1 Executive Summary

The 05 June 2024 a rupture of the Bearspaw South Feedermain (BPSFM) required immediate repairs resulting in Stage 4 water restrictions. There were no reported injuries due to the rupture. Real-time pressure alarms at the water treatment plant alerted the City who enacted the municipal emergency plan.

A practice review was conducted in accordance with the APEGA Graduated Risk-based Practice Review program under the authority of the Practice Review Board. An APEGA practice review is not a technical review. The review focussed on engineering diligence and quality systems, with the overall goal to establish the City of Calgary's alignment with APEGA's expectations for engineering management of the BPSFM in accordance with the Engineering and Geosciences Professions Act, General Regulations, Bylaws and Practice Standards. Despite the non-technical review scope, a high-level literature review was conducted to provide context for the review, in particular, the magnitude and mechanisms of PCCP failures.

At the time of installation in 1974, the BPSFM was reportedly expected to have a 100-year service life. "*The reality is that the lifespan of PCCP from that era is about half that of steel pipe.*[1]" In the late 1960s and early 1970s, the American Water Works Association relaxed the standards for Prestressed Concrete Cylinder Pipe (PCCP) to reduce the cost of manufacturing. After PCCP from this era started experiencing a high rate of premature failures, the engineering and manufacturing standards for PCCP began to improve.[2] PCCP failure mechanisms are well-known; most commonly, corrosion and hydrogen embrittlement of wires results in wire snaps[3] and when PCCP fails, it typically fails catastrophically[4,5].

The forensic investigation attributes the BPSFM rupture to wire snaps in the tensioned steel wires that provide structural capacity for the pipe to withstand internal pressure forces. The conclusions of the BPSFM forensic investigation are consistent with PCCP failures across Canada and the US, which are common and with well-known failure mechanisms.

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[1] Los Angeles Times (2017). Efforts to save money on pipelines in the 1970s will cost water systems billions in the years to come - Los Angeles Times, August 25, 2017.
[2] Price, Lewis, and Erlin (1998) *in* Paulson et al. and Bell et all. (2014). Acoustic Signal Processing for Pipe Condition Assessment. Water Research Foundation, Web Report #4360
[3] Graham Bell on The Current Podcast, Which cities use the same kind of pipe that burst in Calgary? June 18, 2024. https://www.cbc.ca/radio/thecurrent/tuesday-june-18-2024-full-transcript-1.7239843
[4] Zhang et al., 2022. Effect of the Location of Broken Wires on Prestressed Concrete Cylinder Pipes under Working Pressure in *Coatings* 2022, 12, 1361. https://doi.org/10.3390/coatings12091361
[5] Graham Bell on The Current Podcast, Which cities use the same kind of pipe that burst in Calgary? June 18, 2024. https://www.cbc.ca/radio/thecurrent/tuesday-june-18-2024-full-transcript-1.7239843

The practice review found that the City of Calgary has an engineering governance structure across service lines, with a Utility Accountability Committee accountable for overall utility oversight and direction setting. Responsible Members and engineers are in place at all levels of the organization that supports water infrastructure. The City uses a strategic data-driven risk management approach to support prioritization, with engineering involvement in recommendations as evidenced in criticality assessments, vulnerability assessments, and tactical assessments. The Bearspaw South Feedermain was part of these assessments, and the risks associated with PCCP appear to be well-understood.

A Tactical Assessment Management Plan (2017)[6] consolidates the past 30 years' development of an asset management framework to ensure the cost-effective life cycle management of existing and future assets. The asset management approach is *"to combine and implement engineering, economic and financial practices to physical assets with the objective of providing the required level of service in the most cost-effective manner"*. The plan contains an Asset Management Decision Making Model and a watermain risk model. The Strategic Asset Management Plan (SAMP) and Asset Management Plan (AMP) '*aims to prioritize critical infrastructure, manage risks and optimize performance, including monitoring, growth forecasting and investment strategy*'.

The City Asset Management Group has a Feedermain Condition Assessment Program with established criteria. Maintenance and repair plans for various water supply infrastructure are prepared annually. The City provided evidence of engineering risk management and recommendations related to the feedermain network over two decades. The BPSFM was made the top priority for a condition assessment in 2020 and scheduled for completion in 2024 after planning, budget allocation, procurement, and trial shutdowns.

The failure occurred despite the strategic assessment, monitoring and maintenance programs in place. Risk assessment is a predictive management tool and not infallible. The literature demonstrates that the ability to prevent a rupture is not assured with monitoring and predictive technologies based on remote sensing data, and there are examples of failures that occurred despite monitoring and recently after repairs. The City confirmed to APEGA that "*the feedermain condition assessment program was resourced appropriately and planned using an industry-leading risk assessment methodology based on the available information*".

The practice review found that the City of Calgary's engineering practice aligns with APEGA's compliance expectations of a permit holder. It is recommended that the APEGA practice review of the City of Calgary Bearspaw Feedermain rupture be closed.

[6] Water Network Tactical Asset Management plan 2017, City of Calgary

1 Purpose

In accordance with EGPA Section 16(1) and under the authority of the Practice Review Board[7], The Association of Professional Engineers and Geoscientists of Alberta (APEGA) conducted a practice review on the City of Calgary (Permit #4428). As per PRB Motion #24-04-13, the practice review had a specific focus on the Bearspaw South Feedermain (BPSFM) rupture on 05 June 2024.

1.1 Background: The City of Calgary Bearspaw Feedermain

On 05 June 2024 the Bearspaw South Feedermain (BPSFM) ruptured, requiring immediate repairs and resulting in Stage 4 water restrictions. There were no reported injuries due to the rupture. Real-time pressure alarms at the water treatment plant notified the City who took action to respond, and the City enacted the municipal emergency plan.

The BPSFM transports roughly 60 per cent of the City's treated water supply.[8] The 11 km long BPSFM is a prestressed concrete cylinder pipe (PCCP) installed in 1975[9] and part of a 5400 km drinking water transmission and distribution pipe system.[10] At the time of installation, the BPSFM was reportedly expected to have a 100-year service life.

2 Practice Review Framework

A Level 4 (L4) Practice Review was initiated and conducted in accordance with the APEGA Practice Review Board Graduated Risk-based Review of Permit Holder (GRAPH) program (Appendix 1). At the direction of APEGA Council and the Registrar, practice reviews are collegial, seeking clarity on the permit holder's alignment with APEGA's compliance expectations. Compliance expectations for permit holders are documented in the EGP Act, General Regulations, Bylaws and Practice Standards.

Powers of the Practice Review Board

The Province of Alberta Engineering and Geosciences Professions Act (EGPA) establishes the basis for inquiry into the engineering involvement in design, construction, operation, monitoring and maintenance of critical infrastructure.

"16(1) The Practice Review Board

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[7] Engineering and Geoscience Professions Act, RSA 2000, c E-11, https://canlii.ca/t/565r4. Retrieved on 2024-08-04
[8] Calgary's water woes persist — but what is a wire snap? | CBC News
[9] Thurber Engineering (2024). Bearspaw Sough Feedermain Break Emergency Repairs Forensic Investigation. November 18, 2024. File: 56676
[10] City of Calgary Document Review Submission: Referring to Items 3a), b), C) APEGA practice Review request. December 9, 2024. Confidential.

(a) Shall, on its own initiative or at the request of the Council inquire into

(iii) the practice of the profession by professional members, licensees, permit holders or certificate holders generally

(b) may conduct a review of the practice of a professional member, licensee, permit holder or certificate holder in accordance with this Act and the regulations."

"(6) The Board may at any time during an inquiry or review under this section recommend to the Investigative Committee that the inquiry or review be conducted by the Investigative Committee pursuant to Part 5."

2.1 Confidentiality: APEGA Code of Conduct Policy[11]

APEGA's Code of Conduct Policy Section 6.2 Confidential Information states:

"6.2.2. Employees and contractors will maintain the confidentiality of all confidential information relating to APEGA, including but not limited to, its members, volunteers, vendors, employees, contractors, operations, methods of doing business, agreements, research and development, innovations, methodologies, finances, regulatory matters, member discipline matters and government relations matters.

6.2.3. Safeguard all confidential information unless it is relevant to role duties, required by law, authorized in writing, or the information is released by APEGA for public knowledge."

2.2 Conflicts of Interest

All APEGA staff, all members of the Practice Review Board and all members of the Practice Review Subcommittee who are also residents of Calgary were recused from the practice review of the City of Calgary Bearspaw South Feedermain, due to the impacts of water restrictions on Calgarians.

All members of the Practice Review Board with professional work affiliations that create a real or perceived conflict of interest for the practice review of the City of Calgary have been declared and recorded in the minutes of the Practice Review Board meetings.

3 Scope

3.1 Scope of Practice Review

The objective of the APEGA practice review is to establish the City of Calgary's alignment with APEGA's expectations for engineering management of the Bearspaw South Feedermain in accordance with the Engineering and Geosciences Professions Act, General Regulations,

[11] APEGA Code of Conduct Policy, Revision 1.2, April 10, 2024

Bylaws and Practice Standards. The practice review was conducted in accordance with Graduated Risk-based Practice Review program under the authority of the Practice Review Board.

The review focussed on the engineering diligence and quality aspects of the information submitted in response to the document request.

3.2 Limitations (Out of Scope)

Although project and information reviewed are technical in nature and a high-level literature and web review was undertaken, the practice review is not a technical review and does not presume to critique or offer comment on the engineered design or technical aspects of the engineering opinions and recommendations made by licensed professionals.

4 Report Format

In accordance with the scope-specific nature of the GRAPH Level 4 practice review and the volume of information provided by the City to support the review, a formal report format was adopted. In consideration of the safety sensitive materials reviewed, the City's submissions are documented and discussed but not reproduced in this report.

5 Literature and Web Review: PCCP Failures in North America

A high-level literature review was conducted to better understand the technical context of the submissions, in particular, the magnitude and mechanisms of Prestressed Concrete Cylinder Pipe (PCCP) failures.

In the US and Canada there are a quarter million water main breaks annually, occurring in pipes of all materials and all diameters[12,13]. PCCP is a large diameter distribution pipe made from layers of concrete encasing a steel cylinder wrapped with tensioned steel wires and coated in mortar. PCCP pipes are used for urban water distribution in North America and globally[14,15].

PCCP failure mechanisms are well understood. Below is a succinct summary of PPCP pipe failure mechanisms, in pipes of the same vintage as the Bearspaw Feedermain:

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[12] Barfus, 2023. Water Main Break Rates In the USA and Canada: A Comprehensive Study. Utah Water Research Laboratory.
[13] HDR Consultants, 2019. Condition Assessment and Rehabilitation Guide: Managing aging infrastructure and extending asset life
[14] Zhang et al., 2022. Effect of the Location of Broken Wires on Prestressed Concrete Cylinder Pipes under Working Pressure in *Coatings* 2022, 12, 1361. https://doi.org/10.3390/coatings12091361
[15] ACPPA Municipalities Utilizing CPP, by the American Concrete Pressure Pipe Association, 2023

> *"…when the [Metropolitan Water District of Southern California] started installing PCCP lines in the 1970s… they were considered virtually interchangeable with steel pipelines." "Both were expected to last 70 to 100 years. But while the steel pipelines are still mostly 'as good as new,'… "PCCP just doesn't have the same life."*
>
> *"The problem appears to be the liberalization of manufacturing standards in the early 1970s… [when] engineering organizations promulgated liberalized standards for PCCP, incorporating reinforcing steel wires that were stronger, but also thinner. Those wires turned out to be more vulnerable to corrosion and brittleness than expected."*
>
> *"The reality is that the lifespan of PCCP from that era is about half that of steel pipe." "The majority of catastrophic PCCP failures have been traced to pipes of the 1972-1978 vintage, when the eased standards were in effect. By the early 1980s, manufacturing standards had been tightened up considerably"*
>
> Dr. G. Bell in the Los Angeles Times, 2017[16]

Early structural design requirements for the manufacture of PCCP were conservative, with high factors of safety. However, with advances in material science, changes to PCCP specifications were made to reduce the cost of manufacturing. Late 1960s and early 1970s design changes reduced the amount of prestressing steel wire used and allowed wire of smaller diameter which resulted in what appeared to be a more efficient design and economical manufacturing. After PCCP from this era started experiencing a high rate of premature failures the engineering and manufacturing standards for PCCP began to improve.[17]

Despite being considered a reliable and safe pipe design overall, when PCCP fails, it typically fails catastrophically[18]. The most common PCCP failure mechanisms are well-known: corrosion and hydrogen embrittlement of wires results in wire snaps[19]. The loss of structural integrity due to accumulation of broken prestressing wires, leads to loss of compression in the concrete core. Once core compression is compromised, structural failure is imminent[20].

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[16] Los Angeles Times (2017). Efforts to save money on pipelines in the 1970s will cost water systems billions in the years to come - Los Angeles Times, August 25, 2017.
[17] Price, Lewis, and Erlin (1998) in Paulson et al. and Bell et all. (2014). Acoustic Signal Processing for Pipe Condition Assessment. Water Research Foundation, Web Report #4360
[18] Zhang et al., 2022. Effect of the Location of Broken Wires on Prestressed Concrete Cylinder Pipes under Working Pressure in *Coatings* 2022, 12, 1361. https://doi.org/10.3390/coatings12091361
[19] Graham Bell on The Current Podcast, Which cities use the same kind of pipe that burst in Calgary? June 18, 2024. https://www.cbc.ca/radio/thecurrent/tuesday-june-18-2024-full-transcript-1.7239843
[20] Acoustic Signal Processing for Pipe Condition Assessment

PCCP repairs are costly, with technical and logistical challenges. Large diameter pipes need to be taken out of service to conduct repairs[21] and there is often a lack of redundancy in the distribution system, so the water supply is disrupted.[22] Pre-emptive pipe replacement costs are described as 'prohibitive' and requires that the pipe be taken out of service[23]. High replacement costs and the consequence of failure places a high priority on monitoring maintenance, also a challenging engineering task[24].

The following excerpts are from the research paper *Prestressed Concrete Cylinder Pipe Condition Assessment – What Works, What Doesn't, What's Next*[25]:

- *"Selection of a pipeline for condition assessment and failure risk analysis should be based on the criticality of the pipeline. Criticality is based on the likelihood of failure, the consequences of failure, and the system constraints"*.
- *"System constraints must account for shutdown time required for inspection, excavation requirements, and required safety precautions"*.
- *"Uncertainties exist in the results of non-destructive testing (NDT) technologies used for condition assessment of PCCP and in the rate of progression of wire breaks in the future"*.
- *"In general, what works is a program of pipeline asset management aimed to maintain the pipeline risk of failure at an acceptable level. It generally includes periodic inspection, failure risk analysis to identify pipes with unacceptable failure risk, and repair or replacement of such pipes."*
- *"Overkill in Rehabilitation: "In most cases, PCCP with limited number of wire breaks can safely perform under the design loads and pressures for many years" and*
- *"... premature rehabilitation is an ineffective use of limited resources"*.

Condition Assessment typically requires dewatering and depressurizing the pipe[26] meaning that the pipeline needs to be taken out of service during inspection. Condition assessment of a large-diameter pipeline requires detailed planning and coordination to establish dewatering and rewatering procedures, safety protocols, inspection protocols, procurement, outage

[21] Acoustic Signal Processing for Pipe Condition Assessment
[22] Graham Bell on The Current Podcast, Which cities use the same kind of pipe that burst in Calgary? June 18, 2024. https://www.cbc.ca/radio/thecurrent/tuesday-june-18-2024-full-transcript-1.7239843
[23] Lee, Y. and Lee, E-T. (2013). Retrofit Design of Damaged Prestressed Concrete Cylinder Pipes.
[24] Al Wardany,R. Condition assessment of prestressed concrete cylindrical water pipes. September 2008. NRCC-50562
Associated Engineering Report The City of Calgary Forensic Investigation into the Bearspaw South Feedermain Rupture. IP2024-1237. November 2024
[25] Zarghamee et al. (2011)
[26] Acoustic Signal Processing for Pipe Condition Assessment

schedules and planning for water supplies during maintenance shutdown[27]. Depressurizing, dewatering, refilling and repressurizing a pipeline for inspection or repairs places additional stress on the pipe, the stress creating risk of the situation they are trying to avoid.

However, even having these data are typically not enough to decide exactly when to perform maintenance tasks and will not always prevent a failure[28]. *"Although the basis for damage detection using acoustic signals appears intuitive, its actual application poses many significant technical challenges. The most fundamental challenge is the fact that damage is typically a local phenomenon and may not significantly influence the global response of a pipe"*[29]. There are numerous literature examples of failures that occurred despite monitoring and recently after repairs.

6 City of Calgary Bearspaw Feedermain Break Practice Review

6.1 Practice Review Initiation

APEGA practice review of the City of Calgary Bearspaw Feedermain rupture was initiated on July 22, 2024 (PRB Motion #24-04-13), the practice review had a specific focus on the Bearspaw South Feedermain (BPSFM) rupture on 05 June 2024. APEGA met with the City of Calgary ['the City'] on July 18, 2024, as a courtesy, to inform the senior officer and some responsible members that the practice review had been authorized by the PRB and that a formal letter of initiation was pending. During the meeting with the City, APEGA acknowledged that the repair of the water main was the priority public interest and that APEGA had waited for the City to complete the most pressing repairs before initiating the review.

At the time of the July 18, 2024, meeting, the City was collecting data on the primary break and more broadly along the water main, awaiting lab data and remote sensing analysis, and had engaged a consultant to develop a root cause analysis. It was apparent to the City that other areas along the Feedermain required repair, and those repairs were imminent.

In recognition of the repair burden and priorities of key City staff to serve the public interest, APEGA scheduled the first document request for one month after the practice review initiation.

6.2 Document Request

The following documentation requested was:

1. The most current signed and approved version of the City's Professional Practice Management Plan (PPMP).

[27] Geisbush, J. and Ariaratnam, S.T.(2023). Water 2023, 15, 4283. https://doi.org/10.3390/w15244283.
[28] Geisbush, J. and Ariaratnam, S.T.(2023). Water 2023, 15, 4283. https://doi.org/10.3390/w15244283.
[29] Acoustic Signal Processing for Pipe Condition Assessment

2. The City of Calgary's asset management policy.
3. The City's monitoring and maintenance programs related to the Bearspaw water main infrastructure, including:
    a. Roles, responsibilities, accountabilities.
    b. Monitoring and maintenance schedules.
    c. Adherence to or departures from monitoring and maintenance program schedules.
    d. Engineering involvement in data review.
    e. Risk assessment / risk management processes.
    f. The decision process for engineering recommendations.
4. Pre-rupture engineering and recommendations related to monitoring, maintenance, repairs and upgrades to the Bearspaw feeder main:
    a. Engineering reports and recommendations by consultants.
    b. Engineering reports and recommendations by Water Services.
    c. Recommendations made to City Council.
    d. Records of decisions, approvals and deferrals of engineering recommendations.
5. Final design records for the Bearspaw prestressed steel cylinder pipes, in particular, the standards of-the-day utilized for pipe selection.
6. The City of Calgary's root cause investigation report, when it is complete.
7. The third-party report on the failure, when it is complete.

6.3 City of Calgary Practice Review Submission Schedule

At the time of APEGA's document request on August 22, 2024, the primary rupture was repaired, other areas identified for repair were underway or imminent, the root cause investigation report was in progress, and the third-party report was awaiting the appointment of panel of industry leaders. Accordingly, the City proposed a submission schedule which APEGA agreed to (Appendix 2).

7 Practice Review

The documents submitted by the City of Calgary are listed in Appendix 3. The documents are confidential, safety-sensitive, and reviewed in a secure Sharepoint site shared by the City.

7.1 PPMP

The City of Calgary's Professional Practice Management Plan (PPMP) is well-written and contains the required elements of the APEGA Professional Practice Management Plan practice standard. The City's PPMP format does not align with APEGA's Standard format, which is

considered an administrative issue that will be brought to the City's attention for their next PPMP update.

7.2 Monitoring & Maintenance Programs

The City's monitoring and maintenance program information included:

- Summary of corporate water services monitoring and maintenance program.
- Roles, responsibilities and accountabilities.
- Authenticated monitoring and maintenance planning reports from 2020 to 2024.
- The minutes of Water Operations Coordination Committee (WOCC) meeting minutes
- Pressure monitoring data for the interval before and after the rupture.
- Reports and files including tactical assessment, criticality assessment, vulnerability assessment and risk assessment.

7.3 Engineering Involvement in Water Programs Management and Decisions

7.3.1 Roles, Responsibilities, Accountabilities

APEGA observations and assessment of Roles, Responsibilities, Accountabilities as presented in the practice review submissions:

- The City's Overall Engineering & Geoscience Functional Structure is part of the Professional Practice Management Plan.
- APEGA Responsible Members are in key leadership levels of the City organization including General Managers in Infrastructure Services and Operations Services, and at the Director level in Capital Priorities & Investment, Utilities Delivery, Business & Engineering Services.
- APEGA Responsible Members are in Manager levels in project development, asset management planning and infrastructure delivery.
- The Water Services business unit has Responsible Members in the Drinking Water Distribution area, with professional members at the manager level. This area is where the construction, repair and maintenance program for water distribution resides.

7.3.2 City of Calgary Water Utility Governance Model[30]

The City manages water distribution infrastructure through the Water Resources Business Unit and Utilities Delivery Business Unit[31]. *"The Water Utility at the City of Calgary has a service governance model that is in place to enable decision making and manage risk across three lines of service, Water Treatment and Supply, Wastewater Collection and Treatment and*

[30] "4. Pre Rupture Engineering and Recommendations.pdf, practice review submission by the City of Calgary.
[31] PPMP Appendix A. The City of Calgary Overall Engineering & Geoscience Functional Structure.

Stormwater Management" (ibid.). The Utility Accountability Committee is accountable for overall utility oversight and direction setting.

- Utility Accountability Committee (UAC)
- Water Treatment and Supply Service Team
- Water Operations Coordination Committee (WOCC)

The City's monitoring and maintenance programs reside in the following business areas:

- Capital Priorities & Investment
    - Utilities Project Development
        - feasibility reviews, risk analysis
    - Asset Management Planning
        - feedermain inspection, assessment & evaluation of the asset system, performance risk
- Utilities Delivery
    - Linear Infrastructure Delivery
        - feedermain design and construction inspection, construction standards and specifications
- Water Services
    - Drinking water distribution. Operations and Maintenance. Repair.

The functional structure for engineering & geoscience meets APEGA's professional practice expectations for engineering and Responsible Member representation across technical and managerial roles of authority.

7.3.3 Risk Management

Decisions and risk analyses for undertaking the BPSFM Condition Assessment are documented in the minutes of Water Operations Coordination Committee (WOCC) meetings[32], internal memoranda and annual planning reports. The (WOCC) meeting minutes demonstrate ongoing risk assessment, planning, maintenance and repair programs for the City's subsurface water infrastructure.

Advanced Strategic Asset Management Work that assessed risk includes:

- Strategic Asset Management Plan
- Asset Management Plan

[32] City of Calgary practice review submission: minutes of the Water Operations Coordination Committee:
- March 15, 2023 – WPCC Meeting Notes.pdf
- August 16, 2023 – WPCC Meeting Notes.pdf
- 2024.02.21 WOCC Meeting Meeting Minutes.pdf
- 2024.05.15 WOCC Meeting Meeting Minutes.pdf

- Tactical Asset Management Plan

The City's feedermain risk assessment formulation was provided to APEGA, which included assumptions, with a listing and bubble chart of probabilities and consequences[33]. The Strategic Asset Management Plan '*aims to prioritize critical infrastructure, manage risks and optimize performance, including monitoring, growth forecasting and investment strategy'*. The Asset Management Plan focuses on the water network: current state, future needs, strategic initiatives.

Key historic work that contributed to risk management of the BPSFM is summarized in **Table 1**.

Table 1: Chronology of Work Prior to the BPSFM Break[34]

2004	Feedermain Inspection Program	Goal: Determine the baseline condition of feedermains. Inspections twice per year.[35]
2007	Feedermain condition assessment	Pipes made of concrete have the potential to deteriorate and fail in Calgary soils. High risk soil condition areas identified. Inspection discussed: "*access, scheduling and safety are the biggest hurdles.*" Recommended condition assessment for high-risk areas (concrete pipe of similar vintage to McKnight failure in areas with 'hot soil': internal EM inspection, installation of acoustic monitoring, inspection on high-risk areas, followed by excavation to visually confirm. Estimate to complete the work was roughly eight years [36].
2011	Infrastructure Vulnerability Assessment, Water Long-Range Plan [37]	Discussed value of redundancy and the metrics for evaluation of the level of redundancy: reliability, vulnerability, resiliency. Feedermain failure is low frequency. Historic data lacks the information to develop predictive probability estimates for reliability. This work was the *"first application of vulnerability assessment to the City water supply system"*. Critical feedermains were listed. Failure scenarios assessed. List of feedermains selected for vulnerability assessment, included BPSFM.
2015	Linear Infrastructure Criticality Assessment[38]	Recognized highest risk on concrete feedermains. Estimated failure probabilities for feedermains. Probability/consequence bubble graph. High risk / high consequence infrastructure prioritized. In 2015 the BPSFM fell into Category A: High

[33] City of Calgary submission for practice review: Combined_Risk 20111.xls
[34]" Referring to Item 3 d) e) f), and 4: APEGA Practice Review document review request, Chronology of Work Prior to the BPSFM Break" File: 4. Pre Rupture Engineering and Recommendations.pdf.
[35] Water Network Tactical Asset Management Plan 2017. City of Calgary
[36] City of Calgary submission: Feedermain Condition Assessment 2007.pdf
[37] City of Calgary (2011): Technical Memorandum #09 – Infrastructure Vulnerability Assessment. Water Long-Range Plan
[38] Linear Infrastructure Criticality Assessment (undated). 2015, according to the accompanying memo from the City. Water_Feedermain_Criticality_Assessment.pdf

		Consequence / low risk), an asset *"that should be monitored as budget allows and after Category B and D risks are mitigated"*.
2015	Bearspaw South Feedermain Valve Chambers inspection.	Multidisciplinary engineering inspections of valve chamber infrastructure.
2017	2017 Water Network Tactical Assessment Management Plan[39]	Vision, approach: Cost optimization, making the right investments at the right time, fiscal responsibility. Water Network Asset Management Framework Asset Management Decision Making Model Water Piping Network Replacement Value: $12.6B (2016) Concrete pipe: 6.34% of water network, primarily feedermains. High risk and the focus of Water's condition assessment program. Critical Parts Inventory Sustainment to reduce main downtime.
2018	Technical Memo #09 Liner Infrastructure Feedermains Vulnerability Assessment	Project: 2021 Water Long-Range Plan Edit to 2011 Vulnerability Assessment. Changes included an expanded the list of critical feedermains. Review and discussion of long-term and short-term actions that could be delivered within the financial constraints for 2019-2022 business cycle.
2020 - 2022	BPSFM became top of the priority sequence for condition assessment.	Timeframe for condition assessment: 12-month planning/design 2 full low demand seasons (2 years)
2021 - 2024	WOCC meeting minutes discuss the BPSFM work package for condition assessment.	BSFM Condition Assessment work package scope under development in 2022. Test shutdown Fall 2023 and condition assessment planned for fall 2024.
2022	Shutdown of the Glenmore Water Treatment plant revealed water demand challenges.	Series of conversations about the accelerated need to advance critical maintenance work including BPSFM.
2023	Water Treatment and Supply – Service Team Meeting presentation June 1, 2023.	High priority risks / critical risks BPSFM: unable to shut down to perform critical maintenance without impacting service. Test shutdown planned for Dec 2023.

7.3.4 Maintenance and monitoring programs

Since 2020, authenticated monitoring and maintenance plans were prepared annually for routine and non-routine work. Routine work included preventative maintenance work and inspections of hydrants valves, flushing, leak surveys. The plans included lessons learned from the previous year, documented their adherence to the annual targets and priorities and targets for the upcoming year. Alignment with codes, standards and guidelines are documented. A strategic goal to focus on maintenance work that had not been completed in many years or had not been documented before was in place, with progress towards addressing these[40].

[39] Water Network Tactical Asset Management Plan 2017. City of Calgary
[40] 2022 Maintenance Plan June 1, 2022

The City Asset Management Group has a Feedermain Condition Assessment Program with established criteria, a sampling program to assess the aggressiveness of soils around C301 and C303 pipe. Monitoring and maintenance work on feedermains are considered during strategic planning meetings and once scheduled as a priority appear to be managed as a project work package.

Pressure, flow and other parameters are monitored in the Bearspaw South Feedermain (BPSFM), with real time alarms. Pressure monitoring data at the inlet to the BPSFM during the week of the Bearspaw Feedermain rupture were submitted to APEGA. At the time of the break, Operators in the Control Room at the water treatment plant were notified of a large pressure drop on the feedermain and immediately took action to respond.

A permanent Acoustic Fibre Optic (AFO) monitoring system was installed in the fall of 2024, when the feedermain was out-of-service for repairs. The installation of insertion ports was recently completed, allowing for a 2nd phase of AFO to be installed in spring of 2025[41]. The monitoring system will help to provide advance warning of deterioration[42].

The numerous documents and presentations submitted demonstrate strategic engineering management, risk assessment and risk-based priorities of the Calgary water transmission network.

7.3.4.1 Bearspaw Condition Assessment

The City's feedermain inspection programs and condition assessments have been prioritized based on a risk assessment approach since 2004. "*Typically, two or three feedermains are investigated each year*", dependent on the ability of Operations to control these feedermains and to provide access for the insertion of inspection equipment[43].

The Bearspaw South Feedermain condition assessment engineering work portfolio included[44,45,46,47,48] (not an exhaustive summary):

- Water treatment plant performance and infrastructure risks
- Shutdown planning
- Pressure monitoring
- Condition and structural review

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[41] City of Calgary email to APEGA, May 17, 2025
[42] Infrastructure Services Report to Infrastructure and Planning Committee, December 11, 2014. IP2024-1237
[43] Water Network Tactical Assessment Plan 2017. City of Calgary.
[44] City of Calgary submission: Directors Presentation – Transmission and GM Critical Maintenance.pdf (2023)
[45] March 15, 2023 - WOCC Meeting Notes.pdf
[46] August 16, 2023 – WOCC Meeting Notes.pdf
[47] 2024.02.21 WOCC Meeting Meeting Minutes. pdf
[48] 2024.05.15 WOCC Meeting Meeting Minutes.pdf

- Unplanned failure planning
- Risk evaluation and impacts
- Redundancy
- Reservoir Optimization
- Critical Maintenance
- Lifecycle Plan
- Resourcing: FTEs, consulting budget, approvals.
- *"Kenwave inspection technology pilot under consideration - doesn't require shutdown but has not been trialed on pipe >48"*.

Several test shutdowns of the BPSFM were undertaken in the winter of 2023 and spring of 2024 in preparation for a full condition assessment planned for December 2024 as part of an ongoing condition assessment program and maintenance program[49].

7.3.5 Adherence to monitoring and maintenance program schedules

Resource constraints did not allow the City to execute the full recommended routine preventative maintenance program and inspections of hydrants, valve, flushing, and leak surveys for the past five years. A strategic goal to focus on maintenance work that had not been completed in many years or had not been documented before was in place, with progress towards addressing these.

Engineering oversight, risk assessment and life cycle management determine priorities and schedules, continually under scrutiny and modification.

7.4 Bearspaw South Feedermain design & construction records

The City submitted final design drawing packages for the Bearspaw PCCP:

- Underwood McLellan & Associates Limited Consulting Engineers (1971). City of Calgary Bearspaw Water Supply Pipeline. Drawings sets 413.0019.001 through 413.0019.045, authenticated drawings.
- Strong Lamb & Nelson Ltd. Consulting Professional Engineers (1983), Air Valve Chamber drawings. 413.0019.046 to 413.0019.047
- The City of Calgary Engineering Department (1983) Air Valve Chamber drawings. 413.0019.048 to 413.0019.51
- The City of Calgary Bearspaw Water Treatment Plant drawings 413.0019.052 to 413.0019.053. authenticated drawings.

[49] Bearspaw South Feeder Main - Frequently asked questions (FAQs) "When was the pipe last inspected?"

- City of Calgary Engineering Department Bearspaw Feedermain from 33 Avenue NW and 87 Street NW to River at Memorial Drive and 21 Street NW File 413.0043.001, 413.0043.005 to 413.0043.104
- Canron Limited Pipe Division 413.0043.105 to 413.0043.107
- Canron Limited Pipe Division 413.0043.108 to 413.0043.201
- The City of Calgary Engineering Department Contract for the Construction of 900 mm Tie to Suction Line of Shaganappi Pump Station (1983) 413.0104.001 413.0104.012

The original design and as-built drawings demonstrate engineering responsibility, review processes and change management processes were followed for this 1970s era construction project:

- Revision Blocks (varies from drawing to drawing) include:
  - For Tender
  - Addenda
  - For Construction
  - For As Builts
- Review circulations: initialled and/or signed.
- Authentication

7.4.1 Standards of the Day

Three sets of watermain standards were provided to APEGA for the practice review:

- The City of Calgary Engineering Department (1972). Standard Specifications for Watermains and Services (applicable to watermains ≤400mm).
- The City of Calgary Engineering Department (1974). Standard Specifications for Watermains and Services (applicable to watermains ≤400mm).
- American Water Works Association (1972). AWWA Standard for Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids. AWAA C301-72

The industry standard for the design and manufacture of the large diameter Bearspaw watermain at the time of design and installation was the American Water Works Association (AWWA) Standard C301-72[50,51]. Compliance with the standard was addressed during the forensic review by Associated Engineering who concluded that "*there is no information to suggest that applicable standards at the time were not followed*"[52].

[50] American Water Works Association (AWWA) Standard C301-72: AWWA Standard for Prestressed Concrete Cylinder Type, for Water and Other Liquids.
[51] Acoustic Signal Processing for Pipe Condition Assessment
[52] Section 12, Summary of Observations

7.4.2 City of Calgary Current Standards

The current City of Calgary *Standard Specification & Design Guidelines for Potable Water Feedermain Construction (2021)* recognizes the technical qualities and risks related to the selection of PCCP products for new projects (Table 2).

Table 2:

Excerpt from City of Calgary Standard Specification & Design Guidelines for Potable Water Feedermain Construction (2021)

Pipe Product	Typical Failure Mode In Calgary Via Deterioration or Damage	Feedermain Pros	Feedermain Cons
AWWA C301-L and C301-E[53] (PCCP)	Catastrophic rupture	• Rigid pipe • High pressure capacities • Deep bury applications	• Subject to catastrophic failure • Prone to accelerated mortar deterioration and corrosion in Calgary soils • Heavy • Difficult to alter during construction or lifecycle • Resource intensive to repair

8 Forensic Investigation into the Bearspaw South Feedermain Rupture

The forensic investigation report[54] is a publicly available, comprehensive, multidisciplinary report. The forensic investigation concluded that the cause of the 05 June 2024 BPSFM rupture was the loss of structural integrity, primarily through the failure of prestressed wires in a single 4.9 m section of the 1950 mm diameter PCCP[55].

The evidence indicated that microcracking or damage to mortar allowed moisture penetration and corrosive soils to interact with the prestressed wires. The wires are believed to have become brittle due to Stress Corrosion Cracking or Hydrogen Embrittlement. Chloride induced corrosion was deemed to have likely contributed to Stress Corrosion Cracking.

Key forensic observations included:

- "*There is no information to suggest that applicable standards at the time were not followed*"[56].
- *"The design of the pipe in the 1970's, while acceptable at the time, may not have been sufficient to prevent microcracking, leading to accelerated corrosion from aggressive environmental conditions over the entire life of the pipe*" (section 13, probable cause)

[53] AWWA C301-14(R19) Prestressed Concrete Pressure Pipe, Steel-Cylinder Type,
[54] Associated Engineering (2024)
[55] Section 13, Probable Cause (ib id.)
[56] Section 12, Summary of Observations (ib id.)

- soil concentrations of chloride were elevated compared to soils samples collected by the City in 2014, attributed to sodium chloride road de-icers.

Post-rupture electromagnetic scans identified five pipe segments at four locations that were a concern, which have been repaired with a reinforced concrete encasement[57].

9 Discussion

The City retained a multidisciplinary engineering team to undertake an investigation of the Bearspaw South Feedermain rupture[58]. The technical work was found to be a well-supported, thorough review. Assumptions and uncertainties are clearly articulated. The practice reviewers consider these documented observations and interpretation to be a source of reliable information about the standards of the day and the rupture causation.

The City of Calgary summarized the key points of the report as follows[59]:

- The design and operations of the feeder main were not factors that contributed to the deterioration of the feeder main.
- Several failure mechanisms as well as soil conditions contributed to the deterioration of the feeder main and ultimately the June 5th failure.
- The Utility asset management program has a data driven decision-making method that directs its feeder main condition assessment program.

The City's summary of key points is supported by the information submitted and the literature reviewed for context. PCCP pipe failures are well documented, well understood and typically well-publicized due to the broad impacts. The failure mechanism identified in the forensic investigation is consistent with well-established research conclusions about the majority of PCCP rupture mechanisms: aggressive soils contributing to corrosion and embrittlement of prestressed wires resulting in a catastrophic failure.

Design

The Bearspaw South Feedermain (BPSFM) was constructed in 1975. The original design and as-built drawings demonstrate that engineering authentication practices, review processes and change management processes were followed.

[57] Thurber (2024)
[58] IP2024-1237, November 2024
[59] Practice Review of City of Calgary – Permit Number 4428; Request for Information and Documents. Letter, City of Calgary to APEGA, December 19, 2024.

Standards of the Day

The American Water Works Association (AWWA) Standard C301-72[60,61] for design and manufacture of PCCP pipe was the standard-of-the-day at the time of BPSFM design and installation. Early structural design requirements for the manufacture of PCCP were conservative, with high factors of safety. However, changes to PCCP standards were made in the late 1960s and early 1970s to reduce the cost of manufacturing[62]. After PCCP from this era started experiencing a high rate of premature failures the engineering and manufacturing standards for PCCP began to improve. The Associated Engineering forensic report concluded that *"there is no information to suggest that applicable standards at the time were not followed"*[63].

Monitoring & Maintenance

The monitoring and maintenance program information submitted to support the practice review demonstrates the significant portfolio of work related to monitoring and maintaining Calgary's water transmission and distribution pipe system. Overall, the monitoring and maintenance programs appear competently engineered. The City confirmed to APEGA that the feedermain condition assessment program was planned using risk assessment methodology based on the available information.

The City's *2017 Tactical Assessment Management Plan* demonstrates an ongoing, comprehensive and pro-active monitoring and maintenance program for the water delivery network. The body of pre-rupture work related to the BPSFM (Table 1), the annual monitoring and maintenance planning, and the risk-based approach demonstrate a managed technical program for water distribution.

"*Typically, two or three feedermains are investigated each year*", dependent on the ability of Operations to control these feedermains and to provide access for the insertion of inspection equipment. New technologies are trialled as they develop[64]. The City confirmed that they achieved their inspection goals, which included *"any complications resulting from the use of new assessment technology, the sequencing of priorities and actions required to complete condition assessment on more complex and critical feedermains, as well as timing the*

[60] American Water Works Association (AWWA) Standard C301-72: AWWA Standard for Prestressed Concrete Cylinder Type, for Water and Other Liquids.
[61] Acoustic Signal Processing for Pipe Condition Assessment
[62] Paulson et al. and Bell et all. (2014). Acoustic Signal Processing for Pipe Condition Assessment. Water Research Foundation, Web Report #4360
[63] Associated Engineering 2024. Section 12, Summary of Observations
[64] Water Network Tactical Assessment Plan 2017. City of Calgary.

completion of condition assessments to occur during low flow conditions to minimize impacts to Calgarians"[65].

Real time pressure alarms are in place at the water treatment plant and monitored by operators. The drop in pressure was recorded and logged at 19:00 05-June-2024. The pressure alarms worked as intended during this incident. At the time of the break, Operators in the Control Room at the water treatment plant were notified of a large pressure drop on the feedermain and immediately took action to respond. The municipal emergency plan was enacted and by 5AM the City had issued a mandatory water advisory. The pressure monitoring data demonstrates that the City was able to identify the pressure loss when it happened.

Risk Assessment and Data-Driven Prioritization

The City submitted information that demonstrates a long term, proactive, data-driven feeder main condition assessment program. Program elements include risk assessment and risk-based prioritization of watermain assets.

A Tactical Assessment Management Plan (2017)[66] refers the past 30 years' development of an asset management framework to ensure the cost-effective life cycle management of existing and future assets. The asset management approach is *"to combine and implement engineering, economic and financial practices to physical assets with the objective of providing the required level of service in the most cost-effective manner"*. The plan contains an Asset Management Decision Making Model and a watermain risk model.

The Bearspaw South Feedermain was part of risk, criticality, vulnerability, and tactical assessments, with documented evidence of the assessment programs back to 2008 provided to APEGA. A criticality assessment of large diameter concrete feedermains was conducted in 2008 and again in 2015. *"Not unexpectedly, the highest risk values were found to be on concrete feedermains since the probability of catastrophic failure is much higher on concrete main than on metal"*[67]. They don't leak; they break.

The BPSFM was made the top priority for a condition assessment in 2020. The work package outlined in the information provided was comprehensive and scheduled for completion in 2024 after the planning, budget allocation, procurement, and trial shutdowns.

The benefit of redundant systems was recognized and discussed in the assessments provided. The strategic documents set clear objectives for life cycle management, spending the right

[65] City of Calgary to APEGA, email, March 17, 2025
[66] Water Network Tactical Asset Management plan 2017, City of Calgary
[67] Water Network Tactical Asset Management Plan 2017

money at the right time, and acknowledging the challenging water system investment portfolio and the many variables that influence it.[68] The City is reviewing redundancy and rehabilitation investments, with Administration reconsidering risk appetite and risk tolerance related to management of risk.

With the clarity of hindsight, the BPSFM (and all PCCP feeder mains) could have been assigned a higher risk earlier, with additional resources assigned to undertake condition assessments. While it is possible that an earlier condition assessment might have identified the problem areas, it is also clear from the literature that condition assessments are not typically able to identify all problem areas and do not guarantee rupture prevention. *"When a pipe is deteriorating, gathering additional data on the cylinder may seem like an attractive option. However, ask whether the additional data will change your management approach.*[69]*"* Predicting the structural capacity of a pipe that is nearing its service life is both costly and risky because of the stress on pipes during depressurization and re-pressurization. *"In most cases, it is more cost effective to repair a pipe with significant deterioration than to invest in additional inspection and monitoring"* (ibid.).

Monitoring and repair of the BPSFM, whether pre-rupture or post rupture, requires it to be taken out of service with accompanying impacts to Calgarians. However, the community might have had the benefit of advanced communication and mitigation planning for water supply restrictions.

Engineering Involvement

Engineering management and oversight of the City's water distribution network is demonstrated. APEGA Responsible members reside in key positions of the City's operations framework and engineering involvement at all levels of technology. The numerous documents and presentations were submitted confirm strategic engineering management, risk assessment and risk-based prioritization of the Calgary water system.

Third Party-Review Report

City of Calgary commissioned a third-party review of the break to investigate the cause of the pipe failure and why it wasn't discovered before a catastrophic failure of the line. The panel will also be asked to determine to take a deeper dive into assessing the viability of Calgary's water distribution network. The third-party review will be conducted by an independent panel. APEGA has requested a copy of the report when it is ready. APEGA has sufficient information to

[68] Water Network 2017 Tactical Asset Management Plan, The City of Calgary.
[69] Xylem (2023).

support the practice review without the third-party review but remains interested in the review report and conclusions.

Lessons Learned

The City provided the following lessons learned from the rupture:

"…our asset management practices have previously focused to mitigate the effects of high sulphate soils, given the experience gained from previous feedermain breaks. The significance of chlorides will be accommodated in our risk modelling and soil sampling programs. The City also recognizes that our past risk assessment and prioritization approaches were biased towards the mitigation of the likelihood of failure. In the case of the Bearspaw feedermain, the likelihood of failure was extremely low when compared to other feedermains within the network. This emergency has shown the need for our risk and asset management practices to put a larger emphasis on the consequence of failure, given the obvious severity of the break that occurred this past summer. Additionally, we also need to undertake further study to confirm the root causes related to the observed increases of chlorides in the soils. Lastly, we also are committed to review our design specifications and guidelines to apply lessons learned and further mitigate risk."[70]

10 Conclusions

The 05 June 2024 the Bearspaw South Feedermain (BPSFM) rupture required immediate repairs resulting in Stage 4 water restrictions. There were no reported injuries due to the rupture.

PCCP pipe construction standards were relaxed in the late 1960s and early 1970s to reduce the cost of manufacturing, resulting in a high rate of premature failures. The root cause analysis of the BPSFM rupture is consistent with Prestressed Concrete Cylinder Pipe failures across Canada and the US, with well-known failure mechanisms in pipes of this vintage.

The practice review found that the City of Calgary has a well-supported engineering governance structure, with engineers and Responsible Members at all levels of the organization that supports water infrastructure. The City uses data-driven risk management to support prioritization, with engineering involvement in recommendations. There are documented records of criticality assessment, vulnerability assessment and tactical assessment with engineering recommendations to undertake condition assessment of feedermains. Risks appear to be well-understood.

The 2017 Water Network Tactical Asset Management Plan acknowledges that investment decisions are influenced by the funding available each year and is focused on areas of high

[70] City of Calgary to APEGA, email, March 17, 2025

priorities. BPSFM was the top priority for condition assessment in 2022 which was not complete at the time of the rupture.

An audit of budget constraints on each engineering recommendation was beyond the scope of the review. However, the balance of budgets with proactive maintenance and repair is inherent to life-cycle management of assets. The literature reviewed acknowledges that the ability to prevent a rupture is not assured with monitoring and predictive technologies and there are numerous examples of failures that occurred despite monitoring and recently after repairs.

Overall, the submission from the City of Calgary was sufficiently comprehensive to evaluate their practices and process relevant to water distribution infrastructure management. The objectives of the practice review scope have been satisfied.

11 Findings

The practice review found that the City of Calgary's engineering practices related to the water distribution network and the Bearspaw South Feedermain rupture aligns with APEGA's compliance expectations of a permit holder. Overall, the submission from the City of Calgary was sufficiently comprehensive to evaluate their practices and process relevant to water distribution infrastructure management.

The findings practice review of the city of Calgary Bearspaw Feedermain Break are:

a) The objectives of the practice review scope have been satisfied.
b) The City of Calgary's engineering practices related to the water distribution network and the Bearspaw South Feedermain rupture align with APEGA's expectations of a permit holder.
c) It is recommended that the APEGA practice review of the City of Calgary Bearspaw Feedermain Break be closed.

The City's third-party review is not expected in the foreseeable future. APEGA has sufficient information to conclude the practice review without the third-party review but remains interested in the review report and conclusions.

12 Practice Review Report Contributors

Contributor	Date
Wanda Goulden, P.Eng., P.Geo. Corporate Practice Manager, APEGA Practice Reviewer	 2025-05-07 May 7, 2025
APEGA Practice Review Board Approved (PRB Motion #25-03-12)	April 17, 2025
APEGA Practice Review Subcommittee Review by Committee	April 2, 2025
APEGA Practice Review Subcommittee Review by Chair	March 3, 2023

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a. Associated Engineering (2024). *The City of Calgary Bearspaw South Feedermain Break Initial Investigation*. Attachment 2 IP2024-1237. June 2024 (Appendix A)

b. Corrpro (2024a) Water Main Assessment City of Calgary, Corrpro Document No.: 0224-2825-ASE-CPA-001-0. June 11, 2024. Attachment 2 IP2024-1237. (Appendix A)

c. Corrpro (2024b) *Water Main Assessment City of Calgary*, Corrpro Document No.: 0224-2825-ASE-001-0. June 28, 2024. Attachment 2 IP2024-1237. (Appendix C)

d. Thurber Engineering (2024*). Bearspaw South Feedermain Break Emergency Repairs, Forensic Investigation*. File 56676. November 18, 2024. Prepared for Associated Engineering. (Appendix D)

e. Associated Engineering (2024). *The City of Calgary Bearspaw South Feedermain Forensic Investigation Geo-Environmental Review*. November 2024. (Appendix F)

f. Pure Technologies (2024). *Test Results of the Prestressing Wire and Steel Cylinder in the Bearspaw South Feedermain*. September 3, 2024. (Appendix G)

g. Peterman, R.J. (2024*) Laboratory Evaluation of PCCP Prestressing Wire and Steel Cylinder Extracted from the Bearspaw Feedermain in Calgary, Alberta*, RJ Peterman & Associates, Inc. conducted for Pure Technologies. 8-29-2024.

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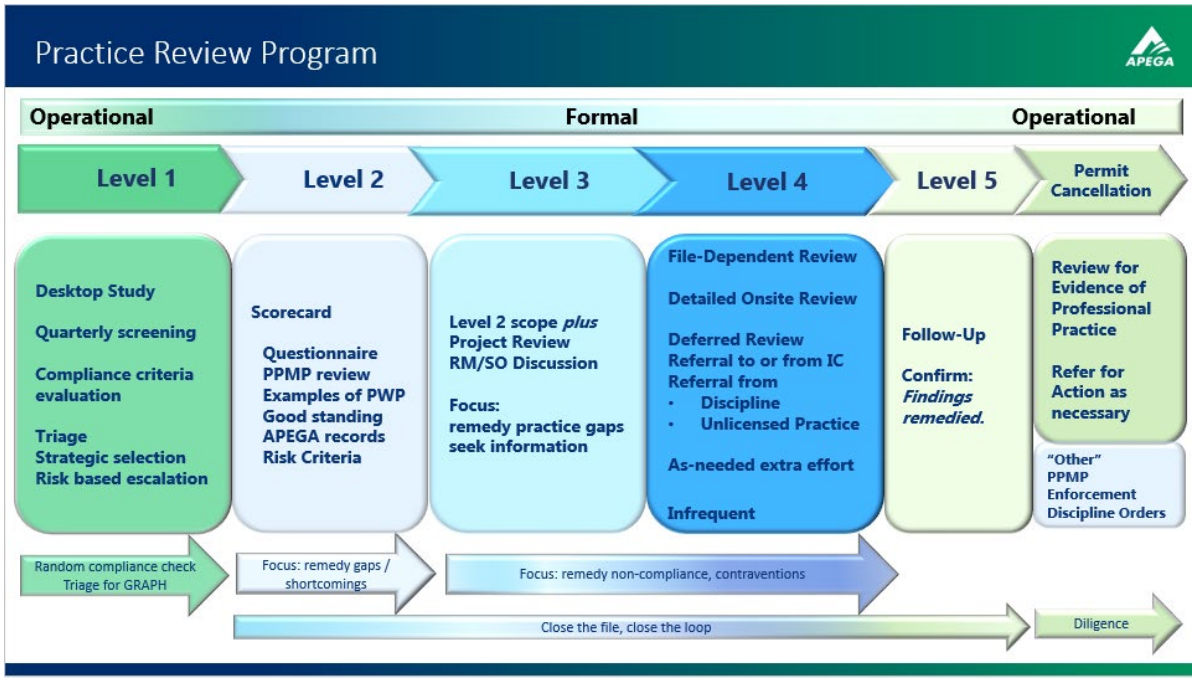
Appendix 1

Graduated Risk Based Assessment of Permit Holders
Practice Review Program



What is a Practice Review?	What a Practice Review is not...
Proactively improve Permit Holder compliance with EGP Act General Regulations Bylaws Practice Standards Assessment of company quality processes against corporate obligations. At the direction of Council and the Registrar: Collegial Collaborative Educational Snapshot in time. Individual good standing and licensure status are looked at; findings are communicated to the Permit Holder.	Not a technical review Not a competency review of individuals: APEGA has regulatory mechanisms for individual competency: Board of Examiners Admissions CPD IPR (pilot) Investigations Not an investigation evidence of unskilled practice or unethical conduct are referred to Investigations Not intended as a sanction or punishment Not an exhaustive audit of all aspects of the business.

Appendix 2

The City of Calgary 2024 Professional Practice Review

Revised Schedule[71]

The City of Calgary 2024 Professional Practice Review	Deadline	Proposed Deadline
Item #1 (PPMP)	September 22, 2024	September 22, 2024 (no change)
Item #2 (Asset Management Policy)	September 22, 2024	September 22, 2024 (no change)
Item #3 (City's monitoring and maintenance programs)	September 22, 2024	December 22, 2024
Item #4 (Pre-rupture engineering and recommendations)	September 22, 2024	December 22, 2024
Item #5 (Final design records)	September 22, 2024	December 22, 2024
Item #6 (City of Calgary's root cause investigation report, when complete)	September 22, 2024	September 22, 2025 (current estimate)
Item #7 (Third-party report on the failure, when complete)	September 22, 2024	September 22, 2025 (current estimate)

[71]Email: Wednesday September 4, 2024, 3:24PM MacDougall to Goulden, RE: <External>RE: ACTION REQUIRED: Request for Information and Documents: APEGA Practice Review of the City of Calgary (#4428)

Appendix 3

Record of City of Calgary Submissions to Support Practice Review

Document Label	Date	Location
APEGA Response Letter	Dec 19 2024	APEGA Practice Review
20240822 Calgary Water Main Information Request	Aug 22 2024	APEGA Practice Review
3. The City's Monitoring and Maintenance Programs.pdf	Unknown	3. Monitoring and Maintenance Program
coc-engineering-geoscience-appendix-a (2)	Aug 16 2024	3. Monitoring and Maintenance Program >a) Roles Responsibilities accountabilities
Alarm setting for pressure monitor maintenance	Nov 21 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>BPSFM Monitoring
SFM Pressure Nov 2023-Nov 2024	Nov 10 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>BPSFM Monitoring
rpt_CGY_Chamber_1_2025-03-09-Final.pdf	Mar 1 2016	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>2015 Chamber Inspections
rpt_CGY_Chamber_2_2025-03-09-Final.pdf	Mar 1 2016	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>2015 Chamber Inspections
rpt_CGY_Chamber_3_2025-03-09-Final.pdf	Mar 1 2016	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>2015 Chamber Inspections
BEARSPAW SOUTH 2018_2022 Survey.pdf	Unknown	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports> Valve Survey
BEARSPAW SOUTH 2023_2024 Survey.pdf	Unknown	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports> Valve Survey
2020_Maintenance Plan Report_Final_Jan31_2020_signed.pdf	Jan 31 2020	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports
2021_Maintenance Plan Report_Final_Mar31_Signed.pdf	Mar 31 2021	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports
2022_Maintenance Plan Report_Final.pdf	June 1 2022	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports
2023_Maintenance Plan Report_Final.pdf	July 26 2023	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports
2023_Maintenance Plan Report_DRAFT.pdf	June 5 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>Maintenance Reports
Bearspaw_Segment1_March_2024-Shutdown_Plan.docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV1 - Bearspaw Plant Stage 1.docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV2 - Bearspaw Plant Stage 2.docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV3 - Stoney Chamber (VC2528).docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV4 - Woods Homes (VC2519).docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV5 - 8343 33 AV (VC2566).docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV6 - 33 AV Pumps (VC5100).docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - AV7 -SD1-Bowcliffe (VC0085).docx	March 1 2024	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - DV1 - Bowness Park.docx	March 1 2025	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - DV2 - 8619 33 AV.docx	March 1 2026	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
Site Package - DV3 - 8015 33 AV.docx	March 1 2027	3. Monitoring and Maintenance Program >2. b) c) Monitoring and maintenance schedules>March 2024 Shutdown Files
4. Pre Rupture Engineering and Recommendations.pdf	Unknown	4. Pre-rupture Engineering and Recommendations
Combined_Risk 20111.xlsx	Unknown	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Directors Presentation - Transmission and GM Critical Maintenance. pdf	June 22 2023	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Feedermain Condition Assessment 2007	Jan 5 2007	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Tech_Memo_#09_Vulnerability_2011-02-28-v4.pdf	Feb 11 2011	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Technical Memo 09 Vulnerability 2018 Edit.pdf	July 4 2018	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Water Network 2017 Tactical Asset Management Plan.pdf	May 1 2017	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents

Water_Feedermain_Criticality_Assessment.pdf	Unknown	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
Water_Treatment_Supply _June-1.pdf	June 1 2023	4. Pre-rupture Engineering and Recommendations>Pre Rupture Engineering and Recommendations Documents
2024.02.21 WOCC Meeting Meeting Minutes.pdf	Feb 21 2024	4. Pre-rupture Engineering and Recommendations>WOCC Meeting Notes
2024.05.15 WOCC Meeting Meeting Minutes.pdf	May 15 2024	4. Pre-rupture Engineering and Recommendations>WOCC Meeting Notes
August 16 2023 - WOCC Meeting Notes.pdf	Aug 16 2023	4. Pre-rupture Engineering and Recommendations>WOCC Meeting Notes
March 15 2023 - WOCC Meeting Notes.pdf	Mar 15 2023	4. Pre-rupture Engineering and Recommendations>WOCC Meeting Notes
5. Final Design Records for the Bearspaw Feeder Main.pdf	Unknown	5. Final Design Records for the Bearspaw Feedermain
1972 - Standard Specifications - Watermains and Services.pdf	Unknown	5. Final Design Records for the Bearspaw Feedermain>Design Records
1974- Standard Specifications - Watermains and Services.pdf	Unknown	5. Final Design Records for the Bearspaw Feedermain>Design Records
AWWA C301-72 (OFFICIAL).pdf	Jan 28 1974	5. Final Design Records for the Bearspaw Feedermain>Design Records
Bearspaw S FM Drawing Pack 41030019, 4130043, 4130104.pdf	March 1 1971	5. Final Design Records for the Bearspaw Feedermain>Design Records
6. Root Cause Investigation Report.pdf	Unknown	6. Root Cause Investigation Report
Bearspaw South Feeder Main Investigation Report - IP2024-1237.pdf	Nov 1 2024	6. Root Cause Investigation Report>Root Cause Investigation Documents
Bearspaw South Feeder Main Investigation Findings - IP2024-1237.pdf	Dec 11 2024	6. Root Cause Investigation Report>Root Cause Investigation Documents
Bearspaw South Feeder Main Investigation Findings Presentation- IP2024-1237.pdf	Unknown	6. Root Cause Investigation Report>Root Cause Investigation Documents
RE: City of Calgary Bearspaw Feedermain rupture practice review: questions for clarity.	March 17, 2025	APEGA Practice Review Files