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REPORT

Regional Municipality of Wood Buffalo

2020 Ice Jam Flood Event Infrastructure Performance

DECEMBER 2020

A Carbon Neutral Company

EXECUTIVE SUMMARY

1 INTRODUCTION AND PURPOSE

On April 26, 2020, an ice jam formed during the breakup of the Athabasca River leading to widespread flooding in various geographic areas of Fort McMurray: Lower Townsite and Longboat Landing, Waterways and Ptarmigan Trailer Court, Draper, Taiga Nova. The Water Treatment Plant was also impacted, with untreated water contaminating the drinking water system, leading to a Boil Water Order implemented for the entire Fort McMurray water service area.

This report is prepared by Associated Engineering for the Regional Municipality of Wood Buffalo, to provide an independent assessment of how Municipal infrastructure performed during the 2020 Ice Jam Flood event. Key findings and recommendations are provided for the Municipality to consider as part of the long-term flood protection strategy.

2 BACKGROUND AND INFRASTRUCTURE STATUS

Previous studies have established the 1:100-year return period flood event for the Lower Townsite as the 250.0 m elevation, and the 1:40-year return period as the 248.5 m elevation. The Trillium (2000) report identified a strategy for establishing flood protection on an incremental basis, by constructing initially to the 1:40-year flood level, and ultimately to the 1:100-year flood level. Trillium (2000) also recommended all storm outfalls be equipped with automatic gates (i.e. flap gates), as well as a secondary line of defence in the form of manually-operated gates and pumping to manage landside drainage when the flap gates are closed.

In general alignment with the Trillium (2000) report, the RMWB constructed the eastern half of Clearwater Drive to a nominal elevation of 248.5m circa 2010 as the first phase of establishing a perimeter flood barrier around the Lower Townsite. Following the Hangingstone River flooding event in 2013, the RMWB renewed their attention on flood standards; the western half of Clearwater Drive was constructed to a nominal elevation of 250.5m, and was substantially completed in 2019. As such, at the time of the 2020 flood, the flood mitigation infrastructure consisted of some reaches built to the 1:40 year standard and some built to the 1:100 year standard, with various low points along the alignment including a significant gap at Riedel Street.

Longboat Landing was developed in general conformance to the flood abatement clauses of Section 60 of the 1999 version of the Land Use Bylaw. In 2013, the Hangingstone River flood destroyed the outfall system for Longboat Landing, including the storm pond and flap gate. At the time of the 2020 flood, there was no backflow preventer in place on the storm system.

There was no completed flood infrastructure in place for Waterways, Ptarmigan Trailer Court or Draper.

Taiga Nova Eco Industrial Park was constructed with a perimeter dyke to the 1:40 year flood level. At the southeast corner of the development, the dyke is connected to the perimeter berms around the lagoons at the Wastewater Treatment Plant.

The Water Treatment Plant was designed with a perimeter flood protection dyke of elevation 253.0 m. Ground settlement over time has reduced the effective dyke elevation to be closer to 252.4 m a the time of the 2020 ice jam flood.

The storm drainage system and reservoir overflow systems at the Water Treatment Plant discharges through an outlet sluice gate chamber which controls drainage to the Athabasca River. The sluice gate inside of the chamber provides the WTP operators the ability to isolate the plant piping from the river. From an operational perspective, this gate is closed every year in advance of river breakup. As part of the underground piping system, the overflow line from each clearwell is also fitted with a flap gate.

3 2020 ICE JAM FLOOD EVENT

As the Athabasca River broke in the morning of April 26, 2020, an ice jam formed along the river near the confluence of the Clearwater River. According to gauges at the Athabasca River bridge, the ice jam was accompanied with an initial rapid spike in water levels, up to approximately 250.25 m. The water levels then fluctuated for a number of hours, before stabilizing at around 249.7 m.

On the Clearwater River, water levels rose quickly to flood levels on April 26, then gradually over the next two days before peaking in the early morning hours of April 29 at 248.9m.

Water levels began to rapidly recede on May 1 as the ice jam broke up, and returned to normal water levels on May 2, 2020.

4 LOWER TOWNSITE

The Snye Dyke / MacDonald Drive causeway was successful at keeping the initial spike on the Athabasca River from impacting the Lower Townsite. Localized flooding was reported at the intersection of Highway 63 and Morrison Street, and is attributed to the fact the Alberta Transportation storm outfall does not have a flap gate.

As the maximum water level on the Clearwater River reached 248.9 m, Clearwater Drive was inundated at all locations which were nominally constructed to only 248.5 m. Emergency clay dykes were constructed overnight on April 26 along Clearwater Drive in an attempt to mitigate the flood damage. In the vicinity of Riedel Street, the road elevation was only 247.7 m, and by the time of construction, the water was too deep and too fast to place clay on the road. As the emergency dyke could not be constructed at Riedel Street, this location became the primary route for overland flooding to enter into the Lower Townsite.

In addition to overland flooding at Riedel Street, the Lower Townsite was impacted by water following underground flow pathways. There is no evidence that the flap gates at the storm outfalls had failed. Rather, water was able to find pathways that bypassed the flap gates and entered the storm system through catch basins, pipes and other openings in the infrastructure between the flap gate and the dyke crest.

Identified locations for underground flow pathways include culvert inlet pipes at the Main Street outfall, catch basins at the Hardin Street outfall, and the parking lot near Riverwalk Villas. The parkade at Riverwalk Villa was itself also a pathway for water to enter into the Lower Townsite, via two large air vents facing the Clearwater River. These vents allowed flood water to flow directly into the parkade, and into the storm sewer and spill onto the street.

The ultimate flood level within the Lower Townsite matched the peak levels on the Clearwater River, at 248.9 m. Any buildings or developments at or below this elevation were vulnerable to flood damage. Homes and other buildings outside of the immediate inundation area were also vulnerable to flood damage, if their basement was near or below the 248.9 m elevation, and their sanitary sewer service was not equipped with a back flow preventer.

The status of the infrastructure in place at the time, combined with the extreme water levels of the 2020 ice jam flood, allowed the flood water to enter the Lower Townsite via both overland flow (at Riedel Street) and multiple underground pathways. The maximum flood level reaching 248.9 within the Lower Townsite, and the associated flood damage, cannot be attributed to the failure of any one particular infrastructure component, but rather that the system as a whole was not prepared for a flood of this magnitude.

In Longboat Landing, the absence of the back flow preventer led to early observations of storm sewer backups in the parking lots and other low points in the development. However, as the Clearwater River levels continued to rise, the flood waters eventually breached Denholm Gate and Fontaine Crescent. At this level, the absence of the back flow preventer was irrelevant, as the flood water levels within the development equalized with the Clearwater River to an elevation of 248.9 m.

Locations where the flood infrastructure and other mitigation measures prevented flood damage include Reach 1 / River Park Glen, Lift Station 1A and the Hospital. There was also no flood damage to any bridges, which allowed the Municipality to re-open transportation corridors immediately after the flood event had passed.

5 WATER TREATMENT PLANT

At the Water Treatment Plant, the flood waters from the Athabasca River were able to bypass both the sluice gate at the outfall chamber, and the two flap gates at the treated water reservoirs (i.e. clearwells). The untreated river water mixed into the treated water and was pumped into the distribution system. Once the contamination was discovered, a Boil Water Order was put into place for the entire Fort McMurray water system.

Following the recovery of the water system, a series of investigations was conducted to determine the failure mechanisms. It was discovered that the mounting platform for the sluice gate was cracked, leading to the stem bending and the gate not properly sealing. Deficiencies were also identified on the two flap gates leading to the reservoir cells. All of the critical deficiencies identified during the inspection have since been repaired.

A follow-up study entitled “Short Term Flood Mitigation Recommendations” identified other improvements to the operation and maintenance at the plant, including installation of additional barriers to prevent another contamination event in the future.

6 TAIGA NOVA ECO INDUSTRIAL PARK

The Taiga Nova Eco Industrial Park was subjected to two flooding mechanisms. During the initial “spike” on the Athabasca River, there is evidence that the floodwaters overtopped the dyke at the storm outfall, flooding the storm pond and causing backup into the roads and properties. The river flood levels dropped below the crest of the dyke before the water levels inside of the industrial park could equalize with the river. The elevated flood levels however still caused water to backflow through the Wastewater Treatment Plant effluent pipeline, and spill out of three manholes. The water from these manholes then followed the ditches into the Taiga Nova storm pond, leading to additional flooding within the industrial park.

7 KEY FINDINGS

A comprehensive Flood Protection System was not in place at the time of the 2020 ice jam flood.

The flood infrastructure that existed at the time of the 2020 flood consisted of a series of dykes constructed to different design criteria, as opposed to a single comprehensive system. With a maximum flood water elevation of 248.9, the 2020 ice jam flood event was higher than what the flood infrastructure was designed to mitigate.

There was no evidence of flap gates failing in the Lower Townsite. However, in conjunction with the lack of a comprehensive system, there was no process in place to identify potential underground pathways for water to bypass the flap gates and backflow under the dykes, and to remedy such issues.

The flood mitigation program completed to date was constructed on an incremental basis over a lengthy time period, in general conformance with the Trillium (2000) report. With respect to Clearwater Drive as a dyke around the Lower Townsite, some infrastructure was constructed to the 1:40-year flood level, and some was constructed to the 1:100-year flood level, with a significant gap between the two at Riedel Street. A dyke system is only as effective as the elevation of the lowest point; the Lower Townsite was therefore vulnerable to any flood greater than 1:40-year flood levels. The implementation of the incremental approach to flood mitigation was still underway at the time of the 2020 flood.

8 KEY RECOMMENDATIONS

The Key Findings noted above leads to Associated Engineering recommending the following as a strategy to mitigate future flood damage.

1. Adopt a consistent flood protection standard in accordance with Provincial guidelines and best practices.

2. Once a flood standard has been adopted, implement a Comprehensive Flood Protection System to that standard.

    a. Accelerate the flood mitigation program for the design and construction of permanent dykes and flood barriers, with consideration for top-lifting or raising to a consistent standard as required.

    b. As part of the Comprehensive Flood Protection System, identify and resolve all underground flood water pathways and other gaps in the dyke system

    c. Apply a multi-barrier approach, including redundancy for critical community infrastructure (i.e. Water Treatment Plant, Wastewater Treatment Plant, Hospital), and means of isolation to limit damage in the event of a breach or single point of failure.

    d. Implement pumping measures to manage drainage inside of the dykes, including rain events while the flap gates are closed, or to address leakage water that may still pass through the dykes. As part of the pumping system, consider alternatives to having hoses running across the road, as these impede emergency access and other vehicle movements.

3. Apply an Asset Management approach for the Flood Protection Infrastructure, including an inspection and maintenance program to preserve the integrity of the system:

   a. Establish key roles, responsibilities and tasks for pre-river break-up activities, during river break, and post river break.

   b. Actively review and monitor existing and proposed infrastructure, developments and other activities that may compromise the Flood Protection System

   c. Apply a multi-faceted approach to protect the integrity of the Flood Protection System. The approach needs to consider public infrastructure, private developments, grading and landscaping activities, third-party utilities, regulatory constraints, natural processes (including erosion), vegetation, and nuisances such as burrowing animals.

TABLE OF CONTENTS

1 INTRODUCTION AND PURPOSE

On April 26, 2020, an ice jam formed during the breakup of the Athabasca River leading to widespread flooding in various geographic areas of Fort McMurray. This included significant portions of Downtown (also known as the Lower Townsite) including Longboat Landing, the community of Waterways including the Ptarmigan Trailer Court, and the community of Draper. The Taiga Nova Eco-Industrial park was impacted, as well as other business industrial lots on the east side of Highway 63 between the Thickwood interchange and the Wastewater Treatment Plant. The Water Treatment Plant was also impacted, with untreated water contaminating the treated water reservoir, leading to a Boil Water Order implemented for the entire Fort McMurray water service area.

This report is prepared by Associated Engineering for the Regional Municipality of Wood Buffalo, to provide an independent assessment of how Municipal infrastructure performed during the 2020 Ice Jam Flood event, substantiated by first-hand field observations and follow-up assessments by Associated Engineering staff.

Key findings and recommendations are provided for the Municipality to consider as part of the long-term flood protection strategy.

2 BACKGROUND

2.1 Previous Studies

The incidence of river ice jam flooding affecting Fort McMurray has been well studied and documented over the past number of decades. The recognition of the flood risks in the area is recorded as early as 1875. James H. Moberly, the Clerk with Hudson Bay Company, documented the sudden break-up of the ice on the Athabasca River, and the rapid rise in water levels that significantly inundated the lands along the riverbanks, including the low-lying lands known then as the Prairies, now the eastern half of the Lower Townsite. Through archival review, it has generally been accepted that the approximate elevation of the flood waters reached during the 1875 corresponds to a geodetic elevation of 253 m above sea level and is the largest flood event on record in Fort McMurray. In addition to the 1875 event, extreme ice jam flood events have also been recorded in the following years: 1885, 1925, 1928, 1936, the back-to-back years of 1962 and 1963, 1977, 1979 and 1997.

Numerous studies have evaluated the flood risks and recommended assorted options for providing flood mitigation. For the purpose of this report, the following three studies are deemed to provide the most relevant background information:

- T. Blench & Associates, "Flood Protection Proposals for McMurray" (Prepared for Provincial Planning Board, Province of Alberta), May 1964;
- Technical Services & Monitoring Division, Water Resources Services, Alberta Environmental Protection, "Review of Flood Stage Frequency Estimates for the City of Fort McMurray – Final Report" (Prepared for Technical Committee, Canada-Alberta Flood Damage Reduction Program), November 1993; and
- Trillium Engineering and Hydrographics Inc, "An Evaluation of Providing Flood Control at Fort McMurray by a Staged Diking Approach", (Prepared for Regional Municipal of Wood Buffalo), July 2000.

The Blench (1964) report recommended the construction of a dam across the southern mouth of the Clearwater River at MacDonald Island to prevent both ice jam formation at that location and the river water backflow up the Clearwater River. This work was undertaken in 1966 to construct the Snye dyke (i.e. the MacDonald Drive causeway), while simultaneously creating the Snye as a backwater channel off the Clearwater River. As discussed in both the Alberta Environmental Protection (1993) study and the Trillium (2000) report, the construction of the Snye dyke did not have the desired effect of eliminating ice jam flooding, but it did have the positive effect of effectively reducing the ice jam flood levels on the Clearwater by approximately one meter. This is on account of moving the effective meeting point of the two rivers 2 km downstream along the Athabasca River (i.e. to a lower point on the hydraulic grade line of the river).

The Alberta Environmental Protection (1993) study is important, both in its statistical treatment of the historic 1875 event, and in its establishment of the benchmark for the 100-year flood. In performing flood-frequency analysis, the 1993 study recognized the benefit of the construction Snye dyke mentioned above, and therefore applied a correction to all historic flood levels recorded prior to the construction of the dyke. The three main conclusions from this study were as follows:

- Information available about the 1875 flood and other historic floods was sufficient to perform a flood-frequency analysis;
- The elevation of 250.0 m is recommended to be adopted as the 1:100-year design flood level for Fort McMurray; and
- The 1875 flood reached an elevation of 253.0 m at the current site of the Athabasca River Bridges and had an estimated return period of approximately 350 years.

The Trillium (2000) report is important because it established a methodological approach of providing incremental flood protection for the Lower Townsite of Fort McMurray and Waterways, and effectively shaped the Municipality's policies over the subsequent two decades. The report recommended that Fort McMurray be protected with dykes constructed with a top elevation of 250.5 m as this provides protection against the 1:100-year flood, plus 0.5 m of freeboard[1]. The report also identified that the construction of an interim dyke at the 1:40-year flood level (248.5 m) would be a cost-effective strategy to provide a base level of flood protection around the Lower Townsite and Waterways, as a phased approach toward eventually providing the 1:100-year flood protection.

In addition to the dyke program for flood protection, the Trillium (2000) report also recommended improvements to the storm system. These include the installation of automatic gates that will close when the water reaches critical levels on the Clearwater River, and a secondary manually-operated gate that can be closed to ensure closure of the outfall and provide back-up to the automatic gate. The other recommended improvement was the implementation of pumping, to remove accumulated stormwater from rainwater or snowmelt during the period when the river levels are high (and the drainage gates are closed). The recommended course of action was the installation of a permanent sump and pump intake line at each outfall, to which a mobile pump could be temporarily connected each year and operated as required. To date, only the automatic gates have been installed in the form of flap gates.

Many other studies have been conducted on the topic of flooding in Fort McMurray. In general, these reports have found relatively consistent results in terms of the flood risk, design flood standard levels, and return periods as the reports identified above. Some reports have recommended alternative options for flood protection in lieu of dykes; however, no alternative options have been found to be technically feasible. For this reason, the other studies and alternative options are not considered relevant to this current report.

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[1] Freeboard is vertical distance added to the design flood construction level to account for uncertainties in the flood-frequency analysis, and to provide a factor of safety to the design to account for phenomenon such as wind and wave action.

Notwithstanding the above, two recent reports merit specific mention, as follows:

- Northwest Hydraulic Consultants Ltd "Fort McMurray Flood Protection Conceptual Design" (Prepared for Regional Municipality of Wood Buffalo), August 2014; and
- Golder Associates Ltd "Fort McMurray River Hazard Study" (Prepared for Alberta Environment and Parks), November 2018.

The Northwest Hydraulic Consultants Ltd (NHC) (2014) report provides a reach-by-reach breakdown of the flood protection system. This report updates the concepts put forward in the Trillium (2000) report, including providing new recommended alignments for the flood protection works. Much of the Municipality's current flood mitigation program including completed works (such as Reach 1) or are currently under design and construction (such as Reaches 7 through 9) are based on this report. Of note, the NHC (2014) report documents a direction by the Regional Municipality of Wood Buffalo to not include the 0.5m freeboard in the establishment of the flood construction level[2]. This standard was in effect for the design and construction of Reach 1 to an elevation of 250.0m. This decision was eventually reversed, and the elevation of 250.5 became the standard for the design and construction of Clearwater Drive west of Riedel Street, and remains the current standard for all other ongoing flood protection works in the vicinity of the Lower Townsite.

The Golder (2018) report was undertaken at the direction of Alberta Environment and Parks (AEP) in part to update the flood mapping for the Fort McMurray area. The report was made publicly available for the purpose of public engagement and technical feedback over the period of July 20 to August 31, 2020. The report is expected to be updated and finalized based on the feedback received.

It is noted that the version of the Golder (2018) report that was made publicly available included material adjustments to the flood frequency analysis, including to the recommended 1:100-year flood level. While this may have some bearing on updated flood standards and flood mapping adopted by AEP, it is noted that the overall report is still considered draft, and the analysis does not include the 2020 flood as a data point. Therefore, the updated flood frequency from Golder (2018) is not taken into consideration in this report, but rather identified for the reader's awareness, as it may change the future context of this current report.

As demonstrated above, ice jam flooding on the Athabasca and Clearwater Rivers is a complex issue that has been studied for decades. The Municipality has also been developing and implementing a flood mitigation strategy over this same extended period. The flood mitigation infrastructure that has been planned and constructed over this time period has also reflected the evolving design standards.

2.2 Land Use Bylaw

The 1999 Consolidated Land Use Bylaw included many clauses to restrict development within the Athabasca and Clearwater River floodplains. Some of these restrictions included the following:

- For residential development, the lowest habitable space must be a minimum of 250.0 m elevation;
- For commercial development, the main building floor slab must be a minimum of 249.0 m elevation; and

[2] Cited in Northwest Hydraulic Consultants Ltd (2014) on page 12 as "A directive provided by the executive branch of RMWB - John Buchko, personal communication". No date given.

- Critical utilities, including life-safety equipment, electrical panels, gas meters, etc. were to be mounted above the 250.0 m threshold.

It is noted that many of these restrictions were repealed in 2013. This was done as part of the redevelopment plans in place at the time, as a means to attract new development into the Lower Townsite.

2.3 Clearwater Drive

As mentioned, the Trillium (2000) report recommended the establishment of a perimeter dyke built to the 1:100-year flood level. It also identified that the construction of a dyke built to the 1:40-year flood level was a prudent first phase of providing flood protection in an incremental manner. The alignment identified in the Trillium report follows what is present-day Clearwater Drive. This alignment had long been identified as a possible transportation corridor, dating as far back as transportation studies conducted in 1983.

In the early 2000s, population growth in Fort McMurray put pressure for new development and redevelopment areas, and in turn, new and updated infrastructure to accommodate the growth. The need for a loop road around the east and north side of the Lower Townsite was identified in the various planning documents in place at the time, including the Municipal Development Plan and the Lower Townsite Redevelopment Plan. The road was divided into two segments: the East Loop Road from Highway 63 to Riedel Street, and the West Loop Road from Riedel Street to Main Street with an optional extension to Morrison Street.

It is noted that the loop road has gone through various naming evolutions, including the East / West Loop Road, Prairie Loop Boulevard, and Clearwater Drive. To maintain consistency, this report uses Clearwater Drive as the name of the current road, and East Loop Road / West Loop Road in reference to the design and construction projects for the eastern and western portions of the road, respectively.

Associated Engineering prepared the preliminary design for both the east and west sections of the loop road. These preliminary designs are documented in the following reports:

- Associated Engineering "Lower Townsite East Loop Road and Connector Roads – Clearwater Drive Predesign Report" (Prepared for Regional Municipality of Wood Buffalo), June 2005; and
- Associated Engineering "Prairie Loop Boulevard – Phase 2" (Prepared for Regional Municipality of Wood Buffalo), December 2010.

As documented in the Associated Engineering (2005) report, the East Loop Road was designed in general conformance with the recommendation from the Trillium (2000) report, with a nominal minimum road elevation of 248.5 m to provide protection against the 1:40-year ice jam flood. The report also identified where storm sewers were required to be extended past the road toward the river, and/or upgraded to meet the current design standards. The outfalls of all storm sewers would also be fitted with a flap gate mounted to a concrete headwall. The flap gate would allow for discharge of stormwater from the Lower Townsite, and then close to prevent backflow of river water into the storm sewer when water levels in the river were high. Municipal Council accepted the preliminary design for the East Loop Road in November 2005.

The preliminary design drawings for the East Loop Road show the road profile as meeting the proposed minimum design elevation of 248.5 m along the entire alignment, with the exception of the western terminus of the project at Riedel Street. At this location, the design was constrained by existing buildings on both sides of the road, including the

Riverwalk Villas on the river side of the road. By design, the road ramped down from starting near Hospital Street, to match the existing elevation of approximately 247.7 m at Riedel Street.

The East Loop Road was substantially completed in 2010. Following construction of the East Loop Road, the record drawings show that the specified minimum elevation was not maintained along the final road profile, likely as a result of adjustments to the design required to tie into existing grades. Including Riedel Street as discussed above, the following intersections and approximate road elevation at locations that fell below the 248.5 m standard are noted below:

Clearwater Drive Intersection	Approximate Road Elevation
Mills Avenue / Saline Creek Drive	248.1 m
Franklin Avenue	247.9 m
Queen Street	248.3 m
Riedel Street	247.7 m

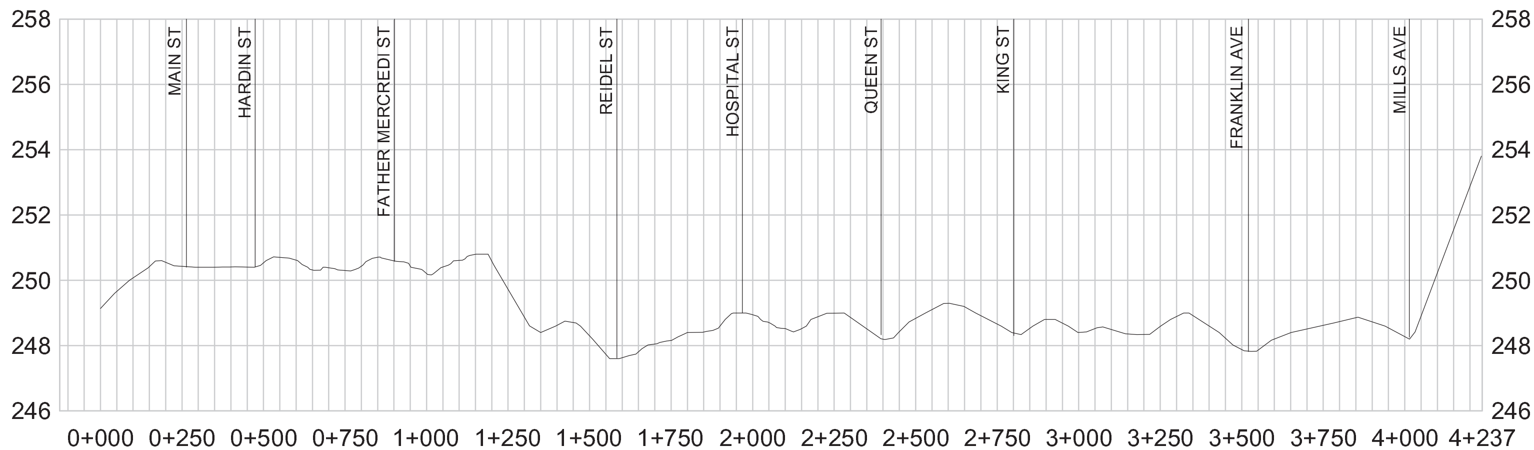
As documented in the Associated Engineering (2010) report, the original preliminary design report for the West Loop Road was similarly based on providing a minimum road elevation of 248.5 m for a 1:40-year flood protection. At locations where this could not be achieved, a berm with top elevation of 248.5 m was to be installed parallel to the road to create a barrier between the road and the river. Such locations included the interface between the West Loop Road and East Loop Road on either side of Riedel Street, and from Main Street to connect to the high ground at Borealis Park.

In June of 2013, a flood event occurred on the Hangingstone River and Saline Creek. Downstream of Highway 63, the Hangingstone River spilled its banks, causing flood damage to Heritage Park, Keyano College, and other properties. The flood also caused significant bank erosion along the communities of Grayling Terrace, Ptarmigan Trailer Court, and washed out the storm pond and outfall at Longboat Landing. While this was an open-water flood event, and not related to ice jam flooding, the event raised the profile flood mitigation, and its importance for community infrastructure.

In part as a result of the response to the 2013 flood, and in accordance with the recommendation of the NHC (2014) report, the Municipality made the decision to raise the design standard for the West Loop Road to the 1:100-year flood. The Municipality also made the decision to include freeboard in the design, thereby establishing the design flood construction level to be 250.5 m. Construction of the West Loop Road was substantially completed in 2019.

As a result of the above factors, the status of Clearwater Drive as a flood barrier for the Lower Townsite consisted of two sections constructed to two different design standards. The eastern portion was constructed to a nominal standard of the 1:40-year flood level, and the western portion was constructed to the 1:100-year level including an allowance for freeboard. A profile of the road surface along the entire length of Clearwater Drive as of 2020 is presented in the following **Figure 2-1**.

PLAN 1:15000



PROFILE H 1:15000 V 1:150

PLOT DATE: 11/25/2020 4:29:08 PM
SAVE DATE: 11/25/2020 4:27:41 PM SAVED BY: UNSWORTHN
DWG PATH: q:\2020-3934-00\civil\3934-00-c-fig4-2.dwg

Associated Engineering

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Regional Municipality of Wood Buffalo

AE PROJECT No.	20203721-00
SCALE	AS SHOWN
APPROVED	J.VANDERZWAAG
DATE	2020NOV24
REV	0
DESCRIPTION	ISSUED FOR DISCUSSION

FIGURE 2-1

REGIONAL MUNICIPALITY
OF WOOD BUFFALO

CIVIL
PRAIRIE LOOP
BOULEVARD PROFILE

2.4 Infrastructure Status

As part of the Municipality's implementation of the incremental approach to flood mitigation, different infrastructure was constructed primarily to two different standards. The two standards were the 1:40-year flood level, and the 1:100-year flood level. In addition, some infrastructure elements considered freeboard, and some did not.

The following provides an overview of the status of various elements of the flood mitigation infrastructure in place at the time of the 2020 ice jam flood.

2.4.1 Lower Townsite

The west side of the Lower Townsite along the Athabasca River is protected by the embankment of the Snye Dyke / MacDonald Drive causeway. This was constructed in 1966 to the elevation of 252.0, to mitigate direct flooding impacts from the Athabasca River. The dyke elevation of 252.0 m is not continuous; where the Athabasca River bridge ramp passes underneath the overpass as it approaches the Franklin Avenue / Highway 63 interface, the elevation of the road is approximately 251.4 m. Alberta Transportation also has a storm outfall immediately northwest of this intersection, and there is no evidence of a flap gate or backflow preventer on this outfall.

Reach 1 was constructed circa 2014, from MacDonald Drive to Borealis Park, with a top elevation of 250.0 m.

Borealis Park is the former location of the water treatment plant, and the berm around the pond (i.e. the former raw water reservoir) is approximately 252.0m. As such, the high ground of the park acts as part of the overall flood barrier.

As discussed previously, Clearwater Drive west of Riedel Street is constructed to a minimum elevation of 250.5m, and east of Riedel Street to a nominal minimum elevation of 248.5m. Both sides contain localized low points, including a significant gap at Riedel Street where the road elevation is 247.7m. As part of the Municipality's flood mitigation program, Reach 5 is intended to remedy this gap at Riedel Street; however, at the time of the 2020 flood there were no works in place.

The southeastern boundary of the Lower Townsite is formed by the Hangingstone River. In 2013 this river flooded over its banks, causing damage to Heritage Park and Keyano College. Following the 2013 flood, temporary berms were constructed along the Heritage Park boundary. Starting in 2019, these temporary berms are being replaced with a clay dyke constructed to the 250.5m elevation, as Reach 9 of the Municipality's flood program.

Other key infrastructure in the Lower Townsite includes sanitary lift stations and water pump stations. Most sanitary lift stations in the Municipality are constructed with a wet well / dry well configuration, where sewage flows are stored and pumped from the wet well, and much of the pumping equipment and related electrical gear is housed in the dry well. The elevation of the main floor slab elevation is therefore critical in preventing water from entering the dry well, where it could submerge and potentially damage the equipment.

Lift Station 1A is located at the north end of Father Mercredi Street. The main floor slab was designed with an elevation of 249.0m. Works were undertaken in 2013 to construct an emergency dyke around the facility, with a top elevation of 250.0m.

Lift Station 1B is located near the intersection of Franklin Avenue and Clearwater Drive. The main floor slab has an elevation of 250.0m.

The Mills Avenue water booster station is located near the intersection of Saline Creek Drive and Clearwater Drive. The main flood slab has an elevation of 250.0m.

2.4.2 Longboat Landing

While still part of the Lower Townsite, Longboat Landing merits special consideration as it is located outside of the Clearwater Drive flood barrier, and was a community developed specifically in accordance with the flood abatement clauses of Section 60 of the 1999 version of the Land Use Bylaw.

As described in the NORR Architects Planners "Longboat Landing Outline Plan" (Prepared for Clearwater Village Properties Inc) September 2010, the risk of flooding in Longboat Landing was acknowledged in the original design of the community. As described in the Outline Plan and in alignment with the Land Use Bylaw, all residential habitable space was specified to be above the 250.0m elevation, all roads above 249.0m, and all parking areas above the 248.0m. All key electrical installations such as power transformers or electrical panels for pumping systems were also specified to be above the 250.0m elevation.

The philosophy of the design of Longboat Landing is that in the event of a flood, the parking lots and roads would flood. In the residential buildings, the underground parkades or ground floor garages would also flood, but the habitable space above the parking areas would not be flood impacted.

The storm sewer collection system in Longboat Landing was designed to be independent of the rest of the Lower Townsite. Originally, the local collection system was routed to a new storm pond on the south side of the neighbourhood, from where it discharged to the Hangingstone River. During the 2013 floods, the entire storm pond and outfall system for Longboat Landing were destroyed when the Hangingstone River banks eroded. In 2016, the Municipality approved a design submitted by the developer to reconstruct the storm outfall system, including a duckbill-style backflow preventer to be installed in the upstream end of the outfall pipe, at the storm manhole in Fontaine Crescent. A review conducted by RMWB Underground Services on November 30, 2020 identified the absence of a flap gate or backflow preventer at this location, suggesting that no backflow preventer was in place at the time of the 2020 flood.

As part of the Municipality's most recent flood protection program, Longboat Landing is scheduled to be protected by two dykes constructed to elevation 250.5m. Reach 7 will parallel the alignment of Franklin Avenue to the Clearwater River. Reach 8 will parallel Fontaine Crescent to provide protection along the Clearwater River and Hangingstone River. At the time of the 2020 flood, these dykes had not yet been constructed.

2.4.3 Waterways and Draper

The Trillium (2000) report identified a flood mitigation strategy for the community of Waterways, following McCormick Street and Tolen Drive as high ground, with new dykes to be constructed along Railway Avenue and then tying back to high ground. Saline Creek Drive was constructed circa 2013, providing a nominal minimum elevation of 248.5m from McCormick Street to Park Street. Southeast of the intersection of Park Street, Saline Creek Drive joins with the original alignment and elevation of Draper Road, which is within the floodplain of the Clearwater River. As such, there is currently no flood protection system in place to protect against flood waters coming into Waterways from the south.

In the NHC (2014) report, Waterways is proposed to be protected with Reach 10 and Reach 11. At the time of the 2020 flood, these works were not in place.

There is no flood protection infrastructure in place for Ptarmigan Trailer Court. The Trillium (2000) report identified that there was no cost-effective solution to provide flood protection for this location, and this was reiterated in the NHC (2014) report.

There is no flood protection infrastructure in place for the community of Draper.

2.4.4 Water Treatment Plant

The Water Treatment Plant was designed with a perimeter flood protection berm of elevation 253.0 m. The Thurber Engineering Ltd. "Fort McMurray Water Treatment Plant Berm Slope Stability Assessment Geotechnical Investigation" (Prepared for Associated Engineering Ltd on behalf of the Regional Municipality of Wood Buffalo), November 2019 identified that the perimeter berm at the Water Treatment Plant had settled between 0.4m and 0.5m, with local extremes of up to 0.6m. The effective berm elevation at the time of the 2020 flood was therefore closer to 252.4 m.

The storm drainage system at the Water Treatment Plant discharges through an outlet sluice gate chamber which controls drainage to the Athabasca River. The overflow pipelines from the treated water reservoirs (i.e. clearwells) also run to the outlet sluice gate chamber. The sluice gate inside of the chamber provides the WTP operators the ability to isolate the plant piping from the river. From an operational perspective, this gate is closed every year in advance of river breakup. As part of the underground piping system, the overflow line from each clearwell is also fitted with a flap gate.

2.4.5 Taiga Nova Eco Industrial Park

The Taiga Nova Eco Industrial Park was constructed circa 2010 on the west side of the Athabasca River, north of the Wastewater Treatment Plant. The park was designed with a perimeter berm set to the 1:40-year flood level with an elevation of 248.0m. This is 0.5m lower than the 1:40-year flood level established for the Lower Townsite, on account of the site being downstream of the mouth of the Clearwater River along the hydraulic grade line of the Athabasca River. The berm is tied into high ground of Highway 63 at the northwest corner, and the Wastewater Treatment Plant lagoon perimeter berms at the southeast corner.

The design of the eco-park includes a series of bioswales to collect local runoff and convey to a storm pond. The storm pond outlets into a manhole to the south, and then directly east to the Athabasca River via a storm outfall and flap gate. This same outfall pipe also conveys flow from a ditch that runs from the Diversified bus yard, draining an area that includes Highway 63 and the frontage road in front of the Wastewater Treatment Plant.

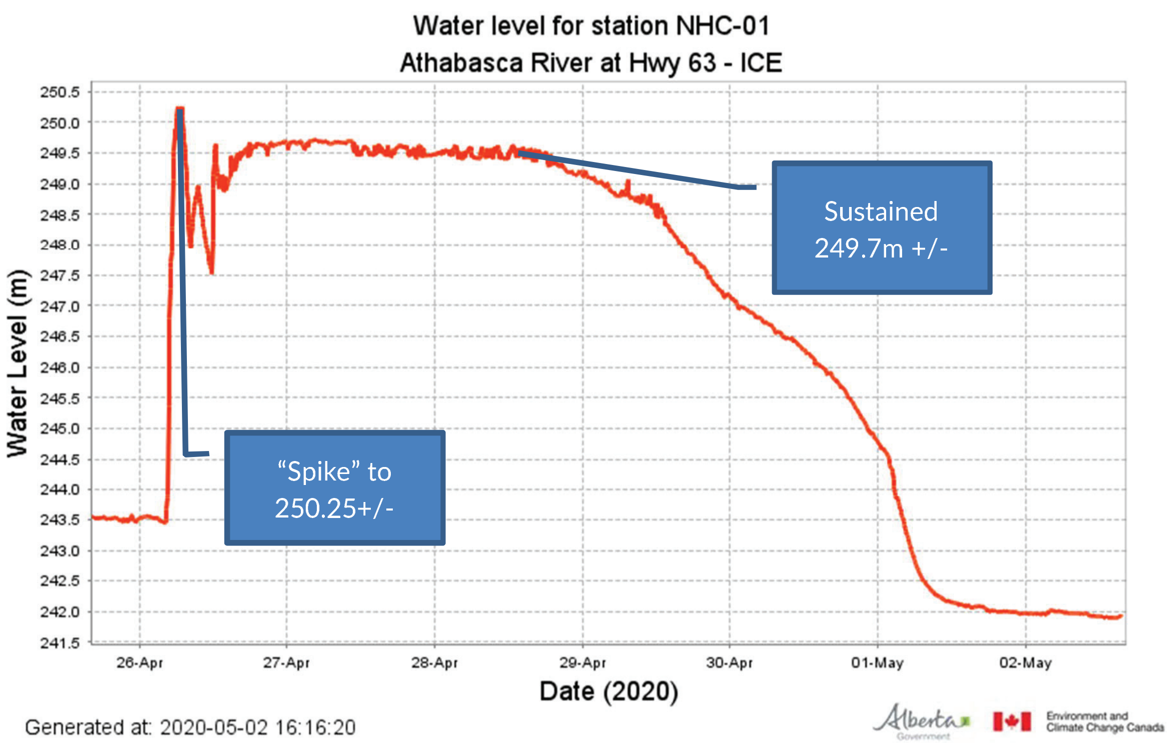
Of note, the Wastewater Treatment Plant effluent discharge outlet pipe is located approximately 150m to the south of the Taiga Nova storm outfall. Unlike the Taiga Nova storm outfall, there is no flap gate or backflow preventer on the effluent discharge pipeline from the Wastewater Treatment Plant.

3 2020 ICE JAM FLOOD EVENT

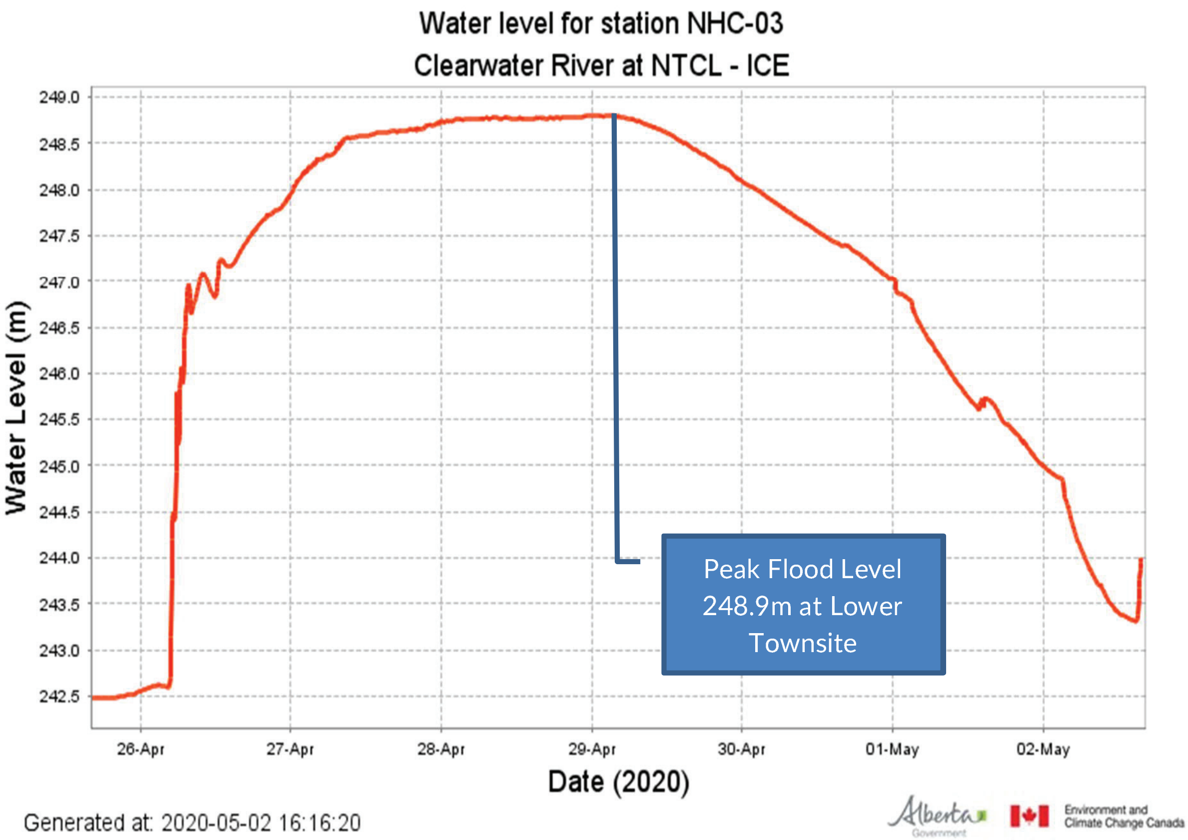
The ice on the Athabasca River began to break up in the morning of April 26, 2020, and nearly immediately formed an ice jam near the confluence with the Clearwater River.

The water level gauge at the Athabasca River Bridge identified a rapid water level rise of nearly 7m within minutes, to a maximum elevation of 250.25m. The water levels at the bridge fluctuated for a few hours, before stabilizing at around 249.7m, where it remained for two full days before the levels began to recede. Water levels returned to open water normal flow conditions on May 1, 2020.

The following figure shows the plot of the water level over the period of the flood event, from April 26 to May 2, 2020.



As with previous river breakup flood events, the ice jam on the Athabasca River caused backflow on the Clearwater River accompanied with increasing water levels. The following figure depicts the water trend as was recorded by the gauge at the NTCL docks on the Clearwater River in downtown Fort McMurray.



Following a rapid rise in water level to 247m on April 26, the water level peaked at approximately 248.9m in the early hours of April 29. The water levels then receded to normal ranges by May 2, 2020.

Based on the observed elevations on the Athabasca and Clearwater Rivers, the 2020 flood was an extreme event. In the context of the historical flood events recorded in Fort McMurray, it is the third-highest flood on record, following the 1875 flood and 1936. It is also the highest flood event since the construction of the Snye dyke in 1966.

4 LOWER TOWNSITE

4.1 Snye Dyke / MacDonald Drive Causeway

The Snye Dyke and MacDonald Drive Causeway was successful at preventing the initial "spike" of 250.25 m and the sustained river flood levels of 249.7 m at the Athabasca River bridge from inundating the Lower Townsite.

During the morning of April 26, there were early reports of flooding on Highway 63 at the intersection with Morrison Street. It is suspected that this is related to water that came up the Alberta Transportation storm outfall. It is recommended that an investigation be undertaken in coordination with Alberta Transportation to determine if remediation works are required at this storm outfall to mitigate this as a potential pathway for future flooding into downtown.

4.2 Clearwater Drive Overland Flooding and Emergency Dyke Construction

By 11pm on the night of April 26, 2020, the water level on the Clearwater River was approaching the 248.0 level. Jason Vanderzwaag of Associated Engineering contacted the Regional Emergency Operations Center to review the status of the 248.5m flood threshold. A site visit identified that the water was at or near breaching Clearwater Drive at several locations. These are identified in the following table, including the approximate sag elevations identified in the record drawings:

Clearwater Drive intersecting road	Record Drawing Elevation (m)
Mills Avenue	248.1
Franklin Avenue	247.9
King Street	248.5
Queen Street	248.3
Riedel Street	247.7 (already breached at the time of the 11pm inspection)

With authorization from Keith Smith, Director of Public Works from the Regional Municipality of Wood Buffalo, Associated Engineering arranged for the mobilization of local contractor CLH to commence the construction of emergency dykes along Clearwater Drive.

The operation entailed the removal of clay from the existing stockpile at McCormick Drive, end-dumping directly on the road surface of Clearwater Drive at locations where the water was on or approaching the road, and track-packing with a dozer. Within two hours, CLH mobilized an excavator, two dozers, twenty dump trucks, and various light plants to illuminate each work zone.

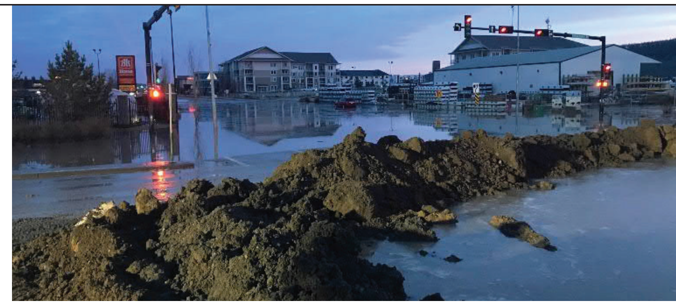
Two crews began working at approximately 1 am on April 27, 2020. The first crew was working at Clearwater Drive and Franklin Avenue. At that location, the decision was made to quickly cut off the access to Longboat Landing, as the community had already been evacuated, and there was no viable means to extend the emergency dyke construction to include it at that time.

The second crew began working at Riedel Street. The initial stages of dyke construction at this location were able to use the existing concrete barricades to start the dyke construction. However, once past the end of the row of concrete barriers, the depth and velocity of water as it ran across Clearwater Drive at this location washed away the clay immediately as it was placed. With the materials and resources immediately available to the crews, no viable solution was found to construct the emergency dyke at this location. At 2:30am the decision was made to leave Riedel Street, and re-deploy the second crew to Queen Street and other locations where the water began breaching.

At 4am on April 27, the dyke had been completed at Queen Street, and King Street was underway. The dyke at Franklin Avenue was about 75% complete. At this time, the crews noticed that water was coming up out of the storm sewers and catch basins on the land side of the works.

At 5:15am the dykes were completed at Franklin Avenue (including the low point in the nearby curve), Queen Street and King Street. Dyke construction was underway at Mills Avenue / Saline Creek Drive. At Saline Creek Drive, the dykes were constructed along the curb returns of the road, to maintain open the haul route along Saline Creek Drive to the McCormick Stockpile site.

The following photos show the status of the emergency dyke construction at Franklin Avenue and Clearwater Drive at approximately 5:30am on the morning of April 27, 2020. As can be seen, the dykes were holding back approximately 1m of water. However, as can be seen in the second photo, water was continuing to rise on the land side of the dyke.



Through the morning and into the afternoon, CLH continued the operation of hauling clay, plugging new low points as they were identified based on the rising water, and strengthening the existing dykes. However, by that afternoon, the water levels inside of the dykes continued to rise, as the water was flowing in from other locations. It was clear that the emergency dykes alone would not be sufficient to stop the flood waters. The rising waters inside of the dyke also posed safety concerns for the hauling operation personnel. At approximately 1:30 pm, the decision was made to suspend the emergency dyke construction operation.

The following photo taken by McMurray Aviation on April 29, 2020 shows the emergency clay dykes constructed on Clearwater Drive. The series of dykes can be seen as the thin dark line running along Clearwater Drive.

Once the water levels on the Clearwater receded, Associated Engineering coordinated again with CLH for the removal of the clay dykes from the road surface. The removal started on Thursday April 30th and was completed on Sunday May 3rd, 2020.

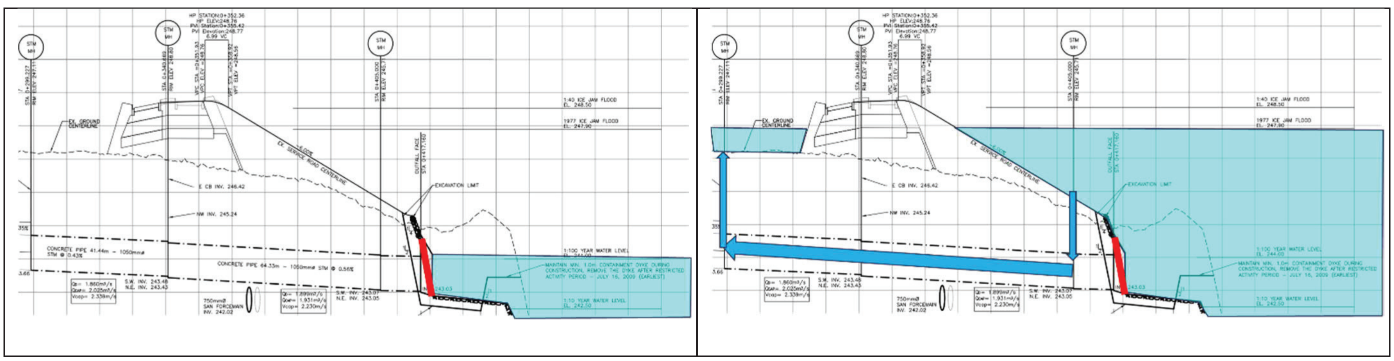
An additional observation of note regarding the operation during the flood, is the impact of pump hoses across the roadway and the impact on emergency vehicle access. While CLH was working on the east end of Clearwater Drive, Inner City Diesel was providing pumping services on the west end of Clearwater Drive, attempting to pump water from inside of the dyke back to the river. The pump hoses from Inner City Diesel were draped across Clearwater Drive, effectively blocking access at that location. While for the most part this was not a problem for CLH due to the different geographic work areas during this event, the potential for access conflicts needs to be considered in the emergency planning for a future flood event.

4.3 Underground Flooding Pathways

The Stantec report "2020 Fort McMurray Flood Storm Sewer Assessment - Outfalls" (Prepared for Regional Municipality of Wood Buffalo), June 2020 included an inventory and assessment of all the storm outfalls in the Lower Townsite and Waterways following the flood event. As indicated in the report, Stantec did not identify that any of the flap gates in the Lower Townsite had failed. Stantec identified that an outfall west of Riedel Street did not have a flap gate. However, a review of the record drawings identified that this outfall only services the local parking lot at 100 Clearwater Drive, and the absence of a flap gate at this location was not a contributing factor to the 2020 flood event.

As indicated in the Stantec (2020) report, there is no evidence of failure of the flap gates. However, it is apparent that flood water was able to find underground pathways, where water was able to bypass the flap gates and enter the storm system. Any structure (such as a manhole, catch basin, inlet pipe) between the flap gate at the outfall and the crest of the dyke is a potential pathway for water to get into the storm system. Once a hydraulic connection has been established, water will equalize, flowing until the water levels inside of the dyke match the water levels outside of the dyke.

The following figures display this concept. The figure on the left depicts a high-water event on the river (light blue) with the flap gate (red line) closed, preventing back flow up into the storm system. During an extreme high-water event, the river level rises to a point near, but not overtopping the road that forms the dyke. If the water is able to enter the storm manhole located on the river side of the dyke, whether through vent holes in the manhole cover, or a connected catch basin, or some other opening, then the water will flow into the connected storm pipe, and backflow underneath the dyke, while completely bypassing the flap gate. Due to the hydraulic forces, water will naturally equalize, by flowing from one side to the other until both reach the same elevation. In this case, the water levels on the land side of the dyke will continue to rise until they equalize with the river, resulting in flooding on the land side.



Following the floods, Associated Engineering conducted a preliminary review of the storm infrastructure in the vicinity of the Clearwater River and Clearwater Drive. Several instances of underground flooding pathways were identified and are presented below.

4.3.1 Main Street

At the Main Street Outfall, there is a storm manhole on the south side of Morimoto Drive. This structure acts as a vertical drop chamber to allow the storm sewer to pass overtop of the adjacent watermain, and then underneath the adjacent sanitary sewer mains. The structure also includes two storm pipe inlets, to intercept the ditch drainage that is flowing in from both directions on the south side of Morimoto Drive.

Main Street outfall

During the 2020 flood, as the river levels began rising, water was able to flow into the two inlet pipes and bypass the flap gate to backflow up the Main Street storm sewer.

4.3.2 Hardin Street

In the vicinity of the Hardin Street Outfall, there are two catch basins in the green space near the entrance to Snye Point Park. These catch basins are connected to the storm sewer. Similarly to the Main Street outfall, as the river levels began to rise, water was able to flow into these catch basins, and bypass the flap gate to backflow up the Hardin Street storm sewer.

Hardin Street outfall

4.3.3 Franklin Avenue

The Franklin Avenue outfall discharges into a ditch that runs along Longboat Landing. There is a flap gate at the end of the pipe. Immediately upstream of the flap gate, at the intersection of Franklin Avenue and Denholm Gate, are three catch basins that are connected to the Franklin Avenue storm sewer.

During the operation for the construction of the emergency clay dykes, a consequence of placing the alignment of the clay dyke on Clearwater Drive at this location was inadvertently stranding these catch basins on the river side of the dyke. As the river waters rose and breached the intersection of Franklin Avenue and Denholm Gate, the water was able to enter the catch basins, bypassing the flap gate, and back flow up the Franklin Avenue storm sewer into the Lower Townsite.

It should be noted that this location was only problematic during the 2020 flood event on account of the alignment of the emergency dyke on Clearwater Drive not protecting the catch basins at Denholm Gate. Depending on the alignment of any future temporary or permanent flood structures, this location may not be problematic or require any particular remedy. This is an example of how easy it is to inadvertently create underground flooding pathways underneath the dyke.

Franklin Avenue

4.3.4 Riverwalk Villas

The Riverwalk Villas condominium complex is located on the river side of Clearwater Drive at Riedel Street. There are two vents that face the Clearwater River, that provide direct connection into the parkade for the Riverwalk Villas development. During a site visit on November 26, 2020, the property manager confirmed that these vents are part of the make-up air system for the parkade. She also reported that during the 2020 flood event, she witnessed flood waters entering the parkade via these vents. The site visit also confirmed that the parkade is a single level, with at-grade access to the street near the intersection of Clearwater Drive and Riedel Street. A trench drain is located immediately outside of the overhead garage door, and this drain is connected directly into the storm sewer.

Vents facing the Clearwater River directly connected to the underground parkade at Riverwalk Villas

Secondary vent identified also connected to parkade

	
Make up Air unit inside parkade, connected to vents	Trench drain in front of at-grade overhead door access to parkade

Based on the review of the infrastructure at Riverwalk Villas, it is evident that the rising flood waters flowed freely through the vents into the underground parkade. Once the floor drain sumps were filled, water then flowed out the garage door, where it would have flowed into the trench drain, and directly into the storm sewer. Once the capacity of the 75mm connection pipe to the storm sewer was exceeded, flood waters would have then flowed freely out to the street, contributing to the overland flooding in the Lower Townsite via Riedel Street.

4.4 Longboat Landing

As discussed in Section 2.4.2, at the time of the 2020 flood, there was no backflow preventer on the storm outfall that serves the Longboat Landing storm system. As the river levels began to rise, water started flowing up the storm sewer in Longboat Landing, spilling from catch basins at the low points in the system. This is the explanation for why residents of Longboat Landing reported seeing backups from the storm sewer within the community while the Clearwater River levels were rising.

Over the course of the flood event as the Clearwater River continued to rise, both Denholm Gate and Fontaine Crescent breached, resulting in the entire community flooding to the same elevation as the river, to a maximum of 248.9m. The absence of a backflow preventer on the storm outfall was irrelevant at that water level, as the water was able to flow into the community over the roadways.

4.5 Reach 1 / River Park Glen

The Reach 1 dyke from MacDonald Drive to Borealis Park was successful at mitigating the overland flood waters at the River Park Glen (formerly Syncrude Towers) development at the end of Richard Street. There was some sanitary sewer back-up into the parking lot that needed to be pumped, on account of being interconnected to the rest of the Lower Townsite system. However, there were no reports of damage to the development, which is in the floodplain elevation range.

4.6 Lift Stations 1A and 1B

Lift Station 1A and Lift Station 1B avoided flood damage during the 2020 ice jam flood event. Lift Station 1B has a flood slab above the floodplain and was not adversely impacted by the flood.

For Lift Station 1A, the dykes constructed in 2013 were successful at keeping the floodwaters away from the immediate vicinity of the facility. A temporary road was constructed over the dyke to connect to the high ground at Father Mercredi Street so as to maintain operational access to the facility while the surrounding flood waters remained elevated.

4.7 Bridges and Culverts

Immediately following the floods, Associated Engineering undertook an assessment of the flood-impacted bridges and culverts, as documented in the technical memorandum: Associated Engineering "Post-Flood Inspections - Bridges and Culverts" (Prepared for Regional Municipality of Wood Buffalo), May 2020.

Based on the inspection, there was no structural damage to any of the bridges as a result of the 2020 ice jam flood. Three bridges were temporarily closed to pedestrians until accumulated debris could be cleaned.

4.8 Northern Lights Regional Health Centre

The basement of the Northern Lights Regional Health Centre (aka the Fort McMurray Hospital) is located within the floodplain and is vulnerable to flooding from high water levels. During the 2020 flood, after water levels had breached Clearwater Drive, the Hospital was identified as the next critical infrastructure requiring protection. Volunteers from the community created a sandbag barrier around the northeast corner of the property to prevent overland flow.

Associated Engineering personnel worked directly with the maintenance personnel for Alberta Health Services at the Hospital to review and identify other possible flood risks to the facility. The catch basin immediately outside of the bay doors is directly connected to the storm sewer, which was backing up at the same rate as the flood waters were rising. As a mitigation measure, the downstream manholes were plugged with sandbags. This slowed the water down sufficiently that the catch basin at the bay doors could be pumped down, and thereby avoiding any flood damage to the Hospital.

4.9 Infrastructure Performance Summary

The existing flood protection system that was in place to protect the Lower Townsite at the time of the 2020 flood was not designed to withstand flood elevations greater than those associated with a 1:40-year return period. With a peak water level of 248.9m, the 2020 ice jam flood inundated all the infrastructure that was only designed for 248.5m. In spite of the construction of emergency clay dykes along most of the way along Clearwater Drive, flood water was able to flow into the Lower Townsite, via overland at Riedel Street, and via the underground pathways discussed above.

There is no evidence that any flap gates failed in the Lower Townsite. However, the underground flow pathways identified in the previous sections provided a pathway for flood water to bypass the flap gate and back flow up the storm sewer. Once water was able to get inside of the dyke, it would flow through and fill the low-lying areas including ditches and sags in the road, and eventually into the sanitary sewers and the basements of impacted homes and other buildings. Because the sanitary sewer system is interconnected across the entire Lower Townsite, the sewer pipes also became a pathway for floodwaters to spread to multiple low-lying areas at the same time. This is the explanation for the reports of residents seeing flood water in the vicinity of the low-lying areas including behind Hill Drive, while the Clearwater River was still rising on April 26.

As the Clearwater River continued to rise over the course of the ice jam flood event, the overland flow at Riedel Street and the underground flow paths led the water level inside of the Lower Townsite to equalize with the river, and match the maximum flood elevation of 248.9 m. Through the roads and sewers, all low-lying areas in the Lower Townsite at the elevation of 248.9 m or lower were vulnerable to be impacted by flood waters. Dwelling units and other buildings outside of the immediate inundation area were also vulnerable to flood waters, if their basement elevation was below the 248.9m flood level and their sanitary service connection was not equipped with a functional backflow preventer.

Locations where the flood protection infrastructure or other applied flood mitigation measures were successful in preventing flood damage include the Snye Dyke / MacDonald Drive causeway, Reach 1 / River Park Glen, Lift Station 1A, the various bridges and culverts within the Clearwater floodplain, and the Hospital.

5 WATER TREATMENT PLANT

During the 2020 Flood event, water levels on the Athabasca River reached an elevation of 250.25 at the Water Treatment Plant. The perimeter dykes prevented overland flow of river water and ice from directly impacting the plant. However, the high water levels caused river water to flow backward through the storm outfall chamber and overflow piping, resulting in contamination of the treated water reservoirs (i.e. clearwells) with untreated and highly turbid river water. A detailed description of the failure mechanism that led to the contamination is discussed in Section 6.2, below.

The high turbidity of the contaminated water entering the clearwells caused an alarm at the SCADA control panel. At that time, the operations staff had approximately 300 simultaneous alarms, on account of the developing flood conditions across the entire system. This resulted in a delayed response to the contamination event. Once the contamination was discovered, operations staff attempted to isolate the affected clearwells, but were not able to close the valves[3]. Due to the inability to quickly isolate the impacted clearwells, and the fact that the overflow chamber is in close proximity to the pump chamber, contaminated water was pumped out to the distribution network almost immediately. The most significantly impacted communities were Timberlea and Thickwood, although the entire system was deemed compromised, on account of the interconnected water supply system leaving the Water Treatment Plant.

As a result of the contamination of the water system from the untreated river water, Alberta Health Services implemented a Boil Water Order across the entire Fort McMurray service area.

5.1 Water System Recovery

A Water System Recovery Plan was developed and executed to lift the Boil Water Order in coordination with the regulatory stakeholders at Alberta Environment and Parks (AEP) and Alberta Health Services (AHS). The water system recovery plan was developed in part based on the expertise and lessons learned from a similar water recovery process conducted following the 2016 Wildfire. The difference was that the primary concern following the Wildfire was

[3] A thorough investigation conducted after the flood event identified build up of precipitate on the valve surfaces, that was a likely contributing factor to the valves being inoperable during the 2020 flood event. This has been attributed to increased usage of caustic soda in the treatment process following the 2016 Wildfire. See Emelko et al. “Drinking Water Security after Severe Wildfire in Alberta: Initial Risks and Treatment Technology Resilience - Research Progress Overview: Evaluation of 2016 Horse River Wildfire Impacts on Drinking Water Treatment in Fort McMurray”, (Prepared for Alberta Innovates and Regional Municipality of Wood Buffalo), December 2020.

physical contaminants that may have entered the water system, so that primary objective was volume displacement to remove potential contaminants. For the 2020 water recovery works, the primary concern was bacteriological contamination from the untreated river water, and the primary objective was therefore disinfection.

The first phase of the recovery plan was the restoration of normal operation at the Water Treatment Plant, including a full cleaning and disinfection of the clearwells. The rest of the recovery plan entailed draining, cleaning, disinfecting and filling all of the reservoirs across the distribution network. As each reservoir was disinfected and filled, this cleaned water was then used for flushing and disinfecting each surrounding neighbourhood. This process of cleaning and disinfection was repeated across the entire water supply system, with appropriate controls in place to prevent recontamination of completed works.

The works were performed in accordance with standards published by the American Water and Wastewater Association. Specifically, AWWA C651-14 Section 4.11.3.3 identified a dose of 4 mg/L of free chlorine for 16 hours for disinfection of in-service pipelines. This dose of chlorine is akin to "pool water", i.e. fit for human contact including bathing and cleaning. Communications and social media were used to advise residents to boil the water (in accordance with AHS guidelines) to reduce the unpleasant tastes and odours. To limit resident exposure, the 16-hour disinfection period within each neighbourhood was followed with a flushing program to replace the disinfection dose water.

Bacteriological, chemical and physical (turbidity) water test samples were taken across the water distribution network to confirm the water quality in support of lifting the Boil Water Order within each community as the work proceeded. Based on the successful execution of the Water Recovery Plan, the last stage of the Boil Water Order was lifted on June 22, 2020.

5.2 Failure Mechanisms

Following the successful recovery of the Fort McMurray water system, an investigation was undertaken into the failure mechanisms that led to the contamination event. This included a detailed site inspection of the sluice gate, the flap gates, the overflow pipelines, and the outfall pipeline to the river. The purpose of the investigation was to understand the conditions and the root causes of the failure, and improve the infrastructure to prevent similar events in the future. The following two reports (included as Appendix A and B respectively) identify the findings and recommendations from the investigation, as well as preventative measures to provide additional barriers to failure.

- Associated Engineering "Fort McMurray Water Treatment Plant Failure Inspections" (Prepared for Regional Municipality of Wood Buffalo), August 2020
- Associated Engineering "Fort McMurray Water Treatment Plant Flood Recovery Short Term Flood Mitigation Recommendations" (Prepared for Regional Municipality of Wood Buffalo), November 2020

The key findings are summarized below:

5.2.1 Sluice Gate

The outfall sluice gate is operated using a manually controlled actuator at the surface of the chamber. The main issue identified when attempting to close the gate was that when the gate was in its 100% closed position, there was still approximately 65-75 mm of opening, which would have caused river water leakage through the gate. The gate pedestal is partially bolted to a 600 mm thick solid concrete structure, and partially bolted to a 150 mm thick concrete hatch, which is cracked. The pedestal takes all the operating thrust of the sluice gate, and therefore, must be adequately secured and supported. When the gate was being closed, the cracked concrete hatch was being moved upward as more pressure was applied, bending the operating stem of the gate and likely contributing to the gate not fully closing.

5.2.2 Clearwell 2 Flap Gate

The Clearwell 2 Flap Gate is on the overflow line that connects Clearwell 2 to the rest of the overflow piping. The gate is attached to a circular frame, which is bolted to the concrete wall of the manhole. The installed pipe leading into this manhole from the clearwell is a steel bare end pipe without a flange. In order to attach the gate to the pipe, a circular plate was installed and bolted to the wall; however, it was not grouted to seal the gap between the manhole and pipe. Thus, when water was entering the manhole, it was able to travel through this gap, bypassing the flap gate, resulting in leakage into the overflow pipe and Clearwell. The gap was measured to be approximately 25 mm between the back of the frame and the wall between each of the bolts. The gap was recommended to be grouted to ensure a proper seal.

During the inspection, the technician also noticed that the flap gate disc was not seated evenly on the lip seal, leaving approximately a 2 mm gap. The inspector was able to adjust the frame by loosening the front nuts and straightening the frame using the back nuts of the frame anchors on site to seal the gate. The inspector also noticed that a shipping bracket was still attached to the gate. While there is no evidence that the bracket interfered with the gate opening and closing operation, it was recommended that the bracket be removed.

5.2.3 Clearwell 1A Flap Gate

The Clearwell 1A Flap Gate is on the overflow line that connects Clearwell 1A to the overflow piping. The flap gate is bolted directly to the manhole wall. During the inspection it was noted that the upper section of the sealing system is damaged, creating leakage. In addition to this, some of the anchor nuts were loose and some washers were missing, which may have caused leakage if the seal between the wall and frame was not fully compressed. Some corrosion was also observed where carbon steel washers were used. The loose nuts were tightened on site; however, the washers still need to be replaced. Some grout on the flap gate disc surface, that may have also cause water to bypass the valve, was also recommended to be removed with a grinder and sandpaper.

5.2.4 Repairs and Operation and Maintenance

The following repairs have been completed at the Water Treatment Plant, based on the inspections described above

- A new design was developed for the support of the sluice gate pedestal at the outfall chamber. The works have been completed, and the gate was confirmed to seal in its closed position.
- The two flap gates for Clearwell 2 and Clearwell 1A respectively have been repaired, in accordance with the inspection recommendations. This work included grouting of the gap between the manhole and the steel pipe at the flap gate for Clearwell 2.
- A dive team removed all the accumulated chemical precipitate on the valves in the clearwell.

Associated Engineering understands that the following initiatives are being planned to be in place in advance of the 2021 River Breakup, in general conformance with the recommendations from the inspection reports:

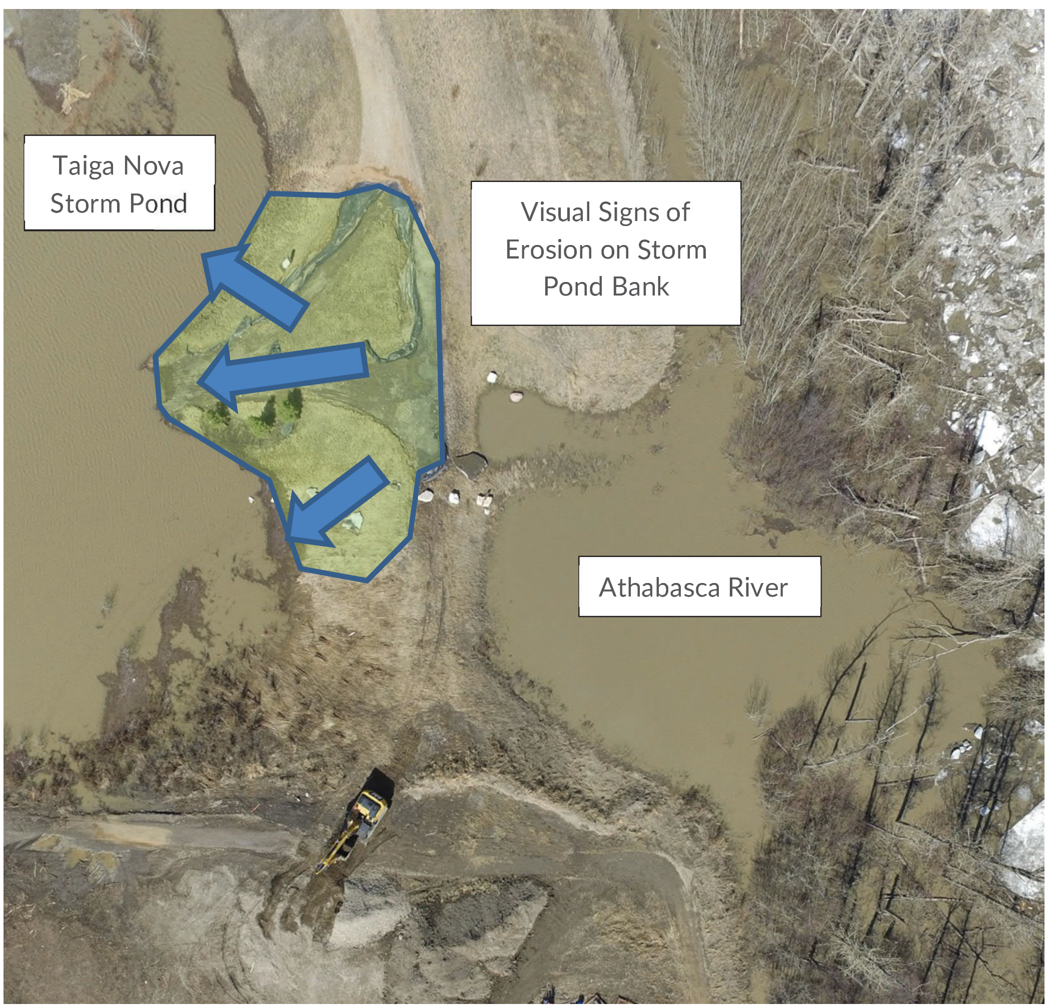
- Enhance Monitoring and alarm systems, including alarm rationalization;
- Automate shut down in the event of turbidity alarms;
- 6-month inspection cycle of valves and other critical infrastructure, to remove precipitate and other debris, and verify operation;
- Install additional flap gates at the end of all outfall pipes, as an additional barrier against flooding; and

- Have inflatable plugs on standby to be deployed in the overflow pipelines if required as a further barrier against flooding.

6 TAIGA NOVA ECO-INDUSTRIAL PARK

The Taiga Nova Eco Industrial Park was one of the first locations to be impacted by flood waters, with a mandatory evacuation order at approximately 10:30am on Sunday April 26th. The source of floodwater into Taiga Nova was not immediately clear. Accurate readings on the Athabasca River water levels in the vicinity of Taiga Nova are also not available because the nearby Water Survey Canada Gauge 07DA001 stopped recording at 4:40am that morning with a final reading of 244.15m, while the water was still rapidly rising. Nonetheless, a review of the available evidence suggests there were two floodwater pathways into Taiga Nova, discussed below.

The first floodwater pathway appears to be a breach overtop of the perimeter dyke near the Taiga Nova Storm outfall. Unfortunately, there are no photos available that capture the actual flow. However, the below photo (taken April 28, 2020) shows signs of bank erosion on the inside of the dyke, as river water spilled over the dyke crest and drained toward the storm pond.

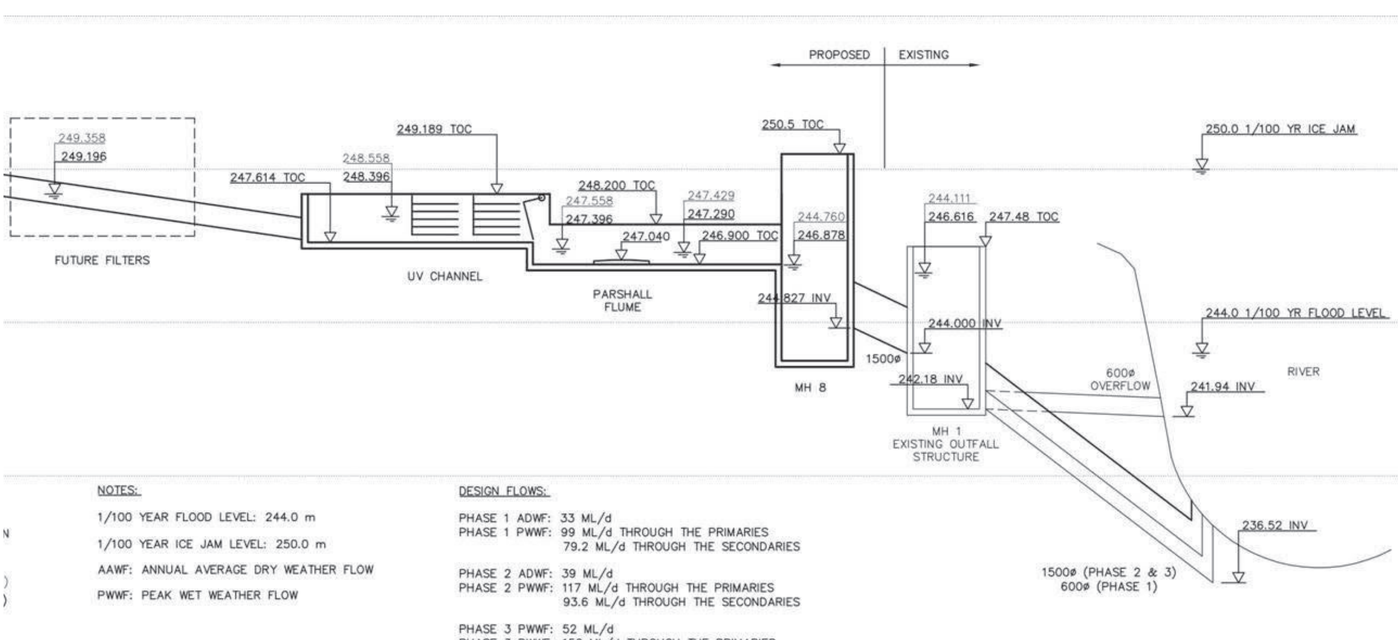


As stated above, accurate river water level at this location information is not known, but is estimated to have peaked just below the 248.0m (say 247.9), as flow was constrained to the location where the ground had settled near the storm outfall, and did not breach the entire berm. Fortuitously, the duration of this breach was relatively short, and likely coincided with the early "spike" that was observed at the Athabasca River Bridge on April 26 as shown in **Figure 3.1**.

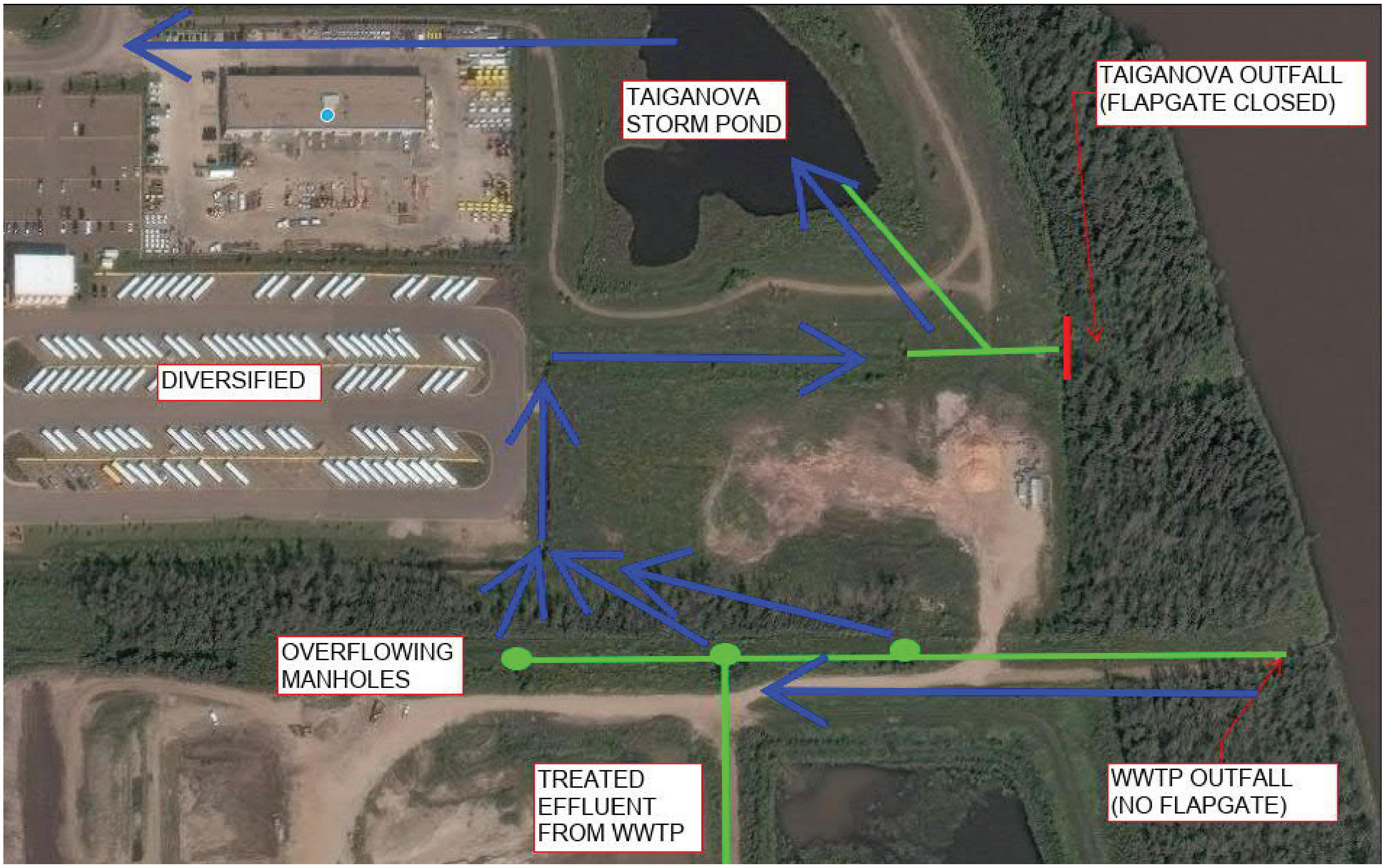
The water that flowed overtop of the dyke caused the Taiga Nova storm pond to overflow and cause flooding in the adjacent properties and roads, eventually reaching a maximum flood elevation inside the park of 245.7m. Once the breach overtop of the dyke had stopped, the flood water inside Taiga Nova was trapped, unable to drain because the flap gate at the Taiga Nova storm outfall was closed. The fact that the flood water elevation inside Taiga Nova never equalized with the river elevation despite the 2 m difference is also evidence that the Taiga Nova dyke and the flap gate did not fail.

Following the initial spike, it is believed that the Athabasca river level stabilized to an elevation of approximately 247.6m in the vicinity of Taiga Nova and the Wastewater Treatment Plant. While not high enough to cause another breach over top of the dyke, this elevated river level led to the second water flooding pathway into Taiga Nova, which was backflow of river water through the Wastewater Treatment Plant effluent discharge line. As indicated previously, there is no flap gate or backflow preventer on this pipe. The outflow pipeline follows a ditch on the north side of the wastewater treatment plant site, between the lagoon berms and the Municipal training yard. Municipal Underground Services staff reported that the concrete slab tops on the manholes along this pipeline had been pushed off from the hydraulic force of water backflowing and overflowing from these manholes. There was also visual evidence of grass caught in the fence line that follows the ditch, approximately 1m up from ground level, as evidence of water flow. Survey of the manhole rims and the grass caught on the fence suggest water was flowing in the ditch with a surface elevation of 247.6m.

The following excerpt from the WWTP record drawings shows the schematic for the outfall pipeline. As a schematic, not all structures are shown. The structure labeled as MH1 in the schematic is representative of the three manholes that were overflowing.



Once in the ditch, water was able to flow north to the Diversified site, then east into the junction manhole where it connects to the Taiga Nova storm outfall. As the flap-gate was closed due to the river levels, the water was then directed into the Taiga Nova storm pond. As the storm pond has already overflowed from the initial breach, this additional water likely contributed to the flooding already occurring in the industrial park. The likely pathway is indicated in the below figure.



One solution to prevent this line from overflowing and flooding into Taiga Nova in the future is to raise the three manholes on the outfall pipe, such that the rim is above the maximum flood elevation. This can be achieved by removing the concrete cover, installing concrete barrels to the required height, and then replacing the covers. The grading and landscaping in the vicinity of the manholes will need to be designed, including possible adjustments to the ditch line.

It should be noted that during the flood event, the wastewater treatment plant was still discharging treated effluent water, at a rate of up to 85 MLD (1,000 L/s) during the period of April 26 through April 29. Based on the analysis presented above, it is likely that the water that was discharging into Taiga Nova was a combination of treated effluent water and river water. The fact that the wastewater treatment plant was able to discharge this volume into Taiga Nova may have prevented the plant from flooding internally. If the overflow discharge pathway will no longer be available in the future scenario, the Municipality will need to review and update the WWTP's Emergency Response Plan in consideration of the hydraulic impacts of the river flood waters on effluent discharge.

7 KEY FINDINGS

A comprehensive Flood Protection System was not in place at the time of the 2020 ice jam flood.

The flood infrastructure that existed at the time of the 2020 flood consisted of a series of dykes constructed to different design criteria, as opposed to a single comprehensive system. With a maximum flood water elevation of 248.9, the 2020 ice jam flood event was higher than what the flood infrastructure was designed to mitigate.

There was no evidence of flap gates failing in the Lower Townsite. However, in conjunction with the lack of a comprehensive system, there was no process in place to identify potential underground pathways for water to bypass the flap gates and backflow under the dykes, and to remedy such issues.

The flood mitigation program completed to date was constructed on an incremental basis over a lengthy time period, in general conformance with the Trillium (2000) report. With respect to Clearwater Drive as a dyke around the Lower Townsite, some infrastructure was constructed to the 1:40-year flood level, and some was constructed to the 1:100-year flood level, with a significant gap between the two at Riedel Street. A dyke system is only as effective as the elevation of the lowest point; the Lower Townsite was therefore vulnerable to any flood greater than 1:40-year flood levels. The implementation of the incremental approach to flood mitigation was still underway at the time of the 2020 flood.

None of the recommendations for establishing a secondary line of flood defense in addition to flap gates, such as manually-operated flow control valves and active pumping of trapped rainwater and snowmelt inside of the dykes as identified in the Trillium (2000) report and other studies, have been implemented.

In recognition of the vulnerability of the system in the Lower Townsite, contractor crews were mobilized on the night of April 26, 2020 as the flood levels were rising to construct emergency dykes along Clearwater Drive. These dykes were constructed along much of the alignment of Clearwater Drive, blocking flood waters through the low points, and were able to hold back approximately 1 m of water. Unfortunately, the construction of emergency dykes along Clearwater Drive was not successful in preventing system wide flooding within the Lower Townsite, for the following three reasons:

1. The crews were unable to successfully build clay dykes at Riedel Street, which is the lowest point along the alignment of Clearwater Drive with an elevation of approximately 247.7m. By the time crews were mobilized, water was already flowing across Clearwater Drive at Riedel Street, and was so deep and fast that any placed clay was immediately washed away. As no emergency clay dyke could be constructed at Riedel Street, water freely flowed overtop of Clearwater Drive and into the Lower Townsite.

2. Flood water was freely flowing through underground pathways beneath the flood protection system, including the emergency clay dykes constructed on Clearwater Drive. These pathways include the outfall pipes at Main Street and Hardin Street, and the parkade at Riverwalk Villas. Other locations that may have contributed to underground pathways include the catch basins outside of Clearwater Drive at Riedel Street and Franklin Avenue.

3. The nature of the road network and the interconnected sanitary sewer system across the entire Lower Townsite made all low-lying areas vulnerable to any single point of water passage through or over the dyke.

With multiple pathways for water to pass through and/or overtop of the dyke, water levels inside of the Lower Townsite were able to equalize with the water levels on the Clearwater River. As the water filled and flowed through the sanitary sewers, all low-lying areas in the Lower Townsite at the elevation of 248.9m or lower were vulnerable to be impacted by flood waters. Homes and other buildings outside of the immediate inundation area were also vulnerable, if their basement elevation was below the 248.9 m and their sanitary service connection was not equipped with a functional backflow preventer.

As a result of the status of the infrastructure in place at the time, and the extreme water levels of the 2020 ice jam flood, the flood water was able to enter the Lower Townsite via both overland flow (at Riedel Street) and multiple underground pathways. Therefore, the maximum flood level reaching 248.9 within the Lower Townsite, and the associated flood damage, cannot be attributed to the failure of any one particular infrastructure component, but rather that the system as a whole was not prepared for a flood of this magnitude.

Flood infrastructure and related mitigation measures were successful in preventing flood damage at various locations, including the Snye Dyke / MacDonald Drive causeway, Reach 1 / River Park Glen, Lift Station 1A, the various bridges and culverts within the Clearwater floodplain, and the Hospital.

At the Water Treatment Plant, a series of infrastructure failures from the sluice gate, the flap gates, and the delayed response led to contamination of the water system by untreated river water. The key repairs have been completed, and additional measures are scheduled for implementation prior to the 2021 River Breakup to provide additional barriers and prevent a repeat occurrence.

At Taiga Nova, there is evidence that the perimeter dyke was overtopped during the initial “spike” of water levels on the Athabasca River. Following the initial spike, the existing dyke and flap gate were successful in holding back approximately 2m of water, preventing significantly worse flooding in the eco industrial pack. Backflow from the Wastewater Treatment Plant outfall line contributed to secondary flooding in Taiga Nova. This can be mitigated in the future by raising the manholes in the ditch between the Wastewater Treatment Plant and the adjacent training yard.

8 KEY RECOMMENDATIONS

Based on the observations, assessments, and findings from the study, Associated Engineering recommends the following as a strategy to mitigate future flood damage.

1. Adopt a consistent flood protection standard in accordance with Provincial guidelines and best practices.

2. Once a flood standard has been adopted, implement a Comprehensive Flood Protection System to that standard.

    a. Accelerate the flood mitigation program for the design and construction of permanent dykes and flood barriers, with consideration for top-lifting or raising to a consistent standard as required.

b. As part of the Comprehensive Flood Protection System, identify and resolve all underground flood water pathways and other gaps in the dyke system

c. Apply a multi-barrier approach, including redundancy for critical community infrastructure (i.e. Water Treatment Plant, Wastewater Treatment Plant, Hospital), and means of isolation to limit damage in the event of a breach or single point of failure.

d. Implement pumping measures to manage drainage inside of the dykes, including rain events while the flap gates are closed, or to address leakage water that may still pass through the dykes. As part of the pumping system, consider alternatives to having hoses running across the road, as these impede emergency access and other vehicle movements.

3. Apply an Asset Management approach for the Flood Protection Infrastructure, including an inspection and maintenance program to preserve the integrity of the system:

a. Establish key roles, responsibilities and tasks for pre-river break-up activities, during river break, and post river break.

b. Actively review and monitor existing and proposed infrastructure, developments and other activities that may compromise the Flood Protection System

c. Apply a multi-faceted approach to protect the integrity of the Flood Protection System. The approach needs to consider public infrastructure, private developments, grading and landscaping activities, third-party utilities, regulatory constraints, natural processes (including erosion), vegetation, and nuisances such as burrowing animals.

9 ACKNOWLEDGEMENTS

Special thanks go out to the municipal staff, consultants and contractor crews who responded to the flood event and assisted with the recovery works. The following organizations are deserving of special recognition, as well as many others who may have been missed:

BMAC Underground Services
Clean Harbors
CLH Contracting
Corcoda
Hatfield Consultants
Maverick Inspection
Northern Underwater Systems
Sureway Construction

As well, a special thank you to McMurray Aviation for the use of aerial imagery of the flood event.

CLOSURE

This report was prepared for the Regional Municipality of Wood Buffalo to provide an independent assessment of how key Municipal infrastructure performed during the 2020 Ice Jam Flood event, substantiated by first-hand field observations and follow-up analysis by Associated Engineering staff.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
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- Associated Engineering “Fort McMurray Water Treatment Plant Failure Inspections” (Prepared for Regional Municipality of Wood Buffalo), August 2020. [Included as Appendix A]
- Associated Engineering “Fort McMurray Water Treatment Plant Flood Recovery Short Term Flood Mitigation Recommendations” (Prepared for Regional Municipality of Wood Buffalo), November 2020. [Included as Appendix B]

APPENDIX A – WATER TREATMENT PLANT FLOOD FAILURE INSPECTIONS

Associated Engineering

GLOBAL PERSPECTIVE.
LOCAL FOCUS.

REPORT

Regional Municipality of Wood Buffalo
Fort McMurray Water Treatment Plant

Water Treatment Plant Flood
Failure Inspections

AUGUST 2020

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1 BACKGROUND

On April 26, 2020, ice jam flooding on the Athabasca River caused water levels to exceed the 1:100-year level in Fort McMurray, AB. This flooding resulted in river water contamination at the Fort McMurray Water Treatment Plant (FMWTP). The river water travelled back through the outfall chamber and piping, into the overflow piping and Clearwells, contaminating the treated water in both Clearwell 1 and 2. Contaminated water was subsequently pumped to the North and South distribution networks. A boil water order was placed on the water system by Alberta Heath Services, as a result, until the water distribution network could be recovered. Full recovery of the distribution system was lifted in various communities through a phased approach, with the final phase being completed on June 19, 2020.

On May 26, 2020, the members of the recovery team from the Regional Municipality of Wood Buffalo (RMWB) and Associated Engineering (AE) met to discuss the various failure mechanisms that resulted in the contamination at the FMWTP. After this meeting, AE was retained by the Municipality to lead the inspection of the points of isolation and further investigate the potential failure modes of the event.

1.1 Description of FMWTP Points of Isolation

The overflow lines from the Clearwells, at the FMWTP, and the local on-site storm drainage lines collect in a single chamber on the east side of the plant, known as the storm outfall chamber. There is a sluice gate mounted on the inside of the chamber, which can isolate the overflow outlet pipe that discharges to the Athabasca River. During the 2020 flood, river water came up through the outfall chamber and sluice gate, as the gate did not appear to be properly seated during the flood event.

Upstream of the sluice gate, the overflow lines connect to Clearwell 1A and 2. Where these lines branch to each respective reservoir, there is a manhole chamber that includes a flap gate for isolation. It was suspected that both flap gates failed, as there was evidence of river water in the overflow line of Clearwell 1A and turbidity alarms in Clearwell 2.

The Clearwell 1A and 2 flap gates were manufactured and supplied by Fontaine, as part of the 2010-2014 upgrades. AE engaged Vanex (Fontaine's recommended service company) to complete an inspection of both flap gates, as well as the sluice gate in the storm outfall chamber, to review the installation, determine potential cause of failure, if repairs would be required, or if improvements could be made.

An inspection of the sluice gate and the flap gates was conducted by AE and Vanex on July 6 and 7, 2020. The findings are described in the following section.

In addition to the items noted above, Valve Chamber #2 was also inspected, as it controls the flow from the raw water pond to the WTP and is another potential pathway for flood waters to reach the WTP. The condition was reviewed to determine if additional valves are required to establish isolation in a future flood event.

2 INSPECTION FINDINGS

The detailed inspection findings and photos are captured in the following three reports included in **Appendix A**:

- Vanex Site Report;
- AE Mechanical Inspection Report; and
- AE Structural Inspection Report.

A summary of the findings is described in the sections below.

2.1 Storm Outfall Chamber

A mechanical and structural inspection were completed to review the condition of the outfall structure, sluice gate and outfall pipe. AE engaged Vanex, a water control gate specialist and service technician, to visit the site and inspect the sluice gate.

2.1.1 Sluice Gate Condition

The outfall sluice gate was manufactured by ARMCO and is operated using a manually controlled Rotork actuator at the surface of the chamber. The main issue identified when attempting to close the gate was that when the gate was in its 100% closed position, there was still approximately 65-75 mm of opening, which would have caused river water leakage through the gate. It was identified that the limit switch was not properly adjusted.

In addition to this, the gate pedestal is partially bolted to a 600 mm thick solid concrete structure, and partially bolted to a 150 mm thick concrete hatch, which is cracked. Since the gate is a rising stem type, the pedestal takes all the operating thrust of the sluice gate, and therefore, must be adequately secured and supported. When the gate was being closed, the cracked concrete cover was being moved upward as more pressure was applied, bending the operating stem and likely contributing to the gate not fully closing.

2.1.2 Outfall Pipe Condition

The site inspection and review of the outfall pipe revealed that the connection between the outfall pipe and sluice gate is compromised. The outfall structure contains a wall thimble, which is a frame embedded in the concrete wall to connect to the sluice gate. The wall thimble appears to have a broken section where it is connected to the outfall pipe. It is suspected that the outfall pipe has shifted down and the wall thimble has stayed in place resulted in a broken section. The 1050 mm outfall pipe is pulled apart by approximately 600 mm behind the sluice gate with granular material/backfill visible from inside the pipe between the two disjoint sections.

2.1.3 Outfall Chamber Flap Gates

While in the outfall chamber, the additional storm flap gates were inspected and determined to be in good working condition. These are original ARMCO flap gates on the storm lines that come into the outfall chamber. The anchor bolts were slightly corroded, and one anchor bolt was found to be loose.

2.1.4 Repair Recommendations and Next Steps

The following repairs are recommended for the outfall chamber:

1) Re-calibrate the actuator to have the gate reach its full closed position and adjust wedges to compress the slide sealing system against the frame seat.
2) Properly anchor gate pedestal to a fixed concrete surface. AE recommends completing a structural design to fully address anchoring the Rotork actuator.
3) Verify the gate stem condition to determine if it requires replacement due to deformation.
4) Replace corroded anchor bolts on the middle storm flap gate.
5) Complete a full investigation of the broken outfall pipe and wall thimble connection to determine rehabilitation requirements.

AE recommends that the RMWB proceed with a structural design for anchoring the gate pedestal, as well as re-calibrating the actuator on the sluice gate and checking the gates stem condition to complete the repair of the sluice gate.

Regarding item #5 listed above, AE recommends proceeding with a civil design review of the outfall pipe in order to determine the extent of the pipe rehabilitation and proceed with the repair.

2.2 Clearwell 2 Flap Gate Manhole

The Clearwell 2 Flap Gate is located in MH09-04 (refer to **Appendix B – Site Layout**) and is a 1050 mm Fontaine gate on the overflow line that connects Clearwell 2's overflow to the overflow pipe that goes to the river via the Storm Outfall Chamber. The gate is attached to a circular frame, which is bolted to the concrete wall of the manhole. The record drawings show the overflow pipe from Clearwell 2 to the manhole is a steel line and attached to the flap gate with a 150 lb flat face flange; however, the installed pipe is a steel bare end pipe without a flange. In order to attach the gate to the pipe, a circular plate was installed and bolted to the wall; however, it was not grouted to seal the gap between the manhole and pipe. Thus, when water was entering the manhole, it would have travelled through this gap, bypassing the flap gate, resulting in leakage into the overflow pipe and Clearwell. The gap was measured to be approximately 25 mm between the back of the frame and the wall between each of the bolts.

Another issue noted was the disc was not seated evenly on the lip seal, leaving approximately a 2 mm gap at two sections on the seating circumference. Vanex was able to adjust the frame by loosening the front nuts and straightening the frame using the back nuts of the frame anchors on site to seal the gate.

The third issue was that the shipping bracket on the gate appears to have been left in place during the installation of the flap gate. There is no evidence to suggest that the gate is experiencing interference with the bracket; however, it should be cut when the other repairs are carried out, to prevent potential interference with the frame nuts if the gate is not perfectly centered in the fully closed position.

The manhole structure itself was inspected and found to be in overall good condition.

2.2.1 Repair Recommendations

The following repairs are recommended for the MH09-04 flap gate:

1) Apply non-shrink high performance grout between the flap gate frame and manhole wall to eliminate gap.
2) Cut shipping bracket to provide clearance from frame nuts, to ensure zero interference with gate closure.

2.3 Clearwell 1A Flap Gate Manhole

The Clearwell 1A Flap Gate is located in MH09-03 (refer to **Appendix B – Site Layout**) and is a 600 mm Fontaine gate on the overflow line that connects Clearwell 1A's overflow to the overflow pipe that goes to the river via the Storm Outfall Chamber. The flap gate is bolted directly to the manhole wall. During the inspection it was noted that the upper section of the sealing system is damaged, creating leakage. In addition to this, some of the anchor nuts were loose and some washers were missing, which may have caused leakage if the seal between the wall and frame was not fully compressed. Some corrosion was also observed where carbon steel washers were used. The loose nuts were tightened on site; however, the washers still need to be replaced.

There was grout material stuck on the flap gate disc surface, which should be cleaned in order to provide optimum sealing. It was cleaned off using a scraper but is recommended to be completed again with a grinder and sandpaper at the same time as completing the other repairs.

2.3.1 Repair Recommendations

1) Replace damaged lip seal and readjust flap gate once the new seal is replaced.
2) Replace carbon steel washers with stainless steel.
3) Clean flap gate disc surface with grinder and sandpaper.

2.4 Valve Chamber #2

The north side of Valve Chamber #2 has an approx. height of 6.0 m in the main areas with approx. 1.0 m of ground cover over top. The area above the ceiling slab had been previously excavated and has yet to be backfilled, causing water to collect in this depressed area. The area of the hatch / ladder extends the full height to top of grade for an approx. height of 7.0 m. The south side of the chamber has an approx. overall height of 11.0 m with approx. 4.0 m extending above grade and covered by structure with a gravel ballast roof with the access hatch/ladder at the top.

At the time of the assessment there was approx. 500mm of water noted covering the floor in both the north and south side. This hindered access to and examination of some areas. Structurally, the interior concrete and wall penetrations appeared to be in good condition with no significant areas of concern or significant groundwater infiltration on both sides. It should be noted that pipe penetrations at the lower elevations, either partially of fully submerged in water could not be accurately assessed for leakage at those penetrations. In order to determine where the water is coming from, the chamber should be pumped out and inspected to try and identify where the leakage is coming from. Regarding the surface drainage in the vicinity of Valve Chamber #2, the RMWB should proceed with the recommendation made in the Fort McMurray Water Treatment Plant Drainage Project (Phase 1 – Assessment) Report, completed by AE in 2020. During this assessment, AE was informed that the grade of the chamber was such that it sat lower than the adjacent site and collected surface runoff. AE recommended raising the valve housing, vertically extending the valve stems to suit and backfilling the area to provide positive drainage.

The steel piping and valves observed were generally in fair to good condition with areas of surface corrosion / epoxy coating failure of varying degrees. There was also sludge still adhered to the pipes passing through the wall at the bottom of the space, which would seem to indicate that the water level inside had previously been much higher than observed at the time of inspection. Tube and clamp scaffolding were in place on the north side in areas, which may have been for recent maintenance work.

After review of drawings and on site, there is no isolation valve noted on the pond overflow piping. Adding an isolation valve to prevent overflow into the chamber, if the pond levels rise above overflow is possible; however, it would not provide protection to the chamber. The record drawings show the top of berm in this area is at 253.0 m and the pond overflow pipe is at 253.1 m; therefore, if a flood event resulted in high water levels in the raw water pond, reaching 253.0 m or higher, the flood water would breach the berm. A closed valve on the overflow line might protect the chamber itself for a short period; however, water would likely come in from the top of the chamber, since it would breach the berm. Recommendations were made under the Fort McMurray Water Treatment Plant Drainage Project (Phase 1 – Assessment) Report to raise the berms where they were found to be lower than designed.

3 ADDITIONAL IMPROVEMENTS

In addition to the required repairs on the current infrastructure, it is prudent to review the overflow and storm system in its entirety to determine if other redundancies should be built into the system and if other improvements are required to protect the WTP from future flood and rain events. Climate change is resulting in the frequency and potential severity of these events; therefore, it is important for the RMWB to plan for them and be adequately protected. The following list of items should be covered in a future study:

1) A functional review of the storm and overflow piping, to determine if the two systems should be separated into separate outfall chambers to adequately protect the WTP, particularly in a rain and flood event occurring simultaneously.
2) A review of adding in another point of isolation on the overflow system, for example a manhole and sluice gate between MH09-05 and MH09-06 (refer to the attached layout in **Appendix B**) to provide additional redundancy.
3) Developing a maintenance plan for inspection of WTP assets, based on manufacturer's recommendations.
    a. The following tasks should be carried out at the recommended frequencies:

Table 3-1
Series 20 Sluice Gate

Maintenance Task	Frequency
Clean gate with clear water to remove all deposits	6 months
Inspect the resilient seals and slides to make sure they are in good condition	6 months
Inspect stem threads and lift-nut threads for wear	6 months
Clean and lubricate the stem	6 months
Check all fasteners for correct tightening	6 months

Table 3-2
Series 60 Flap Gate

Maintenance Task	Frequency
Clean gate with clear water to remove all deposits	6 months
Remove any debris or obstacles preventing proper seating	6 months
Inspect hinges to detect premature wear of bearing	6 months
Inspect the seal. Door must seat evenly on the entire perimeter of the EPDM gasket ring. Apply pressure by leaning on door.	6 months
Check all fasteners for correct tightening.	6 months

These tables are from Fontaine's O&M manual for Sluice Gates and Flap Gates. If the RMWB has the original ARMCO O&M manual for the outfall chamber sluice gate, this should be referenced and used.

4 REPAIR RECOMMENDATIONS SUMMARY

4.1 Repair Summary Table

The follow table outlines the various repair recommendations, timeline recommendation in terms of priority (low, medium or high) and approximate cost for repairs:

Table 4-1
Repair Summary Table

Repair Item	Location	Repair Description	Priority	Approximate Cost
1	Outfall Chamber	Re-calibrate sluice gate actuator, re-seal gate	High	$35,000
2	Outfall Chamber	Anchor gate pedestal	High	$50,000
3	Outfall Chamber	Review gate stem and replace if damaged	High	$15,000
4	Outfall Chamber	Rehabilitate outfall pipe and gate connection	Medium	$150,000
5	Clearwell 2 Manhole	Apply grout between the flap gate frame and manhole wall	High	$40,000
6	Clearwell 2 Manhole	Cut shipping bracket on flap gate	High	
7	Clearwell 1 Manhole	Replace seal and readjust flap gate	High	$20,000
8	Clearwell 1 Manhole	Replace carbon steel washers with stainless steel and clean flap gate	Medium	
9	Outfall Chamber and Overflow Piping	Additional Improvements: Review overflow piping & storm system, make improvements to separate outfall chambers, & add another point of isolation	Medium	$2,500,000*
10	Valve Chamber #2	Pump out chamber to inspect source of leak	Medium	$20,000

*Cost includes detailed design to construction completion.

5 FINAL RECOMMENDATIONS AND CONCLUSION

Associated Engineering recommends that the Regional Municipality of Wood Buffalo proceed with the repairs to the flap gates and outfall sluice gate, as soon as possible, to protect the treated water supply in the Clearwells. As well, further investigation into the outfall structure and pipe should be completed to review the condition and determine the extent of rehabilitation required.

A review and study of the items listed under “Additional Improvements” should be completed to ensure the Fort McMurray Water Treatment Plant is adequately protected from future natural disasters and to determine if the current infrastructure still meets the plant’s requirements, or if future improvements should be implemented.

CLOSURE

This report was prepared for the Regional Municipality of Wood Buffalo, Fort McMurray Water Treatment Plant to provide inspection findings from the flood that occurred at the Water Treatment Plant and determine potential causes of failure at each of the points of isolation, as well as to provide repair recommendations and next steps.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

PROFESSIONAL ENGINEER STEVEN G. JUSTUS ALBERTA
2020-Jul-30

Steve Justus, P.Eng.
Project Manager

PROFESSIONAL ENGINEER SARAH BRUCE ALBERTA
2020-07-30

Sarah Bruce, P.Eng.
Project Engineer

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.

Signature ______________
Jeff Fetter 2020-07-30

PERMIT NUMBER: P 03979
The Association of Professional Engineers and Geoscientists of Alberta

APPENDIX A – INSPECTION REPORTS

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SITE REPORT

PROJECT: FORT MCMURRAY BUFFALO WOOD REGION **Date:** July 6th & 7th, 2020

CLIENT REFERENCE: Outfall gate and flap gates

Direct customer: ASSOCIATED ENGINEERING AB Ltd

Contact(s): Sarah Bruce (Process Engineer, ASSOCIATED ENGINEERING Ltd)

Site contact(s): Troy McKinnon (Technician, ASSOCIATED ENGINEERING Ltd)
Paul St-Claire (Maintenance Manager, BUFFALO REGION)

Visit main goal(s):

To perform the inspection of two leaking flap gates and the “Outfall” sluice gate.

DETAILS:

We arrived at the WTP at 8:30h am on July 5th 2020 as previously agreed. After the site meeting with all people involved, we have started with the 600mm diameter flap gate inspection located inside the manhole 09-03 at the North-East of the water plant. The 1050mm diameter flapgate was then inspected followed by the inspection of the OUTFALL gate on the second day.

The following report will provide details of those equipment inspection.

General view of Fort McMurray Drinking Water Facilities

EQUIPMENT IDENTIFICATION

Customer ID……………09-03
Type of equipment……Flap gate
Manufacturer………… FONTAINE
Dimensions…………… 600mm diameter

600mm flap gate

Equipment manufacturer nameplate

1- SEAL DAMAGED

Situation: This flap gate is equipped with a neoprene lip seal secured onto the equipment wall frame. However, the upper section of the sealing system is damage thus creating leakage. *Refer to pictures below.*

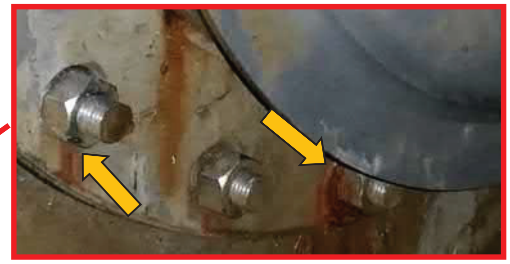
Upper section of the frame

Lip seal damaged

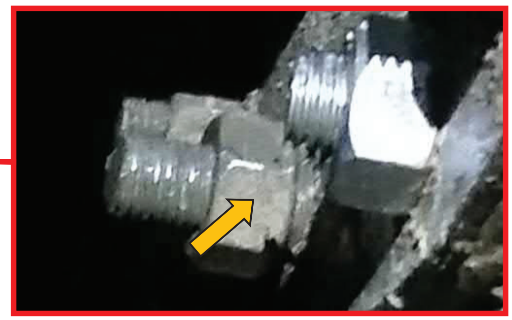
Recommendations: The damaged lip seal will need to be replaced and the flap gate disc readjusted as per the new seal. *Refer to picture aside for a new seal view.*

2- ANCHORS & FASTENERS

Situation : We have found several anchor nuts not properly tighten and without washers. This can create some leakage between the wall and the frame if the wall gasket is not properly compressed. Also, there was a rusted carbon steel washer that is contaminating the stainless steel flap gate. *Refer to pictures below.*



Missing and corroded washers



600mm flapgate

Loose nuts

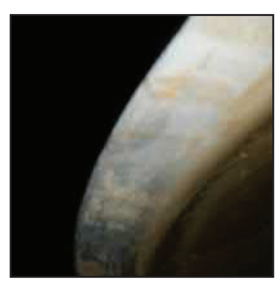
Recommendations: We have retightened the loose nuts but we had no stainless steel washers available of this size. New stainless steel washers will need to be installed when replacing the flap gate lip seal and the nuts will need to be properly tighten in order to make sure there is no leakage at the EPDM wall gasket.

3- GROUT ON THE DISC SEAT

Situation: The seat of the flap gate disc is a machined surface. This surface must be flat and clean in order to achieve the expected sealing performance while seating onto the frame lip seal. However, this machined surface had some kind of grout material stick on it thus can create some leakage since the lip seal is not seating on a flat surface.

Recommendations: We have cleaned most of the grout using a scraper. However, it will be better to use a grinder with sandpaper in order to get a cleaner surface. *Refer to picture aside.*

Grout on the disc seat

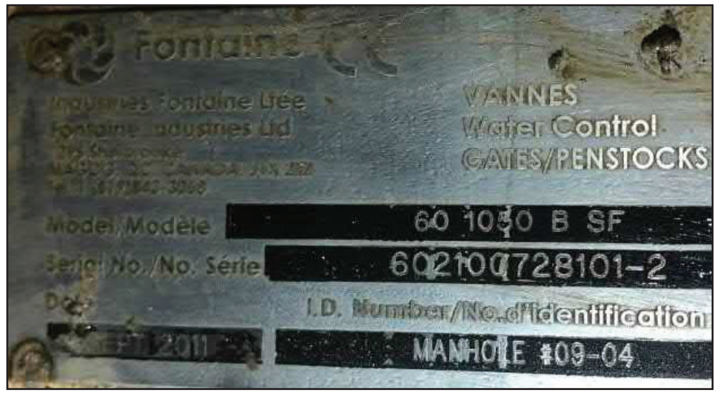


Grout cleaned

<u>**EQUIPMENT IDENTIFICATION**</u>

Customer ID……………09-04
Type of equipment……Flap gate
Manufacturer………… FONTAINE
Dimensions…………… 1050mm diameter

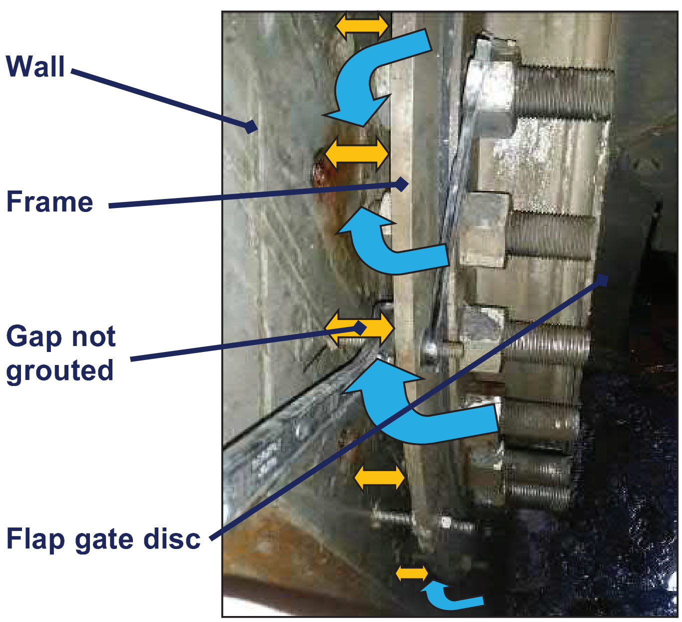
1050mm flap gate



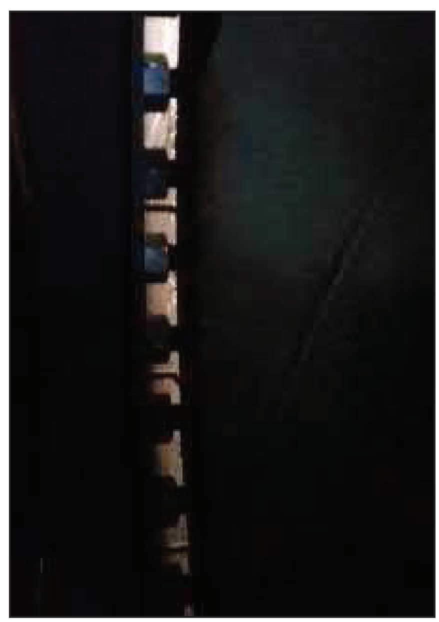
Equipment manufacturer nameplate

1- FRAME NOT GROUTED

<u>Situation:</u> The original flap gate installation works was not properly completed. The frame was not grouted on the wall as it should be; leaving a couple inches gap all around the frame circumference thus creating heavy leakage. *Refer to pictures below.*



Water is bypassing the flap gate



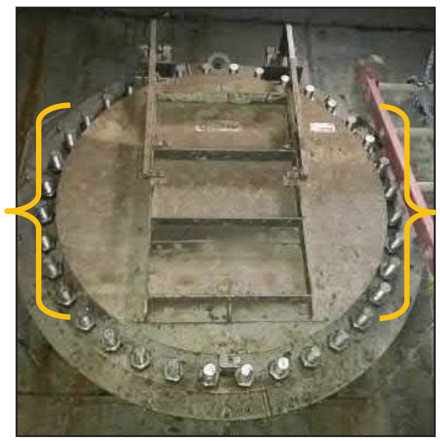
View from inside the pipe

<u>Recommendations:</u> The flap gate frame must be properly grouted using high performance none-shrink grout suitable for this application.

2- FLAP GATE ADJUSTMENT

Situation: The flap gate disc seating surface was not perfectly seating evenly onto the lip seal on both sides. There was up to a +/-2mm gap at two sections of the seating circumference.

Recommendations: Since the frame was not grouted yet, we have taken this "opportunity" to perform our self the required frame adjustment during this inspection. We loosen the front nuts and restraighten the frame using the backing nuts of the frame anchors. We were able to closed the gaps between the disc and the seal fairly easily. The frame is now ready to be poured. *Refer to picture below.*



+/-2mm gap sections

Frame readjustment using anchors back nuts

3- SHIPPING BRACKET INTERFERENCE

Situation: In order to avoid damage to the equipment during the shipping process, the manufacturer welded a shipping bracket to secure the flap gate in full close position. We noticed that this bracket could potentially interfere with the two frame nuts nearby. Therefore, if the flap gate is closing slightly sideways, this bracket will sit on the nuts and will prevent the disc to fully close. *Refer to picture below.*

Recommendations: We recommend to "zipcut" some of the bracket material on both sides (red lines on the picture aside) in order to get an acceptable clearance with the frame nuts.

Frame bottom section

EQUIPMENT IDENTIFICATION

Customer ID……………15-SGV-6001 Outfall valve
Type of equipment……Cast iron wedge-action sluice gate
Manufacturer………… ARMCO
Dimensions…………… 42''X42''
Motorization………….. ROTORK

ARMCO sluice gate

Manufacturer nameplate

Pedestal and actuator

Nameplate

1- ACTUATOR NOT PROPERLY ADJUSTED

<u>Situation:</u> The gate was automatically stopping at 75mm before reaching it full close position. After looking deeper into the actuator settings, we noticed that the full close limit switch was not properly adjusted. Therefore, this gate was heavily leaking due to this situation. Otherwise, this sluice gate is generally in good condition. *Refer to pictures below.*

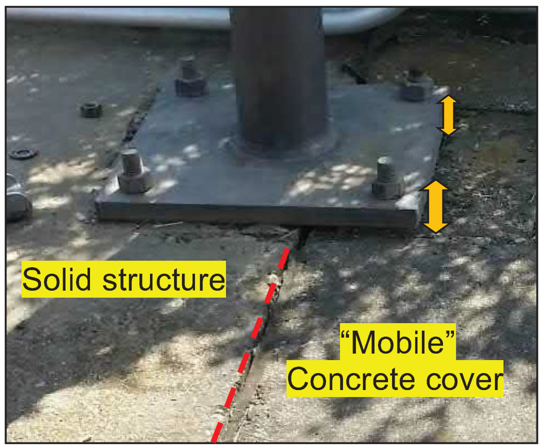
ARMCO sluice gate

Full close wedges at 75mm away

<u>Recommendations:</u> The actuator will need to be re-calibrated in order to have the sluice gate reaching it full close position. Eventually, the wedges will also require some adjustment to properly compress the slide sealing system against the frame seat.

2- PEDESTAL PARTIALLY BOLTED ON CONCRETE COVER

Situation: This gate is a rising stem type. With this operating arrangement, the pedestal (along with the actuator) is the key component and it is taking the entire sluice gate operating thrust. Therefore, it must be strongly secured onto a structural concrete floor slab or proper supports. However, the pedestal of this "Outfall sluice gate" have only two anchors bolted in the concrete slab and two anchors bolted inside a "mobile" concrete cover which is not attached to the structure. When the gate is reaching near the full close position, the concrete cover is moving upward thus bending the operating stem and not closing the gate. This could be the reason why the full close setting of the actuator was originally adjusted before the sluice gate is reaching it full close position. *Refer to pictures below.*



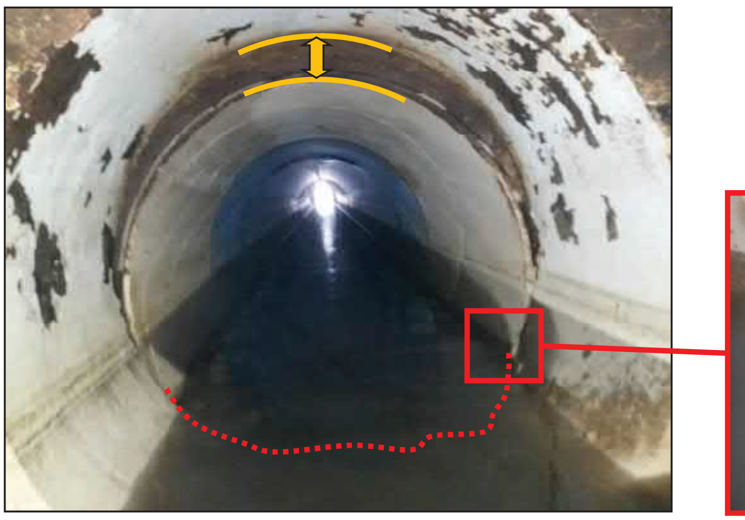
The pedestal is moving to the left because the cover is moving upward when closing the sluice gate

Operating stem and guides view from underneath

Recommendations: The pedestal must be anchored onto a fix and structurally sound surface. It could be possible to have a stainless steel bracket bolted on the thickness of the concrete slab in order to bolt on the 2 anchors that are actually on the "mobile" concrete cover. Another possibility is to extend the structural concrete slab underneath the entire pedestal. This will require a structural engineer to determine the best solution to solve this situation. We also recommend to have the operating stem straightness verify to make sure there is no permanent bent since it will affect the sluice gate operation. When all modifications and installation is completed the actuator switches will need to be readjusted as well as the closing wedges to make sure the gate is reaching it full close position and the actuator will stop before forcing/damaging any components.

3- SLUICE GATE WALL TIMBLE BROKEN

Situation: This ARMCO sluice gate is bolted directly against a "wall timble". A wall timble is a heavy-duty frame embedded in the concrete wall with the female thread bolt pattern that is matching with the sluice gate. The gate itself has a square opening but the outfall pipe is round. The downstream side of the wall timble is design to match with the outfall pipe diameter. However, we noticed that the junction of the wall timble and the outfall pipe is broken at the bottom section. We suspect that the outfall pipe has moved downward but since the wall timble was strongly poured in the concrete wall it could not follow so it has broken at the bottom section. Also, we can see that the soil is coming out from erosion at the broken junction thus it may create supporting issues in the future. *Refer to pictures below.*



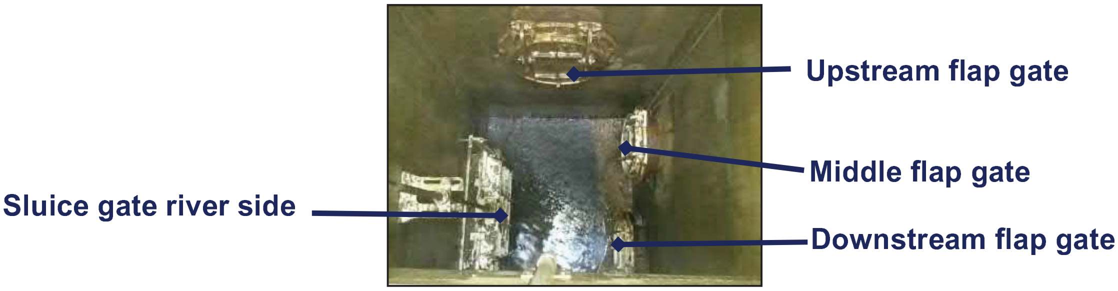
View inside the outfall pipe

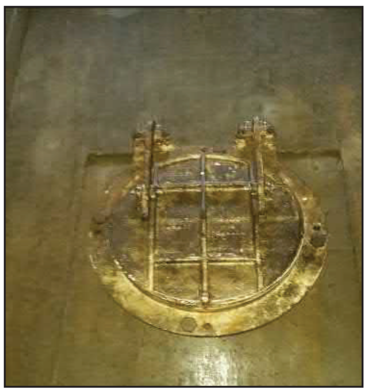
Wall timble broken section

Recommendations: We recommend to have an engineer to investigate deeper into this situation in order to avoid further issues.

4- OUTFALL CHAMBER FLAP GATES No.1, No.2 & No.3

<u>Situation:</u> Since we were inside the outfall chamber, we took a quick look at the 3 ARMCO flap gates installed inside it. Those are all in good working condition without damages on the disc, hinges nor the frames. However, the anchor bolts are in steel and slightly corroded. Also, one anchor is loose on the middle flap gate that will need to be repaired or replaced. *Refer to pictures below.*





Upstream side of river

Middle flap gate

Downstream

<u>CONCLUSION</u>

During this site visit we were able to safely and properly complete our scope of work by inspecting the "outfall" ARMCO sluice gate and the two leaking FONTAINE flap gates as described in this report. We had a very good collaboration and support from all people involved at the jobsite.

Do not hesitate to contact us for further information or if precisions are needed concerning this Buffalo Region water outfall project report.

Donald Côté,
Technical Service
VANEX INC.
Cell (819) 640-5490
donald@vanex.pro
www.vanex.pro

INSPECTION REPORT

OWNER:	RMWB	REPORT NO.:	2020-46
PROJECT:	Fort McMurray WTP Flushing	SHEET:	1 OF 3
LOCATION:	Fort McMurray, Alberta	PROJECT NO.:	2020-3783
REPORT TO:	Jeff DaSilva, RMWB	FILE NO.:	2020-3783-00
CONTRACTOR:	Vanex / Clean Harbours	DATE:	July 06 - 07, 2020
WEATHER:	Varying Clouds (am) / Varying Clouds (pm)	TEMPERATURE:	High: +27 Low: +16

Labour Force: **Vanex**: 1 - Inspector
Bravo Target Safety: 2 - Safety Personnel
Clean Harbors: 3 - Hydrovac Personnel

Equipment on Site: **Vanex:** 1 - Crew Vehicle
Bravo Target Safety: 2 - Crew Vehicles
Clean Harbors: 1 – Hydrovac Truck, 1 - Crew Truck

Overview:

Vanex (Donald Cote) was contracted to be on site with Associated Engineering (Troy McKinnon / Alyssa Fortin-Paossi) Monday, July 6 and Tuesday, July 7th at FMWTP for condition assessments of the existing Flap Gates to Clearwell 1 (in manhole MH09-03) and Clearwell 2 (in manhole MH09-04) as well as the existing Sluice Gate in the Outfall Chamber. Associated Engineering was also to conduct a preliminary condition assessment of the valves and piping in Valve Chamber 2.

Preliminary Summary/Schedule of Work to be Completed:

July 6:
* Inspection of Clearwell 1 Flap Gate by Vanex and AE.
* Inspection of Clearwell 2 Flap Gate by Vanex and AE.
* Bravo Target Safety on site to provide confined space entry and rescue services.
* Clean Harbors on site to dewater outfall chamber.

July 7:
* Inspection of Outfall Chamber by Vanex and AE.
* Inspection of Valve Chamber 2 by AE.
* Bravo Target Safety. to provide confined space entry and rescue services.
* Clean Harbors back on site if required for further dewatering.

Progress Report:
July 6:
Work planning meeting held from 8:30am - 9:30am with AE, RMWB, Vanex, Bravo Target Safety and Clean Harbors to discuss logistics and plan work procedures for the day.

Clearwell 1 Flap Gate:
Inspection of 600mm Clearwell 1 Flap Gate (manufactured by Lafontaine) was completed by Vanex and AE at interior of manhole MH09-03, with the bottom of the flap gate 500mm up from the bottom on the manhole. No major defects were noted in the installation. However, minor (1-2mm) gapping was noted at the bottom half of the flap gate, allowing for the small possibility of water seeping past should it rise slowly in the structure and not put enough pressure on the flap gate to completely seal it closed. It was recommended by Vanex that the gasket be replaced. Also, some frame bolts were missing washers at the bottom, these should be replaced and all bolts retorqued.

(If necessary, continue report on another sheet.)

ASSOCIATED ENGINEERING REPRESENTATIVE: Troy McKinnon

Approximately 200mm of standing water was noted at the bottom of the manhole at the time of inspection. This is level with the invert of the 1200mm concrete pipe out of the structure.

An assessment at the interior of the manhole was conducted by AE with the structure found to be in good overall condition with no issues noted.

Clearwell 2 Flap Gate:
Inspection of 1050mm Clearwell 2 Flap Gate (manufactured by Lafontaine) was completed by Vanex and AE at interior of manhole MH09-04, with the bottom of the flap gate 2000mm up from the bottom on the manhole. It was noted immediately that grout was missing from around the levelling bolts around the backside of the frame where it is mounted to the concrete wall around the steel pipe. Without this grout in place, water was able to leak in around these bolts in the approx. 25mm space between the back of the frame and the wall. This is a deficiency in the installation that was not noted. Also, a minor adjustment on the flap gate to slightly move it to a more centered position in the frame opening was also recommended and able to be completed by Vanex.

An assessment at the interior of the manhole was conducted by AE with the structure found to be in good overall condition with no issues noted.

Outfall Chamber:
Clean Harbors worked throughout the day to complete dewatering of the Outfall Chamber.

At end of day, Vanex entered the Outfall Chamber to conduct a preliminary inspection of the sluice gate. It was noted that even with the Rotork Actuator showing that the gate was fully closed, these was still an approx. 65mm gap at the bottom. This would have allowed rising river water to bypass this sluice gate and enter the overflow piping. It was then attempted to manually close the sluice gate further, but in doing so it was noted that the stem down to the sluice gate from the Rotork Actuator began to lean sideways to the north as more pressure was used in attempting to close the gate. RMWB WTP (Paul Sinclair) on site to discuss and it was concluded that the two bolts to the left (north) side of the mounting plate were securely anchored through 600mm thick concrete and could take the strain, the two to the right (south) were only through the corner of the 150mm thick concrete hatch that was cracking/lifting as more pressure was applied. Further discussion to be held next day with AE Structural Engineer on site.

July 7:
Work planning meeting held from 8:30am - 9:15am with AE, RMWB, Vanex and Bravo Target Safety to discuss logistics and plan work procedures for the day.

Clearwell 1 Flap Gate:

No work completed here today as all was completed last day.

Clearwell 2 Flap Gate:

Today, Vanex re-entered the structure to complete work on minor adjustments to the flap gate to slightly move it to a more centered position in the frame opening. The existing seal was lifted from the edges of the frame to allow it to better expand to a less compressed state. The bolts at to top of the flap gate were also backed off slightly to allow it to stick out more at the top and make a good seal all the way around the opening.

All that remains to be completed in the grouting around the around the levelling bolts around the backside of the frame where it is mounted to the concrete wall around the steel pipe that was noted during entry last day.

Outfall Chamber:

Clean Harbors worked throughout the day last day to complete dewatering of the Outfall Chamber.

Today, Vanex re-entered the Chamber to conduct a further inspection of the sluice gate as well as the flap gates into the chamber from the existing storm lines. Last day, it was noted that even with the Rotork Actuator showing that the gate was fully closed, these was still an approx. 65mm gap at the bottom. This would have allowed rising river water to bypass this sluice gate and enter the overflow piping. It was then attempted to manually close the sluice gate further, but in doing so it was noted that the stem down to the sluice gate from the Rotork Actuator began to lean sideways to the north as more pressure was used in attempting to close the gate. The existing flap gate were all deemed to be in good working condition.

AE Structural Inspector on site and entered the structure to complete a structural assessment of the interior of the structure and to discuss the issue noted last day regarding the anchoring of the Rotork Actuator. At the interior of the chamber, it was noted that the 1050mm outfall pipe had completed pulled apart approx. 600mm behind the Sluice Gate with granular material visible. At the exterior, she agreed with the observations made last day that the two bolts to the left (north) side of the mounting plate were securely anchored through 600mm thick concrete and could take the strain, the two to the right (south) were only through the corner of the 150mm thick concrete hatch that was cracking/lifting as more pressure was applied.

A separate report to be completed containing any comments/observations from the interior of the chamber as well as recommendation/options to be provided for either using structural steel to reinforce to area under these two bolts to the south, or to remove the 150mm thick concrete hatch and replace this area with 600mm thick reinforced concrete to match the north side.

<u>Valve Chamber 2:</u>

AE Inspector on site in the afternoon and entered both the north and then the south hatches to conduct a condition assessment at the interiors.

The north side of the chamber has an approx. height of 6.0m in the main areas with approx.1.0m of ground cover over top. The area above the ceiling slab had been previously excavated and has yet to be backfilled, causing water to collect in this depressed area. The area of the hatch / ladder extends the full height to top of grade for an approx. height of 7.0m. At the time of the assessment there was approx. 500mm of water noted covering the floor. This hindered access to and examination of some areas. Structurally, the interior concrete appeared to be in generally good condition with no significant areas of concern noted. The wall penetrations observed also were in generally good condition with no strong indications of groundwater infiltration. It should be noted that pipe penetrations at the lower elevations, either partially of fully submerged in water could not be accurately assessed for leakage at those penetrations. The steel piping and valves observed were generally in fair to good condition with areas of surface corrosion / epoxy coating failure of varying degrees noted throughout the space. There was also a sludge still adhered to the pipes at approx. the lower 3.0m of the space which would seem to indicate that the water level inside had previously been much higher than observed today. Tube and clamp scaffolding was also noted to still be erected in multiple areas which may have been for recent maintenance work.

The south side of the chamber has an approx. overall height of 11.0m with approx. 4.0m extending above grade and covered by structure with a gravel ballast roof with the access hatch / ladder at the top. Approx. 8.0m down there in an access landing at the bottom of the ladder where the inspection was conducted from as there was also approx. 500mm of water noted to be covering the floor at this side as well. The observations here were very much as was noted at the north side. Structurally, the interior concrete here also appeared to be in generally good condition with no significant areas of concern noted. The wall penetrations observed were also in generally good condition with no strong indications of groundwater infiltration. Again, the steel piping and valves observed were generally in fair to good condition with areas of surface corrosion / epoxy coating failure of varying degrees noted throughout the space. There was also a sludge still adhered to the pipes passing through the wall at the bottom of the space which would seem to indicate that the water level inside had previously been much higher than observed today.

ASSOCIATED ENGINEERING REPRESENTATIVE: Troy McKinnon

INSPECTION/SITE MEETING REPORT

Owner:	Regional Municipality of Wood Buffalo	**Project No.:**	2020-3783	**Report No.:**	1
Project:	Fort McMurray WTP Flushing	**File No.:**	2020-3783-00	**Page:**	1 of 7
Component:	Structural	**Date:**	July 7, 2020		
Location:	Water Treatment Plant	**Issue Copies To:**	N/A		
AE Representative:	Alyssa Fortin-Paossi, E.I.T.	**Project Manager:**	Steve Justus, P.Eng.		
Others Present:	Troy McKinnon, AE Donald Cote, Vanex	**Owner Contact:**	Paul Sinclair		

A visual structural inspection of the Outfall Chamber at the Water Treatment Plant was completed on July 7, 2020 by Alyssa Fortin-Paossi, E.I.T. The following photo report includes images of the defects and issues identified.

1. Looking at new outfall chamber gate

2. Looking at former concrete outfall chamber gate

3. Deteriorated joint caulking around former concrete gate opening. Install new caulking.

4. Bolted plate bearing 110 mm on former gate opening with cracking shown

5. Bolted plate not touching concrete by 10 mm

6. Cracking shown on former concrete gate opening.

7. Looking at inside of outfall chamber walls from top platform. Concrete wall in generally good condition.

8. Pipe opening of overflow line in Outfall Chamber to WTP. No immediate concern.

9. Section of outlet pipe to river disconnected, 3 ft from opening.

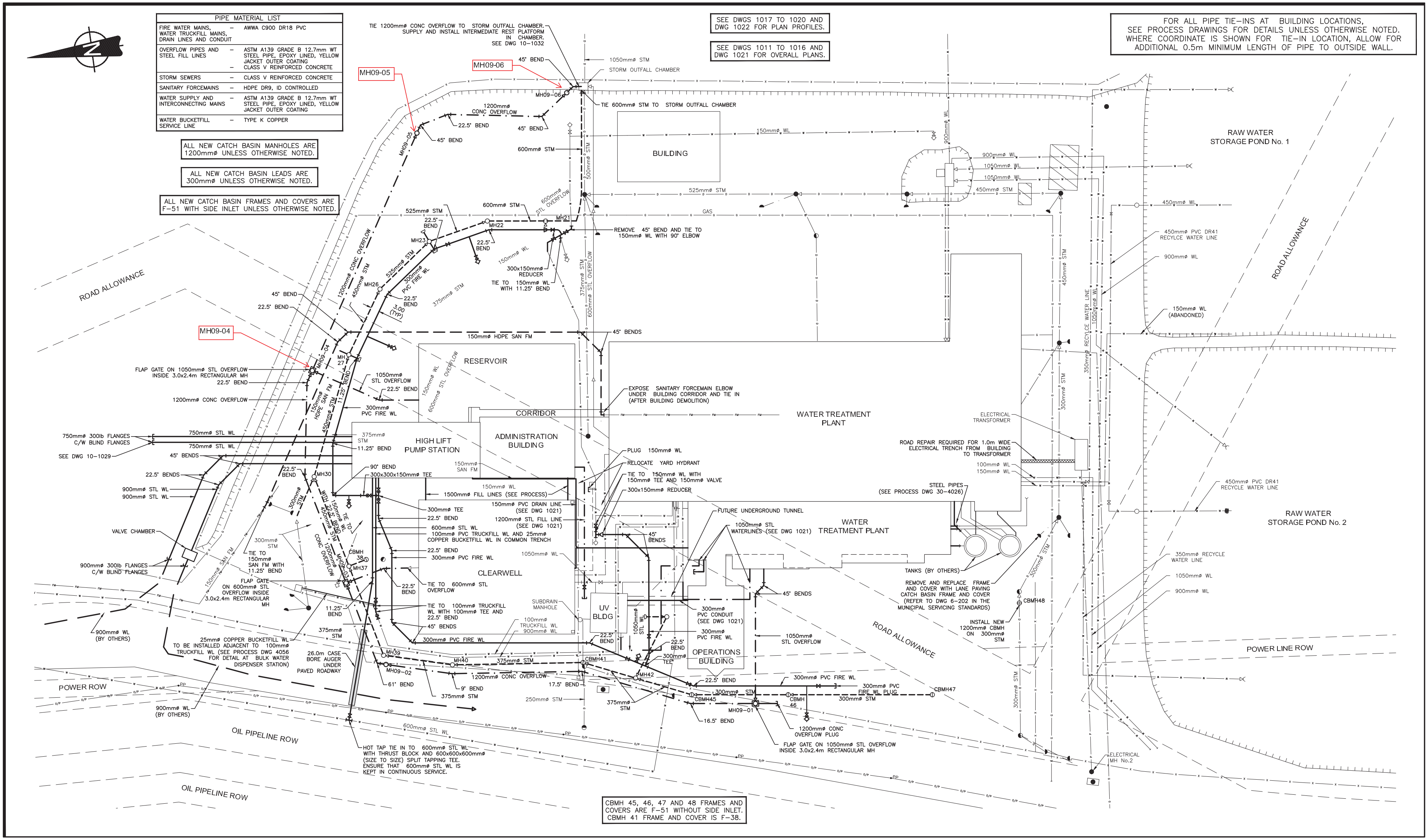
10. Damaged bottom of pipe with exposed backfill

11. Hairline cracking from pipe penetration. No immediate concern.

12. Looking at pipe penetration with surface corrosion on pipe.

Written By: Alyssa Fortin-Paossi, E.I.T.
Reviewed By: Kevin Danyluk, P.Eng.

APPENDIX B – SITE LAYOUT



NO.	DATE	ENG.	BY	SUBJECT
2	14/12/15	D.S.	J.C.	RECORD DRAWING
1	10/07/23	D.S.	J.C.	ISSUED FOR CONSTRUCTION
0B	10/05/19	D.S.	J.C.	ISSUED FOR ADDENDUM No. 8
0A	10/05/05	D.S.	J.C.	ISSUED FOR ADDENDUM No. 6
0	10/03/11	D.S.	J.C.	ISSUED FOR TENDER

REVISIONS

VERIFY SCALES
BAR IS 20mm ON ORIGINAL DRAWING
0 — 20mm
IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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SCALE	1 : 600	
DRAWN	J. CALIGIURI	
DESIGNED	D. SIGVALDASON	
CHECKED	G. STERPARN	
APPROVED	E. ASSELIN	
DATE	2009-10	INITIAL

Regional Municipality of Wood Buffalo

FORT MCMURRAY
WATER TREATMENT PLANT UPGRADE

CIVIL SITE WORKS
OVERALL PLAN
UTILITIES

DRAWING NUMBER	REV. NO.	SHEET
10-1010	2	10 / 31

APPENDIX B - FORT MCMURRAY WATER TREATMENT PLANT FLOOD RECOVERY - SHORT TERM FLOOD MITIGATION RECOMMENDATIONS

Associated Engineering
GLOBAL PERSPECTIVE. LOCAL FOCUS.

REPORT

Regional Municipality of Wood Buffalo
Fort McMurray Water Treatment Plant Flood Recovery

Short Term Flood Mitigation Recommendations

NOVEMBER 2020

EXECUTIVE SUMMARY

1 BACKGROUND

The Fort McMurray Water Treatment Plant (WTP) is owned and operated by the Regional Municipality of Wood Buffalo (RMWB). In April 2020, high water levels in the Athabasca River caused river water to flow back through the storm outfall chamber and overflow piping at the WTP, resulting in contamination of the clearwells. A post-flood inspection of the points of failure was completed and the outcome of the inspection provided in the Post-Flood Failure Inspection Report (Associated Engineering, 2020). Proposed mitigations strategies were developed as part of the post-flood recovery works and will be discussed in this report, with recommendations on immediate steps forward to provide the WTP with improved flood protection. These strategies include:

- Repair of the sluice gate pedestal at the outfall chamber so that it can be fully sealed and provide isolation from the river.
- Confirmation that there are no existing cross connections between the clearwell overflow piping and the storm sewer through camera inspection of the overflow piping.
- Review of the options and development of a solution to install a temporary plug for the overflow piping to the river.

2 FLOOD MITIGATION STRATEGIES

2.1.1 Sluice Gate Repair and Further Recommendations

AE provided a design drawing to adequately support the sluice gate pedestal to allow the gate to close. This work was completed, and the gate was confirmed to seal in its closed position. Associated also noted that sedimentation was present at the bottom of the sluice gate at the time of testing. This will prevent a proper seal and was noted to the RMWB personnel present at the time.

2.1.2 Overflow Pipe Inspection

Tristar completed a site-wide camera inspection of the overflow piping on October 13, 2020. In general, the pipe is in good condition overall, however further cleaning is required to remove sticks and debris that are present as noted in the report that follows. No cross connections between the storm and overflow piping were observed.

2.1.3 Temporary Plug Options

A review of two inflatable plug options for flood protection of the overflow piping was completed as requested. The Lansas Multi-size Domehead plug and Oatey Cherne I-Series plug both are used for plugging storm sewer lines temporarily and were evaluated based on technical requirements, cost, and delivery. The Oatey Cherne plug was able to meet the required pressure requirements, is lighter weight, smaller when deflated, was quoted at a lower cost and faster delivery time than the Lansas plug.

The possibility of installing a Tideflex check valve in the overflow piping was also considered. The Tideflex valve can meet the pressure requirements and would be a permanent installation in the concrete overflow pipe. It would be a higher cost than the inflatable plugs requiring pipe modifications and civil work to install. Given this, along with a longer delivery time, it would not be an immediate solution.

Based on the information presented above, the inflatable plugs are the most cost-efficient option for the short term. The Tideflex check valve should be further investigated with the long-term options being considered.

3 CONCLUSION AND RECOMMENDATION

In conclusion,

- The outfall sluice gate has been repaired and is functional.
- The overflow pipe is in good condition, although more cleaning is recommended. Based on the camera inspections of the overflow pipe, no cross connections with the storm system or other piping were observed.
- The supply of three temporary plugs will cost $20,995 and will provide an additional level of protection for the WTP.
- The RMWB should continue to investigate the long-term solution for the Storm Outfall Chamber.

AE recommends the following steps for the short-term flood mitigation measures:

1. Clean the build up of debris at the bottom of the outfall sluice gate seat and alignment pins and fully stroke the valve to ensure proper seating as part of flood preparation.
2. Remove remaining debris from overflow pipe by flushing the line and manually removing debris as required.
3. Protect overflow pipe from nuisance animals by installing a trash grate.
4. Provide temporary additional flood mitigation by purchasing and installing two inflatable plugs on the overflow pipe and one on the pipe from Valve Chamber #2 to the river.
5. Operate the clearwells at 85% to allow for extra room for error an overflowing occurrence while plugs are installed.

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1 BACKGROUND

The Fort McMurray Water Treatment Plant (WTP) is owned and operated by the Regional Municipality of Wood Buffalo (RMWB). It services the Fort McMurray area and surrounding communities of Anzac, Draper, Gregoire Lake Estates and Saprae Creek Estates. In April 2020, high water levels in the Athabasca River caused river water to flow back through the storm outfall chamber and overflow piping at the WTP, resulting in contamination of the clearwells.

The Municipality engaged Associated Engineering (AE) to provide engineering services to support them in developing temporary flood mitigation strategies at the Water Treatment Plant. In July 2020, Associated Engineering carried out inspections of the points of failure at the WTP and prepared the flood failures inspection report. From this report and discussions with the Municipality, the proposed mitigation strategies were developed and include:

- Repair the sluice gate pedestal at the outfall chamber so that it can be fully sealed and provide isolation from the river.
- Confirm there are no existing cross connections between the clearwell overflow piping and the storm sewer.
- Review options and develop a solution to install a temporary plug for the overflow piping that travels from the WTP, through the Storm Outfall Chamber to the river and Valve Chamber 2's pipe to the river.

This report summarizes findings from the three items above and provides recommendations for next steps.

2 STORM OUTFALL CHAMBER IMPROVEMENTS

2.1 Sluice Gate Pedestal Bracket

AE provided a design drawing to the RMWB to adequately support the sluice gate pedestal (**Attachment 1 Appendix A**). This has been installed by Chandos and the sluice gate was adjusted and confirmed to be sealing correctly by Vanex. The final report provided by Vanex is included as an attachment to this report. (**Attachment 2 Appendix A**).

2.1.1 Sluice Gate Maintenance

During the inspection of the sluice gate after the pedestal was rehabilitated, an accumulation of sediment was found at the bottom of the storm outfall chamber. The bottom of the gate sits close to the bottom of the chamber. Furthermore, there is no sump within the storm outfall chamber, so accumulation builds up on the wall face where the gate is installed and can impede sealing the gate fully. Sand/gravel was noted in the depression for the alignment pins at the bottom of the sluice gate and had to be cleaned out in order to close the gate fully. For this reason, AE recommends that prior to closing the sluice gate in preparation of flood season, the RMWB clean out the bottom of the chamber to confirm the sluice gate is closed fully.

3 CAMERA INSPECTION OF OVERFLOW PIPE

The findings from the camera inspection of the overflow pipe are summarized in **Table 3-1.** On October 13, 2020, Tristar was onsite to complete the camera inspection of the overflow pipe. **Figure 3-1** shows the sections that were inspected, as well as the areas that could not be accessed by the camera crawler due to debris buildup. On May 9, 2020, during the flood recovery work, Image Pipelines completed a camera inspection of the overflow piping from MH09-03 to MH09-06. In order to fill the gaps missed on October 13, 2020, AE reviewed the photos and videos from the May 9, 2020 and have included this information in **Table 3-1**. Reports and videos for the CCTV inspections have been passed over to the RMWB for their records.

Table 3-1
Overflow Pipe Summary

Start	End	Condition/Cross Connections	Observations	Missed Section on Oct 13, 2020
MH09-01	WTP Connection	Good/None	• Approx. 15% pipe filled with water, 20 m from MH09-01. • Abandoned at 45° bends, 36 m from MH09-01.	Approx. 12 m
MH09-01	Plug South of MH	Good/None	• None	None

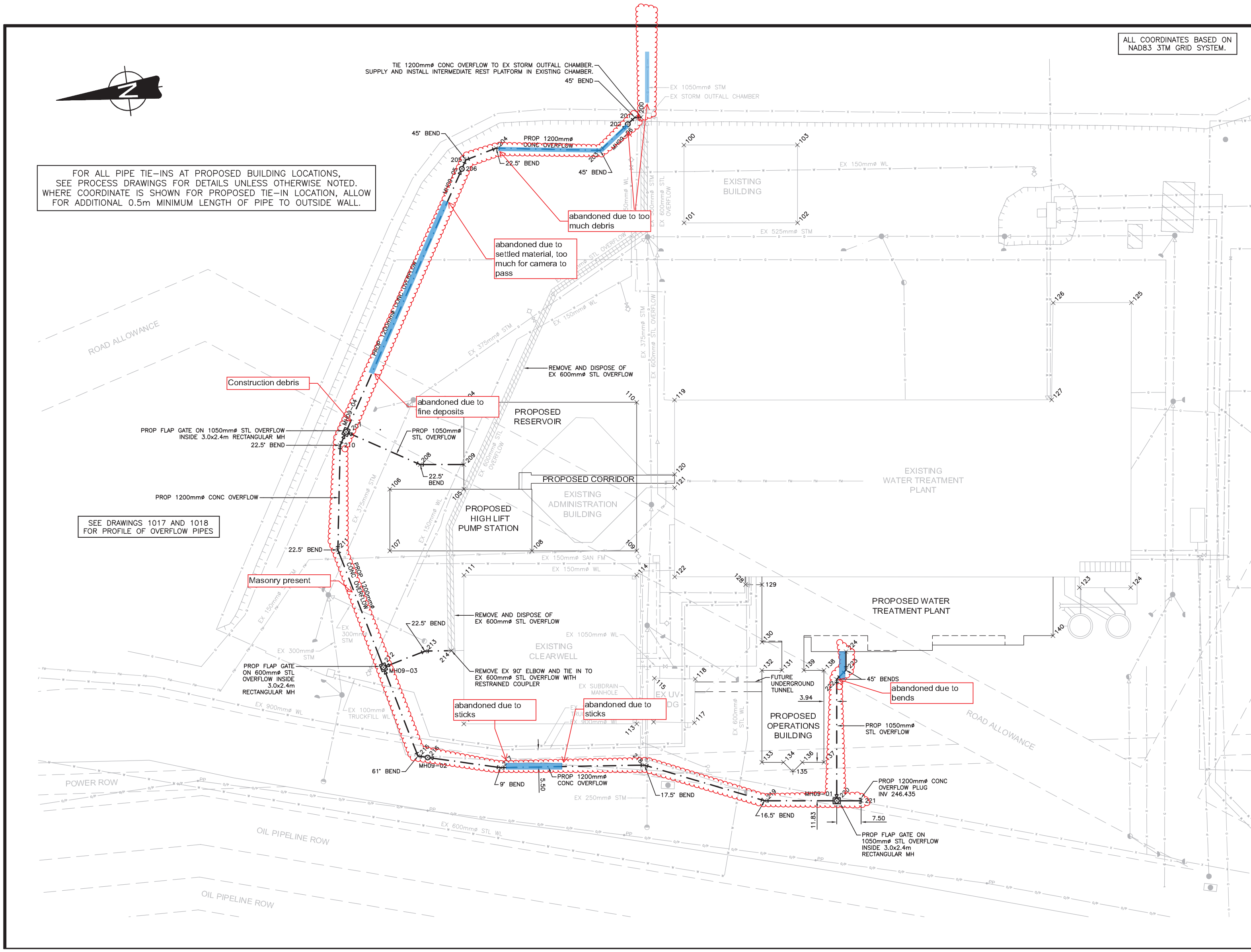
MH09-01	MH09-02	Fair: Surface reinforcement visible at 18.75m from MH09-02 to MH09-01	• Sticks discovered 46 m & 87 m from MH09-01.
			  • Abandoned at 87 m as camera could not pass.
			• Moved camera to MH09-02 & travelled back towards MH09-01.
			• Sticks found at 11 m & 27 m.
			  • Abandoned at 27 m as camera could not pass.
				Approx. 11 m

MH09-02	MH09-03	Good/None	• Small amount of water present.	None
MH09-03	MH09-04	Good/None	• Piece of wood found 22 m from MH09-03	None

MH09-04	MH09-05	Unknown from Oct. 13 inspection.
		Good condition & no cross connections from May 9 inspection.
			• Debris at 0.2 m from MH09-04.
			• Settled gravel & fines found at 11 m & 19 m from MH09-04, respectively.
			  • Abandoned at 19 m as camera could not pass.
			• Moved camera to MH09-05 & travelled back towards MH09-04.
			• Settled fines found at 11 m.
			  • Abandoned at 11 m as camera could not pass.
				Approx. 60 m

MH09-05	MH09-06	Unknown from Oct. 13 inspection.
		Good condition & no cross connections from May 9 inspection.
			• Settled fines found at 11 m.
			  • Abandoned as camera could not pass.
			• Moved camera to MH09-06 & travelled back.
			  • Settled fines found immediately and survey abandoned.
				Approx. 45 m

MH09-06	Outfall Structure	Good/None	• Small amount of water present	None
Outfall Structure	River	Unknown from Oct. 13 and May 9 inspection. From the outfall chamber, the storm outfall pipes connection is compromised.	• Debris found at 0.4 m from outfall structure. • Abandoned as camera could not pass.	Entire steel pipe section from chamber to river



ALL COORDINATES BASED ON NAD83 3TM GRID SYSTEM.

Building Corner Coordinate Point Table

Point #	Northing	Easting
100	6288929.3445	−24736.9105
101	6288932.4430	−24760.7096
102	6288897.7359	−24765.2282
103	6288894.6374	−24741.4291
104	6289006.9201	−24806.7073
105	6289010.4085	−24833.2793
106	6289033.0344	−24830.3090
107	6289035.5075	−24849.1473
108	6288992.0801	−24854.8485
109	6288960.0351	−24859.0554
110	6288954.0736	−24813.6451
111	6289013.8579	−24859.5539
112	6289019.8191	−24904.9615
113	6288966.9729	−24911.9020
114	6288961.0113	−24866.4916
115	6288959.7247	−24898.6637
116	6288961.7331	−24912.0145
117	6288949.3005	−24913.8967
118	6288947.2921	−24900.5460
119	6288942.4429	−24814.4764
120	6288945.3875	−24837.1701

Building Corner Coordinate Point Table

Point #	Northing	Easting
121	6288945.9212	−24841.2356
122	6288949.5006	−24868.5002
123	6288826.2149	−24888.0165
124	6288810.4853	−24890.0748
125	6288798.8842	−24803.0016
126	6288822.8052	−24799.9113
127	6288827.1442	−24829.5064
128	6288928.1563	−24873.7229
129	6288923.1022	−24874.3864
130	6288925.4074	−24891.9457
131	6288920.4451	−24901.3718
132	6288926.5735	−24900.5672
133	6288930.2652	−24928.6880
134	6288923.6468	−24929.5568
135	6288921.1543	−24932.8026
136	6288917.9085	−24930.3102
137	6288911.2900	−24931.1790
138	6288907.5983	−24903.0583
139	6288913.7267	−24902.2538
140	6288836.1705	−24901.6436

Overflow Coordinate Point Table

Point #	Northing	Easting
200	6288941.3167	−24726.7178
201	6288943.2459	−24726.5036
202	6288945.6649	−24728.2780
203	6288955.1273	−24735.2189
204	6288986.8817	−24730.3376
205	6288996.6142	−24732.7211
206	6288998.1701	−24735.2862
207	6289044.1214	−24811.0439
208	6289022.7878	−24823.9839
209	6289009.4186	−24825.7390
210	6289046.4551	−24814.8915
211	6289051.3566	−24846.7768
212	6289042.1276	−24884.4613

Overflow Coordinate Point Table

Point #	Northing	Easting
213	6289028.7848	−24881.1937
214	6289020.6669	−24882.1122
215	6289035.1380	−24913.0024
216	6289032.2458	−24913.7994
217	6289010.3396	−24919.8360
218	6288966.2496	−24924.8249
219	6288930.9341	−24940.5330
220	6288908.9205	−24943.4204
221	6288901.4842	−24944.3957
222	6288904.0534	−24906.3148
223	6288900.8484	−24903.8537
224	6288900.1117	−24898.2418

NO.	DATE	ENG.	BY	SUBJECT
1	10/07/23	D.S.	J.C.	ISSUED FOR CONSTRUCTION
0	10/03/11	D.S.	J.C.	ISSUED FOR TENDER

REVISIONS

VERIFY SCALES
BAR IS 20mm ON ORIGINAL DRAWING
0 20mm
IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROFESSIONAL ENGINEER ALBERTA
STAMPED AND SIGNED
By: D. SIGVALDASON
Date: 10/07/23
Revision: 1

APEGGA Permit to Practice
Permit Number: P 3979

Associated Engineering

PROJECT No.	2007–3411	
SCALE	1 : 600	
DRAWN	J. CALIGIURI	
DESIGNED	D. SIGVALDASON	
CHECKED	G. STERPARN	
APPROVED	E. ASSELIN	
DATE	2009–10	INITIAL

Regional Municipality of Wood Buffalo

FORT MCMURRAY
WATER TREATMENT PLANT UPGRADE

CIVIL SITE WORKS
UTILITIES
OVERFLOW

DRAWING NUMBER	REV. NO.	SHEET
10-1011	1	11 / 29

Generally, the overflow pipe is in good condition. It does not appear to have any cross connections with the storm system or any other pipe. Below are two photos comparing the pipe section from MH09-04 to MH09-05:

Figure 3-2
Photo Comparison MH09-04 to MH09-05

It appears that in both cases, there was water and debris buildup in the pipe. The inspection shows that further cleaning of the pipe is required to remove the remaining debris. This will require jet cleaning, followed by manual removal of the debris at the end of the line through entering the pipe and shovelling out the debris.

It is also recommended that the RMWB install a trash grate on the end of the outfall pipe to prevent nuisance animals from entering. After discussions with the RMWB, this was completed around the beginning of October. An additional grate could be placed on the 1200 mm overflow pipe where it enters the storm outfall chamber for further protection.

4 ISOLATION OPTIONS

AE reviewed short-term solutions for providing additional temporary flood protection to the WTP via the concrete overflow and Valve Chamber #2 to the river. The options reviewed include: (1) Inflatable plugs and (2) Duckbill check valves.

4.1 Hydraulic Pressure Requirements

The hydraulic pressure requirements were determined based on flood river levels and pipe elevation. This information is provided below and was used to confirm whether the isolation options could meet the required hydraulic pressure.

1. 1200 mm concrete overflow pipe = 250.50 m – 244.37 m = 6.13 m of TDH = **8.70 PSI**
2. 900 mm steel pipe at Valve Chamber #2 to the river = 250.50 m – 243.75 m = 6.75 m of TDH = **9.63 PSI**

4.2 Inflatable Plug Options

Two plugs were reviewed for the inflatable plug option and relevant technical data is captured in the table below. A practical comparison of each follows.

Table 4-1
Inflatable Plug Comparison

Location	Manufacturer	Pipe Size & Material for Plug Location	Min/Max Pipe Diameter (in)	Required Inflation Pressure (psi)	Maximum Back/Test Pressure (psi)	Product Dimensions		
						Deflated Length (in)	Deflated Diameter (in)	Weight (lbs)
Valve Chamber 2	Lansas Multi-size Domehead	900mm (36") steel pipe	22.00" – 48.25"	15	8	84.0"	21.5"	107
Valve Chamber 2	Oatey Cherne I-Series	900mm (36") steel pipe	19.00" – 40.00"	22	10.2	46.25"	18.5"	66
Overflow Pipe	Lansas Multi-size Domehead	1200mm (48") concrete pipe	34.50" – 60.25"	10	6	84.0"	29.5"	192
Overflow Pipe	Oatey Cherne I-Series	1200mm (48") concrete pipe	20.50" – 50.00"	22	10.1	68.0"	19.1"	125

As shown in Table 4-1, the Lansas Multi-Side Domehead plugs cannot meet the required backpressure of 8.7 psi and 9.6 psi. The supplier notes that although the maximum back pressure for the plugs is 8 psi and 6 psi respectively, additional reinforcement can increase the backpressure rating to upwards of 75 psi of head pressure. This can be accomplished by attaching a 1.4" steel cable and securing it to a nearby structure. The Oatey Cherne I-Series plugs meet the pressure requirement without additional reinforcement. Furthermore, the deflated diameter of the Lansas plugs are larger, making it challenging to install into a standard manhole. Modifications to the manhole structure would be required to install it at the overflow piping. The deflated diameter of the Oatey Cherne I-Series are 470 mm (18.5") and 485 mm (19.1") which will fit through a standard 600 mm manhole cover.

Both plug options come equipped with an inflation kit that has a pressure gauge with a hose, so the plug pressure can be monitored at anytime without entering the manhole or pipe. Further installation details can be provided by the supplier once the plugs are purchased. To provide double isolation of the overflow piping, one plug can be provided upstream of MH09-05 and another upstream of MH09-06, as shown in the drawing (**Attachment 3**, **Appendix A**). Technical datasheets are also provided for reference (**Attachment 4 & 5**, **Appendix A**).

Should the RMWB proceed with the inflatable plug, there is risk that the clearwells could overflow and backup in the pipe without being able to overflow to the river. In order to reduce the risk of this occurring, AE recommends the RMWB keep the clearwell levels to a maximum of 85% while the plugs are installed to provide more room for error during this time.

4.3 Check Valve Options

AE reviewed the possibility of adding in a duck bill check valve to the overflow piping and Valve Chamber 2, as an alternative to the inflatable plugs. The UltraFlex CheckMate Tideflex was recommended for this application and a technical data sheet is provided as **Attachment 6** in **Appendix. A** Tideflex valve is intended for use on overflow lines to prevent unwanted backflow when river levels rise. They are typically used in combined sewer systems to prevent wastewater from entering stormwater catchments. The Tideflex valve is a more permanent solution than the inflatable plugs, as once they are installed, they are designed to last. The UltraFlex CheckMate can handle up to 30 psi of backpressure. This would provide protection up to a river level of 265.5 m at the overflow piping and 264.9 m at Valve Chamber #2. They are also a low headloss valve and will open and flow with as little as 1" of head pressure. Once the head pressure reaches 50-75% of the pipe diameter, the bill will fully open into a concave shape, allowing flow to increase up to the maximum flow capacity of the valve.

Significant effort would be required to install such a valve, as the valves are bigger than the manhole access and cannot be disassembled for installation. A rectangular manhole structure would be required, or modifications to the top portion of MH09-06 to fit the valve into the pipe.

4.4 Cost Comparison and Recommendations

Costs for both plug options and check valve are summarized in **Table 4-2** below:

Table 4-2
Cost Comparison

Manufacturer	Size (mm)	Cost	Type	Notes
Lansas	900	$6,355	Plug	• Shipping from US is estimated at $2,000 for order. • Protective sleeves are a $3,000 add on. • Delivery is within 1-2 months.
Oatey Cherne	900	$3,802	Plug	• Rental rate is $1,080/month and would be discounted from purchase price if RMWB chooses to purchase. (Under 30 days, 100% of paid rent is discounted, within 90 – 120 days, 60% of paid rent is discounted). • Protective sleeves are a $1,925 add on. • Delivery is 5-10 business days.
Tideflex	900	$16,734 + ($25,000 manhole addition)	Check Valve	• Installation costs and manhole modifications not included. • Delivery is 12 – 14 weeks.
Lansas	1200	$10,980	Plug	• Same comments as above.
Oatey Cherne	1200	$5,569	Plug	• Same comments as above.
Tideflex	1200	$37,793 + ($25,000 manhole addition)	Check Valve	• Same comments as above.

Based on the information presented above, the inflatable plugs are the most cost-efficient option for the short term that will serve the purpose of providing additional isolation measures for the upcoming flood season. The plugs will provide a third and fourth point of isolation on the overflow piping now that the sluice gate and flap gates are functional.

Knowing the long-term plan for the storm outfall chamber will assist in determining how to proceed with further permanent isolation. If the long-term plan is to keep the overflow and storm outfall chamber combined, the Tideflex valve would provide the further isolation during flood events. Furthermore, it negates the concern for the possibility of a major flood event and major storm event happening at the same time and both systems being overrun. The check valves should be investigated further as part of the long-term solutions for the system.

Between the two plug options presented, AE recommends proceeding with purchasing and installing the Oatey Cherne plugs for the following reasons:

- Ability to meet pressure requirements without reinforcement;
- Lighter and smaller when deflated;
- Lower cost; and
- Faster delivery time.

The total supply cost for the plugs, if two are purchased for the overflow piping and one is purchased for Valve Chamber 2, is summarized below:

Table 4-3
Estimated Costs

Item	Part #	Description	Qty	Each	Total
1	314408	Cherne 20”-40” Pipe Plug	1	$3,802.00	$3,802.00
2	314488	Cherne 24”-48” Pipe Plug	2	$5,569.00	$11,138.00
3	301028	Protective Sleeve	3	$1,925.00	$5,775.00
		Shipping from Edmonton			280.00
				TOTAL	**$20,995.00**

The cost for installation of the plugs has not been included in **Table 4-2**. The assumption is this will be done by the RMWB. The quote for the supply of the plugs is included as **Attachment 7** in **Appendix A**.

5 CONCLUSION AND RECOMMENDATION

In conclusion,

- The outfall sluice gate has been repaired and is functional. It was proven to be fully closed after repairs were complete. Cleaning the bottom of the outfall chamber should be completed prior to isolating.
- The overflow pipe is in good condition, although more cleaning is recommended. Based on the camera inspections of the overflow pipe, no cross connections with the storm system or other piping were observed. A trash grate needs to be in place to prevent nuisance animals from entering and debris buildup.
- The three temporary plugs will cost $20,995 for supply and will provide an additional level of protection for the WTP.

AE recommends the following steps for the short-term flood mitigation measures:

1. As part of flood preparation in April, clean the build up of debris at the bottom of the outfall sluice gate seat and alignment pins and fully stroke the valve to ensure proper seating.
2. Remove remaining debris from overflow pipe. Tri-Star proposes sending a Sewer Flusher into the pipe and removing as much material as they can with their hydrovac, and then sending a crew into the manholes to remove the remaining debris. They have provided an estimated cost of $12,411.00 to complete this work (see Attachment 8 in the Appendix). This assumes three 10-hour days to clean the pipe and complete a post camera inspection. Tri-Star developed this estimate based their inspection of the current state of the pipe. If additional days are required, an hourly rate of $220.00 would apply, however they believe the pipe can be cleaned out in the three days quoted.
3. Protect overflow pipe from nuisance animals by installing a trash grate. Additional measures could be provided by installing a second trash grate at the storm outfall chamber on the 1200 overflow pipe as it enters the chamber.
4. Provide temporary additional flood mitigation by purchasing and installing two inflatable plugs on the overflow pipe; One upstream of MH09-06 and another upstream of MH09-05 and one plug for the pipe from Valve Chamber #2 to the river. Further review the long-term plan for the storm outfall chamber to look at installing a check valve in an existing or new manhole, or separating the storm and overflow chambers, as well as investigate condition of outfall pipe from the outfall chamber to the river.
5. Operate clearwells at 85% to allow for extra room for error to prevent overflowing while plugs are installed.

CLOSURE

This report was prepared for the Regional Municipality of Wood Buffalo Fort McMurray Water Treatment Plant Flood Recovery to assist the Municipality with developing short term flood mitigation strategies for the WTP and provide recommendations for immediate flood protection needs.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

PROFESSIONAL ENGINEER SARAH BRUCE ALBERTA
2020-11-09

PROFESSIONAL ENGINEER NELSON DOS SANTOS ALBERTA
2020-11-09

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Process Engineer

Nelson Dos Santos, P.Eng. ENV SP
Civil Engineer

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.

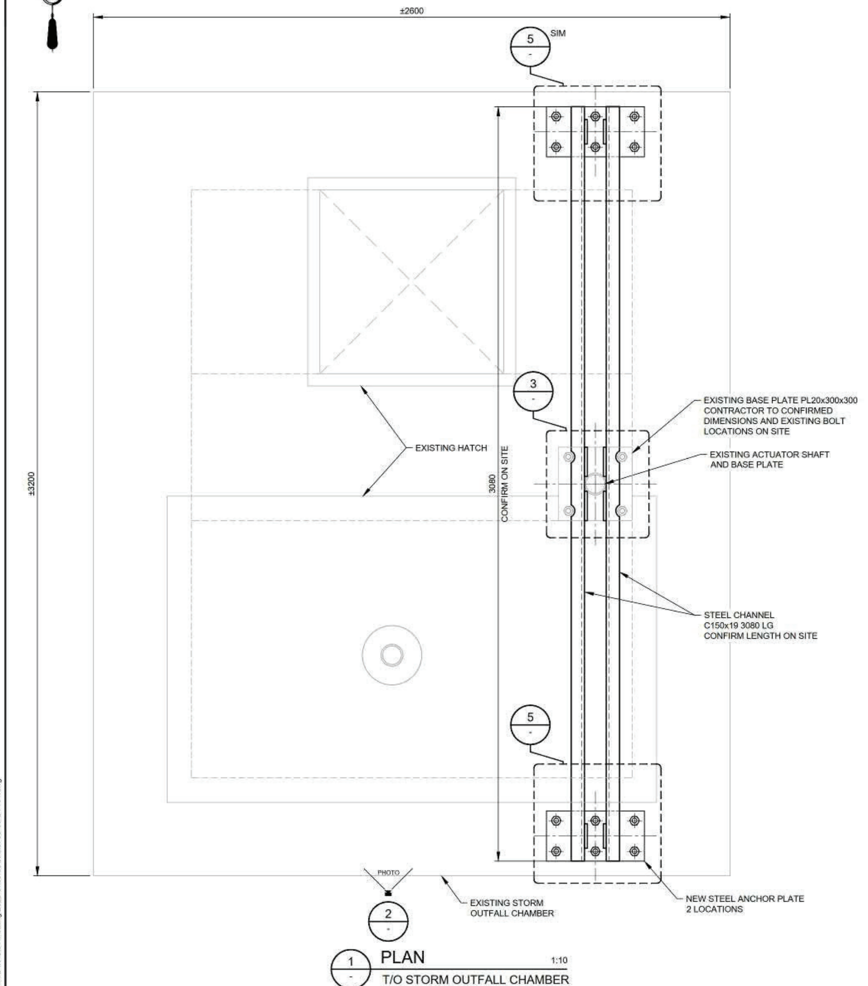
Signature ______________________
Jeff Fetter 2020-11-09

PERMIT NUMBER: P 03979
The Association of Professional Engineers and Geoscientists of Alberta

APPENDIX A - ADDITIONAL INFORMATION

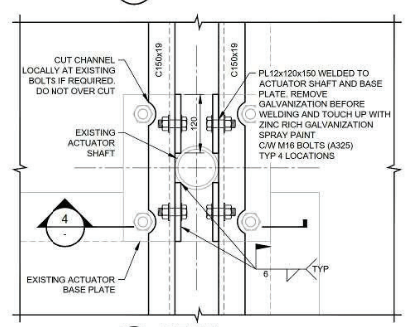
IF NOT 50 mm ADJUST SCALES 50 mm SCALE(S) SHOWN ARE INTENDED FOR ANSI D (22X34) SIZE DRAWINGS, TABLOID (11X17) SIZE DRAWINGS ARE 1/2 OF SCALE(S) SHOWN UNLESS NOTED OTHERWISE

Attachment 1

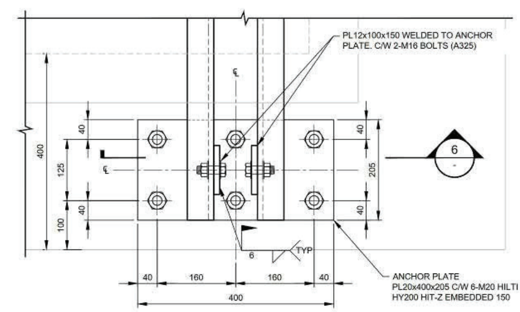


1 PLAN 1:10
T/O STORM OUTFALL CHAMBER

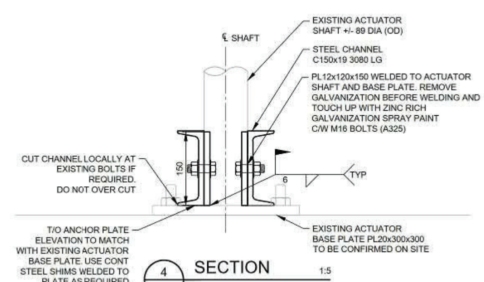
2 PHOTO N.T.S.



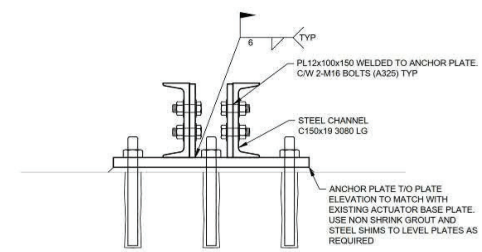
3 DETAIL 1:5
ACTUATOR BASE PLATE



5 DETAIL 1:5
ANCHOR PLATE



4 SECTION 1:5



6 SECTION 1:5

GENERAL NOTES

1. THE USE OF THIS DRAWING IS LIMITED TO THAT IDENTIFIED IN THE REVISION COLUMNS. DO NOT USE THIS DRAWING FOR CONSTRUCTION UNLESS THEY ARE MARKED "ISSUED FOR CONSTRUCTION".
2. THE CONTRACTOR SHALL REVIEW THE DRAWINGS AND REPORT ANY DISCREPANCIES BETWEEN STRUCTURAL DRAWINGS, OTHER DISCIPLINES, AND RECORD DRAWINGS FOR CLARIFICATION BEFORE PROCEEDING WITH WORK.
3. THE CONTRACTOR TO VERIFY ALL DIMENSIONS OF THE EXISTING STRUCTURE AND REPORT TO ENGINEER FOR ANY DISCREPANCIES PRIOR TO FABRICATION.

STRUCTURAL AND MISCELLANEOUS STEEL

1. DETAILING, FABRICATION, AND ERECTION SHALL CONFORM TO CSA S16.
2. PLATES AND ANGLES SHALL BE CSA G40.21 GRADE 300W
3. CHANNELS SHALL BE CSA G40.21 GRADE 350W.
4. WELDING SHALL CONFORM TO CSA W59.
5. FABRICATORS SHALL SUBMIT EVIDENCE OF CERTIFICATION TO CSA W47.1 DIVISION 1 OR 2.
6. ALL STEEL TO BE PAINTED WITH A ZINC RICH GALVANIZING PAINT AFTER FABRICATION.
7. ALL DAMAGED AREAS TO BE TOUCHED UP WITH A ZINC RICH GALVANIZING PAINT.

DESIGN LOADS

1. MAXIMUM VERTICAL THRUST FORCE 25 kN AT ACTUATOR SHAFT BASE PLATE.
2. SNOW LOAD
   i. GROUND SNOW LOAD Ss (1/50) 1.5 kPa
   ii. RAIN Sr (1/50) 0.1 kPa
   iii. IMPORTANCE FACTOR Is = 1.25 (ULS)

PLOT DATE: 9/17/2020 5:06:37 PM
SAVE DATE: 9/17/2020 5:00:09 PM SAVED BY: WYNNYKB
DWG PATH: \\s-ft-fs-01\working\2020-3783-00\stru\3783-00-s-7101.dwg

Associated Engineering

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2020-09-17

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.
Signature
Nelson Dos Santos 2020-09-17
PERMIT NUMBER: P 03979
The Association of Professional Engineers and Geoscientists of Alberta

REV	DATE	DESIGN	DRAWN	DESCRIPTION
0	2020SEP17	C. LUO	R. BERGANTINOS	ISSUED FOR CONSTRUCTION

REGIONAL MUNICIPALITY OF WOOD BUFFALO

WTP OVERFLOW CHAMBER REPAIRS

2020-3783

SCALE: AS SHOWN

REGIONAL MUNICIPALITY OF WOOD BUFFALO

STRUCTURAL
OVERFLOW CHAMBER
PLANS, SECTIONS, DETAILS, AND GENERAL NOTES

DRAWING	REVISION	SHEET
3783-00-S-101	0	1

CHANDOS

Attachment 2

VANEX
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Magog, Quebec - Canada J1X 5R9

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SITE REPORT

PROJECT: FORT MCMURRAY BUFFALO WOOD REGION **Date:** July 6th & 7th, 2020

CLIENT REFERENCE: Outfall gate and flap gates

Direct customer: ASSOCIATED ENGINEERING AB Ltd

Contact(s): Sarah Bruce (Process Engineer, ASSOCIATED ENGINEERING Ltd)

Site contact(s): Troy McKinnon (Technician, ASSOCIATED ENGINEERING Ltd)
Paul St-Claire (Maintenance Manager, BUFFALO REGION)

Visit main goal(s):

To perform the inspection of two leaking flap gates and the “Outfall” sluice gate.

DETAILS:

We arrived at the WTP at 8:30h am on July 5th 2020 as previously agreed. After the site meeting with all people involved, we have started with the 600mm diameter flap gate inspection located inside the manhole 09-03 at the North-East of the water plant. The 1050mm diameter flapgate was then inspected followed by the inspection of the OUTFALL gate on the second day.

The following report will provide details of those equipment inspection.

General view of Fort McMurray Drinking Water Facilities

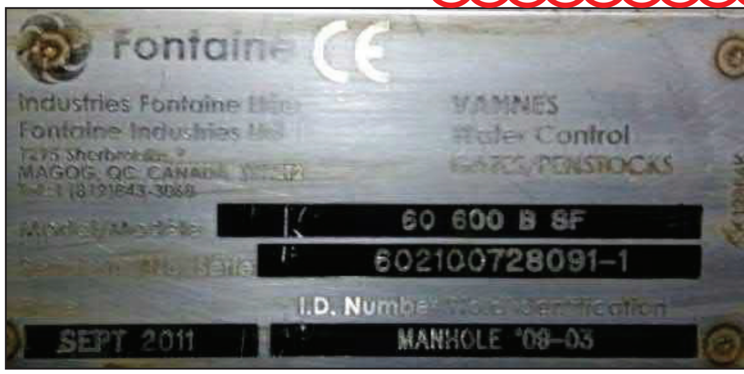
Support VANEX to repair flap gate. This is a confined space entry

All Repair Pictures at end of Document

EQUIPMENT IDENTIFICATION

Customer ID...............09-03
Type of equipment......Flap gate
Manufacturer............. FONTAINE
Dimensions............... 600mm diameter

600mm flap gate



Equipment manufacturer nameplate

1- SEAL DAMAGED *VANEX*

Situation: This flap gate is equipped with a neoprene lip seal secured onto the equipment wall frame. However, the upper section of the sealing system is damage thus creating leakage. *Refer to pictures below.*

Upper section of the frame

Lip seal damaged

Recommendations: The damaged lip seal will need to be replaced and the flap gate disc readjusted as per the new seal. *Refer to picture aside for a new seal view.*

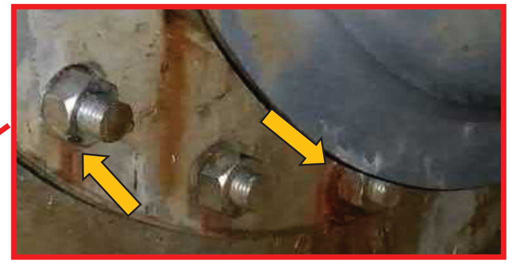
Seal repaired with Sika 1a By Donald of Vanex Monday October 5th 2020

2- ANCHORS & FASTENERS

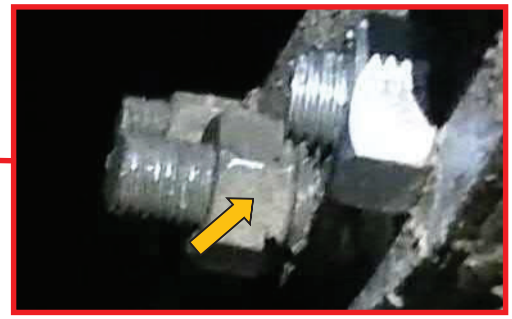
VANEX/CHANDOS

Situation : We have found several anchor nuts not properly tighten and without washers. This can create some leakage between the wall and the frame if the wall gasket is not properly compressed. Also, there was a rusted carbon steel washer that is contaminating the stainless steel flap gate. *Refer to pictures below.*

600mm flapgate



Missing and corroded washers



Loose nuts

Recommendations: We have retightened the loose nuts but we had no stainless steel washers available of this size. New stainless steel washers will need to be installed when replacing the flap gate lip seal and the nuts will need to be properly tighten in order to make sure there is no leakage at the EPDM wall gasket.

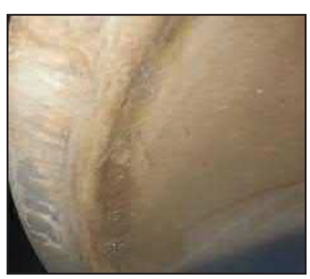
New stainless steel washers added and nuts tightened Monday October 5 2020 by Donald of Vanex

3- GROUT ON THE DISC SEAT

CHANDOS

Situation: The seat of the flap gate disc is a machined surface. This surface must be flat and clean in order to achieve the expected sealing performance while seating onto the frame lip seal. However, this machined surface had some kind of grout material stick on it thus can create some leakage since the lip seal is not seating on a flat surface.

Recommendations: We have cleaned most of the grout using a scraper. However, it will be better to use a grinder with sandpaper in order to get a cleaner surface. *Refer to picture aside.*



Grout on the disc seat

Grout cleaned

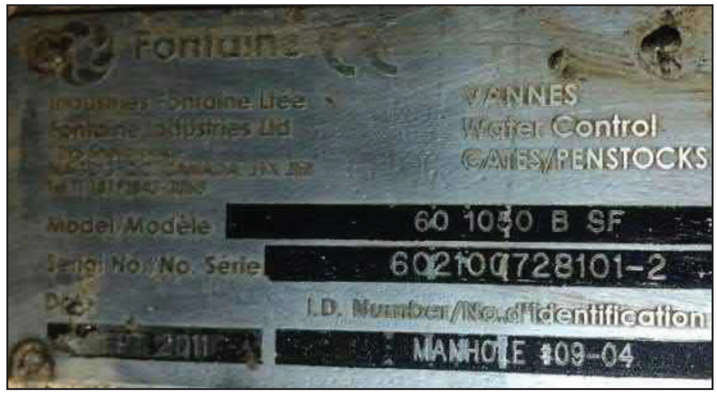
Donald of Vanex used sandpaper Monday October 5 2020 to remove remaining grout from disk seat

Support VANEX for misc adjustments. Provide construction services to pour grout around flap gate flange gap. This is a confined space entry with the flap gate 2 meters above the floor.

EQUIPMENT IDENTIFICATION

Customer ID...............09-04
Type of equipment...... Flap gate
Manufacturer............ FONTAINE
Dimensions............... 1050mm diameter

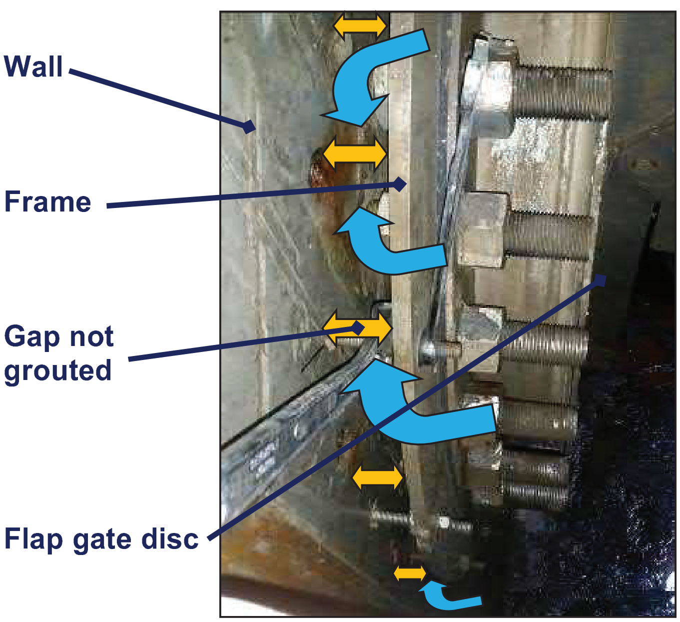
1050mm flap gate



Equipment manufacturer nameplate

1- FRAME NOT GROUTED *CHANDOS*

Situation: The original flap gate installation works was not properly completed. The frame was not grouted on the wall as it should be; leaving a couple inches gap all around the frame circumference thus creating heavy leakage. *Refer to pictures below.*



Water is bypassing the flap gate

View from inside the pipe

Recommendations: The flap gate frame must be properly grouted using high performance none-shrink grout suitable for this application.

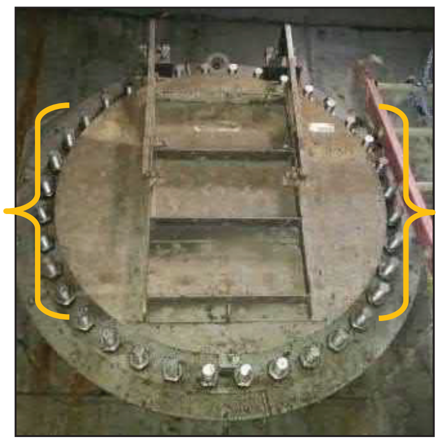
Between Tuesday September 29 and Wednesday October 7 2020 Dave Stout of Chandos formed , poured Sika 212 grout to gap between 1050mm flap gate and concrete wall and stripped forms .

2- FLAP GATE ADJUSTMENT

VANEX

Situation: The flap gate disc seating surface was not perfectly seating evenly onto the lip seal on both sides. There was up to a +/-2mm gap at two sections of the seating circumference.

Recommendations: Since the frame was not grouted yet, we have taken this “opportunity” to perform our self the required frame adjustment during this inspection. We loosen the front nuts and restraighten the frame using the backing nuts of the frame anchors. We were able to closed the gaps between the disc and the seal fairly easily. The frame is now ready to be poured. *Refer to picture below.*



+/-2mm gap sections

Frame readjustment using anchors back nuts

Donald Cote of Vanex inspected proper seal before and after placement of grout by Chandos

3- SHIPPING BRACKET INTERFERENCE

CHANDOS

Situation: In order to avoid damage to the equipment during the shipping process, the manufacturer welded a shipping bracket to secure the flap gate in full close position. We noticed that this bracket could potentially interfere with the two frame nuts nearby. Therefore, if the flap gate is closing slightly sideways, this bracket will sit on the nuts and will prevent the disc to fully close. *Refer to picture below.*

Recommendations: We recommend to “zipcut” some of the bracket material on both sides (red lines on the picture aside) in order to get an acceptable clearance with the frame nuts.

Dave Stout of Chandos cut shipping bracket off entirely (at weld) Wednesday September 30 2020

Frame bottom section

This is a confined space approximately 10 meters deep. VANEX will work on the sluice gate. CHANDOS will install pedestal bracket and remove ladder cage from 1st level ladder Confined space support is required for VANEX socpe of work.

EQUIPMENT IDENTIFICATION

Customer ID...............15-SGV-6001 Outfall valve
Type of equipment......Cast iron wedge-action sluice gate
Manufacturer............. ARMCO
Dimensions............... 42''X42''
Motorization............. ROTORK

ARMCO sluice gate

Manufacturer nameplate

Pedestal and actuator

Nameplate

1- ACTUATOR NOT PROPERLY ADJUSTED *VANEX*

Situation: The gate was automatically stopping at 75mm before reaching it full close position. After looking deeper into the actuator settings, we noticed that the full close limit switch was not properly adjusted. Therefore, this gate was heavily leaking due to this situation. Otherwise, this sluice gate is generally in good condition. *Refer to pictures below.*

ARMCO sluice gate

Full close wedges at 75mm away

Recommendations: The actuator will need to be re-calibrated in order to have the sluice gate reaching it full close position. Eventually, the wedges will also require some adjustment to properly compress the slide sealing system against the frame seat.

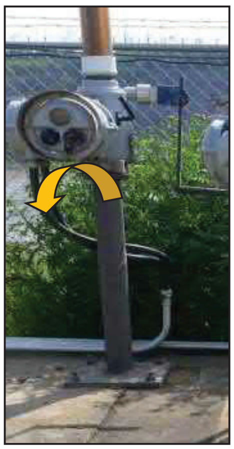
Donald Cote of Vanex with the assistance of Dave Stout of Chandos repaired these problems Tuesday October 6 2020, it was found that there was ~~some sort of grout~~ as well as sand and gravel in the depression for the alignment pins at the bottom of the sluice gate , this was the main reason the gate would not fully close . The depression was chiseled/cleaned out, the sluice gate operating shaft was removed and straightened and the fully closed depth was reset with in the Rotork motor. To ensure proper closing in the future it is recommended the the depression at sluice gate bottom be cleaned regularly.

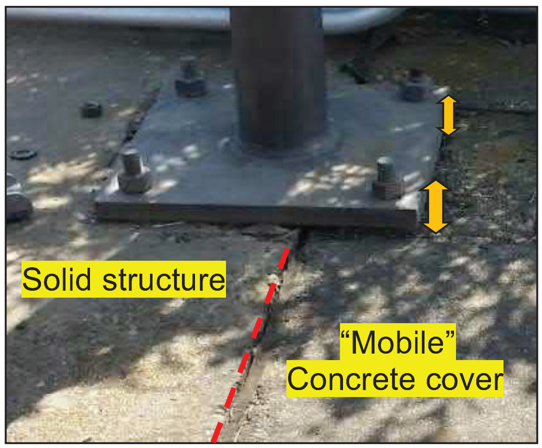
Install new pedestal bracket to secure pedestal to concrete base

CHANDOS

2- PEDESTAL PARTIALLY BOLTED ON CONCRETE COVER

Situation: This gate is a rising stem type. With this operating arrangement, the pedestal (along with the actuator) is the key component and it is taking the entire sluice gate operating thrust. Therefore, it must be strongly secured onto a structural concrete floor slab or proper supports. However, the pedestal of this "Outfall sluice gate" have only two anchors bolted in the concrete slab and two anchors bolted inside a "mobile" concrete cover which is not attached to the structure. When the gate is reaching near the full close position, the concrete cover is moving upward thus bending the operating stem and not closing the gate. This could be the reason why the full close setting of the actuator was originally adjusted before the sluice gate is reaching it full close position. *Refer to pictures below.*





The pedestal is moving to the left because the cover is moving upward when closing the sluice gate

Operating stem and guides view from underneath

Recommendations: The pedestal must be anchored onto a fix and structurally sound surface. It could be possible to have a stainless steel bracket bolted on the thickness of the concrete slab in order to bolt on the 2 anchors that are actually on the "mobile" concrete cover. Another possibility is to extend the structural concrete slab underneath the entire pedestal. This will require a structural engineer to determine the best solution to solve this situation. We also recommend to have the operating stem straightness verify to make sure there is no permanent bent since it will affect the sluice gate operation. When all modifications and installation is completed the actuator switches will need to be readjusted as well as the closing wedges to make sure the gate is reaching it full close position and the actuator will stop before forcing/damaging any components.

October 1 2020 Dave Stout of Chandos added 2 steel base plates anchored to the concrete vault top with Hilti anchors and Hilti Hit, October 2 Northweld welded steel brackets to new base plates and existing sluice gate operating pedestal base plate,2 C channel were then bolted across all there base plates. During sluice gate adjustments on October 6 it was found that this completely fixed the problem of unwanted movement in sluice gate operating shaft.

OUT OF SCOPE

3- SLUICE GATE WALL TIMBLE BROKEN

Situation: This ARMCO sluice gate is bolted directly against a “wall timble”. A wall timble is a heavy-duty frame embedded in the concrete wall with the female thread bolt pattern that is matching with the sluice gate. The gate itself has a square opening but the outfall pipe is round. The downstream side of the wall timble is design to match with the outfall pipe diameter. However, we noticed that the junction of the wall timble and the outfall pipe is broken at the bottom section. We suspect that the outfall pipe has moved downward but since the wall timble was strongly poured in the concrete wall it could not follow so it has broken at the bottom section. Also, we can see that the soil is coming out from erosion at the broken junction thus it may create supporting issues in the future. *Refer to pictures below.*

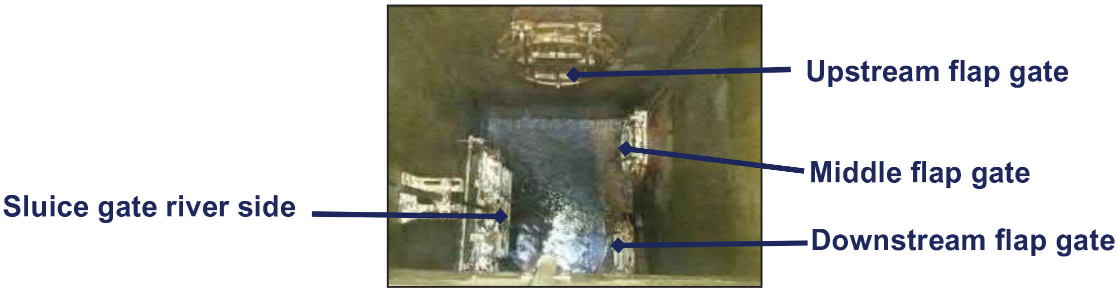
View inside the outfall pipe

Wall timble broken section

Recommendations: We recommend to have an engineer to investigate deeper into this situation in order to avoid further issues.

4- OUTFALL CHAMBER FLAP GATES No.1, No.2 & No.3

Situation: Since we were inside the outfall chamber, we took a quick look at the 3 ARMCO flap gates installed inside it. Those are all in good working condition without damages on the disc, hinges nor the frames. However, the anchor bolts are in steel and slightly corroded. Also, one anchor is loose on the middle flap gate that will need to be repaired or replaced. *Refer to pictures below.*




Upstream side of river


Middle flap gate


Downstream

CONCLUSION

During this site visit we were able to safely and properly complete our scope of work by inspecting the "outfall" ARMCO sluice gate and the two leaking FONTAINE flap gates as described in this report. We had a very good collaboration and support from all people involved at the jobsite.

Do not hesitate to contact us for further information or if precisions are needed concerning this Buffalo Region water outfall project report.

Donald Côté,
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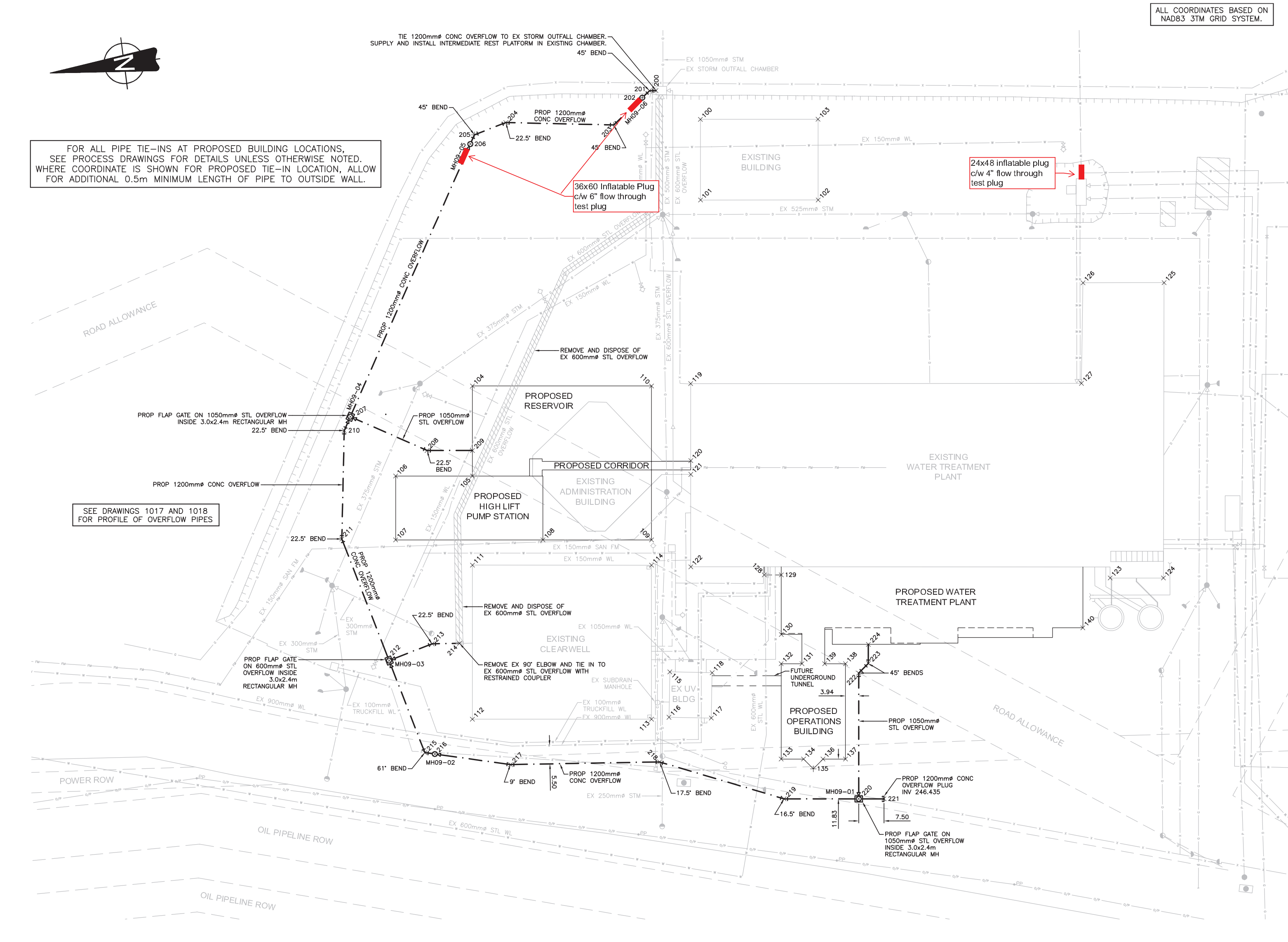
donald@vanex.pro
www.vanex.pro

Attachment #3



Building Corner Coordinate Point Table		
Point #	Northing	Easting
100	6288929.3445	−24736.9105
101	6288932.4430	−24760.7096
102	6288897.7359	−24765.2282
103	6288894.6374	−24741.4291
104	6289006.9201	−24806.7073
105	6289010.4085	−24833.2793
106	6289033.0344	−24830.3090
107	6289035.5075	−24849.1473
108	6288992.0801	−24854.8485
109	6288960.0351	−24859.0554
110	6288954.0736	−24813.6451
111	6289013.8579	−24859.5539
112	6289019.8191	−24904.9615
113	6288966.9729	−24911.9020
114	6288961.0113	−24866.4916
115	6288959.7247	−24898.6637
116	6288961.7331	−24912.0145
117	6288949.3005	−24913.8967
118	6288947.2921	−24900.5460
119	6288942.4429	−24814.4764
120	6288945.3875	−24837.1701

Building Corner Coordinate Point Table		
Point #	Northing	Easting
121	6288945.9212	−24841.2356
122	6288949.5006	−24868.5002
123	6288826.2149	−24888.0165
124	6288810.4853	−24890.0748
125	6288798.8842	−24803.0016
126	6288822.8052	−24799.9113
127	6288827.1442	−24829.5064
128	6288928.1563	−24873.7229
129	6288923.1022	−24874.3864
130	6288925.4074	−24891.9457
131	6288920.4451	−24901.3718
132	6288926.5735	−24900.5672
133	6288930.2652	−24928.6880
134	6288923.6468	−24929.5568
135	6288921.1543	−24932.8026
136	6288917.9085	−24930.3102
137	6288911.2900	−24931.1790
138	6288907.5983	−24903.0583
139	6288913.7267	−24902.2538
140	6288836.1705	−24901.6436

Overflow Coordinate Point Table		
Point #	Northing	Easting
200	6288941.3167	−24726.7178
201	6288943.2459	−24726.5036
202	6288945.6649	−24728.2780
203	6288955.1273	−24735.2189
204	6288986.8817	−24730.3376
205	6288996.6142	−24732.7211
206	6288998.1701	−24735.2862
207	6289044.1214	−24811.0439
208	6289022.7878	−24823.9839
209	6289009.4186	−24825.7390
210	6289046.4551	−24814.8915
211	6289051.3566	−24846.7768
212	6289042.1276	−24884.4613

Overflow Coordinate Point Table		
Point #	Northing	Easting
213	6289028.7848	−24881.1937
214	6289020.6669	−24882.1122
215	6289035.1380	−24913.0024
216	6289032.2458	−24913.7994
217	6289010.3396	−24919.8360
218	6288966.2496	−24924.8249
219	6288930.9341	−24940.5330
220	6288908.9205	−24943.4204
221	6288901.4842	−24944.3957
222	6288904.0534	−24906.3148
223	6288900.8484	−24903.8537
224	6288900.1117	−24898.2418

NO.	DATE	ENG.	BY	SUBJECT
1	10/07/23	D.S.	J.C.	ISSUED FOR CONSTRUCTION
0	10/03/11	D.S.	J.C.	ISSUED FOR TENDER

REVISIONS

VERIFY SCALES
BAR IS 20mm ON ORIGINAL DRAWING
0 — 20mm
IF NOT 20mm ON THIS SHEET, ADJUST SCALES ACCORDINGLY

PROFESSIONAL ENGINEER ALBERTA — STAMPED AND SIGNED By: D. SIGVALDASON Date: 10/07/23 Revision: 1

APEGGA Permit to Practice
Permit Number: P 3979

Associated Engineering

PROJECT No.	2007-3411	
SCALE	1 : 600	
DRAWN	J. CALIGIURI	
DESIGNED	D. SIGVALDASON	
CHECKED	G. STERPARN	
APPROVED	E. ASSELIN	
DATE	2009-10	INITIAL

Regional Municipality of Wood Buffalo

FORT MCMURRAY
WATER TREATMENT PLANT UPGRADE

CIVIL SITE WORKS
UTILITIES
OVERFLOW

DRAWING NUMBER	REV. NO.	SHEET
10-1011	1	11 / 29

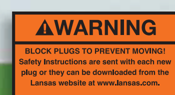
Attachment 4

Lansas PRODUCTS
Manufactured by Vanderlans & Sons, Inc.

New 5-LINE MULTI-SIZE FRONT & BACK PLUGS

The new 5-Line™ Multi-Size Front and Back Plugs are *better* in a number of ways. The most noticeable difference is in the very unique new design featuring the LANSAS proprietary "Flat-Rib"™ design which holds 60% more back pressure than standard O-ring ribbed plugs. We are using our improved reformulated rubber and laying the fabric in a way that the plugs can get the widest range of use on the market today. As with all other LANSAS products included in the 5-Line™ group, our 5-Line™ Multi-Size Front and Back plugs are equipped with the LANSAS RP2 Rupture Protection. We trust in this design enough to back it with the 5-Line™ 5 YEAR WARRANTY. If you are looking for the most Return on Investment look no further than the LANSAS 5-Line™ where once again it shows LANSAS is BETTER BY DESIGN™ since 1955.

Custom Designs Are Always™ Available



DOMEHEAD™ FRONT & BACK PLUGS

Patent # 5,785,090 Patent # 5,379,802 Patent # 4,079,755

THE LANSAS DOMEHEAD™ is the most durable multi-size pipe plug available. The unique design of this plug is covered under two U.S. patents. The first patent relates to the 2-ply of cross biased tire cord reinforcement (more on larger sizes). This design allows for controlled expansion of the plug. As this plug inflates it gets larger in diameter and shorter in length. By changing the shape of the plug rather than stretching the rubber we are able to make contact in the pipe at a lower pressure. This gives us higher contact pressure per square inch at an overall lower inflation pressure. Contact area and pressure are everything.
The second patent covers our superior end design. The ends are reinforced with a steel "spider™" ring wrapped in fabric. The fabric extends from the spider™ into the body of the plug. This advanced design transfers the stress of the inflation through the fabric to the steel spider™ ring leaving the bond at the base plate at a more relaxed state.

RUPTURE PROTECTED DOMEHEAD™ PLUGS

LANSAS RUPTURE PROTECTED PLUGS have a built in air relief valve that will prevent the plug from being over inflated due to faulty gauges or operator error. Once the valves cracking pressure is reached the Lansas RP™ Valve will open relieving the excess pressure. The RP™ Valve will reset at, or just below the required inflation pressure for the plug.

RP™ RUPTURE PROTECTED PLUG

Features:
- Eliminate operator error
- No broken discs to be replaced
- Plug stays in service
- Valve is recessed to prevent damage
- RP™ valves now available on most Multi Size Plugs manufactured by Lansas Products
- Don't be sold by cheap imitations of the original
- Another original design by Lansas Products

LANSAS Newly Redesigned Protective Sleeves

The LANSAS Protective Sleeve now has large D-Rings in place of the typical loops you see on other manufacturer's sleeves. This simple design improvement is superior in strength and makes it much easier to restrain the sleeve using the LANSAS SMART-SECURE™ Protective Sleeve Cable Restraint System.
These D-Rings are tied into the sleeve with 2-Ply's of biased cord fabric for added strength to ensure years of reliable service.
LANSAS Protective Sleeves help protect the plug while in the pipeline saving it from damage from debris, degraded pipe, barnacles, and more while in the pipeline. Additionally, it protects the Pipe Plug, your real investment, while on harsh job sites when stored improperly or simply from being moved from spot to spot during normal use.
LANSAS Protective Sleeves often times can be repaired at the LANSAS Factory Warehouses where repairs are completed.

IMPROVED

LANSAS® PRODUCTS

Manufactured by Vanderlans & Sons, Inc.

New 5 Line

ITEM 1 IN PRICE LIST

5 LINE MULTI-SIZE PLUGS

MULTI-SIZE BACK PLUG

PART NUMBER	RANGE OF USE: MINIMUM PIPE DIAMETER	RANGE OF USE: MAXIMUM PIPE DIAMETER	REQUIRED INFLATION PRESSURE	MAXIMUM BACK/TEST PRESSURE	BYPASS SIZE	PRODUCT DIMENSIONS: LENGTH	PRODUCT DIMENSIONS: DEFLATED DIAMETER	PRODUCT DIMENSIONS: WEIGHT
550-816	7.4"	16.25"	30 psi	15 psi	N/A	32.0"	7.3"	14 lbs.
550-1018	9.1"	18.25"	30 psi	15 psi	N/A	35.0"	9.0"	21 lbs.
550-1224	10.6"	24.25"	30 psi	15 psi	N/A	41.5"	10.5"	30 lbs.
MULTI-SIZE FRONT PLUG								
551-1018	9.1"	18.25"	30 psi	15 psi	3/4" + 1/4"	35.0"	9.0"	26 lbs.
551-1224	10.6"	24.25"	30 psi	15 psi	3/4" + 1/4"	41.5"	10.5"	37 lbs.

ITEM 2 & 4 IN PRICE LIST

MULTI-SIZE DOMEHEAD™ BACK PLUG

PART NUMBER	RANGE OF USE: MINIMUM PIPE DIAMETER	RANGE OF USE: MAXIMUM PIPE DIAMETER	REQUIRED INFLATION PRESSURE	MAXIMUM BACK/TEST PRESSURE	PRODUCT DIMENSIONS: LENGTH	PRODUCT DIMENSIONS: DEFLATED DIAMETER	PRODUCT DIMENSIONS: WEIGHT
050-46	3.5"	6.25"	30 psi	15 psi	9.5"	3.5"	1 lbs.
050-610	5.3"	10.25"	30 psi	15 psi	19.7"	5.0"	4 lbs.
050-812	7.3"	12.25"	25 psi	15 psi	20.0"	7.0"	8 lbs.
050-1016	9.5"	16.25"	25 psi	15 psi	30.0"	9.30"	19 lbs.
050-1218	11.5"	18.25"	25 psi	15 psi	30.0"	11.0"	29 lbs.
050-1224	11.5"	24.25"	25 psi	15 psi	41.0"	11.0"	33 lbs.
050-1530	14.0"	30.25"	20 psi	8 psi	55.0"	13.0"	48 lbs.
050-1530RP	14.0"	30.25"	20 psi	8 psi	55.0"	13.0"	50 lbs.
050-2036	19.0"	36.25"	20 psi	8 psi	64.0"	18.5"	71 lbs.
050-2036RP	19.0"	36.25"	20 psi	8 psi	64.0"	18.5"	73 lbs
050-2448	22.0"	48.25"	15 psi	8 psi	84.0"	21.5"	102 lbs.
050-2448RP	22.0"	48.25"	15 psi	8 psi	84.0"	21.5"	104 lbs.
050-3660	34.5"	60.25"	10 psi	6 psi	84.0"	29.5"	187 lbs.
050-3660RP	34.5"	60.25"	10 psi	6 psi	84.0"	29.5"	189 lbs.
050-4278	37.0"	78.25"	10 psi	6 psi	101.0"	37.0"	314 lbs.
050-4278RP	37.0"	78.25"	10 psi	6 psi	101.0"	37.0"	316 lbs.
050-4872	46.0"	72.25"	10 psi	6 psi	84.0"	43.5"	331 lbs.
050-4872RP	46.0"	72.25"	10 psi	6 psi	84.0"	43.5"	333 lbs.
050-5496	53.0"	96.25"	10 psi	6 psi	114.0"	51.0"	496 lbs.
050-5496RP	53.0"	96.25"	10 psi	6 psi	114.0"	51.0"	498 lbs.
050-6096	58.0"	96.25"	10 psi	6 psi	110.0"	56.0"	515 lbs.
050-6096RP	58.0"	96.25"	10 psi	6 psi	110.0"	56.0"	517 lbs.

Plug for 900 mm steel pipe

Plug for 1200 mm concrete pipe

ITEM 3 & 4 IN PRICE LIST

MULTI-SIZE DOMEHEAD™ FRONT

PART NUMBER	RANGE OF USE: MINIMUM PIPE DIAMETER	RANGE OF USE: MAXIMUM PIPE DIAMETER	REQUIRED INFLATION PRESSURE	MAXIMUM BACK/TEST PRESSURE	BY-PASS SIZES	PRODUCT DIMENSIONS: LENGTH	PRODUCT DIMENSIONS: DEFLATED DIAMETER	PRODUCT DIMENSIONS: WEIGHT
051-46	3.5"	6.25"	30 psi	15 psi	1/4" + 1/4"	9.5"	3.5"	2 lbs.
051-610	5.3"	10.25"	30 psi	15 psi	1/2" + 1/4"	18.0"	5.0"	7 lbs.
051-812	7.3"	12.25"	25 psi	15 psi	3/4" + 1/4"	20.0"	7.0"	10 lbs.
051-1016	9.5"	16.25"	25 psi	15 psi	3/4" + 1/4"	27.5"	9.30"	20 lbs.
051-1218	11.5"	18.25"	25 psi	15 psi	3/4" + 1/4"	28.5"	11.0"	30 lbs.
051-1224	11.5"	24.25"	25 psi	15 psi	3/4" + 1/4"	41.0"	11.0"	35 lbs.
051-1530	14.0"	30.25"	20 psi	8 psi	3/4" + 1/4"	55.0"	13.0"	50 lbs.
051-1530RP	14.0"	30.25"	20 psi	8 psi	3/4" + 1/4"	55.0"	13.0"	52 lbs.
051-2036	19.0"	36.25"	20 psi	8 psi	3/4" + 1/4"	64.0"	18.5"	73 lbs.
051-2036RP	19.0"	36.25"	20 psi	8 psi	3/4" + 1/4"	64.0"	18.5"	75 lbs.
051-2448	22.0"	48.25"	15 psi	8 psi	3/4" + 1/4"	84.0"	21.5"	105 lbs.
051-2448RP	22.0"	48.25"	15 psi	8 psi	3/4" + 1/4"	84.0"	21.5"	107 lbs.
051-3660	34.5"	60.25"	10 psi	6 psi	3/4" + 1/4"	84.0"	29.5"	190 lbs.
051-3660RP	34.5"	60.25"	10 psi	6 psi	3/4" + 1/4"	84.0"	29.5"	192 lbs.
051-4278	37.0"	78.25"	10 psi	6 psi	3/4" + 1/4"	101.0"	37.0"	318 lbs.
051-4278RP	37.0"	78.25"	10 psi	6 psi	3/4" + 1/4"	101.0"	37.0"	320 lbs.
051-4872	46.0"	72.25"	10 psi	6 psi	3/4" + 1/4"	84.0"	43.5"	335 lbs.
051-4872RP	46.0"	72.25"	10 psi	6 psi	3/4" + 1/4"	84.0"	43.5"	337 lbs.
051-5496	53.0"	96.25"	10 psi	6 psi	3/4" + 1/4"	114.0"	51.0"	501 lbs.
051-5496RP	53.0"	96.25"	10 psi	6 psi	3/4" + 1/4"	114.0"	51.0"	503 lbs.
051-6096	58.0"	96.25"	10 psi	6 psi	3/4" + 1/4"	110.0"	56.0"	520 lbs.
051-6096RP	58.0"	96.25"	10 psi	6 psi	3/4" + 1/4"	110.0"	56.0"	522 lbs.

NOTE: 10" x 16" PLUGS AND LARGER HAVE 2 INFLATION PORTS. (1) STANDARD 1/4" (F) NPT AND (1) SECONDARY 1/2" (F) NPT.

ITEM 2 & 4 IN PRICE LIST

PROTECTIVE SLEEVES

PART NUMBER	FITS PLUGS WITH NOTED PART NUMBERS	WEIGHT
069-610	050-610, 051-610	2.5 lbs.
069-610FT	093-610	2.5 lbs.
069-812	050-812, 051-812	3 lbs.
069-812FT	092-812, 094-812, 096-812	3 lbs.
059-816	550-816	5 lbs.
069-1016	050-1016, 051-1016	6 lbs.
069-1016FT	094-1016, 096-1016, 098-1016	6 lbs.
059-1018	550-1018, 551-1018	8 lbs.
069-1218	050-1218, 051-1218	10 lbs.
069-1218FT	094-1218, 096-1218, 098-1218	10 lbs.
059-1224	550-1224, 551-1224	15 lbs.
069-1224	050-1224, 051-1224	14 lbs.
069-1224FT	094-1224, 096-1224, 098-1224	14 lbs.
069-1530	050-1530, 051-1530, 094-1530S	21 lbs.
069-1530FT	094-1530H, 096-1530, 098-1530	21 lbs.
069-2036	050-2036, 051-2036, 094-2036S	28 lbs.
069-2036FT	094-2036H, 096-2036, 098-2036	28 lbs.
069-2448	050-2448, 051-2448, 094-2448, 096-2448, 098-2448	53 lbs.
069-3660	050-3660, 051-3660, 094-3660, 096-3660, 098-3660	78 lbs.
069-4278	050-4278, 051-4278, 094-4278, 096-4278, 098-4278	93 lbs.
069-4872	050-4872, 051-4872, 094-4872, 096-4872, 098-4872	89 lbs.
069-5496	050-5496, 051-5496, 094-5496, 096-5496, 098-5496	160 lbs.
069-6096	050-6096, 051-6096, 094-6096, 096-6096, 098-6096	166 lbs.

Custom sleeves always available

Attachment 5

I-SERIES TEST-BALL PLUGS (NO BYPASS TUBE)

CHERNE

Cherne's I-Series plugs were designed to meet the needs of both the US and International markets in terms of size and expansion range. Our I-Series plugs have full body cording for added durability.

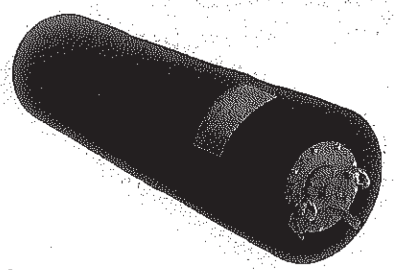
I-Series Plug Features:

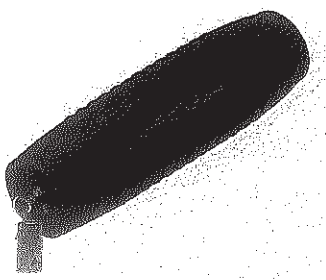
- Superior expansion range
- Small deflated diameters
  - All plugs up through our 24-60" size easily fit through a 24" manhole frame
  - 48–72" and 54–96" plugs fit through 36" openings

15-32" and Larger Plug Features:

- Aluminum end plates – minimizes rust/corrosion
- 3/4" eyebolts on plugs 15–32" and larger – better holding strength
- Patented field replaceable rupture discs or pressure relief valves on plugs 15–32" and larger – protects plug from over-inflation

I-SERIES PLUGS





Protective sleeves available for 12"–18" diameter and larger plugs. **See page 23.**

PART NUMBER	NOMINAL SIZE	USAGE RANGE	MAXIMUM BACK PRESSURE	INFLATION PRESSURE	PRODUCT WEIGHT	DEFLATED LENGTH	DEFLATED DIAMETER	INFLATION THREAD	CHAIN / EYE BOLTS
310328	15" – 32" (380 – 800 mm)	15" – 32" (380 – 800 mm)	**	25 (1,72 bar)	65 lbs (29.5 kg)	48" (1220 mm)	14.3" (363 mm)	1/4" & 1/2"	3/4" (2)
310408	20"–40" (500–1000 mm)	19"–40" (475–1000 mm)	**	22 psi (1,5 bar)	66 lbs (30 kg)	46.25" (1175 mm)	18.5" (470 mm)	1/4" & 1/2"	3/4" (2)
310488	24" – 48" (600–1200 mm)	20.5"–50" (521–1270 mm)	**	22 psi (1,5 bar)	125 lbs (57 kg)	68" (1730 mm)	19.1" (485 mm)	1/4" & 1/2"	3/4" (2)
310600	24" – 60" (600–1500 mm)	20.5"–60.5" (520–1537 mm)	**	22 psi (1,5 bar)	140 lbs (63.6 kg)	88" (2235 mm)	19.1" (485 mm)	1/4" & 1/2"	3/4" (2)
310728	48" – 72" (1200–1800 mm)	44"–72.25" (1118–1835 mm)	**	12 psi (0,83 bar)	290 lbs (132 kg)	100" (2540 mm)	43" (1092 mm)	1/2" (2)	3/4" (3)
310968	54" – 96" (1400–2400 mm)	54"–96.25" (1400–2450 mm)	**	11 psi (0,75 bar)	500 lbs (228 kg)	128" (3200 mm)	50" (1270 mm)	1/2" (2)	3/4" (3)

** Consult back pressure table below.

BACK PRESSURE DATA: I-SERIES PLUGS

PLUG SIZE	PIPE DIAMETER 4"	6"	8"	12"	15"	18"	19.35"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	84"	96"
15"-32"		-	-	-	18.6 psi	17.6 psi	17.2 psi	16.6 psi	15.4 psi	12.2 psi	-	-	-	-	-	-	-	-	-
20"-40"		-	-	-	-	-	-	13.6 psi	12.5 psi	11.2 psi	10.2 psi	8.7 psi	-	-	-	-	-	-	-
24"-48"		-	-	-	-	-	-	-	15.2 psi	13.9 psi	12.8 psi	11.4 psi	10.1 psi	-	-	-	-	-	-
24"-60"		-	-	-	-	-	-	-	15.6 psi	15.2 psi	14.8 psi	14.0 psi	12.6 psi	9.6 psi	6.0 psi	-	-	-	-
40"-60"		-	-	-	-	-	-	-	-	-	-	15.0 psi	13.0 psi	11.0 psi	8.7 psi	-	-	-	-
48"-72"		-	-	-	-	-	-	-	-	-	-	-	7.2 psi	6.8 psi	6.4 psi	6.2 psi	6.0 psi	-	-
54"-96"		-	-	-	-	-	-	-	-	-	-	-	-	7.3 psi	7.2 psi	6.9 psi	6.8 psi	6.6 psi	6.4 psi

Consult page 69 for back pressure conversion to feet of head pressure.

ALWAYS BLOCK PLUGS WHEN CONDUCTING AIR TESTS.

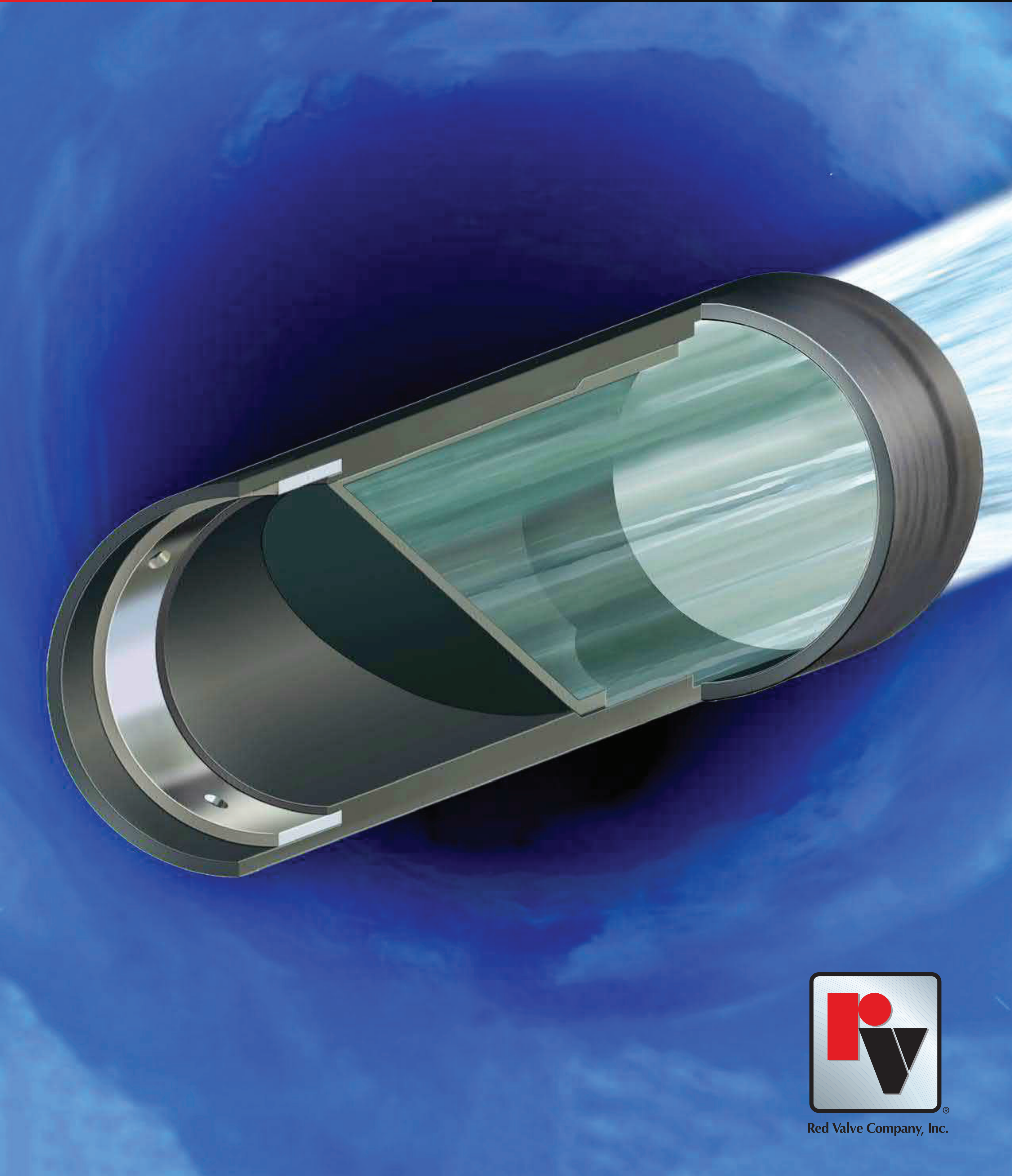
Attachment 6

Red Valve®

THE CHECKMATE® ADVANTAGE

The World's Most Reliable Check Valve

Engineering Guide



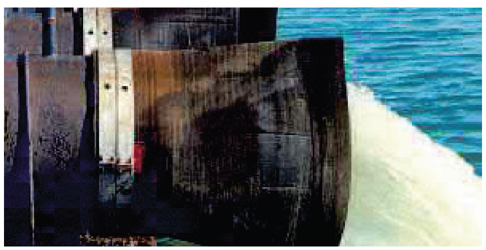
Red Valve Company, Inc.

Continuing a Legacy of Innovation, Leadership and Customer Service

More than 60 years ago, Red Valve Company was founded on a simple promise: provide the highest quality engineered valves backed by an unsurpassed level of technical innovation and customer service. With that promise began a legacy of leadership—and a never-ending quest to solve the world's toughest flow control challenges while exceeding our customers' expectations.

As the world leader in Pinch Valve and Check Valve technology, that legacy lives on every day at Red Valve Company, and the innovative CheckMate® Inline Check Valve is proof. The CheckMate® Inline Check Valve is rooted in the same superior understanding of elastomer technology as the legendary Tideflex® Check Valve, one of the most well-known valves proven for providing reliable long-lasting backflow prevention, across the globe.

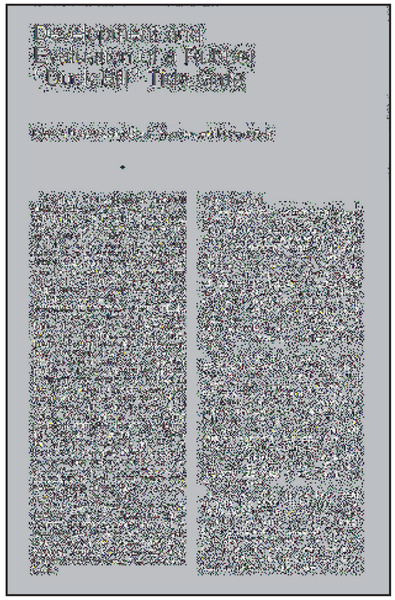
Being a world leader in valve technology is more than a slogan—it's a promise, carried forward by the hundreds of dedicated Red Valve employees and sales representatives around the world. Call us any time. We are ready to speak with you personally—right now.



The patented CheckMate® Inline Check Valve is rooted in the same superior understanding of elastomer technology as the legendary Tideflex® Check Valve, one of the most well-known valves in the world.

A Pioneer in the Check Valve Industry

In 1984, the United States Environmental Protection Agency (EPA) commissioned Red Valve Company to develop and test an alternative to tide gate valves. In their report, Development and Evaluation of a



Rubber "Duck Bill" Tide Gate, the EPA states, "Increasing the reliability and performance of tide gates has a beneficial impact on the general pollution abatement program for the nation's waterways."

In response, Red Valve Company developed and patented its elastomer "duckbill" Tideflex® Check Valve to eliminate the operational and maintenance problems associated with flapgate check valves, including corrosion of mechanical parts, freezing open or shut, warping and clogging due to entrapped debris.

The EPA rigorously tested the Tideflex® Check Valve for two years and found that the valve showed, "Significant improvement over flapgate valves in terms of leakage inflow, entrapment of debris, capability to self clean and susceptibility to marine fouling."

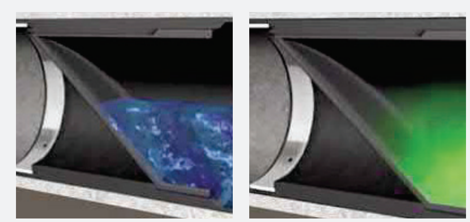
Since the creation of the Tideflex® Check Valve in 1984, years of research and development, testing and proven performance has led to the globalization of the TF-2 Tideflex® Check Valve and the next generation Tideflex® TF-1. With improved flow efficiency characteristics and the latest technology in elastomers, Red Valve continues to deliver on its promise of staying on the forefront of technology and new product development. The Tideflex® name is respected and recognized around the world as the most reliable valve for backflow prevention. It is also worth noting that the first Tideflex® Check Valve sold in 1984 is still in service today, with more than 700,000 Tideflex® Check Valves in service around the world, reliably solving inflow and intrusion problems.

CheckMate® Valve Solves City's Odor Problem

When foul odors were plaguing a soybean producing town in Illinois, officials turned to Red Valve for the most reliable, cost-effective solution.

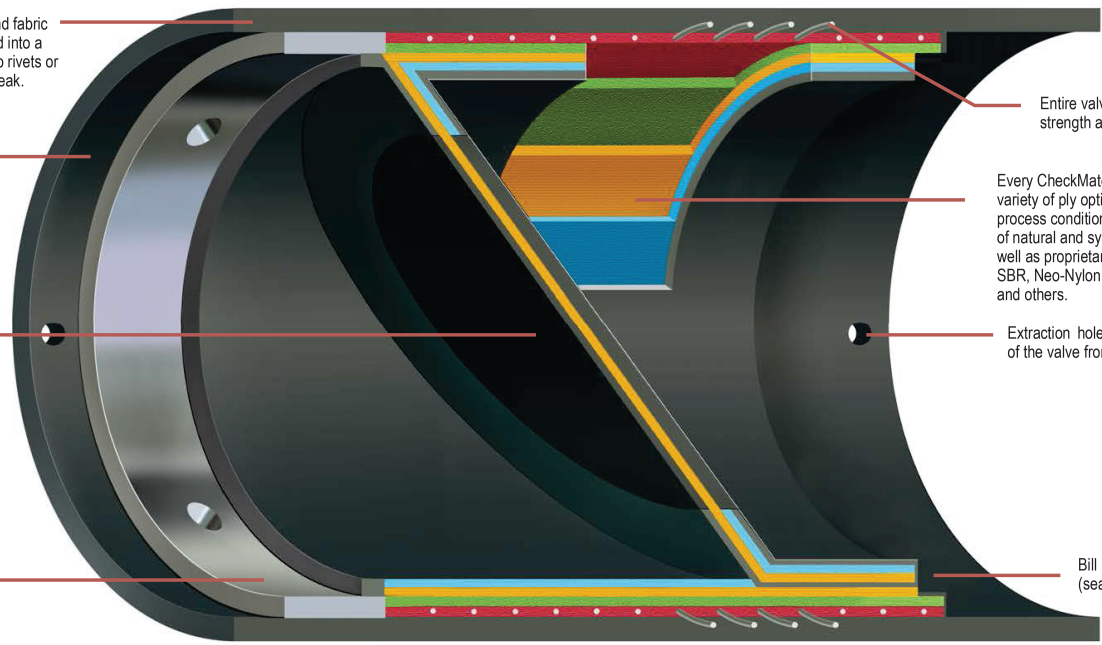
A chemical deodorizing system and a pump station were also evaluated, but far exceeded budget constraints. The CheckMate® Inline Check Valve proved to be the perfect solution.

The CheckMate® Inline Valve was installed in 2012 and has worked flawlessly ever since, completely blocking the backdraft of the odor. Best of all, there has been zero maintenance expense. According to a public works official, ***"This is one of the most cost-effective solutions to a nagging quality of life problem the City has ever implemented. We are now looking at other parts of the combined sewer system that has a few small odor problems due to escaping sewer gas."***



For an animated demonstration of the CheckMate® in operation, please visit: http://www.tideflex.com/checkmate

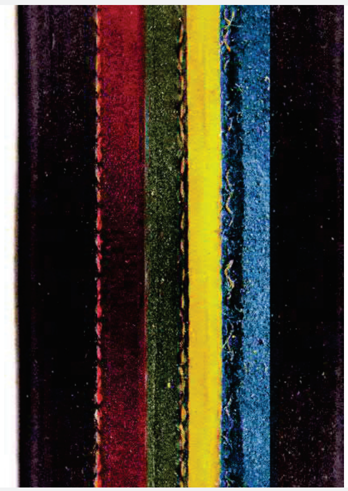
There Is Only One CheckMate® Inline Valve!



The CheckMate® Inline Check Valve: Accept No Substitutes!

The innovative CheckMate® Inline Check Valve has quickly become the specified choice for inline residential, municipal and commercial areas where complete, dependable backflow prevention is critical. It has also become the valve of choice for municipal and industrial applications such as storm water, wastewater, highway runoff, CSO, SSO and flood control by preventing unwanted backflow that can cause surges and flooding. The CheckMate® Inline Check Valve minimizes damage to wetlands, beaches and residential areas and eliminates hydraulic surges to wastewater treatment plants, saving municipalities millions of dollars in maintenance and treatment costs.

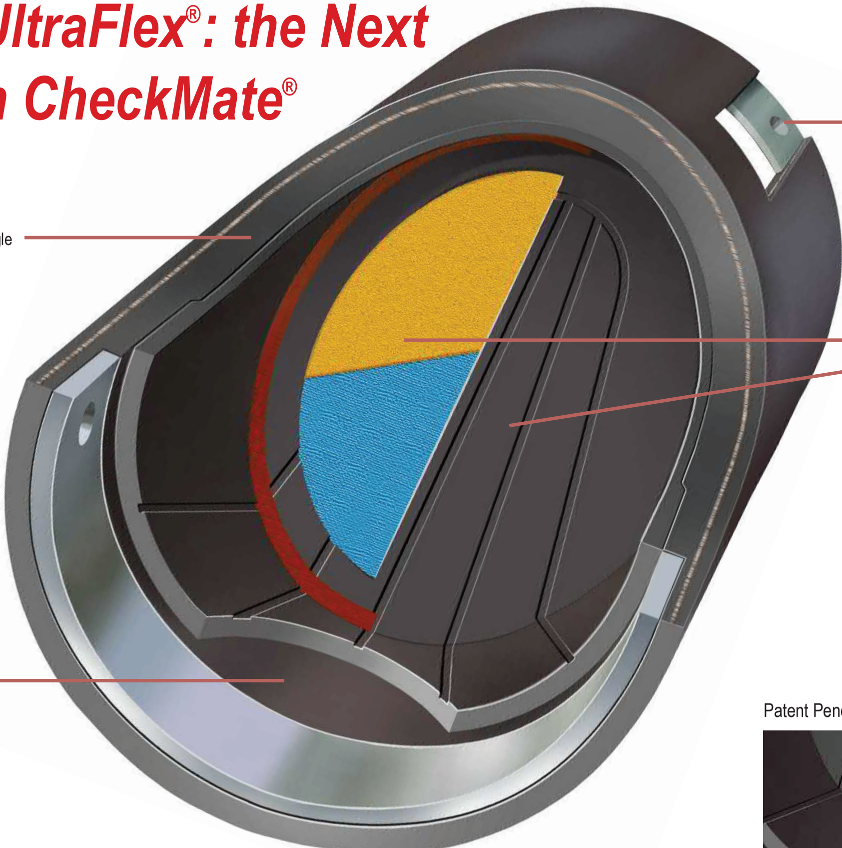
One of the keys to the CheckMate® Valve's exceptional dependability and longevity is Red Valve's unmatched elastomer experience—experience, application knowledge and engineering know-how. Every CheckMate® Inline Check Valve is hand-fabricated, made of multiple layers of varying natural and synthetic elastomers, wire and fabric-reinforced plies, all of which are vulcanized into a robust unibody valve. Unlike competing designs, there are no molded parts or mechanical fasteners and rivets that will loosen, act as catch points, break or corrode—ever. The key to CheckMate® Valve's longevity, performance and low headloss characteristics is the design and construction.



Red Valve's legendary elastomer technology and knowledge is the real story behind the CheckMate® Valve's unrivaled performance. Every CheckMate® Valve is reinforced with various natural and synthetic plies, specifically engineered for your specific application.

CheckMate® Inline Check Valves use state-of-the-art elastomers and fabric technology with no metal hinges, rivets, fasteners or moving parts. The valve's unibody construction is ideally suited for CSO and diversion chamber applications and installed inside the pipeline on either the upstream or downstream side of a diversion chamber.

Introducing UltraFlex®: the Next Generation in CheckMate® Technology!

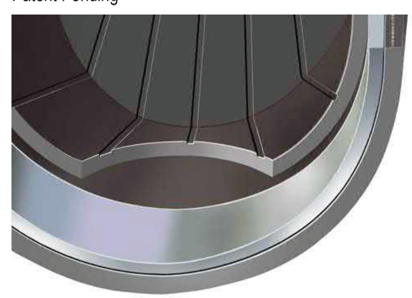


Unmatched Elastomer Research, Innovation and Knowledge

The patented CheckMate UltraFlex® Inline Check Valve features drastically improved hydraulic and performance characteristics to its predecessor, the original CheckMate® Check Valve. Strategically placed reinforcing ribs, segmented pads and the "Arc Notch" bill combine to significantly improve flow efficiency with significantly reduced headloss, while providing absolute backflow protection.

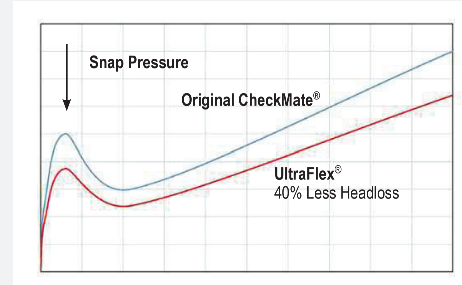
Once upstream head pressure reaches a specific level, CheckMate® Inline Check Valves are designed to "snap" or "pop" open, allowing the rapid discharge of flow. The new UltraFlex®, with its patented "Arc Notch" and optimized construction, allows the next generation CheckMate® Valve to open 40% sooner. As a result, the pipeline and entire collection system drains up to 40% faster. Because the UltraFlex® Valve "snaps" or "pops" open with less head pressure, pipeline capacity is significantly increased while the chance for standing water to collect upstream of the valve is totally eliminated.

Patent Pending



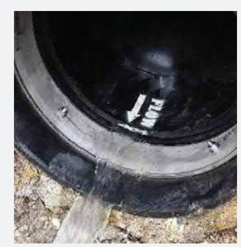
Strategically placed reinforcing ribs, segmented pads and the bill's unique "Arc Notch" combine to significantly improve flow efficiency with significantly reduced headloss while providing absolute backflow protection.

UltraFlex® Boasts 40% Lower "Snap Pressure"



The new CheckMate UltraFlex® Valve boasts a 40% lower snap pressure requirement to open or unseat the valve, without compromising the valve's ability to seal. This greatly improves capacity in pipelines and the rapid drainage of upstream flow through the valve. With its patented "Arc Notch" design, the CheckMate UltraFlex® Inline Check Valve boasts a significantly improved flow efficiency, due to reduced head pressure levels required to "snap" open the valve.

When upstream head reaches 50-75% of pipe diameter (for example, 9" head in a 12" valve), the UltraFlex® bill "snaps" open into a concave shape, allowing substantially more flow with the same amount of head. The valve will progressively open with increased head and flow. Picture shows moment when the valve "snaps" open.



The CheckMate® Valve will crack open and flow with as little as 1" of head pressure.

Once the CheckMate® Valve "snaps" open, it achieves rapid discharge of flow.

Independently Tested, Field Validated

Independent Hydraulic Testing

CheckMate® Inline Check Valves are independently tested to determine their hydraulic characteristics in both free and submerged discharge applications. Published hydraulic data is validated through this independent testing, and Finite Element Analysis data is also provided to ensure the CheckMate® Valve meets your exact specifications. CheckMate® Valves are ideally suited for interceptor, manhole and outfall pipelines because they allow flow to discharge with very little headloss and prevent backflow. The CheckMate® Valve's innovative inline design allows it to be easily installed without modifications to existing structures, making it the perfect choice for both municipalities and commercial property owners.

To supplement independent hydraulic testing, Red Valve continually conducts research and development and additional in-house testing to improve existing products and develop new products.

Thousands of CheckMate® Inline Check Valves are currently in service around the globe.

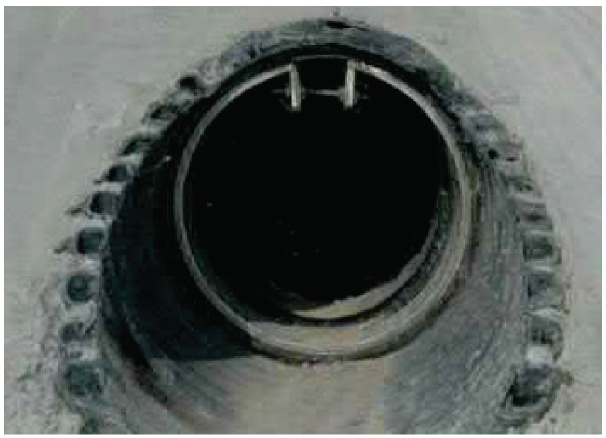
Features and Benefits of CheckMate®

- Extremely Low Headloss
- No Moving Mechanical Parts to Corrode, Catch Debris or Fail
- Heavy Duty Elastomer Unibody Construction
- Quick and Easy Installation
- Seals Around Debris
- Operates on Differential Pressure, Totally Passive
- Virtually No Maintenance
- Self-draining, 1" of Cracking Pressure
- Silent, Non-slamming
- Available in Sizes 3" (75 mm) to 84" (2100 mm)
- Extensive Independent Hydraulic Testing

CheckMate® Valves are ideally suited for interceptor, manhole and outfall pipelines, because they maximize pipeline storage and capacity while preventing backflow into upstream pipelines, collection systems and sewage treatment plants.

Simple Design for Simple Installation

The CheckMate® Inline Check Valve is extremely easy to install, regardless of the existing environment or piping. Its inherent design makes it the most user-friendly inline check valve on the market today. From the upstream or downstream end of the pipe, simply insert the valve into position and clamp it into place. Typically, no modification to the pipe or structure is required to install the CheckMate®. Because the CheckMate® is recessed inside of the pipe, additional permitting is not required. The results are construction cost savings, reduced installation time, and reduced operational costs.



CheckMate® Valves are easily installed regardless of difficult pipe end geometry or pipes in poor end condition. There is no need to rebuild headwalls.

A Wide Range of Shapes and Sizes

Elliptical, Arch and Rectangular Pipes

Elliptical, Arch and Rectangular Pipes for drainage and flood prevention projects have become popular, particularly in high water table areas with shallow surface gradients. CheckMate® Inline Check Valves are the perfect solution as they can be customized to meet your specifications.

Arch Pipe CheckMate®

Elliptical Pipe CheckMate®

Rectangular Pipe CheckMate®

Rubber Flanged

Rubber Flanged CheckMate® Valves can be manufactured with an integral rubber upstream or downstream flange. The flanged CheckMate® gets inserted into the host pipe, then can be bolted to a mating flange or anchored to a concrete headwall. The flange can be circular with standard drilling, or circular, square or rectangular with custom flange drilling. The valve is supplied with retaining rings for mounting.

Thimble Inserts

A CheckMate® Thimble Insert is simply a CheckMate® Valve that is factory installed, clamped and pinned into flanged or plain-end pipe. The thimble insert assembly can either be inserted into the I.D. of the host pipe, or can be mounted to a mating flange or concrete headwall and extend beyond the pipe. Plain end thimble inserts are inserted into the host pipe and non-shrink grout is placed between the thimble insert O.D. and host pipe I.D. to form the seal.

Upstream Flanged CheckMate®

CheckMate® Thimble Insert

Red Valve Company, Inc.

Tideflex Technologies

600 N. Bell Avenue
Carnegie, PA 15106

PHONE:
412/279-0044

FAX:
412/279-7878

www.redvalve.com

"Rely on Red" for a Total System Solution to Your Water and Wastewater Treatment Challenges

No other company can match Red Valve's "Total System Solution" for water and wastewater treatment plants and municipal collection and distribution systems.

Since 1953, Red Valve has provided products for each phase of collection, distribution, separation, aeration, treatment and final discharge. Our complete product line provides customers with one source for on/off and control valves, check valves, pressure measurement, expansion compensation, air diffusers and effluent diffusers. All Red Valve products are designed to handle the rigors of handling raw sewage, sludge, scum and grit with abrasion-resistant, non-clogging designs.

Contact us today for a free copy of our new "Total System Solution" brochure for Municipal Collection and Distribution, or our comprehensive Valve Selection Guide for Wastewater Treatment.

Attachment 7

mvs mountainview systems

Quote

Mountainview Systems Ltd. provides BC, AB, and SK contractors, surveyors and municipalities with quality products and services designed to increase productivity and lower costs, while maintaining the highest level of accuracy

Quote Number:
Date: Oct. 22/20

EXPIRY DATE: Nov. 22/20

Prepared For: Sarah Bruce, Associated Engineering

Salesperson	Description	Shipping Method		Delivery Date	Payment Terms	# of Pages
EDM-HOUSE		PICKUP			NET30	

Item	Part #	Description	Qty	Each	Total
1	310408	Cherne 20″-40″ Pipe Plug, no Bypass (10.2 PSI Back Pressure at 36″)	2	$3,802.00	$7,604.00
2	310488	Cherne 24″-48″ Pipe Plug, no Bypass (10.1 PSI Back Pressure at 48″)	2	$5,569.00	$11,138.00
3	314408	Cherne 20″-40″ Pipe Plug w/ 4″ NPT Bypass (10.2 PSI Back Pressure at 36″)	2	$4,598.00	$9,196.00
4	314488	Cherne 24″-48″ Pipe Plug w/ 4″ NPT Bypass (10.1 PSI Back Pressure at 48″)	2	$7,628.00	$15,256.00
		Prices include 30′ controller hose w/ 60 PSI gauge, valve & fittings for each			
		plug and freight from Brampton, Ontario to Edmonton			
		GST is extra			

Protective sleeves are $1,925 each.

Quote

TRISTAR HYDROVACS LTD.

Date: **October 28th 2020**

Service Provider
Tristar Hydrovac Ltd.
370 Falconer Cresent
Fort McMurray, AB
T9H 0H9
Phone: 1-780-881-0997
Email: ryan@tristarcanada.net
Ryan Brenton

Customer
Associated Engineer
Requested By: Sara Bruce

Worksite Location: Fort McMurray Water Treatment Plant

Job Description: Supply Sewer Flusher and crew to clean storm lines at the Water Treatment Plant in Fort McMurray. Upon completion of the flushing and debris removal, we will then camera the lines to confirm that they are clean and check the condition of the pipe.

Description	Quanity	Rate	Total
Hydrovac Hours	30	$ 220.00	$ 6,600.00
Water Charges	9	$ 40.00	$ 360.00
Dumping Fees	6	$ 220.00	$ 1,320.00
Fuel Surcharge 2.5%			$ 165.00
Camera per meter	450	$7.50	$ 3,375.00
			$ -
			$ -
		Subtotal	$ 11,820.00
		GST	$ 591.00
		Total	$ 12,411.00

Operations Manager: ____________

Information is not an invoice and only an estimate of services described above. If You have any concerns you can contact me anytime at 780-881-0997 or via email at ryan@tristarcanada.net.

Thank You and have great day.