts for relocation of lateral utilities, grinding off portions of the surface layer of asphalt for changes to pavement markings, excessive wear and tear from FEI's large excavators and other heavy construction equipment, and cuts to access the NPS 20 Pipeline.

Como Lake Avenue

Como Lake Avenue is a critical corridor for the region:

- Como Lake Avenue is one of Coquitlam's busiest highways. Approximately 27,000 vehicles travel along Como Lake Avenue per day. A map of the City of Coquitlam Data Management System showing 26,630 as the average daily traffic counted on Como Lake Avenue near Thermal Drive over one week in September 2017[1] is attached as Appendix A.

- Como Lake Avenue is designated an arterial road by the City's Official Community Plan[2] and it forms part of the regional Major Road Network.[3]

- Three public transit routes run along Como Lake Avenue (routes 151, 153, 156) and it is a Primary Emergency Response route.

- At a minimum Como Lake Avenue has four lanes, with two lanes in each direction. There are auxiliary left-turn lanes at many intersections. Eighteen of the intersections along the section impacted by the Project have traffic signals.

- There are eight schools next to or close to Como Lake Avenue:

  1) Dr. Charles Best Secondary School (next to)

  2) Hillcrest Middle School (next to)

  3) Parkland Elementary (within one block)

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[1] Average Daily Traffic = VOL (24-hour volume count) x SF (applicable month/day combination seasonal factor) x AF (applicable axle-correction factor).

[2] City of Coquitlam, *Citywide Official Community Plan*, online: < http://www.coquitlam.ca/planning-and-development/resources/Property-Developer-and-Builder-Resources/Citywide-Official-Community-Plan.aspx>. Arterial roads are the main arteries for vehicles travelling through a city and between urban areas.

[3] The regional Major Road Network supports the safe and efficient movement of people and goods across the greater Vancouver area. It includes more than 600 kilometres of major arterial roads that carry commuter, transit, and truck traffic. The Major Road Network connects the provincial highway system with the local road network, and some corridors also serve cyclists and pedestrians. See generally TransLink, *Major Road Network & Bridges*, online: <https://www.translink.ca/Getting-Around/Driving/Major-Road-Network-and-Bridges.aspx>.

4) Queen of All Saints (next to)

5) Porter Elementary School (within one block)

6) Harbour View Elementary School (the only arterial access is via Como Lake Avenue)

7) Banting Middle School (within one block)

8) Miller Park Community School (within one block)

- There are 895 residential properties (including condo buildings) and 71 commercial properties immediately adjacent to Como Lake Avenue.

- The City provides for weekly recycling and green waste collection and bi-weekly garbage collection to single family residential properties along Como Lake Avenue.

Traffic management in the area of Como Lake Avenue is impacted by large geographical and land-use features, including Mundy Park, Vancouver Golf Course, and a steep escarpment. These features limit detour options for travelers, adding to the importance of Como Lake Avenue to the community and to the region. Also as a result of these features, Como Lake Avenue is one of very few east/west routes in the area and is congested with multiple underground linear utilities along the corridor:

- two BC Hydro duct banks
- two water mains
- two drainage mains
- QNet communication ducts
- two street lighting conduits
- FEI's NPS 20 Pipeline
- a FEI distribution gas main

There are also over 800 lateral utilities that cross the Project route:

- 147 gas lines
- 186 water lines
- 167 drainage lines
- 66 sanitary sewer lines
- 57 underground electrical lines
- approximately 170 traffic loops

- 21 street light conduits

In addition, there are 180 poles for overhead utilities (BC Hydro distribution) between Mariner Way and North Road, with the majority of these poles also used for Shaw and Telus communications distribution lines.

Issue 4: Removal of the decommissioned NPS 20 Pipeline

The City's position is that the decommissioned NPS 20 Pipeline will remain FEI's property and liability. Under no circumstances will the City assume ownership of or responsibility for the decommissioned NPS 20 Pipeline or any harm to persons or property that might result if the decommissioned pipeline is left in place. FEI has confirmed that the decommissioned NPS 20 Pipeline will remain FEI's responsibility and that FEI will remove it if it interferes with municipal infrastructure.[4]

The City is not aware of a standardized approach for how decommissioning end-of-life natural gas pipelines in underground municipal areas should proceed; however, there are two basic options:

(i) the pipeline owner can make the pipeline safe (e.g., by filling it to prevent its collapse which could cause a sinkhole or other damage), leave it in place and subsequently remove it when the space is needed (FEI's position), or

(ii) the pipeline owner can immediately remove the pipeline, backfill and restore the surface (the City's position).[5]

The disruption that would be caused by either of these two basic options must be considered in the context of the specific site. In this present case, the context includes the importance of Como Lake Avenue to the community and the region as one of the only east/west routes in the area, the demonstrated need for the space in an already congested underground corridor, and the planned development for the area.

The Government of Canada's discussion paper titled *Pipeline Abandonment - A Discussion Paper on Technical and Environmental Issues*, attached as Appendix C, notes that a key factor influencing the choice between the two options is present and future land use. Future land use should be considered because a pipeline abandoned-in-place could become a physical obstruction to development.

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[4] See Tri-City News article dated August 1, 2018: < https://www.tricitynews.com/news/update-coquitlam-battlesfortis-over-pipeline-plan-l .233 86463 > attached as Appendix B.

[5] See generally, Government of Canada, *Pipeline Abandonment - A Discussion Paper on Technical and Environmental Issues,* (November 1996) attached as Appendix C.

The National Guide to Sustainable Municipal Infrastructure published a paper that surveyed practices that exist across the country for coordinating infrastructure works. A copy of this paper is attached at Appendix D. The paper highlights the problems associated with the waste and inefficiency where a road is dug up and repaved, only to be dug up again a short time later, and emphasizes a coordinated approach. The net effect of improved coordination includes reduced project costs through efficiencies of scale and avoidance of repeat repair costs (e.g. repeated pavement repair).[6]

The City believes that sooner or later FEI will have to remove the entire approximately 5.5km of NPS 20 Pipeline to make space for other utility projects that support the public interest (e.g., water mains, sewers, electrical conduits for street lighting and traffic signals, telecommunications, etc.). Coquitlam is one of the fastest growing municipalities in greater Vancouver. The projected rapid growth and development in Coquitlam, in particular in the Burquitlam area, will only increase the need for underground space for additional utilities to serve this growth. The presentation attached at Appendix E provides a high-level summary of the planned growth in key areas in Coquitlam and illustrates the increased congestion, both above and below ground, particularly within an 800m radius of the Burquitlam SkyTrain Station, which includes the 380m section of Como Lake Avenue.[7] The maps attached at Appendix F also show the extent of current and recent developments in proximity to Como Lake Avenue, some of which are already under construction. The map also illustrates how Mundy Park, the Vancouver Golf Course, and the escarpment contribute to limited east/west routes in the area and congestion in this corridor.

The City believes that FEI's current plan to leave the decommissioned NPS 20 Pipeline in place would require FEI to,

(i) in the short term:

- make the pipeline safe by filling it with concrete (as planned by FEI),
- excavate Como Lake Avenue in numerous places to access the pipeline and fill it with concrete,
- backfill such excavations and repair damage to the road, and

(i) in the future,

- excavate Como Lake Avenue again to remove the pipeline or sections of it,
- remove and dispose of pipeline filled with concrete, and

[6] See generally *Coordinating Infrastructure Works*, page 2, attached at Appendix D.
[7] See Slide 7 of Appendix E.

- backfill such excavations and repair damage to the road.

FEI has proposed that if the NPS 20 Pipeline is abandoned in place and future City works conflict with the abandoned pipeline, the City's contractor would be required to expose the NPS 20 Pipeline using precautions as this pipeline is believed to contain asbestos, and then wait for FEI to remove the conflicting parts of the pipeline prior to continuing with the work. This approach would greatly complicate the contractor's schedule and construction activity, and this would increase costs to the City. This would also cause increased costs for FEI as a result of repeated excavation and repaving in the same area.

The City believes that the preferred and most cost-effective approach is for FEI to remove the entire 5.5km of NPS 20 Pipeline as soon as possible (i.e., when the NPS 30 Pipeline is in service), rather than fill it with concrete and then remove it separately in the future. This approach is appropriate in the circumstances of Como Lake Avenue, namely the importance of the road to the community and region (lack of detour options) and the illustrated need for the space in the near future to support the City's development plan.

This is not a situation where a decommissioned pipeline can be filled with concrete and left, out of mind, for a century. This is a situation where the space is needed in the foreseeable future, and the road will already be subjected to extensive damage by the installation of the NPS 30 Pipeline.

The most urgent need for space currently occupied by the NPS 20 Pipeline is the 380m section between North Road and Clarke Road in the Burquitlam area. The space currently occupied by this 380m section is needed by the City for a new 250mm water main and 450mm sanitary sewer, which the City has deferred installing to avoid having to relocate the NPS 20 Pipeline while it remains in service and to make way for the new NPS 30 Pipeline. Once the new NPS 30 Pipeline is in service, the 380m section of the decommissioned NPS 20 Pipeline must be removed immediately to make space for the City's new water and sanitary sewer lines.

The crux of Issue 4 appears to be FEI's assumption that the City's water main and sewer upgrade project between North Road and Clarke Road is at a "very preliminary" stage as stated by FEI in section 5.1 of its Application. FEI's assumption in regard to the timing of the City's project is not correct. Detailed designs for the water main replacement and the proposed sanitary sewer are underway. The water line has been in the City's DCC program for a number of years, and the sanitary sewer is being added to the 2018 Development Cost Charges project list. Appendix G shows where the NPS 20 Pipeline conflicts with the planned alignment of the City's new water and sanitary sewer lines. These lines are needed to serve the current and planned major developments near this section of Como Lake Avenue, as shown at Appendix E and Appendix F.

Appendix G also shows the congestion of utilities under Como Lake Avenue between North Road and Clarke Road. There are BC Hydro duct banks, water mains, drainage mains, QNet communication ducts, street lighting conduits, the NPS 20 Pipeline and a FEI distribution gas main currently in the 380m section.

With respect to the 1957 Operating Agreement between the City and FEI, the City's position is that this agreement does not permit FEI to decommission and abandon its pipelines in underground areas in Coquitlam. The City's position is that a decommissioned pipeline is effectively garbage, and the 1957 Operating Agreement does not permit FEI to abandon its garbage in Coquitlam. The City believes that the 1957 Operating Agreement applies only to in-service functioning FEI pipelines and that permanently decommissioned pipelines do fall within the term "the said works" as used in the agreement.

The City further believes that this Issue 4 needs to be considered in the context of the legislative scheme surrounding gas utilities operating in municipalities, including the *Community Charter*, the *Gas Utility Act* and the *Utilities Commission Act*. The City's position is that in the absence of an operating agreement providing otherwise, the City can require FEI to remove its decommissioned NPS 20 Pipeline from the City's lands.

Issue 5: Repair and repaving of damage to Como Lake Avenue caused by the Project

It is common ground that the 1957 Operating Agreement requires FEI to reinstate the paving or surface on public property which it has disturbed in as good a state of repair as it was prior to its disturbance and in accordance with reasonable specifications laid down by, and subject to the supervision of, the Municipal Engineer. FEI acknowledges that pursuant to the 1957 Operating Agreement, FEI is responsible for the costs of repairing the damage its Project will do to Como Lake Avenue.

In addition, the City confirms its requirement for FEI to pay for the pavement restoration is fully consistent with the purpose of the City's long-standing policies and practices, including the *Fees and Charges Bylaw*, No, 4790, 2017, which require all third parties working on City streets, including third party utility companies, to pay the costs of repairing the damage caused by their works.

The scope of Issue 5 is not whether FEI will be responsible for reinstating Como Lake Avenue in as good a state of repair as it was prior to its disturbance as a result of the Project, but rather the expected extent of disturbance that will be caused by FEI's Project and the extent of repair and paving required.

The City submits the whole of the 5.5km section of Como Lake Avenue must be returned to an acceptable standard at the end of the Project. FEI's proposal to pave only the middle

lanes of Como Lake Avenue will not abide by the terms of the 1957 Operating Agreement as all four lanes will be extensively damaged by the Project.

FEI acknowledges that the two centre lanes of Como Lake Avenue will be fully involved with the installation of the new NPS 30 Pipeline as a trench will be excavated along the 5.5km length of the affected section, and will need to be repaired. FEI does not acknowledge that the curb lanes will also be extensively damaged by the Project.

The City believes that FEI's position does not have due regard to the following causes of damage to the Como Lake Avenue curb lanes:

- numerous lateral cuts for relocation of many of the more than 800 lateral utilities and other services that cross the Project route (as described above);
- changes to pavement markings (e.g., lane markings) for traffic management during construction, which includes grinding off portions of the surface layer of asphalt to remove existing markings, applying interim markings across all lanes, and grinding off portions of the surface layer of asphalt to remove the interim markings;
- changes to the in-pavement traffic loops during construction, which includes relocation of the loops to accommodate temporary lane configurations, and then restoration of the loops back to their original locations. Both of these steps involve damage to the pavement.
- excessive wear and tear from FEI's large excavators and other heavy construction equipment operating in all lanes; and
- cuts to access the NPS 20 Pipeline to either remove it or fill it with concrete once it has been decommissioned.

Based on many decades of municipal underground utility construction, replacement and repair experience, the City believes that the Project will leave Como Lake Avenue, a major arterial road and part of the regional Major Road Network, in urgent need of full rehabilitation. The cuts and excavation along and across Como Lake Avenue will damage both the surface asphalt and the road base. The City fully expects that FEI's proposed approach to repairing the damage its Project will cause to all four lanes of Como Lake Avenue would leave the road degraded to such an extent that it will not be adequate to meet the demands on it as outlined in the Como Lake Avenue section, above, including approximately 27,000 cars, trucks and buses travelling along this road per day and its function as part of the regional Major Road Network.

FEI has already begun construction on its LMIPSU Project and the damage to roads in other municipalities has been substantial. Attached at Appendix H is a collection of photos taken on August 1, 2018 and September 13, 2018 respectively, which shows extensive damage to the lands adjacent to the main trench, including excessive wear and tear from FEI's large excavators and/or heavy construction equipment.

Yours very truly,

CITY OF COQUITLAM

Mark Zaborniak, P.Eng.

Encs.

cc. Regulatory Affairs, FortisBC Energy Inc.

Coquitlam

MS2

City of Coquitlam
Transportation Data Management System

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Disclaimer: The traffic counts contained herein are provided as an information service by the City of Coquitlam. These counts are taken at a specific day and time, and are only an approximate representation of traffic activity and not actual daily averages. The City of Coquitlam assumes no responsibility for the use of the traffic count data by any person.

List View | All DIRs

Record 1 of 1 Goto Record go

Location ID	COM-W-THE-01	MPO ID	
Type	SPOT	HPMS ID	
On NHS		On HPMS	
LRS ID		LRS Loc Pt.	
SF Group	-	Route Type	
AF Group		Route	
GF Group		Active	Yes
Class Dist Grp		Category	
Seas Clss Grp			
WIM Group			
Fnct'l Class	Arterial	Milepost	
Located On	Como Lake Ave		
Loc On Alias			
WEST OF	Thermal Dr		

PR	MP	PT
0		

More Detail

STATION DATA

Directions: 2-WAY | EB | WB

ADT — Create 2-Way

Year	ADT	DHV-30	K %	D %	PA	BC	Src
2017	26,630						
2013	26,938						
2008	24,430						
1997	28,835						
1996	21,447						

|<< < > >>| 1-5 of 7

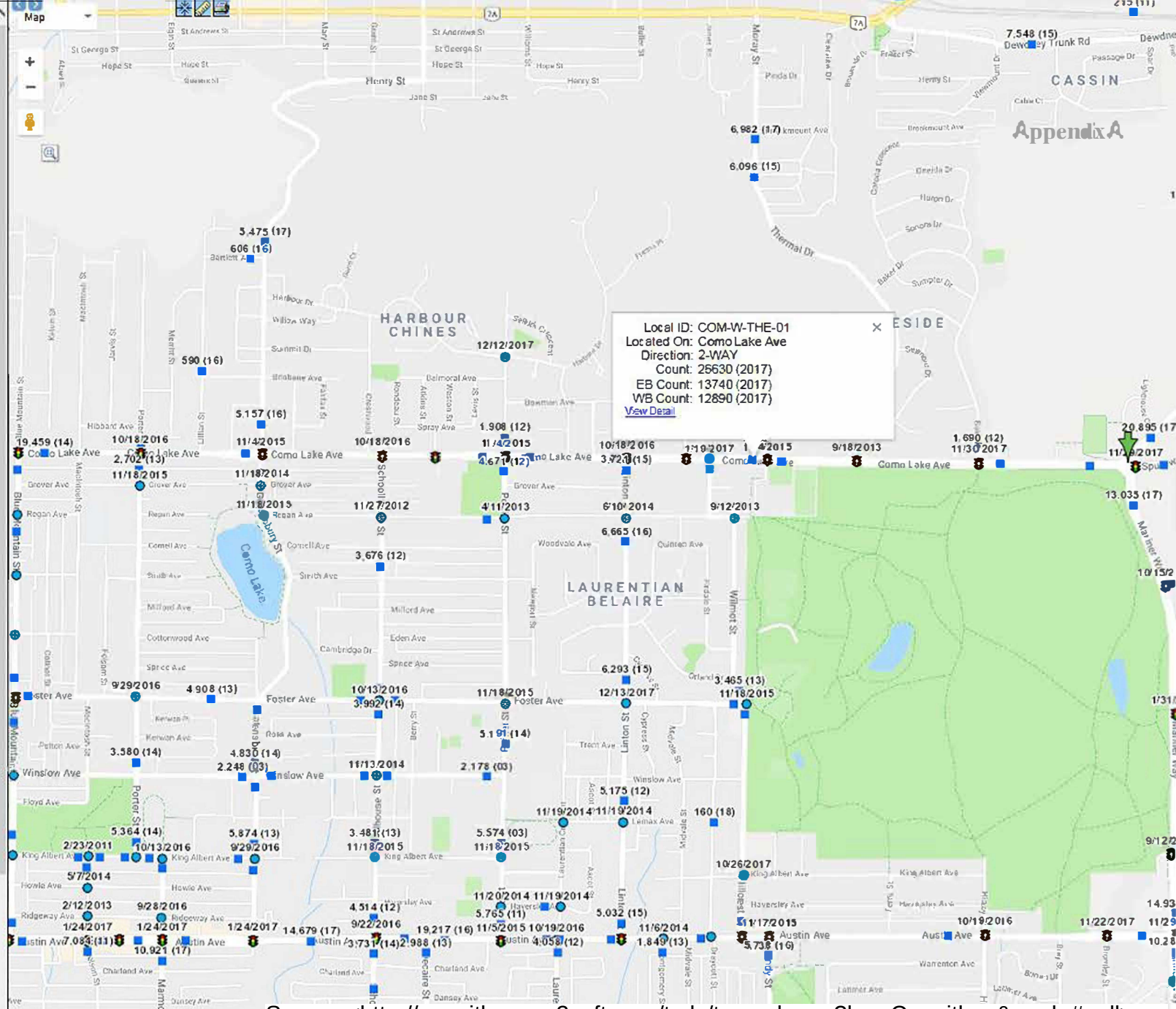
Travel Demand Model

Model Year	Model AADT	AM PHV	AM PPV	MD PHV	MD PPV	PM PHV	PM PPV	NT PHV	NT PPV

VOLUME COUNT

Date	Int	Total
Tue 9/19/2017	60	28,683
Mon 9/18/2017	60	28,964
Sun 9/17/2017	60	20,514
Sat 9/16/2017	60	24,090
Fri 9/15/2017	60	23,566
Thu 9/14/2017	60	29,283
Wed 9/13/2017	60	23,326
Fri 12/6/2013	60	29,273
Thu 12/5/2013	60	23,953
Wed 12/4/2013	60	28,647

|<< < > >>| 1-10 of 19 To Date



Appendix A

Source:<http://coquitlam.ms2soft.com/tcds/tsearch.asp?loc=Coquitlam&mod=#null>

UPDATE: Coquitlam battles Fortis over pipeline plan

City wants pipe gone; road will be tied up for months

Gary McKenna / Tri-City News
AUGUST 1, 2018 09:25 AM

A dispute between the city of Coquitlam and FortisBC over the replacement of a natural gas pipeline running under Como Lake Avenue is heading to the BC Utilities Commission.
Photograph By GOOGLE MAPS

A dispute between the city of Coquitlam and FortisBC over the replacement of a natural gas pipeline running under Como Lake Avenue is heading to the BC Utilities Commission.

The municipality is asking the utility provider to remove the 5.5-km section of the line it will decommission as part of an upgrade next year that will severely reduce traffic flow on the busy arterial route for months.

But FortisBC has told engineering staff it intends to fill the old 20-inch pipe with concrete and leave it in place, which the company says is standard practice.

That's not good enough, according to city manager Peter Steblin, who told a council-in-committee meeting Monday that staff are concerned about the increased congestion of utilities and infrastructure under city roads.

"In our opinion, [FortisBC does] not show enough credence to other users," he said. "They are very focused on their needs and they are not as concerned as we believe they should be… with other utilities and other stakeholders present and in the future."

He later added: "We have been trying to negotiate with the company what we consider are reasonable requirements in terms of how they should deal with that pipeline and we have not been successful."

The city, which is to receive a $300,000 community amenity contribution from the utility company, also wants FortisBC to repave Como Lake Avenue from curb to curb, a requirement the company has indicated it will not meet.

Discussions between FortisBC and the city over the project have been ongoing for more than four years. And because of the impasse, FortisBC recently took the issue to the BC Utilities Commission, where it is seeking approval to move ahead with construction without a permit from Coquitlam.

The company wants to upgrade its service with a 30-inch line that will replace the existing 20-inch pipe that has been in the ground for more than 50 years and is nearing the end of its lifespan. The work is part of a larger project, the Lower Mainland Intermediate Pressure System Upgrade, which has already started along 1st Avenue in Vancouver and will continue into Burnaby later this year. The work in Coquitlam is not expected to get underway until 2019.

FortisBC told The Tri-City News the replacement of the line is necessary in order to ensure the safe delivery of natural gas to 200,000 local residents, 31,000 in Coquitlam.

Doug Stout, the company's vice-president of market development and external relations, said removing the old line would

increase the length of time it will take for construction and add additional cost to the project.

He noted that lines installed in the 1950s have a coating that “has been known to contain low levels of asbestos” and removal would have to be done in accordance with workplace safety regulations. He said the most recent estimate for the pipe’s removal is between $70 million and $100 million.

“Leaving it in place reduces the impact to communities,” he said. “Removing it requires us to dig up twice as much road, adding months of inconvenience to the community. Doing so would also have significant costs.”

He said while the line is underground, FortisBC is still responsible for it and will remove section if it interferes with municipal infrastructure.

As for repaving Como Lake Avenue, Stout said it is customary for utility providers to replace the pavement disturbed during construction rather than the entire street. “The cost of additional repaving would need to be borne by FortisBC customers, which we do not feel is prudent,” he said.

Stout noted the project has received permits and approvals from the city of Vancouver and Burnaby without being required to remove the existing pipeline.

But Jozsef Dioszeghy, Coquitlam’s general manager of engineering and public works, said the Como Lake corridor has unique issues not seen in Vancouver and Burnaby. For one, the thoroughfare is much narrower than 1st Avenue, which has a large boulevard separating the east- and westbound lanes, creating more room for utilities underground.

Work in Coquitlam will also see greater traffic impacts, he said. Vancouver and Burnaby have multiple route alternatives while Como Lake Avenue, which is expected to be reduced to between one and two lanes for the duration of the eight-month project, is one of only a couple of east-west corridors in the southwest neighbourhoods of the municipality.

“They have more alternatives than we do,” Dioszeghy told The Tri-City News following Monday’s council meeting. “[Traffic] is going to spread all over the city and it is going to be chaotic… The problems the city of Vancouver is having will be magnified in Coquitlam.”

Mayor Richard Stewart said the city recognizes the need for the project and supports the infrastructure improvements but said the company needs to take the existing line out of the ground when it installs the new one. “To suggest the taxpayers of Coquitlam ought to subsidize their operations, I find offensive,” he said during Monday’s meeting.

“Take your garbage with you when you leave,” he added later.

The B.C. Utilities Commission will deal with the matter later this summer and is expected to receive feedback and written submissions from the public.

gmckenna@tricitynews.com

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➜ Pipeline Abandonment - A Discussion Paper on Technical and Environmental Issues

Pipeline Abandonment - A Discussion Paper on Technical and Environmental Issues

Prepared for the Pipeline Abandonment Steering Committee (comprised of representatives from the Canadian Association of Petroleum Producers, the Canadian Energy Pipeline Association, the Alberta Energy and Utilities Board, and the National Energy Board)

November 1996

Visit the Alberta Energy Utilities Board (EUB) Web site to view the companion document entitled "Pipeline Abandonment Legal Working Group Report". You can log in as a guest and search for the words "pipeline abandonment".

Disclaimer

This Discussion Paper was prepared under the auspices of the Pipeline Abandonment Steering Committee, a Committee comprised of representatives and employees of the Canadian Association of Petroleum Producers (CAPP), the Canadian Energy Pipeline Association (CEPA), the Alberta Energy and Utilities Board (EUB), and the National Energy Board (NEB). While it is believed that the information contained herein is reliable, CAPP, CEPA, the EUB, and the NEB do not guarantee its accuracy. This paper does not necessarily reflect the views or opinions of CAPP, CEPA, the EUB, or the NEB, or any of the

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Copies of this Discussion Paper are available from any of the following (by hardcopy on request or

through Internet access):

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640 Fifth Avenue S.W.
Calgary, Alberta
T2P 3G4
Telephone: 403-297-8311
Internet: http://www.aer.ca/

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Executive Summary

The Canadian oil and gas industry and federal and provincial regulatory authorities recognize the need to develop guidelines that companies can follow in order to abandon oil and gas pipelines in an environmentally sound, safe, and economical manner. To meet this objective, the Canadian Association of Petroleum Producers and the Canadian Energy Pipeline Association (through their industry participants) have participated along with the National Energy Board and various departments of the Government of Alberta in the development of this discussion paper.

This paper reviews the technical and environmental issues associated with pipeline abandonment and is intended to provide a basis for further discussion on the issue. In order to complete the assessment of this issue, a review of the legal and financial aspects of pipeline abandonment need to be undertaken. More particularly, the core issues of long-term liability and funding need to be addressed both in the context of orphaned pipelines and those with an identifiable owner/operator.

This paper is intended to assist a company in the development of an abandonment plan through the recognition of the general issues which result from the abandonment of a pipeline and by providing the means to address those issues. Land use management, ground subsidence, soil and groundwater contamination, erosion, and the potential to create water conduits are among the topics addressed.

Some follow-up may be required in respect of the technical analysis presented on the issue of ground subsidence. It is suggested that tolerance criteria be developed and that the industry survey referred to in the paper be complemented with a field investigation program. Scale modelling could also be performed to confirm the theoretical ground subsidence calculations.

As illustrated by the diagram on the following page, the pipeline abandonment planning process is a multi-dimensional exercise that requires wide stakeholder input. The abandonment project schedule should also provide an opportunity for meaningful input into the planning process by the affected public, as defined by the scope of the project. It is especially important that landowners and land managers have a central role in this process.

In practice, the decision to abandon in place or through removal should be made on the basis of a comprehensive site-specific assessment. In this context, the analysis presented in this paper has limitations in that all site specifics could not possibly be addressed, particularly in relation to potential environmental impacts or impacts on land use.

The development and implementation of a pipeline abandonment plan that will both minimize impacts to the environment and land use and be cost-effective requires many activities similar in scope to the planning or installation of a new pipeline. For any large-scale abandonment project, it is unlikely that any one abandonment technique will be employed. Rather, a project will usually involve a combination of pipe removal and abandonment-in-place along the length of the pipeline. A key factor influencing the choice between the two options is present and future land use.

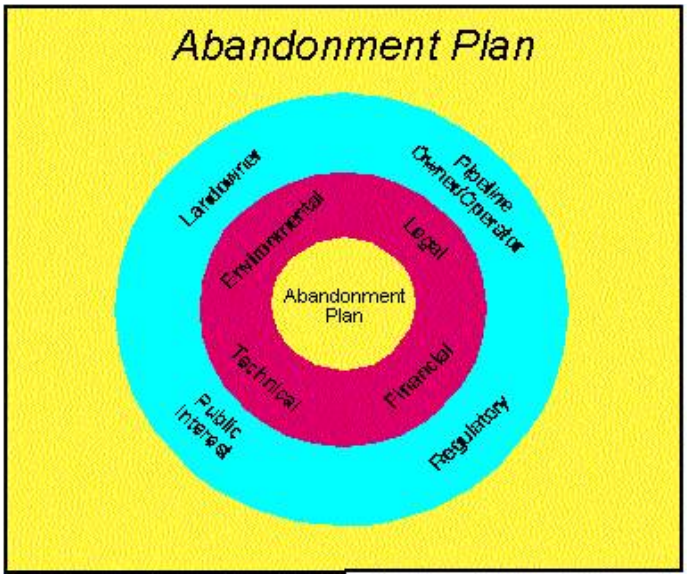
In summary, the key features of a proper abandonment plan are

(i) that it be tailored to the specifics of the project,

(ii) that an early and open opportunity be provided for public and landowner input, and

(iii) that it comply with current regulatory requirements. It is also necessary that the plan be broad in scope and encompass post-abandonment responsibilities in the form of right-of-way monitoring and remediation of problems associated with the abandonment.

A major issue still to be addressed is the question of who would assume responsibility if the owner/operator becomes insolvent. In this regard, industry has established a fund in Alberta to cover the cost of reclamation and abandonment of orphaned oil and gas wells and certain associated pipeline facilities.



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Committee Representative Lists

Steering Committee

Bob Hill (Chair)	Canadian Energy Pipeline Association
Jim Dilay	Alberta Energy and Utilities Board
Ken Sharp	Alberta Energy and Utilities Board
Ian Scott (Secretary)	Canadian Association of Petroleum Producers
John McCarthy	National Energy Board
Fred Webb	Pembina Corporation

Technical Subcommittee

Ron McKay (Chair)	Novagas Clearinghouse Ltd.
Tom Pesta	Alberta Energy and Utilities Board
Ian Scott	Canadian Association of Petroleum Producers
Arnold Bell	Federated Pipe Lines Ltd.
Marsh Yerichuk	Interprovincial Pipe Line Inc.
Robert Power	National Energy Board
Christine van Egmond	National Energy Board
Frank Hagedorn	NOVA Gas Transmission Ltd.
Glen Fyfe	Pembina Corporation
Rudy Wartlik	Westcoast Energy Inc.

Environmental Subcommittee

Karen Etherington (Chair)	NOVA Gas Transmission Ltd.
Keith Lyseng	Alberta Agriculture, Food and Rural Development
Wayne Tedder	Alberta Agriculture, Food and Rural Development
Ivan Weleschuk	Alberta Energy and Utilities Board
Dennis Bratton	Alberta Environmental Protection
Adolf Bruneski	Alberta Environmental Protection
Paul Vasseur	Alberta Agriculture, Food and Rural Development (Farmers Advocate)
Jim Anderson	National Energy Board
Fred Kuipers	Pembina Corporation

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Abbreviations

AEP	Alberta Environmental Protection
C&R	Conservation and Reclamation
CAPP	Canadian Association of Petroleum Producers
CEPA	Canadian Energy Pipeline Association
EPEA	*Environmental Protection and Enhancement Act* (Alberta)
EUB	Alberta Energy and Utilities Board (formerly the Alberta Energy Resources Conservation Board)
H_2S	hydrogensulphide
km	kilometre
mm	millimetre
NEB	National Energy Board
O.D.	outside diameter
PCB	polychlorinated biphenyl
ROW	right-of-way

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Glossary of Terms

Abandonment	Refers to the permanent removal from service of the pipeline. A section of pipeline can be abandoned in place or removed. In theformer case, it is assumed that cathodic protection of the pipeline is discontinued and that no other measures are taken to maintain the structural integrity of the abandoned pipeline (other than the potential use of solid fill material at roadway and railway crossing sites or other locations sensitive to ground subsidence).
Associated Apparatus	All apparatus associated with a pipeline system, both above and below the ground surface, including pipeline risers, valve assemblies, signage, pig traps, culverts, tanks, and sumps.
Cathodic Protection	A technique to prevent the corrosion of a metal surface by making the surface the cathode of an electrochemical cell.
Corrosion	The deterioration of metal as a result of an electrochemical reaction with its environment.
Deactivation	Refers to the temporary removal from service of the pipeline. In the context of this paper, it is assumed that corrosion control measures are maintained.
Decontamination	The removal or neutralization of chemical substances or hazardous material from a facility or site to prevent, minimize, or mitigate any current or future adverse environmental effects.
Decommissioning	One of the steps of pipeline abandonment, generally involving the physical removal of all above-ground appurtenances.

Discontinued	See "deactivation".
Erosion	The process of wearing away the earth's surface through the action of wind and water.
Groundwater	All water under the surface of the ground.
Land Surface Reclamation	The stabilization, contouring, maintenance, conditioning, or reconstruction of the surface of the land to a state that permanently renders the land with a capability that existed just prior to the commencement of abandonment activities, and as close as circumstances permit to that which existed prior to pipeline installation.
Negative Salvage	The net cost of abandoning a pipeline through removal, calculated as the cost of removal less salvage revenue generated from the sale of the removed material for scrap or use by others.
Orphaned	Pipelines and associated facilities for which the licensee and successors are insolvent or non-existent.
Owner /Operator	The individual, partnership, corporation, public agency, or other entity that owns and/or operates the pipeline system.
Pipe Cleaning	The removal of all substances (solid, liquid, or gaseous) and build-ups within the pipeline to a pre-determined level.
Pipeline	All metallic onshore pipelines within the scope of the CSA Z662-94 "Oil and Gas Pipeline Systems" standard, including associated appurtenances such as valve assemblies, drip pots, cathodic protection beds, signage, and headers, but not including station facilities such as pump or compressor stations.
Pipeline System	The combination of pipelines, stations, and other facilities required for the measurement, processing, storage, and transportation of oil, gas, or other hydrocarbon fluid.

Reclamation	Any one of the following: • the removal of equipment or buildings or other structures or appurtenances; • the conducting of investigations to determine the presence of substances; • the decontamination of buildings or other structures or other appurtenances, or land or water; • the stabilization, contouring, maintenance conditioning, or reconstruction of the land surface; or • any other procedure, operation, or requirement specified in the regulations (as defined in the Alberta *Environmental Protection and Enhancement Act*)
Removal	The pipeline is completely removed from the right-of-way.
Roach	Excess soil placed over the ditch line to compensate for soil settlement.
Road or Railway Crossing	The crossing by a pipeline of a highway, road, street, or railway.
Sight Block	A mechanism to restrict the visual impact of a pipeline right-of-way.
Soil	The naturally occurring, unconsolidated mineral or organic material at least 10 centimetres thick that occurs at the earth's surface and is capable of supporting plants. It includes disturbance of the surface by human activities such as cultivation and logging but not displaced materials such as mine spoils.
Spoil	Soil materials other than topsoil excavated from the trench. In most cases, the excavated soil is suitable for return to the pipeline trench, and allows for re-contouring of the right-of-way.
Subsoil	Although a common term it cannot be defined accurately. It may be the B horizon of a soil with a distinct profile. It can also be defined as the zone below the plowed soil in which roots normally grow.
Surface Water	Water in a watercourse and water at a depth of not more than 15 metres beneath the surface of the ground.
Suspension	The cessation of normal operation of a pipeline pursuant to its licensed use. The pipeline need not be rendered permanently incapable of its licensed use, but must be left in a safe and stable state during this period of suspension, as prescribed by the applicable regulations and guidelines. See also "deactivation".

Topsoil	The organo-mineral suface "A", organic surface "O" horizon, or dark coloured surface soil materials, used synonymously with first lift. First lift materials are usually removed to the depth of the first easily identified colour change, or to specified depth where colour change is poor, and contain the soil Ah, Ap, O, or Ahe horizon. Other horizons may be included in the first lift if necessary.
Water	All water on or under the surface of the ground.
Water Conduit	A channel for conveying water. In the context of pipeline abandonment, refers to a pipeline that has become corroded and perforated and transports ground or surface water to a different location.
Watercourse	(i) The bed and shore of a river, stream, lake, creek, lagoon, swamp, marsh, or other natural body of water; or (ii) a canal, ditch, reservoir, or other man-made surface feature, whether it contains or conveys water continuously or intermittently.

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Section 1 - Introduction

1.1 Background

Approximately 540,000 km of operating oil and gas pipelines currently exist in Canada, about 50 percent of which are located in Alberta. Ultimately, all oil and gas pipelines will reach the end of their useful lives, and will be abandoned. The issue of pipeline abandonment should therefore be reviewed by all stakeholders.

The Alberta Energy and Utilities Board (EUB) estimates that about 17,000 km of pipeline were abandoned or discontinued in Alberta as of April 1994. This number includes an estimated 3 600 km of orphaned abandoned pipelines. The majority of abandoned pipelines in Alberta are gathering lines 168.3 mm or less in outside diameter.

Regulatory requirements for pipeline abandonment vary across jurisdictions in Canada, and in many cases do not completely address associated long-term issues.

1.2 Review Initiatives

In 1984, several parties at a National Energy Board (NEB) hearing into the tolls of a major natural gas transmission pipeline company showed an interest in addressing the issue of negative salvage as it related to pipeline abandonment. As a result, the NEB issued a background paper in September 1985 addressing the negative salvage impacts of pipeline abandonment. The issue was not pursued again until 1990, when industry, the Alberta Energy Resources Conservation Board (now the EUB), and Alberta Environmental Protection (AEP) discussed the issue of pipeline abandonment while considering amendments to the pipeline regulations issued pursuant to the *Pipeline Act* (Revised

Statutes of Alberta 1980). The issue was not resolved at that time, and was again raised in 1993 by the Alberta Pipeline Environmental Steering Committee, an industry, government, and public stakeholder group established to address pipeline related issues.

In October 1993, the Canadian Association of Petroleum Producers (CAPP) received the endorsement of the Alberta Petroleum Industry Government Environment Committee to establish a steering committee to oversee the issue of pipeline abandonment. Shortly thereafter, the EUB requested that CAPP and the Canadian Energy Pipeline Association (CEPA) organize a steering committee to resolve the concerns surrounding abandonment.

In April 1994, representatives from CAPP, CEPA, the EUB, and the NEB met to establish a pipeline abandonment steering committee. It was also decided at that time that separate subcommittees be struck to address the technical, environmental, legal, and financial aspects of pipeline abandonment. The technical and environmental subcommittees were the first to be formed and, together with the steering committee, were responsible for this discussion paper. The legal and financial subcommittees have not yet been struck.

1.3 Scope

This discussion paper is intended to apply to all buried metallic pipeline facilities falling within the scope of the CSA Z662-94 "Oil and Gas Pipeline Systems" standard, except for offshore pipelines. Many of the same issues and concepts (such as those relating to land use and pipe cleanliness) also apply to plastic and fibreglass pipelines. It addresses pipeline abandonment only (i.e. permanent removal from service), and does not consider pipeline deactivation (i.e. temporary removal from service). Likewise, this document does not address the abandonment of aboveground facilities associated with pipelines, such as stations or tank farms, or specific facilities such as underground vaults.

This paper addresses the technical and environmental aspects of pipeline abandonment. In order to complete the assessment, a review of the legal and financial aspects of pipeline abandonment needs to be undertaken. More particularly, the core issues of long-term liability and funding need to be addressed both in the context of orphaned pipelines and those with an identifiable owner/operator.

1.4 Abandonment Options

The two basic options that are considered in this paper are (i) abandonment-in-place and (ii) pipeline removal. In the former case, it is assumed for the purposes of this paper that cathodic protection of the pipeline is discontinued and that no other measures are taken to maintain the structural integrity of the abandoned pipeline (other than the potential use of solid fill material at roadway and railway crossing sites or other locations highly sensitive to ground subsidence).

As noted in Section 2, for any large-scale abandonment project it is unlikely that only one of these options will be employed. Rather, a project will usually involve a combination of pipe removal and abandonment-in-place along the length of the pipeline. A key factor influencing the choice between the two options is present and future land use.

It is further noted that the abandonment techniques presented are confined to those possible using currently available technology. While developments in pipeline removal and abandonment technologies were evaluated, no major improvements to the methods currently in use were discovered. However, as pipeline abandonments become more prevalent, improved abandonment methods will likely be developed.

1.5 Objective

The objective of this discussion paper is to assist the user in the development of a pipeline abandonment plan, a framework for which is provided in Section 2 of this paper. More particularly, the paper is meant to assist parties in making an informed decision between abandoning in place or through removal. Section 3 outlines the general technical and environmental issues that should be considered when abandoning a pipeline, while Section 4 elaborates on post-abandonment responsibilities. Site-specific issues should be addressed on a case-by-case basis.

The objective of creating an abandonment plan is to ensure that identified issues have been addressed and that the pipeline is abandoned in a way that provides a forum for meaningful stakeholder input and ensures that public safety and environmental stability are maintained.

1.6 Regulatory Requirements

The NEB is responsible for regulating interprovincial and international pipeline systems in Canada, while the individual provinces are responsible for regulating intraprovincial pipeline systems. Within each province, gathering, transmission, and distribution pipelines may be regulated by different agencies. For example, in Alberta the EUB regulates gathering and transmission lines as well as higher-pressure distribution lines (greater than 700 kPa), while lower-pressure distribution lines are regulated by Alberta Transportation and Utilities. AEP, through the *Environmental Protection and Enhancement Act* (EPEA), regulates conservation and reclamation activities for all three categories of pipelines.

In addition to the primary regulators, there may be other governmental agencies within each of the respective jurisdictions that may have an interest in the abandonment and reclamation of a pipeline. These other agencies may include local governments, especially in populated areas where pipeline abandonment may impact upon land uses.

In Alberta, the EUB sets the requirements for the abandonment of gathering and transmission lines. In addition to meeting the EUB's abandonment requirements, the pipeline right-of-way must be reclaimed to AEP standards. Reclamation certificates are issued by inspectors designated under EPEA. For removal projects that are classified as Class I projects,[1] the operator is required to obtain an approval under EPEA from AEP to ensure that proper conservation and reclamation occurs. For smaller projects, AEP's *Environmental Protection Guidelines for Pipelines* are to be followed during construction.

[1] A Class I pipeline is defined by the Activities Designation Regulation (AR 110/93) under EPEA as any pipeline that has an index of 2690 or greater, determined by mutiplying the diameter of the pipeline in millimetres by the length of the pipeline in kilometres (e.g. 168.3 mm x 16 km = 2693).

For federally regulated pipelines, approval to abandon a pipeline must be granted by the NEB and pipelines must be abandoned in accordance with the requirements of the NEB's *Onshore Pipeline Regulations*. These regulations are in the process of being revised, and future regulations will likely require that applications for pipeline abandonment be treated on a case-by-case basis.

A summary of the current regulatory requirements for pipeline abandonment across Canada has been included as Appendix A.

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Section 2 - Developing an Abandonment Plan

This paper addresses the common issues that pipeline abandonment plans should address regardless of regulatory jurisdiction. It is intended to assist a company in the development of an abandonment plan through the recognition of the general issues which result from the abandonment of a pipeline and by providing the means to address those issues.

In practice, the decision to abandon in place or through removal should be made on the basis of a comprehensive site-specific assessment. In this context, the analysis presented in this paper has limitations in that all site specifics could not possibly be addressed, particularly in relation to potential environmental impacts or impacts on present and future land use.

The development and implementation of a pipeline abandonment plan that will minimize impacts to the environment and land use and be cost-effective requires many activities similar in scope to the planning or installation of a new pipeline. For any large-scale abandonment project, it is unlikely that any one abandonment technique will be employed. Once the principal technique has been chosen, therefore, the owner/operator should assess on a site-specific basis whether an alternate approach should be followed for selected segments of line.

The abandonment project schedule should provide an opportunity for meaningful input into the planning process by the affected public, as defined by the scope of the project. It is especially important that landowners and land managers have a central role in this process.

The development of an abandonment plan should be initiated by reviewing the general requirements of the regulatory jurisdiction(s) under which the pipeline is operated. Beyond the requirements of the principal regulatory agencies, other legislation may affect the particular abandonment project. For example, municipal requirements and federal legislation such as the federal *Navigable Waters Protection Act* or the *Fisheries Act* may affect the abandonment options.

It is also critical that easement agreements be reviewed, as their terms and conditions may bear on the abandonment decision-making process.

The development and implementation of an abandonment plan consists of at least the following seven steps:

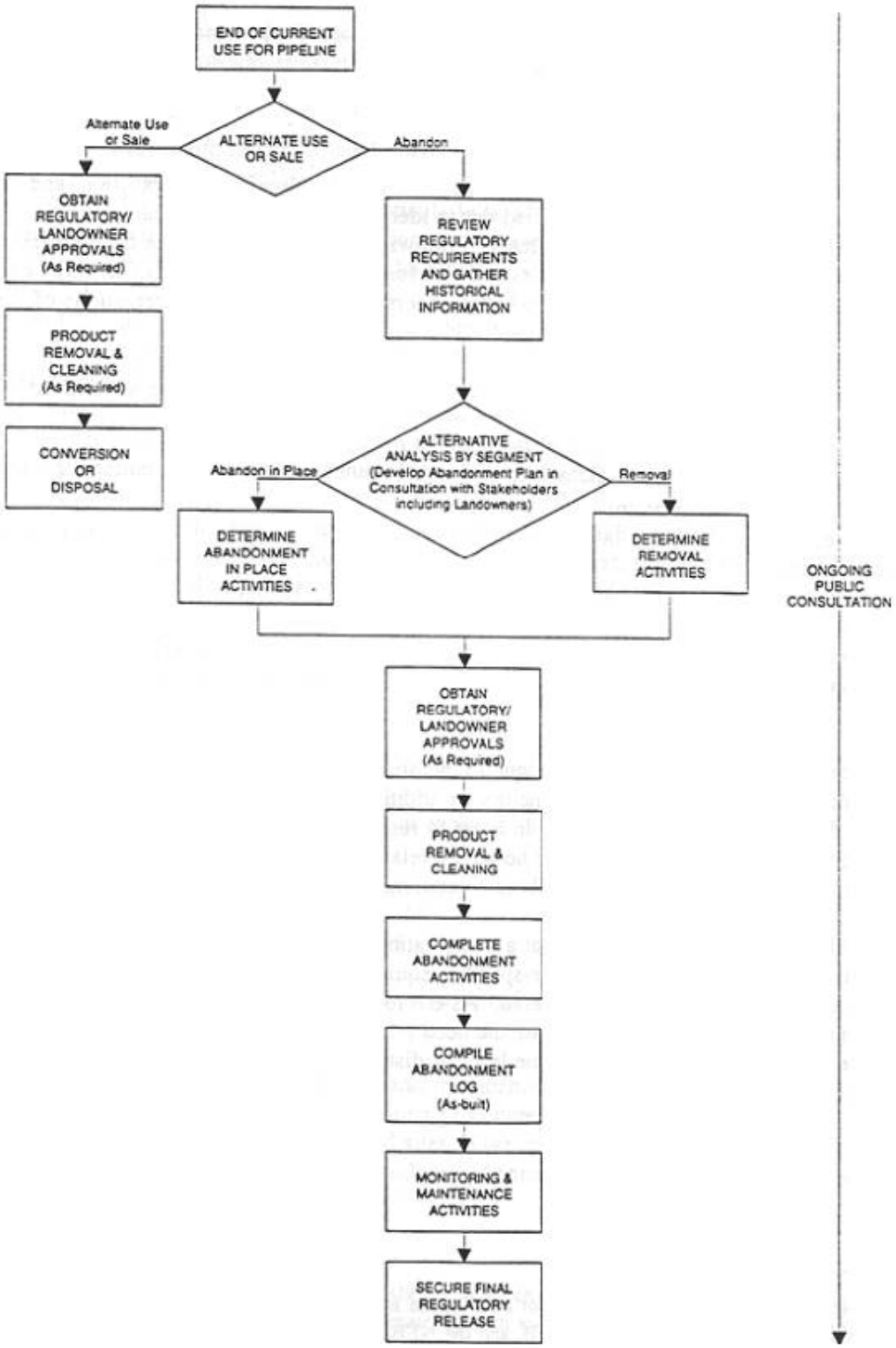
1. review prevailing regulatory requirements applicable to the abandonment project;
2. compile all relevant information on the pipeline system, including easement agreements;
3. analyze by segment taking into account the factors addressed in Section 3 of this paper, including present and future land use;

4. develop the abandonment plan in consultation with stakeholders (such as landowners, government authorities, and other directly affected parties), incorporating the information compiled in the above steps;
5. secure regulatory and landowner approvals as required for the pipeline abandonment and site reclamation;
6. implement the abandonment plan, the scope of which should include post-abandonment responsibilities (addressed in Section 4); and
7. secure final regulatory release.

A proponent undertaking an abandonment plan should follow these six steps, recognizing that site-specific conditions may require additional steps in the development of the plan.

Please refer to the next page for a flowchart of the abandonment planning process and to Appendix B for a detailed abandonment checklist.

Figure 2-1
Diagramme illustrant la cessation d'exploitation d'un pipeline



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Section 3 - Technical and Environmental Issues

3.1 Issue Identification

Abandonment issues arise from the need to address public safety, environmental protection, and future land use. An initial scoping exercise was carried out to identify the various technical and environmental issues associated with abandonment. Following the development of a detailed issues list, field studies of existing abandoned facilities were performed to verify the issues. In some cases, detailed studies were commissioned in order to better understand the effects and interactions of certain issues.[2]

[2] (Refer to the Bibliography in Appendix E for a list of the studies, copies of which are available for public viewing in the libraries of CAPP, CEPA, the EUB, and the NEB.)

The primary issues that were identified, and which are addressed in this section, are as follows:

- land use management;
- ground subsidence;
- soil and groundwater contamination;
- pipe cleanliness;
- water crossings;
- erosion;
- utility and pipeline crossings;
- creation of water conduits;
- associated apparatus; and
- cost of abandonment.

It was determined that most issues are not unique to the abandonment phase of the pipeline life-cycle, but could involve an altered scope, varied timeline, or additional stakeholders when compared to the issues of pipeline installation and operation. In order to responsibly abandon a pipeline, the operator must consider all of the issues and determine how they relate to the specific pipeline under consideration, in addition to addressing stakeholder concerns and incorporating collected input.

In any abandonment project, it is possible that a combination of both the abandonment-in-place and removal options would be used, based on site-specific requirements. Thus, it is important that all aspects of the abandonment issues be considered. As the following discussion illustrates, the abandonmen-in-place option does not eliminate the need for land disturbance or field activity, while pipeline removal need not encompass the same level of disturbance or activity as that of pipeline construction.

3.2 Land Use Management

Land use is the most important factor to consider in determining whether a pipeline section should be abandoned in place or removed. Therefore, an understanding of the current and potential land uses along the pipeline right-of-way is essential to making informed decisions on available abandonment options.

Of particular concern with respect to land use management are areas sensitive to land disturbance, such as native prairie, parks and ecological reserves, unstable or highly erodible slopes, areas susceptible to severe wind erosion, and irrigated land, particularly flood irrigation systems.

Additionally, land improvement activities such as the installation of drainage tile or other drainage systems, landscaping, and permanent structure installations could be affected by a proponent's decision to abandon a line.

Future land use should be considered because a pipeline abandoned in place could become a physical obstruction to development, such as excavation for foundations, pilings, or ongoing management practices such as deep ploughing or the installation of sub-drains. It is critical that input be gathered from appropriate sources such as landowners, land managers, lessees, and municipal agencies to support the decision to abandon in place. In addition, sufficient documentation must be kept to allow for detailed location information for future developers or owners.

As noted in Section 2, the decision to abandon in place or through removal should be made on the basis of a comprehensive site-specific assessment. In this context, the land management characteristics that may be better suited to pipeline abandonment-in-place include, but are not limited to:

- parks and natural areas;
- unstable or highly erodible surfaces;
- water crossings;
- flood irrigated fields;
- road and railway crossings;[3]
- foreign pipeline crossings;
- extra depth burial of pipe (i.e. depth well in excess of one metre);
- native prairie and native parkland;
- forest cut blocks;
- designated waterfowl and wildlife habitat; and
- areas exhibiting poor and/or limited access.

[3] (as detailed in Section 3.8, consideration should be given to filling pipeline sections abandoned in place underneath roadways and railways with a solid material such as concrete in light of potential ground subsidence impacts.)

The key environmental protection measures to be considered when a pipeline is to be abandoned in place are as follows:

- minimal disruption to ongoing or future land management activities;
- a complete and documented pipeline cleaning procedure;
- the clean-up of any spills or contaminated sites to prevailing regulatory requirements;
- a revegetation strategy to achieve pre-abandonment conditions, keeping erosion control and soil stability as a priority;
- topsoil conservation for all areas disturbed during the abandonment process;
- reclamation of all site access roads, including those which had been developed for the operational phase of the pipeline and any opened or developed for abandonment activity;
- documented as-built information for future reference;
- application of sight blocks where appropriate (e.g. recreational areas and wildlife habitat); and
- a monitoring program acceptable to all affected parties to ensure a process to complete remediation.

Proper environmental protection measures should be implemented, including appropriate soil handling procedures, timber management, contingency plans (e.g. for spills and wind or water erosion), protection of cultural features, weed control, and site reclamation. For example, in Alberta, a Conservation and Reclamation (C&R) report may be required by AEP for pipelines which were constructed before the C&R regulations came into effect.

Prior to the commencement of field activity, reclamation criteria should be agreed upon by the owner/operator, regulatory authority, and landowner. The reclamation program will normally be designed to ensure that the condition of the right-of-way land surface is made at least equivalent to that existing just prior to the commencement of abandonment activities, and as close as circumstances permit to the condition of the land that existed prior to pipeline installation, and may entail:

- removing, storing, and replacing topsoil;
- soil contamination analysis and-clean up, if required;
- contouring disturbed land to control drainage;
- seeding affected areas to prevent erosion and establish vegetation;
- removal of all structures to a minimum depth of one metre below final contour elevation;[4]
- roaching and/or compacting excavated areas to compensate for future settlement; and
- site-specific environmental requirements (e.g. reforestation).

[4] (In areas where circumstances such as special farming practices or nearby urban development exist, consideration should be given to removing structures more than one metre below the final contour elevation.)

As noted in Section 4, a right-of-way monitoring plan should be developed to ensure that reclamation efforts are successful and that no problems arise.

3.3 Ground Subsidence

3.3.1 General

The long term structural deterioration of a pipeline abandoned in place may lead to some measure of ground subsidence. This is a primary issue to consider for larger-diameter pipelines because of potential environmental and safety concerns. More particularly, ground subsidence could create the potential for water channelling and subsequent erosion, lead to topsoil loss, impact on land use and land aesthetics, and/or pose a safety hazard.

The acceptable subsidence limits and the potential factors affecting those limits are significant areas requiring attention in the development of any abandonment plan. Erosion may cause direct siltation to a watercourse, or cause slope failures and subsequent siltation. Where potential siltation is an issue, proponents must be prepared to deal with fisheries protection measures to remain in compliance with provincial and federal legislation.

The rate and amount of ground subsidence over time is difficult to predict as it depends on a complex combination of site-specific factors, such as the corrosion mechanics in the vicinity of the pipeline, the thickness and diameter of the pipeline, the quality of the pipeline's coating, burial depth, soil type, the failure mechanics of the pipeline material, and soil failure mechanics.

Given the absence of previously documented research, studies were commissioned on corrosion and soil mechanics in an attempt to establish the connection between pipeline corrosion, the structural deterioration of pipe, and the resultant ground subsidence that might be observed. Summaries of these studies and the conclusions that were reached follow.

3.3.2 Pipeline Corrosion

The corrosion consultant's report addressed the mechanism of corrosion leading to ultimate structural failure of a pipeline. The report stated that the rate of corrosion of an abandoned pipeline can vary significantly due to the many factors which must be present for corrosion to take place. Corrosion of buried pipelines occurs through an electrochemical reaction that involves the loss of metal in one location (called the anode) through the transfer of the metal ions to another location on the pipeline (called the cathode). The rate of metal transfer depends on a number of factors such as the quality of the pipeline coating, soil aeration (which supplies oxygen to the pipe to allow the corrosion process to occur), types and homogeneity of soils, soil moisture, and electrical factors which create the potential differences for a corrosion cell to be established.

The corrosion of a coated pipeline is normally restricted to those isolated areas where there are defects in the coating or where the coating has become disbonded from the pipe. Corrosion can be expected to be almost negligible in areas where the coating integrity is intact. Based on his experience, the consultant observed that coating holidays or disbondment occur on less than one percent of the length of most pipelines. Pipeline corrosion in most cases occurs as localized pits, or spiral corrosion areas, which eventually result in random perforations throughout the length of the pipeline. It is extremely rare for corrosion to cover large areas of pipeline, rendering a long segment of the pipeline susceptible to sudden and complete structural failure.

To illustrate typical corrosion rates, the consultant used an example of a 323.9 mm O.D. pipeline in soils commonly found throughout Alberta and estimated that penetrating pits would occur in the range of 13 to 123 years. Based upon the slow rate of pitting corrosion that would occur in most cases, complete structural failure is not likely to occur for decades or even centuries. Furthermore, given the non-uniform nature of the corrosion process, it can be concluded that it is highly unlikely that significant lengths of the pipeline would collapse at any one time.

3.3.3 Soil Mechanics

The soil mechanics report indicated that there has been no documented incidence of ground subsidence due to pipeline structural failure. In order to predict soil reaction to pipeline structural failure, the consultant modelled its review on shallow mining and tunnelling research and documented case histories. The focus of the study was to estimate possible surface subsidence that could be attributed to the complete failure of tunnels of equal diameter and depth as the pipelines being modelled. This represented a worst-case scenario, since as noted earlier a complete pipeline collapse of any significant length is considered highly improbable.

The report employed two different theoretical soil modelling techniques, the Rectangular Soil Block and the Active Soil Wedge, to reflect the most common types of soils that may be encountered. The ranges of subsidence calculated for varying sizes of pipelines provided an approximation of the impacts that a significant pipeline collapse would have on soils. The analysis indicated that ground

subsidence associated with the collapse of pipelines up to 323.9 mm in diameter at typical burial depths would be negligible. The analysis further indicated that while there would be some degree of subsidence associated with larger pipeline sizes, it may be of sufficiently small scale so as to be in a tolerable range.

3.3.4 Field Investigation Program

In order to validate the conclusions of the technical reports, the subcommittees undertook to document the ground subsidence of known abandoned pipelines.

As a first step, the subcommittees searched the EUB's records and identified pipelines 168.3 mm or larger in diameter that had been abandoned in place. Questionnaires were forwarded to the owners/operators of some of those lines, requesting information on pipeline diameter, coating type, year abandoned, whether cathodic protection had been removed, and ground subsidence observations (reference Appendix C for copy of questionnaire). The responses to the survey, as well as industry discussions, did not reveal any instances of observed subsidence.[5]

[5] (As indicated in Appendix C, all of the survey results gathered by the subcommittees are available for public viewing in the libraries of CAPP, CEPA, the EUB, and the NEB.)

3.3.5 Summary of Findings

The analyses indicated that the structural failure of an abandoned pipeline due to corrosion may take many decades, and that significant lengths of the pipeline would not collapse at any one time due to the localized nature of the pitting process. Furthermore, the analyses indicated that, even if the worst-case scenario of uniform and total structural collapse was realized, ground subsidence would be negligible for pipelines up to 323.9 mm in diameter.

The degree of subsidence associated with larger-diameter pipelines is highly dependent on pipeline diameter, depth of cover, and local soil conditions, but can be expected in many cases to be in a tolerable range. It should be noted that tolerance to soil subsidence is in itself a site-specific issue, as it depends on land use and the local environmental setting. Any pipeline owner/operator considering the abandonment-in-place of a larger-diameter pipeline should therefore conduct a site-specific analysis in order to evaluate both the degree and tolerability of any long-term subsidence that might be expected. Such analyses should take into account the potential for heavy vehicular loadings (e.g. farm equipment or logging trucks).

On the basis of the foregoing, it is suggested that ground subsidence associated with the structural failure of pipelines abandoned in place will not usually be a critical issue. This conclusion was corroborated by the industry survey referred to in Section 3.3.4. In areas where no settlement is allowed, either by regulation or agreement (such as at highway crossing sites, as further explained in Section 3.8), the option would exist to fill the pipeline with an approved solid material such as concrete or sand.

In terms of follow-up on this issue, it is suggested that tolerance criteria be developed and that the industry survey referred to in this paper be complemented with a field observation program. Scale modelling could also be performed to confirm the theoretical ground subsidence calculations.

3.3.6 Subsidence as a Result of Pipeline Removal

The physical act of removing a pipeline is essentially the reverse operation of pipeline construction and involves topsoil removal, backhoe excavation of the subsoil to a depth at least even with the top of the pipe, pipe removal, backfilling and compaction of the trench, replacement of the topsoil, and revegetation measures.

During pipeline construction, a roach consisting of subsoil overlaid with topsoil is usually employed to compensate for the settlement that will occur as the ditch line settles. The same strategy can be employed at the abandonment stage to avoid the need for reclamation in future years due to settlement and erosion. In general, if extra topsoil or soil materials are required for this operation, it could be recovered from areas immediately adjacent to the pipeline right-of-way. For older pipelines built before mandatory soil conservation, this is where extra topsoil or soil materials may have been disposed. Further surveys or examinations of topsoil depths and soil volumes may be required to identify these potential borrow areas.

Without the concern of compaction damaging the pipeline, a company may undertake a more rigorous compaction of the soil being replaced in the ditch following pipe removal than after backfilling for new construction. Additional compaction may also result in less topsoil handling and, therefore, fewer impacts due to the decreased need to strip topsoil to accommodate the feathering out of subsoil material caused by the excavation.

3.4 Soil and Groundwater Contamination

The abandonment plan should address the potential for contamination associated with the abandonment activities, as well as the need to eliminate any contamination that may already exist, and include the appropriate pipe cleaning or pigging procedure. Any contamination noted prior to abandonment activity should be cleaned up to the applicable regulatory standards prior to full project disturbance, unless it is more economically efficient to include the cleanup in the scope of abandonment activity and it can be demonstrated that environmental damage will not be amplified.

In order to gain additional insight into the issue of contamination, a study was commissioned into the types and quantities of contaminants that might be released from pipelines abandoned in place.

The potential sources of contamination were identified as:

- the substances produced from the reservoir in the hydrocarbon stream and deposited on the walls of the pipeline;
- treatment chemicals which could enter the pipeline and be deposited;
- the line pipe and associated facilities;
- pipeline coatings and their degradation products;
- historical leaks and spills of product that were not cleaned to current standards; and
- possible PCB contamination, if PCBs were used in the pump or compressor lubricants at some point in the history of the pipeline.

The quantity of residual contaminants can be expected to decrease as the product moves from the wellhead through the gathering, processing, and distribution systems. Traditionally, oil pipelines contain a greater volume of wax and scale than do natural gas pipelines, but this is dependent on the

circumstances of the particular production field. The study concluded that the effectiveness of pipeline pigging and cleaning procedures prior to abandonment was the most critical determinant of the potential quantities of residual contaminants.

The subject of pipeline cleaning is addressed at length in Section 3.5 and Appendix D. An operator should become familiar with prevailing regulatory standards for soil and groundwater, as these standards may dictate the minimum acceptable level of pipe cleanliness. Sound environmental protection practices should be observed throughout the pipeline cleaning process, such as the use of properly engineered containment and storage for all collected material, proper labelling, disposal processes conforming to local regulations, and effective spill contingency plans. Detailed documentation should be recorded on the results of the cleaning process or the clean-up of a contaminated site.

Operators should also have an understanding of the composition of pipe coatings and their associated characteristics to assess any potential risk that may be derived from abandoning the pipeline in place. For example, pipeline coatings containing asbestos should be handled through special means by trained personnel. It has been suggested that if pipe coating compounds would be accepted at local landfills, then abandoning a pipeline with the same compounds in place may not be a concern, depending on site conditions and concentration levels. Presently, limited information exists regarding the long-term decomposition of pipeline coatings. However, it can be assumed that as the coating adhesive degrades, or is consumed by soil organisms, coatings will eventually disbond and contribute to the corrosion process.

Many of the same contamination prevention measures to be employed for abandonment-in-place also come into play in the context of pipeline removal. Of prime importance is the need to clean the pipeline to accepted standards prior to the commencement of the removal operation, and the employment of measures to prevent spills of the substances collected as a result of the cleaning process. Collection trays should be used during the pipe cutting operation to catch any residual fluids.

During pipe removal, proper soil handling measures must be implemented to ensure topsoil conservation.

In addition to the pipeline itself, the dismantlement of any connected facilities should be carried out such that the potential for contamination is controlled by proper containment and storage for disposal at an approved facility.

3.5 Pipe Cleanliness

3.5.1 Cleanliness Criteria

In light of potential contamination concerns, the cleanliness of the pipeline is an issue for both abandonment techniques. Although responsible cleaning procedures have been defined and are discussed in detail in Section 3.5.2 and Appendix D, the question of "how clean is clean" has not been resolved. In addition, the question remains as to whether pipe that will be removed should be subject to the same cleanliness criteria as pipe that will be left in place. It should be assumed that pipe that is to be removed should be cleaned to a level where any remaining residues will not cause harm in any future intended use of the pipe. Removed pipe that may eventually be put to some alternative use

(e.g. pilings) may require more study to determine the appropriate cleanliness requirements for the future use. For pipe that is targeted for disposal, existing disposal or landfilling guidelines will determine the required cleanliness of the pipe.

For pipe that will be abandoned in place, the issue of pipe cleanliness is related to corrosion and the creation of water conduits. Eventually the pipe will corrode until perforated and, aided by the destructive forces of the freeze-thawing of infiltrated water, the structural integrity of the pipe will suffer. Whether the rate of deterioration will be greater than the life of the contaminants left as internal residue of the pipe is unclear. Similarly, an issue remains over the rate and structural location of any corrosion, in that it may allow water to infiltrate the abandoned pipe and transport pipe residues to some other exit point.

3.5.2 Cleaning Procedures

The pigging procedure used during the final operating stages and during evacuation of the pipeline is critical in preparing the line for abandonment. The study on contaminants concluded that the small quantities of hydrocarbons left in the line after a concerted pig cleaning effort will not result in any significant environmental concerns.

The factors impacting the effectiveness of any pig cleaning procedure will vary with each pipeline. Cleaning programs must therefore be customized to the specific circumstances of the pipeline under consideration for abandonment. For guidance purposes, Appendix D sets out general cleaning considerations and describes typical cleaning methods for an oil pipeline in a medium duty service [6] or for a pipeline carrying relatively dry natural gas. Operators planning a pigging program for a specific line should consider these guidelines as a starting point only. The abandonment of pipelines carrying products other than the two noted above require customized pigging procedures to ensure proper cleaning. Care should be taken in all cases to properly contain and dispose of pigged effluent.

[6] Medium duty service refers to relatively wax and direct free operation with a scraping program undertaken occassionally to move along anything collected or adhering to the pipe wall.

A pipeline to be abandoned in place should be left such that no solids or waxy build-up are visible at any point along the pipeline as observed through standard pipe openings such as opened flange or sample connections and the contents have been cleaned out to the extent that no more than a thin oily film on the inside pipe wall surface can be detected by feel or sight. Sour liquid or natural gas pipelines should be checked to confirm that H2S levels are below acceptable limits.

Pipe cleaning is also of critical importance in the context of pipeline removal, given the desire to minimize the risk of soil and groundwater contamination during the removal process and the hazards associated with pipe removal (e.g. health and flammability hazards of exposed vapours). Cleanliness considerations relating to the future intended use or disposal of the pipe should also be taken into account, bearing in mind that supplementary cleaning techniques may be employed once the pipe has been removed from the ground.

Cleaning effectiveness can be determined by taking pipe coupons and swabs of any film found on the inside of the pipe and analyzing them for contamination, using cutout means such as hot tapping or line cutouts.

After allowing some time for the collection of remaining liquids in low areas (minimum one week suggested), the pipeline should be excavated at random low areas. A minimum of one excavation site per scraper trap or 80 km interval is suggested. However, in undulating areas multiple excavation sites may be required. Excavation sites should be chosen to avoid environmentally sensitive areas and to minimize clearing associated with the opening of access roads. If the examination of the inside wall shows that the cleanliness criteria has been met, the cleaning task can be considered complete.

3.6 Water Crossings

The effect of pipelines on water crossings is an important issue at any stage of a pipeline project. This issue is a significant social consideration due to the visibility of crossing activities, the importance of fisheries resources, public use of waterways, the sensitivity of the resource, and the fact that waterways are an important cultural and historical feature of the land.

There are many factors to consider in deciding whether a section of pipeline crossing a water body or wetland (e.g. muskeg, swamp, or flood plains) should be abandoned in place or removed. More specifically, the risks associated with abandoning the pipeline in place, including the potential for contamination and pipe exposure, have to be weighed against the cost and environmental impact of removal.

These trade-offs should be assessed on a site-specific basis, taking into account the size and dynamics of the water body, the design of the pipeline crossing, soil characteristics, slope stability, and environmental sensitivities. While these issues must be evaluated, in most cases it can be expected that abandonment-in-place will be the preferred option.

If the pipeline crossing is to be abandoned in place, the pipe should be left in as clean a state as possible to minimize the potential for contamination of the waterbody should the eventual perforation and failure of the pipe allow any internal residues to escape. As described in Section 3.9, the strategic placement of caps and plugs will also help mitigate this concern by interrupting the movement of potential contaminants through the abandoned pipe.

The risk of pipe exposure is two-fold. First, the pipeline could become exposed if the overlying soil is gradually eroded or washed away because of the dynamics of the water body (e.g. stream bank migration, scour, or flood conditions). Secondly, an empty pipeline crossing a water body or wet area could float toward the surface if buoyancy control mechanisms fail (e.g. if concrete saddle weights slide off). In either case, the owner/operator should assess the probability that the pipeline could become exposed and the impacts that exposure would entail. If the risk of flotation is a concern, it could be addressed by either perforating the line following an appropriately sensitive line cleaning program to allow it to fill with water or by filling the line with concrete or some other solid material. In the case of the former option, plugs and caps should be used to prevent water migration through the pipeline.

If applicable, the risks associated with abandoning a pipeline in place which runs parallel to an operating pipeline at a water crossing should also be assessed.

If the pipeline is to be removed in whole or in part, the issues would be similar in many ways to those associated with initial construction across the water body or wetland. More specifically, many of the same construction techniques and environmental protection measures would apply. Aspects to address include fisheries resource timing sensitivities, habitat protection, sediment control, vehicle and equipment crossing methods, backfill material specifications and source, erosion control measures (both short term and long term), and bank restoration. Damage to any existing bank stabilization structures or destabilization of previously stable banks should be considered.

It is crucial that the pipe be as clean as possible prior to excavation to minimize the potential for contamination of the waterbody should the pipe be damaged and a spill occur during the removal procedure. Blinding off the ends of the section being removed is recommended to prevent contamination by any remaining traces of material.

3.7 Erosion

Soil erosion is a concern during all phases of the pipeline life-cycle, particularly as it relates to slope stability. Leaving a pipeline in the ground may entail a certain amount of activity along the right-of-way to ensure responsible abandonment, such as excavations to confirm cleaning quality and the installation of caps or plugs. The potential impact of the ensuing right-of-way disturbance will vary greatly with the geographic location of the activity. For example, a forest area "duff" layer may not be as susceptible to erosion and slope instability as a region of native prairie topsoil.

If the pipe is to be removed, erosion and slope stability concerns will be similar to those for pipeline construction. For example, traffic, soil compaction, and the wind and water erosion of disturbed soil may be of concern. In addition, the pipeline may have become a structural support to many slopes over time, and its removal may affect the integrity of the slope.

When developing an abandonment plan, the pipeline owner/operator should review any erosion remediation that had occurred over the operating life of the pipeline. If erosion control measures have been regularly required at specific locations, the owner/operator should determine if it would be appropriate to implement longer term erosion control measures.

If the abandonment activities necessitate disturbing erosion-prone areas including slopes, protection measures designed to current standards should be implemented. In addition, the integrity and effectiveness of any existing ditch plugs, sub-drains, berms, or other installations should be reviewed.

It is usually more appropriate to abandon pipe at unstable slopes in place, due to the potential requirement for extensive remediation if the pipeline is removed. On sensitive slopes, the use of sight blocks or other measures should be considered to discourage use of the right-of-way. In areas where the right-of-way has been traditional access for recreational users or hunters, the operator should attempt to reach an agreement with the land manager for ongoing remediation, if necessary.

In areas where slope movement was being monitored during the pipeline's operating life, the monitoring program should be re-evaluated and continued, if warranted. Temporary access roads to slopes should be reclaimed as appropriate.

Protective measures to be considered when removing a pipeline from a slope would be similar to those used during pipeline construction. The integrity of the slope must be maintained during the removal activities, as well as after the line is removed. If the removal calls for spot excavations (bellholes) instead of an open ditch removal, the stability of the entire slope, as well as the region surrounding the bellholes, should be evaluated. Re-installation of diversion berms and ditch plugs to prevent water channelling may be required.

Development of the abandonment plan should include consultations with other pipeline owners/operators that may be affected by right-of-way disturbances on the slope. In addition, regulators and landowners should be consulted in order to determine an appropriate period for right-of-way monitoring after the pipeline is removed. A typical monitoring period would be two years. Revegetation programs should consider the inclusion of a species that is quick to establish in the revegetation mixture, as this may help to provide short term erosion control; however, the environmental effect of introducing a non-native species must be considered. Regulatory/landowner approval of the seeding mixture would likely be required. A weed control plan should be initiated during the pipe removal process to address potential concerns immediately following surface disturbance.

3.8 Road, Railway, and Utility Crossings

All crossings associated with a pipeline that is being abandoned must be addressed in an appropriate manner. Of particular importance are the agreements relating to the crossings of railways, primary and secondary highways, roads, other pipelines, power lines, and communication lines, and the constraints they may place on the abandonment process.

The parameters to be considered in selecting an abandonment technique for a crossing site include the line diameter, installation details (including burial depth), subsidence tolerance, impact of excavation, impacts on other cathodic protection systems (e.g. for crossings of other pipelines), and long term development plans. Special consideration should be given to the sensitivity of roadway and railway crossings to slight ground depressions that could result from any abandonment related subsidence. The potential may also exist for disruption to crossing traffic, both during and as a result of the pipeline abandonment. As a result, more stringent abandonment requirements may be imposed, such as filling the pipeline at the crossing site with concrete or other approved material. Similarly, cased crossings may require a solid fill even if the carrier pipe is removed.[7]

[7] If the carrier pipe remains in situ, both it and the casing annulus may require a solid fill (need should be assessed on a site-specific basis.)

The proper notification and location of the pipeline or utility being crossed is essential to maintaining a safe working environment. Operators of utilities and other pipelines may have established plans or expectations that may affect the design and timing of the abandonment. Utility crossing or pipeline crossing locations may be of concern when a pipeline is removed, due to the loss of support for the remaining facility, or the interference of the abandonment operation or the abandoned pipeline with the operation of the crossed utility or pipeline. Thus, discussions with utility and other pipeline companies will add value to the resulting abandonment plan and initiate protection planning.

The main steps of the abandonment evaluation and implementation process for any particular

crossing site are as follows:

- review the existing crossing agreement and determine if there are any terms and conditions relating to abandonment-in-place or pipeline removal;
- establish communications with the utility or pipeline being crossed and negotiate terms and conditions (both technical and legal) to abandon the pipeline in place or remove the pipe;
- amend the existing crossing agreement to address the terms and conditions of the abandonment plan;
- notify all affected parties about abandonment activities and responsibilities;
- ensure that necessary approvals (e.g. from regulatory authorities, the utility being crossed, and the landowner) are obtained and kept on record;
- obtain proper location and identification of pipelines and utilities in the area using agencies such as Alberta First Call prior to commencing removal activities, and alert landowners to the activities taking place;
- file the necessary permanent records of the pipeline abandonment plan with interested parties (including pipeline regulatory authorities, provincial one-call systems, environmental groups, land titles, pipeline registers, and the affected crossing parties); and
- in the case of abandonment-in-place, ensure that the inspection requirements for the crossing are part of the post-abandonment monitoring plan.

3.9 Creation of Water Conduits

The potential to create water conduits as a result of the abandonment process is of concern as it could lead to unnatural drainage and material transport. This issue is primarily of concern when a pipeline is abandoned in place, since water will eventually infiltrate the pipe through perforations in the pipe wall caused by corrosion.

Unless water pathways through the pipeline are interrupted, this could lead to the unnatural drainage of areas such as muskegs, sloughs, or marshes, thus affecting the natural balance of the ecosystem. Likewise, a previously stable low area could be flooded by volumes of water exiting from a perforated pipeline. This issue can be related to the concern for contamination and the protection of wetland systems. If water infiltrates the pipeline, the potential exists for that water to carry any residual contaminants left in the abandoned pipeline to some point of exit. The point of exit could be a watercourse, thereby contaminating the watercourse if contaminant levels are sufficiently great in volume and concentration at the point of exit. The possibility of soil contamination may also exist, depending on the nature of the contaminant transported through the pipeline.

Plugs should be installed at appropriate spacings to ensure that changes in surface and ground water conditions will not result in water flow through the pipeline. When identifying locations for the plugs, consideration should be given to pipeline access during the placement of the plugs and the resulting effects of the ground disturbance. Where the pipeline crosses a wet area, a plug should be placed just downstream of the wet area, to prevent its drainage, and also at an appropriate location upstream of the wet area, to prevent the wet area contamination by water flowing along the pipeline. The plugs should be long enough so that corrosion downstream of the plug will not result in water entering the pipe.

On slopes, water could seep into the pipeline through perforations and exit at unacceptable locations such as agricultural areas or areas where excessive erosion would result. The water should be allowed to exit at frequent intervals and at preferred locations in order to minimize potential impacts from the flow of water and the disruption to natural drainage patterns. Typical locations for plugs are provided in the following table.

Table 3-1
Recommended Plug Locations

Terrain Feature	Plug Locations
waterbodies/watercourses	above top of bank
long inclines (>200m), river banks	at top and bottom of slope and at mid-slope for long inclines
flood plains	at boundaries
sensitive land uses (e.g. natural areas, parks)	at boundaries
near waterfalls, shallow aquifers, groundwater discharge and recharge zones, marshes, sloughs, peatlands, highwater table areas	at boundaries and should include an adequate buffer zone
cultural features (population centres)	at boundaries

The plugs should adhere to the pipe, be impermeable and non-shrinking, and able to resist deterioration. Examples of suitable materials are concrete grout or polyurethane foam. The use of impermeable earthen plugs may also be a viable option.

In the case of pipeline removal, water pathways through the uncompacted pipeline trench material must be prevented or interrupted. The principles governing the locations of trench breakers are the same as those governing the locations of plugs for pipelines abandoned in place.

3.10 Associated Apparatus

The development of any abandonment plan should also give consideration to the disconnection, removal and disposal of apparatus associated with the pipeline, including:

- aboveground valve sites and manifolds;
- underground valve sites and manifold piping, as well as protruding elements such as valve topworks;
- underground tanks;
- pipeline scraper traps;
- pipeline risers;
- line heaters;
- drip pots;
- pipeline access culverts (e.g. for tie-ins, valves, liners, etc.);
- cathodic test posts, fink stations, rectifier sites, and ground beds (to a depth of one metre);

- aboveground tanks and containment berms;
- access roads, gates, and fences;
- anchor blocks and steel piles; and
- miscellaneous apparatus such as radio antennae, buildings, fencing, wiring, electrical equipment, and slope monitoring equipment.

It is recommended that all surface and subsurface apparatus (including signage) along the route of a pipeline that is to be abandoned through removal also be removed as part of the abandonment process.

For pipeline sections that are to be abandoned in place, it is recommended that all surface apparatus as well as subsurface apparatus to a depth of at least one metre be removed, with the notable exception of signage identifying the location of the buried line pipe (i.e. line markers and aerial markers). This applies to apparatus located on operator owned land as well as apparatus located on pipeline-specific surface leases on public or private land.

Any apparatus that is left in place should be secured and properly marked and recorded, and should not pose a hazard to people, equipment, or wildlife and livestock.

3.11 Cost of Abandonment

The cost of abandoning a pipeline may be quite significant. There is a broad scope of costs to consider, from the traditional costs associated with abandonment to more intangible items such as a company's public image and the costs of environmental consequences. In order to make responsible decisions regarding abandonment, all of these costs must be considered.

The cost of abandoning a pipeline will depend on the resources required to complete the work, the value of any salvaged material, the extent of remediation and reclamation work required (as well as any associated security requirements [8]), and many other factors. Proponents should also consider the costs associated with monitoring a site and potential future remediation, as well as the consequences of the abandonment activities and any legal issues that may arise. Changes in the regulatory environment may also give rise to unanticipated abandonment costs to ensure "no responsibility by the owner/operator" after a prescribed monitoring period.

[8] For example, in Alberta, if an approval under EPEA is required for the abandonment of a Class 1 pipeline, security is to be provided to AEP before the approval is issued. The security amount is determined using an estimate of the cost of reclamation.

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Section 4 - Post-Abandonment Responsibilities

Once a pipeline has been abandoned, the owner/operator may retain a number of responsibilities. More particularly, the owner/operator may be responsible for ensuring that the right-of-way and any facilities left in place remain free of problems associated with the abandonment. For that reason, a right-of-way monitoring program should be included in the post-abandonment plan and accounted for in the abandonment budget.

Monitoring plans will vary from case to case, depending on the location and size of the pipeline, the land use, and the features of the terrain traversed by the right-of-way (such as water crossings or slopes). When developing a monitoring plan, the effects of each abandonment issue described in Section 3 should be thoroughly examined for each specific segment of the pipeline being abandoned. Specific monitoring requirements should be included for potentially sensitive areas.

Right-of-way maintenance should also be considered in the post-abandonment monitoring plan and factored as necessary into the abandonment budget. As noted in Section 3.2, the reclamation program will normally be designed to ensure that the condition of the right-of-way is made at least equivalent to that existing just prior to the commencement of abandonment activities, and as close as circumstances permit to the condition of the land that existed prior to initial pipeline installation. The degree to which the right-of-way has to be maintained in that state depends largely on land use and environmental sensitivities. For pipe left in place, the owner/operator would normally remain responsible for the maintenance of signage.

Additionally, the owner/operator may be responsible for maintaining post-abandonment information about the pipeline. This information should be recorded in a post-abandonment log book, so that it is available when needed and can be turned over to an alternate responsible authority if required by future regulations. The post-abandonment log book should contain:

- any regulatory permits and conditions attached to permits (including reclamation certificates);
- full particulars on any pipeline facilities abandoned in place, including a physical description, location and depth of cover, plug locations, and details of any sections filled with a solid material;
- copies of all past crossing agreements;
- records of post-abandonment aerial surveillances;
- records of any slumping over the pipe, or water flow through the pipe, that was noted during post-abandonment monitoring;
- records of any changes in pipeline state from the original abandonment plan (e.g. if pipe sections abandoned in place are subsequently removed);
- records of any remedial work performed on the pipeline after abandonment; and
- records of any areas that become contaminated after the abandonment and reclamation work is complete.

The owner/operator will also be responsible for notifying landowners, municipal authorities, and other affected parties (such as one-call associations) of the abandonment of the pipeline. Any input provided by these groups should be recorded in the post-abandonment log book.

Finally, any pipeline abandoned in place should remain part of any provincial one-call program, so that third parties can be advised whether the lines they wish to have located are active or abandoned.

In closing, a major issue still to be addressed is the question of who would assume responsibility if the owner/operator becomes insolvent. In this regard, industry has established a fund in Alberta to cover the cost of reclamation and abandonment of orphaned oil and gas wells and certain associated pipeline facilities.

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Appendix A - Current Regulatory Requirements

Refer to the following three tables for an outline of the current regulatory requirements for pipeline abandonment across Canada.

REGULATORY REQUIREMENTS FOR PIPELINE ABANDONMENT[1]

JURISDICTION	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
FEDERAL	National Energy Board	*National Energy Board Act*	All pipelines	Part V, Para. 74(d)	Leave of the Board
		Onshore Pipeline Regulations	All pipelines	Sec. 50	For abandoned facilities left in place, disconnect from operating facilities, fill with approved medium, seal ends, empty storage tanks then purge of hazardous vapours, and maintain cathodic protection.[2]
YUKON	National Energy Board	*Canada Oil and Gas Operations Act* (COGOA)	All pipelines	none specified	none specified
N.W.T.	National Energy Board	*Canada Oil and Gas Operations Act* (COGOA)	All pipelines	none specified	none specified

JURISDICTION	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
BRITISH COLUMBIA	*Employment and Investment (Energy and Minerals Division)*	*Pipeline Act*	All pipelines	Part II, Sec. 9	Approval of Minister. Removal of structures which may be likely to menace public safety or create a fire hazard

[1] This table lists current regulatory requirements for pipeline abandonment only and does not address the abandonment of stations or other above-ground facilities. Similarly, it does not address the requirements for pipeline deactivation or discontinuance.
[2] The NEB is in the process of amending its *Onshore Pipeline Regulations* and has proposed that these specific requirements be revoked, on the basis that abandonment applications will be treated on a case-by-case basis pending the outcome of the industry/government review into the matter.

REGULATORY REQUIREMENTS FOR PIPELINE ABANDONMENT (continued)

JURISDICTION	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
ALBERTA	Alberta Energy and Utilities Board	*Pipeline Act*	All pipelines	Part IV, Sec. 33	Consent of the Board

JURISDICTION	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
		Pipeline Regulations	All pipelines	Secs. 66-69	For facilities abandoned in place, disconnect abandoned pipeline from operating facilities, clean and purge with approved medium, cap all open ends and advise the Board when work is complete.[3]
	Alberta Environmental Protection	*Environmental Protection and Enhancement Act* (Alta. Reg. 115/93)	All pipelines on private land & Green Area	Sec. 122	Reclamation Certificate from AEP
	Alberta Agriculture, Food & Rural Development	Environmental Protection and Enhancement Act (Alta. Reg. 115/93)	Class I & II lines on White Area public lands		Reclamation Certificate from AFRD (responsibility delegated under EPEA)
SASKATCHEWAN	Department of Energy and Mines	*Pipelines Act*	All pipelines	none specified	none specified

JURISDICTION	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
MANITOBA	Oil and Gas Conservation Board	The *Oil and Gas Act*	All pipelines	Part 14, Sec. 171	Application to an inspector. Responsible for any repairs required within six years from the day of issuance of the Certificate of Abandonment in respect of the oil and gas facility site.
ONTARIO	Ministry of Consumer and Commercial Relations[4]	*The Energy Act*	All pipelines	none specified	none specified
		Gas Pipeline Systems Regulations	Gas pipelines	none specified	none specified
		Oil Pipeline Systems Regulations	Oil pipelines	none specified	none specified

[3] Presently the EUB does not require the removal of an abandoned pipeline; however, in most cases it will expect a notification to the landowners, occupants, and those affected by sour gas setback distances of the abandonment. This is to ensure that affected parties are made aware of the abandonment and that their land will no longer be impacted by the pipeline.
[4]Starting in May 1997, Ontario's pipeline safety regulation program will be administered by the Technical Standards and Safety Authority, a private non-profit organization.

REGULATORY REQUIREMENTS FOR PIPELINE ABANDONMENT (continued)

JURISDICTION/	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
QUEBEC	Regie du Gaz Naturel	*Gas Distribution Act*	Gas pipelines	none specified	none specified
		Regulations Respecting Gas and Public Safety	Gas pipelines	none specified	none specified[5]
NOVA SCOTIA	Energy and Mineral Resources Conservation Board	*Pipeline Act*	All pipelines	Sec. 20	Consent of the NSEMRCB
NEW BRUNSWICK	Natural Resources and Energy	*Pipeline Act*	All pipelines	none specified	none specified[6]
		Pipeline Regulations	All pipelines	Sec. 85	Consent of Minister and approval of Board. For facilities abandoned in place, disconnect abandoned pipeline from operating facilities, purge with approved medium, cap open ends and advise Minister when work is complete.[7]

JURISDICTION/	AGENCY	LAW	SCOPE	ABANDONMENT/ REMOVAL CLAUSE	ACTION REQUIRED
PRINCE EDWARD ISLAND	Department of Energy and Forestry	No applicable legislation	N/A	N/A	N/A
NEWFOUNDLAND	Canada-Newfoundland Offshore Petroleum Board	*The Petroleum* and Natural Gas Act	Offshore pipelines [8]	none specified	none specified

[5] Sec. 3(2) of the *Regulations Respecting Gas and Public Safety* states that the construction, installation, repair, maintenance, replacement or removal of any gas distribution piping shall be in accordance with Code CAN1-B149.1-78 "Installation Code for Natural Gas Burning Appliances and Equipment".
[6]Sec. 28 of the Pipeline Act states that no pipeline shall be taken up or removed without consent of the Minister and subject to his conditions.
[7]Secs. 83-84 of the Pipeline Regulations list the application requirements and criteria for the take up and removal of a pipeline, namely that it must be physically isolated from operating facilities, purged with an approved medium, and that the Board must be advised when the work is complete.
[8]Newfoundland does not at present have any legislation applicable to onshore pipelines.

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Appendix B - Abandonment Checklist

1.0	**Alternate Use Analysis** a. ___Review alternate uses within company or corporate family b. ___Determine if asset can be sold to another company for continued or alternate use c. ___Decision that pipeline should be abandone

2.0	**Product Removal & Cleaning** **2.1 Liquids Pipeline** a. ___Pre-Abandonment pigging for cleaning b. ___Temporary piping modifications c. ___Temporary product measurement, storage & transportation d. ___Product removal pigging, propellant e. ___Post removal cleaning, solvents f. ___Product toxicity analysis g. ___Pipe testing for contaminants h. ___Waste disposal **2.2 Gas Pipeline** a. ___Pre-abandonment pigging for cleaning/liquid removal b. ___Liquids disposal c. ___Temporary piping modifications d. ___Pressure reduction by operating facilities e. ___Pressure reduction by pulldown compression f. ___Sour/toxic product analysis g. ___Blowdown, Flaring h. ___Post removal cleaning using pigging, solvents i. ___Pipe testing for contaminants

3.0	**Information Required for Planning/Approvals**

3.1 Facility Description/History

a. ___Lineal Description of the Pipeline
   ___pipe specification
   ___coating
   ___appurtenances
   ___connections to other facilities
   ___road, highway, railroad crossings (obtain crossing agreements)
   ___pipeline/utility crossings (obtain crossing agreements)
   ___water crossings
   ___topography/terrain
   ___soil information
   ___weed/vegetation information
   ___environmentally sensitive areas
   ___land use/developed areas
   ___parallel pipelines, connections
   ___slope instabilities
   ___road accesses
b. ___Operating History
   ___all products
   ___potential contamination
   ___operating failures/spills/clean-up
   ___slope movement monitoring

3.2 Regulatory Jurisdictions/Approvals

a. ___Operating Authority: Liaison, Application and Approvals (Federal and/or Provincial)
b. ___Environmental Authority: Liaison, Application and Approvals (Federal and/or Provincial)
c. ___Public Lands Disposition (e.g. Land Administration Branch of AEP)
d. ___Other Authorities: DFO, Coast Guard, etc.
e. ___Municipal Authorities: Permits/Bylaws

3.3 Landowner/Public Contact Activities

a. ___Title Search
b. ___Landowner/Tenant Contact, Survey Clearance
c. ___Abandonment Rights in Pipeline Easement/Disposition Documents
d. ___Landowner/Tenant Contact/Negotiations
e. ___Public Lands Managers Contact/Negotiations
f. ___Release of Land Rights/Warranties/Setback Requirements
g. ___Public Participation/Stakeholder Contacts (for federally regulated facilities, early public notification as per NEB's guidelines)
h. ___Damage Negotiation/Payment

3.4 Environmental Assessment

a. ___Soil conservation, stability (possible C&R report)
b. ___Fish & Wildlife population, habitat
c. ___Groundwater
d. ___Erosion, stream sedimentation potential
e. ___Natural Areas, Native Prairie and Native Parkland
f. ___Archaeological study

4.0	**Identify Abandonment Activities (Develop Abandonment Plan)** a. ___Identification of activities required to meet regulatory requirements b. ___Identification of activities required to meet environmental conditions c. ___Economic analysis and decision regarding activities where remove/salvage andabandon in place alternatives are available. **4.1 Appurtenances Removal/Modifications** a. ___Valve Assemblies, Line Heaters, Drip Pots b. ___Cathodic Protection Facilities c. ___Warning Signs, Aerial Markers, Fence Posts d. ___Access Roads, Bridges, Culverts e. ___Fences, Power lines, Antennas, Buildings f. ___Aerial Crossings g. ___Slope Monitoring Equipment h. ___Sumps and Tanks i. ___Any facility/equipment buried less that 1 m deep **4.2 Crossings** a. ___Review of appropriate measures to prevent settlement/collapse and/or disturbance b. ___Liaison with Crossed Facility Operator c. ___Road, Highway Crossings d. ___Railway Crossings e. ___Water Crossings (Minor, River, Lake, Swamp) f. ___Foreign Pipeline Crossings g. ___Utility Crossings h. ___Drainage Crossings **4.3 Environmental Protection/Reclamation Activities** a. ___Remediation of Historical Spill Sites b. ___Gravel Removal, Topsoil Replacement at sites c. ___Topsoil conservation d. ___Surface Stone Removal e. ___Erosion control, Ditch Plugs, Slope/Soil Stabilization f. ___Revegetation g. ___Weed Control h. ___Reforestation (if required) i. ___Access Road Reclamation j. ___Timing windows k. ___Fish and Wildlife Habitat **4.4 Pipe Removal** a. ___Right-of-Way Boundary and Pipe Location Survey b. ___Access Development

	c. ___Grading d. ___Trenching e. ___Coating removal if required (precautions if asbestos containing) f. ___Pipe cutting and removal g. ___Pipe loading, transportation, storage h. ___Backfill/Compaction i. ___Clean-up **4.5 Salvage Analysis** a. ___Sale of pipe for structural or piling applications b. ___Sale of pipe, valves, fittings for remelting scrap c. ___Sale or reuse of valves, pipe fittings d. ___Sale of fencing and other minor materials e. ___Sale of Land and/or Land Rights **4.6 Pipe Abandoned In Place** a. ___ Filling to eliminate settlement/collapse risks b. ___Pipe cuts or pipeline plugs for groundwater stability c. ___Soil conservation/stability measures at excavation sites d. ___Measures to prevent floating pipe e. ___Slopes, erosion control
5.0	**Monitoring/Maintenance Activities** a. ___Aerial Patrol b. ___Specific site visits c. ___Weed Monitoring/Control d. ___Liaison with landowners, tenants, public land managers e. ___"First-Call" response and location of underground pipe f. ___ Crossings g. ___Erosion Control Maintenance

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Appendix C - Industry Questionnaire

ABANDONMENT INFORMATION

Refer to the following two pages for a copy of the abandonment questionnaire that was used for the industry survey conducted in autumn 1995.

Background Information

Owner/Operator: _____

Name of Pipeline: _____ Construction date: _____

Location (Legal Description) From: _____ To: _____

Length: _____ Outside Diameter: _____ Wall Thickness: _____ Grade: _____

Substance(s) transported : _____

Coating Type: External: _____ Internal: _____

Cathodic protection during operation: Impressed Current: _____ Anodes : _____

Depth of Pipe Burial: _____

Was the pipeline constructed through wet areas: Yes: _____ No: _____

Are you aware of any adverse soil conditions (i.e. salinic, acidic): Yes: _____ No: _____

If Yes, What Types:

_____

Did the pipeline have any crossings (i.e. road, railway, water): Yes: _____ No: _____

If Yes, What Types:

_____

Abandonment

Abandonment date: _____

Reason(s) for Abandonment: _____

Pipe Condition at Abandonment:

External Corrosion: None _____ Some _____ Significant _____
Internal Corrosion: None _____ Some _____ Significant _____

Abandonment Activity:

When answering the items below, please note whether the answer refers to the entire pipeline or to specific parts of the pipeline.

Cleaning Procedure: _____

Cleanliness Criteria: _____

Capping (Weld Caps): Yes: _____ No: _____

If Yes: Frequency: _____

Number of Pipe Segments: _____

Filling (i.e. N_2, Concrete, Grout, etc.): Yes: _____ No: _____

If Yes: Fill Type: _____

Road/Railway Crossings: Yes: _____ No: _____

If Yes: How was Pipe Abandoned: _____

Water Crossings: Yes: _____ No: _____

If Yes: How was Pipe Abandoned: _____

Slopes: Yes: _____ No: _____

If Yes: How was Pipe Abandoned: _____

Plugging: Yes: _____ No: _____

If Yes: How was Pipe Abandoned: _____

Cathodic Protection: Retained: _____ Not Retained: _____

Monitoring After Abandonment

Type of monitoring: _____

Frequency of Monitoring: _____

Summary of Monitoring Findings: _____
_____

Has an abandonment study ever been done on the pipeline to determine the effectiveness of the abandonment? _____
_____

Are alignment sheets and drawings available to help identify potential dig sites?
Yes: _____ No: _____

Since abandonment, are you aware of any:

a) Surface settlement over the pipe? Yes: _____ No: _____

If Yes, please provide details: _____

b) Water flow through the pipe? Yes: _____ No: _____

If Yes, please provide details: _____

c) Pipe exposure? Yes: _____ No: _____

If Yes, please provide details: _____

d) Environmental contamination? Yes: _____ No: _____

If Yes, please provide details: _____

e) Any other problems? Yes: _____ No: _____

If Yes, please provide details: _____

Have any additional abandonment measures been completed since the initial abandonment? Yes: _____ No: _____

If Yes, please provide details: _____
_____

Other Comments: _____
_____
_____
_____

Is your company planning any type of excavation on or near this abandoned pipeline this summer?
Yes: _____ No: _____

If Yes, please provide details: _____
_____

For further information contact :

Name: _____
Title: _____
Tel.: _____ Fax: _____

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Appendix D - Cleaning Guidelines

D.1 General Considerations

The operating history of the pipeline to be abandoned should be reviewed to enable the planning of the specific cleaning procedures required for abandonment. Information such as oil/gas analysis, piping modifications, operating flow records, records of anomalies, and maintenance records may provide some insight into additional work needed to develop an effective pipeline cleaning plan.

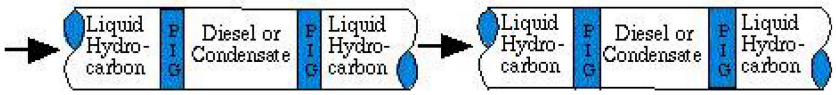
The owner/operator should ensure that there are adequate sending and receiving traps in place. This may require the use of temporary assemblies. If the pipeline in question is part of a larger system, the section to be abandoned should be physically disconnected upon completion of the cleaning process.

Safety precautions appropriate to the in-service product hazards (i.e. flammability and explosivity of hydrocarbons, toxicity of sour products) must be established throughout the activity.

For gas pipelines, any residual gas should be vented or flared once the pressure in the pipeline has been reduced to the extent possible using operating facilities or a pull down compressor. The residual gas should be monitored for signs of liquid.

For liquid pipelines, before line flow ceases, a sufficient number of scraper pigs should be run through the line to remove the bulk of any solids or waxy build-up. As illustrated by the figure below, a batch of solvent-type hydrocarbons such as diesel fuel or condensate inserted between two scraper pigs is recommended as an effective method of reducing solids or waxy build-up. This process should be repeated until solids can no longer be detected on the pigs as they are removed from the receiving trap.

Figure D-1
In-Service Initial Cleaning for Liquid Pipelines



Specialized chemical cleaning may be required if the routine cleaning method described is not successful, if the pipeline is known to have an unusually high contamination level, or if unusually high cleanliness standards are to be met. Special precautions must be exercised when the pipeline is opened up to control vapour hazards of flammability, explosiveness, and toxicity (e.g. hazardous compounds such as benzene).

D.2 Cleaning Methods for Natural Gas Pipelines

A stiff rubber scraping pig should be pushed through the pipeline (at a constant speed consistent with the pig manufacturer's recommendation) using nitrogen or some other inert gas to prevent explosive mixtures. Free liquids pushed ahead of the pig may be either pushed into the downstream pipeline section or collected in a containment tank designed and isolated according to prevailing local guidelines, for disposal in accordance with area legislation or local by-laws. This process should be repeated until free liquids are no longer evident by visual inspection. Low areas of the pipeline should be checked for the collection of liquids or other contaminants.

After these initial pigging runs, the pipeline should be checked for cleanliness. If contamination is evident, the pigging procedure should be repeated using a slug of solvent between two pigs. As with the free liquids, the solvent should be collected in a containment tank and disposed of in accordance with area legislation or local by-laws. Solvent fumes should be purged with nitrogen or a similar inert gas.

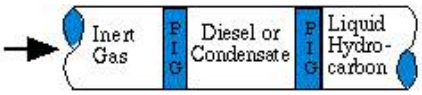
D.3 Cleaning Methods for Liquid Pipelines

Following completion of the initial in-service cleaning efforts, a final cleaning step should be done in conjunction with line evacuation. The following procedure is commonly used, although many variations exist which should be considered. Consultants specializing in the cleaning of contaminated facilities can advise and provide plans for both normal and unusual circumstances.

A slug of liquid hydrocarbons having solvent properties such as condensate or diesel fuel is pushed through the pipeline between two stiff rubber scraper pigs at a constant speed by an inert gas such as nitrogen. Other additives or treatment chemicals may be added if desired. As a rule of thumb, the volume should be calculated to maintain a minimum pipe wall contact time by the fluid ranging from five to ten minutes (or longer), depending on the effectiveness of the initial in-service cleaning process.

For lines having encrusted or high paraffin build-up, an additional volume of solvent preceding the first pig can be considered. All contact times should be increased for excessive lengths of line as the solvent may become saturated with hydrocarbons before completion of the run. The following diagram illustrates the pipeline sequence of movement. At the endpoint, the solvent and hydrocarbons are pushed into another section of pipeline or collected in a containment tank for disposal.

Figure D-2 - Final Cleaning and Evaluation for Liquid Pipelines



A repeat run of the pig train described above should be conducted if there are any indications of liquids or contaminants remaining on the pipe wall in excess of the established cleanliness criteria. The effectiveness of the cleaning process can be gauged by either obtaining samples of the solvent near the tail end of the passing batch, at approximate 25 km intervals, and analyzing the samples for hydrocarbon content, or by monitoring the quality and quantity of the solvent hydrocarbons expelled from the line and comparing it with that injected.

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Appendix E - Bibliography

The documents that were used in the preparation of this discussion paper are listed below. Copies of the studies that were commissioned by the Pipeline Abandonment Steering Committee are available from the Canadian Association of Petroleum Producers, the Canadian Energy Pipeline Association, the Alberta Energy and Utilities Board, and the National Energy Board.

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COORDINATING INFRASTRUCTURE WORKS

A BEST PRACTICE BY THE NATIONAL GUIDE TO SUSTAINABLE MUNICIPAL INFRASTRUCTURE

National Guide to Sustainable Municipal Infrastructure

Guide national pour des infrastructures municipales durables

Canada

NRC · CNRC

Federation of Canadian Municipalities

Fédération canadienne des municipalités

Coordinating Infrastructure Works
Issue No 1.0
Publication Date: July 2003

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FOREWORD

In spite of recent increases in public infrastructure investments, municipal infrastructure is decaying faster than it is being renewed. Factors such as low funding, population growth, tighter health and environmental requirements, poor quality control leading to inferior installation, inadequate inspection and maintenance, and lack of consistency and uniformity in design, construction, and operation practices have impacted on municipal infrastructure. At the same time, an increased burden on infrastructure due to significant growth in some sectors tends to quicken the ageing process while increasing the social and monetary cost of service disruptions due to maintenance, repairs, or replacement.

With the intention of facing these challenges and opportunities, the Federation of Canadian Municipalities (FCM) and the National Research Council (NRC) have joined forces to deliver the *National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices*. The Guide project, funded by the Infrastructure Canada program, NRC, and through in-kind contributions from public and private municipal infrastructure stakeholders, aims to provide a decision-making and investment planning tool as well as a compendium of technical best practices. It provides a road map to the best available knowledge and solutions for addressing infrastructure issues. It is also a focal point for the Canadian network of practitioners, researchers, and municipal governments focused on infrastructure operations and maintenance.

The *National Guide to Sustainable Municipal Infrastructure* offers the opportunity to consolidate the vast body of existing knowledge and shape it into best practices that can be used by decision makers and technical personnel in the public and private sectors. It provides instruments to help municipalities identify needs, evaluate solutions, and plan long-term, sustainable strategies for improved infrastructure performance at the best available cost with the least environmental impact. The five initial target areas of the Guide are potable water systems (production and distribution), storm and wastewater systems (collection, treatment, disposal), municipal roads and sidewalks, environmental protocols and decision making and investment planning.

Part A of the *National Guide to Sustainable Municipal Infrastructure* focuses on decision-making and investment planning issues related to municipal infrastructure. Part B is a compendium of technical best practices and is qualitatively distinct from Part A. Among the most significant of its distinctions is the group of practitioners for which it is intended. Part A, or the decision making and investment planning component of the Guide, is intended to support the practices and efforts of elected officials and senior administrative and management staff in municipalities throughout Canada.

As previously discussed, current funding levels are insufficient to meet infrastructure needs. Municipal infrastructure tends to be taken for granted, so much so that the fundamental role it plays relative to both our standard and quality of life is marginalized. Infrastructure competes with corporate priorities such as police, fire, social services, parks, recreation, and libraries, which often tend to receive higher priority for funding. The net effect of this situation is a chronic deficiency in capital budgets for infrastructure to the point that infrastructure, both current and new, is rapidly deteriorating. In an attempt to mitigate this situation, Part A of the Guide has identified specific best practices.

These best practices are intended to articulate the relevance and fundamental importance of municipal infrastructure by simplifying complex and technical material into "non-technical" decision-making concepts and principles. By doing so, it is anticipated that the need for adequate sustainable funding can be understood and ultimately realized. However, Part A best practices should not be construed as definitive "best" practices; rather, they should be interpreted as guidelines and concepts. Furthermore, Part A best practices are not normative and, as such, are not intended to usurp the discretion of those most knowledgeable about the local municipality. Quite the contrary, it is hoped that the best practices will inspire decision makers to optimize their municipal infrastructure management practices by providing high level, simple, easy to understand approaches and concepts for representing municipal infrastructure issues. In this way, the gulf between the non-technical community and the technical community of engineers and public works officials may be bridged.

It is expected that the Guide will expand and evolve over time. To focus on the most urgent knowledge needs of infrastructure planners and practitioners, the committees solicited and received recommendations, comments, and suggestions from various stakeholder groups, which shaped the enclosed document. Although the best practices are adapted, wherever possible, to reflect varying municipal needs, they remain guidelines based on the collective judgements of peer experts. Discretion must be exercised in applying these guidelines to account for specific local conditions (e.g., geographic location, municipality size, climatic condition).

For additional information or to provide comments and feedback, please visit the Guide Web site at www.infraguide.gc.ca or contact the Guide team at infraguide@nrc-cnrc.gc.ca.

ACKNOWLEDGEMENTS

The dedication of individuals who volunteered their time and expertise in the interest of the *National Guide to Sustainable Municipal Infrastructure* is acknowledged and much appreciated.

This best practice was developed by stakeholders from Canadian municipalities and specialists from across Canada, based on information from a scan of municipal practices and an extensive literature review. The following members of the National Guide's Decision Making and Investment Planning Technical Committee provided guidance and direction in the development of this best practice. They were assisted by the Guide Directorate staff and by New East Consulting Services Ltd.

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This and other best practices could not have been developed without the leadership and guidance of the Project Steering Committee and the Technical Steering Committee of *the National Guide to Sustainable Municipal Infrastructure*, whose memberships are as follows:

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EXECUTIVE SUMMARY

This document outlines best practices for the coordination of infrastructure works, to minimize disruption and maximize value. All public works managers have, at one time or another, been exposed to significant public complaints about the lack of effective coordination among the various infrastructure components. How well this issue gets handled, significantly affects the overall effectiveness of infrastructure providers and, therefore it is important for the various infrastructure renewal programs to be coordinated to the maximum extent possible.

A wide variety of practices exist across the country. The review identifies best practices, which will work in different situations. This, in turn, will enable individual municipalities to choose the practices appropriate for their organization. The review included:

- preliminary interviews with a wide variety of municipalities across the country;
- the selection of 20 municipalities for detailed follow-up interviews;
- the development of a series of detailed questions;
- detailed follow-up interviews with the 20 final municipalities;
- a literature review of pertinent aspects of other formal studies;
- a review of a variety of consultant reports and models; and
- the use of the personal experiences of the team members who were involved in creating this best practice.

The benefits anticipated from improving service delivery models in this area include:

- reduced costs;
- increased sensitivity of infrastructure managers to considerations in other infrastructure components;
- reduced disruption and social costs;
- improved coordination of long-term infrastructure works with development related works;

- improved full cost accounting;
- improved public perception of infrastructure providers;
- increased council and public awareness for the need of life cycle replacement strategies; and
- improved funding approval procedures.

A number of risks and possible consequences are associated with how the practices itemized are dealt with, including:

- increased administrative costs;
- premature replacement;
- skewed priorities;
- opposition from external utilities;
- reduced flexibility; and
- lost opportunity costs.

The various best practices identified as a result of this review can be placed in five generic areas with a number of subcategories.

1. Coordination Practices – The effective coordination of the various utilities involved is critical. The following specific practices are highlighted:
    - multi-year plans;
    - formal committees (both internal and external committees); and
    - coordination of development-related works.
2. Corridor upgrades – Corridor upgrades have significant benefits with respect to maximizing coordination and minimizing repeat disruption. Care needs to be taken to ensure the economic life lost to early replacement does not exceed the economic benefits resulting from improved coordination. In situations where a "smaller percentage life" is still remaining in an underground utility, additional economic analysis should be undertaken to evaluate and justify complete corridor renewal and rehabilitation. Refinement on the corridor approach includes the installation of utilidors, and the upgrading of many blocks on a particular street or an entire neighbourhood at the same time.

3. Restrictive practices – Municipalities use a variety of restrictive practices to promote enhanced coordination. They include:

   - permit requirements;
   - no-cut rules;
   - pavement restoration procedures; and
   - pavement degradation fees.

   The above restrictive practices all form incentives to minimize disruption to a particular road surface and to enhance the coordination of various infrastructure programs.

4. Approval processes/communicating needs – A variety of planning processes and how the needs get communicated are outlined as part of this review. They include the role of:

   - dedicated funding sources;
   - block funding;
   - formal planning tools; and
   - presentations, public notices, and other information dissemination.

All these areas serve specific roles in the infrastructure approval process and affect how well individual programs are coordinated.

5. Technical considerations – In addition to policy and procedure-related best practices, there are some technical considerations. They include how to account for social and environmental costs, pre-installation of services, use of computer software for coordination of capital works programming of various infrastructure components, and trenchless technologies.

How this best practice should be applied and its limitations are also outlined as part of this review. Due to the wide variation in the number of practices employed, in most cases, the review lists the various practices without specifying which are preferable. However, on occasion it is clear that some practices are preferable to others. Where this occurs, commentary is provided. Examples include:

- multi-year plans;
- formal coordination committees;

- corridor reviews;
- pavement degradation fees;
- dedicated funding approvals for infrastructure needs;
- block funding approvals; and
- highlighting life cycle costing in presentations.

Since the success of the various practices outlined is subjective, evaluations of the performance of individual municipalities are difficult. However, criteria to measure the success of particular organizations include:

- the length of the plans distributed to the various infrastructure providers;
- the frequency of contact with external agencies;
- the existence of a formal multi-agency committee to review these issues;
- the existence of no-cut rules and pavement degradation fees;
- the size of the annual infrastructure deficit and the frequency of reporting to council and the public on these issues; and
- the existence of block funding approvals.

It should always be remembered that the primary indication for success is the overall effectiveness of infrastructure providers in the eyes of the local council and the community.

1. GENERAL

1.1 INTRODUCTION

This best practice document is part of the *National Guide to Sustainable Municipal Infrastructure*. Its goal is to assist municipalities with the management of all components of the municipal infrastructure and provide a road map for the Canadian network of practitioners, researchers, and municipal officials to solve today's municipal infrastructure challenges. This best practice document is concerned with the coordination of infrastructure works to minimize disruption and maximize value. It has been produced under the guidance of the Decision Making and Investment Planning Committee but targets more of a technical audience compared with other best practices produced by this Committee.

All public works managers have, at one time or another, been exposed to significant public complaints about the lack of effective coordination among the various infrastructure components. The problems associated with effective coordination are significant as various components of the infrastructure are installed at different times, with different expected life cycles, differing degrees of maintenance, and management by different staff groups. Some components are managed by entirely different organizations, which have different mandates and funding sources. This presents a significant technical and communication challenge in minimizing the disruption caused to the community and maximizing the value of infrastructure investments. There is little that is more disturbing to the public than to see a significant public works project in progress, with the associated disruption and social cost to the community, and to observe the reinstatement of the pavement surface only to have the entire street dug up again for an entirely different purpose a short time later. While technical explanations for this phenomenon can be offered, the perception of waste and inefficiency in the service delivery of infrastructure works is an inevitable outcome. It is therefore important for the various infrastructure renewal programs to be coordinated to the maximum extent possible.

1.2 PURPOSE AND SCOPE

The overall purpose of this best practice is to conduct a review of the various practices that cities across Canada use, to improve coordination among the various infrastructure programs, and identify the best practices used. It should be noted that there is a wide variety of needs across the country and a wide variety of cultures within both the cities at large and within their council make-up. It is not a purpose of this review to attempt to change the culture of individual cities. Rather, its goal is to identify a variety of best practices, which work in different situations that, in turn, will enable individual municipalities to choose which practices are appropriate for their organization. On occasion, some practices offer enhanced opportunities for effective co-operation, and these are noted, yet it

must be acknowledged that implementation may not be possible in all organizations.

1.3 Review Methodology

The Decision Making and Investment Planning Committee of the National Guide used the services of a consultant who had extensive background in the management of municipal government, general engineering practices, and related practical experience. The assembled consultant team also had significant background in infrastructure-related topics. It was generally felt that although many cities had previously participated in extensive technical surveys, the required input for this survey would be difficult to achieve following traditional survey methodologies. Consequently, municipalities across the country with varying population, size, and climatic considerations were contacted directly by telephone. Brief descriptions of the practices followed in each of these municipalities were produced, and 20 municipalities were selected for follow-up interviews. A series of detailed questions were developed that were distributed in advance of the interviews. In addition, a request was made that, for each infrastructure area involved, technical experts be present at the follow-up interviews. The detailed interviews were conducted with representatives from the various technical and decision-making and investment planning committees in attendance, along with the consultants carrying out the detailed reviews. This provided consistency and allowed synergies to develop in a committee format. The background information on each municipality, produced from the preliminary interviews, served as a valuable starting point for the detailed interviews. Anywhere from one to six representatives of the municipality assisted in answering the detailed questions (depending on the size, complexity, and expertise involved). It was felt that this review methodology obtained the required information in a co-operative, cost-effective manner. In addition, rapport was established between the Guide team and the various municipalities involved, which will aid in future best practice scans.

A literature review was conducted to incorporate pertinent aspects of other formal studies. A specific review was made of a variety of consultant reports and models in current use in the municipalities involved. The best practice scan also used the personal experiences of the team members who had significant expertise in the management of these types of processes. This review methodology was successful in obtaining the information required in a very co-operative manner and should be considered for other best practices.

1.4 How to Use This Document

This best practice reveals that there are a variety of techniques being used throughout the country. The outcome is a mix of considerations including physical, financial, organizational, and behavioural. Many of the practices identified involve values, which are difficult to measure with fixed criteria. As

there is wide variation in the stakeholders involved, there is a danger of trying to make one model fit all communities. A number of factors influence this issue:

- **political:** how a community is represented (ward basis or at large elections), the council term (very short compared to the time frame of infrastructure-related issues) and the values/preferences a particular council has with respect to capital verses operating, user pay, fees and charges, etc.;

- **socio-economic:** the community size and its relative budgets and affordability, the community age, and where it is in the infrastructure life cycle;

- **financial considerations:** competition for tax funds, the effects of downloading and general cutbacks in the government sector, the existence of dedicated funding and who owns the various infrastructure areas, and the general practice of locating external utilities (above or below ground);

- **asset-related issues**;

- **organization:** how an organization is staffed and structured; and

- **culture.**

All these factors result in the use of a wide variety of detailed techniques; however, there are also significant consistencies between municipalities when this issue is considered in an overview manner. The strategies employed by the various municipalities contacted fall into the following five broad categories.

1. **Coordination practices** include utility committees, the development of multi-year plans and the formal circulation of plans and programs among various infrastructure components.

2. **Corridor upgrades** involve the replacement of a variety of infrastructure components at the same time.

3. **Restrictive practices** include no-cut rules and pavement degradation fees.

4. **Approval processes/communicating needs** includes the role of dedicated funding, block funding approvals and the timing of approvals, and how the issues are presented.

5. **Technical considerations** refer to the pre-installation of lateral and service connections, trenchless construction techniques, etc.

In each category, a wide variety of practices have been followed. It is the general conclusion of this review that no one approach will fit all organizations, and

variety is appropriate. Rather than make specific recommendations, it is preferable to list a variety of practices that seem to work in different situations and provide commentary on the relative merits of each. This allows a wide variety of municipalities and individual areas to select from the various best practices listed that best fit the culture of their community and council.

1.5 GLOSSARY

Asset management — The combination of management, financial, economic, engineering and other practices applied to physical assets with the objective of providing the required level of service in the most cost-effective manner.

Best practices — State of the art methodologies and technologies for municipal infrastructure planning, design, construction, management, assessment, maintenance and rehabilitation that consider local economic, environmental, and social factors.

Block funding — Approval of budgets on a program level for roads, drainage, water/sanitary, etc. as opposed to at an individual project level. This allows for significant flexibility with respect to changing priorities among individual projects.

Corridor upgrading — The upgrading of all elements of infrastructure on a specific street or in a geographic area at the same time.

Dedicated funding — Funding raised for a specific utility and restricted by a policy framework for use on one infrastructure component.

External utilities — Commonly refers to utilities not owned and operated by the municipality. They typically include hydro, telephone, cable, and fibre optics but may include infrastructure, which is traditionally municipal in nature (if it is owned by an external company or another level of government).

Full cost accounting — A process, which relates all the associated costs and effects of a particular program to its funding source.

Infrastructure renewal programs — A systematic program, which rehabilitates or reconstructs an infrastructure system near the end of its physical life.

Life cycle replacement strategy — An infrastructure renewal strategy, which recognizes that each component has a limited life span and takes that life span into account when determining an annual program.

Long-range infrastructure planning processes — Refers to a planning horizon of five to ten years.

Municipal infrastructure — Roads, water, sanitary sewer, and stormwater systems which form a network and serve whole communities, where the system as a whole is intended to be maintained indefinitely at a particular level of service potential by the continuing replacement and refurbishment of its components. The network may include normally recognized ordinary assets as components.

Municipality — A legally incorporated or duly authorized association of inhabitants of limited area for local governmental or other public purposes.

No-cut rule — A moratorium on all excavation activity within the pavement surface for a specific period of time after a pavement overlay.

Pavement degradation fee — A fee charged to an agency cutting the pavement, which is in addition to the repair cost. This accounts for the reduced service life of the pavement infrastructure as a result of the excavation process.

Short-term infrastructure planning processes — Generally refers to a planning horizon of less than five years.

Utilidor — A linear utility chamber constructed to accommodate a variety of utilities. (Those utilities could include hydro, telephone, cable, steam heat, etc.).

2. RATIONALE

2.1 BACKGROUND

Although specific procedures and followed practices varied significantly among municipalities, there was instant recognition that the topic of this best practice was very pertinent to all the communities surveyed. All the staff involved quickly recognized that the need for effective coordination was one of the most important building blocks to an effective infrastructure replacement strategy. The five key elements listed in this best practice were prevalent in most of the communities surveyed. While the precise methodology of addressing this issue did differ significantly among the communities, the various practices used can be grouped into:

- coordination practices;
- corridor upgrades;
- restrictive practices;
- approval processes/communicating needs; and
- technical considerations.

2.2 BENEFITS

A wide variety of benefits result from improving service delivery models.

2.2.1 REDUCED COSTS

The net effect of improved coordination includes reduced project costs through efficiencies of scale and avoidance of repeat repair costs, primarily in the pavement repair area. Since funding allocations are often made on overall affordability criteria, more efficient use of funding enables more projects to be implemented, thereby reducing the infrastructure deficit.

2.2.2 INCREASED SENSITIVITY OF INFRASTRUCTURE MANAGERS TO CONSIDERATIONS IN OTHER INFRASTRUCTURE AREAS

The inevitable result of many of the improved coordination techniques is improved education, and sensitivity of infrastructure providers and project managers in one utility area of the needs and considerations in other areas. This, in turn, leads to improved decision making, even before any specific coordination efforts are undertaken.

2.2.3 REDUCED DISRUPTION AND SOCIAL COSTS

Infrastructure works result in the inevitable physical disruption, which leads to social costs, which are incurred but are not accounted for in the project budget.

This would include lost time and business opportunities, additional fuel consumption, etc., resulting from the effects of traffic disruption, noise, air pollution, and other environmental/social impacts. Improved coordination has the potential to reduce these impacts dramatically.

2.2.4 Improved Coordination of Long-Term Infrastructure Works with Development-Related Works

This capitalizes on the possible efficiencies and the benefit of having new development works fund some long-term infrastructure priorities.

2.2.5 Improved Full Cost Accounting

Traditionally, the roads area has had the greatest difficulty in maintaining appropriate funding levels, as its traditional funding source is the highly sensitive tax base. Historically, this area also has greater infrastructure deficits associated with it. Some practices identified in this review highlight areas where more full cost accounting may be possible. As an example, the effects of the underground utilities on the life of the road infrastructure are often not captured in traditional cost sharing practices even though those utilities can be on a user pay basis and have a more secure funding source. Some practices would transfer some long-term funding requirements from the more sensitive roads area to the utilities, which often have dedicated funding sources. This shift is fair and appropriate, and would result in increased balance in funding infrastructure priorities and improved overall service to the community.

2.2.6 Improved Public Perception

Poor coordination reduces the public image of infrastructure providers. As public perception is invariably reflected in a local council's attitudes and actions, any improvements in co-coordinating efforts have long-term benefits to all public works service providers.

2.2.7 Increased Council and Public Awareness of Life Cycle Replacement Strategies

A number of the education and communicating needs/procedures highlighted are required on an annual basis for budget purposes. However, they also have the tangential effect of increasing awareness of infrastructure needs, which has long-term benefits.

2.2.8 Better Funding Approval Procedures

A number of the practices highlighted involve approval processes, which can significantly increase the flexibility and coordination procedures surrounding these issues. Better funding approval procedures that allow planning for individual projects to occur earlier and more cost effectively result in significant benefits. They also have the potential to reduce administrative costs associated with the approval process and to increase the opportunities for coordination mid-year, which have direct financial benefits.

2.3 RISKS/POSSIBLE CONSEQUENCES

There are risks associated with a number of the practices itemized.

2.3.1 INCREASED ADMINISTRATIVE COSTS

There is a cost in terms of staff time and direct funding associated with a number of the committees/processes highlighted. Increased staff workload and costs associated with establishing some of the committees listed may result. In larger urban areas, where a number of different committees can be set up on various aspects related to this issue, this risk is greater.

2.3.2 REPLACEMENT TIMING

The corridor upgrade philosophy highlighted may result in replacing some individual infrastructure works before the end of their life. This may offset some benefits gained through increased coordination, reduced disruption, and reduced pavement repair costs. Therefore, proper analysis is critical in deciding on the degree to which these practices should be followed.

2.3.3 IMBALANCED FUNDING

Many communities do not have sufficient funding to balance infrastructure renewal works among various program areas and, therefore, effective coordination in certain program areas is difficult. In extreme cases, the vast majority of program funding can be totally consumed in coordinating works related to either development or one of the other program areas, leaving few resources to fund the remainder of the utility needs. This can result in insufficient flexibility to coordinate with other utilities while addressing the individual utility's needs.

2.3.4 OPPOSITION FROM EXTERNAL UTILITIES

Since a number of outside utilities have different cost centres and different mandates than that of municipalities, resistance may be incurred by adopting some of the techniques highlighted. Depending on the degree of opposition, this can become a major issue, and can by itself consume significant time and resources. Consequently, care must be taken to ensure that relationships do not deteriorate due to the practices outlined.

2.3.5 REDUCED FLEXIBILITY

Adoption of some of the restrictive practices highlighted (e.g., no-cut rules) can reduce the flexibility but increase the criticism of an operation. Care should be taken to ensure that the created expectations can be met.

2.3.6 LOST OPPORTUNITY COSTS

Not following a number of the practices highlighted has the potential of increasing the costs of individual projects and reducing resources available to fund fixed needs.

3. DESCRIPTION OF APPROPRIATE PRACTICE AREAS

As indicated earlier, the various practices identified as a result of this review can be placed into five generic categories with a number of subcategories. They are discussed in more detail in the following subsections.

3.1 COORDINATION PRACTICES

A wide variety of coordination practices were evident among the various municipalities interviewed. Despite the variety, the intent of each municipality's practice was similar: to provide more effective coordination among the various utilities (both internal and external). The following specific practices were in use.

3.1.1 MULTI-YEAR PLANS

The development of multi-year plans, which have specific projects identified, is key to effective coordination of different programs. The practices seem to vary significantly in this area with some cities having plans that are projected out for 10 years, and others which only concentrate on the coming year. The development of multi-year plans is an important consideration for this best practice. The prevailing best practice seems to concentrate on a three to five year horizon. One-year horizons coordinate the upcoming construction season, but do not offer enough lead time for effective long-term coordination and the pursuit of joint opportunities. Many municipalities indicated that outside utility companies in their areas were unable to produce plans for more than a one or two year horizon for a variety of reasons (e.g., unpredictable customer demand). It is noted that municipalities seem to have the ability to project further than most of the outside utility companies although municipal services are planned to meet the customer demand as well. This difference in approach is a significant roadblock to coordinating effective long-range programs.

Once the multi-year plans are developed, many municipalities have a formal circulation system wherein each area's plans/programs are circulated to the other areas. Through that process, it is ensured that pending underground works are completed before the street works.

In addition to providing a good base for coordinating programs, the distribution of longer-term capital plans can reduce the tendency for political direction to modify priorities for the upcoming year. This is especially important for communities governed by wards.

Once the following year's program has been selected, some municipalities mail specific letters for each project to all the other utilities to ensure that attention is brought to the specific project. This seems to be more prevalent in smaller areas

where there are fewer projects. A benefit of this type of process is that specific attention is brought to the street in question. This practice concentrates on the short term (upcoming construction season) but is useful in ensuring that all affected program areas conduct a final check on coordination issues before construction begins.

Some communities (e.g., Kelowna, British Columbia) have an extensive communications plan process for significant projects. This degree of formalized communication with the public is the exception rather than the standard. Others publish notices in the local papers or distribute letters to adjacent directly affected properties.

3.1.2 Formal Committees

A very common method of coordination is the establishment of formal committees with representation from a variety of service areas. This method seeks to ensure there are open lines of communication between the various service providers. There seems to be two distinctly different types of committees used to coordinate these types of works.

- Internal committees include representatives from each of the internal areas affected, which are usually sewers, water, drainage, and roads.

- External committees are sometimes called joint utility coordination committees and generally concentrate on the relationship of the external utility companies to the city programs. These external committees involve the various agencies responsible for the infrastructure, which the municipality does not own. They are usually coordinated and chaired by the municipality, but participation and commitment from the external utility companies seem to be greater if they are involved in chairing and coordinating the committee. Specifically, some municipalities use a rotating chair concept (e.g., Sudbury). In Winnipeg, all participants fund the coordinating efforts and the budget of the committee. These techniques maximize the involvement of the outside utility companies, which is an important factor in effective coordination.

Occasionally, the internal and external committees are combined and, in some cities, a number of other specific purpose committees are set up. (For example, Edmonton uses neighbourhood improvement committees.)

The frequency of meetings of these committees seems to vary dramatically with some meeting just once a year, while others meet monthly or more often.

Individual practices, with respect to committees, vary significantly depending on circumstances. There is no preferred set-up as the individual needs, staff resource levels, and other factors vary significantly. However, strategies involving outside utility companies directly in the management of the overall

issue increase their participation and improve coordination efforts. It is noted that earlier coordination achieves better integration.

3.1.3 Coordination of Development-Related Works

Other municipalities coordinate development-related works with ongoing program areas through development-related committees. Some municipalities take cash in lieu of the required works from the developer to coordinate the development-related works with their capital programs. Occasionally, an annual budget amount is set aside to undertake capital works in conjunction with development works in high growth municipalities (e.g., Surrey).

3.2 Corridor Upgrades

It is relatively common, in a number of areas, to look for opportunities for redevelopment of an entire corridor. The trigger for review of the corridor, however, seems to vary significantly depending on the specifics of the municipality involved. Some municipalities start with the street program and once the street is identified, specific reviews are conducted for the other internal programs, such as water, sewer, and drainage, with priority given to upgrading as many elements as possible. Other municipalities start with a program, such as the water program. In those cases, the overall corridor upgrading starts with the specific underground program, and the opportunity is taken to repave the entire roadway when the underground utility is complete.

While corridor upgrades are relatively common in many cities, the practice itself varies significantly depending on a number of factors, such as balanced funding availability, and the age and condition of infrastructure components. The range of practice varies all the way from very few corridor upgrades to it being the upgrading approach of choice (e.g., Yellowknife, Hamilton). Many believe that complete corridor upgrades are the best practice for their community as it maximizes the coordination benefits and minimizes repeat disruption to the community. However, concerns with this practice have also been articulated (e.g., Saskatoon). Those concerns centre on the economic life lost due to premature replacement of some infrastructure components. In many cases, the economic benefits of corridor replacements are not sufficient to offset the lost life. When considering this issue, cities should conduct an economic analysis of the trade-off between economic life lost due to premature replacement and the cost avoided by repeat pavement repairs and social disruption to the area. The effects of a complete renewal on revitalizing the area and encouraging other investment in the area should also be considered. In situations where a "smaller percentage life" is still remaining in an underground utility, additional economic analysis should be carried out to evaluate and justify complete corridor renewal and rehabilitation.

Partial corridor upgrades can also occur with some but not all program areas being upgraded at the same time. In those cases, it is common to complete a

check on all other utilities and rectify any deficiencies before the corridor upgrade. Another approach, which provides enhanced economies of scale, is to seek approval for upgrading for many blocks of a particular street or an entire neighbourhood at the same time. This provides construction efficiencies and concentrates the disruption to the community to a very specific time frame.

3.3 Restrictive Practices

Individual municipalities use a variety of restrictive practices to promote coordination and, more important, minimize the disruption to a newly completed project for a number of years.

3.3.1 Permit Requirements

Most of the municipalities interviewed use a system requiring all excavators to obtain a permit from the municipality before excavation. The permit fee itself is generally nominal; however, the practice does enable the municipality to exercise a degree of control over the excavation of streets. This enables municipalities to implement additional restrictive policies if they wish.

3.3.2 No-cut Rules

About half the municipalities surveyed had a no-cut rule of some sort in their municipality. A no-cut rule or moratorium on excavations specifies that no excavations are allowed for a certain number of years after pavement overlays unless emergency circumstances prevail. If a no-cut rule exists, the most common time frame is three years, although in some cases it is longer (e.g., five years). The prevalence of a no-cut rule varied significantly depending on the culture in the municipality, the degree of development (high development areas used fewer no-cut rules) and the sensitivity of the elected officials and the community to repeat disruptions. There were different levels of approvals required with some organizations, requiring approval of Council for an exception to the rule and others producing a wide variety of circumstances, which would allow exceptions to the policy. It is noted that even when a no-cut rule exists, its success in restricting repeat excavations is variable. A recent study prepared for Ottawa highlighted that even very proactive cities found a significant percentage of their moratorium streets had been re-excavated within two years of resurfacing. Unless this is understood when instituting a no-cut rule, false expectations can be raised which, in turn, can lead to additional negative perceptions of public works coordinators.

3.3.3 Pavement Restoration Procedures

With respect to the actual road repair procedures, various mechanisms are used, ranging from the utility company repairing the excavation to municipal specifications, to the city coordinating the final pavement restoration at the utility company's expense, to a flat charge pavement repair system which transfers the responsibility for the final repair to the city in exchange for a per square metre charge to the utility company. The individual system adopted varies significantly

among municipalities. While it is difficult to indicate a preferred approach, there is a tendency for individual municipalities to pay more attention to the quality of the final repair than outside excavation agencies, as the municipality will ultimately inherit any deficiencies in the repair process. This leads to the conclusion that the best practice is the one with very active involvement by the municipality.

3.3.4 Pavement Degradation Fees

Pavement degradation fees have been studied in detail by some municipalities. An inherent by-product of utility cuts is the reduced service life of pavements. No matter how well a utility cut is repaired, the nature of the excavation process and the disturbance of the sub base have a significant effect on lessening the overall life of the pavement infrastructure. In general, road infrastructure is in poorer condition than the underground utilities and is usually the more difficult area for raising funds due to the lack of a dedicated funding source. This fee for excavations was discussed in significant detail with the majority of municipalities interviewed. While few municipalities across the country are using the concept (Ottawa, Surrey), there was significant interest and support for it. It assists in moving toward full cost accounting and appropriately charges the agencies responsible for long-term costs. It also has the side benefit of encouraging coordination among the various infrastructure areas to avoid repeat fees.

A number of the municipalities that have implemented such a fee have related the fee to the age of the last overlay. Others have adopted a flat rate for ease of administration. Technically, a relationship to the age of the last overlay is a more accurate method of reflecting the true effects of utility cuts on pavement life, but a flat rate is much easier to administer, and does not require a large database. It is suggested that adopting the concept of a pavement degradation fee in addition to proper road repair procedures is a worthwhile practice for most municipalities to pursue. The choice of a flat or variable rate can be left to the discretion of the individual municipality.

3.4 Approval Processes and the Need for Better Communication

As part of this best practice, a review was carried out of existing planning procedures and how the needs get communicated to the elected officials and the public, along with the adequacy of existing budget levels, in each of the areas for which municipalities were responsible.

3.4.1 Dedicated Funding Sources

Existing budgets were generally not sufficient to replace the infrastructure components in question on a life cycle basis, but there was significant variation among urban areas in this regard. The roads and drainage areas usually had greater difficulty in obtaining adequate funding than the sewer and water areas. This was primarily due to the existence of dedicated funding for the sewer and

water areas through utility rates. Generally, roads and drainage were funded from the general tax base and had to compete directly against many other program areas. The relatively higher level of funding for the roads program is evident where a dedicated funding source is available to subsidize the program (e.g., a share of fuel tax in Edmonton and in the member municipalities of the Greater Vancouver Regional District). It appeared that the public and the funding agency are much more willing to provide adequate funding levels if there is a direct link between the users of the system and how the funding is raised. It follows logically that establishing dedicated funding for the various infrastructure service areas should be an overall priority for all infrastructure providers.

3.4.2 Block Funding

The timing of the approvals of different funding programs did not seem to be a significant deterrent to enhance coordination as the key coordinating efforts occurred at separate times from the approval process. It was generally acknowledged that early approvals (preferably in the fall for the following year) are very important for effective coordination processes to occur. In addition, the way individual programs and projects were approved has a significant effect on the ability to coordinate throughout the year. Specifically, a number of cities have approval processes, which concentrate on block funding approvals with individual projects submitted only for information purposes or not submitted at all. These types of arrangements are very flexible and allow the municipality to change individual projects if information comes up late in the planning process. This increases the ability of the relevant agencies to coordinate individual program areas with other works. Other cities need to specify exactly which projects will be constructed that year and need council approval in that regard. This practice prevents coordination with other outside influences. It is suggested that the best practice, in this regard, is to seek program level approvals and to supply project detail for information. It is recognized that the ability of individual municipalities to achieve this is influenced significantly by the culture within the community and its council, and this practice may only be achieved over time.

3.4.3 Presentations of Infrastructure Needs

Most organizations make periodic presentations to their council on their long-term infrastructure plans, and a wide variety of detail is used. It is suggested, as a minimum, that each municipality include in its presentations the replacement value of each infrastructure component, the expected life of that component, a calculated life cycle replacement target, a description of proactive initiatives to meet the target, and the benefits of meeting the target. This budget should then be compared to the actual expenditures in each program area. The difference highlights the needs. Some organizations formalize this to the extent that they call that difference the infrastructure deficit, and it is reported annually. The political support organization's experience varies dramatically with some communities expressing strong support for infrastructure-related issues and others receiving the information with seldom any action taken. The goal should

not be to obtain specific funding levels, but to inform the council and the community of infrastructure issues, to make them aware that continued deferral of this issue is a form of deficit, and that long-term support be generated for infrastructure-related issues. Presentations which address positive outcomes for individual councils and the community as a whole (e.g., reduced emergency repairs with their associated disruptions) are better received than those dwelling on negative outcomes. Regardless of the specific responses, it is apparent that knowledge and awareness of infrastructure-related issues have increased dramatically since the infrastructure movement started in Canada in the early 1980s, and there has been a substantial number of initiatives (the Guide being only one).

3.5 Technical Considerations

3.5.1 Formal Planning Tools

Many municipalities used formal planning tools. It is very common to use computerized pavement management systems to aid in the prioritization of individual projects. In the sewer and water areas, available models seem to concentrate more on capacity issues than condition issues. A number of cities are participating in pilot projects involving an integrated infrastructure management-upgrading program (e.g., Hamilton). This process concentrates on integrating all aspects of infrastructure into one program. However, while a number of municipalities have started to use this technology, it is premature to provide commentary as to how well it works. In addition to formal planning tools, a number of cities (e.g., Saskatoon, Hamilton) have restructured their public works and engineering departments to include a formal asset management branch. This ensures that attention is being placed in an ongoing manner on infrastructure-related issues and is a very effective way of ensuring a continued long-term focus on these issues.

Municipalities use various means to test the condition of infrastructure. They range from the use of field observation and maintenance records to condition rating equipment. Condition rating data are compiled manually or with computer software. Using the condition rating data, municipalities develop capital programs in conjunction with capacity upgrading needs, which are identified through field monitoring and capacity modelling software. When the infrastructure capacity is upgraded, municipalities consider the projected future demand growth in the range of 10 to 30 years.

Several observations are made in the usage of various tools.

- Most municipalities use capacity modelling software for roads, water, sewer, and drainage systems. Some software is integrated with a municipal geographical information system (GIS), which presents better opportunity for coordination of individual capacity upgrading programs.

- Pavement condition rating and rehabilitation strategy/program development software is more widely used by municipalities than similar software for water, sewer, and drainage systems.

- Some municipalities use closed-circuit television (CCTV) inspection and leak detection to determine underground infrastructure rehabilitation needs or in reaction to frequent maintenance requirements. Some municipalities use a computer-based maintenance management system to track the maintenance cost of specific components in the infrastructure. These systems are sometimes integrated with a GIS.

- Many municipalities have specific material replacement programs, such as paving unpaved roads and replacing cast iron or asbestos cement pipes.

In summary, it has been observed that even partial integration of infrastructure capital works programming aspects facilitates coordination among the various program components. However, there is a need for more comprehensive infrastructure capital works programming software to integrate the various areas.

3.5.2 Social and Environmental Costs

Most organizations were aware of the social and environmental costs of their projects, but very few attempted to quantify them in any formal sense. Most environmental considerations were dealt with as a result of formal mandated senior level government environmental review and assessment processes. The social issues were generally acknowledged but not dealt with in any formal sense. One example of attempting specifically to quantify social costs is through the concept of a lane rental charge included in the project budget (e.g., Hamilton). This formally quantified traffic disruption to some degree in that municipality. As part of the literature research, Alberta's Transportation Environmental Construction Operations Plan was reviewed. It outlines a very detailed framework for considering environmental issues and ensures that they receive a very high profile as part of project planning. Although this type of detailed environmental planning framework was not prevalent, many acknowledged the need for such an approach.

3.5.3 Pre-Installations and Interim Services

The pre-installation of lateral service connections is a refinement of the corridor upgrade approach. Some pavement cuts resulting from land development can be avoided if lateral and building service connections are pre-installed in anticipation of future development. The cost of such pre-installations can usually be recovered from future developers. To install an appropriate number of connections at appropriate locations, future development layouts must be predicted.

In some cases, where accurate future development layouts are difficult to predict, a larger than standard building service connection may be installed to

accommodate higher demand than that expected from a single building service connection (e.g., for multiple buildings).

Municipalities with very high growth rates also occasionally install interim size utilities first and then upgrade the utilities when future demand warrants it. Sometimes, interim size utilities are installed under interim roads to be widened in the future. In such cases, the location of ultimate utilities should be predetermined to avoid or minimize pavement cuts during upgrading.

3.5.4 Utilidor and Trenchless Technologies

A refinement to the corridor upgrade approach is the installation of a utilidor to house a variety of utilities, such as fibre optics, telephone, cable, and hot water for central heating. While utilidors are relatively common in Europe and in buildings throughout North America, their application to urban infrastructure is new. This type of installation, which is relatively uncommon in Canadian urban infrastructure at present, is usually justified only in downtown cores, where utility space is at a premium or under extreme weather conditions. The benefits of utilidors include:

- one-time construction of the corridor;
- long term access to utilities;
- ease of maintenance; and
- minimal disruption to surfaces, such as roads.

Prince George, British Columbia is moving forward on the installation of a utilidor in its downtown over the next few years, and the city's experience will be useful to monitor.

Many municipalities use various trenchless construction techniques to rehabilitate or install underground utilities. Overall benefit can be achieved by avoiding pavement cuts and the resulting disruptions.

4. APPLICATIONS AND LIMITATIONS

4.1 APPLICATIONS

In their efforts to improve coordination of the various infrastructure works, local governments employ a wide range of practices. The exact practices employed vary due to a number of factors, which are often community or politically based. It is felt that, except in some specific circumstances, it is not appropriate to specify which practice should be used in all situations. This report generally provides a listing of the various practices, which have been employed, to enable individual communities looking to improve their practices to choose from the options. On occasion, it is clear from a technical perspective, that some practices are preferable from the context of maintaining infrastructure. Where this occurs, commentary is provided. Examples include:

- multi-year plans;
- formal coordination committees;
- corridor reviews;
- pavement degradation fees;
- dedicated funding approvals for infrastructure needs;
- block funding approvals; and
- highlighting life cycle costing in presentations.

The actual implementation of those practices will be affected to a significant degree by the community culture and the specific council's attitude. It may not be possible to achieve certain practices in some areas.

4.2 LIMITATIONS

Practices are often driven by a number of factors, specific to the municipality or area in question. For example, Yellowknife practices a high degree of corridor replacement, which is largely driven by history and the climate of the far north. Other urban centres have not yet hit the replacement phase, which is common in older cities. For example, Gander, Newfoundland was largely developed at one time after the war, but Surrey, British Columbia, with its very high growth rates in the last two decades, has the vast majority of its infrastructure in good condition due to its relatively young age. Specific potential limitations on the success of some of the practices outlined include the short planning horizon of some infrastructure providers (e.g., external utility companies), which are not within the control of individual municipalities. The trends in government toward downsizing and cutting administrative costs also may significantly limit the

ability of individual organizations to undertake many of the practices listed. The attitude of some councils regarding delegation, approval processes, and equity across the city also pose significant limitations on implementing a number of practices.

Many other limitations not discussed here, relate to community acceptance of restrictive practices and disruption.

5. EVALUATION

Success in implementing the practices outlined in this best practice is subjective. Due to the differing cultural attitudes within communities, priority should be placed on achieving incremental improvements in the various tools used. Evaluations can be made to measure a particular community against its past practice and the practices employed by other municipalities, as outlined in this best practice. However, it needs to be recognized that there is a wide range of practices in use, and the need for certain practices varies significantly with respect to the size of the community. The larger the community, the more complex the various procedures generally need to be.

Notwithstanding that many of these practices vary significantly among communities, it is possible to review the various practices outlined and periodically evaluate the success of a particular organization in implementing them. Appropriate criteria might include:

- the length of the plans distributed to the various infrastructure providers;
- the frequency of contact with external agencies;
- the existence of a formal multi-agency committee to review these issues;
- the existence of no-cut rules and pavement degradation fees;
- the size of the annual infrastructure deficit and the frequency of reporting to council and the public on these issues; and
- the existence of block funding approvals.

It should always be remembered that the primary consideration for success in this area is the overall effectiveness of the infrastructure providers in both the eyes of the local council and the community. This is affected by many intangible factors, but is the ultimate measure of success.

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City of Coquitlam

Transit Oriented **Development**

Coquitlam

Overview

- Coquitlam Context
- Transit-oriented Development Strategy
- Burquitlam-Lougheed Neighbourhood Plan
- City Centre Area Plan update
- Funding for Growth
- Parking Management
- Pinetree Way enhancement project
- North Road/Clarke Road enhancement project

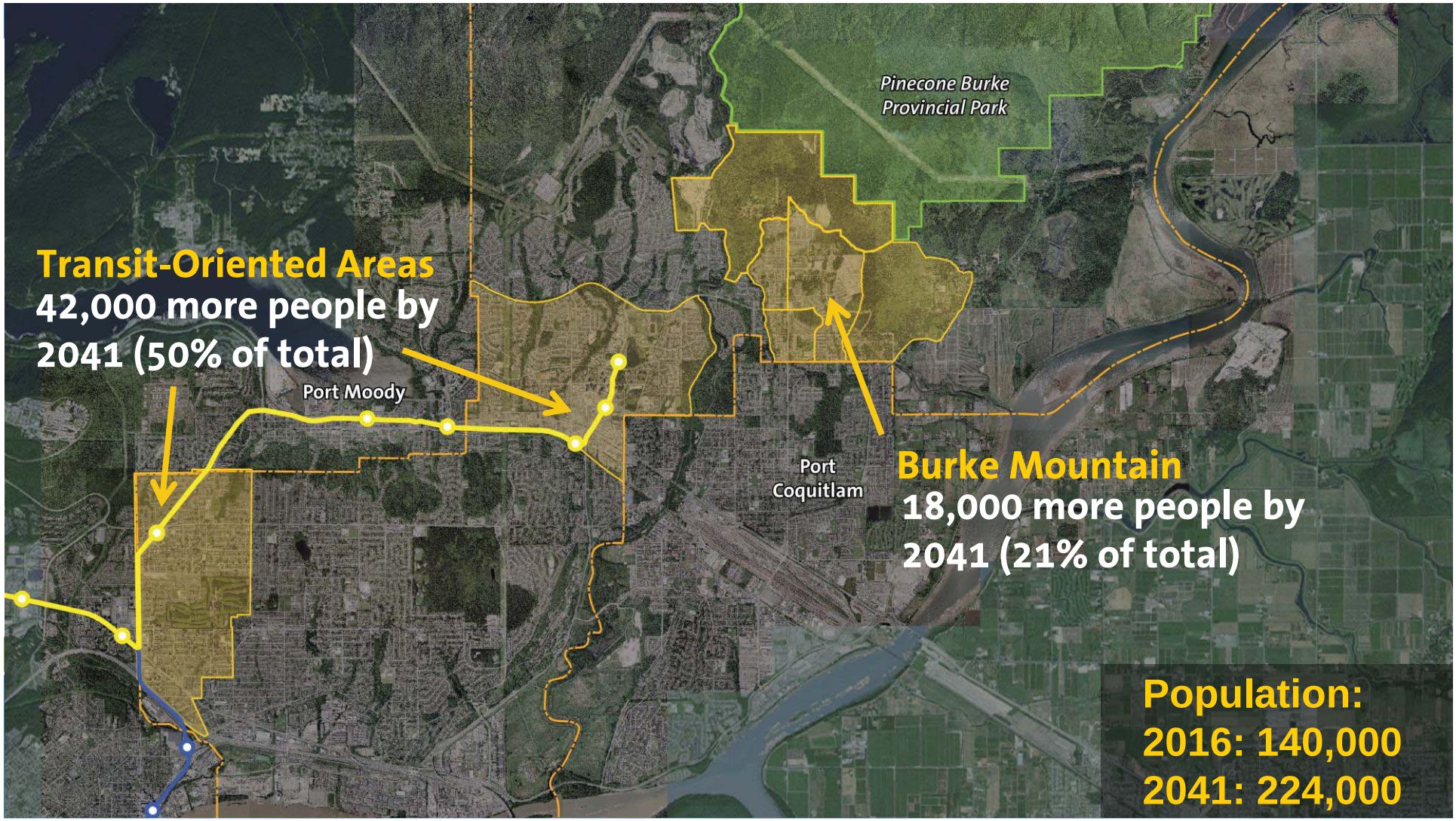
Coquitlam at a Glance

- **Population** – 152,000 (2018)
- **Growth Rate** – 2.5% per year (2011-2016), one of the fastest in BC
- **Diverse Community** – 40% of population born outside of Canada
- **Demography** – younger than the Region as a whole

High Growth Community

- Coquitlam is the fastest growing municipality in greater Vancouver (per capita)
- Growth focused in two areas – along SkyTrain corridor and on Burke Mountain
- Coquitlam is not just growing rapidly, the community is also changing and evolving as we grow




Pinecone Burke
Provincial Park
Transit-Oriented Areas
42,000 more people by
2041 (50% of total)
Port Moody
Port
Coquitlam
Burke Mountain
18,000 more people by
2041 (21% of total)
Population:
2016: 140,000
2041: 224,000

Shaping Growth

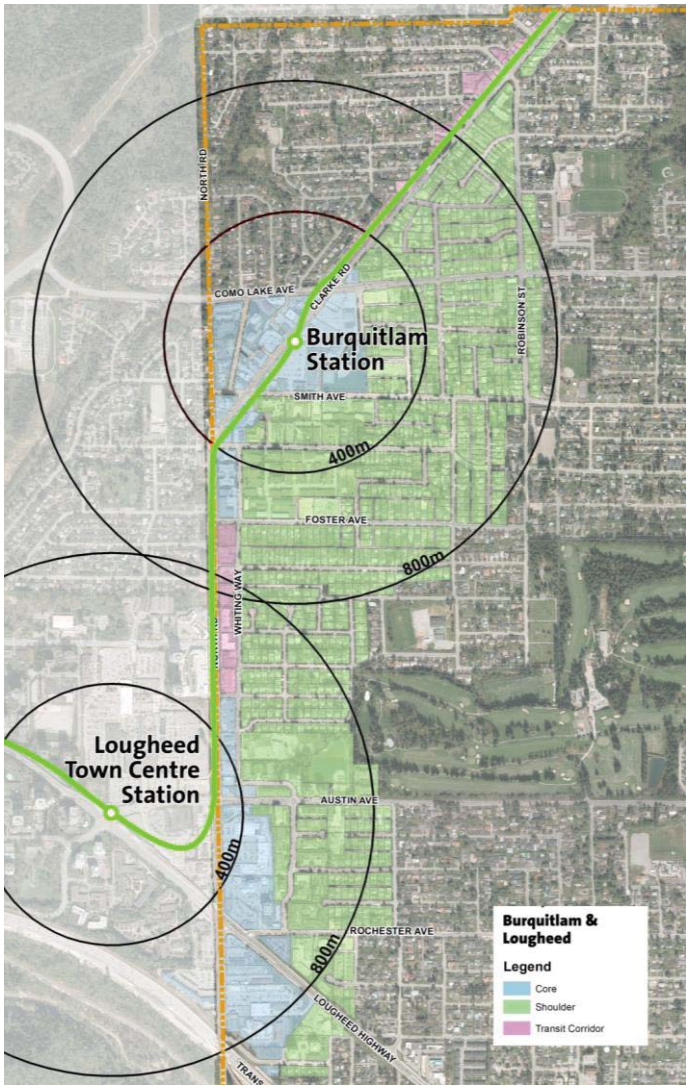
The SkyTrain will influence growth for next 100 years

Leverage this investment, to create:

- density around stations
- mixed-use development
- pedestrian-friendly streets
- new amenities

Transit-Oriented Development Strategy (TDS)

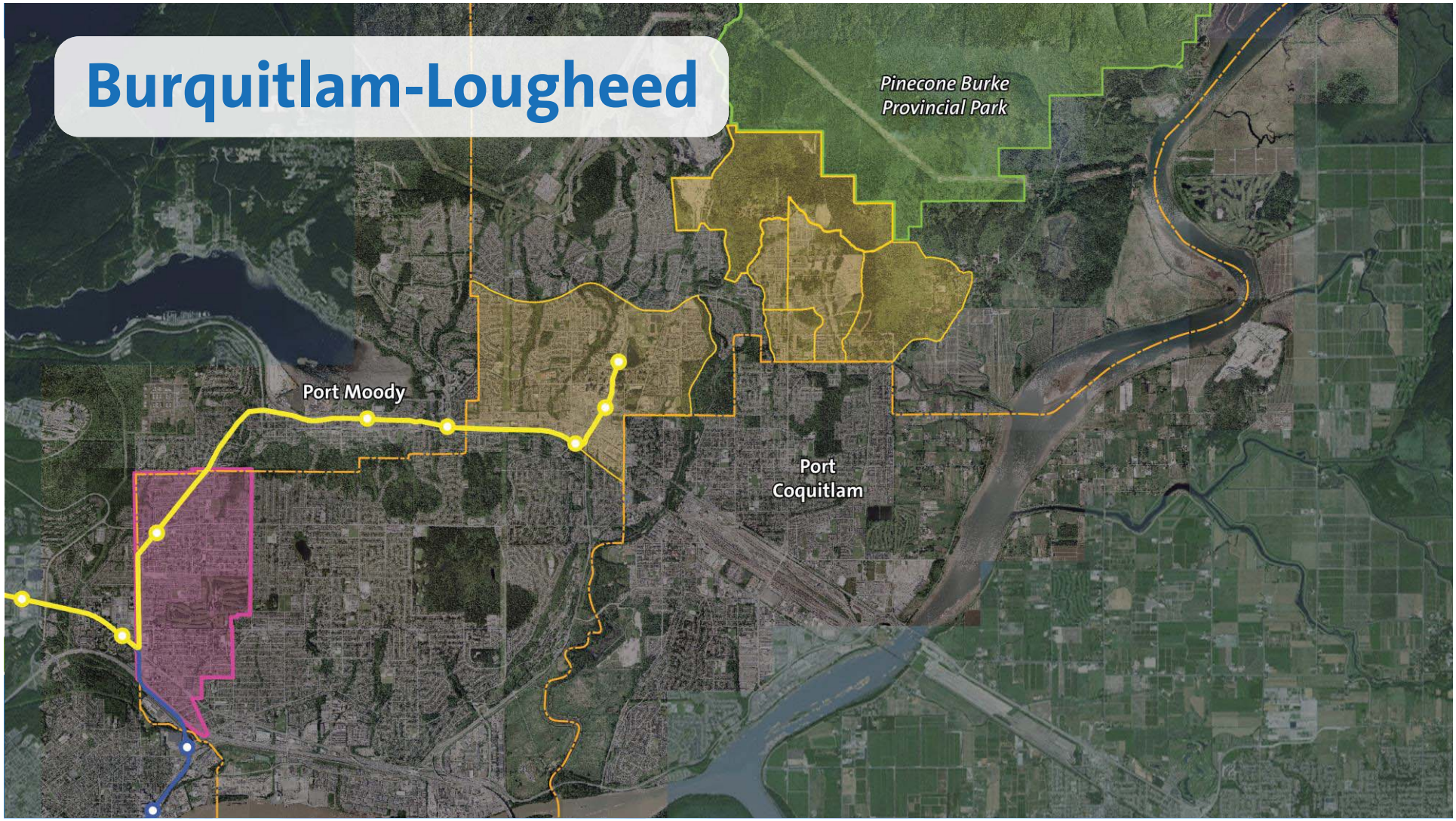
- High-level, focused process completed in 2012
- Interim policy to guide development until comprehensive plan updates
- Focus growth near stations, while building Great Places
- Designated “Core” and “Shoulder” areas

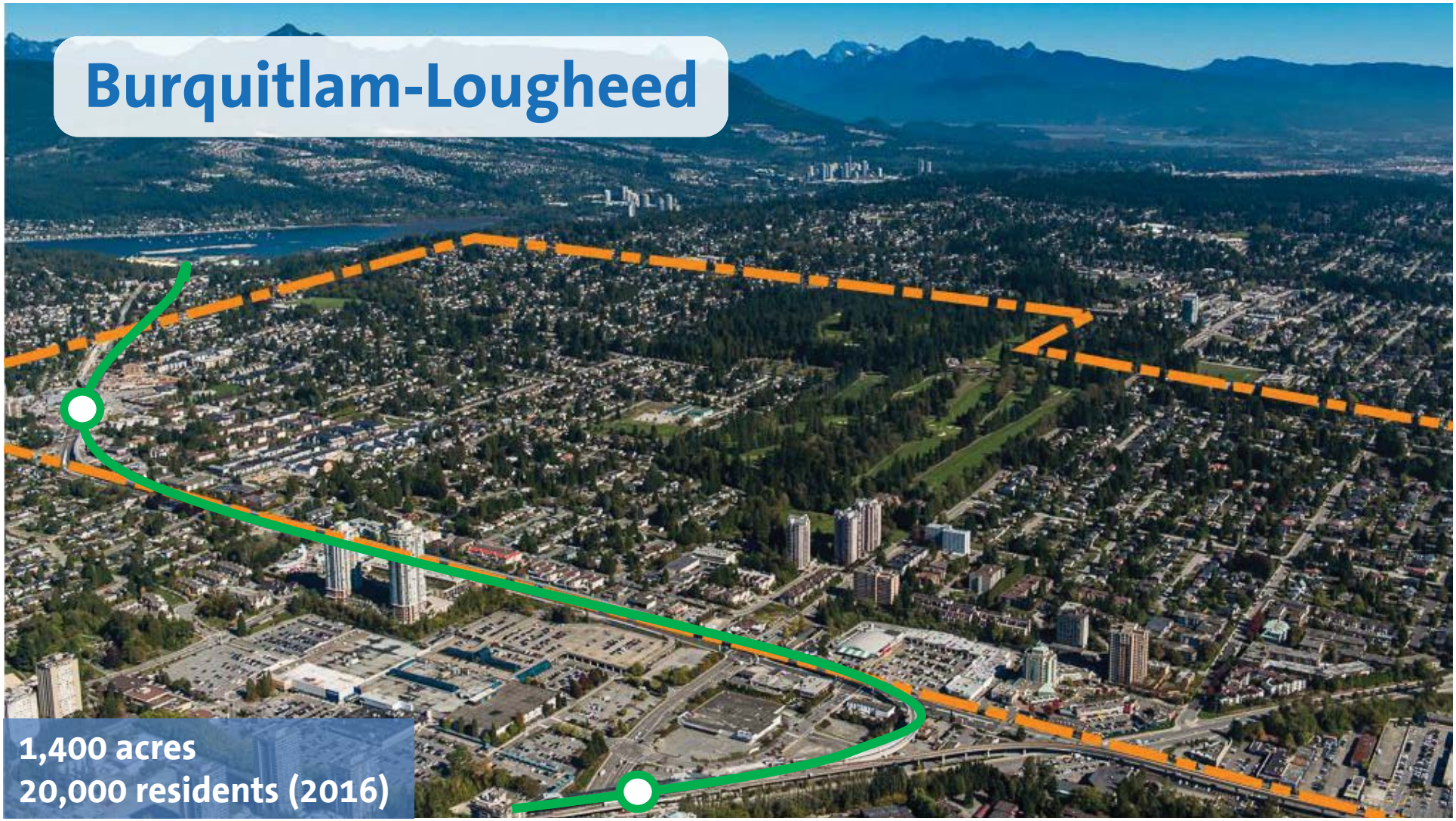


TDS Key Objectives

- Create compact, complete neighbourhoods
- Create great places
- Develop transit-supportive density
- Promote sustainable transportation choices
- Implement high quality urban design
- Manage parking

Burquitlam-Lougheed




Burquitlam-Lougheed
1,400 acres
20,000 residents (2016)

Planning Process

- **Phase 1 – Background, ideas and opportunities**
- **Phase 2 – Land Use, transportation and amenities**
- **Phase 3 – Draft Plan**

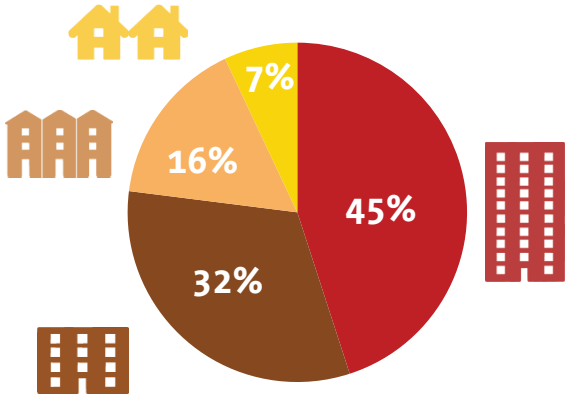
Land Use Overview

Guide 'locally appropriate' growth:

- Focus density into 'Core' areas, as per TDS
- Improve transition between land uses
- Family-friendly housing mix
- Support transportation, streetscape, park and amenity improvements
- Redevelopment directed to 34% of plan area

Unit Projection

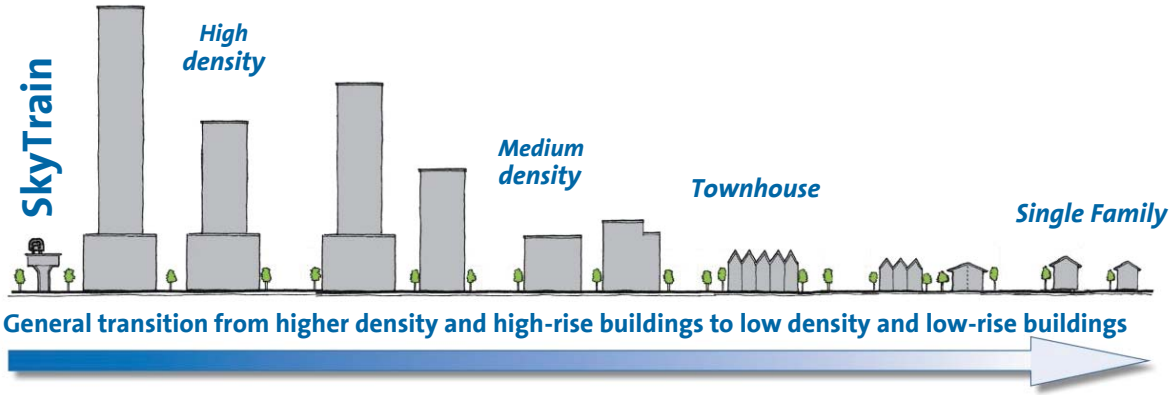
To 2041

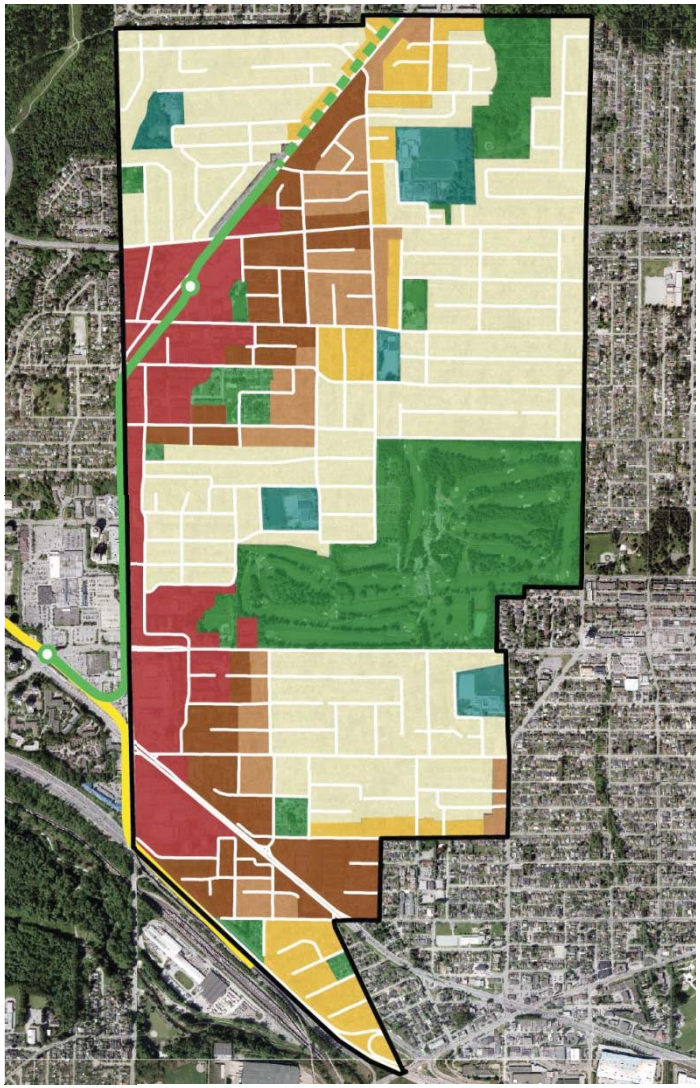


9,000-10,000 units

Land Use Overview

- 300 acres for 7,000 apartments
- 100 acres for 1,500 townhouses
- 85 acres for Housing Choices
- 150 acres of single-family re-designated to higher and better uses

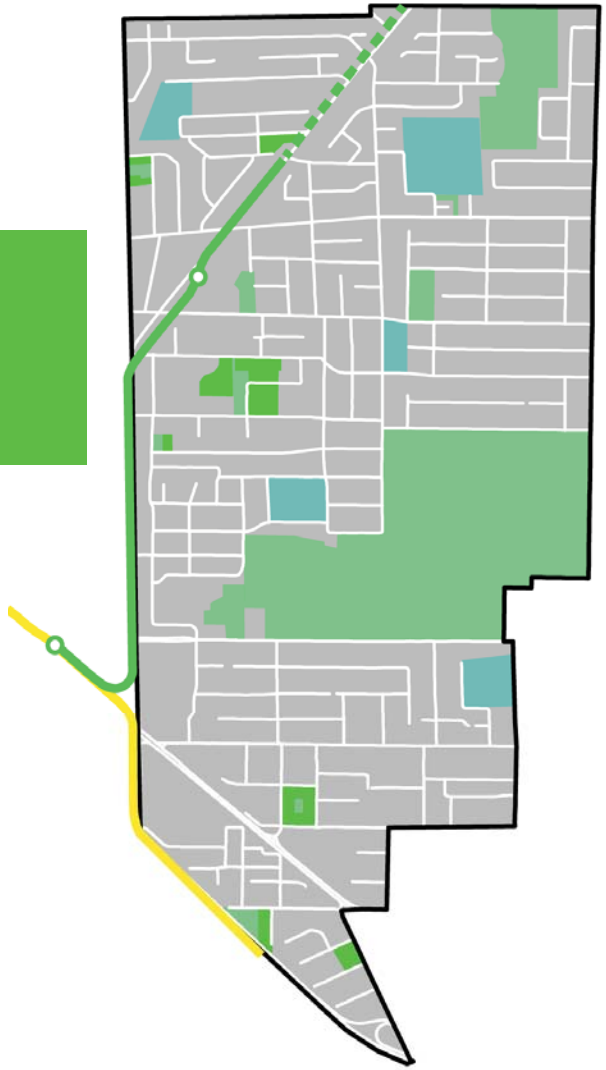




Parks Approach

New Parks

- Double the park space
- Approximately 10 hectares (25 acres) of new parks over 30 years
- Priority determined by Park Prioritization Framework and as opportunities arise

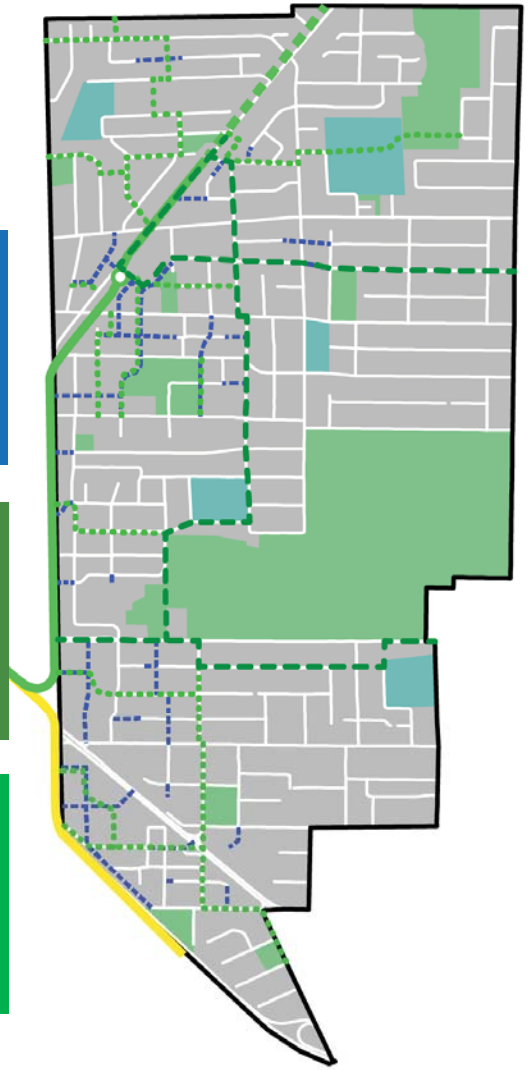


Transportation Approach

New Streets and Lanes

Citywide Greenways

Neighbourhood Greenways

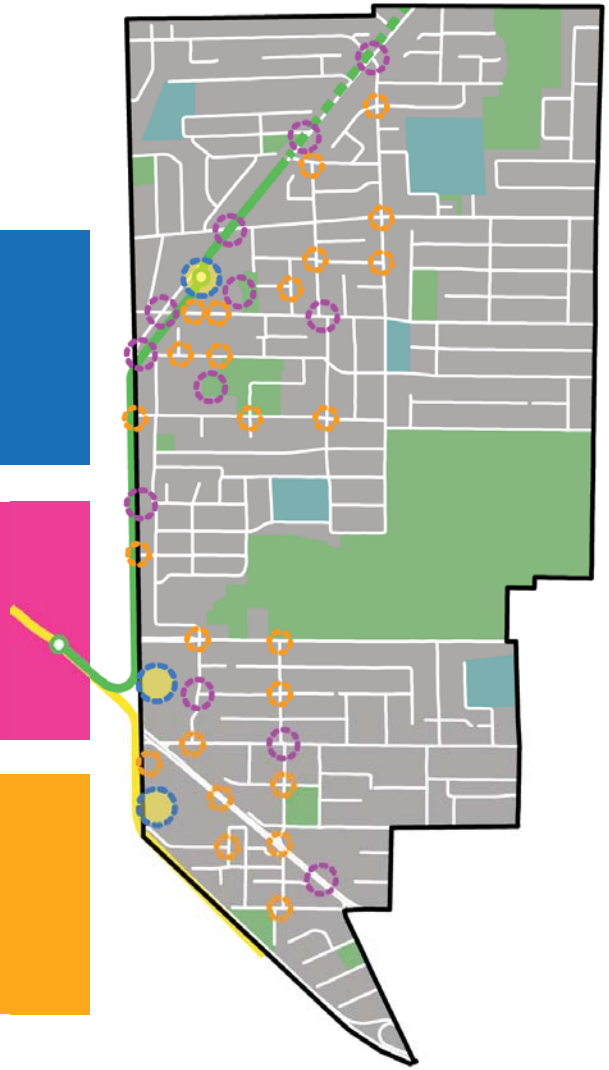


Urban Design Framework

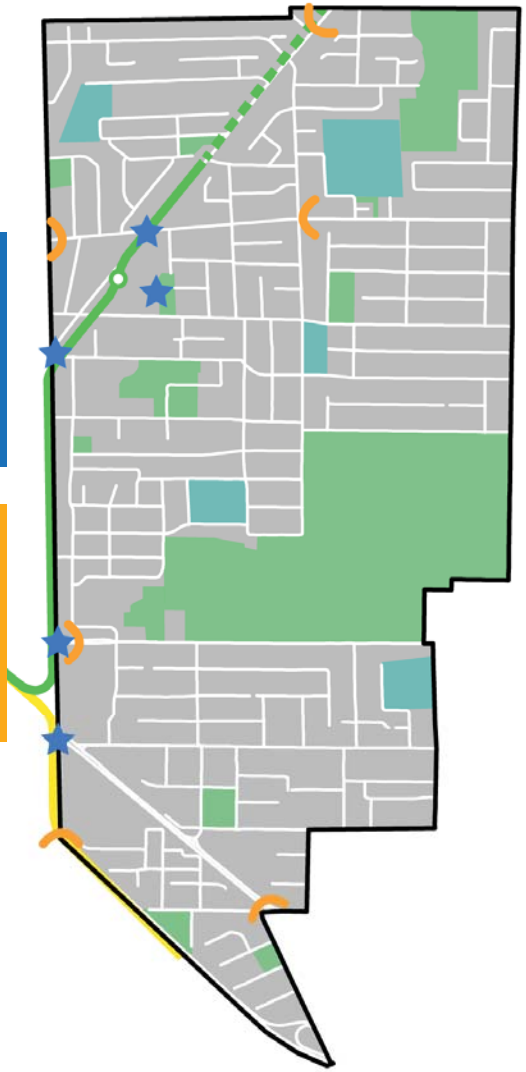
Primary Node

Major Node

Minor Node



Urban Design Framework



Public Consultation Process

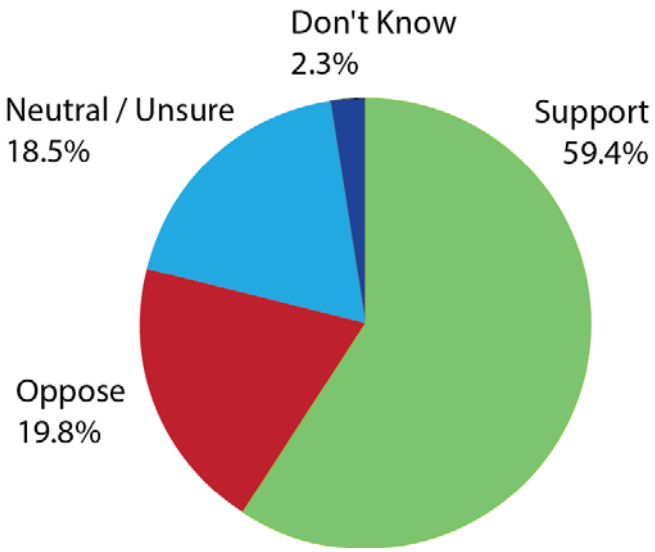
- 1,500 Community Information Session attendees
- 1,750 survey responses
- 28 meetings with community and stakeholder groups
- 21 petitions received
- 600+ letters and emails

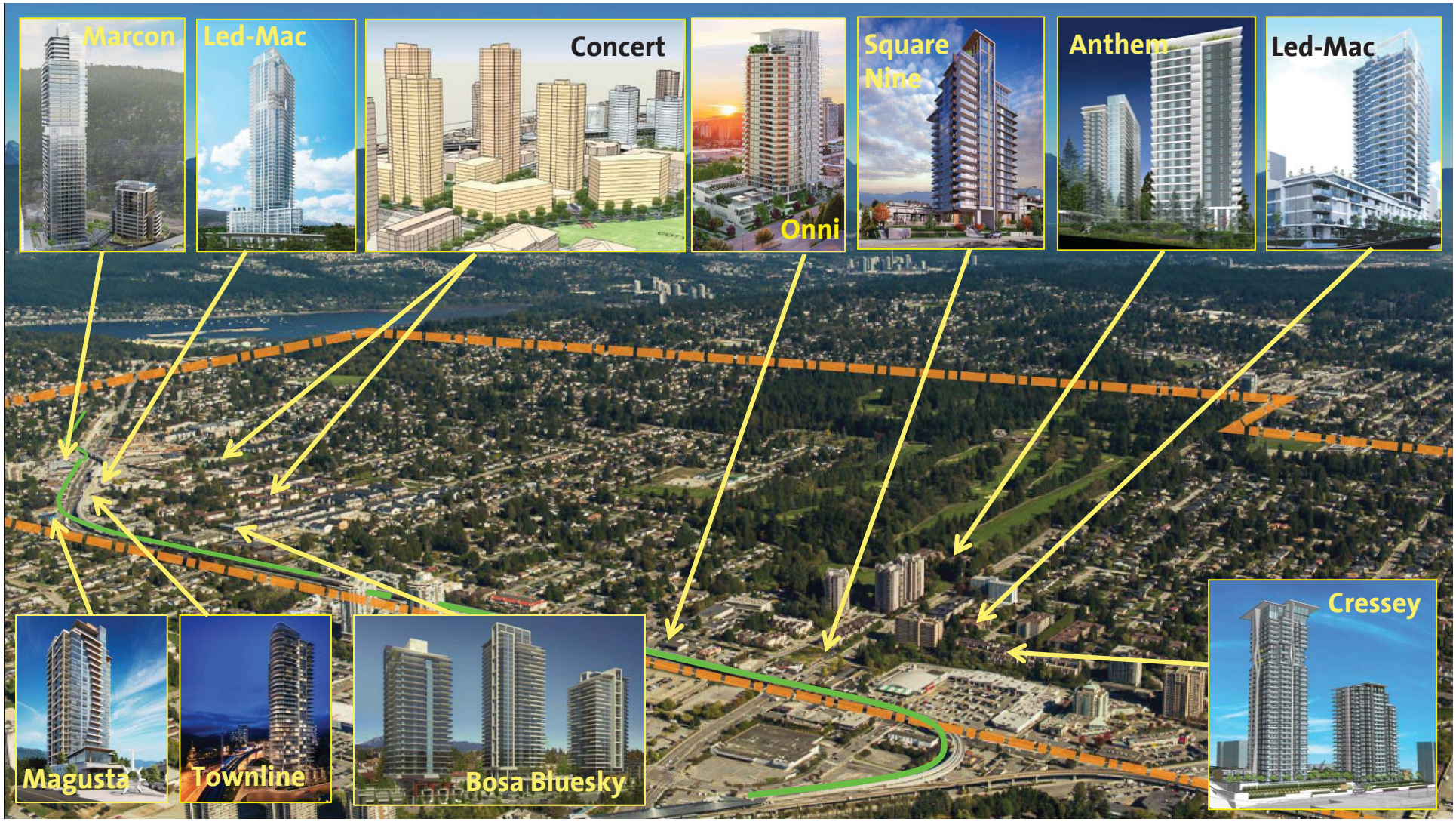
4,700+
Participant Interactions

What we heard

Overall Support for the Draft Plan:

- **60% in support**
- **Level of those neutral / unsure similar to opposed**



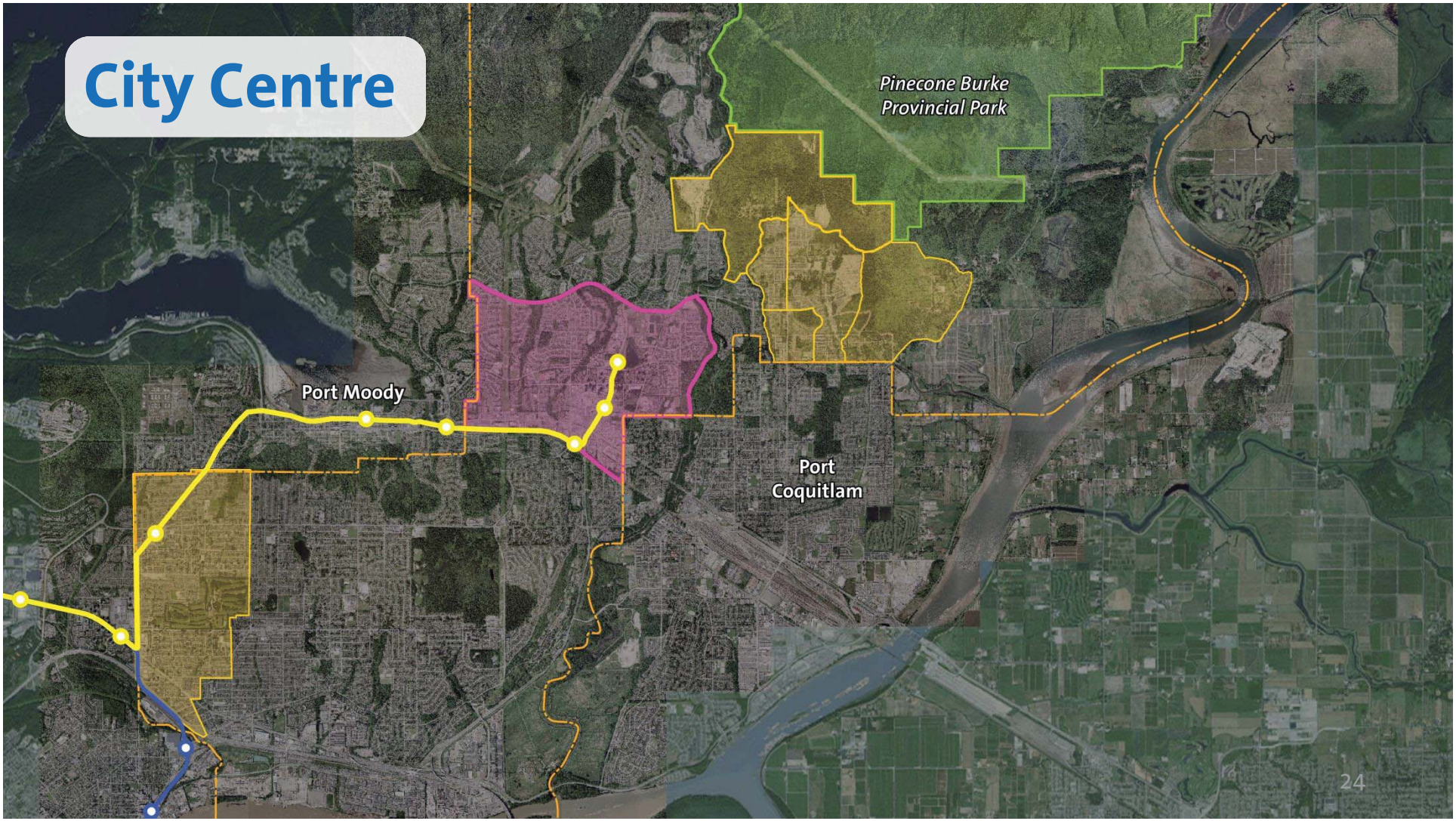

Marcon
Led-Mac
Concert
Onni
Square Nine
Anthem
Led-Mac
Magusta
Townline
Bosa Bluesky
Cressey


Marcon
Led-Mac
Concert
Onni
Square Nine
Anthem
Led-Mac
7,300+ units of current development activity
Magusta
Townline
Bosa Bluesky
Cressey

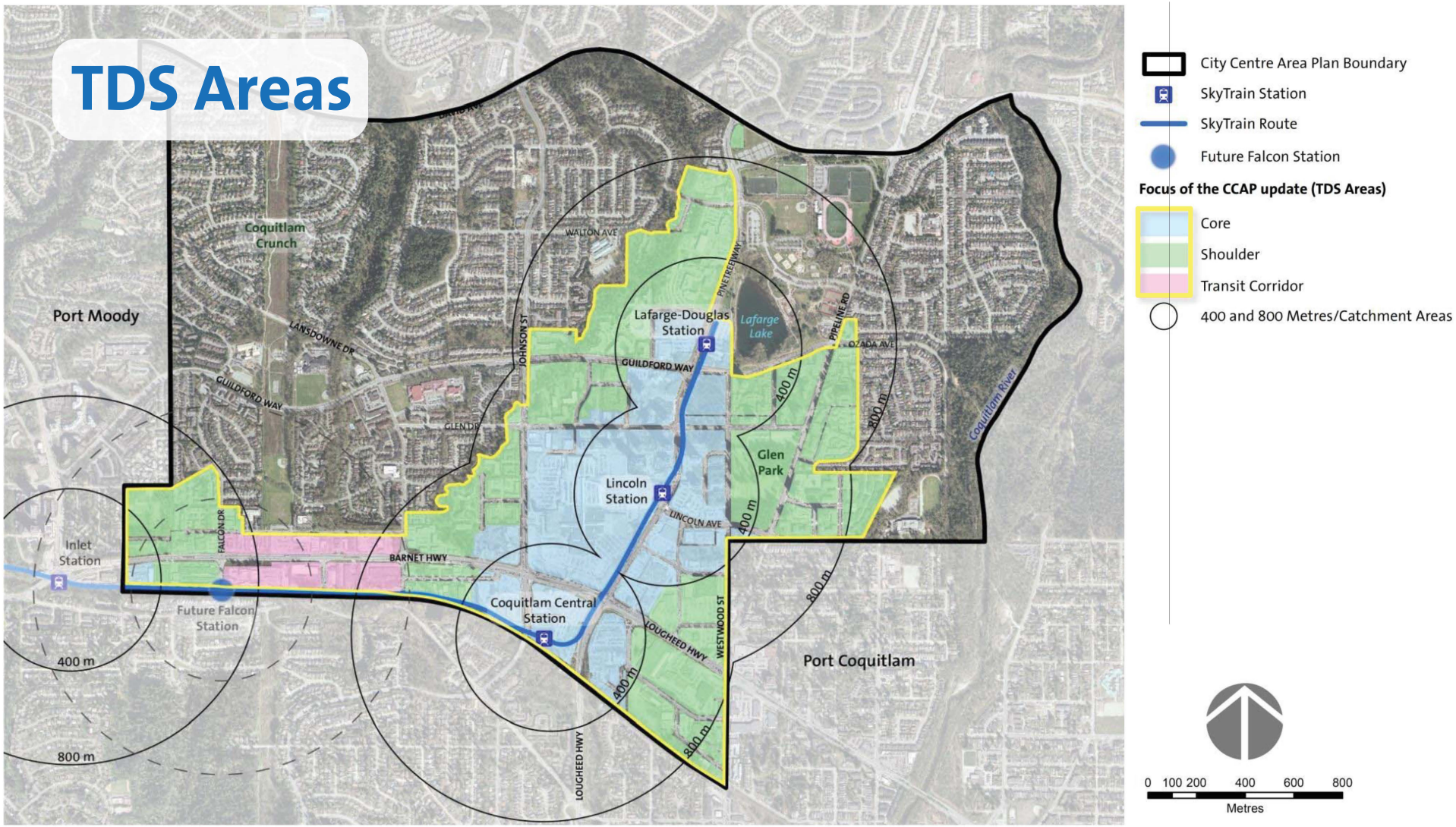
North Road: Today

North Road: Future

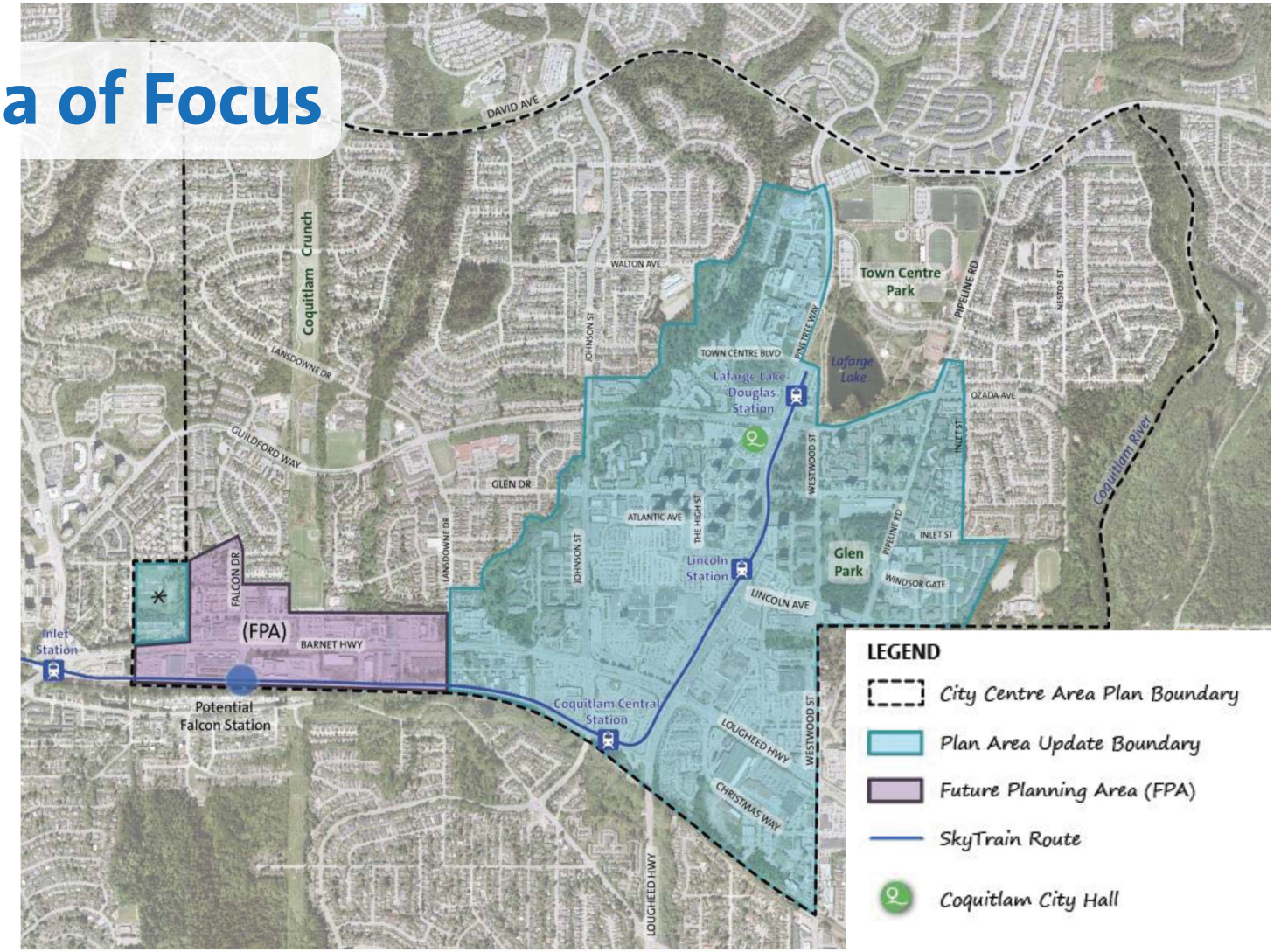
City Centre



TDS Areas

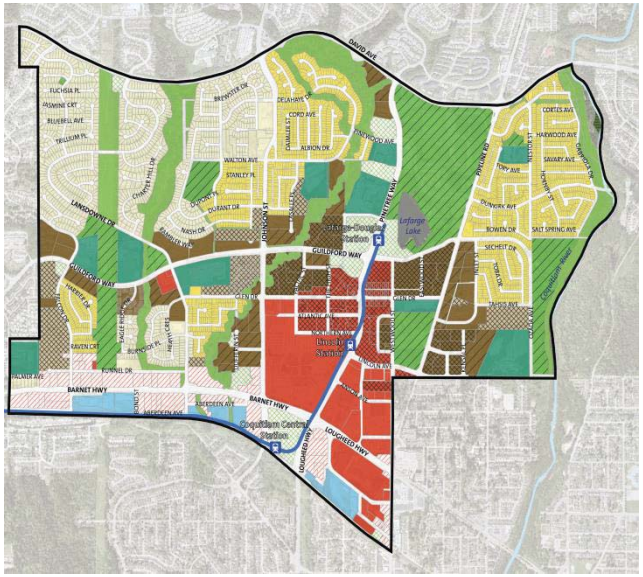

Port Moody
Coquitlam Crunch
LANSDOWNE DR
GUILDFORD WAY
GLEN DR
WALTON AVE
JOHNSON ST
PINETREE WAY
Lafarge-Douglas Station
Lafarge Lake
PIPELINE RD
OZADA AVE
Coquitlam River
Glen Park
Lincoln Station
LINCOLN AVE
400 m
800 m
Inlet Station
FALCON DR
BARNET HWY
Future Falcon Station
Coquitlam Central Station
LOUGHEED HWY
WESTWOOD ST
Port Coquitlam
City Centre Area Plan Boundary
SkyTrain Station
SkyTrain Route
Future Falcon Station
Focus of the CCAP update (TDS Areas)
Core
Shoulder
Transit Corridor
400 and 800 Metres/Catchment Areas
0 100 200 400 600 800
Metres

Area of Focus

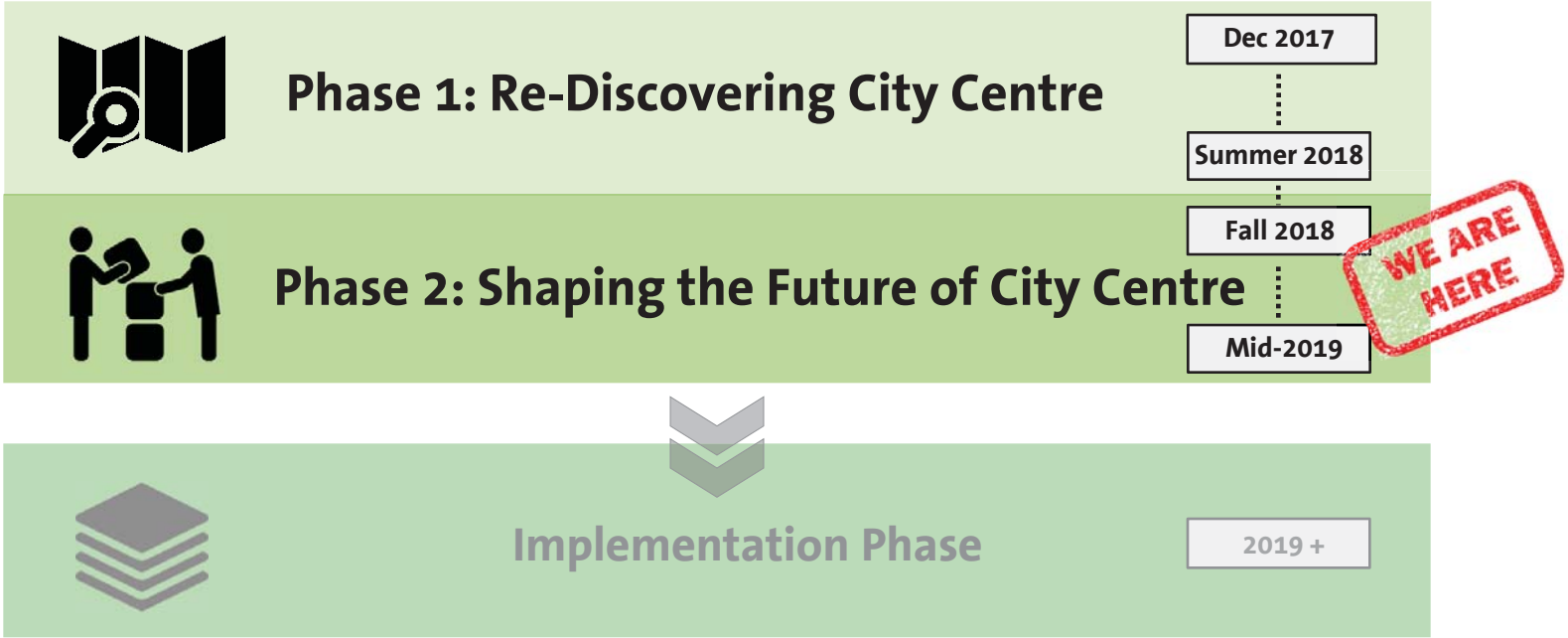


Scope of Work

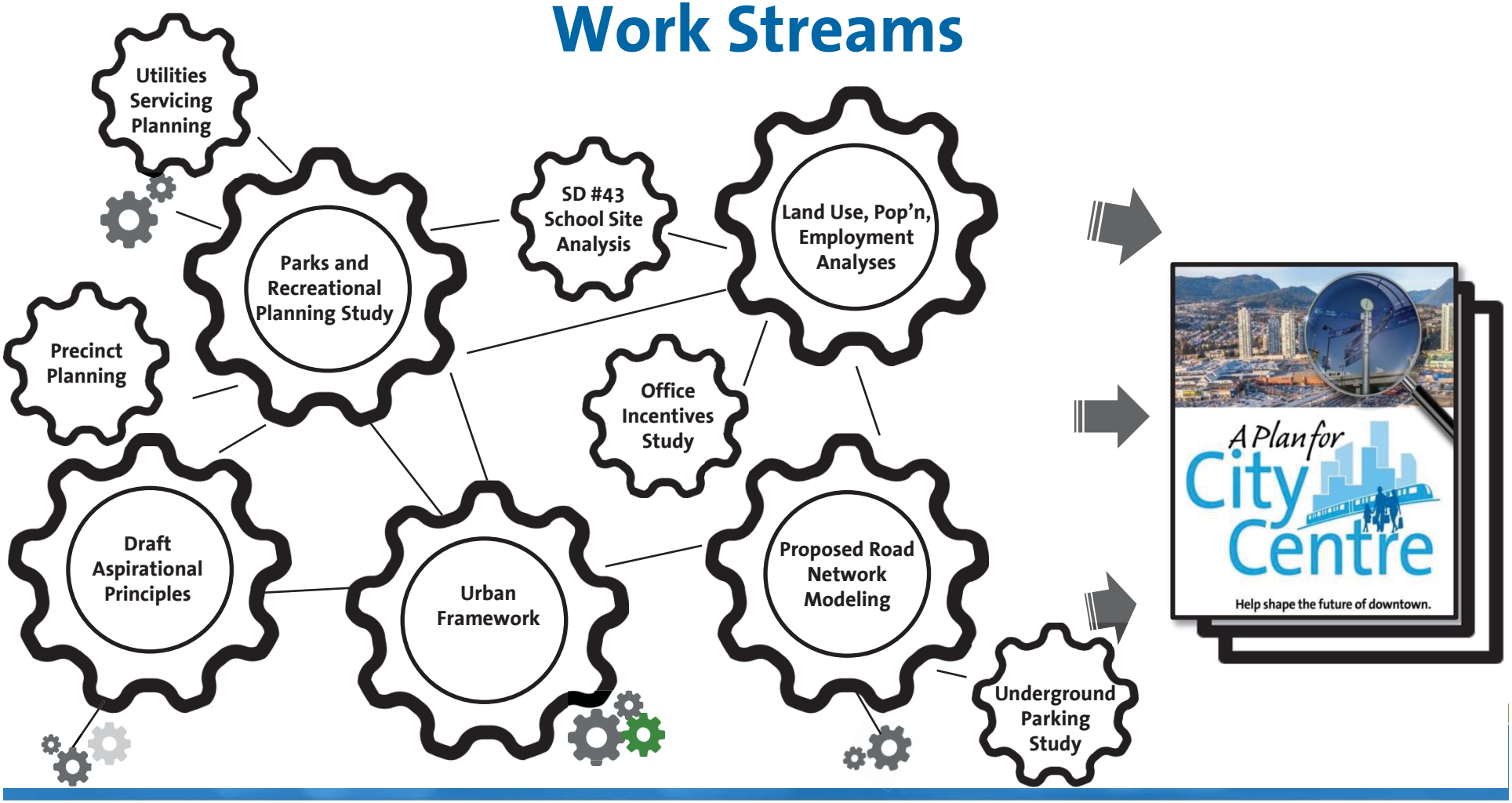
- Solidify City Centre as a regional centre and downtown
- Update OCP land uses & policies
- Prepare urban framework
- Attracting employment
- Establish finer street grid and smaller blocks
- Public open space network
- Plan for public utilities and amenities



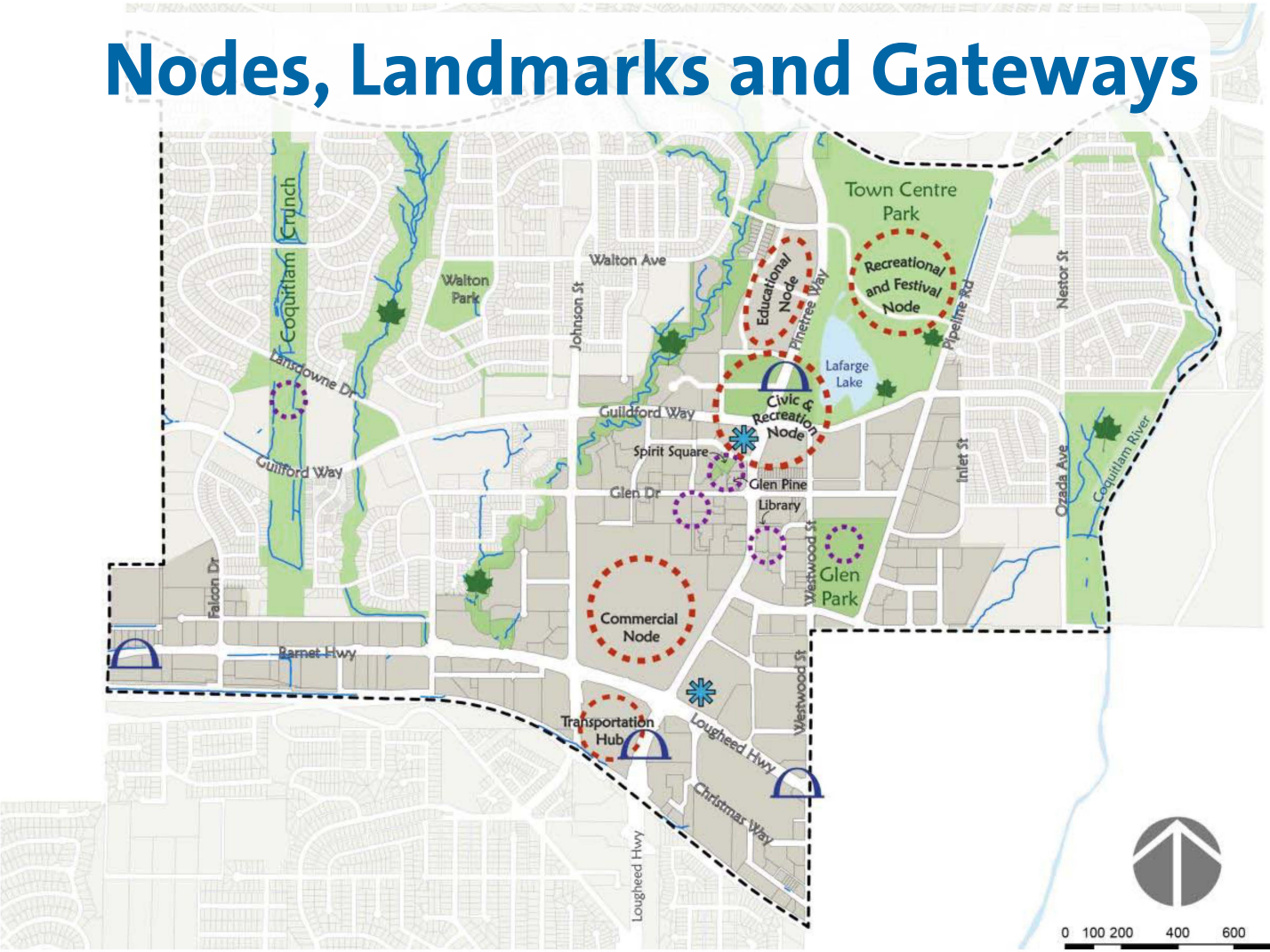
City Centre Area Plan Update Timeline



Work Streams



Nodes, Landmarks and Gateways



LEGEND

- City Centre Area Plan Boundary
- Plan Area Update Boundary
- Current Major Node
- Current Minor Node
- Built Landmarks
- Environmental Landmarks
- Future Gateway
- Watercourses

Major Nodes are large spaces that encourage public gathering and are characterized by a high level of activity.

Minor Nodes are smaller public spaces that encourage public gathering and are typically used by people who live or work in the area.

Landmarks are physical points of significance, e.g. iconic buildings, mountains, bridges, and monuments that often represent ideas or events of special significance and are important to the community. They are typically visible from various distances, and aid in wayfinding.

Gateways will be developed as points of significance that create a sense of arrival and announce the entrance or passage into City Centre.

Plazas, Gardens & Squares

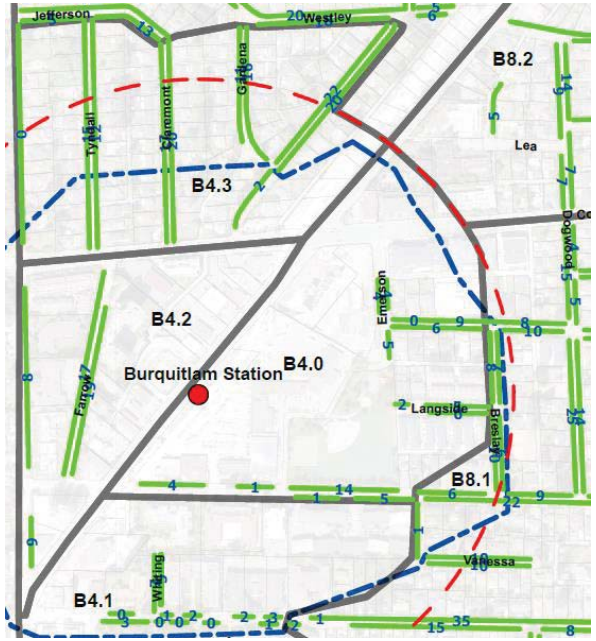
- Built Through Development and Publicly Accessible 24/7
- Contribute to the quality of life of residents, workers and visitors
- Implemented to fill in gaps and create new focal points
- Unique character and opportunity to connect open spaces
- Types: plazas, gardens, squares, courtyards, parkettes, etc.

Funding for Growth

Growth Shall pay for Growth

- Development Cost Charges
- Density Bonus
- Community Amenity Contributions (CACs)

Parking Management

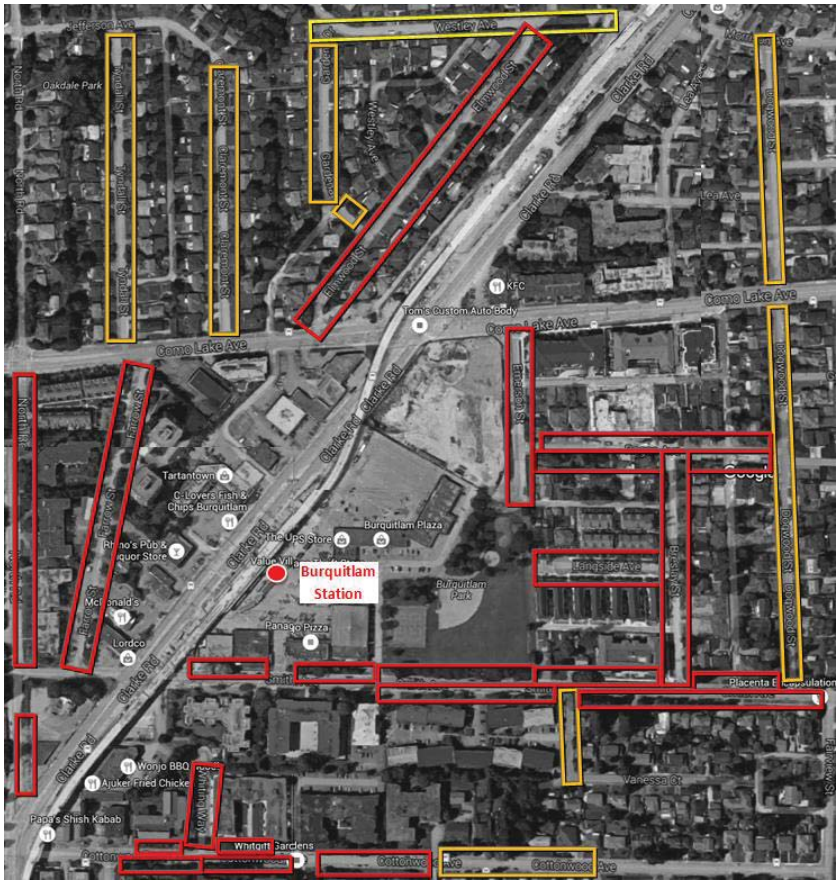


Unrestricted Daytime Spare Capacity

Before Intervention
Blocks under pressure

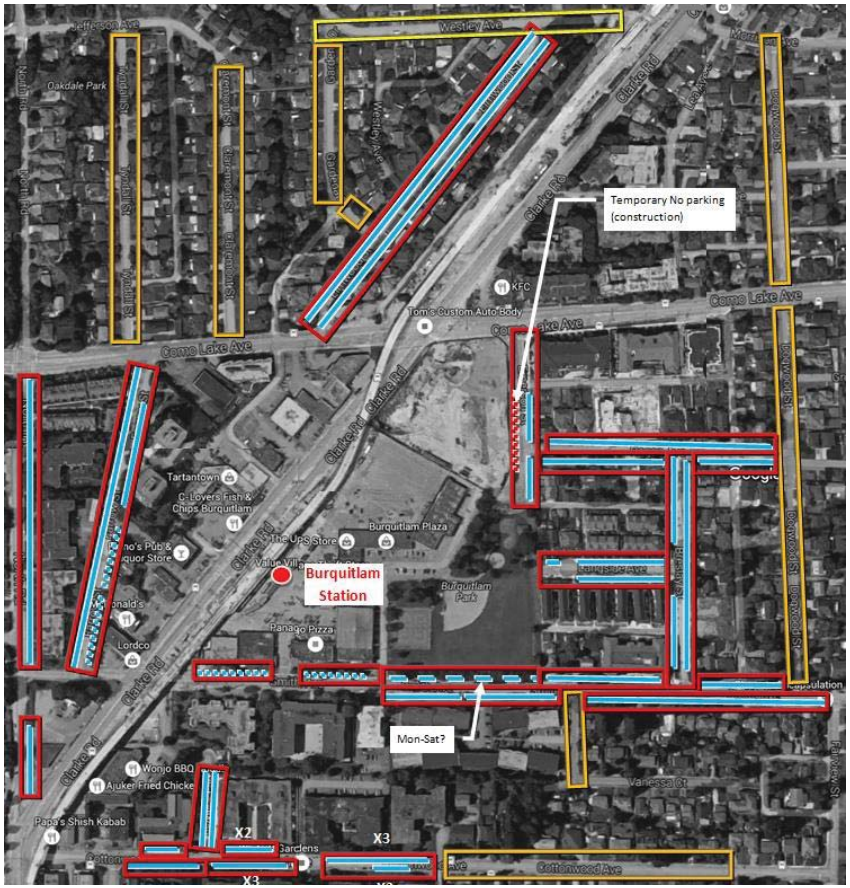
After Intervention
Anticipated blocks under pressure and requiring monitoring

After Intervention
Fringe Blocks requiring monitoring

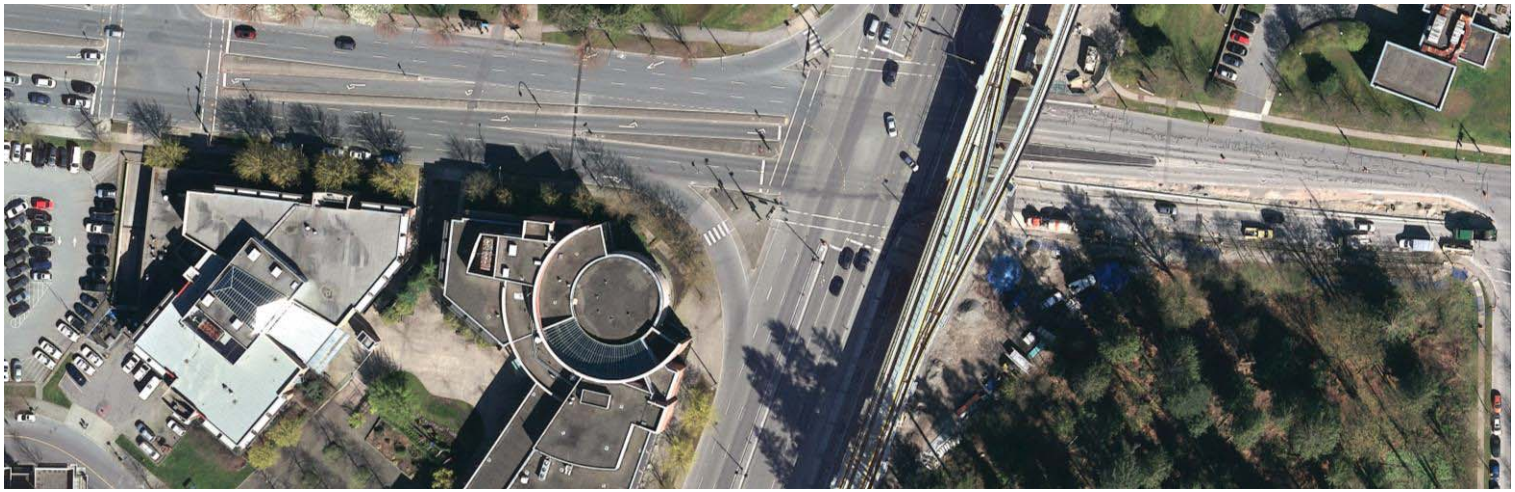


Parking Management

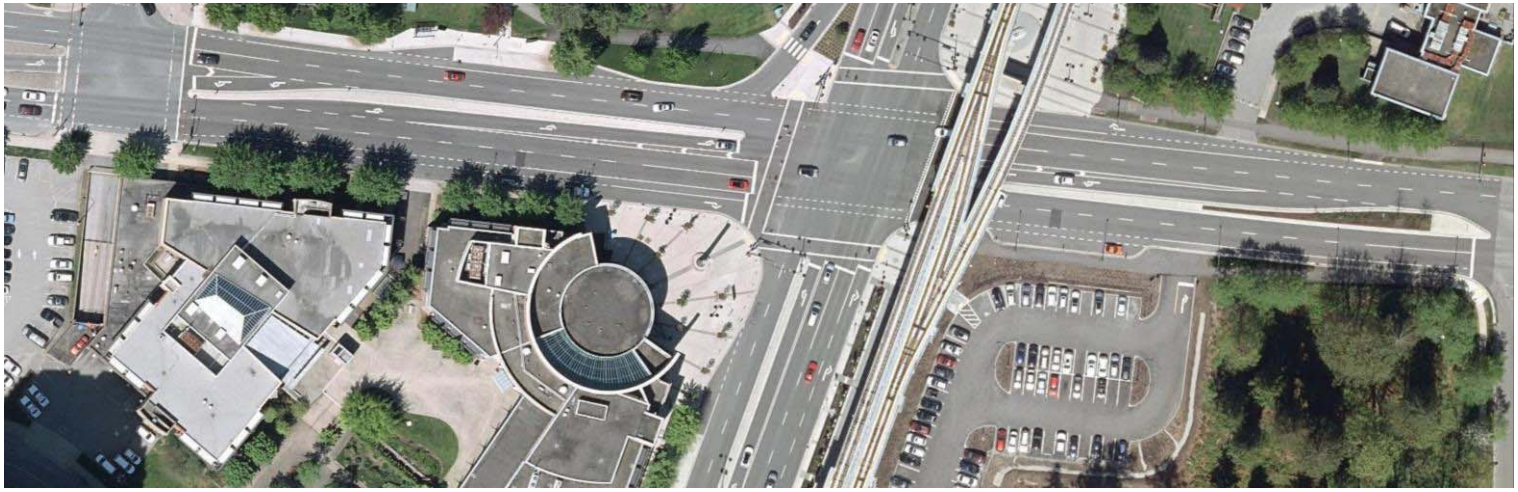
- Pay – Up to 2 hrs 8am-6pm Mon-Fri
- Pay – Up to 4 hrs 8am-6pm Mon-Fri
- Pay – Up to 4hrs 8am-6pm Mon-Sat
- Time – Up to 2hrs 8am-6pm Mon-Fri
- Time – Up to 4hrs 8am-6pm Mon-Fri
- Time – Up to 4hrs 9am-3pm Mon-Fri



Before



After



Before

After


NORTHERN
Northern
Lincoln Sta
Bubble Vi
Hilton
melitopol

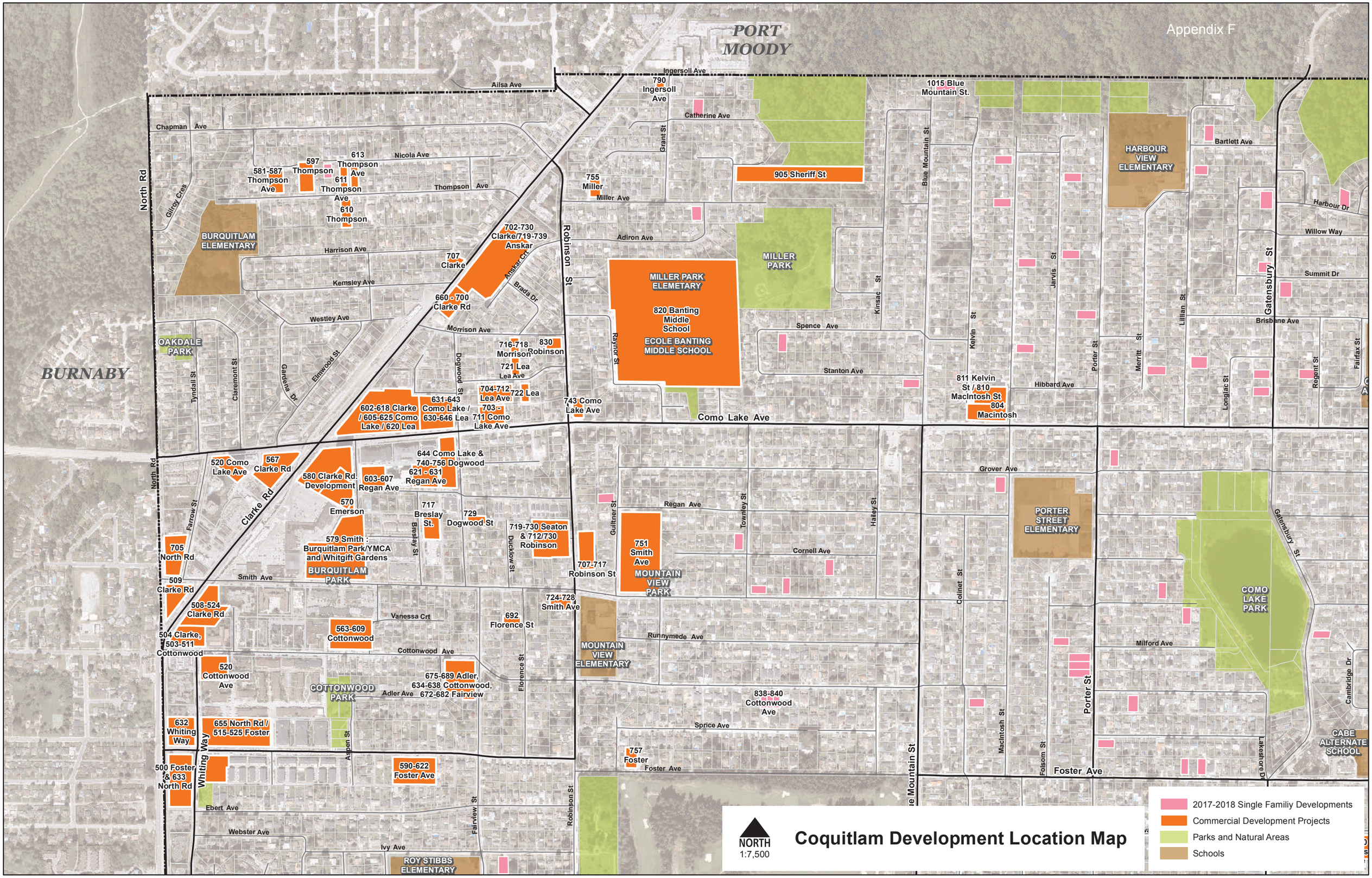

RE
427


NORTH ROAD
CAMERON STREET
SHOPPERS
DRUG MART

Thank-You!

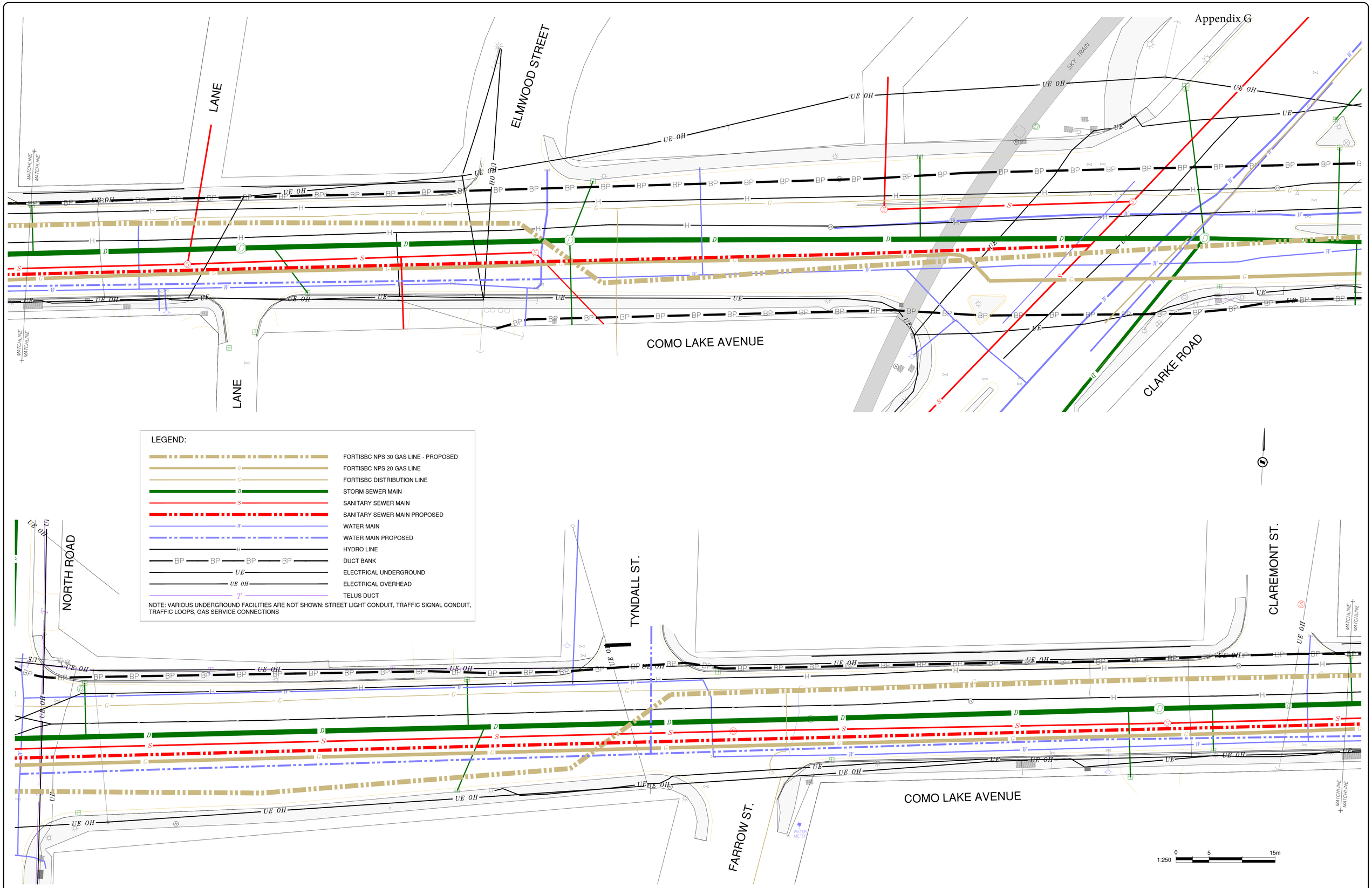
Andrew Merrill
Manager Community Planning
amerrill@coquitlam.ca

Appendix F


PORT MOODY
BURNABY
Ingersoll Ave
790 Ingersoll Ave
Ailsa Ave
Catherine Ave
1015 Blue Mountain St.
Chapman Ave
Nicola Ave
581-587 Thompson Ave
597 Thompson
613 Thompson Ave
611 Thompson Ave
610 Thompson
Thompson Ave
Grant St
905 Sheriff St
HARBOUR VIEW ELEMENTARY
Bartlett Ave
Harbour Dr
Willow Way
Summit Dr
Brisbane Ave
Gatensbury St
North Rd
Gilroy Cres
BURQUITLAM ELEMENTARY
755 Miller
Miller Ave
Blue Mountain St
Harrison Ave
702-730 Clarke/719-739 Anskar
707 Clarke
Anskar Crt
Robinson St
Adiron Ave
MILLER PARK
MILLER PARK ELEMETARY
820 Banting Middle School
ECOLE BANTING MIDDLE SCHOOL
Kemsley Ave
Brada Dr
660 - 700 Clarke Rd
Westley Ave
Morrison Ave
Kinsac St
Jarvis St
Kelvin St
Spence Ave
Raynor St
Lillian St
Merritt St
Porter St
Fairfax St
Regent St
Longlac St
OAKDALE PARK
Tyndall St
Claremont St
Gardena Dr
Elmwood St
716-718 Morrison
830 Robinson
721 Lea
Lea Ave
Dogwood St
704-712 Lea Ave
722 Lea
Stanton Ave
Hibbard Ave
811 Kelvin St / 810 MacIntosh St
804 Macintosh
602-618 Clarke / 605-625 Como Lake / 620 Lea
631-643 Como Lake / 630-646 Lea
703 - 711 Como Lake Ave
743 Como Lake Ave
Como Lake Ave
520 Como Lake Ave
567 Clarke Rd
580 Clarke Rd Development
603-607 Regan Ave
644 Como Lake & 740-756 Dogwood
621 - 631 Regan Ave
Grover Ave
Farrow St
Clarke Rd
570 Emerson
717 Breslay St.
729 Dogwood St
Regan Ave
Guilfner St
Townley St
Hailey St
PORTER STREET ELEMENTARY
Gatensbury St
705 North Rd
579 Smith : Burquitlam Park/YMCA and Whitgift Gardens
Breslay St
Ducklow St
719-730 Seaton & 712/730 Robinson
751 Smith Ave
Cornell Ave
BURQUITLAM PARK
Smith Ave
509 Clarke Rd
707-717 Robinson St
MOUNTAIN VIEW PARK
Colinet St
COMO LAKE PARK
508-524 Clarke Rd
724-728 Smith Ave
Vanessa Crt
692 Florence St
504 Clarke, 503-511 Cottonwood
563-609 Cottonwood
Runnymede Ave
MOUNTAIN VIEW ELEMENTARY
Milford Ave
Cottonwood Ave
520 Cottonwood Ave
Florence St
675-689 Adler, 634-638 Cottonwood, 672-682 Fairview
COTTONWOOD PARK
Adler Ave
838-840 Cottonwood Ave
Cambridge Dr
632 Whiting Way
655 North Rd / 515-525 Foster
Aspen St
Sprice Ave
Macintosh St
Porter St
CABE ALTERNATE SCHOOL
757 Foster
Foster Ave
Folsom St
Lakeshore Dr
500 Foster & 633 North Rd
Whiting Way
590-622 Foster Ave
Ebert Ave
Fairview St
Robinson St
Webster Ave
Ivy Ave
ROY STIBBS ELEMENTARY
NORTH
1:7,500
Coquitlam Development Location Map
2017-2018 Single Familiy Developments
Commercial Development Projects
Parks and Natural Areas
Schools


PORT MOODY
Bend Crt
Chine Cres
Marine Cres
Harbour Dr
Willow Way
Summit Dr
Broadview Crt
Gatensbury St
Brisbane Ave
CRESTWOOD PARK
Balmoral Ave
Regent St
Fairfax St
QUEEN OF ALL SAINTS SCHOOL
Crestwood Dr
Rondeau St
Atkins St
Weston St
Levis St
Spray Ave
Fresno Pl
Selkirk Cres
840 Prospect St
Bowman Ave
Prospect St
St Laurence St
Custer Crt
Park Cres
Corona Cres
Sonora Dr
Huron Dr
Baker Dr
Sumpter Dr
BAKER DRIVE ELEMENTARY
Rogerson Dr
Hawser Ave
COQUITLAM GREEN LINKS
Thermal Dr
Seymour Dr
DR. CHARLES BEST SECONDARY SCHOOL
Lighthouse Crt
2601 Spuraway Ave
Como Lake Ave
Spuraway Ave
2600 Spuraway Ave
Grover Ave
PARKLAND ELEMENTARY
1990 Como Lake Ave
COMO LAKE VILLAGE
Montrose St
HILLCREST MIDDLE SCHOOL
Regan Ave
Gatensbury St
Cornell Ave
Woodvale Ave
Quinton Ave
Lomond St
Pinnacle St
Mariner Way
Smith Ave
COMO LAKE PARK
Poplar St
Arbury Ave
Firdale St
Milford Ave
Newport St
Rideau Ave
Walnut Cres
Lost Lake Dr
MUNDY PARK
Eden Ave
Cambridge Dr
CRANE PARK
Orland Dr
Cypress St
Wilmot St
Sprice Ave
GOOD NEIGHBOUR CABE PARK
ALTERNATE SCHOOL
Lakeshore Dr
Foster Ave
Schoolhouse St
Linton St
Ross Ave
1410 Ross Ave
Berry St
POIRIER CIVIC GROUNDS
Trent Ave
Mckvale St
Draycott St
Hillcrest St
RIVERVIEW FOREST
Winslow Ave
Poirier St
Centennial Secondary School 570 Poirier
Laurentian Cres
614-618 Ascot St
NORTH
1:7,500
Coquitlam Development Location Map
2017-2018 Single Familiy Developments
Commercial Development Projects
Parks and Natural Areas
Schools

Appendix G



COMO LAKE AVENUE UNDERGROUND UTILITIES

September 13, 2018

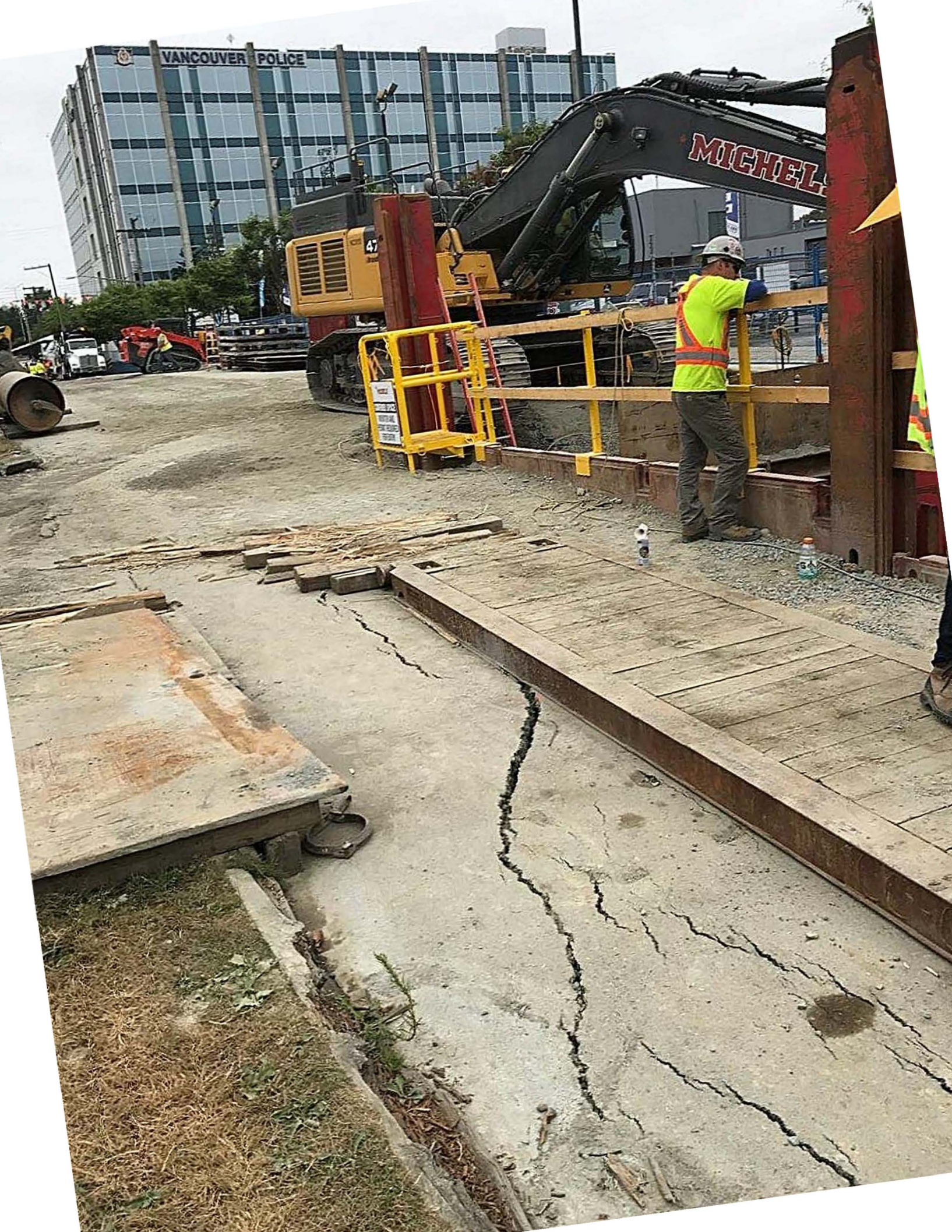
September 13, 2018

September 13, 2018

August 1, 2018

August 1, 2018

August 1, 2018


VANCOUVER POLICE
MICHEL