Concept Drainage Study - DRAFT

North Battleford
Treaty Six Territory | Heartland of the Métis | Saskatchewan | Canada

Prepared For: City of North Battleford

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1.0 GENERAL DEVELOPMENT AREA

The Parsons Industrial Park Subdivision (Parsons) development is located within the City of North Battleford, SK (CoNB) within SEC22, 27, 28, 33 & 34 of T43-R16-W3. The subdivision is in the southeast sector of the City and is bound by Highway 16 and CN Rail (Aberdeen Subdivision) to the north and the North Saskatchewan River to the south. The existing land is a currently developed industrial area with various industrial tenants including (but not limited to) Cargill, Discovery Co-op, University of Saskatchewan, Purolator, Sask Hospital, CoNB Wastewater Treatment Facility, etc. The study area covers an area of approximately 9.94 km^2 (994 ha), there are an additional 6.35 km^2 (635 ha) of contributing area that impacts Parsons Industrial Park.

The existing topography of the site is generally sloped from northeast to southwest. The maximum and minimum elevations of the site are 518.400m and 498.820m above sea level, respectively. Drainage of Parsons Industrial Park is currently controlled utilizing a minor piping system along Thatcher Avenue and overland drainage via roads and ditches elsewhere. The Parsons area discharges to the North Saskatchewan River at many points and is adjacent to the subdivision on the south side.

The area to the north of Parsons and Highway 16 currently drains south through the subdivision via culverts crossing Highway 16 and the CN Rail line. There are also existing City of North Battleford drainage areas that are directed through the ravine on the north side of the North Battleford Golf and Country Club and ultimately to the North Saskatchewan River. The existing area can be seen in Figure 1 below.

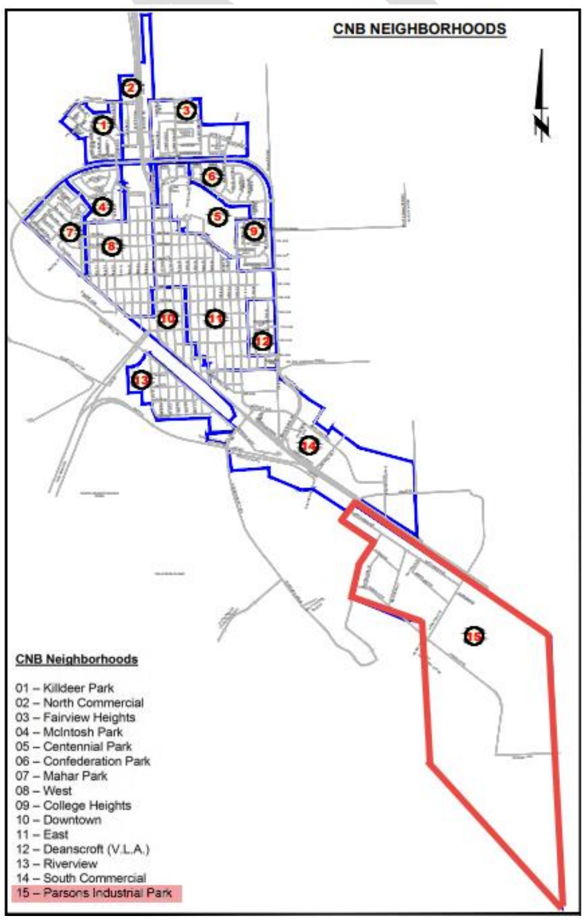

Figure 1 Existing Area

2.0 BACKGROUND INFORMATION REVIEW

2.1.1 Contaminated Sites

On November 8, 2023, the City of North Battleford provided a contaminated sites figure for the Parsons area. Allnorth reviewed this document and has considered this as part of the study.

2.1.2 LiDAR and Topographic Survey

In October 2023, Allnorth completed a survey of the Parsons Industrial Park utilizing UAV LiDAR and GPS RTK technologies. The survey captured the entire Parsons area, utilizing a LiDAR resolution of 5cm horizontal and 5cm vertical, processed using surveyed ground control and exported to a 1m grid Digital Elevation Model (DEM) surface. The LiDAR surface is shown below in Figure 2.

The GPS RTK topographic survey was also completed to capture physical features such as culverts, inverts, manholes, etc. to a greater accuracy and definition than the UAV LiDAR. Photos and information were also captured for all accessible culverts within the area, providing some context on their current condition (Appendix A).

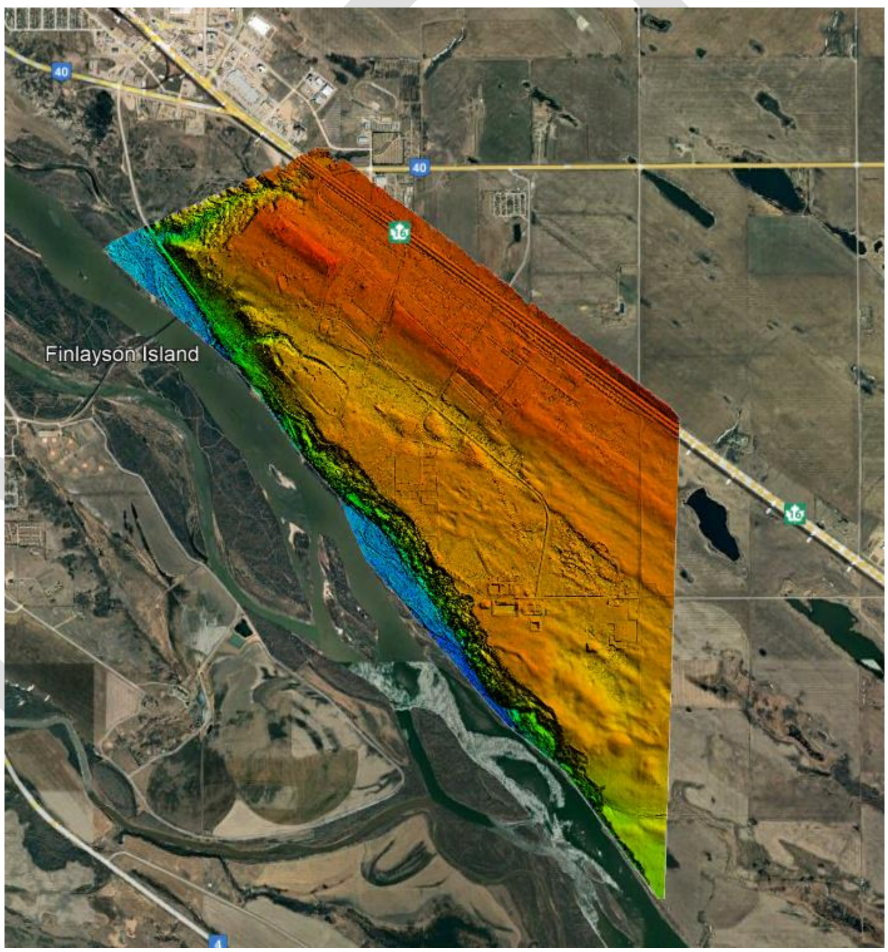

Figure 2 UAV LiDAR DEM Surface

2.1.3 City of North Battleford Information

On September 21, 2023, Allnorth and the City of North Battleford met to discuss the project and understand the background information for the Parsons Industrial Park. The CoNB provided context to the drainage issues being experienced within the area. The existing area constraints are discussed in Section 3 below.

Through the Asset Management (AM) Services project, Allnorth has acquired an intimate knowledge of existing drainage routes and stormwater infrastructure, constraints, current conditions, and operational concerns related to surface drainage within the Parsons Industrial Park (Catchment Areas 21 and 22).

The current stormwater management systems in the Parsons Industrial Park consists of both an overland major system and a minor system. The major system includes ditching and open channel drainage throughout the subdivision, enhanced by a minor system of manholes, mains, catch basins, and culverts. In the City as a whole, approximately 66% of the minor stormwater system meets the sizing standards for 1 in 2-year storm events and limits roadway flooding during major storm events. Similarly, approximately 85% of the City's culverts have exceeded their 40-year service life and, based on our assessment of the infrastructure during the AMP project, performance and condition of the system overall is poor to fair. Assessment of the surface drainage within Parsons Industrial Park is an important first step in addressing the performance and condition of the City's major stormwater system as it accounts for approximately 43% of the major system.

In general, stormwater collected within Parsons Industrial Park west of Holstein Street and north of Fyfe Avenue discharges into the natural drainage swale to the west of Simmental Street via a rip rap outfall installed in 1980. While stormwater collected south and east of Fyfe Avenue and Jersey Street, respectively, flows to a natural drainage swale to the south of Canola Avenue.

The area's only underground storm infrastructure (concrete storm sewer mains and manholes) was installed along Thatcher Avenue, Jersey Street, and the utility corridor west of Jersey Street in 1983/1984.

3.0 EXISTING AREA CONSTRAINTS

Based on discussions with the City of North Battleford it is understood that the Parsons Industrial Park experiences drainage issues during spring runoff and high frequency rainfall events. Some of the issues known to occur within the subdivision are as follows:

- Lot flooding
- Large area ponding
- Inadequate ditch capacity & volume
- Erosion

Potential causes for these issues based on discussions with the City of North Battleford are as follows:

- Unauthorized grading/ditch work by lot owner/lease
- Improperly managed off-site runoff
- Inadequate culvert/catch basin maintenance
- Inadequate overland drainage
- Lack of storm water attenuation and storage capacity
- Major/minor system conveyance constraints

The following sections of the report will detail the modelling work completed for the area and identify the potential causes and recommendations for the drainage improvements.

4.0 STORMWATER MODELLING

The Parsons subdivision and it's contributing areas were modelling using InfoWorks ICM (Version 2024.5.0). InfoWorks ICM is an advanced integrated catchment modelling software. The software utilizes '1D' and '2D' model engines where '1D' models are traditionally better suited for representing flow through pipes and '2D' models are better suited to representing complex floodplain mechanisms. InfoWorks ICM can integrate '1D' and '2D' models to generate a comprehensive model that excels at representing flow through pipes and floodplain mechanics.

To build out the model the LiDAR and topographic survey data were utilized to generate a 3D ground model in the software to which rainfall through a storm event could be applied in addition to informing the model on the pipe material, size, and slopes.

The storm event used in the model is the final critical requirement of the model. It informs the model of the rainfall intensity, over time, to apply to the model. The rainfall events chosen for this model are discussed in greater detail in Section 4.2.

The model results will allow Allnorth to highlight areas that may be of interest or concern for the City due to flooding, overtopping infrastructure, ponding or surcharging underground storm sewer. We can analyze the model output through profile view to highlight the peak elevations water achieves.

4.1 Model Parameters

Due to the model running primarily on the ICM '2D' engine, the following model parameters were required to more accurately represent the existing on-site surface conditions:

- Mannings Roughness Coefficient ('n') for surface features as shown below in Table 1.
- Horton Infiltration Equation variables for soil infiltration capacity as shown below in Table 2.

Table 1 – Mannings Roughness Coefficient ('n') for Surface Features

Material	Mannings 'n'
Asphalt Roads	0.076
Developed Lot	0.019
Empty Lot	0.250
Gravel Roads	0.081
Hwy #16	0.087
Meadow/Pasture	0.400

Table 2 – City of Saskatoon - Horton Infiltration Equation Variables

Variable	Value
Maximum Infiltration Rate (mm/hr)	125
Minimum Infiltration Rate (mm/hr)	15
Decay Rate of Infiltration (1/hr)	9

The 'n' value for a given surface describes the roughness of the surface and is one of the most important parameters in hydrological calculations as it is used to calculate discharge and flood water elevations.

The Horton Infiltration Equation describes the infiltration capacity over time for a given soil. If infiltration is not considered as part of the model, the model would be considered more conservative as there would not be a consideration for surface water lost to infiltration. As there are no known values for the infiltration for the City of North Battleford, Allnorth has applied City of Saskatoon Infiltration Equation variables to the model.

For the portions of the model that are completed under the ICM '1D' engine the following model parameters were required to accurately represent the conditions for the culverts, storm sewer, and external catchments:

- Mannings Roughness Coefficient ('n') for pipes and culverts as shown below in Table 3.
- Sub-catchments parameters as noted below.

Table 3 – Mannings 'n' for Pipes and Culvert

Material	Mannings 'n'
Corrugated Steel Pipe (CSP)	0.024
Concrete, HDPE & PVC	0.015
Steel	0.012

The 'n' value for a given pipe material describes the roughness of the pipe or conduit and is one of the most important parameters as it is used to calculate the capacity in gravity-flow pipes and conduits in combination with the diameter and slope of the pipe.

The external catchments that were considered in the model are discussed in greater detail in Section 4.3 of this report. External catchments were setup to meet City of Saskatoon Modelling parameters. All external catchments have been set to have a slope of 2% (0.02).

4.2 Rainfall Data

For the purposes of this drainage study, storm data from the City of Saskatoon Design Standards were utilized to generate hyetographs to simulate rainfall events for a given duration and return period. 1:5 yr and 1:100 yr return periods were selected to analyze the behavior of the infrastructure. In general, when modelling or analyzing storm water infrastructure a 1:5 Return Period rainfall events are used to analyze subsurface infrastructure. While 1:100 yr return period rainfall event are used to analyze surface or overland flow routes. The 1:5 yr scenario is run with a 1-hour storm duration while the 1:100 scenario is run with a 24-hour storm duration. The rainfall event data for the 1:5 and 1:100 yr return periods can be found in Appendix B.

4.3 Catchment Areas

The study area captured by Allnorth's drone survey covers the full extents of the Parsons subdivision as shown in Figure 2, and is inclusive of Catchments 21 & 22 (City of North Battleford's Storm Sewer System – February 2017) shown in Appendix C.

However, additional areas outside of the drone survey area contribute to the runoff that passes through the Parsons development. Catchments 14, 15, 18, 19, 20 (City of North Battleford's Storm Sewer System – February 2017), as well as additional catchments that were delineated by Allnorth utilizing Surface DEM datasets available from the Government of Canada have been considered for runoff generated in the model. The additional areas contribute to the area and culverts passing across the Yellowhead Highway as shown below in Figure 3.

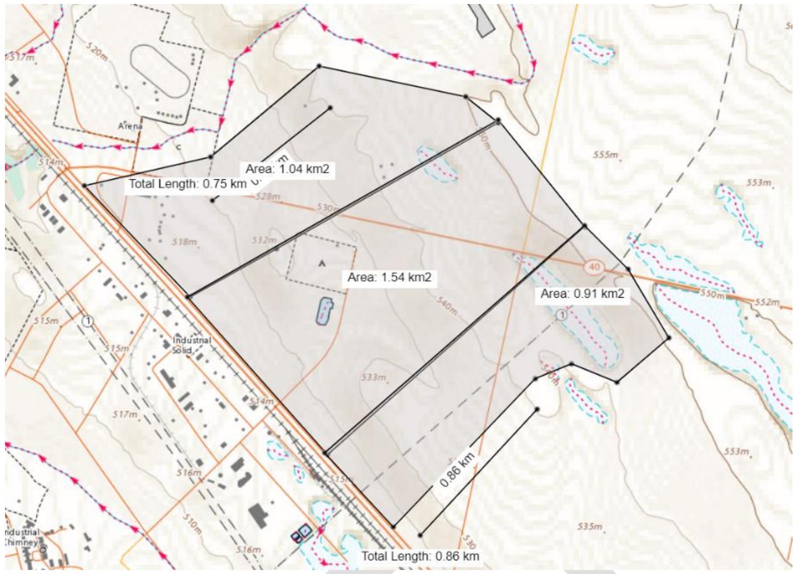

Figure 3 External Catchments

4.4 Results

4.4.1 1:5 Storm Event – Minor System Performance

Minor system analysis via Infoworks ICM model simulation was completed on the minor storm system that currently exists on Thatcher Avenue from Simmental Street to Holstein Street, Jersey Street from Thatcher Avenue to the rear of Block 301, and the main along the rear of Block 301.

In general, the minor system appears to be functioning well. The sewer main does not appear to be experiencing any surcharging and may even have additional capacity to service the existing or future development areas. It should be noted that the model assumes that the inlets into the storm sewer system are in good condition and are free from defects or blockages that would affect the entry of water into the storm sewer system.

However, there is one catch basin adjacent to the frontage of Lots 6/7 of Block 301 that seems to experience some low levels of ponding. This does not appear to be a major issue as the ponding clears up relatively quickly with no long-term ponding remaining. In addition to this there is a slight surcharging of one metre or less, occurring at the inlet of the large diameter storm sewer main at Lot 1/2 of Block 304.

It was noted during this scenario that there are portions of the road ditch network within the currently developed industrial subdivision that may experience some low levels of flooding as it appears in the model that there are some poorly graded ditches and/or culverts restricting the flow and movement of the surface water.

Refer to Appendix D for profiles of the minor system during peak flows.

One distress that was noted in this model simulation was the large two metre diameter culvert that is located on the southwest limit of the site at the ravine crossing on Poundmaker Trail. It appears in the model that there is potential for overtopping of the roadway at this location with a magnitude of up to 2.2 metre. It is worth mentioning that the overtopping condition is present for approximately one hour and 15 minutes with the worst of the overtopping taking approximately 35 minutes to pass. This overtopping would be further exacerbated in more extreme weather events.

Refer to Appendix E for storm event flood mapping of the above area.

4.4.2 1:100 Storm Event – Major System Performance

Generally, the major system is intended to accept and convey runoff water from the minor system once the capacity of the minor system (which consists of inlets and pipes for underground storm sewer networks) has been exceeded. Typically, this will happen when a storm or runoff event exceeds a 1:5-year storm event. Once a greater than 1:5-year event has been achieved, it is expected that the minor system would begin to surcharge and backup to the major system (surface) and the major system will then begin to convey water.

There are two ways to achieve a successful major system:

- Attenuate and Store runoff water (This is the more desirable and responsible option)
- Allow for an unencumbered flow path to an outlet

Upon our review of the contributing areas, we have concluded that there are no allowances made to attenuate and store runoff water while at the same time it appears that water is not allowed to flow unencumbered within the right of ways to an outlet. It should be noted that an unencumbered pathway would be regarded as a significant ditch with a minimum 3m wide bottom and a minimum of 1m of depth and may increase in size, depending on the levels of flow that are required for conveyance.

Development in the Parsons Industrial Subdivision has been on going for ~50+ years and will therefore present challenges to resolving some of the drainage issues for the following reasons

- Right of Way widths have been previously chosen and set.
- Intercepting storm water for attenuation may be difficult without additional property upstream of the Parson's development.
- Budgetary Constraints may limit the scope and type of work that may be chosen to correct distresses.

During the 1:100 scenario, it was noted that there is the potential for flooding in the following areas on public property:

- Durum Avenue
- Thatcher Avenue
- Aberdeen Street
- Holstein Street
- Jersey Street – From Thatcher Avenue to Fyfe Avenue
- Canola Avenue – From Aberdeen St to Canola Avenue curve

Additionally, it was noted that private property will likely experience flooding in the areas shown in Table 4.

Table 4 – Private Property Expected to Flood Areas

Block Number	Lot Number(s)	Fronting Street
301	3 – 16	Thatcher Avenue
303	1, 18, 19 & 23 – 25	Thatcher Avenue
303	20, 21 & 27	Fyfe Avenue
304	1 - 7	Thatcher Avenue
307	1 – 6	Thatcher Avenue
307	13 – 16 & 20	Marquis Avenue
308	1 – 3	Thatcher Avenue
308	4	Holstein Street
X	N/A	Thatcher Avenue

The flooding that occurs on the properties could be considered a concern as the maximum depth achieved is expected to be approximately 1.0 m with the worst of the flooding situated in the rear of the lots. There are some exceptions to this, and the worst case of private lot flooding is expected to impact Block 303 Lots, on the rear property line of approximately 1.3 m.

The distress that was noted in the 1:5 model simulation for the large two metre diameter culvert that is located on the southwest limit of the site at the ravine crossing on Poundmaker Trail is further expanded upon for this scenario. In this model simulation, there is overtopping of the roadway at this location with a magnitude of up to 2.95 metres. It is worth mentioning that the overtopping condition is present for approximately one hour and 30 minutes with the worst of the overtopping taking approximately 30 minutes to pass. The total amount of time that the roadway at this location is experiencing either overtopping or water near the shoulder is 8 hours and 30 minutes.

Refer to Appendix E for storm event flood mapping of the above areas.

4.5 Off site Water

Fill words….

Opinion of flows and impacts to parsons. Further study to understand predev flow rates .

4.6 Future Development

At the time of model and report preparation, Allnorth was only aware of the land to the east of the Cargill Site that the CoNB is considering for future development as outlined below in Figure 4.

In general, any future development should carefully consider attenuation and capturing of storm water to reduce the downstream impacts. Additionally, consideration should be given to the relationship between the road, ditch, or storm drain elevations, and building elevations to ensure that building footprints are raised high enough to minimize or eliminate site specific flooding concerns. However, specific to this site, the general grade is to the south and naturally drains towards an existing low point that directs storm water flows toward the east limit of the development area. Regarding future storm water and drainage, it appears that this site would be a suitable candidate for development. However, this opinion does not include the ability nor the difficulty of servicing the site with underground utilities or the geotechnical suitability of the site.

City of saskatoon/Regina storm water policy…attenuation and storage, on site storage etc.

Comment on wetlands use to store water.

Figure 4 Future Development Area

4.7 Recommendations

Based on the existing information that we have examined, feedback from the City of North Battleford on site specific issues, and the outputs from the model the following recommendations can be made to improve the drainage within Parsons Industrial Subdivision.

4.7.1 Minor System Improvements

4.7.1.1 Minor System Capacity Study

While the model does note that there is additional capacity in the system, a capacity study is outside of the current scope of work for this model and reporting. A capacity study would reveal the additional area that could be serviced as well as any opportunities for extending the minor system or adding additional catch basins in existing areas.

4.7.1.2 Minor System Additions

As the minor system appears to have some excess capacity, areas adjacent to the minor system that are experiencing some form of drainage distress may be a good candidate to extend the minor system through the addition of catch basins along the current main.

Further study would be required to recommend locations where the minor system could be extended.

4.7.1.3 Minor System Maintenance

To keep the minor system in the best operating condition, it would be beneficial to maintain all entrances into the storm sewer to allow water to freely enter pipes that come to grade or water to freely enter the catch basin frame and cover.

Additional maintenance would be to remove detritus from the sumps of the manholes and catch basins (if they were installed with sumps), and to jet out any pipes (inflowing or outflowing) to ensure that the peak inlet conditions are maintained.

4.7.2 Major System Improvements

4.7.2.1 Culvert Maintenance

Maintenance should be performed on the existing culverts as an ongoing practice. There were many majority? locations noted during Allnorth's investigation where the inlet or outlet of the culvert is damaged or distressed.

Typical modes of distress noted were partially collapsed ends, foliage blockages, or partially buried infrastructure – each of these distresses will reduce the efficiency of the infrastructure and may contribute to localized flooding.

In the springtime, culvert ends should be free and clear of snow and ice so that the water may flow more freely through the culvert. This is especially critical during the freeze/thaw melting cycle, as allowing the culvert end to be free will allow the warmer day time air to enter and thaw the culvert.

It is recommended that a jetting program be considered, starting with the pipes that have been observed to have the most amount of material remaining. Culvert jetting will ensure that the barrel of a given culvert is free from sediment and other detritus by removing it with high-pressure water spray.

4.7.2.2 Culvert Upgrades

At points where there are concerns with flooding it may be a worthwhile to investigate increasing the size and/or the number of culverts at a particular location. Careful consideration needs to be given to making changes like this to the storm network as making an improvement upstream may move and exacerbate the issue at a downstream location due to increased infrastructure size and the potential to flow greater amounts of water. Any improvements that will increase the amount of flow need to be approached holistically and started from the outlet, working up and away from the outlet to ensure that increased flow is able to be conveyed by downstream improvements.

4.7.2.3 Ditch Maintenance

Ditch maintenance is an oft overlooked maintenance item for many municipalities. Often times, ditches will collect sediment and eroded material from lots and the roadway which are deposited into the ditch bottom, where given enough time, will cause the grades to become altered from their original state. The deposited material may affect the ditches in the following ways:

- Reduce storage capacity in the ditch.
- Create grade differentials at culvert inlets/outlets.
- Negatively impact the ditch grade which can decrease flow rates.
- If enough material is deposited in the ditch, it may become non-functional.

Typically, excavations from a ditch are considered maintenance if 150mm or less material is removed from the ditch bottom.

4.7.2.4 Ditch Improvements

Reprofiling or over excavating a ditch to establish a new grade is generally considered a ditch improvement. Where 150mm or more material is removed from a ditch this would be considered an improvement.

With additional study, ditches may be deepened, widened and/or reprofiled. In addition to this, unapproved ditch work completed by entities other than the municipality should be removed. Based on the ditch improvements described above, the following effects would be expected on the ditch network depending on the chosen improvement but may include:

- Additional storage within the ditch before property or roadway infrastructure are impacted.

- Increased flow in the ditch if ditch grades can be increased.
- Re-establish intended design pathway by removing illegal ditch blocking.

4.7.2.5 Runoff Attenuation and Storage

Slowing down and storing runoff water is an excellent strategy to relieve the stress on drainage infrastructure. However, this is more difficult to implement in existing areas of development; generally, this is because the grades of roadways and drainage infrastructure are set, and adjacent properties may not be owned by the City to provide a location for storage of runoff water.

Areas that are not experiencing flooding could have the inlets or outlets of culverts restricted to slow the flow rate of water down and activate some storage of water in the ditches. This may be a good approach in select areas as it may be more cost effective to utilize existing infrastructure as is, compared to improving or adding to the existing infrastructure.

For areas of future development or areas that are not yet fully built out where the City still has land control, the City may wish to consider creating a or some areas to detain storm water to be released at a lower rate than would otherwise be possible without the storage.

4.8 Prioritizing Recommendations

The above recommendations generally apply to the entire site where development has taken place. However, based on the model results there are areas within the development that stand out as candidates that require further study, engineering design and investment in infrastructure improvements and maintenance. Table 5 is a summary of the areas that, based on the model, present the most risk to private and public property.

Table 5 – Private Property Expected to Flood Areas

Priority Area	Block Number(s)	Lot Number(s)	Fronting Street	Distress
3	301	3 – 16	Thatcher Avenue	Rear Lot Flooding
2	303	1, 18, 19 & 23 – 25	Thatcher Avenue	Rear Lot Flooding
2	303	20, 21 & 27	Fyfe Avenue	Rear Lot Flooding
1	304	1 - 7	Thatcher Avenue	Lot Flooding, Public Roadway Flooding
1	307	1 – 6	Thatcher Avenue	Lot Flooding, Public Roadway Flooding
3	307	13 – 16 & 20	Marquis Avenue	Lot Flooding
1	308	1 – 3	Thatcher Avenue	Lot Flooding, Public Roadway Flooding
1	308	4	Holstein Street	Lot Flooding, Public Roadway Flooding
4	X	N/A	Thatcher Avenue	Lot Flooding
2	N/A	N/A	Poundmaker Trail	Overtopping road at large dia. Culvert.

5.0 SAFE BUILDING ELEVATIONS

5.1 New Development/Infill Development

During the design of a new development or infill of existing lots, careful consideration should be given to the relationship between the road, ditch, or storm drain elevations, and building elevations. It is much easier to incorporate and be proactive with flood mitigation than reactive attempting to alter existing infrastructure.

5.2 Existing Building and Development

Existing buildings or structures that may experience pressure from flooding during rain events will require a modified approach to maximize the safety of the existing building grade. This is due to the expense and complexities or raising or relocating existing buildings. The design methodologies used to minimize flooding of affected lots would be to improve the overland drainage network downstream of any afflicted properties such that the high water realized during a flood would be lower than the existing building grade.

6.0 REGULATORY APPROVALS

Should any of the recommendations herein be advanced to preliminary engineering, detailed engineering, or construction execution the following regulatory agencies should be notified and approvals received, if required:

- Water Security Agency
- North Saskatchewan River Valley Basin Council
- Department of Fisheries and Oceans (DFO)
- Saskatchewan Association of Watersheds
- Transport Canada – Navigable Waters
- CN Rail

7.0 CAPITAL PLANNING

Allnorth understands that the City of North Battleford will ultimately remediate some of the drainage issues within Parsons Industrial utilizing approximately $150,000-$200,000 of budget per year. Immediate and medium-term remediation recommendations have been identified below with associated capital cost estimate (+/- 50%) for consideration.

7.1 Immediate Term Recommendations

The following items should be focused on within 0-5 years in order to remediate some of the most urgent drainage issues within the Parsons Industrial Park:

Item	Capital Cost Estimate
Culvert maintenance (Cleaning, end treatments, spot grading, etc.)	$25,000/year
Culvert design/replacement (3 locations)	$90,000/year
Ditch maintenance (Cleaning, grading, etc.)	$35,000/year
Drainage Design and Cost Estimating for Blocks 304, 307 and 308.	$50,000 – One Time Expense

A maintenance program should be established to address culverts and ditches on a yearly basis. During our time on site, we have observed that many of the ditches and culverts, (especially on Thatcher Avenue), have had material deposited into the ditches leaving many of the culverts partially or completely covered.

Specific locations of culverts and ditches can be identified and prioritized in conjunction with City of North Battleford however, the City will likely have to find additional budget or funding to accomplish the necessary infrastructure improvements to improve the drainage conditions of the areas noted in Section 4.4.2. Local maintenance initiatives will likely improve the distresses these areas could experience in a large rain event; however, it appears that major improvements including reconfiguring the ditches and adding in additional storm water detention upstream of the Parsons development will be necessary to ensure minimal impacts to public and private property.

The anticipated capital costs that have been provided to Allnorth as a budget for maintenance and improvements appears to be insufficient to resolve the drainage distresses being experienced within the development, especially if major improvements like reconfiguring ditches are concerned. As the development continues to infill the remaining lots, and runoff is intensified by an increase in impermeable area the current distresses may be exacerbated. Therefore, a further recommendation would be to increase the budget to address the distresses within the development from approximately $200,000 maximum to approximately $500,000 maximum per year. This would allow the City to save funds and tackle larger portions of the work identified in the medium-term recommendations every other year while continuing with maintenance.

7.2 Medium Term Recommendations

The following items should be focused on when budget allows or after 5+ years in order to remediate some of the larger drainage issues within the Parsons Industrial Park. The work should consider the priority in which to proceed with each project. Allnorth has provided Table 5 in section 4.7 of this report as a basis for project prioritization:

Item	Capital Cost Estimate
Minor system improvements	$0.05M – $0.25M per location
Drainage Improvements Block 304, 307, 308	$1.0M+
Ditching improvements Block 301	$0.5M+
Ditching improvements Block 303	$0.5M+
Culvert Improvement on Poundmaker Trail at Ravine crossing	$0.7M+
Stormwater management facility	$2.5M+

7.0 CONCLUSIONS

Regarding the overall performance of the drainage within the Parsons Development, during the 1:5 scenario, Allnorth observed that generally the minor system does not have any major distresses that in our opinion would need to be immediately addressed and may be improved with a capital maintenance program. One note of concern was the large diameter culvert crossing on Poundmaker Trail. The model showed that this location of the roadway would be overtopped for a brief period of time. Our recommendations have proposed a cost to improve the crossing location with engineering design and infrastructure upgrades.

Concerning the 1:100 scenario, Allnorth observed that the larger storm event does create pressure on the minor system, which is expected, and the major overland drainage infrastructure (Culverts and ditches). A large portion of the pressure is fixated on Thatcher Avenue and the surrounding private properties adjacent to the right of way.

Alleviation of the issues will involve a mix of upstream attenuation, culvert and ditching improvements and additions to the minor system.

To address all the distresses, the CoNB may have to find additional budget or secure funding to resolve some of the more complicated distresses that will involve extension of the storm minor system, ditch excavation and reprofiling, resetting of large numbers of culverts at one time and creation of upstream storm water attenuation.

This report should also be revisited in a 5-year timeframe to realign the conditions that will exist in the future to the findings and recommendations of this report. This can also act as a check in to see how many of the distresses have been addresses and if there are further recommendations to be made at that time.

We trust this report satisfies your requirements at this time and thank you for the opportunity to work with you on the project. If you have questions or concerns do not hesitate to contact our office.

Yours truly,

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Appendix A Culvert Photolog

Appendix B Rainfall Event Data

Appendix C City of North Battleford's Storm Sewer System – February 2017

Appendix D Minor System Profiles

Appendix E Storm Flood Mapping