JUNE 2019

Corrosion and Odour Reduction Strategy

Capital and Operational Plan

Table of Contents

Section 1

Executive Summary

Over the past decade, residents of Edmonton have reported over 10,000 instances of odours related to the sanitary and combined sewer network. A sewer odour mitigation strategy was initiated by Drainage Services prior to the transfer of Drainage to EPCOR, and as part of the transfer agreement EPCOR committed to presenting a completed strategy and implementing it if approved by Utility Committee.

To develop a robust strategy, EPCOR conducted public consultation, engaged with community members across the City, conducted advanced sewer air monitoring campaigns, and expanded its sewer asset inspections. The assessment has determined that:

- Because odour issues are caused by the formation and release of hydrogen sulphide (H_2S) from the sewer system, in addition to the negative impact on customers and communities, H_2S also corrodes infrastructure and makes maintenance and inspections challenging.
- Odour issues are more dynamic and complex than initially anticipated, and in some instances changes in the sanitary network have caused odour issues to shift across communities and emerge in new areas.
- Public engagement survey results show that odour issues have a high impact in areas that are more concentrated than previously anticipated.
- Feedback from previous Utility Committee meetings regarding the need to more quickly address odour concerns in areas with consistent odour issues has been incorporated into the strategy.

Previous odour mitigation plans focused on reducing community impacts by controlling and treating sewer gas releases across the City. The cost of previous plans ranged from approximately $350 million to $460 million. Since that time, EPCOR has conducted public consultation, engaged with community members across the City, conducted advanced sewer monitoring campaigns, and expanded its sewer inspections. EPCOR has also presented progress to Utility Committee and received feedback on timing and approach to odour issues. In addition, the Corrosion and Odour Reduction Strategy was developed using similar principles and approaches to EPCOR's Stormwater Integrated Resource Plan to determine an optimized mix of operational and capital solutions to reduce corrosion and odour.

By incorporating the additional information from the more recent assessment into the strategy, EPCOR has produced a Corrosion and Odour Reduction (CORe) Strategy that expands the previous plan by focusing on preventing the formation of H_2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. The current strategy also differs from previous plans by segregating the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches are proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. Odours within different areas have distinct causes and require a different mix of solutions.

The Corrosion and Odour Reduction Strategy includes $217.3M in early action items, to be completed by 2026. This includes $199.2M in capital projects and $18.1M in operating expenses over the period of 2019 – 2026. The capital projects and operating activities included in the strategy address three focus areas:

1. Prevent the formation of H_2S gas in the sewer system. Odour reports are a leading indicator of asset-related issues. Hydrogen sulphide gas is causing premature asset degradation and failures due to corrosion. Capital and operating changes to reduce H_2S formation will deliver lower-cost and faster solutions to community odour issues, and do a better job of protecting assets from corrosion (as compared to investments that focus only on controlling and treating sewer gas releases). Preventing the formation of H_2S in the system can be accomplished by keeping the wastewater moving, adding chemical treatment, and expanding inspections and cleaning.
2. Control the release of air from the sewer system. Odours are pushed out of the sewers when the air inside the sewer is pressurized and there is an opening to the atmosphere. Odours can be controlled by reducing air pressure in the sewers, adding containment structures, and providing controlled release points in areas with lower community impact.
3. Adapt the system using real-time monitoring technologies and improved inspection data. Sewer trunks are 30 – 40 meters underground, and those built before 1990 generally do not meet current standards for access. Approximately 80km of trunk lines are currently beyond the reach of inspection technologies and do not allow inspections to identify whether H_2S is forming and causing corrosion and odour issues, or whether the line contains sags or deposits of sediment/fat that require cleaning and may cause odour or operational issues in the future. Adapting the system can be accomplished by expanding inspection and reporting data, developing real-time monitoring capability, and advancing modelling and mitigation research.

Costs to implement the Corrosion and Odour Reduction Strategy are as follows:

Initiative	Capital	Operating
Consistent Odour Area Actions (2019-2025)		
Odour prevention projects in Steinhauer, Allendale and Bonnie Doon	$62.0M	$5.9M
Bypass tunnel construction at Duggan	$78.5M	-
Citywide Actions (complete by 2025)		
Construction of 26 access manholes by 2025	$56.0M	
Deployment and use of monitoring equipment, updated pumping practices, research and modelling, city-wide projects	$2.7M	$12.2M
Total	**$199.2M**	**$18.1M**

The capital and operating program is expected to:

- Reduce odour intensity in Steinhauer-Duggan by 2020.
- Permanently reduce sewer odour intensity in the consistent sewer odour areas by 2025 (Steinhauer-Duggan, Allendale-Pleasantview, and Bonnie Doon).
- Appreciably reduce sewer odour city-wide through operational improvements and trunk line cleaning.

- Provide the data and monitoring needed to develop efficient and effective solutions for the future.

Recommendation

Utility Committee is asked to provide feedback on the proposed Corrosion and Odour Reduction Strategy and EPCOR's intention to apply for approval of a non-routine adjustment to City Council.

EPCOR recommends adopting the proposed Corrosion and Odour Reduction strategy with its three focus areas:

1. Prevent the formation of H2S gas in the sewer system
2. Control the release of air from the sewer system
3. Adapt the system using real-time monitoring technologies, increased system access and improved inspection data

The total capital cost for all aspects of the Corrosion and Odour Reduction Strategy is $199.2 million with operational expenditure totaling $18.1 million for the period 2019-2026.

Implementation of the proposed strategy requires a non-routine adjustment of $0.58 per month for the average residential customer in 2020 and $0.90 per month in 2021, and an average cost increase of $1.50 per month that will be included in the next Drainage Performance Based Rate (PBR) filing.

EPCOR intends to apply for approval of a non-routine adjustment to Drainage Rates beginning January 1, 2020 to recover the increase in its drainage revenue requirement to begin implementation of the corrosion and odour reduction priorities identified as part of this Corrosion and Odour Reduction Strategy.

Section 2

Definition of the Problem

Since 2003, the City of Edmonton and EPCOR have maintained records of reports from the public for both indoor and outdoor sewer related odours. The dataset has been used to identify the communities most heavily impacted by sewer odours. EPCOR has supplemented this dataset with reports from meter readers who provide monthly reports on odours experienced on their meter routes, from direct asset inspections, and by using hydrogen sulfide monitoring. This additional data has revealed that multiple communities throughout Edmonton experience moderate to severe sewer odours with the potential to impact quality of life, including the communities surrounding Allendale, Bonnie Doon and Steinhauer in South Edmonton and the communities surrounding Beaumaris, Downtown, Oliver and West Jasper in North Edmonton.

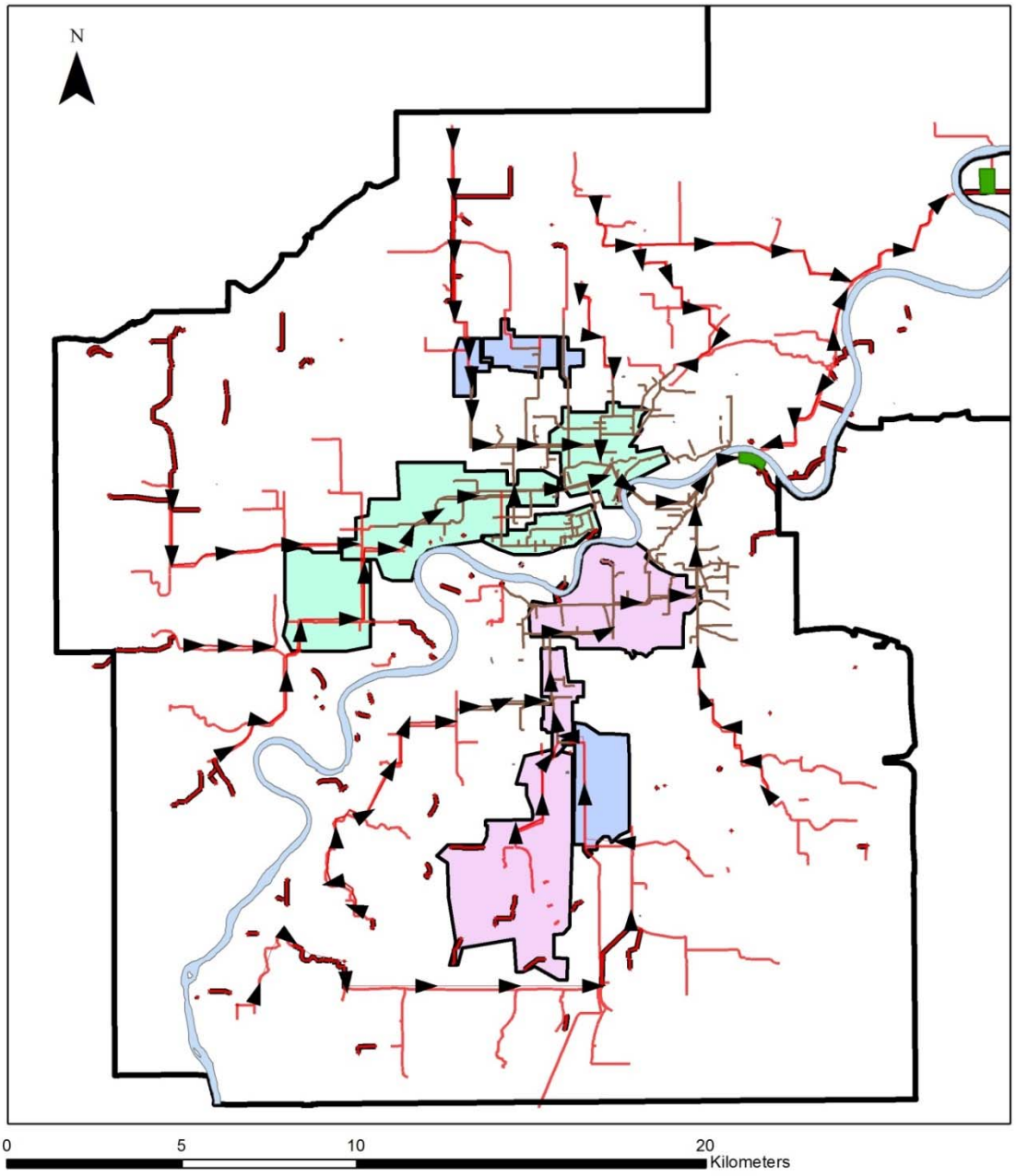
Odour issues in the City of Edmonton typically cluster around major sanitary and combined sewer trunks. These sewer trunks are large diameter tunnels that collect and carry significant volumes of wastewater that originate from multiple communities and locations over large portions of the city. EPCOR has identified 9 specific sanitary service areas with major trunk lines that, through their own unique design and connections, contribute to odour issues across the city.

Edmonton's sanitary and combined sewers are undergoing continuous development and expansion and odour issues across the city can be highly dynamic. City-wide analysis has identified three types of odour regions. Each type requires a different mix of solutions to address odour issues.

1. **Consistent odour areas.** These service areas have had long-term and constant sewer odour issues. There have been no major changes to the sanitary system, other than infill development, that has occurred recently or are expected in the near term.
2. **Dynamic odour areas.** These service areas have had long-term sewer odour issues but the locations and intensity of the sewer odours has been observed to be dynamic. These areas are experiencing changes in both the observed sewer odour intensity and the locations where the impacts occur.
3. **Emerging odour areas:** These service areas are locations where sewer odour problems are beginning to emerge. They are areas that have begun to receive substantial flows from new developments or are the downstream recipient of major trunk line expansions or pump stations. Odour issues have been dynamic in these areas and are expected to continue to evolve as trunk line development continues onwards.

The 9 sanitary/combined sewer service areas with consistent, dynamic and emerging sewer odour issues include the following areas:

Areas of Concern	Communities within Service Area	Upstream Service Areas
Consistent Odour Areas		
Steinhauer-Duggan Service Area	Bearspaw, Blackburne, Blue Quill, Calgary Trail South, Duggan, Ermineskin, Keheewin, Rideau Park, Skyrattler, Steinhauer, Sweet Grass and Twin Brooks	None
Allendale Service Area	Allendale, Calgary Trail North, Pleasantview, Queen Alexandra and Strathcona Junction	Most of South Edmonton via the Steinhauer-Duggan, Parsons Road and Terwillegar sanitary trunks
Bonnie Doon Service Area	Avonmore, Bonnie Doon, Cloverdale, Holyrood, Idylwylde, Kenilworth, King Edward Park, Ritchie, Strathearn, Strathcona and Mill Creek	Allendale service area and University trunks as well as from the Rossdale community
Dynamic Odour Areas		
West Jasper Place Service Area	Elmwood, Glenwood, Jasper Place, Lynnwood, Meadowlark Park, Sherwood, West Jasper Place and West Meadowlark Park	The trunk line serving communities near Cameron Heights, and from flows originating in Laurier Heights
Glenora Service Area	Canora, Central McDougall, Crestwood, Glenora, Grovenor, North Glenora, Oliver, Queen Mary Park, parts of West Jasper Place and Westmount	West Jasper, the North West Industrial District and from the trunk line serving the communities near Trumpeter
Parkdale Service Area	Boyle Street, Cromdale, Eastwood, McCauley, Parkdale and Virginia Park	Most of North Edmonton, including Downtown, the Glenora trunk line and flows diverted from the North Edmonton Sanitary Trunk (NEST).
Downtown Service Area	Portions of the communities of Boyle Street, Downtown and Oliver	None
Emerging Odour Areas		
Parsons Road Service Area	Coronet Industrial, Papaschase Industrial and Parsons Industrial	Mill Woods, the South East Sanitary System (SESS) and from the County of Leduc (SERT)
Lauderdale Service Area	Calder, Kensington, Killarney, Lauderdale, Prince Charles Rosslyn and the Yellowhead Corridor West	North East Sanitary Trunk (NEST)



Above is an overview of Edmonton sanitary and combined sewer system.

The main goal of the strategy is to identify mitigation measures that will minimize sewer odour impact across the city with early actions to provide immediate relief to customers and communities experiencing consistent odour issues.

The prioritization and design of odour mitigation projects are dependent on developing a comprehensive understanding of the network assets and the operational conditions controlling sewer odour processes, both now and in the future.

EPCOR has adopted a solution philosophy that considers a broad range of concepts and options to address the sewer odours experienced by customers while also ensuring:

- That drainage infrastructure is protected from deterioration due to hydrogen sulfide corrosion.
- That a safe environment for employees and residents is provided by reducing exposure to sewer generated gases such as hydrogen sulfide.
- That the risk of environmental impact due to premature asset failure is reduced.

Section 3

Mitigating Sewer Odours

Odour Generation

Sewage naturally smells however under certain conditions odorous chemicals can form in sewage that substantially increases its odour intensity. Hydrogen sulfide, or H_2S, is one of the most common chemicals associated with sewer odour, and is often used as the primary indicator of sewer odour because it is easy to measure, is often found in the largest quantities and because it conveniently forms under the same conditions as most other odour causing compounds. Beyond odour, the hydrogen sulfide created in septic areas of the sanitary network is also significant because of its impact on sewer asset condition and employee safety. Hydrogen sulfide gas is extremely reactive with metals and concrete. Its presence causes assets to corrode and fail before the end of their expected service life. High hydrogen sulfide concentrations also impact EPCOR's capacity to inspect, manage and repair sewer assets. Within certain sewer assets, high concentrations of hydrogen sulfide can make the safe entry by employees prohibitively difficult. This can make minor repairs and preventative maintenance less feasible, impacting the overall condition of the sewer network over the long-term.

Odour causing sewer gases are mostly formed in wastewater as a result of the natural decomposition of organic matter when no oxygen is present. This often occurs in areas where flows are impeded, held or stopped entirely since that can limit the transfer of oxygen from the air into the wastewater or expose the wastewater to mature and dense communities of micro-organisms capable of rapidly consuming the organic chemicals found in the wastewater.

Due to the challenges associated with inspecting the large trunk system, such as insufficient access, hazardous conditions, and safety risk, there is a lack of up-to-date system-wide inspections for sewer assets that have been exposed to high concentrations of hydrogen sulfide. While EPCOR has not been able to completely identify the full extent of corrosion in deep trunk lines, the high number of odour reports and direct measurements of sewer gas surrounding certain assets is an indicator that sewer corrosion is a major risk factor in many trunk lines.

Inside Edmonton sewers, hydrogen sulfide concentrations can often exceed 100 ppm which is roughly 10,000 times higher than the odour threshold for hydrogen sulfide. As a result, even a small volume of air exiting a particularly odorous section of a sewer can cause significant odours in a community.

Odour can also be caused in parts of the sewer system with lower concentrations of H_2S if a larger volume of air escapes. This can occur as air exits the sewer when the air pressure in the sewer is much greater than at the surface, causing the gases in the sewer to escape through any possible venting points, such as manhole openings, catch basin openings, lateral sewers, unsealed abandoned sewers, combined sewers, combined sewer overflow (CSO) outfalls, and other openings.

A more detailed explanation of the causes and release of odours is contained in Appendix A.

The Corrosion and Odour Reduction Strategy proposes a set of capital projects and operating activities that focus on three key areas to address both corrosion and odours within the sewer system:

1. Prevent the formation of H_2S gas in the sewer system.
2. Control the release of air from the sewer system.
3. Adapt the system using real-time monitoring technologies and improved inspection data.

Prevent the Formation of H_2S Gas in the Sewer System

Odour reports are a leading indicator of asset-related issues. Hydrogen sulphide gas is causing premature asset degradation and failures due to corrosion. Capital and operating changes to reduce H_2S formation will deliver lower-cost and faster solutions to community odour issues, and do a better job of protecting assets from corrosion (as compared to investments that focus only on controlling and treating sewer gas releases). Preventing the formation of H_2S in the system can be accomplished by:

- Keeping the wastewater moving,
- Adding chemical treatment, and
- Expanding inspections and cleaning.

Keep the Wastewater Moving

When wastewater stagnates it loses oxygen and quickly goes septic. Letting wastewater sit idle also provides more time for chemical reactions to occur and for suspended solids to settle out. Ultimately the longer wastewater sits, the more odorous it becomes. In the sewer system wastewater flows become stagnant for a variety of intentional and unintentional reasons. Sanitary wastewater can intentionally be held for multiple hours at pumping stations, storm surge storage areas and at flow control structures. Elsewhere in a sanitary network, wastewater can become stagnant unintentionally at pipe sags, near blockages and where large sediment deposits have accumulated. Operationally there are opportunities to improve pump station and storage area operations to reduce storage times and inspection and cleaning can be employed to target blockages and sediment. By removing impediments to flow and keeping wastewater moving, sewer odours can be drastically reduced.

EPCOR has identified a number of operational opportunities for improvement at pump stations and wastewater storage areas that can result in rapid odour mitigation. The improvements focus on reducing:

- Wastewater storage volumes
- Wastewater storage times
- Sludge and sediment accumulation

Proposed actions to reduce odour generation include:

- Reviewing and updating the operational philosophy at pump stations to take advantage of reduced flow periods and downstream sewer capacity
- Providing minor capacity upgrades to pumping infrastructure and initiating minor repairs that affect pumping capacity
- Reducing upstream infiltration and inflow to reduce wastewater volume
- Prioritizing pump station cleaning
- Investigating alternative operational regimes

A system wide review of the sanitary and combined sewer system has indicated that pursuing opportunities for applying operational improvements, particularly at pumping and storage stations will provide immediate reductions to local and downstream odour intensity while still remaining cost effective.

Adding Chemical Treatment

There are a large number of technologies and treatment systems available for odour management at pumping stations and storage facilities. The techniques employed usually focus on either limiting hydrogen sulfide generation or alternatively removing excess hydrogen sulfide at its source after it has been generated.

Chemical dosing systems are popular and widely proven to be effective at managing odours at pump stations. Multiple chemical solutions exist. Some work as a biocide, killing the odour generating micro-organisms, some provide an alternative food source for the micro-organisms whose waste product is less odorous than hydrogen sulfide, and some chemicals react directly with hydrogen sulfide to remove it from the wastewater altogether.

Prior to recommending a chemical dosage system at a pumping station or storage area, the operation and sulfide generation rates at the station will be monitored and quantified. Proper characterization is not only required in order to select an appropriate treatment method but also to ensure the chemical dosage system is used appropriately and does not result in excessive chemical waste. If operational improvements such as optimized pump timing or pipe cleaning reduce downstream hydrogen sulfide concentrations sufficiently, those actions may be completed in lieu of on-going chemical treatment of the wastewater.

EPCOR is also working in conjunction with the University of Alberta to explore alternative odour management systems at pumping stations and storage facilities.

Expanding Inspections and Cleaning

Sediment accumulations in trunk lines block and impede flow. This causes, water stagnation, odour generation, and accelerated asset degradation locally and downstream. Cleaning the trunk lines will allow the wastewater to move more freely and quickly reducing system wide retention times and odour generation. Additionally, it is possible that hydrogen sulfide and other odorous gases are being made by microorganisms inside the sludge and sediment deposits found in sewers. Removing the sludge will not only remove a source of stagnation but also remove an odour generation source as well. Trunk line cleaning

is dependent on the rollout of access manholes across the city but is expected to provide significant reductions in local and downstream sewer odours once completed.

The Corrosion and Odour Reduction Strategy will increase trunk line access to inspect and identify fatberg prevalence and potential sources within the city. The data will be used to assist with the implementation of an improved source control program. Removing fat deposits and build-ups will reduce flow blockages and improve wastewater movement through the sanitary system.

Control the Release of Air From the Sewer System

It is not always practical to completely eliminate the generation of odour causing chemicals such as hydrogen sulfide in sewers. In addition, even non-septic wastewater carries an odour that, under certain circumstances, can cause nuisance. Odour can be caused in parts of the sewer system with lower concentrations of H_2S if a larger volume of air escapes. Odours are pushed out of the sewers when the air inside the sewer is pressurized and there is an opening to the atmosphere. In many of Edmonton's neighbourhoods, the containment and controlled discharge of sewer air remains necessary to effectively eliminate sewer odour completely. In sewer systems with combined networks in particular, reducing the volume of sewer air discharged into the neighbourhood can greatly reduce the overall prevalence of sewer odour in a community. There are three main ways to reduce sewer air discharge volumes in neighbourhoods:

- Reducing air pressure in the sewers by modifying drop structures
- Adding containment structures such as one-way flaps and manhole seals
- Providing controlled release points for sewer air using assets such sewer vents

Reducing Air Pressure in the Sewers by Modifying Drop Structures

The modification of drop structures involves the installation of several horizontal pipes between the drop structure and a newly constructed air re-circulation shaft. The principle is that the air entrained due to the falling effect of the wastewater is recirculated through the connection pipes between the drop shaft and the air circulation shaft. This recirculation configuration prevents the entrained air from pressurizing the downstream trunk system.

A number of drop shaft modifications have been constructed in Edmonton. Monitoring and evaluation of the existing modification projects has determined that the air recirculation system can reduce downstream tunnel air pressures by about 40%. This novel arrangement was published in the Journal of Environmental Engineering and received the prestigious Samuel Arnold Greeley Award by the American Society of Civil Engineers in 2017.

Researchers at the University of Alberta, in co-operation with EPCOR, have developed improvements to the overall design as illustrated below that may further reduce downstream air pressure in the trunk lines by as much as 70%.

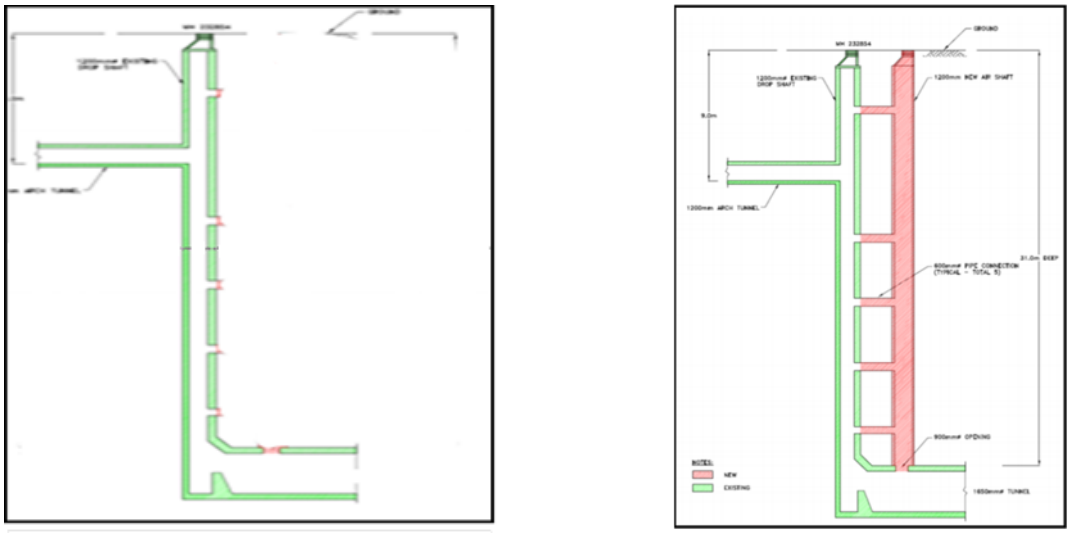


Illustration depicting how a sanitary drop shaft can be modified to reduce its effect on downstream air pressure

Adding Containment Structures Such as One-way Flaps and Manhole Seals

In communities served by combined sewer systems, pressurized sewer trunks can push odorous air into smaller side-sewers that serve the community where it then often exits freely from connected storm catch-basins. In certain sections of a neighbourhood, it can be advantageous to block the sewer airflow from exiting the trunk line at all. In Edmonton, one-way flaps, manhole seals and air curtains have been used successfully to limit air out-flow from certain sewers.

An example of a one-way flap that was used to prevent sewer air from exiting the combined sewer system through an upstream catch-basin

One-way flaps open when water accumulates behind them but only open enough to let the water exit without letting air through and can be used to isolate catch-basins and small side sewers from trunk line sewer air. Manhole sealing prevents air from exiting the sewer through manholes and their pick holes. They are relatively affordable and simple to install and have the cross benefit of reducing infiltration during storm events or spring run-off.

Examples of manhole pick inserts and a manhole sealing installation (ISC)

Air curtains and air jumpers are massive structures built into major trunk lines to control air flow. Air curtains act as a major plug in a trunk line similar to a one-way flap. They permit wastewater to flow but completely stop airflow through the trunk line.

Example of an air curtain in the City of Los Angeles

The deployment of air containment infrastructure can be very disruptive to air flow in the sewer system. If some level of controlled ventilation and treatment is not provided, the installation systems can often transfer odour issues elsewhere. None the less, with proper engineering and planning they can be very useful in trunk lines where air flows and structural conditions do not permit the use of other mitigation infrastructure.

Providing Controlled Release Points for Sewer Air Using Assets Such as Sewer Vents

Controlling the locations where air is released from the sewer systems can minimize impact by forcing releases into less sensitive areas while allowing for active odour treatment of the sewer air before it is discharged. In addition there are benefits for asset condition from removing odorous air from the sewers since lowering the hydrogen sulfide concentrations in the sewer can reduce sewer corrosion.

Sewer vent stacks provide controlled air discharge points along sewer trunks and side-sewers. They generally consist of a tall stack that contains an odour adsorption filter at their base. They are a passive system with no fans, so the air in the sewer must be sufficiently pressurized to push through the stack effectively. The air is treated before it is discharged and is released several meters above surface level to allow it to mix with ambient air more fully. These systems are effective for areas where a large number of

manhole sealing and one-way flaps have been employed as they provide control over the discharge location of the sewer air. They are essential when air jumpers or air curtains are employed.

Source: City of San Francisco

Source: Sydney, Australia

Examples of sewer vents used in other municipalities

Odour control units (OCU) are large scale vent stacks with fan-forced air ventilation. An OCU is employed instead of a vent stack when the volumes of air requiring treatment are larger than what can be treated through passive ventilation. Using an OCU, large volumes of sewer air can be withdrawn from the sewer network and passed through advanced odour treatment systems. The air, fully de-odorized, is then discharged to the atmosphere.

Odour control units have been installed throughout Edmonton in the past. The systems require considerable care in their design and construction to ensure they operate successfully. They can also have a larger physical footprint in the communities where they are installed requiring public outreach prior to their construction. These systems are only recommended in areas where very large volumes of odorous air are being generated and released. Below are two examples of odour control units in Edmonton. With proper design their presence in the community can be minimized.

King Edward Park Odour Facility

West End Odour Filter – 151 St/100 Ave

Adapt the System Using Real-time Monitoring Technologies and Improved Inspection Data

Sewer trunks are 30 – 40 meters underground, and some do not meet current standards for access. Approximately 80km of trunk lines are currently beyond the reach of inspection technologies and do not allow inspections to identify whether H_2S is forming and causing corrosion and odour issues, or whether the line contains sags or deposits of sediment/fat that require cleaning and may cause odour or operational issues in the future. In order to provide odour relief across the city, the Corrosion and Odour Reduction Strategy proposes that programs to gather meaningful data in terms of how odours are reported and how the drainage system behaves in generating and transporting odours. The data will also provide information on the condition of the drainage assets, direction on investment prioritization and provide guidance when identifying opportunities for immediate operational improvements and longer term capital solutions. Adapting the system can be accomplished by:

- Expanding inspection and reporting data,
- Developing real-time monitoring capability, and
- Advancing modelling and mitigation research.

Expanding Inspection and Reporting Data

The condition within significant portions of Edmonton's sanitary and combined deep trunk lines remains unknown because there is insufficient access infrastructure for the safe and effective entry and inspection of those sewers. Improving large trunk line access across the city for inspections, cleaning, and repair are necessary for the safe entry into sewers and trunk lines for both staff and inspection equipment.

A review of system access across the city has identified that sewer trunks built prior to 1990 generally do not meet the access requirements specified in the current design standards. For example, the Steinhauer trunk line, which is 1200 mm in diameter with multiple bends, drops, junctions and a pump station at its terminus only has two useable access manholes over its entire 3000 meter length. Approximately eighty kilometers of trunk line currently have insufficient access capacity. Within those areas, this strategy has identified 26 locations for the addition of an access manhole to provide benefits for both odour mitigation and trunk line inspection capacity. These locations will provide access to initiate trunk inspection and cleaning.

The Corrosion and Odour Reduction Strategy proposes to use newly constructed access manholes to access the deep trunk lines, monitor hydrogen sulfide concentrations, and identify if there is sufficient sediment accumulation to justify trunk cleaning. The proposed locations have been strategically chosen in consultation with EPCOR's planned proactive trunk inspections and system rehabilitation program to maximize their benefit. Each proposed access location has been identified to align with trunk locations where asset condition inspections and assessments have not been possible.

Access to the deep trunk lines is critical to the success of the Corrosion and Odour Reduction Strategy. The current lack of deep trunk access represents a major unknown impacting future strategy development. Asset condition, sediment accumulation, fatberg formation and prevalence are major factors influencing city-wide sewer odours and their characterization requires trunk line access. Improved access will provide the capacity to effectively prioritize mitigation measures that target those issues in the highest impact areas.

Additionally, completing proactive mitigation measures such as trunk line cleaning require safe and reliable access conditions. The additional access is key to providing long term city-wide odour control and management as a result.

Developing Real-time Monitoring Capability

Currently, EPCOR only has the capacity to provide temporary sewer air pressure and odour monitoring at 9-10 locations simultaneously. EPCOR does not currently employ any permanent sewer odour monitoring stations. Improved monitoring capacity is required in order to properly identify and characterize sources of sewer odour, sewer behaviour, identify emerging odour areas and to evaluate mitigation performance on a project by project basis. The Corrosion and Odour Reduction Strategy is proposing the acquisition and deployment of monitoring infrastructure for an additional 50 long-term sewer odour monitoring installations.

City-wide monitoring has three main purposes:

1) To provide improved characterization of odour problems in each sanitary service area
2) To aid in the design of capital projects and identify opportunities for operational improvements
3) To measure the success of the applied mitigation solutions

The data is acquired through field measurements for hydrogen sulfide, sewer air pressure, and liquid wastewater quality parameters at strategic locations within the city's sanitary and combined sewer systems. Air quality measurements, including hydrogen sulfide concentrations and air pressure readings, will be gathered using long term data logging instruments that can be installed in the sewers systems unattended for uninterrupted periods of as long as 2 months. Wastewater characterization will require direct sampling, extraction, and analysis by a certified laboratory.

The sampling and monitoring program will assist with characterizing odour problems throughout the city by assisting in identifying odour generating sources and quantifying their hydrogen sulfide generation rates. Near areas where wastewater agitation occurs, monitoring will assist in determining how much odour is released when the wastewater falls over drops and obstacles. At pumping stations and storage areas, the rate of hydrogen sulfide generation and septicity of the wastewater can be quantified.

Overall characterization and monitoring at proposed project locations allows for future prioritization of projects in the strategy. At pump stations, monitoring and characterization of baseline operation is required for the selection of appropriate treatment chemicals as well as to effectively improve dosing control.

Long term city-wide monitoring will also be integrated into the overall strategy performance metric since it provides a quantitative and immediate review of project effectiveness. Monitoring will be completed prior to project implementation at each location in order to establish the baseline condition. Following project completion continued monitoring downstream of the asset will be used to determine if the project was successful or if it requires further modifications. In areas with multiple large and intersecting projects, monitoring will be completed at several strategic locations along the main trunk lines to assess the overall benefit to the communities.

Advancing Modelling and Mitigation Research

There is a need to explore the feasibility of building a long-term model framework to facilitate the simulation of hydrogen sulphide formation processes and releases from Edmonton's trunk sewers. The anticipated framework is proposed to integrate a MIKE URBAN CS model, a new system ventilation model, and a Wastewater Aerobic/Anaerobic Transformations in Sewers model developed by Aalborg University. This framework will help assess overall system efficiency and reliability of any odour mitigation measures.

The current Fats, Oil and Grease Program will be continued, but with an additional focus placed on identifying the main sources of oils and grease. There is a need to undertake a study to confirm the main sources of FOG in Edmonton's collection system so that an appropriate source control approach can be implemented.

The current sewer design standard employed in Edmonton is now undergoing a comprehensive review process with the goal of modernizing it. Involvement with the design standard review will aid in providing guidance that reduces the long term odour impact of new sewer assets. Under this strategy, a review of potential updates will be completed with the goal of providing guidance on additions that consider or impact sewer odour generation and release.

To effectively implement some of the solutions identified in this strategy, research into innovative approaches to sewer gas/air movement analysis and odour mitigation is currently ongoing and should be continuously supported. There are a number of questions that need to be addressed as technical knowledge in this area is currently limited. Questions that research will be attempting to clarify include:

- How are sewer gases generated?
- How do sewer gases move through the system?
- How do sewer gases reach the surface?
- What is the most efficient way to treat sewer odour?

Collaborative work with the University of Alberta and industry partners will improve the scientific understanding of sewer odours as described above.

Section 4

Public Engagement

This section provides an overview of the public opinion research process, summarizes the primary conclusions from the research that was fielded between January and February 2019, and details EPCOR's recommendations for incorporating public input into the Corrosion and Odour Reduction Strategy.

The public engagement was designed to:

- Quantify existing odour levels and quality of life impacts vs other sources of odours in affected hotspot communities, as well as control neighbourhoods.
- Identify any differences between the odour "hotspot" communities that could inform decisions about urgency and sequencing of work (i.e. whether the experiences in some communities was materially worse than others to the point that it indicates work should happen in those areas first)
- Understand ratepayer attitudes towards funding improvements.

The survey polled residents in known odour hotspot communities in north and south Edmonton, as well as a city-wide control group of residents who live in communities where odours are not commonly reported.

Public input & recommended actions

Key findings from public engagement include the following:

1. **Significant Impact –** Residents in hotspot communities report negative experiences from sewer odours at a significantly higher rate than residents in the rest of Edmonton, experience odours that are more intense, and experience sewer odours more frequently. Half of residents in hotspot communities noted that sewer odours negatively impact their quality of life, compared to 21% of respondents in the rest of Edmonton. Residents characterize the issue with sewer odours as a *'persistent nuisance.'*

   Survey respondents noted how the sewer odours negatively impact them:

   > *"I worry because some of the main roads in my area have the smell. I worry that it may come into my home."*
   >
   > *"I can't keep the windows open in the summer because the smell comes in. I won't have people over or invite them to the neighbour because of the smell mostly in the summer time."*
   >
   > *"When the storm sewer smells in front of my house I can't spend time in my front yard."*

2. **Location of Sewer Odours –** The research confirms and complements other information about the location of odour issues, including 311 calls, meter reader reports, and system monitoring.

   The research also confirmed that the incidence of sewer odour is highest in the hotspot communities south of the North Saskatchewan River. This trend was consistent when residents were asked about strength of smell, frequency of odours, duration of odour and seasonality of odour.

3. **Action to be taken -** Residents favour both quick action and low rate impacts. Almost 80 per cent of residents in the hotspot communities who have experienced odours would like to see them eliminated within the next five years. While most residents are not willing to pay anything more on their monthly bill, four in 10 residents supported a modest rate increase to pay for odour mitigation projects.

Appendix B contains more detail on the survey methodology and findings.

Section 5

Proposed Mitigation Projects

Based on engineering assessments and research, EPCOR has identified capital and operational projects to mitigate sewer odour issues in several major Edmonton neighbourhoods. The solutions identified focus on keeping wastewater moving in the system, eliminating sewer odours at the source, controlling the release of sewer gases, and preventing sewer corrosion.

In this strategy, nine sanitary service areas with odour issues have been divided into three action categories to guide project rollout. The three action categories are:

- **Consistent odour areas,** where the system processes affecting sewer odours are well understood and where changes in system capacity and design are expected to be limited to minor intensification and infill activities
- **Dynamic odour areas**, where odour issues have been present for many years but where the odour issues are dynamic and rapidly changing due to major sanitary upgrades or capacity additions directly within the service area or upstream
- **Emerging odour areas**, where odour issues have recently intensified due to more recent increases in sanitary capacity or because of major changes to the operation of the sanitary network.

Different approaches are proposed for each region to ensure that causes of the odour are fully assessed and to ensure that capital projects will provide sustainable relief. Odours within different areas have distinct causes and require a different mix of solutions. The following projects are proposed for communities with consistent odour areas, with dynamic odour areas, and emerging odour areas. In total and in alignment with the types of solutions explained in Section 3, the projects are focused on:

1. Preventing the formation of H2S gas in the sewer system
2. Controlling the release of air from the sewer system
3. Adapting the system using real-time monitoring technologies and improved inspection data

Proposed Actions in Consistent Odour Areas

The Corrosion and Odour Reduction Strategy places significant emphasis on consistent odour areas due to the impact on customers and communities, and provides immediate relief within these service areas. Since significant research and analysis has already been completed in these areas the capital projects and operating activities required to address corrosion and odour issues are well understood. The following summarizes the capital and operating expenses forecast for consistent odour areas.

Capital ($000s)	2019	2020	2021	2022-2026	Total
Steinhauer-Duggan	$5,010	$963	-	-	**$5,973**
Duggan Tunnel Bypass	$1,086	$986	$8,316	$68,135	**$78,522**
Allendale-Pleasantview	-	$11,953	$13,187	$2,928	**$28,068**
Bonnie Doon		$1,214	$7,440	$54,048	**$62,702**

Operational ($000s)	2019	2020	2021	2022-2026	Total
Steinhauer-Duggan	$261	$341	$341	$1,705	**$2,648**
Allendale-Pleasantview		$65	$543	$525	**$608**
Bonnie Doon		$35	$566	$2,021	**$2,622**

An overview of the capital projects and operating activities for each service area with consistent odours is provided below, and a more detailed explanation is included as Appendix C.

Consistent Odour Area: Steinhauer – Duggan Sanitary Service Area

The CORe strategy proposes to reduce the odour impact both in Duggan and in the downstream communities by reducing the odour generation at three upstream pump stations both through identifying opportunities for operational improvements and through active odour treatment of the wastewater. This will achieve immediate odour reduction locally and downstream. The strategy then proposes to further reduce the creation and release hydrogen sulfide along the Duggan trunk line through major structural upgrades to the trunk line.

Proposed Capital / Operational Solutions

To mitigate odours in the Steinhauer-Duggan service area, the mitigation strategy proposes the following projects:

- Construction and operation of chemical dosage systems for the treatment of odour at the Kaskitayo, Blackburne and Twin Brooks pump stations
- Installing 10 manhole inserts and one-way flaps
- Pursuing the implementation of operational improvements at the Kaskitayo, Blackburne and Twin Brooks pump stations
- Construction of a new sanitary trunk bypass and the permanent abandonment of the Duggan (PS105) pump station and existing deep trunk line

It is proposed that the Duggan tunnel and pump station be abandoned and bypassed by a new, shallower line. This project has been proposed as an alternative to the deployment of multiple operationally intensive odour control systems. The project may also reduce the need for trunk line rehabilitation that could potentially be required to prevent the risk of operational failure in the next 10-15 years. The proposed tunnel by-pass and abandonment activities will significantly reduce odour issues locally and as far downstream as Bonnie Doon. Meanwhile the proposed pump station and manhole sealing projects within the odour strategy will provide significant odour relief during and after tunnel construction.

Without the tunnel by-pass, achieving an equivalent level of odour mitigation upstream and downstream of this service area would require an additional $12million on a Net Present Value (NPV) basis including $265,000 per year of operational expenditures. Overall, the proposed tunnel by-pass offers superior long-term value by:

- Reducing yearly operational expenditures
- Having a longer service life than mechanical odour treatment systems and sanitary pump stations
- Replacing a 52 year old (58 years when new tunnel is commissioned) sanitary trunk whose service life expires at 75 years
- Eliminating the need for potential rehabilitation work in the trunk-line and the construction of a new pump station

To further support these projects additional access manholes are required in Steinhauer-Duggan to provide inspection access where severe corrosion is expected. The primary purpose of these access manholes is for infrastructure assessment but they are also critical for ensuring the success of the tunnel by-pass by ensuring that the tie –in locations are in good condition. Starting in 2019, two access manholes will be constructed and a third existing manhole will be modified to support future access.

The Steinhauer – Duggan service area will also benefit from actions taken as part of the operational improvement initiatives. In particular, both operational and capital allowances have been made for applying operational improvements at the upstream pump stations.

Recommendations for further investigation and monitoring

Steinhauer is the first sanitary service area to be targeted under the Corrosion and Odour Reduction Strategy. The effectiveness of the treatment solutions, particularly at the pump stations, will be evaluated to identify potential opportunities for enhanced operational improvements in the Steinhauer service area as well as other odour areas.

Consistent Odour Area: Allendale – Pleasant View Sanitary Service Area

To reduce odour nuisance in Allendale and Pleasant View communities, the primary actions proposed by the odour mitigations strategy is to:

- Reduce odour contributions from the upstream Duggan and Parsons Road trunk lines
- Isolate several sewer laterals from the air headspace of the deep trunk line
- Reduce pressurization of the deep trunk
- Complete sewer inspections of the trunk line and if significant quantities of sediments or sludge are found, perform trunk line cleaning
- Investigate the potential for operational improvements at pump stations in the Terwillegar area

Proposed Capital / Operational Solutions

To mitigate odours in the Allendale and Pleasant View sanitary service area, the mitigation strategy proposes the following:

- Construction of 6 drop structure modifications to reduce trunk pressurization
- Construction of 8 access manholes
- Inspecting and cleaning 10.9 km of trunk lines with a high risk of sediment accumulation
- Installing 14 manhole inserts and one-way flaps
- Investigate the potential for providing chemical odour treatment at 12 pump stations that feed into the Terwillegar-Whitemud trunk. PS-102 Westbrook specifically, will be prioritized for monitoring

The Allendale sanitary service area will also benefit from actions taken as part of the operational improvement initiatives. In particular, both operational and capital allowances have been made for applying operational improvements upstream along the Parsons Road sanitary service area and for a number of the pumping stations located within the Terwillegar sanitary service area. Applying operational improvements will be dependent upon the results of the city-wide monitoring program.

Recommendations for further investigation and monitoring

Future monitoring is proposed for the following purposes:

- To quantify the wastewater quality and hydrogen sulfide contributions from Parsons Road, Duggan and Terwillegar trunk lines.
- To quantify hydrogen sulfide generation at the 14 upstream pump stations within the Terwillegar sanitary service area.

Consistent Odour Area: Bonnie Doon Sanitary Service Area

The Corrosion and Odour Reduction Strategy proposes employing many of the same methods proposed for the Pleasant View / Allendale communities to reduce the odour impact in Bonnie Doon. This includes:

- The isolation of sewer laterals from the main trunk lines
- Reducing trunk line air pressurization
- Trunk line inspection and cleaning
- Evaluating the performance of pump stations 121 and 171 in order to assess their overall impact on the downstream sewer system and determine what extent of odour mitigation can be achieved through operational modifications or direct odour treatment of the wastewater.

The modification of several large drop structures near Millcreek Ravine are of particular importance as they have been determined to be causing considerable downstream pressurization of the trunk line.

Proposed Capital / Operational Solutions

To mitigate odours in the Bonnie Doon sanitary service area the mitigation strategy proposes the following:

- Construction of 21 drop structure modifications to reduce trunk pressurization
- Construction of 4 access manholes
- Inspecting and cleaning 8.0 km of trunk lines that have a high risk of sediment accumulation
- Installing 62 manhole inserts and one-way flaps
- Installation of 3 vent stacks to provide localized pressure relief control

- Constructing and operating chemical dosage systems for the treatment of odour at 2 pump stations
- Construction of 2 air curtains

The Bonnie Doon sanitary service area will also benefit from actions taken as part of the operational improvement initiatives. In particular, both operational and capital allowances have been made for applying operational improvements at pump stations PS 171 and PS 121. Applying operational improvements will be dependent upon the results of the city-wide monitoring program.

Recommendations for further investigation and monitoring

Further monitoring is also required for the Bonnie Doon sanitary service area and includes:

- Fully quantifying the odour contribution from outside sources including, Allendale, University of Alberta and the Davies Industrial district.
- Measuring and profiling pump station performance and hydrogen sulfide generation at the Walterdale pump station and wastewater storage trunk (PS 171) to identify if operational modifications can sufficiently lower the odour impact of those facilities.
- Measuring and profiling pump station performance and hydrogen sulfide generation at the Cloverdale pump station (PS 121). This will be required before recommending any specific treatment options.

Proposed Actions in Dynamic Odour Areas

Given the nature of dynamic odour areas, the Corrosion and Odour Reduction Strategy recommends actions that will allow EPCOR to better understand the causes of odours and takes immediate operational actions to provide relief through operational activities. The following summarizes the capital and operating expenses forecast for dynamic odour areas.

Capital ($000s)	2019	2020	2021	2022-26	Total
West Jasper Place				$4,338	**$4,338**
Glenora				$8,675	**$8,675**
Parkdale			$1,193	$3,145	**$4,338**
Downtown				$4,338	**$4,338**

Operational ($000s)	2019	2020	2021	2022-26	Total
West Jasper Place		$200	$200	$478	**$878**
Glenora		$200	$200	$430	**$830**
Parkdale		$200	$200	$484	**$884**
Downtown		$200	$200	$463	**$863**

An overview of the capital projects and operating activities for each service area with dynamic odours is provided below, and a more detailed explanation is included as Appendix C.

Dynamic Odour Area: West Jasper Place Sanitary Service Area

The West Jasper sanitary service area is considered a dynamic odour area due to several recent and major modifications to the sanitary trunk system in that area. These modifications have been observed to have a corresponding impact on local sewer odours. The strategy proposes targeting odour in West Jasper by building improved access infrastructure, setting up odour monitoring, carrying out wastewater characterization and initiating operational improvements at odour generating assets. These actions are critical to ensuring the success of future odour mitigation activities in the community.

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution
- Increase trunk line access capacity by constructing 2 additional access manholes
- Initiate trunk line cleaning and inspection

Proposed Capital / Operational Solutions

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring.

The West Jasper Place sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

Recommendations for further investigation and monitoring

Monitoring of the following locations is recommended:

- Cameron Heights (PS 197)
- St. Georges Crescent (PS 112)
- William Hawrelak Park (PS 108)
- Quesnell Heights (PS 212)
- Buena Vista (PS 120)
- Laurier Heights (PS 111)
- Wolf Ridge Estates (PS 151)
- Fort Edmonton Park (PS 101)
- South Westridge (PS 110)

Dynamic Odour Area: Glenora Sanitary Service Area

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution.
- Increase trunk line access capacity by constructing 4 additional access manholes

- Initiate trunk line cleaning and inspection

Proposed Capital / Operational Solutions

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring.

The Glenora sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

Recommendations for further investigation and monitoring

Monitoring of the following locations is recommended:

- Trumpeter Station 213 (PS 213)
- Clifton Place (PS 113)
- Starling Station 217 (PS 217)
- Hawks Ridge Pump Station (PS 223)

The odour contributions from the Edmiston, Trumpeter and West Jasper trunk lines will be monitored near their point of entry into the Glenora service area to determine their individual contributions to odour nuisance. This data will be used in order to better guide the development of future phases of odour mitigation.

Dynamic Odour Area: Parkdale Sanitary Service Area

Historically, odour report frequency in this area has been very high, particularly near Jasper Avenue at 84th Street where a major wastewater storage facility is located. Since 2015, odour report frequency in this area has decreased substantially coinciding with the completion of mitigation work at a major wastewater storage site. While improvements to odour nuisance have been observed around Jasper Avenue, odour still persists especially further north in the community of Parkdale due to contributions from the North Edmonton trunk lines (NEST) and actions to mitigate the odours are still recommended.

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution
- Increase trunk line access capacity by constructing 4 additional access manholes
- Trunk line cleaning and inspection

Proposed Capital Solutions

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring.

The Parkdale sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

Recommendations for further investigation and monitoring

Monitoring of RTC 3 located at 8502 Jasper Avenue NW is recommended.

Dynamic Odour Area: Downtown Sanitary Service Area

The Downtown sanitary service area does not receive wastewater from outside sanitary areas. Because sewer assets in this area are quite old, condition deterioration and settlement and the accumulation of sediments are likely. Odour generation is expected to primarily occur in those areas where sediment has accumulated and where pipe sags are prominent. Even without major sources of odour generation, because of the large number of major drop structures in the service area (27 in total), and due to the combined nature of the system in this location, even the natural odour of the wastewater is likely to be noticeable at street level.

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Increase trunk line access capacity by constructing 2 additional access manholes
- Initiate trunk line cleaning and inspection

Proposed Capital Solutions

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring.

The Downtown sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

Proposed Actions in Emerging Odour Areas

Within emerging odour areas, odours are relatively recent and are less understood than in other types of regions. EPCOR is therefore recommending an approach within these areas that focuses on gathering data and evaluating the requirement for operational activities and potentially capital projects that could be proposed at a future time. This approach allows EPCOR to respond appropriately as the system continues to evolve. The following summarizes the capital and operating expenditure forecast for emerging odour areas.

Capital ($000s)	2019	2020	2021	2022-26	Total
Lauderdale		$150	$300	$300	**$750**
Parsons Road		$150			**$150**
Other Areas		$150	$150	$1,050	**$1,350**

Operational ($000s)	2019	2020	2021	2022-26	Total
Lauderdale	$150	$400	$600	$666	**$1,816**
Parsons Road	$150	$400	$200	$200	**$950**
Other Areas: • Pump Station Treatment • Odour Containment • Trunk Inspection and Cleaning • Monitoring and Control • Operational Strategy Development • Research	$100	$1015	$1015	$3,844	**$5,973**

Emerging Sewer Odour Area: Lauderdale Area

The Lauderdale area receives wastewater flows from several upstream pump stations. Of these pump stations; the NC1 pump station likely has the greatest downstream impact on odour. A preliminary review of the NC1 pump station operational performance has identified several modifications that can be applied that have the potential to reduce downstream odour.

Due to the severity of odour in the Lauderdale service area, monitoring activities and the evaluation the NC1 pump station is already underway with the goal of implementing some form of operational improvement before the end of 2019. Further study and review will continue in the subsequent years. Each pump station will be reviewed and its hydrogen sulfide generation quantified. As further opportunities for operational efficiencies are identified they will be applied. The monitoring will also determine if some form of odour treatment by chemical dosing is recommended.

Recommendations for further investigation and monitoring

Monitoring will be completed in the summer of 2019 at three trunk line locations in Lauderdale and Calder and at the discharge point for the NC1 pump station. The information gained from the monitoring will be used to identify the main sources of odour in the sanitary lines as well as identify opportunities for immediate operational improvements and to evaluate the potential future mitigation projects.

Emerging Sewer Odour Area: Parsons Road Sanitary Service Area

Parsons road receives wastewater from the South Edmonton Sanitary System (SESS), the Mill Woods Community, and from Leduc County. Starting in late 2017, there has been a major increase in the number odour reports received along Parsons Road in South Edmonton. Odour reports received from EPCOR's water meter field staff and direct monitoring also supports that Parsons Road is developing a significant sewer odour problem.

The Parsons Road area receives wastewater flows from several upstream sources including:

- South Edmonton Sanitary System (SESS) Pump Station (PS185)
- South East Regional Service Line (SERT)

- Millwood's Community

The SESS pump station is expected to have the greatest downstream impact on odour. A review will be completed to identify if there are any opportunities for immediate operational improvements that can reduce odour generation at the SESS PS185 Pump Station. EPCOR will also evaluate if there is a potential to decrease odour contributions from the incoming SERT line. Monitoring of the Millwoods trunks and pump stations is proposed to determine if they represent a source of odour containing wastewater.

Recommendations for further investigation and monitoring

Monitoring will be initiated in the summer of 2019 and 2020. Monitoring locations will include the SESS pump station and the receiving trunk lines particularly at Parsons Road and 30th Avenue. The information gained from the monitoring will be used to identify the main sources of odour in the sanitary lines as well as to identify opportunities for immediate operational improvements and to evaluate the potential for future mitigation projects.

Other Areas

A number of City-wide actions are proposed to allow EPCOR to adapt the system and implement operational changes that will assist in avoiding future odour issues. As new odour areas emerge, they will require access to inspect and potentially repair and clean the pipes, and could potentially require treatment. A forecast of these costs is included to allow EPCOR the flexibility to respond quickly as new areas emerge. Costs are also included for specific actions related to implementing operational improvements at pumping and storage areas across the city, as well as the development of a City-wide pumping and storage strategy to manage the duration that sewage sits idle across the city.

Operational Improvements at Pumping Stations and Storage Areas

Throughout the city several opportunities to reduce the downstream odour impacts of pumping stations and wastewater storage areas have been identified. Operational improvements can include:

- Cleaning and removing sediments from wet wells,
- Modifying the pumping philosophy to reduce wastewater stagnation
- Minor improvements and modifications to the pumps to improve capacity

The strategy is proposing that funding be allocated to support efforts to proceed with operational improvements at 5 pumping stations within the Steinhauer and Bonnie Doon service area as well as at 12 pumping stations across the city. Examples of pumping stations that will be targeted for review include, the NC1, PS188 north of Lauderdale, the SESS PS185 that contributes wastewater into the Parsons Road service area as well as several pump stations that contribute wastewater into West Jasper Place and Glenora.

Operational improvements to pump stations and storage areas are expected to be able to be successfully implemented with an operational expenditure of $7.35 million over 5 years and a capital expenditure of $5.65 million over 5 years.

Development of a City-Wide Pumping and Storage Strategy

EPCOR Drainage Services will develop a City-wide wastewater pumping and storage strategy that encompasses the following:

- A city-wide system approach to how, where and when wastewater flows are stored and pumped to minimize odour generation potential.
- Establishing a management of change protocol to assess the impact of system changes that could affect the generation and emission of odour
- Establishing policies, standards and procedures for the storage and pumping of wastewater including comprehensive design standard updates

Proposed Program Rollout by Area during Mitigation Strategy (2019 – 2025)			
	Consistent Odour Areas	**Dynamic Odour Areas**	**Emerging Odour Areas**
Early Action Capital Projects	Underway	Under Development	Under Investigation
Trunk line Access Improvements	Underway	Under Development	Under Development
Trunk line Inspection and Cleaning	Under Development	Under Development	Under Development
Odour Monitoring	Underway	Underway	Underway
Operational Improvements	Underway	Underway	Underway

Odour generation, sewer pressurization and the proposed mitigation activities for each sanitary service area are discussed in greater detail in Appendix B.

Section 6

Delivery Plans

The table below provides summary of project types and timelines of when the projects will be completed to provide improved quality of life in the various communities.

Communities / Locations	Project Type	Year(s) of Construction	Communities / Locations	Project Type	Year(s) of Construction
Steinhauer - Duggan	Three Pump Station Treatments Facilities	2020-2021	**Bonnie Doon**	21 Drop Structure Modifications	2020-2025
	Ten Manhole Inserts and Reverse Gas Flow Devices	2018-2019		Three Ventilation Control Units	2023-2024
	Three Access Manholes	2019-2020		8.03 km of Trunk Cleaning and four Access Manholes	2022-2024
	Tunnel By-Pass	2019-2026			
Allendale - Pleasantview	Six Drop Structure Modifications	2020-2022		Three Pump Station Treatments Facilities	2021-2022
	One Ventilation Stack	2021-2022		62 Manhole Inserts and Reverse Gas Flow Devices	2022-2023
	10.91 km of Trunk Cleaning and eight Access Manholes	2020-2022	**West Jasper Place**	5.67 km of Trunk Cleaning and two Access Manholes	2024-2026
	14 Manhole Inserts and Reverse Gas Flow Devices	2021-2022	**Glenora**	4.69 km of Trunk Cleaning and four Access Manholes	2024-2025
Lauderdale	1.34 km of Trunk Cleaning	2024			

Parsons Road	Monitoring	2019-2022	**Parkdale**	3.2 km of Trunk Cleaning and two Access Manholes	2025-2026
Downtown 7.95 km of Trunk Cleaning and three Access Manholes 2021-2026					

In most cases, projects are scheduled such that major upstream mitigation projects are prioritized. Due to the interdependencies of the drainage network, odour problems in an area cannot be resolved completely without the consideration of problems in the upstream sanitary service areas which are often the main contributory sources of sewer odours.

Projects within the Steinhauer, Allendale, and Bonnie Doon sanitary service areas will be executed between 2019 and 2025. The majority of the city wide access, cleaning and monitoring programs will be completed by 2025 however a small number of activities will extend into the beginning of 2026.

Section 7

Drivers and Measures of Success

The successful implementation of the Corrosion and Odour Reduction Strategy will result in improved quality of life for residents in affected communities, reduced sewer odours city-wide and longer asset lifespans due to reductions in sewer corrosion. The overall success of the program in achieving those goals will depend on the effectiveness of the infrastructure upgrades and operational changes in reducing the creation of odour causing chemicals, air pressurization in the deep trunks and limiting opportunities for sewer air to discharge from sewer openings. Beyond direct impacts on sewer odours, effective project management is also critical for the successful implementation of the Odour Strategy. In order to quantify the success of the overall program, as well as to provide the capacity to identify areas for improvement, several metrics and measures will be tracked throughout the duration of Corrosion and Odour Reduction Strategy.

The success of the strategy will be, in part, determined by changes to local odour report frequency by spatially compiling each year's odour reports and calculating the changes in odour report density in the communities and neighbourhoods. Previous actions that resulted in reductions to odour intensity in neighbourhoods with long-term odour issues, such as past pump station and the real-time control rehabilitation efforts were found to result in a reduction in the local odour report densities in subsequent years. Tracking odour report frequency at the community level is therefore expected to provide feedback on the overall program impact as well as provide some indication regarding the effectiveness of individual solution implementations.

Despite their overall value, there are several recognized limitations to relying solely on voluntary odour reports from the public to determine program effectiveness. These limitations need to be overcome in order to effectively evaluate program success. Some issues include:

- The large number of reports required to evaluate changes in community odour impact can limit strategy evaluation to yearly and possibly multi-year intervals
- Relying solely on public odour reports does not allow for pro-active management of odours as action initiation depends on first receiving a public report of odour nuisance
- Using only odour reports, it can be difficult to evaluate the effectiveness of a single project within the overall strategy.

In order to better measure the success of the odour mitigation program, in addition to tracking public odour reports, the strategy will measure success based on:

- Odour reports from internal field staff
- In-sewer measurements of hydrogen sulfide and headspace air pressure pre and post project implementation
- Measurement of sewer air-discharge rates and ambient hydrogen sulfide concentrations near identified problem assets pre and post mitigation.

These metrics for measuring success will provide immediate and project specific feedback on the project impacts to odour intensity locally and in the downstream communities.

The overall goal from a project management standpoint is to complete the projects on-time and on-budget while still identifying opportunities for operational improvements. The following project progress metrics will be tracked as a result:

- Kilometers sewer access added per year
- The total length of sewer inspected and cleaned per year
- Realized synergy with other local drainage infrastructure projects

Identifying opportunities to provide operational improvements on projects and with assets that provide odour relief will also be pursued.

Section 8

Financial Evaluation of Alternatives

EPCOR considered the following alternatives for the Corrosion and Odour Reduction Strategy:

1) **Primary Hot Spots Priority** – where capital solutions for odour mitigation are deployed city-wide but hots-spots receive prioritization in terms of project timing;

2) **Systematic** - where capital solutions for odour mitigation are deployed city-wide where project timing prioritization is based on internal capacity, external project allocation and opportunities for project synergies as opposed to odour intensity;

3) **Hotspots Only** - where capital solutions for odour mitigation are deployed only for the resolution of odour issues around identified "odour hotspots"; and

4) **Proposed Strategy** – consisting of three phases, as follows: :

   a) **Phase 1: 2019-2026** – implementation of city-wide early action operational improvements and targeted long-term solutions in consistent odour areas;
   b) **Phase 2: 2027-2032** - a future mitigation phase which continues to exploit opportunities for city-wide operational improvements and extends long-term odour mitigation solutions into the dynamic and emerging odour areas; and
   c) **Phase 3: 2032 onwards** - on-going corrosion and odour reduction management which continues operational improvements and long-term odour mitigation solutions as odour issues emerge.

Assumptions

1. Study period. To provide for comparability, each alternative has been evaluated over a 25 year term.

2. Revenue Requirements: The incremental revenue requirements for each alternative consist of:

   a) Operating and maintenance expenses, including: staff costs and employee benefits, materials and supplies, contractor services, and other non-capital period costs. These costs are inflated at 2.1% annually.

   b) Capital-related costs including: depreciation and debt and equity returns on the assets used to provide corrosion control and odour reduction. Since EWSI's Drainage and Wastewater Treatment utilities share the same customers, the business risk of the Drainage utility is assumed to be the same as that of EWSI's Wastewater Treatment utility. Therefore, the corrosion control and odour reduction assets are assumed to be financed through a mixture of 60% debt and 40% equity, with the cost of equity equal to 10.175%. The cost of debt is

assumed to be 4.51%, based on Drainage's weighted average cost of debt, yielding a weighted average cost of capital of 6.83%).

c) Franchise Fees. Since the revenues associated with the non-routine and special rates adjustments will be subject to EPCOR Drainage Services' franchise agreement with the City of Edmonton, the revenue requirement also includes a franchise fee of 8% of the incremental revenue requirement.

3. Customer and Consumption Forecasts: Average impacts on customers are based on EWSI's long-term customer growth and consumption forecasts.

Comparison of Alternatives

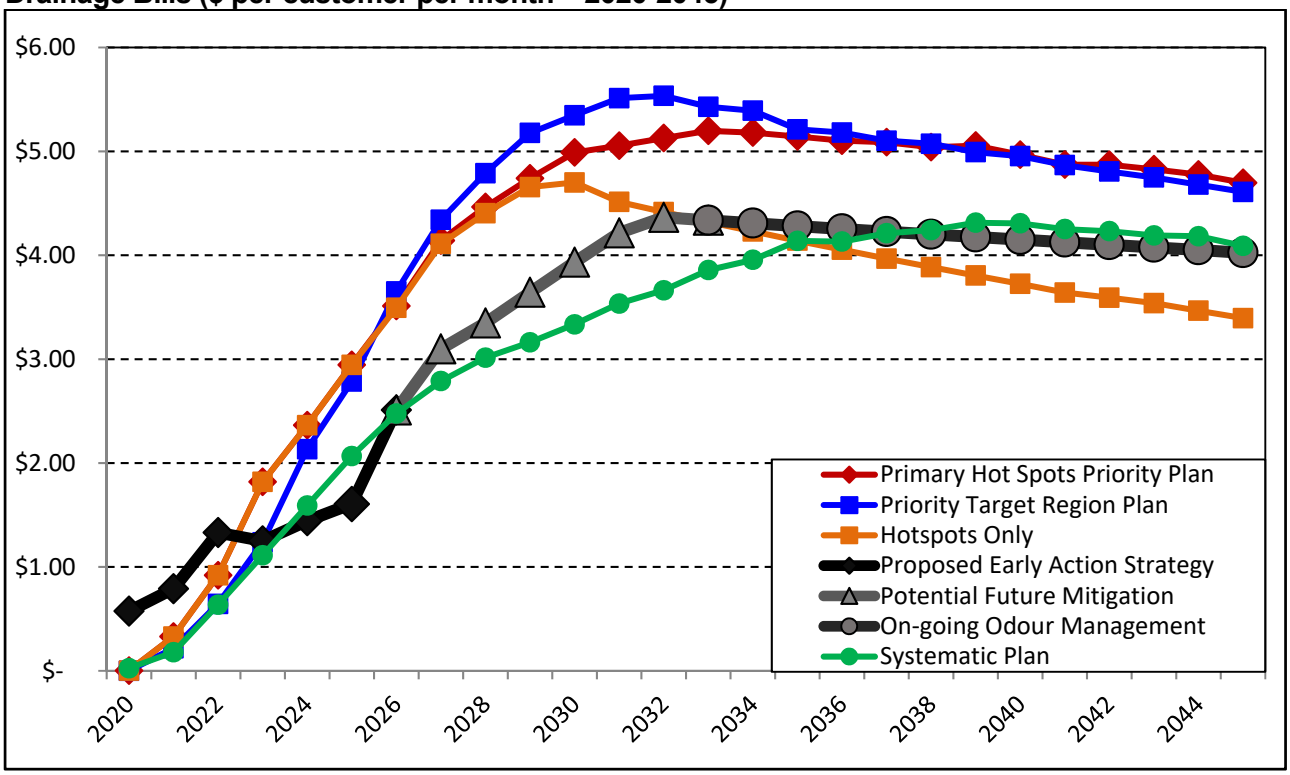
Previous odour mitigation plans focused on reducing community impacts by controlling and treating sewer gas releases across the City. The cost of previous plans ranged from approximately $350 million to $460 million. Since that time, EPCOR has conducted public consultation, engaged with community members across the City, conducted advanced sewer monitoring campaigns, and expanded its sewer inspections. EPCOR has also presented progress to Utility Committee and received feedback on timing and approach to odour issues. In addition, the Corrosion and Odour Reduction Strategy was developed using similar principles and approaches to EPCOR's Stormwater Integrated Resource Plan to determine an optimized mix of operational and capital solutions to reduce corrosion and odour.

By incorporating the additional information from the more recent assessment into the strategy, EPCOR has produced a Corrosion and Odour Reduction (CORe) Strategy that expands the previous plan by focusing on preventing the formation of H_2S gas, which will reduce community odour impacts and lengthen the life of sewer network assets. The current strategy also differs from previous plans by segregating the City into regions with consistent odour issues, those with dynamic odour issues, and those with emerging odour issues. Different approaches are proposed for each region to ensure that causes of the odour are fully understood and to ensure that capital projects will provide sustainable relief. Odours within different areas have distinct causes and require a different mix of solutions.

As a result of these changes in the proposed strategy, the cost requested within this strategy has been reduced to $217.3 million. As the Drainage network continues to evolve, the Corrosion and Odour Reduction strategy will also adapt to these changes. Information will continue to be shared with Utility Committee in future PBR applications and progress reports as the strategy evolves.

The graph below provides a comparison of the increases in an average residential customer's bill over a 25 year study period under each alternative strategy.

Incremental Impact of Corrosion and Odour Reduction Alternatives On Average Monthly Residential Drainage Bills ($ per customer per month – 2020-2045)



Inflation adjusted rate impact comparison of currently proposed and previously proposed odour mitigation strategies. The proposed strategy currently extends from 2020 to 2025. Future and on-going rate impacts are estimated assuming city-wide long-term odour mitigation solutions are pursued from 2026 to 2031 and that on-going odour mitigation efforts continue into the future as new odour issues emerge.

The graph shows that the average bill impacts of the Proposed Strategy are considerably less than the Primary Hot Spots, Priority Target Region and Hotspots Only options. Although the average bill impacts of the Proposed Strategy are similar to the Systematic alterative, under the Systematic alternative, the city-wide capital mitigation project rollout will not be completed until 2045, 14 years later than the Proposed Strategy. Unlike the Proposed Strategy which addresses consistent odour areas by 2025, the Systematic alternative does not prioritize consistent odour areas over other areas of the city, so these areas will not experience immediate sewer odour relief. The Proposed strategy, with its emphasis on real time monitoring, also allows EPCOR to leverage operational improvements, providing additional benefits, including:

- Reductions in odour intensity in the Steinhauer – Duggan sanitary service area by 2020
- Significant long-term reductions in sewer odour intensity in consistent sewer odour areas by 2025 and appreciable reductions in sewer odour city wide due to the implementation of operational improvements and trunk line cleaning.
- With future mitigation efforts, significant long-term reductions in sewer odour city-wide by 2031
- The ability to target future emerging odour areas in the long-term
- A reduction in accelerated corrosion across the city associated with the presences of hydrogen sulphide.

The following section describes the use of project selection criteria to assess alternate solutions and projects for each odour area.

Project Selection Criteria

Odours within different areas have distinct causes and require a different mix of solutions. The solutions and projects selected for each area are designed to ensure that capital and operational projects provide sustainable relief in each of the consistent, dynamic and emerging odour areas. The operational criterion for each type of solution is defined below:

1) **Pump Station Treatment**
   a) The pump station has a sufficiently large service area to maintain an average dry weather flow of 30 m^3/day.
   b) Peak hydrogen sulfide generation exceeds 1 mg/L
   c) Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day.
   d) Alternate chemicals will be considered based on the configuration of the pump station

2) **Drop Structure Modifications**
   a) The asset must serve an upstream area with an average dry weather flow greater than 300 m^3/day.
   b) The asset must result in a height drop greater than 8 meters for a trunk line or 10 meters for a sewer lateral
   c) Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day.
   d) The asset is demonstrated to increase downstream air pressure by 20 Pascal or more.

3) **Access Manholes, Inspection and Cleaning**
   a) The sewer asset has been determined to not have sufficient access capacity for inspections to be completed in a safe manner
   b) The asset is a sewer trunk line of a diameter greater than 650 mm.
   c) Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day or are suspected of reaching such concentrations if access is not available for monitoring.
   d) The location choice should consider access safety during construction and potential impacts to traffic
   e) All current inspection technologies and techniques have been considered and explored for suitability using existing access structures

4) **Sewer Vent Stack with Treatment**
   a) Downstream hydrogen sulfide concentrations exceed an average of 2 ppm over 24 hours or reach a peak concentration above 10 ppm at least once a day.
   b) Average in-sewer air pressure is 20 Pascal or more.

c) A one-way flap, manhole sealing or air curtain was installed within 400 meters of the proposed vent stack location

5) **Manhole sealing, one-way flaps and air curtains**
These devices are installed on a case-by-case basis and require an engineering evaluation to determine if they can be:
a) Installed safely
b) Do not pose a risk of causing sanitary surcharges
c) Will not transfer odours to a new location in a significant manner

Non-Routine Adjustment Application

EWSI intends to file an application for a Non-Routine Adjustments ("NRAs") to Drainage Rates beginning January 1, 2020 to recover the average annual increase in Drainage's revenue requirement of approximately $4.7 million per year for the remaining two years of the current PBR term (2020-2021) necessary to implement its proposed Corrosion and Odour Reduction Strategy. The resulting NRAs applied to the variable portion of Sewer Utility rates amount to $0.0415 per m^3 in 2020 and $0.0658 per m^3 in 2021. The capital expenditures, revenue requirements and average residential bill impact (based on average monthly consumption per customer of 14.0m^3 in 2020 and 13.7m^3 in 2021) of the Proposed Strategy are summarized in Table below.

Capital Expenditures, Revenue Requirements and Average Monthly Residential Bill Impact for 2019 to 2026 ($thousands)

		A	B	C	D	E	F
		2019	**2020**	**2021**	**Total**	**2022-2026**	**Total**
	Capital Expenditures						
1	Trunk Access	3,918	5,964	9,651	19,533	36,436	55,968
2	Drop Structure Modifications	-	7,204	11,630	18,833	38,532	57,365
3	Pump Station Treatment and Optimization	1,092	1,413	989	3,494	2,158	5,652
4	Duggan Tunnel By-Pass	1,086	986	8,316	10,387	68,135	78,522
5	Ventilation Control	-	-	-	-	1,695	1,695
6	Total Capital Expenditure	6,095	15,567	30,585	52,247	146,955	199,203
7	Capital Revenue Requirement ($000s)	-	213	1,042	1,255	34,517	35,773
	Operating Expenses						
8	Monitoring and Control, Operational Strategy Development and Research		2,015	2,015	4,029	3,644	7,673
9	Pump Station Treatment and Optimization	600	941	941	2,482	3,505	5,987
10	Trunk Inspection and Cleaning	-	45	864	908	3,055	3,964
11	Odour Containment	61	55	246	361	86	447
12	Total Operating Expenses	661	3,055	4,065	7,781	10,290	18,070
13	Operating Revenue Requirement	-	3,409	4,697	8,106	15,251	23,357
14	**Total Revenue Requirement**		**3,622**	**5,739**	**9,361**	**49,769**	**59,130**
15	**Average Residential Bill Impact ($ increase from 2019)**		**0.58**	**0.90**	**0.74 Average**	**1.50 Average**	**1.29 Average**

Section 9

Recommendation

Utility Committee is asked to provide feedback on the proposed Corrosion and Odour Reduction Strategy and EPCOR's intention to apply for approval of a non-routine adjustment to City Council.

EPCOR recommends adopting the proposed Corrosion and Odour Reduction strategy with its three focus areas:

4. Prevent the formation of H2S gas in the sewer system
5. Control the release of air from the sewer system
6. Adapt the system using real-time monitoring technologies, increased system access and improved inspection data

EPCOR recommends the capital projects and operating activities described within the Corrosion and Odour Reduction Strategy, with the approaches outlined for areas with consistent odour issues, dynamic odour issues, and emerging odour issues.

The total capital cost for all aspects of the Corrosion and Odour Reduction Strategy is $199.2 million with operational expenditure totaling $18.1 million for the period 2019-2026.

The $217.3M in early action investments are expected to:

1. Reduce odour intensity in Steinhauer-Duggan by 2020
2. Permanently reduce sewer odour intensity in the consistent sewer odour areas by 2025
3. Appreciably reduce sewer odour city-wide through operational improvements and trunk line cleaning

The subsequent phase of work is expected to:

1. Target emerging odour areas with efficient and effective solutions informed by real-time monitoring, improved inspection data, and system modelling
2. Significantly reduce sewer odour city-wide by 2031

EPCOR Water Services Inc. ("EWSI") intends to proceed with a request to City Council to fund the costs of the Corrosion and Odour Reduction Strategy through sanitary sewer rates, via a non-routine adjustment charged to City of Edmonton drainage customers in the 2020 Rate Sheets to be filed pursuant to Bylaw 18100, the EPCOR Drainage Services Bylaw ("the Bylaw"). These non-routine adjustments provide rate increases to EWSI's drainage customers to reflect the revenue requirement impacts associated with EWSI's Corrosion and Odour Reduction Strategy for the period from January 1, 2020 to December 31, 2021. The NRA increases the monthly bill for the average residential drainage customer by $0.58 per month in 2020 and $0.90 per month in 2021.

The revenue requirement for the proposed alternative for the period 2020-2021 is summarized in the table below. The costs associated with this program exceed the $500,000 annual revenue requirement threshold to be eligible for City approval as a NRA.

Section 10

Appendix A – Mechanisms of Odour Generation and Release in Edmonton Sewers

Odour Generation

Sewage naturally smells however under certain conditions odorous chemicals can form in sewage that substantially increases its odour intensity. Hydrogen sulfide is one of the most common chemicals associated with sewer odour. It is known for its characteristic rotten egg smell. The chemical is a poignant odour due, in large part, to the incredible detection sensitivity of the human nose to the presence of sulfide at very low concentrations. An average person can detect hydrogen sulfide at concentrations as low as 0.01 parts per million (ppm), which is when only 0.00001% percent of the air volume contains hydrogen sulfide. For perspective, this is equivalent to being able to taste the difference if someone dropped a single grain of sugar into a large and generously filled bathtub.

Hydrogen sulfide is not the only odorant associated with sewage however; several other organic compounds also add their own unique odours to the mix. Like hydrogen sulfide, these compounds are also made from the natural microbial breakdown of carbon and sulfur based chemicals often found in sewage. Some common odour causing chemicals found in sewage include ethyl mercaptan, dimethyl sulfide and carbon disulfide, many of which can also be detected by the human nose at very low concentrations.

Hydrogen sulfide is often used as the primary indicator of sewer odour because it is easy to measure, is often found in the largest quantities and because it conveniently forms under the same conditions as most other odour causing compounds. Inside Edmonton sewers, hydrogen sulfide concentrations can often exceed 100 ppm which is roughly 10,000 times higher than the odour threshold for hydrogen sulfide. As a result, even a small volume of air exiting a particularly odorous section of a sewer can cause significant odours in a community.

Odour causing sewer gases are mostly formed in wastewater as a result of the natural decomposition of organic matter when no oxygen is present. This often occurs in areas where flows are impeded, held or stopped entirely since that can limit the transfer of oxygen from the air into the wastewater or exposes the wastewater to mature and dense communities of micro-organisms capable of rapidly consuming the organic chemicals found in the wastewater.

Typical situations and locations where odour generation can occur include:

- At sewer pump stations, storage facilities and syphons
- In areas where sludge, sediment, fat-bergs or other debris build-ups occur
- In areas with pipe sags or poorly abandoned pipes

Targeting these areas in a mitigation strategy can eliminate odour issues at their source and provide additional benefits beyond odour such as reducing asset loss from sewer corrosion.

Locations that Cause Odour Generation in Sewers

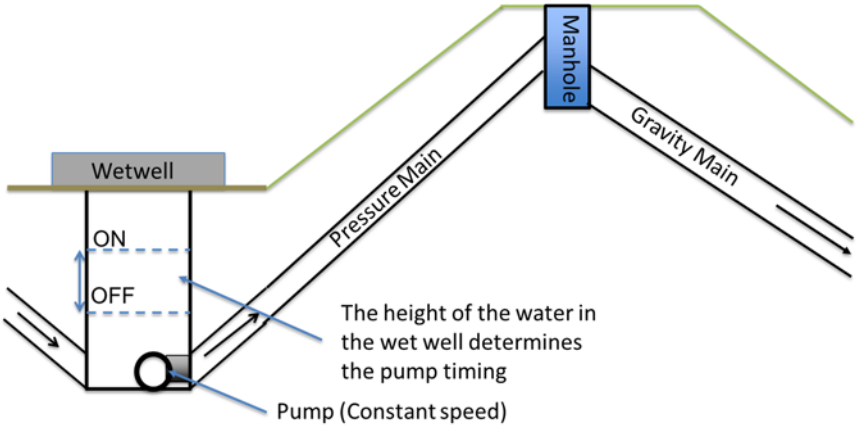
Pump Stations and Sewage Storage Facilities

The purpose of a sanitary pump station, also known as lift station, is to push waste water uphill to a higher elevation. They are used to get wastewater around obstacles, out of valleys, or when normal gravity sewers have reached depths that go beyond what can be reasonably constructed. A typical pump station consists of a wastewater holding tank (wet well), a pump and a closed sewer pipe that the wastewater is pumped through (a pressure main). When the wet well becomes full, the pump turns on and pushes the wastewater into and out of the pressure main until the wet well is mostly emptied. Because of their purpose, pump stations are a critical component of most modern sewer systems.

Pump stations are widely recognized in the wastewater industry as a primary location for the creation of the chemical compounds that cause intense sewer odours. The mechanisms that cause the formation of hydrogen sulfide at pumping stations have been studied for decades and are now well understood. When the wastewater is held in the wet well and in the pressure main pipe, the oxygen contained in the wastewater is rapidly consumed by micro-organisms in the wastewater, and by micro-organisms that are established on the walls of the pipes and holding tanks. The oxygen is not replenished because the wastewater is no longer mixing with air. In a typical pump station, once pumping ceases, the dissolved oxygen can be completely consumed in less than 15 minutes. Once there is no longer any oxygen in the wastewater, other species of micro-organisms begin to turn on. Of relevance to sewer odour is a type of micro-organism called sulfate-reducing bacteria. Once oxygen is completely removed from the wastewater the sulfate-reducing bacteria will begin to breathe in the chemical sulfate and exhale hydrogen sulfide. Large communities of sulfate reducing bacteria have been found to be present on the pipe walls of pressure mains. As a result, a lot of hydrogen sulfide can be made in a pressure main even over short periods of time.

In a similar manner, wastewater storage facilities can also be an area where significant amounts of hydrogen sulfide are created. In Edmonton, most wastewater storage areas are used to hold back wastewater during major storms. Without the storage areas, during a major storm, the additional storm flows entering the combined sewer system have the potential to exceed the capacity of both the sewer network and wastewater treatment plants. The storage areas provide relief during storms that help reduce the risk of discharging raw wastewater from either combined overflows or from the wastewater treatment plants. When used properly, storage areas should only pose an odour risk during storms, however due to age and capacity issues, some storage areas accumulate and store wastewater during normal operation, becoming a constant source of odour.

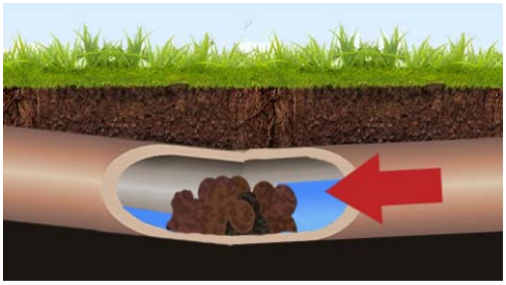
An assessment of the Edmonton sanitary system has identified 38 pump stations and 9 storage areas that are expected to create the majority of the hydrogen sulfide observed in the collection system. Addressing odour generation at these assets is critical to decreasing overall sewer odours across the city.



Simplified schematic of a pumping station and its pressure main

Solids, Sludge's and other Debris

In a clean, well designed gravity sewer, wastewater flows quickly downhill mixing with the oxygen containing air in the sewer so that it is constantly replenished with oxygen. However, when debris is allowed to accumulate in large enough quantities, the wastewater slows down and oxygen replenishment can decrease or stop entirely causing septic conditions to occur. Even worse, much of the sludge in the accumulated debris can contain sufficient numbers of sulfate-reducing bacteria to create significant quantities of odour causing chemicals. Sediment accumulation can occur anywhere but is particularly prevalent in areas where sanitary pipes begin to degrade structurally or sag. This can be a particularly problematic in older pipes, but is not unheard of in newer pipes.



In pipe sags sediments can accumulate causing further stagnation and potential septicity locally

Complicating matters further, sewer utilities have recently begun to experience two new phenomenon that make sewer blockages more common, reduced flows and the creation of "fatbergs". "Fatberg" is an informal name given to deposits of fats, oils and greases (FOGs). Some cities such as London, New York, Denver, and Melbourne have found fatbergs weighing 100-130 tons that are 250-750 meters long. These deposits cause sewer clogs and overflows which results in service disruptions, environmental impacts, and are costly to remove. In addition to causing severe operational issues in municipal sewer systems, fatbergs can also cause sewer odours by restricting flow and acting as a surface that hosts odour causing micro-organisms.

The formation mechanism of fatbergs is not yet well understood. In general, it appears that fatbergs are the result of fats, oils, or greases chemically reacting with calcium, magnesium, or sodium in the wastewater to create a sticky, insoluble mass very similar in composition to the plaque found in human arteries. The mass

of fats stick to surfaces of sewer infrastructure and capture other materials such as rags, wet wipes and organic sludge. Fatbergs are typically found in commercial districts with restaurants where cooking wastes may be improperly captured and deposited into the sewers. However, fatbergs can form anywhere as fats are normally not well digested and, depending on the individual's diet, can be found in human stool in large concentrations.

Due to lack of inspections in our system, fatbergs have not yet been observed in the trunk lines. However, masses of fats, oils, and grease have been found to accumulate at several pump station wet wells and it is likely there are deposits in trunk lines as well. Further inspection capacity is required to fully assess if fatberg accumulation is a widespread issue in the deep and large sewer trunks.

Fatberg masses in UK Sewers

Air Emission from Sewers

Odour causing chemicals in wastewater are usually released into the headspace in a sewer through wastewater mixing and turbulence. In many sewers, the air in the headspace of a sewer is under pressure. When the air pressure in the sewer is much greater than at the surface, the gases in the sewer will begin to escape through any possible venting points, such as manhole openings, catch basin openings, lateral sewers, unsealed abandoned sewers, combined sewers, combined sewer overflow (CSO) outfalls, and other openings. If the released sewer air is odorous, there is potential for impacts to the quality of life of nearby residents and citizens.

Poorly maintained catch basins can act as a source of sewer odours when connected to a combined system, providing a location for sewer air to escape from

One of the main factors impacting how much sewer air escapes from the sewer system is the sewer headspace air pressure. If the air pressure within the sewer is much higher than the air pressure at the surface, large volumes of air will begin to escape from any orifice or any holes found in the sewer network. Air pressure in the sewer system can become pressurized from the force exerted on air by water dropping over large drop structures or by structure elements or flow conditions that restriction air flow such as blockages, pipe terminations and hydraulic jumps.

Reducing opportunities for sewer air emission remains critical for areas where the sources of odour generation are widely distributed and as a result of the natural odour of wastewater. Modifications that reduce sewer air emission are proposed in areas where both high discharge volumes of sewer air have been observed and where there are upstream processes that result in sewer odour.

In pressurized sewer systems manhole pick holes are common escape point for sewer gases

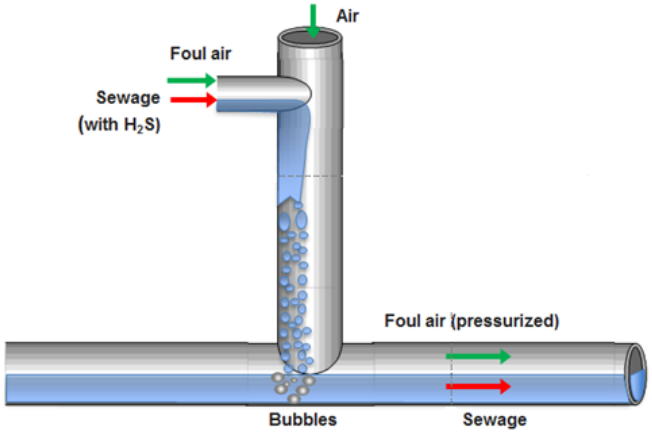
Mechanisms that cause air pressurization in sewers

Drop Structures

In Edmonton, drop structures are a major contributor to headspace pressurization. Many of Edmonton's large sewer trunks are between 30 to 40 meters underground. However, the smaller sewers that collect wastewater directly from houses and business usually are no deeper than 15 meters. When the smaller

collection sewers reach the deeper trunk lines, the wastewater is often allowed to fall the entire distance in a vertical shaft called a “drop structure”.

Large drop structures have two significant impacts on sewer odour throughout the city. First the agitation of wastewater as it falls will release most of the odour causing chemicals from the wastewater. As a result, the sewer air downstream of a drop structure can contain a lot more hydrogen sulfide if it was present in the received wastewater. Just as significantly, as the water falls down the drop shaft it disperses into tiny droplets and then begins to drag sewer air down with it. The drop shaft acts as an air pump, forcing large volumes of air into the deeper trunk line and pressurizing it. There are over 800 drop structures with drop heights greater than 5 meters in the City of Edmonton with many having heights as high as 40 m. Where they are located in large numbers, trunk line pressurization becomes a major issue.



Downstream Air Passage Blockage

There are a number of drainage structures and phenomenon that block the downstream passage of sewer air and force the air to vent into inappropriate locations. Examples of such blockages occur at:

- River crossing (inverted) syphons: Sanitary sewers north of the North Saskatchewan River usually stay north and flow towards the treatment plant via syphons which allow flows to cross the River. There are currently 5 syphons for this purpose.
- Lift stations: At some stations, flows are stored in the upstream tunnels for some time as occurs in Steinhauer-Duggan community. At this particular station, the current operation of the pump causes the upstream trunk to surcharge leading to sewer air backing up and causing odour emission along the trunk on 106 Street.
- Hydraulic jumps: These occur in cases where a steeper sewer trunk suddenly levels off and attains a shallower slope. This phenomenon generates a large amount of sewer air and an increase in sewer air pressure and odour emissions. EPCOR’s assessment indicates that there are about 120 locations within the trunk system where hydraulic jumps can occur.

Sewer Corrosion and Premature Asset Loss from Sewer Odours

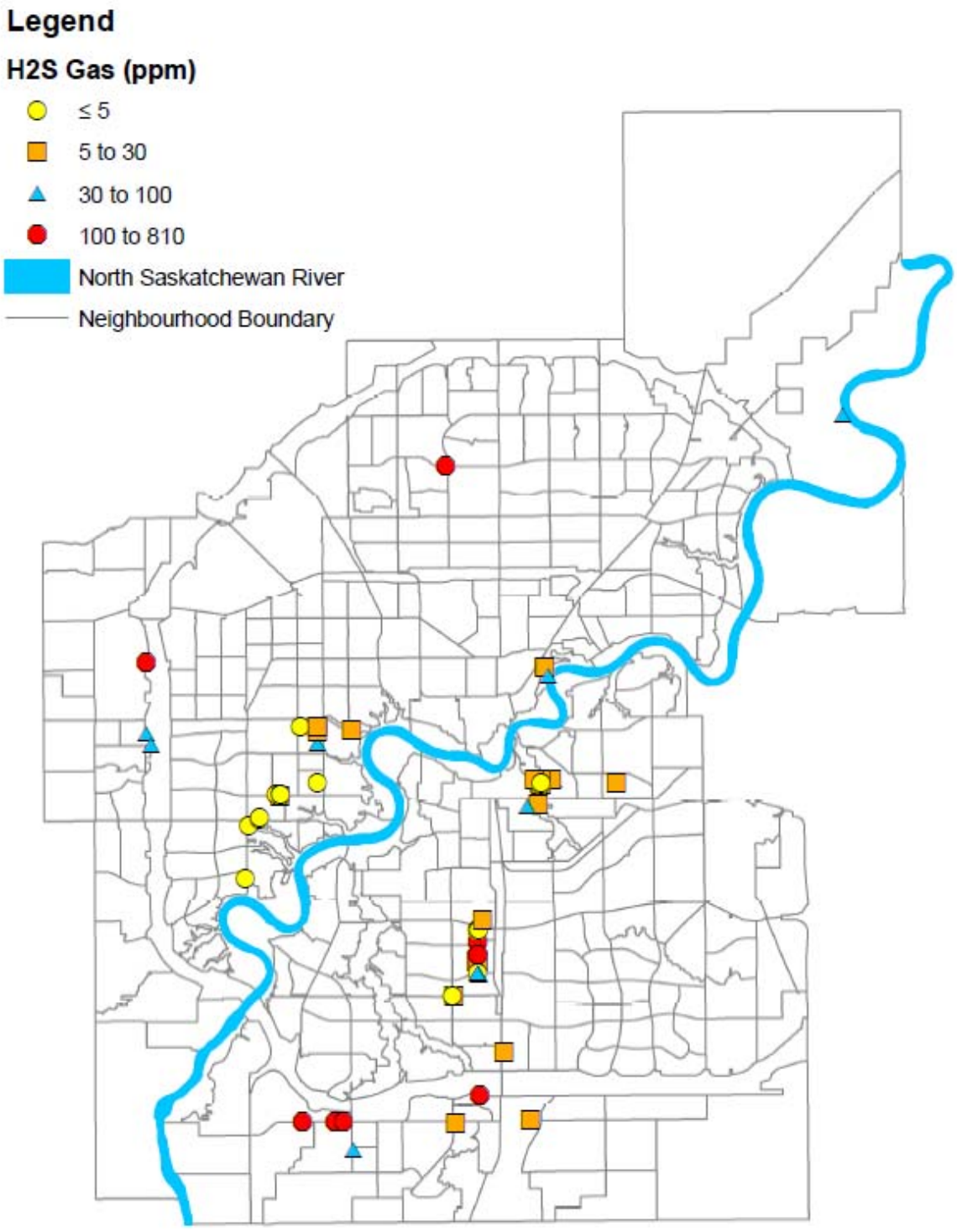
Beyond odour, the hydrogen sulfide created in septic areas of the sanitary network is also significant because of its impact on sewer asset condition and employee safety. Hydrogen sulfide gas is extremely reactive with metals and concrete. Its presence causes assets to corrode and fail before the end of their expected service life. EPCOR is currently in the process of reviewing the financial impact from premature sewer replacements due to sewer corrosion, however preliminary findings indicate that several hundred million dollars' worth of required sewer rehabilitation has been undertaken in the last 10 years and there is a significant need for sewer rehabilitation in the immediate future. There is strong evidence supporting that these requirements for premature rehabilitation are due in part to the accelerated deterioration of sewer assets because of excessive hydrogen sulfide exposure.

High hydrogen sulfide concentrations also impact EPCOR's capacity to inspect, manage and repair sewer assets. Within certain sewer assets, high concentrations of hydrogen sulfide can make the safe entry by employees prohibitively difficult. This can make minor repairs, and preventative maintenance less feasible impacting the overall condition of the sewer network over the long-term.

When hydrogen sulfide gas contacts concrete and metals it is transformed into corrosive sulphuric acid. When sewer material comes into contact with the sulphuric acid, the material corrodes, reducing its integrity. Corrosion can reduce the longevity of sewers, lead to system failure, and eventually result in significant costly disruption of service to customers and adverse impacts to the environment. For concrete sewer assets, hydrogen sulfide concentrations between 10 to 20 ppm have been reported to cause corrosion rates of between 2-7 mm per year in concrete depth loss.

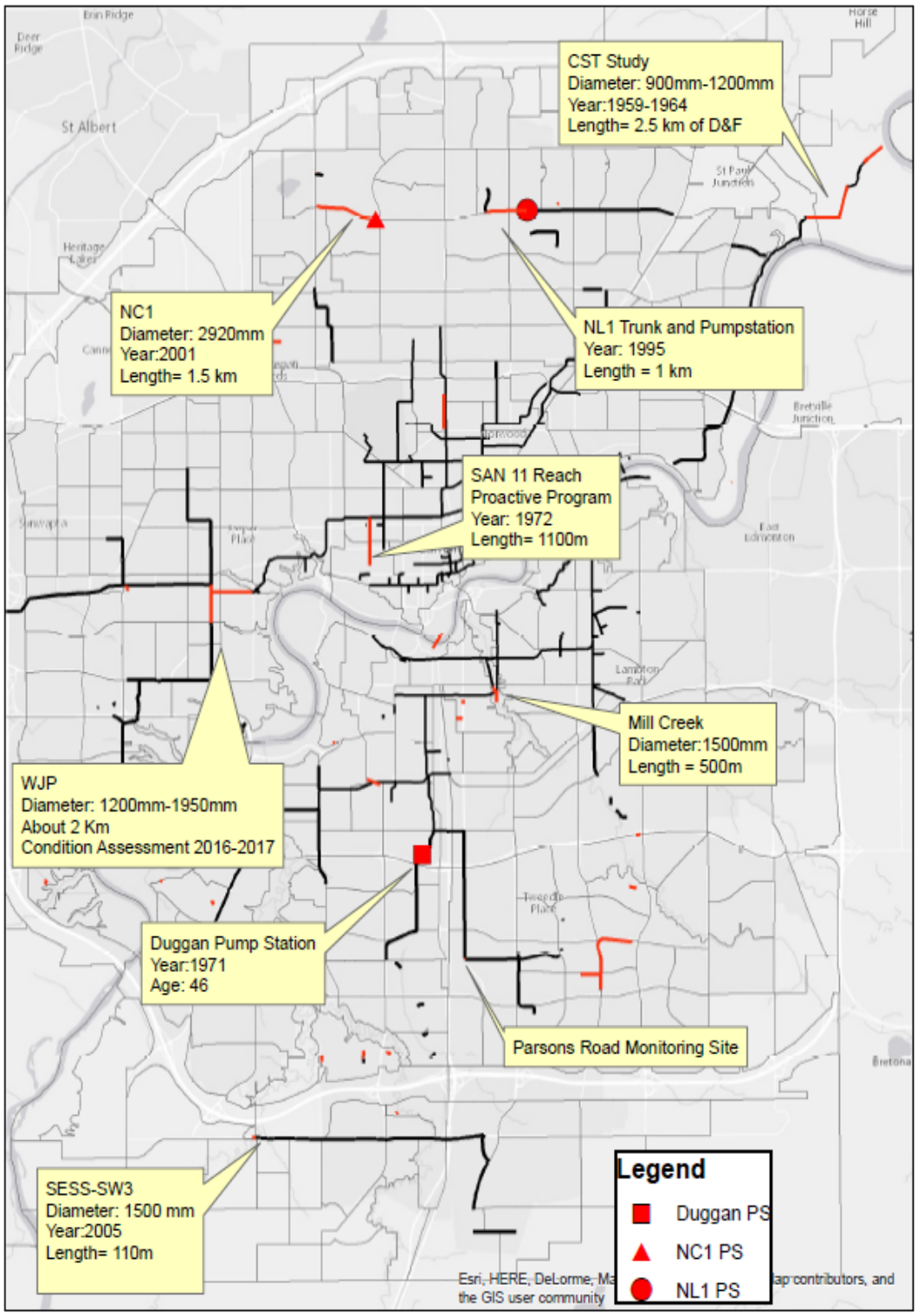
Due to the challenges associated with inspecting the large trunk system, such as insufficient access, hazardous conditions, and safety risk, there is a lack of up-to-date system-wide inspections for sewer assets that have been exposed to high concentrations of hydrogen sulfide. While EPCOR has not been able to completely identify the full extent of corrosion in deep trunk lines, the high number of odour reports and direct measurements of sewer gas surrounding certain assets is an indicator that sewer corrosion is a major risk factor in many trunk lines. Preventing the formation of hydrogen sulfide will not only reduce odour impact in the community but also substantially reduce the risk of corrosion in these sewer assets and lengthen their service life.

The figure below shows locations in the trunk system where hydrogen sulfide gas measurements have been taken in the past. Hydrogen sulfide gas levels within the sewers as high as 810 ppm have been recorded near Rabbit Hill Road/Ellerslie Road, more than 550 ppm near the intersection of 109 Avenue/199 Street, and up to 200 ppm along 34 Avenue/106 Street in Steinhauer-Duggan area.



Past sewer gas hydrogen sulfide measurements within Edmonton. Concentrations greater than 30 ppm are generally considered to correspond with severe corrosion risk

Large Trunk Corrosion Issues



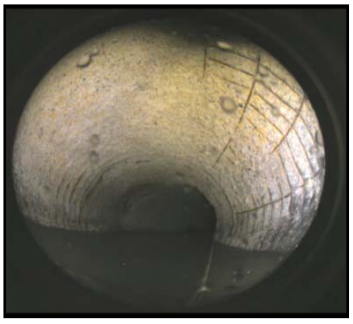
Severe corrosion has been observed in several major trunk lines. Because of city-wide access restrictions, awareness of corrosion issues typically only occurs after major operational difficulties begin

As part of EPCOR's planned proactive trunk inspections and system rehabilitation program, locations with higher number of sewer odour reports have been used as one of the key criteria in identifying trunks that need inspections. Access into critical trunk lines has been very limited across the city due to insufficient access infrastructure however, preliminary inspections at some locations have observed that corrosion in the sanitary and combined trunks is causing accelerated structural deterioration and decreased lifespan. The pictures below provide observed conditions of some of those assets in the collection system.

Corroded manhole, Mill Creek

Handful of corroded concrete from manhole, Mill Creek

Sulfur deposits & exposed rebar from corrosion, Duggan Sanitary Tunnel



100 mm of concrete corrosion exposes rebar in Clareview Sanitary Trunk

Rebar failure in Gold Bar Utilidor

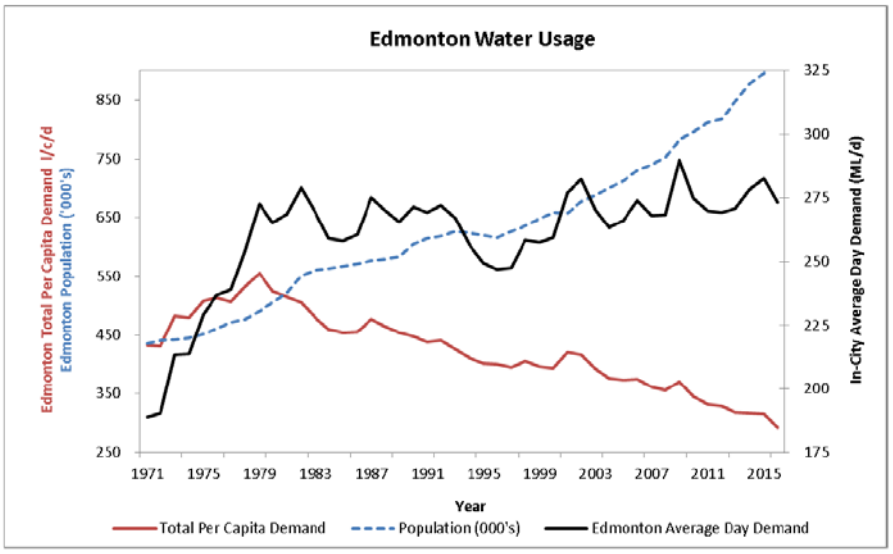
Exposed rebar mesh in Gold Bar Utilidor

Water Consumption Trends

Reduced sewer flows are a result of better water conservation by customers. While the benefits of improved water conservation are significant, the reduction in wastewater volumes can have consequences in sewers when it results in lower wastewater velocities. In sewers that were designed with much higher expected flows, the drop in velocity may be sufficient to allow sediments to accumulate resulting in stagnation.

Water consumption in the City of Edmonton has changed dramatically over the past three and a half decades. Edmontonians are using less water in their homes due to the installation of water efficient fixtures and appliances (predominantly toilets and washing machines) that are common in the marketplace. While decreases in per capita demand are advantageous with respect to supply management, reducing environmental impacts, and deferring capital investment related to water and wastewater treatment, the decline in water use presents new challenges in older sanitary collection systems.

In a report prepared by EPCOR Water in 2017 on this subject, it was found that the average day demand of water for Edmonton is roughly what it was in the late 1970s, even though the city population has grown by approximately 450,000 people. Total water use per person is down over 20 percent since 1991. Edmontonians once used as much as 500 liters of drinking water per person per day. Today the average resident only uses 180 litres of drinking water per day. Other municipalities are down to using 120-140 liters per person per day so it is very likely that Edmonton per capita water use will continue to decline.



As Edmonton's population has grown the total amount of water demand city-wide has remained mostly constant. This is in large part due to great strides in household water conservation efforts.

Data analysis undertaken by the Gold Bar Treatment indicates that despite major population growth, there has been a reduction in both wastewater flows and total solids reaching their wastewater treatment plant in the past 20 years.

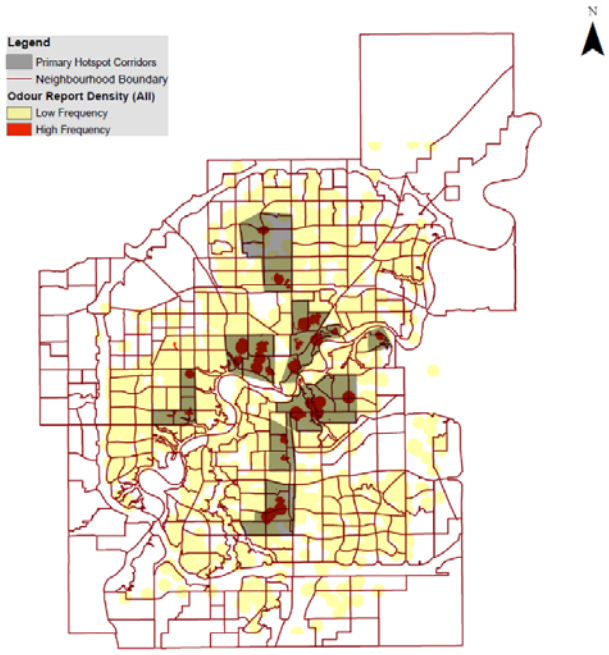
Section 11

Appendix B – Public Engagement

Research Process

From January to February 2019, EPCOR conducted a public opinion survey with 1,600 Edmontonians, using a statistically reliable sampling methodology to test and validate public preferences for odour mitigation (priority over other sources of odour and general quality of life impacts). The survey was conducted primarily by telephone with an option to complete online.

The sample was drawn from Drainage Services customers representing communities with pre-existing sewer odour concerns. As shown in the map at right, eight odour "hotspots" (red & grey areas) were identified based on high frequency of odour complaints received through 311 calls: four north of the river and four south of the river. For comparison purposes, a separate control group was based on other areas of the city with a low frequency of 311 complaints (yellow areas).



Awareness and quality of life impacts of various odours were tested to allow for comparison, including: Outdoor storm or sanitary sewers, garbage or composting, and commercial or industrial business operations. Respondents were asked whether they've experienced each odour source and then asked to describe: frequency, duration, nature and intensity of the odours, and overall quality of life impacts. Additional questions were asked for respondents who cited outdoor storm or sanitary sewers to test preferences for timeframe and cost to address odour issues, how they have reported issues and whether they were satisfied with the response.

For consistency, odour questions were developed using standard terminology and parameters used by 311 and EPCOR field staff (e.g. water meter readers) to report odours.

Demographics of Respondents

The survey participants (n=1,501) had the following demographic characteristics:

- Gender: 50% male, 50% female
- Age: 16% 18-34, 38% 35-54; 40% 55+

- Tenure in Edmonton: 7% less than a year, 26% 1 – 5 years, 16% 6 – 10 years, 21% 11 – 20 years, 30% more than 20 years
- Home ownership: 83% own, 15% rent
- Dwelling: 87% single detached, 9% duplex/semi-detached, 4% other
- Household income: 30% <$50k, 29% $50-99k, 41% $100+k
- Education: 17% high school, 30% college, 53% university
- Employment: 67% employed, 22% retired, 2% student, 8% unemployed

Residents living in impacted communities enjoy a high quality of life — reporting higher overall satisfaction with their neighbourhood than residents in the control group. Two-thirds (67%) of residents in impacted communities say their neighbourhood offers an excellent quality of life (7 or 6 on 7-point scale) versus 63% in the control group. Seven-in-ten from impacted communities say their neighbourhood is a good place to spend time in the yard or on a patio, versus 62% in the control group.

Key Finding 1: Impacted communities are more likely to experience sewer-related odours and quality of life impacts.

Sewer odours are not an issue of significant concern for more residents. When asked what they like least about their neighbourhood, 3% of residents in impacted communities mention “sewer odour” as top-of-mind. For comparison, some 16% mentioned crime and safety as a concern, followed by traffic and poor infrastructure (9% each). Other complaints that garnered more than 5% of concerns included poverty issues, noise, in-fill development and poor access to amenities. However, the majority of residents (28%) said they had no complaints in particular.

However, the research confirms that sewer odours are far more common in impacted communities than in non-impacted communities. One-half of the residents in impacted communities have noticed an issue with sewer odours compared with 21% in the control group. Of the half of all impacted residents who noticed sewer odours, about half said they had a negative impact on quality of life. Stated generally, about one-quarter of all residents in impacted communities have been negatively impacted by sewer odours.

Out of all sources of odour tested in the research, sewer odour is by far the most prevalent — 48% said they experienced it in their neighbourhood — compared with fire pits (16%), commercial/industry operations (12%), garbage and composting (6%) and other odours such as vehicles or smoke (5%). Some 60% of all residents in impacted neighbourhoods also noticed sewer odours in other Edmonton communities outside their own.

Sewer odours also tend to be experienced more frequently in the impacted communities compared to other odours. Of those who reported sewer odour concerns in impacted communities, 74% said they experienced the odours “frequently” and 58% said the odours tend to linger longer than a few days. Sewer odours are generally experienced year-round.

Residents reported a variety of quality of life impacts, including recreation, use and enjoyment of homes, health and safety, avoiding parts of the neighbourhood, property value and odours penetrating vehicles. Comments about how sewer odours have affected residents include:

- *"Don't want to go outside and sit in the front, the kids won't play outside if they can smell the odour."*
- *"I can't keep the windows open in the summer because the smell comes in. I won't have people over or invite them to the neighbour because of the smell mostly in the summer time."*
- *"People have come to the city and were interested to purchased property and they were turned off by the strong sewer smell. It affects my family and myself every time we park or stop by a red light."*

Key finding 2: Odours and their impacts are more pronounced in southern hotspots.

There was some difference in results between the four hotspots north of the river and the four hotspots south of the river. In general, communities south of the river tended to report more incidences of odour, frequency and duration:

Base: all impacted communities (n=1200)

Question	**North**	**South**	**TOTAL**
% of neighbourhood complaints related to sewer odour (unaided)	3%	6%	4%
Overall neighbourhood quality of life rated as "excellent"	60%	75%	67%
Incidence of odour from outdoor storm/sanitary sewer	45%	52%	48%

Base: all residents who experienced sewer odours in impacted communities (n=577):

Question	**North**	**South**	**TOTAL**
Sewer odour impact on quality of life	49%	48%	49%
Residents who notice sewer odours frequently	68%	79%	74%

Question	North	South	TOTAL
Residents who noticed odours lasted longer than 2 days	52%	62%	58%
Residents who say odours are more noticeable overall	49%	58%	54%
Residents who report behavioural impacts from odours they experience	60%	62%	61%

Key Finding 3: Residents favour both quick action and low rate impacts.

To understand public attitudes towards the timing and cost of the upgrades necessary to improve odour, we asked how likely residents would be willing to pay extra on their monthly utility bills.

Whether they've experienced odour issues or not, most residents were not likely to be willing to pay extra on their bills:

39% were somewhat or very willing to pay $5 extra a month

22% were willing to pay $10 extra a month

59% were not very or not at all likely to be willing to pay $5 extra a month

76% were unwilling to pay $10 extra a month

That said, of all respondents who reported experiencing odour concerns, 79% believed that sewer odours in their neighbourhood should be resolved in the next 5 years or less, while 12% believed completion in the next 10 years is an appropriate timeframe.

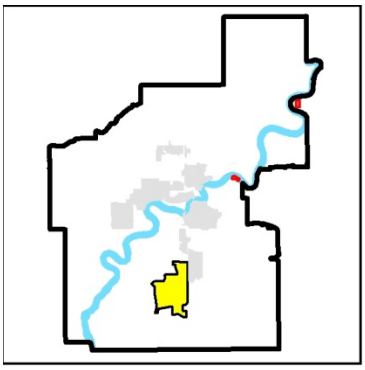
Some 23% of these individuals have attempted to report their concerns primarily through 311 or EPCOR; however, most of those who reported concerns (58%) were dissatisfied with the response. The primary reason cited for dissatisfaction was the perception that nothing was done to address the odour.

Said one respondent: *"They straight up told me the problem and said it could not be solved within a known timeframe."*

Section 12

Appendix C – Detailed Corrosion and Odour Reduction Projects by Area

Consistent Odour Area: Steinhauer – Duggan Sanitary Service Area



The Steinhauer-Duggan sanitary service area is located on the South West side of Edmonton and serves approximately 7000 properties over an area of 1700 hectares. Multiple assets within the service area are a major contributor to odour issues both within and downstream of the communities of Steinhauer-Duggan. The assets are a significant contributing factor for sewer odour issues encountered in Allendale, Pleasant View, and as far away as Bonnie Doon. Because of the intensity of the odour along the Steinhauer – Duggan sanitary corridor, the causes and release mechanisms for odour in this area have been studied in great detail.

Four specific sewer assets within this service area have been identified that create the conditions required to create odorous wastewater in the sewer system:

1. The Kaskitayo Pump Station
2. The Twin Brooks Pump Station
3. The Blackburne Pump Station
4. The Duggan Pump Station and storage tunnel

Monitoring and water sampling at the pump stations has confirmed that septic conditions are occurring within sections of the pump stations pressure main pipes and in their upstream storage areas. This is resulting in the creation of the chemical Hydrogen Sulfide (H_2S) in the wastewater, a primary component of sewer odour.

Additionally, two specific sewer assets have created pressurized conditions that force odorous sewer air to expel from the sewer system and discharge into the outside environment:

1. Two sewage drop structures located at Saddleback Road and 111th Street and at 34th Avenue and 106th Street
2. The Duggan Pump Station and storage tunnel

The hydrogen sulfide containing wastewater discharged from the Kaskitayo, Twin Brooks and Blackburne pump stations travels northwards towards the Duggan trunk line. At Saddleback Road and 111th Street, the wastewater falls more than 35 meters into the deeper Duggan trunk. This results in the hydrogen sulfide in the wastewater being stripped out of the liquid and released into the sewer headspace. The falling wastewater also causes the receiving deep trunk to receive considerable volumes of air from the upstream

trunks. The Duggan trunk line becomes highly pressurized with odorous air which then escapes from nearby openings to the atmosphere. The numerous odour complaints surrounding the intersection of Saddleback Road and 111th Street are a result of these two combined processes.

The entire deep trunk upstream of the Duggan pump station is used for wastewater storage. Even during dry weather conditions, the holding times are sufficiently long to allow for considerable volumes of wastewater to go septic and create odorous chemicals in the wastewater. Because the tunnel can fill completely with wastewater and because the Duggan pump station does not allow further air movement to downstream pipes, any air that enters the trunk is forced into the attached sewer laterals feeding into the trunk. The drop structure located at 34th Avenue and 106th Street further agitates and pressurizes the tunnel forcing significant volumes of sewer air into the surrounding community. The sewer odour complaints surrounding 106th Street are a direct consequence of these issues.

The Duggan pump station then discharges the highly septic wastewater into the trunk line that serves the community of Allendale and Pleasant View and which further continues towards Bonnie Doon. Because of the high holding times and large volumes of wastewater that are discharged from the Duggan Pump Station, the downstream odour impact is very large.

The Corrosion and Odour Reduction Strategy proposes to reduce the odour impact both in Duggan and the downstream communities by reducing the odour generation at the pump stations both through operational changes and through active odour treatment of the wastewater. It then further proposes to limit the release of any remaining hydrogen sulfide and reduce the pressurization of the Duggan trunk line through major structural upgrades to the trunk line.

Proposed Capital / Operational Solutions

To mitigate odours in the Steinhauer-Duggan service area, the mitigation strategy proposes the following projects:

- Construction and operation of chemical dosage systems for the treatment of odour at the Kaskitayo, Blackburne and Twin Brooks pump stations,
- Installing 10 manhole inserts and one-way flaps
- Pursuing the implementation of operational improvements at the Kaskitayo, Blackburne and Twin Brooks pump stations
- Construction of a new sanitary trunk and the permanent abandonment of the Duggan (PS105) pump station and existing deep trunk line

It is proposed that the Duggan tunnel and pump station be abandoned and bypassed by a new, shallower line. This project has been proposed as an alternative to the deployment of multiple operationally intensive odour control systems. The project may also reduce the need for trunk line rehabilitation that could potentially be required to prevent the risk of operational failure in the next 10-15 years. The proposed tunnel by-pass and abandonment activities will significantly reduce odour issues locally and as far downstream as Bonnie Doon. Meanwhile the proposed pump station and manhole sealing projects within the odour strategy will provide significant odour relief during and after tunnel construction.

Without the tunnel by-pass, achieving an equivalent level of odour mitigation upstream and downstream of this service area would require an additional $12million on a Net Present Value (NPV) basis including $265,000 per year of operational expenditures. Overall, the proposed tunnel by-pass offers superior long-term value by:

- Reducing yearly operational expenditures,
- Having a longer service life than mechanical odour treatment systems and sanitary pump stations
- Replacing a 52 year old (58 years when new tunnel is commissioned) sanitary trunk whose service life expires at 75 years
- Eliminating the need for potential rehabilitation work in the trunk-line and the construction of a new pump station

To further support these projects additional access manholes are required in Steinhauer-Duggan to provide inspection access where severe corrosion is expected. The primary purpose of these access manholes is for infrastructure assessment but they are also critical for ensuring the success of the tunnel by-pass by ensuring that the tie –in locations are in good condition. Starting in 2019, two access manholes will be constructed and a third existing manhole will be modified to support future access.

The Steinhauer – Duggan service area will also benefit from actions taken as part of the city-wide operational improvement initiatives. In particular, both operational and capital allowances have been made for applying operational improvements at the upstream pump stations. The spending is detailed where the city-wide projects are discussed.

Capital Expenditure					
	2019	2020	2021	2022-26	Total
Pump Station Treatment	$1,092,105	$963,158	$0	$0	$2,055,263
Access Manholes	$3,917,777				$3,917,777
Duggan Tunnel Bypass	$1,085,579	$985,904	$8,315,557	$68,135,842	$78,521,822
Total					**$84,494,862**

Operational Expenditure					
	2019	2020	2021	2022-26	Total
Pump Station Treatment	$200,000	$341,053	$341,053	$1,705,265	$2,587,371
One Way Flaps	$35,000	$0	$0	$0	$35,000

Manhole Sealing	$25,500	$0	$0	$0	$25,500
Total					**$2,647,871**

Recommendations for further investigation and monitoring

Steinhauer is the first sanitary service area to be targeted under the Corrosion and Odour Reduction Strategy. The effectiveness of the treatment solutions, particularly at the pump stations, will be evaluated to identify potential opportunities for enhanced operational improvements in the Steinhauer service area as well as city-wide.

Contributions from projects in other sanitary service areas

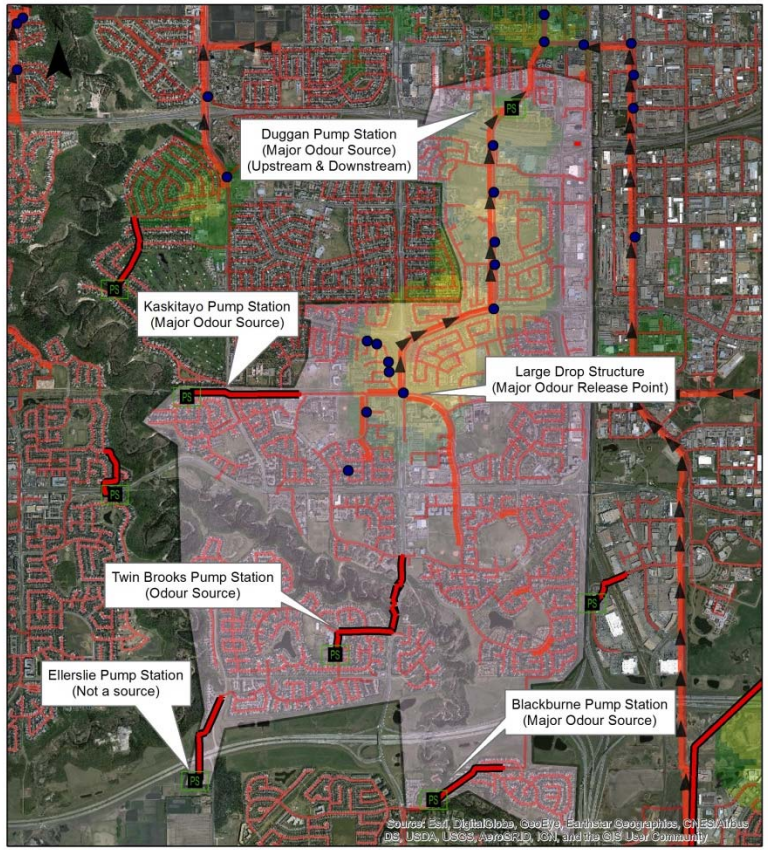
No other sanitary service areas flow into the Steinhauer-Duggan service area.

Downstream Benefits

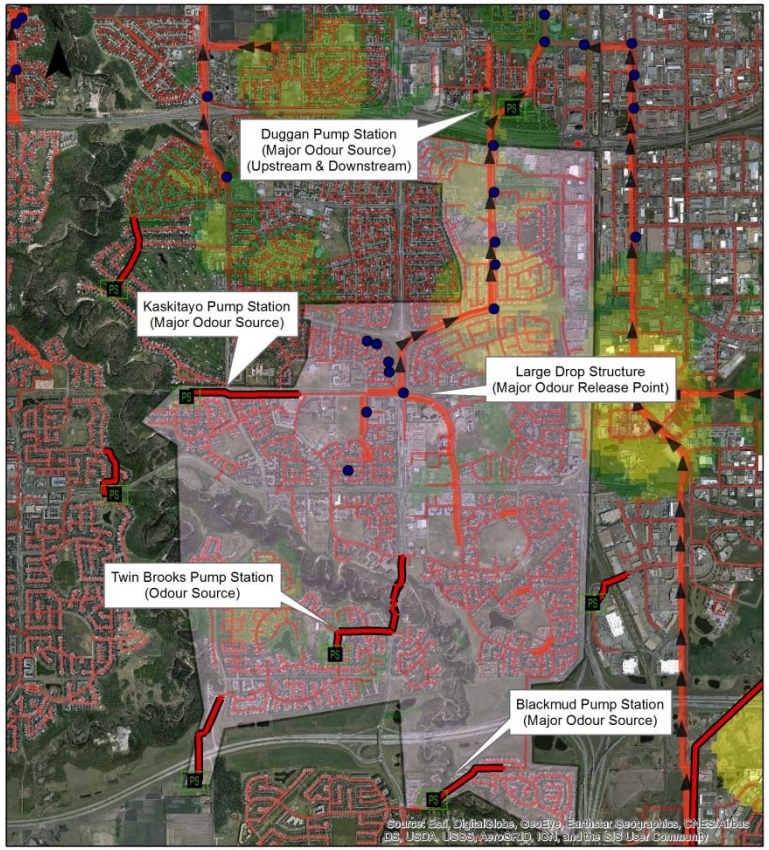
The Duggan – Steinhauer sanitary service area is one of the major odour contributors in South Edmonton. The mitigation projects conducted in this service area will have positive benefits as far downstream as Bonnie Doon by removing the source of a significant portion of the hydrogen sulfide observed in downstream trunk lines.

Implementation Risks

The proposed projects depend on the successful completion of the Duggan tunnel replacement to ensure their long term effectiveness down stream of Steinhauer-Duggan service area. In the long term, increased odour contributions from SESS and Mill Woods development may limit the downstream impact of the improvements in Steinhauer-Duggan on odour relief in the Allendale sanitary service area to the north.



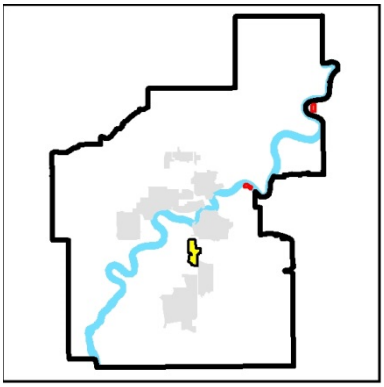
Duggan Sanitary Catchment,
System Configuration
and
Odour Sources



Duggan Sanitary Catchment,
System Configuration
and
Odour Sources

Overview maps highlighting relative potential odour sources in the Steinhauer-Duggan sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Consistent Odour Area: Allendale – Pleasant View Sanitary Service Area



The communities of Allendale and Pleasant View sit atop a major trunk line that receives wastewater from most of the South and Southwest of Edmonton. There are no major sewer assets within Allendale and Pleasant View that may create significant amounts of odour causing chemicals, instead the main trunk line receives wastewater that is septic and contains odorous compounds from both the upstream Duggan trunk line and the Parsons Road trunk line.

The wastewater in the trunk line beneath Allendale and Pleasant View does not pass over any major drops, limiting its agitation. However because the wastewater at this location contains sufficient quantities of hydrogen sulfide and other odorous chemicals, the wastewaters normal movement through the sewer pipe is still sufficient to release odour causing chemicals into the air. Further, the trunk line receives considerable volumes of wastewater from numerous side sewers that must first drop over their own drop structures. While this is not expected to release additional odorous compounds from the wastewater, it does pressurize the trunk line sewer headspace.

Starting at Allendale, the sewer conveyance network becomes a combined sewer network, and then begins to receive water from numerous street side storm basins. Because the storm basins are open to the atmosphere, larger volumes of sewer air can exit from the trunk lines further increasing odour in the surrounding neighbourhoods. With the larger volumes of air leaving the sewer, odour nuisance occurs even with lower concentrations of odour causing compounds in the deep trunk lines headspace.

To reduce odour nuisance in Allendale and Pleasant View communities, the primary actions proposed by the odour mitigations strategy is to reduce the generation of odour causing chemicals in the upstream Duggan and Parsons Road trunk lines. Within Allendale and Pleasant view, the strategy also proposes to further limit odour nuisance by isolating several sewer laterals from the air headspace of the deep trunk line and to further reduce pressurization of the deep trunk by structurally modifying several drop structures. Finally, because of the age of the sewer assets, there is the possibility that a significant build of sediments and sludge have accumulated in the deep trunk. A buildup of sediment can block and slow down wastewater sufficiently to allow it to go septic and generate odours. The accumulation of solids/sludge is also septic and may release its own odours. In response, sewer inspections of the trunk line will be completed once sufficient access has been constructed. If significant quantities of sediments or sludge are found, they will be removed using trunk line cleaning equipment providing significant odour reductions locally.

Proposed **Capital / Operational Solutions**

To mitigate odours in the Allendale and Pleasant View sanitary service area, the mitigation strategy proposes the following:

- Construction of 6 drop structure modifications to reduce trunk pressurization
- Construction of 8 access manholes
- Inspecting and cleaning 10.9 km of trunk lines with a high risk of sediment accumulation
- Installing 14 manhole inserts and one-way flaps
- Investigate the potential for providing chemical odour treatment at 12 pump stations that feed into the Terwillegar-Whitemud trunk. PS-102 Westbrook specifically, will be prioritized for monitoring.

Capital Cash Flows					
	2019	2020	2021	2022-26	Total
Drop Structure Modifications		$5,989,311	$4,728,781	$0	$10,718,092
Access Manholes		$5,964,145	$8,458,242	$$2,927,853	$17,350,240
Total					$28,068,332

Operational Cash Flows					
	2019	2020	2021	2022-26	Total
Inspection & Cleaning		$9,800	$524,850	$0	$534,650
One Way Flaps		$55,000	$10,000	$0	$65,000
Manhole Sealing		$0	$8,500	$0	$8,500
Total					$608,150

The Allendale sanitary service area will also benefit from actions taken as part of the city-wide initiatives. In particular, both operational and capital allowances have been made for applying operational improvements upstream along the Parsons Road sanitary service area and for a number of the pumping stations located within the Terwillegar sanitary service area. Applying operational improvements will be dependent upon the results of the city-wide monitoring program.

Recommendations for further investigation and monitoring

Future monitoring is proposed for the following purposes:

- To quantify the wastewater quality and hydrogen sulfide contributions from Parsons Road, Duggan and Terwillegar trunk lines.

To quantify hydrogen sulfide generation at the 14 upstream pump stations within the Terwillegar sanitary service area.

Contributions from projects in other service areas

Outside of local actions, the proposed mitigation activities in the upstream Duggan sanitary service area will provide the greatest reduction to odour within the Allendale area. In consideration of recent odour data, wastewater contributions from the Parsons Road sanitary service area are also likely to contribute significantly to local odour issues. Sampling and monitoring planned for the summer of 2019 will better quantify the impact of the Parsons Road trunk line and provide guidance for potential improvement through immediate operational changes at several upstream pumping stations. While the Terwillegar trunk line has 14 upstream pumping stations, odour reports have not been common in the communities surrounding or downstream of their local pump stations. It is likely that the Terwillegar trunk line is not a major source of odour containing wastewater when it enters the Allendale sanitary service area. Sampling and monitoring will be completed along the Terwillegar trunk line and at its upstream pump stations in 2020 and 2021 to quantify any potential for odour nuisance that it may contribute. Future recommendations for actions and potential operational changes will be made thereafter.

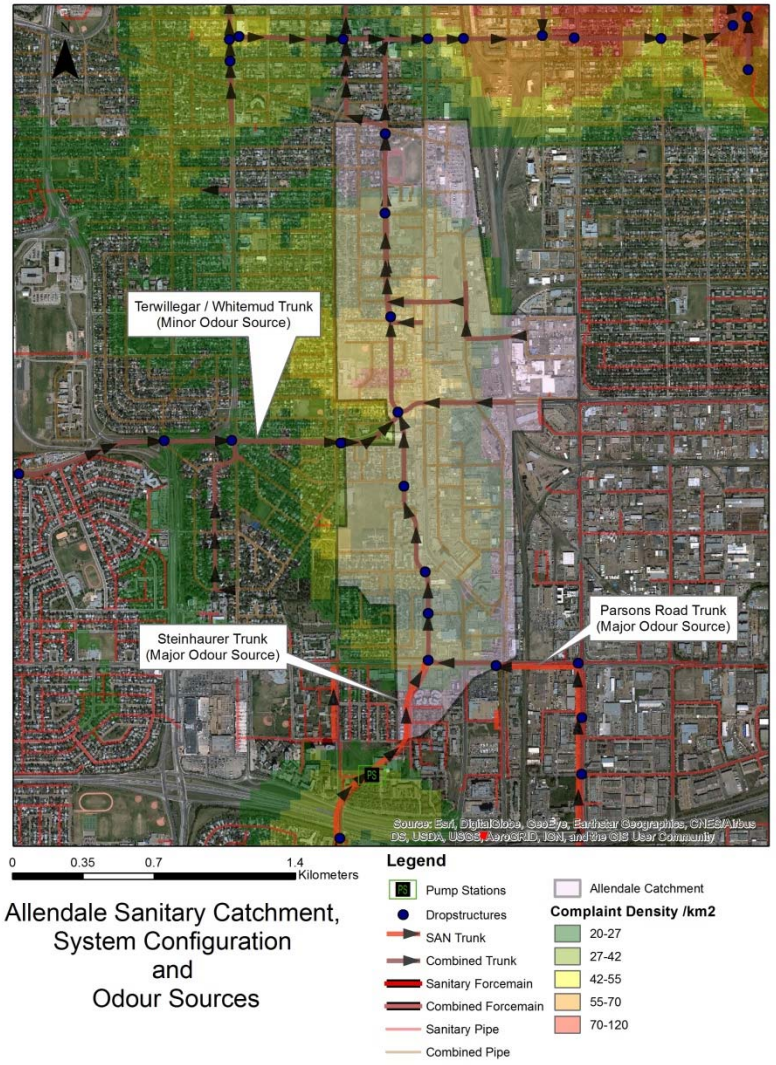
Downstream Benefits

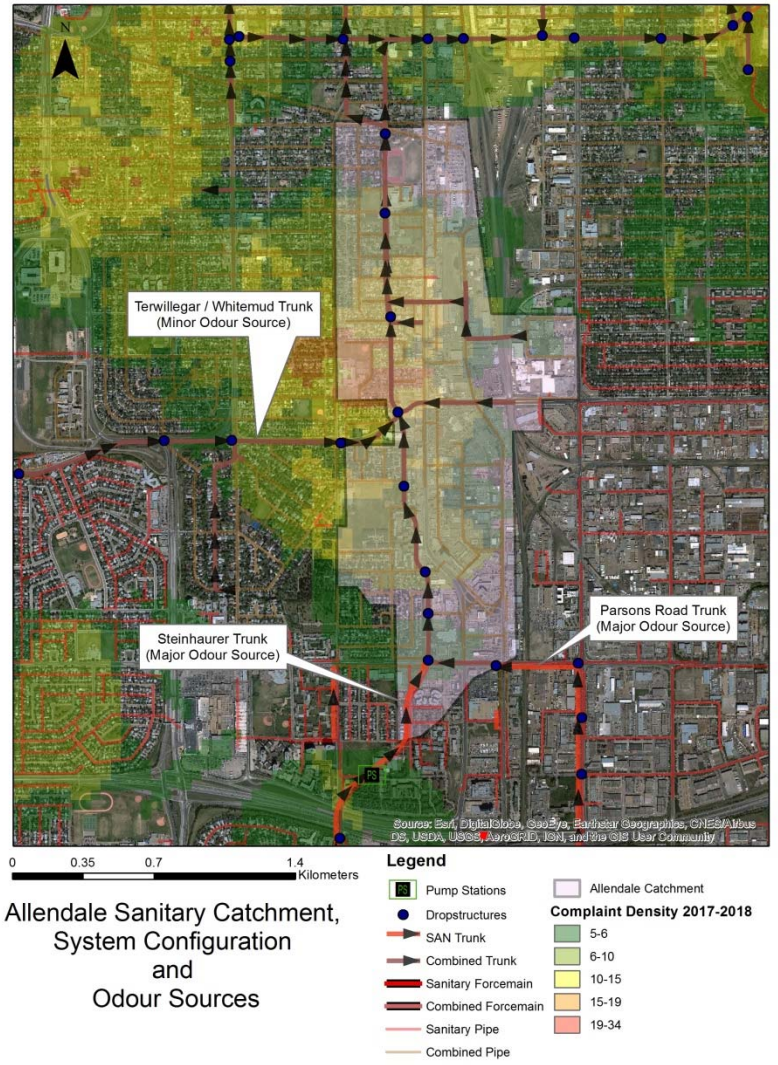
The downstream communities in the Bonnie Doon Sanitary service area will directly benefit from the trunk cleaning activities in the Allendale sanitary trunks. Cleaning the trunk lines will reduce flow blockages, remove septic materials from the sewer and allow for greater oxygenation of the wastewater in the trunk line. The trunk line will likely exhibit reduced hydrogen sulfide generation and increased removal rates of any hydrogen sulfide contributed by upstream sources. Most of the remaining proposed mitigation actions within Allendale provide localized odour relief and are unlikely to have any major downstream effect.

Implementation Risks

There are several implementation risks that need to be considered in order to effectively mitigate odours within Allendale.

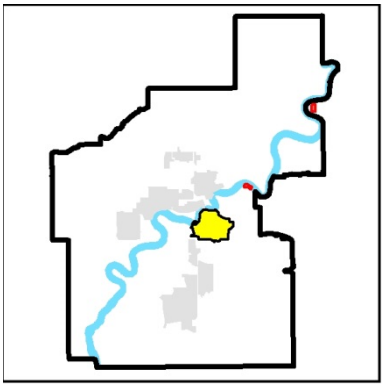
- Sewer access may be limited if severe asset deterioration is present
- Manhole sealing and the installation of one-way flaps have the potential to transfer odour issues elsewhere if an alternative air release point has not been provided. Following the installation of the containment infrastructure the installation of one or more sewer vents will need to be reviewed.





Overview map highlighting relative potential odour sources in the Allendale sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Consistent Odour Area: Bonnie Doon Sanitary Service Area



The Bonnie Doon sanitary service area lies beneath the communities of Bonnie Doon, Kenilworth, Idylwylde, Ottewell, and Strathcona. The sewer trunk passing beneath Bonnie Doon receives wastewater from most of South Edmonton and a portion of the Edmonton Downtown and Rossdale community. Bonnie Doon has two pump stations within its service area that also likely have an odour impact. With the addition of multiple drop structures within the service area, including several large drops in the Mill Creek Ravine, and because the sewers are a combined storm/sanitary system, the odour nuisance in Bonnie Doon is severe.

Most of the wastewater entering Bonnie Doon comes from the Pleasant View trunk line. Hydrogen sulfide measurements have not been taken directly from where the Allendale enters Bonnie Doon however; it is likely that there is still a significant amount of hydrogen sulfide remaining in the wastewater when it reaches the Bonnie Doon sanitary service area. In 2018, measurements taken along 80th Avenue between 102 street and 96th Street found wastewater with hydrogen sulfide concentrations high enough to be a severe odour issue. While it is currently assumed that the majority of the hydrogen sulfide entering the Bonnie Doon sanitary service area originates from the Pleasant View trunk line, there remains the possibility that some odour is contributed from the trunk line serving the University of Alberta area. Further monitoring will be required to properly assess its overall contribution.

Pump stations 171 and 121 are also likely to have conditions that are favorable for the creation of odour causing chemicals, though they have not received any sampling or monitoring. Pump station 171 is a particular concern because it draws from a large sewage storage facility located under the North Saskatchewan River. Even if the pump station only creates small quantities of odorous sewer compounds, because of its proximity to Bonnie Doon and because the receiving sewers are open to the atmosphere (a combined sewer system), its contribution to odour nuisance at the surface would still be high. The trunk lines serving Bonnie Doon have several steep sections and large drops throughout their length as well as multiple drop structures for receiving wastewater from residential laterals. The extreme agitation, pressurization of the sewer lines, and the combined nature of sewer system in this community makes it one of the worst odour areas in the City.

The Corrosion and Odour Reduction Strategy proposes employing many of the same methods proposed for the Pleasant View / Allendale communities to reduce the odour impact in Bonnie Doon. This includes the isolation of sewer laterals from the main trunk lines, modification of several drop structures to reduce sewer pressurization, and trunk line cleaning and inspection. The modification of several large drop structures near Millcreek Ravine are of particular importance as they have been determined to be causing considerable downstream pressurization of the trunk line. The pump stations 171 and 121 will require monitoring in order to assess their overall impact on the downstream sewer system. The results of the monitoring will help determine what extent of odour mitigation can be achieved through operational modifications or direct odour treatment of the wastewater.

The modification of several large drop structures near Millcreek Ravine are of particular importance as they have been determined to be causing considerable downstream pressurization of the trunk line.

Proposed **Capital / Operational Solutions**

To mitigate odours in the Bonnie Doon sanitary service area the mitigation strategy proposes the following:

- Construction of 21 drop structure modifications to reduce trunk pressurization
- Construction of 4 access manholes
- Inspecting and cleaning 8.0 km of trunk lines that have a high risk of sediment accumulation
- Installing 62 manhole inserts and one-way flaps
- Installation of 3 vent stacks to provide localized pressure relief control
- Constructing and operating chemical dosage systems for the treatment of odour at 2 pump stations
- Construction of 2 air curtains

Capital Expenditure					
	2019	2020	2021	2022-26	Total
Drop Structure Modifications	$0	$1,214,247	$6,900,861	$38,531,669	$46,646,777
Ventilation Control Unit	$0	$0	$0	$1,695,125	$1,695,125
Pump Station Treatment	$0	$0	$538,843	$808,265	$1,347,108
Access Manholes	$0	$0	$0	$13,012,680	$13,012,680
Total					$62,701,690

Operational Expenditure					
	2019	2020	2021	2022-26	Total
Ventilation Control Unit	$0	$0	$0	$9,000	$9,000
Pump Station Treatment	$0	$0	$0	$1,364,212	$1,364,212
Inspection & Cleaning	$0	$34,826	$338,968	$571,134	$944,928
One Way Flaps	$0	$0	$210,000	$0	$210,000
Manhole Sealing	$0	$0	$17,000	$76,500	$93,500
Total					$2,621640

The Bonnie Doon sanitary service area will also benefit from actions taken as part of the city-wide initiatives. In particular, both operational and capital allowances have been made for applying operational improvements at pump stations PS 171 and PS 121. Applying operational improvements will be dependent upon the results of the city-wide monitoring program.

Recommendations for further investigation and monitoring

Further monitoring is also required for the Bonnie Doon sanitary service area and includes:

- Fully quantifying the odour contribution from outside sources including, Allendale, University of Alberta and the Davies Industrial district.
- Measuring and profiling pump station performance and hydrogen sulfide generation at the Walterdale pump station and wastewater storage trunk (PS 171) to identify if operational modifications can sufficiently lower the odour impact of those facilities.
- Measuring and profiling pump station performance and hydrogen sulfide generation at the Cloverdale pump station (PS 121). This will be required before recommending any specific treatment options.

Contributions from projects in other sanitary service areas

The Allendale sanitary service area and its upstream contributors are the only inflows received in Bonnie Doon that have proposed upstream odour mitigation projects. The odour mitigation projects proposed in Steinhauer-Duggan are likely to have a positive impact on odour within Bonnie Doon. Trunk cleaning in Allendale is also expected to benefit the communities in the Bonnie Doon sanitary service area.

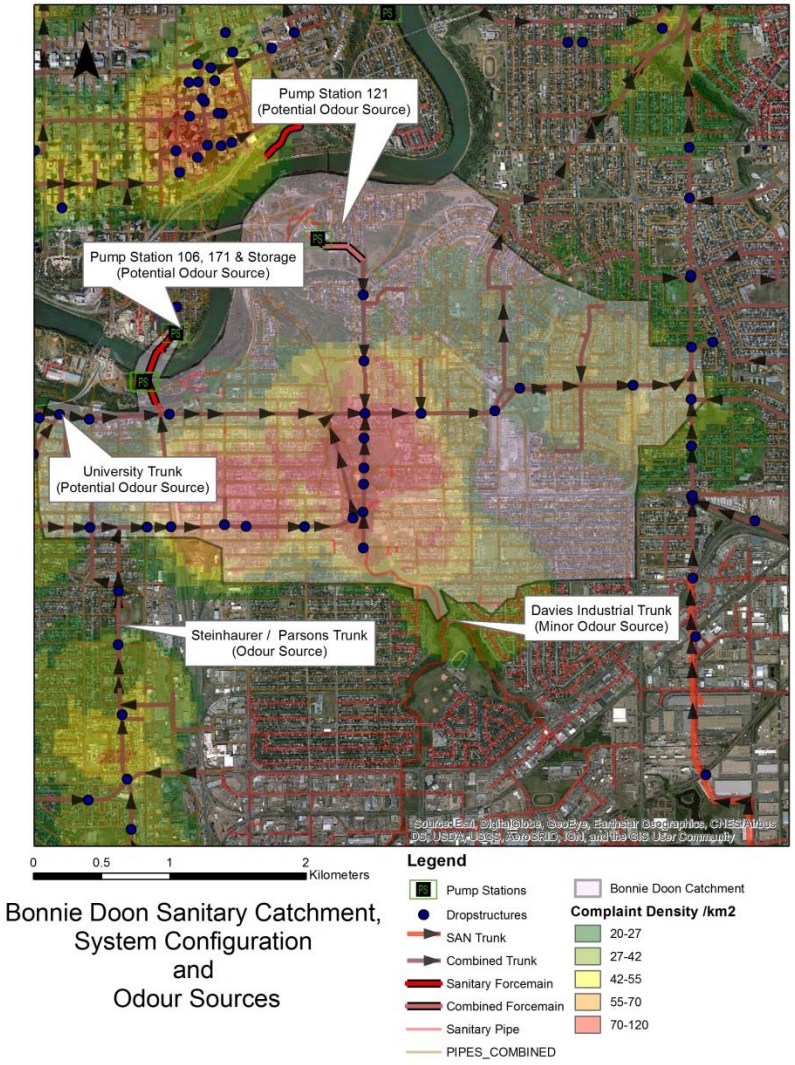
Downstream Benefits

Although, not marked as an area where odour is a consistent and immediate issue, the proposed odour mitigation projects in Bonnie Doon will result in reduced potential for sewer odour along the length of the trunk line along 75th Street as it continues towards the Goldbar wastewater treatment plant.

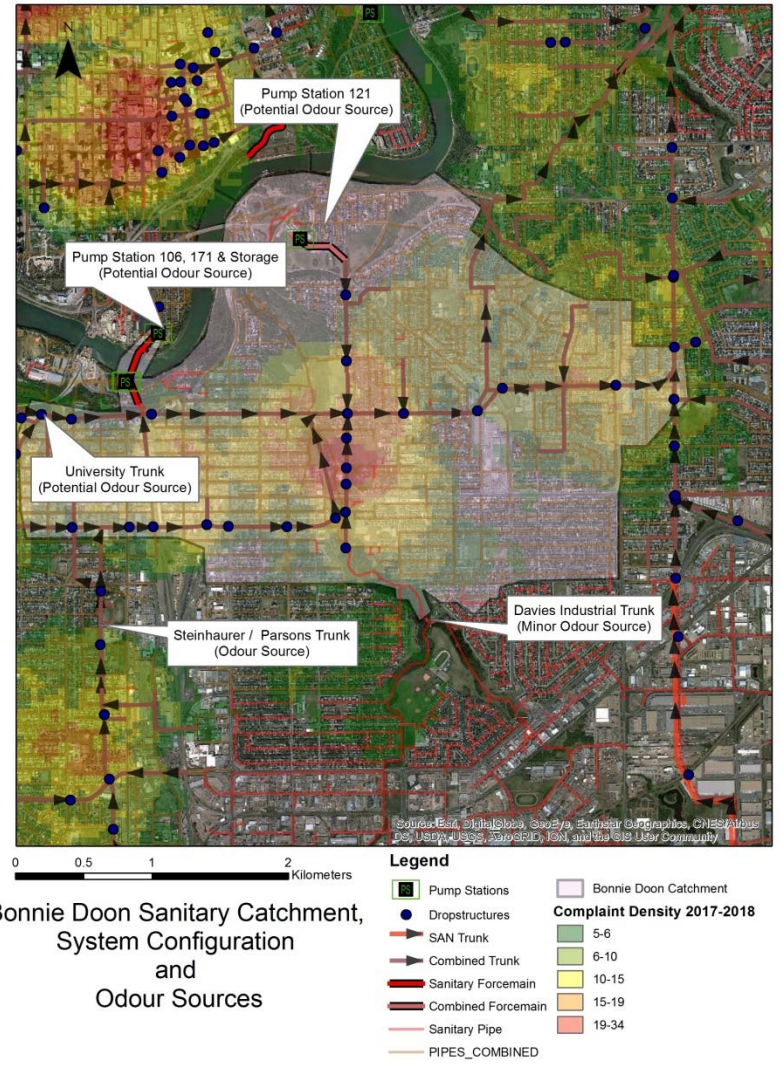
Implementation Risks

There are several implementation risks to consider in Bonnie Doon:

- Care must be taken in evaluating manhole sealing to ensure odours are not transferred to other neighborhoods.
- There is observational evidence of severe asset deterioration within the Bonnie Doon service area. This has potential to impact the ease of building asset tie-ins, completing inspections and performing cleaning activities.
- There is current and planned construction activities related to both water and drainage assets in the area. In general, the construction activities can be used as an opportunity for project synergy and to reduce overall construction impact in the community. However, for projects where the scope of work is not yet fully defined, there remains the risk the planned projects may conflict with odour mitigation work. Several projects will be close to on-going work related to the LRT expansion so there is the risk of project delays if there are road closure limitations or site access limitations due to the LRT construction work.



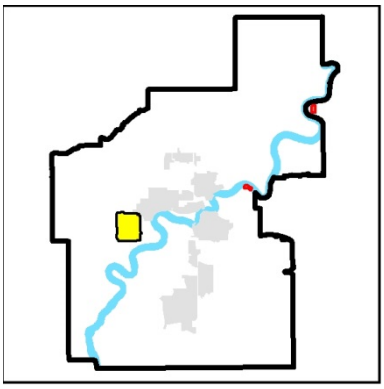
Bonnie Doon Sanitary Catchment,
System Configuration
and
Odour Sources



Bonnie Doon Sanitary Catchment,
System Configuration
and
Odour Sources

Overview map highlighting relative potential odour sources in the Bonnie Doon sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Dynamic Odour Area: West Jasper Place Sanitary Service Area



In the proposed first stage of the strategy, building improved access infrastructure, setting up monitoring, wastewater characterization and intimating operational improvements at odour generating assets is required in this area and is critical to ensuring the success of future odour mitigation activities in the community.

The West Jasper Place Sewer Service area lies beneath the communities of Crestwood, Jasper Place, Parkview and West Edmonton. The West Jasper Place sewer service area has traditionally been a high odour nuisance area. However, there is evidence that the completion of several major construction projects, particularly the upgrades to the 150th Street trunk line have been responsible for a decrease in odour intensity and customer complaint frequency in 2016 to 2018. While the overall sewer odours in certain areas of West Jasper and its surrounding communities may have decreased, odour intensity still remains significant along 87th Avenue and surrounding the intersection of 150th Street and 99th Avenue.

The West Jasper Place trunk line receives wastewater from Southwest Edmonton communities that are north of the river. Cameron Heights and its surrounding communities most likely remain the primary source of the odour containing wastewater that passes beneath Jasper Place. The upstream communities make use of 8 pump stations to convey wastewater north. None the less, the sewer network within West Jasper is entirely dedicated to sanitary flows with no combined flow connections, limiting how much air escapes to the surface. As a result, even with high number of upstream pump stations, the areas where odours are experienced by residents have remained close to the trunk line and usually only centre around large drop structures. The Laurier / Buena Vista pump stations have been a past source of odour along its downstream receiving sewers; however the pump stations are currently being abandoned and re-built as a single facility. Efforts are being made to ensure the design and proposed operational philosophy of the new facility minimizes future odour impact.

The Corrosion and Odour Reduction Strategy proposes that the odour contributions from the upstream pump stations be quantified in order to provide improved operational guidance and to determine the most appropriate direct treatment solution. Inspections of the trunk lines, particularly those upstream of West Jasper Place will also be conducted in order to identify if excessive sediment accumulations are present and commence trunk line cleaning. Along the trunk line, modifications to several of the drop structures as well as the installation of air treatment and venting infrastructure to provide sufficient headspace pressure reductions along the trunk line will likely be the most effective mitigation method for the area. The exact solution will however depend on the results of the monitoring and inspection campaign.

Proposed **Capital / Operational Solutions**

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution.

- Increase trunk line access capacity by constructing 2 additional access manholes
- Initiate trunk line cleaning and inspection

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring campaign in 2022 – 2023

Capital Expenditure					
	2019	2020	2021	2022-26	Total
Access Manholes	$0	$0	$0	$4,337,560	$4,337,560
Total					$4,337,560

Operational Expenditure					
	2019	2020	2021	2022-26	Total
Inspection & Cleaning	$0	$0	$0	$146,893	$277,762
Monitoring & Operational Improvements	$0	$200,000	$200,000	$200,000	$600,000
Total					$877,762

The West Jasper Place sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

Recommendations for further investigation and **monitoring**

Monitoring of the following locations is recommended:

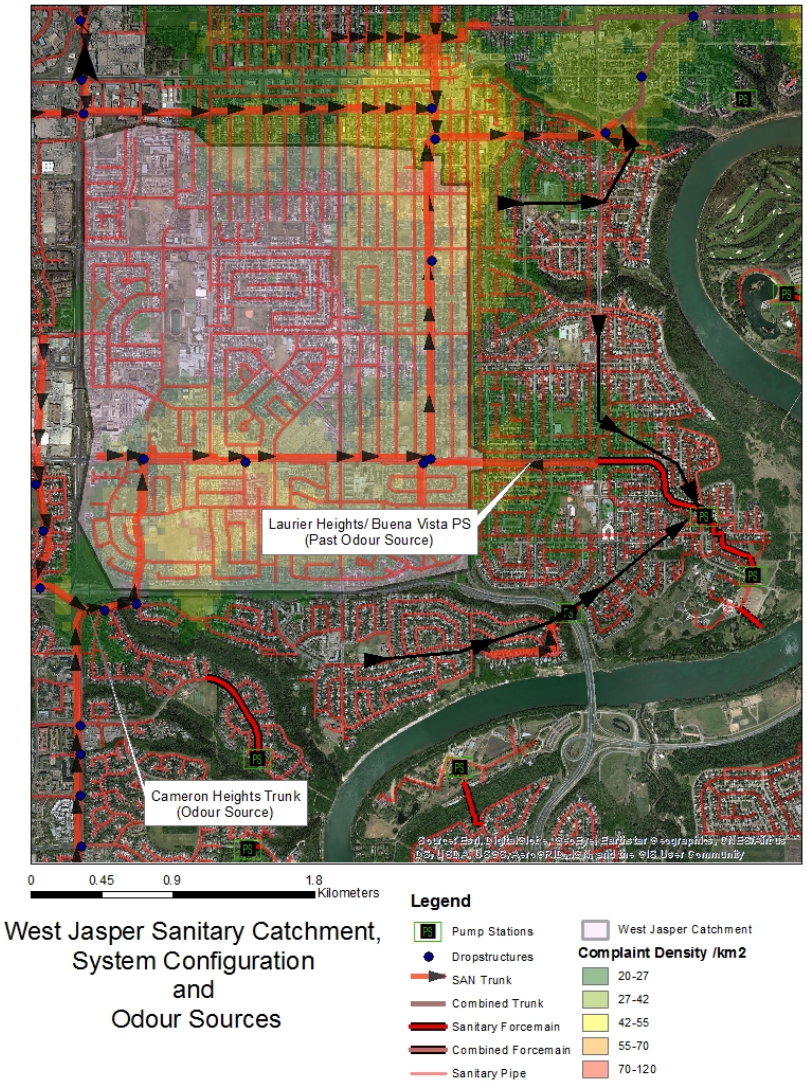
- Cameron Heights (PS 197)
- St. Georges Crescent (PS 112)
- William Hawrelak Park (PS 108)
- Quesnell Heights (PS 212)
- Buena Vista (PS 120)
- Laurier Heights (PS 111)
- Wolf Ridge Estates (PS 151)
- Fort Edmonton Park (PS 101)
- South Westridge (PS 110)

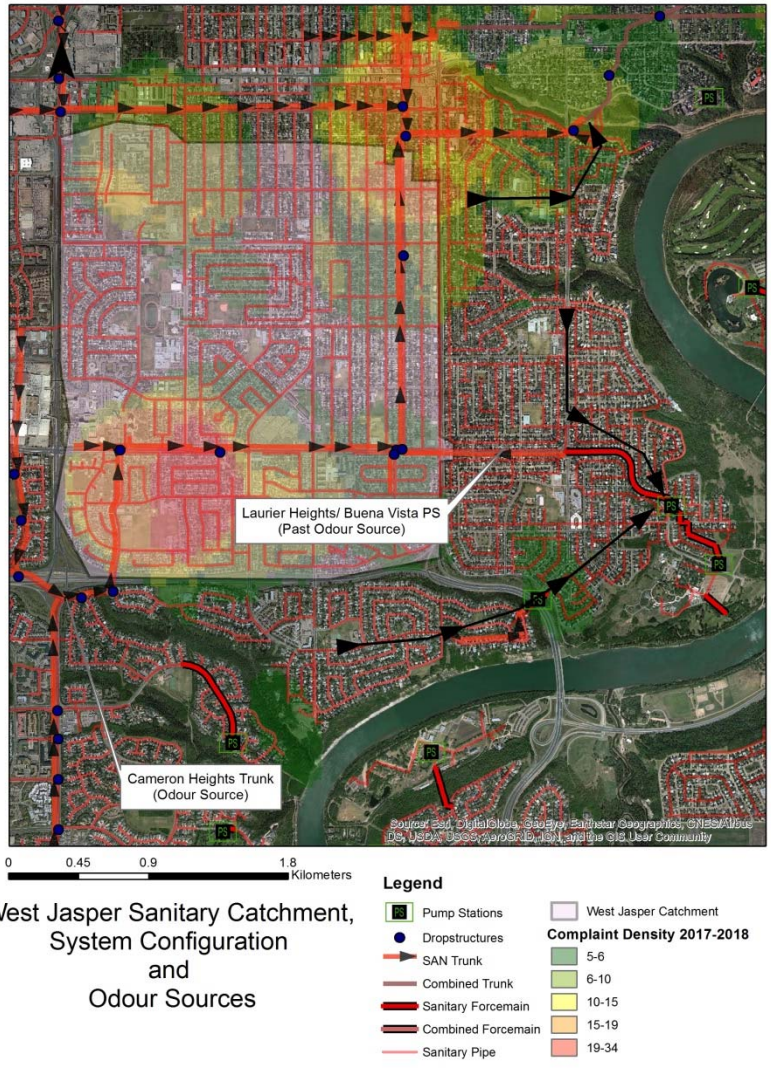
Contributions from projects in other service areas

Odour generation at pumping stations in the Cameron Heights area from pumping stations will be monitored and quantified in 2022-2023 with the goal of identifying immediate opportunities for operational improvement and to evaluate if chemical treatment is an appropriate future mitigation strategy in that region. Any reduction in odour generation in Cameron Heights will have a positive impact in the Jasper Place Sanitary service area.

Downstream Benefits

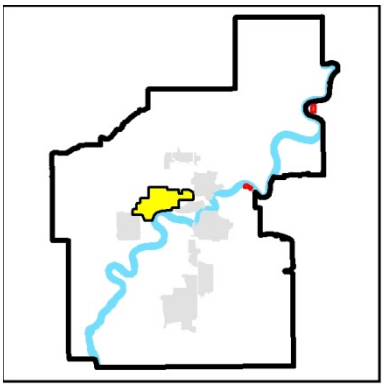
Any reductions in septicity and odour generation in this sanitary service area will provide moderate benefits for downstream communities in Glenora.





Overview map highlighting relative potential odour sources in the West Jasper sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Dynamic Odour Area: Glenora Sanitary Service Area



The Glenora sewer service area lies beneath several communities such as Oliver, Westmount, and Queen Mary Park. Several major trunk lines pass beneath the communities but they all receive odour containing wastewater from both the West Jasper trunk line and a trunk line that serves the Trumpeter and Northeast Edmonton communities. Upstream measurements of sewer headspace hydrogen sulfide concentrations determined that there is sufficient hydrogen sulfide in the incoming wastewater to be a severe odour nuisance. In particular, the trunk line serving Trumpeter has high concentrations of hydrogen sulfide in its headspace. Within the service area, there is evidence that the Clifton Place pump station is creating a severe, though localized, odour nuisance. The age and complicated design of the multiple trunk lines and lateral sewers, the combined system configuration, and large number of drop structures has resulted in an odour nuisance that is intense and widespread throughout the service area.

There are a large number of interconnections between the major trunk lines as well between the smaller sewers that connect to the multitude of sewer trunk lines. Because of the high level of interconnections, it is difficult to effectively isolate side sewers from odorous sections of the main trunk lines. Instead primarily mitigation methods that lead to overall depressurization of the entire trunk lines, such as modifying drop structures and installing ventilation infrastructure are more appropriate. Control of odour generation at its source is also critical for lowering the overall odour nuisance. This can include odour management efforts along the West Jasper Service area and from the Trumpeter trunk line, cleaning of the trunks, and improving the operation of the Clifton Place pump station. Because the Clifton Place pump station immediately discharges into a combined sewer area and the wastewater flows quickly and encounters a drop structure, the control of odour generation at that pump station is also critical as its impact on odour nuisance in its immediate area is high.

Proposed **Capital / Operational Solutions**

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution.
- Increase trunk line access capacity by constructing 4 additional access manholes
- Initiate trunk line cleaning and inspection

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring campaign in 2022 – 2023.

Capital Expenditure					
	2019	2020	2021	2022-26	Total
Access Manholes	$0	$0	$0	$8,675,120	$8,675,120
Total					$8,675,120

Operational Expenditure					
	2019	2020	2021	2022-26	Total
Inspection & Cleaning	$0	$0	$0	$229,671	$229,671
Monitoring & Operational Improvements	$0	$200,000	$200,000	$200,000	$600,000
Total					$829,671

The Glenora sanitary service area will also benefit from actions taken as part of the city-wide initiatives.

Recommendations for further investigation and monitoring

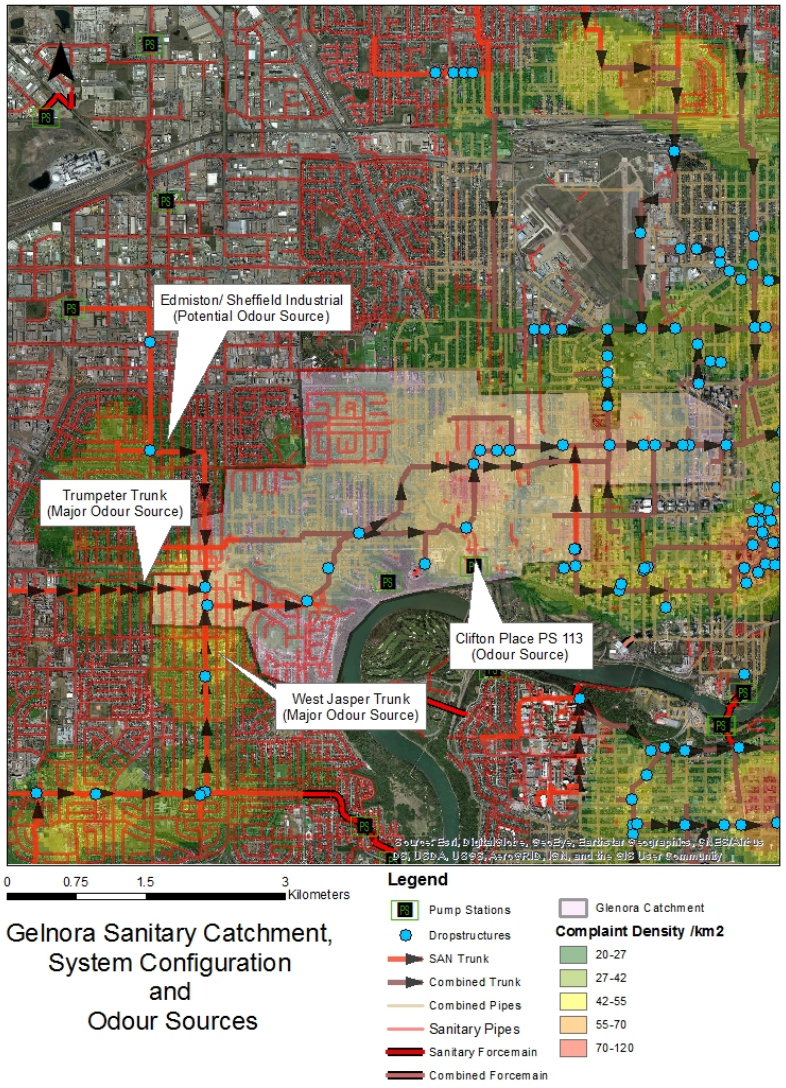
Monitoring of the following locations is recommended:

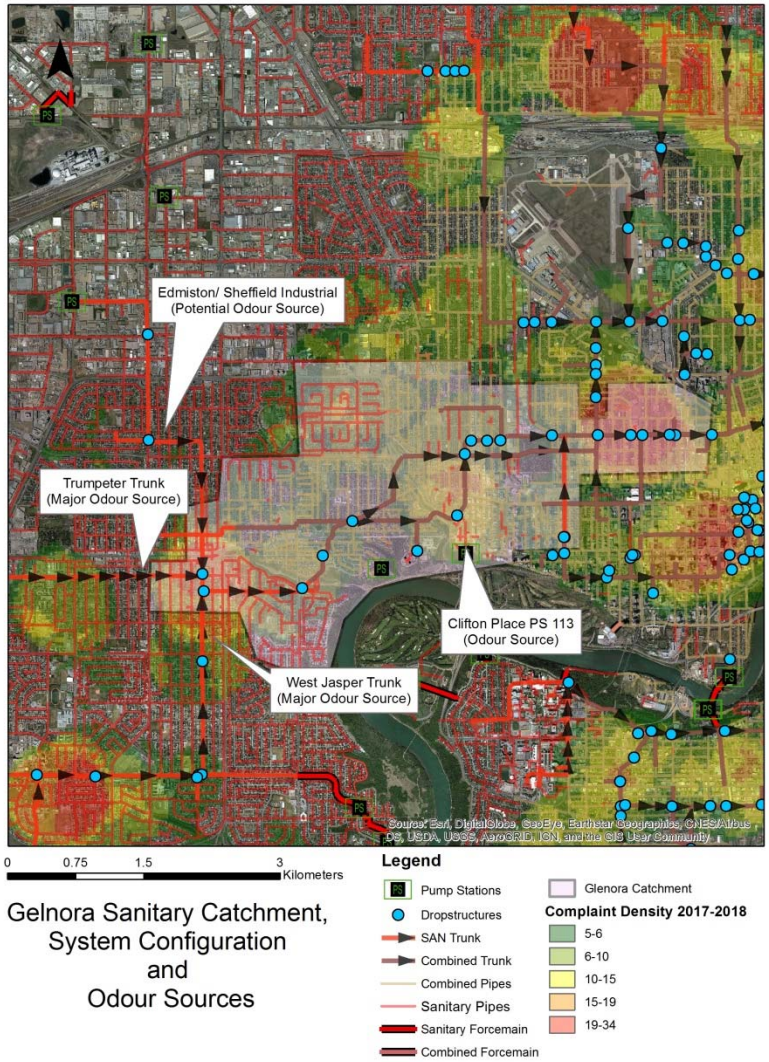
- Trumpeter Station 213 (PS 213)
- Clifton Place (PS 113)
- Starling Station 217 (PS 217)
- Hawks Ridge Pump Station (PS 223)

The odour contributions from the Edmiston, Trumpeter and West Jasper trunk lines will be monitored near their point of entry into the Glenora service area to determine their individual contributions to odour nuisance. This data will be used in order to better guide the development of future phases of odour mitigation.

Contributions from projects in other sanitary service areas

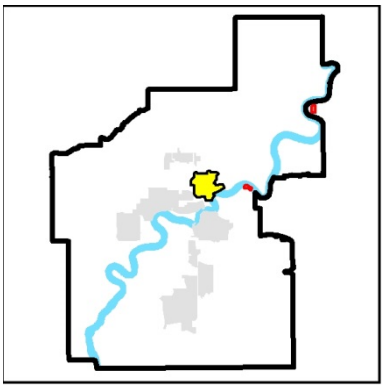
Any reduction in odour contributions from the Jasper Place or Trumpeter trunk lines will provide a reduction in odour nuisance in the Glenora sanitary service area. Odour generation at primary pumping station in the Trumpeter community will be monitored and quantified in 2021-2022 with the goal of identifying immediate opportunities for operational improvement and to evaluate if chemical treatment is an appropriate future mitigation strategy in that region.





Overview map highlighting relative potential odour sources in the Glenora sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Dynamic Area: Parkdale Sanitary Service Area



The Parkdale sewer service area includes in its area portions of the Edmonton Downtown, Parkdale, McCauley, and Cromdale communities. The Parkdale sanitary service area is a junction point for most of the major trunk lines in Northern Edmonton and receives flows from over half of the city as a result. Historically, odour report frequency in this area has been very high, particularly near Jasper Avenue at 84th Street where a major wastewater storage facility is located. Since 2015, odour report frequency in this area has decreased substantially coinciding with the completion of mitigation work at the wastewater storage site. While improvements to odour nuisance have been observed around Jasper Avenue, odour still persists further north in the community of Parkdale due to contributions from the North Edmonton trunk lines (NEST).

The construction of several upstream pump station wastewater odour treatment systems upstream outside of the Parkdale sanitary service area in northern Edmonton can likely provide significant odour relief within the service area. Providing treatment at four pump stations in particular is expected to greatly reduce the amount of odorous compounds reaching the Parkdale Sanitary service area. Within Parkdale, several structural modifications to the sewer lines, including drop structure modifications, manhole sealing, and the installation of air curtains may be appropriate to control and limit the dispersion of odorous air within the local system. Because of the age of the sewer system in Parkdale, inspection and trunk cleaning is also very likely to have a high impact on odour within the area, as sediment accumulation and flow barriers are expected to be common in this region.

Proposed Capital Solutions

The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

- Quantify the odour contributions from the upstream pump stations in order to provide improved operational guidance and to determine the most appropriate direct treatment solution.
- Increase trunk line access capacity by constructing 4 additional access manholes.
- Trunk line cleaning and inspection.

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring campaign in 2022 – 2024

Capital Expenditure					
	2019	2020	2021	2022-26	Total
Access Manholes	$0	$0	$1,192,829	$3,144,731	$4,337,560
Total					$4,337,560

Operational Expenditure					
	2019	2020	2021	2022-26	Total
Inspection & Cleaning	$0	$0	$0	$283,938	$283,938
Monitoring & Operational Improvements	$0	$200,000	$200,000	$200,000	$600,000
Total					$883,938

The Parkdale sanitary service area will also benefit from actions taken as part of the operational improvement initiatives.

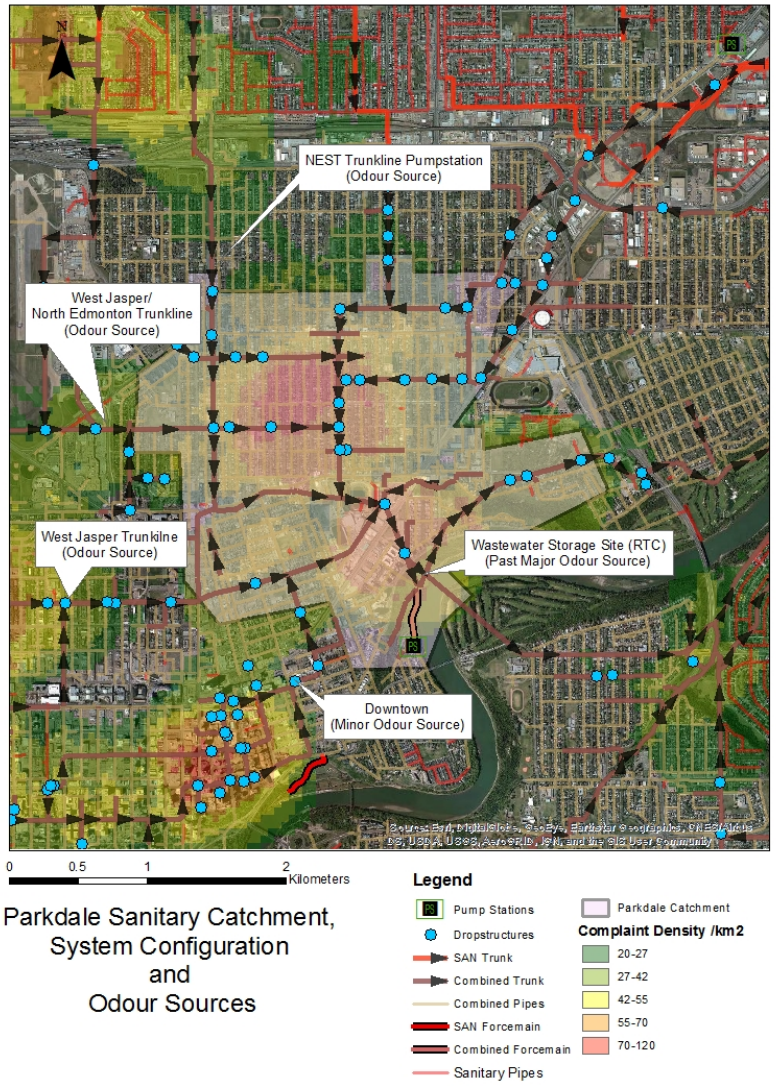
Recommendations for further **investigation and monitoring**

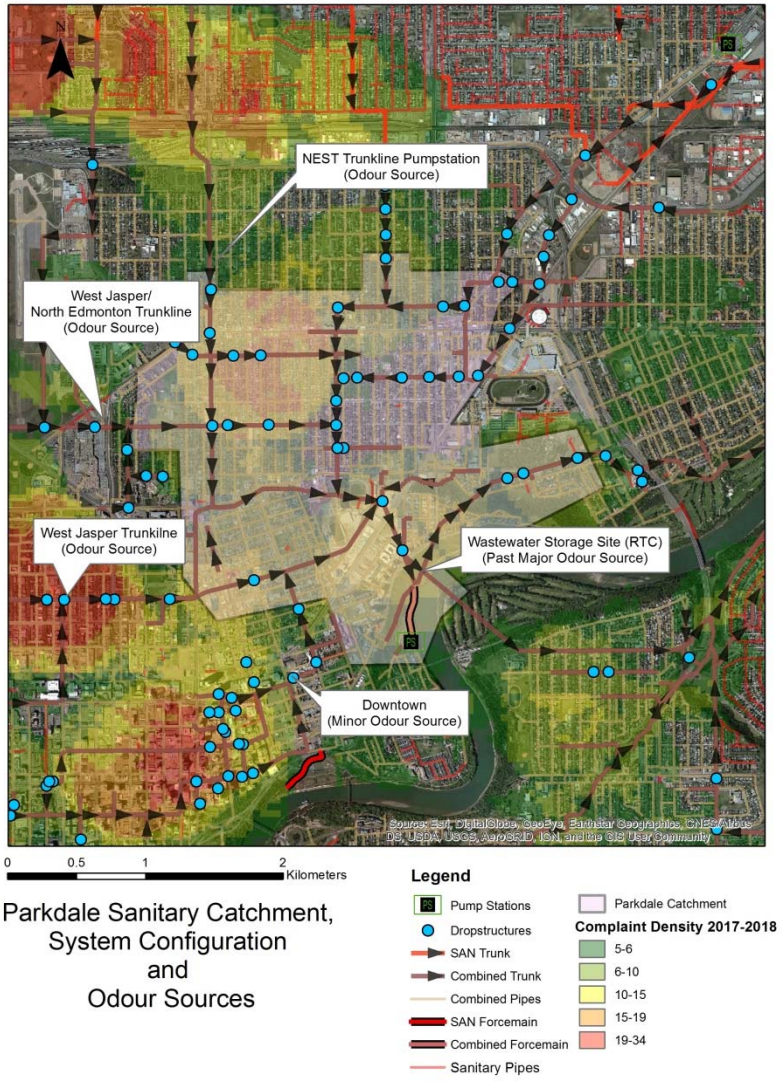
Monitoring of the following locations is recommended:

- RTC 3 located at 8502 Jasper Avenue NW

Contributions from projects in other sanitary service areas

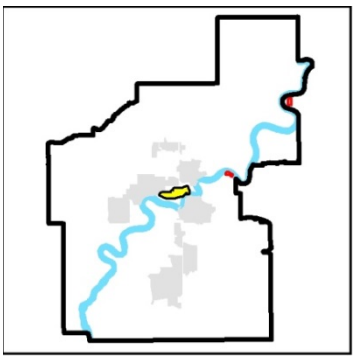
Any reduction in odour contributions from the Lauderdale, Downtown, or Glenora trunk lines will provide a reduction in odour nuisance in the Parkdale sanitary service area. Plans for monitoring and potential odour mitigation through operational actions are detailed specifically in each service area report section. No odour mitigation capital projects are proposed at this phase of the Corrosion and Odour Reduction Strategy.





Overview map highlighting relative potential odour sources in the Parkdale sanitary service area: Left: 2003-2018 data, Right 2016-2018 data

Dynamic Area: Downtown Sanitary Service Area



The Downtown sanitary service area does not receive wastewater from outside service areas however due to the high residential and commercial density, downtown remains a major wastewater contributor in the sewer and has several trunk lines that carry significant flows. The service area only has one minor pump station within its boundary and there are no major storage assets. Because sewer assets in this area are quite old, condition deterioration and settlement and the accumulation of sediments are likely. Odour generation is expected to primarily occur in those areas where sediment has accumulated and where pipe sags are prominent. Even without any major sources of odour generation because of the large number of major drop structures in the service area (27 in total), and due to the combined nature of the system in this location, even the natural odour of the wastewater is likely to cause some nuisance.

Odour mitigation in the Downtown sanitary service area is expected to primarily consist of trunk cleaning and obstruction removal to improve flows and air flow control to promote odour containment. Monitoring and trunk inspections will be necessary to properly assess the full scope of mitigation activities required.

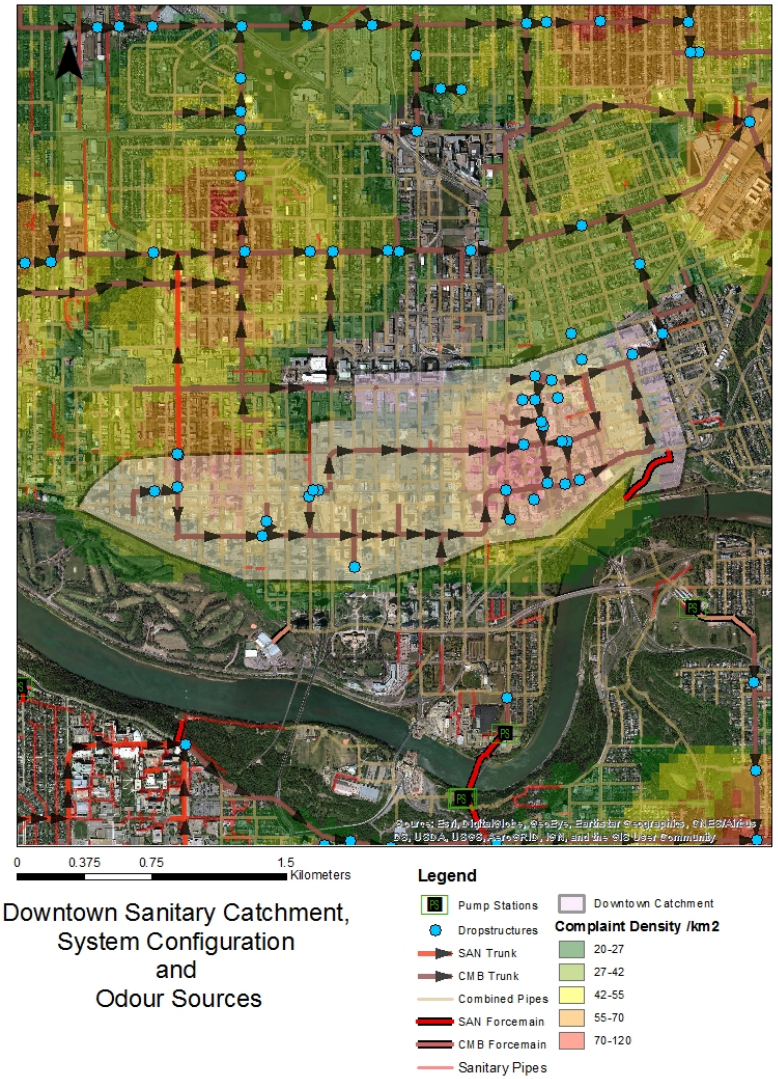
The Corrosion and Odour Reduction Strategy proposes that the following actions be taken:

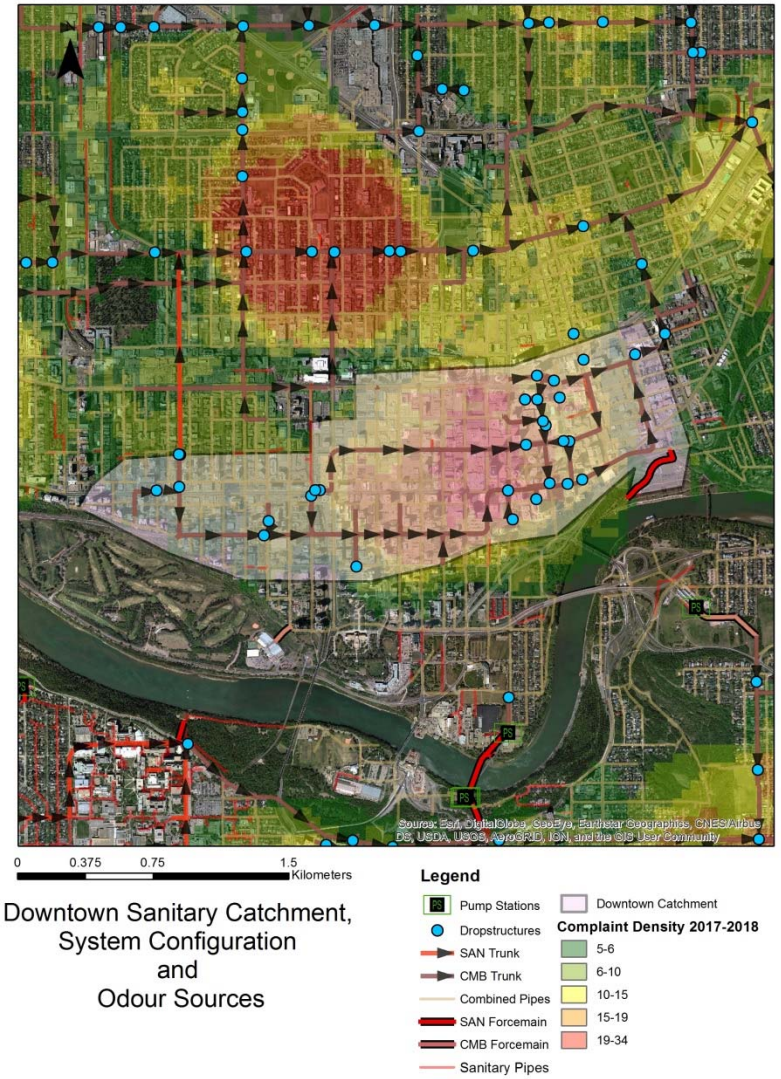
- Increase trunk line access capacity by constructing 2 additional access manholes
- Initiate trunk line cleaning and inspection

Proposed Capital Solutions

The construction of access manholes is recommended as it contributes to the overall goal of providing city-wide sewer access and cleaning. Further capital projects for odour mitigation may be proposed following the completion of a system monitoring campaign in 2022 – 2023

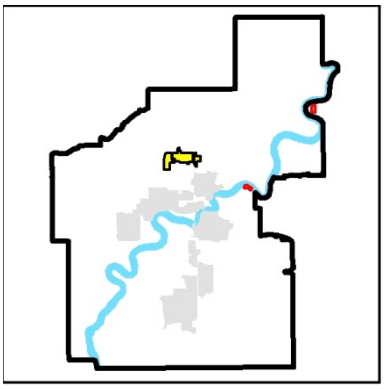
Capital Expenditure					
	2019	2020	2021	2022-26	Total
Access Manholes	$0	$0	$0	$4,337,560	$4,337,560
Total					$4,337,560
Operational Expenditure					
	2019	2020	2021	2022-26	Total
Inspection & Cleaning	$0	$0	$0	$262,563	$262,563
Monitoring & Operational Improvements	$0	$200,000	$200,000	$200,000	$600,000
Total					$862,563





Overview map highlighting relative potential odour sources in the Downtown sanitary service area: Left: 2003-2018 data, Right: 2016-2018 data

Emerging Sewer Odour Area: Lauderdale Area



Data collected since 2015 indicates sewer odour within the Lauderdale area is becoming a severe issue. The emerging intensification of sewer odours is most severe in the communities of Calder, Killarney and Lauderdale. In addition, much of the wastewater that is causing severe odours in those communities is then flowing into the Parkdale sewer service area, where it is likely also a significant contributor to sewer odour nuisance. The odour containing wastewater originates primarily from hydrogen sulfide generation observed at a pump station located along the north Edmonton sanitary trunk with three other community pump stations in Dunluce, Oxford and Beaumaris possibly also contributing additional odour. The areas where odour reports are being received coincide closely with where the odour containing wastewater transitions from the separate sanitary system into the combined sanitary/storm sewer system.

Major construction work is on-going or planned in northern Edmonton to upgrade and expand the sanitary sewer trunks. Outside of the Corrosion and Odour Reduction Strategy, EPCOR is ensuring that the necessary sewer capacity upgrades also consider odour control and abatement in their design.

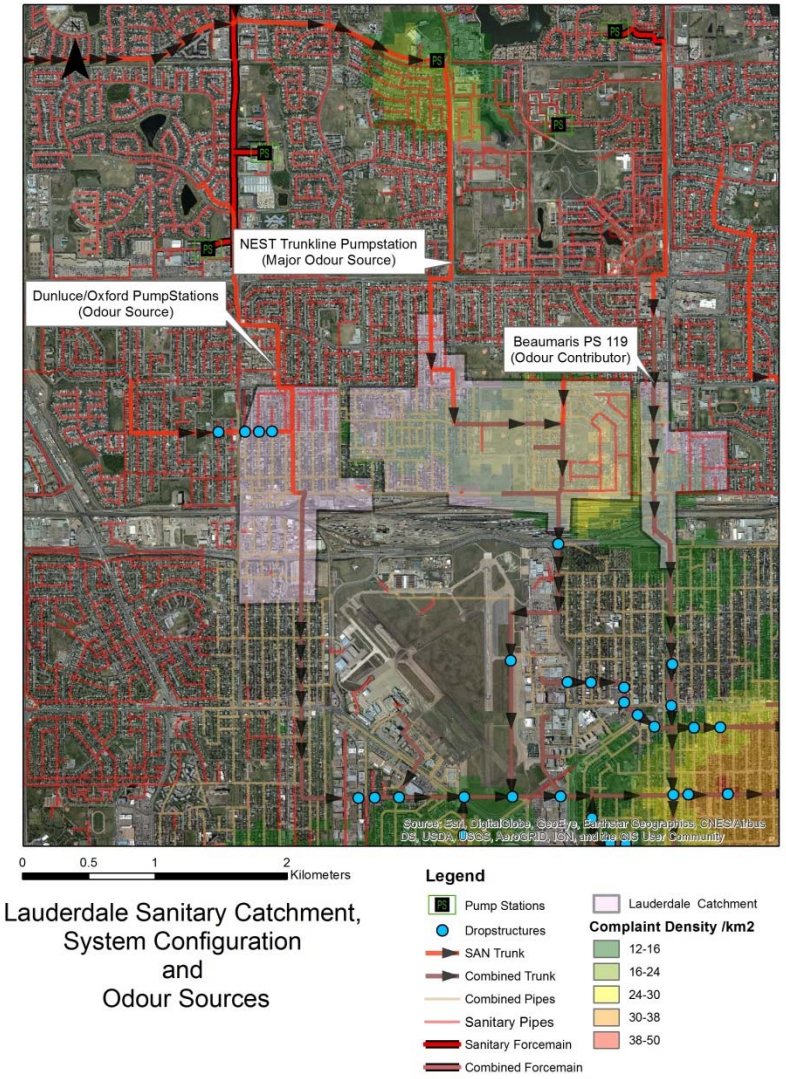
Mitigation opportunities through operational improvements

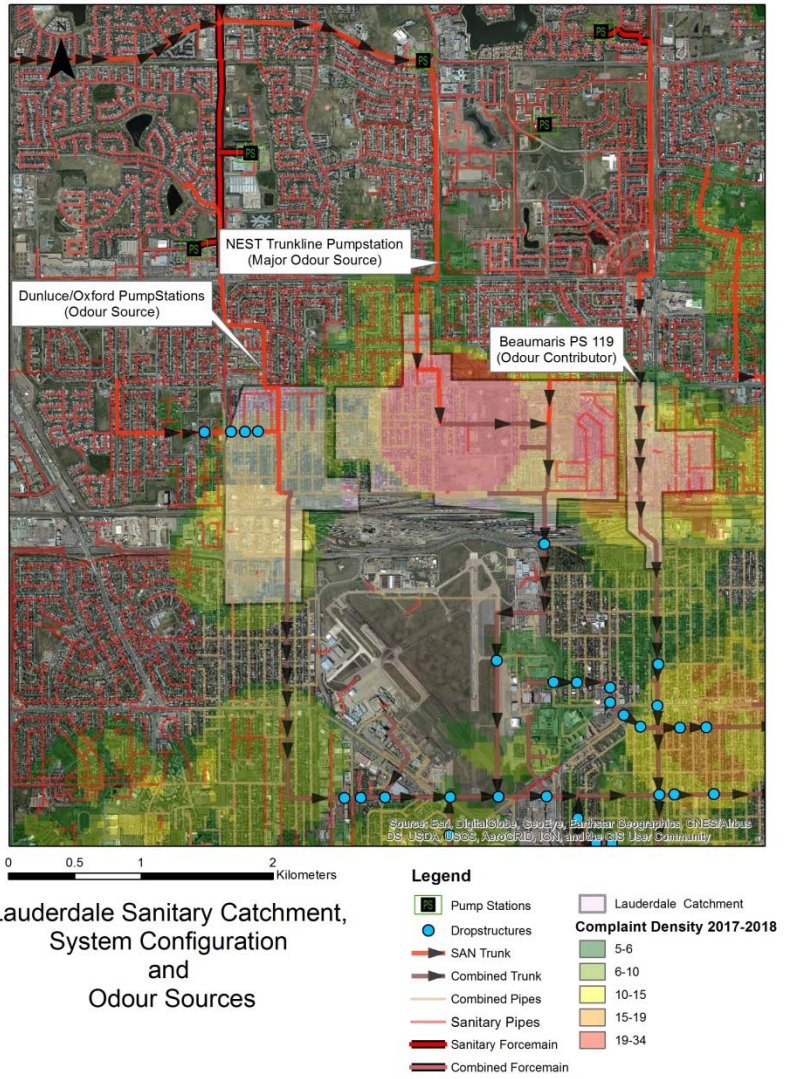
The Lauderdale area receives wastewater flows from several upstream pump stations. Of these pump stations; the NC1 pump station likely has the greatest downstream impact on odour. A preliminary review of the NC1 pump station operational performance has identified several modifications that can be applied that have the potential to reduce downstream odour.

Due to the severity of odour in the Lauderdale service area, monitoring activities and the evaluation the NC1 pump station is already underway with the goal of implementing some form of operational improvement before the end of 2019. Further study and review will continue in the subsequent years. Each pump station will be reviewed and its hydrogen sulfide generation quantified. As further opportunities for operational efficiencies are identified they will be applied. The monitoring will also determine if some form of odour treatment by chemical dosing is recommended.

Recommendations for further investigation and monitoring

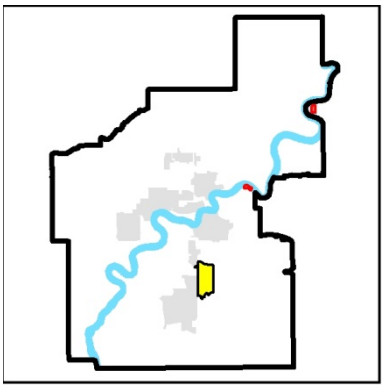
Monitoring will be completed in the summer of 2019 at three trunk line locations in Lauderdale and Calder and at the discharge point for the NC1 pump station. The information gained from the monitoring will be used to identify the main sources of odour in the sanitary lines as well as identify opportunities for immediate operational improvements and to evaluate the potential future mitigation projects.





Overview map highlighting relative potential odour sources in the Lauderdale sanitary service area: Left: 2003-2015 data, Right: 2016-2018 data

Emerging Sewer Odour Area: Parsons Road Sanitary Service Area



Starting in late 2017, there has been a major increase in the number odour reports received along Parsons Road in South Edmonton. Odour reports received from EPCOR's water meter field staff and direct monitoring support that Parsons Road is developing a significant sewer odour problem.

Parsons road receives wastewater from South Edmonton Sanitary System (SESS), Mill Woods, and Leduc County. A major pump station transfers wastewater from SESS to a trunk line that travels along the west most edge of Mill Woods. The pump station was commissioned in December of 2017. Prior to 2017, wastewater from south of the Anthony Henday entered a private sanitary line that conveyed the wastewater into Edmonton discharging at Parsons Road and 30th Avenue. While this also involved the use of a pump station, the system was reaching peak capacity resulting in much shorter wastewater holding times which partially limited the odour generation potential. Redirecting the SESS flows to the new pump station has since increased the wastewater retention times at both pumping stations and likely accounts for the increase in sewer odours observed at multiple locations downstream.

There are three major drop structures along the trunk line on 30th Avenue and each one carries significant wastewater flows. As a result, the trunk lines beneath Parsons Road are very pressurized making it difficult to fully contain the sewer air within the trunk lines. A larger number of odour reporting events are occurring in proximity to drop structures at both Parsons Road and 30th Avenue and 91st Street and 30th Avenue as a result. While much of the order nuisance is occurring along Parsons Road and 91st Street, the trunk line is also contributing odorous wastewater to the Allendale trunk line to the north and order impacts likely extend as far as Bonnie Doon.

There continues to be capacity upgrades to the south Edmonton sanitary system however in the near term without intervention odour impacts are likely to persist. The Corrosion and Odour Reduction Strategy is proposing to look at operational methodology improvements at the SA1 SESS pump station to reduce odour generation and downstream impacts. The potential to modify the three largest drop structures in the service area will also be investigated to determine if their impact to downstream trunk line air pressure can be mitigated effectively.

<u>Mitigation opportunities through operational improvements</u>

The Parsons Road area receives wastewater flows from several upstream sources including

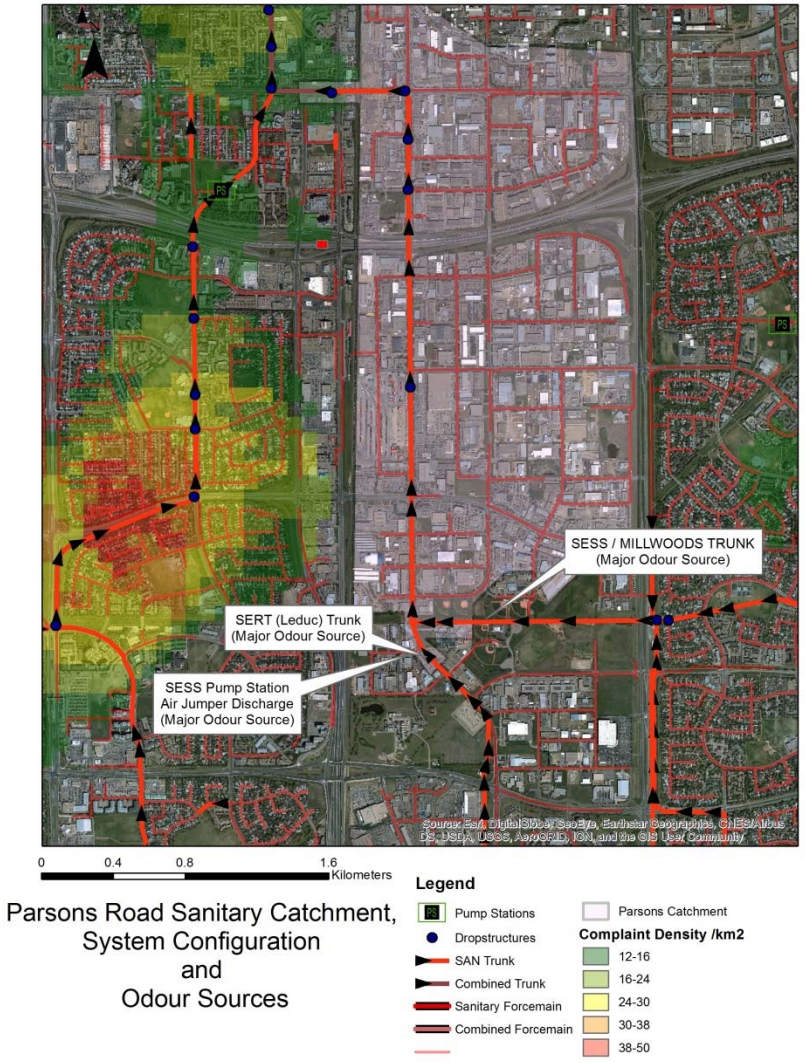
- South Edmonton Sanitary System (SESS) Pump Station (PS185)
- South East Regional Service Line (SERT)
- Millwood's Community

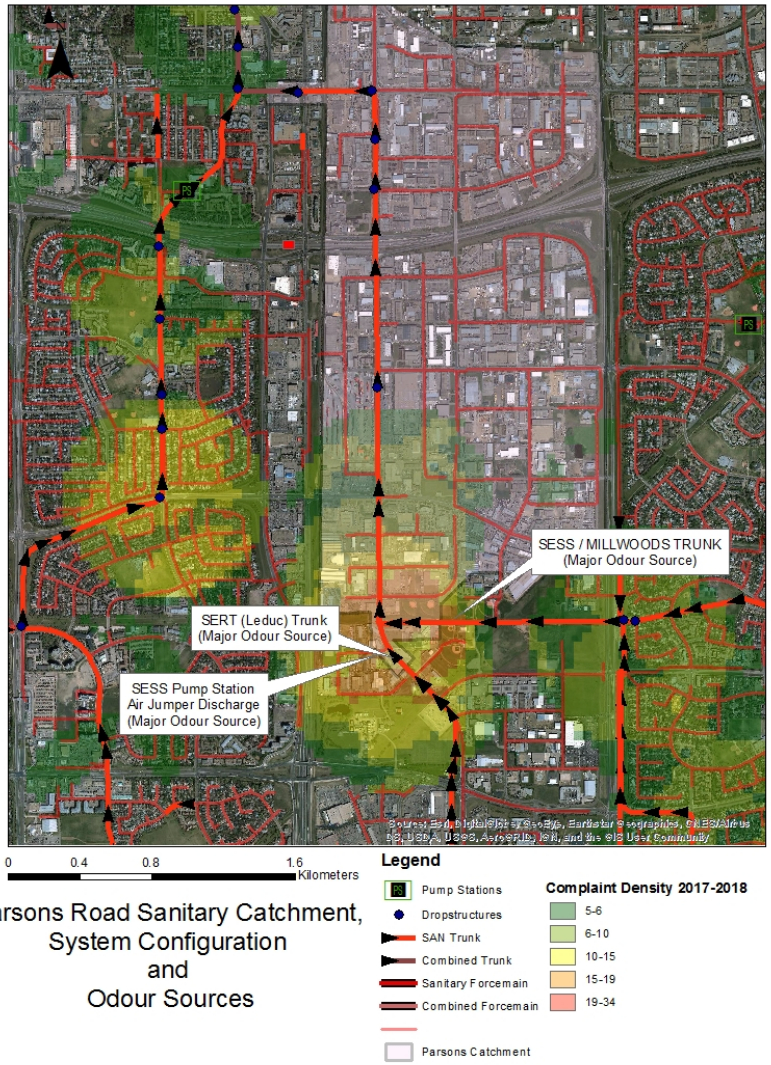
The SESS pump station is expected to have the greatest downstream impact on odour. A review will be completed to identify if there are any opportunities for immediate operational improvements that can reduce odour generation at the SESS PS185 Pump Station. EPCOR will also evaluate if there is a potential to

decrease odour contributions from the incoming SERT line. Monitoring of the Millwoods trunks and pump stations is proposed to determine if they represent a source of odour containing wastewater.

Recommendations for further investigation and monitoring

Monitoring will be initiated in the summer of 2019 and 2020. Monitoring locations will include the SESS pump station and the receiving trunk lines particularly at Parsons Road and 30th Avenue. The information gained from the monitoring will be used to identify the main sources of odour in the sanitary lines as well as to identify opportunities for immediate operational improvements and to evaluate the potential for future mitigation projects.





Overview map highlighting potential odour sources in the Parsons Road sanitary service area: Left: 2003-2015 data, Right: 2016-2018 data