TECHNICAL MEMO:

TO : Lynda Vanderwoerd - Village Of Linden

COPY TO : Arlen Babcock, P.Eng,- CIMA+

FROM : Pawan Bhattarai, P.Eng.
Dindo Pangilinan, P.Eng., PMP

DATE : October 07, 2024

SUBJECT : **CA000928-Village of Linden – North Linden ASP (Northwest Area) Conceptual Stormpond Sizing**

1. INTRODUCTION

CIMA+ has prepared the conceptual storm pond analysis in support of the Linden Area Structure Plan (ASP) for the Northwest Area, which is located within SW-29-30-25 W4. The contemplated land use within the ASP consists of a mix of industrial and residential developments, as shown in the concept plan prepared by Palliser (November 2023) and found in Appendix A. This contemplated land use will increase the imperviousness of the area, resulting in increased stormwater runoff. Consequently, a stormwater management facility (storm pond) will be necessary to manage the excess runoff and provide water quality enhancement.

2. PROPOSED DEVELOPMENT

The study area covers approximately 21.04 hectares, including 15.20 hectares of residential lots, commercial/industrial lots, parks, and a public utility lot (PUL) designated for a future storm pond. Additionally, based on available LIDAR data, there are approximately 53.18 hectares of upstream (offsite) lands contributing to the study area. The anticipated post-development imperviousness of different land uses within the study area is shown in Table 1 below.

Table 1: Proposed land use and imperviousness.

Proposed Development	Area (ha)	Imperviousness (%)
Commercial and Light Industrial	7.33	85
Residential	5.20	65
Park	2.12	5
Internal Roads	4.36	85
Pond (PUL)	1.55	100

The runoff generated from individual lots will be routed to the storm pond through the minor and major (overland) systems, where it will be collected and treated before being discharged at a controlled rate. However, the runoff from the offsite areas will be routed into the future storm pond as flow-through and will not be considered in the pond sizing.

Figure 1: Proposed development along with upstream catchment area.

3. CONCEPTUAL POND ANALYSIS

The Public Utility Lot (PUL) area, as shown in Figure 1, is designated for the stormwater management facility. The catchment delineation information was extracted from the Village of Linden Infrastructure Master Plan (CIMA+, 2021), which illustrates the general drainage patterns from north to south and southeast. The Infrastructure Master Plan recommends an allowable release rate of 1.40 L/s/ha.

The total runoff from the upstream offsite areas is estimated at 406 L/s for the 1:100-year storm events and will be routed to the storm pond as flow-through discharge. The total allowable discharge from the pond, including the upstream flow-through discharge, is estimated at 435 L/s (refer to Table 2 for details).

Table 2: Allowable release from the pond,

Catchment	Area (ha)	Recommended UARR (L/s/ha)	Total Release from Pond (L/s)
Proposed Development	20.56	1.40	28.78
Upstream Catchment (Flow through)	53.18	Flow-through	406
Total:	73.74		435

A hydraulic model analysis was performed to determine the pond size. The analysis utilized the City of Calgary rainfall data for a 24-hour 1:100-year storm (single-event simulation) and the Calgary International Airport precipitation data spanning the period from 1960 to 2014 (continuous simulation).

The model employed the Horton infiltration approach, and due to the absence of field values for infiltration parameters, the soil infiltration parameters used in this model are based on recommendations from the City of Calgary Stormwater Management & Design Manual (2011).

Table 3: Infiltration parameter used in the model as per CoC manual.

Parameter	Value	Unit
Initial Infiltration	75	mm/hr
Final Infiltration	7.5	mm/hr
Decay Constant	4.14	1/hr
Drying Time	7	days

The depression storage values used for this model were also obtained from the City of Calgary and are 1.6mm for impervious surfaces and 3.2mm to 5mm for the pervious surfaces. The Manning's 'n' values used are 0.015 and 0.25 for impervious and pervious surfaces respectively.

Water surface evaporation was also included in the continuous simulation analysis based on the shallow lake evaporation as presented in Table 4-1 of the City of Calgary Stormwater Design Manual by converting the total monthly evaporation to average daily evaporation rate.

Conceptual Pond Design

The conceptual pond is designed to accommodate the peak flow up to 70 L/s/ha from the entire ASP area, with a pond release rate of 435 L/s, which includes the upstream flow-thorough discharge. The schematic pond design and stage-storage are shown in the figure below.

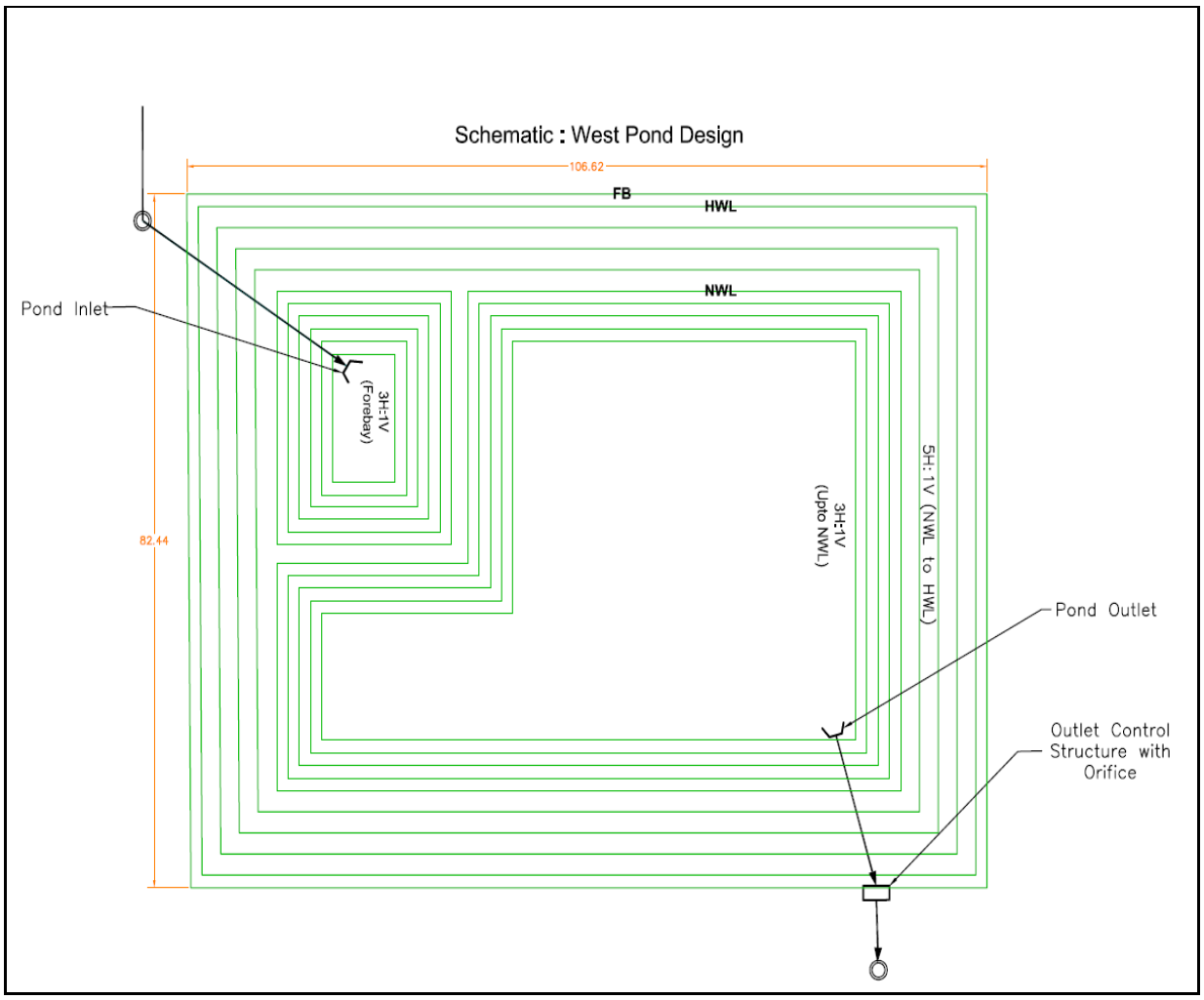

Figure 2: Schematic Pond Design, West

The following assumptions were used in the pond design:

- The pond is designed as a wet pond, with a permanent pool depth of 2.0 meters below the normal water level (NWL) and an active storage depth of 2.0 meters.
- A forebay is designed at 0.5 meters below the bottom of main pond cell for the allocation of sediment deposit.
- The total pond depth is 4.8 meters from the bottom of designed forebay and 4.3 meters from bottom of main cell, including a 0.3-meter freeboard.
- No allowance was made for stormwater reuse, such as an allocation for irrigation.
- The peak allowable discharge from the pond is controlled at 435 L/s. The outlet from the pond is routed to an undeveloped road allowance south of Picci Ct and then heads east along 11MR, ultimately draining to the coulee.

- The pond is designed to accommodate the runoff from the ASP area at an average rate of 70 L/s/ha. Additionally, storm runoff from upstream undeveloped agricultural land will be routed through the pond as flow-through discharge.
- The pond will have 3H:1V slope from bottom up to NWL and 5H:1V from NWL to HWL.

Table 4: Preliminary Pond Stage Storage

Pond	Depth (m)	Total Area (m^2)	Forebay Area (m^2)	Total Storage Capacity (m^3)	Active Storage (m^3)
Bottom of Forebay	0.0	126	126	0	-
Bottom of Main Pond	0.5	2,755	205	720	-
NWL	2.5	4,819	703	8,204	-
HWL	4.5	8,209	-	21,208	15,549
Freeboard	4.8	8,766	-	23,754	-

Model Result

The precipitation-runoff simulation within the proposed area is analyzed with single event and continuous simulation techniques using PCSWMM model. 24 hours 1:100-Year storm event for City of Calgary and continuous simulation for the period of 1960 to 2014 (inclusive) model result are discussed below. A frequency analysis has been performed to determine 1:100-year pond volume based on the continuous simulation results.

The total volumetric summary of the single event, continuous simulations and statistical analysis are presented in the Table 5 below. The continuous simulation result governs the required pond volume which is the largest among the simulation results that is 19,930 m^3.

Table 5: Summary of Model Simulation Results

Event	Unit	Total Volume (m^3)	Depth (m)
24 hr 1:100-Year. Flow through	m^3	17,680	4.05
Continuous Simulation from 1960 to 2014 (City of Calgary rainfall data). Flow through	m^3	19,930	4.34
Statistical Analysis (Log Normal III)	m^3	15,600	

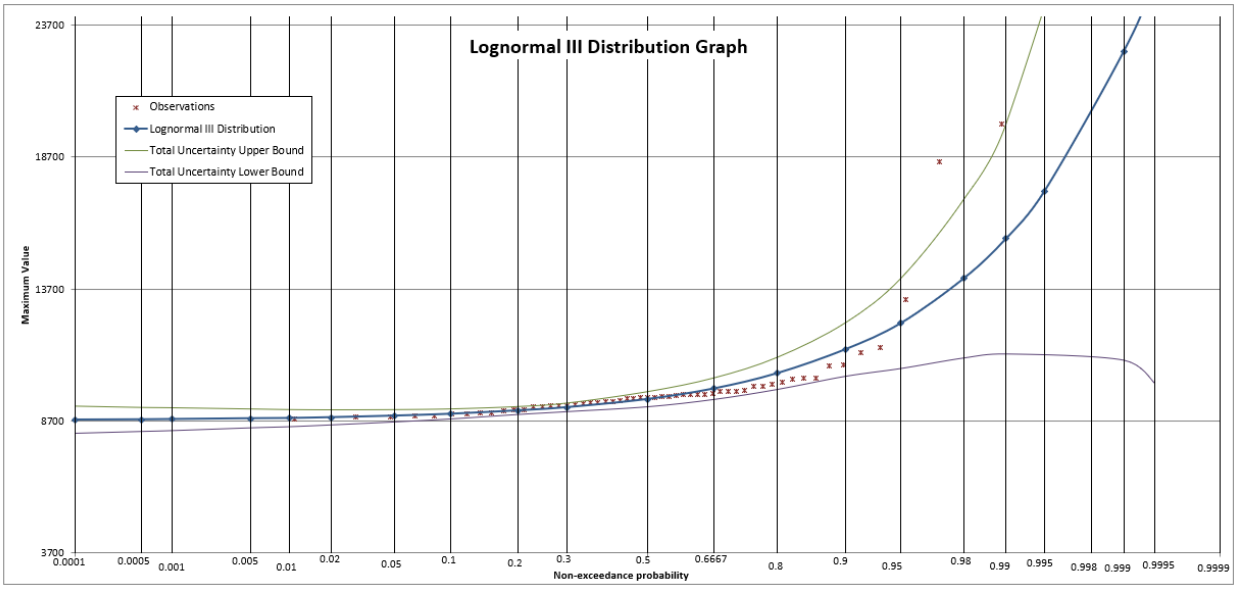

Figure 3: Visual Goodness of Fit for Lognormal III Distribution Graph using City of Calgary data and frequency sheet.

As indicated in Tables 4 and 5, the conceptual pond with a capacity of 21,201 m³ at HWL can accommodate the total volume requirement of 19,930 m³. The storm pond will attenuate the flow and provide the water quality enhancement for the storm runoff to meet or exceed 1:100-year storm events.

The conceptual storm pond size for the Linden West ASP is presented in Table 6 below. The size offers an approximate estimate of the necessary footprint, based on assumption made which follows the City of Calgary Stormwater Management Guidelines (2011). If the land uses and volume targets deviate from our study assumptions, the required pond volume will need to be adjusted accordingly.

Table 6: Conceptual Storm Pond Size.

West Pond	Unit	Quantity	Remarks
Depth of Forebay	m	2.5	
Depth from Bottom of Forebay to HWL	m	4.5	
Side Slope up to NWL		3H:1V	
Side Slope from NWL to HWL		5H:1V	
Freeboard at above the HWL	m	0.3m	
Surface Area at bottom of Main Cell	m^2	2,755	
Surface Area at HWL	m^2	8,209	
Surface area at pond top (at Freeboard level)	m^2	8,766	0.88 ha
Total capacity of pond at HWL	m^3	21,208	

The designed surface area at the freeboard of (the conceptual) pond is approximately 0.88 ha for storage purpose only. Additional area within the dedicated PUL will be required for maintenance access road, perimeter pathways (where applicable), outlet control structures, escape route, and other recreational features which should be finalized during NASP stage or detailed pond design stage.

4.0 Upstream Off-site Flow Options

The conceptual pond designed with an orifice outlet for worst case scenario where stormwater runoff from all the upstream areas will be routed as flow through discharge from the pond. The allowable release from the development is 28.78 L/s (UARR of 1.4 L/s/ha) and 406 L/s of flow through discharge accounting for total discharge of 435 L/s from the designed orifice.

However, this study also accounts for several options to route the upstream off-site runoff which as discussed below.

Option 1: Routing Entire Off-site to Flow Through Development

The entire upstream off-site flow can be captured and routed through the proposed development to the pond and discharged as flow-through from the designed pond outlet. This option will necessitate the need to design the minor and major stormwater system to accommodate the additional off-site flow which could result in bigger pipe sizes.

Option 2: Routing Off-site Flow (West of Hwy 806) Towards the South

This option assumes approximately 40 ha of off-site external drainage west of Highway 806 will be drained to the south through the existing east ditch along Highway 806 which ultimately drains to the coulee south of Township Road 304. The approach will partially eliminate the requirement to route the off-site flow through the proposed development and the accommodation in the storm conveyance system.

Option 3: Routing Off-site Upstream Flow to Coulee By-Passing the Development.

The upstream off-site flow to bypass the ASP area by constructing ditches around the development to capture and convey the off-site flow directly into the coulee. This option will completely eliminate the need to accommodate the additional flow in the minor system within the proposed development.

The decision as to which of the above options is best suited to accommodate the upstream offsite runoff will be made in consultation with the Village of Linden. While the pond's size and footprint will remain consistent for all three options, the orifice design, outlet pipe from the pond and emergency escape route will vary based on the specific option chosen.

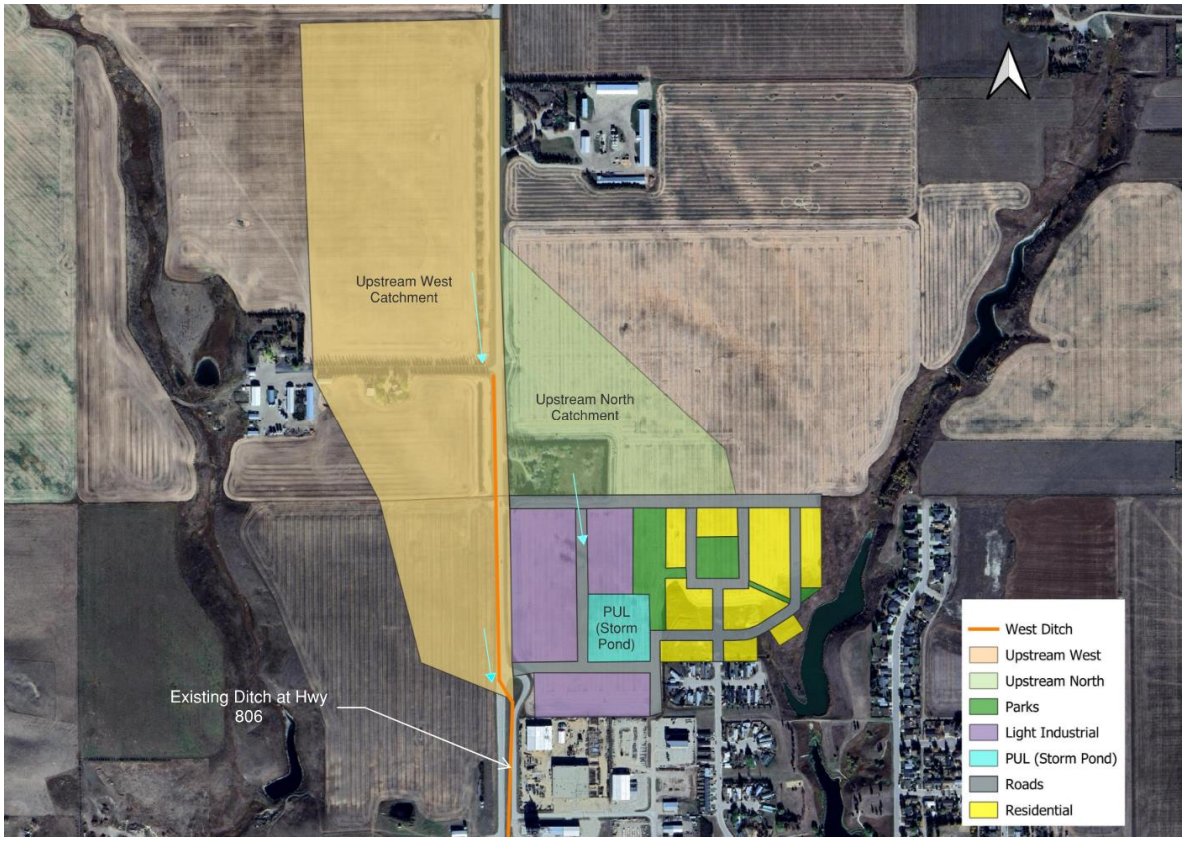

Figure 4: Offsite West Catchment and the Existing Ditch

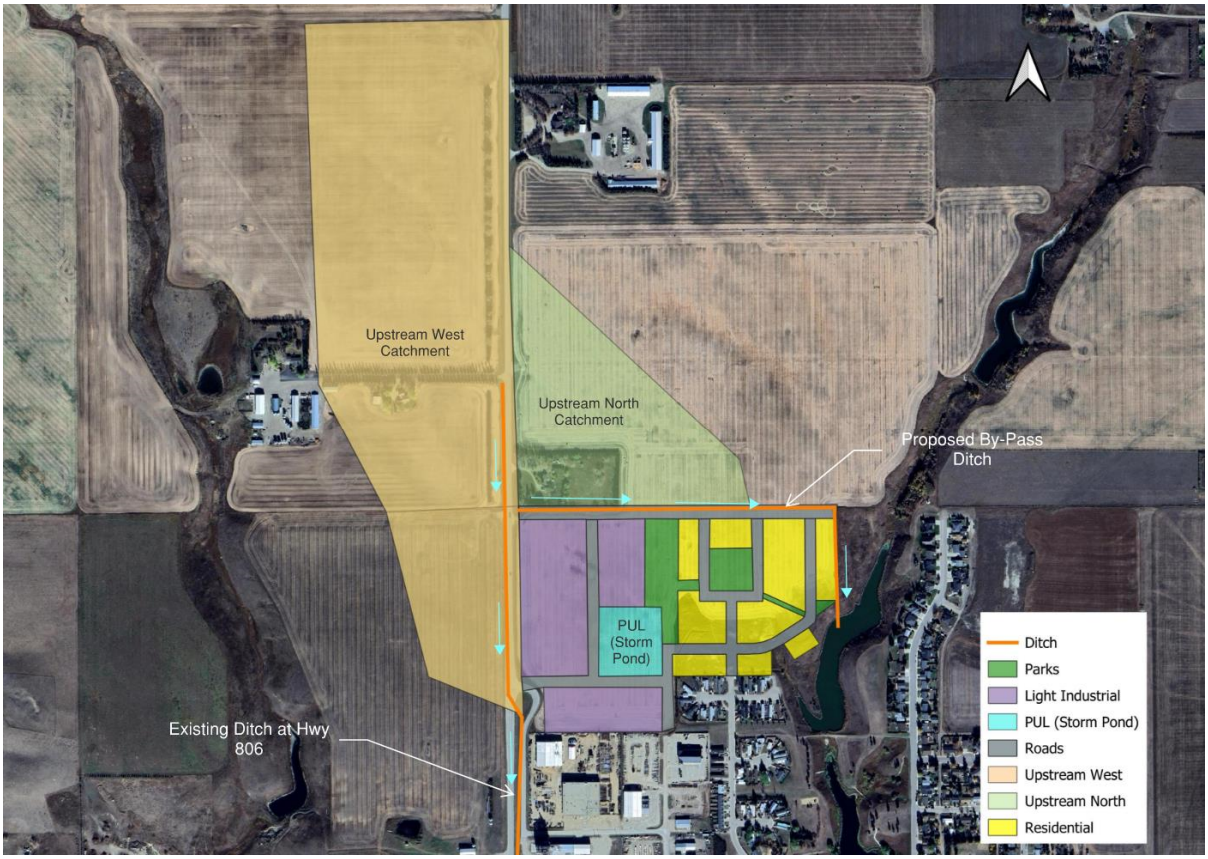

Figure 5: Proposed Bypass Ditch and Existing West Ditch

4. CONCLUSION

+ The proposed Northwest Linden ASP development encompasses approximately 21.04 ha of land. The conceptual pond is designed to accommodate the discharge from the development at the peak rate of 70 L/s/ha and to release at 1.4 L/s/ha from the development, and additional flow-through discharge of 406 L/s from upstream off-site catchment.
+ A PCSWMM model was used to optimize the preliminary pond volume including forebay and permanent pool. A wet pond of total capacity of 21,208 m^3 is proposed with approximately 0.88 ha of surface area at top of the pond. Additional PUL land should be allocated for maintenance access, perimeter pathways, outlet control structures and other recreational features around the pond.
+ Study proposes three possible options to handle the off-site drainage runoff. The decision as to which of the above options is best suited to accommodate the upstream offsite runoff will be made in consultation with the Village of Linden. Regardless of which option is selected, the required pond volume will stay the same for all scenarios.
+ This Memo provides guidance on the conceptual storm pond design in terms of its size, footprint and location. The design of the pond will be further refined and finalized at detail design stage.

5. LIMITATIONS

The drainage analysis undertaken is for surface water only. No hydrogeological impacts, geotechnical or geomorphological analysis, or snow melt scenario was undertaken as part of this study.

Any use which a third party makes of this report, or any reliance or decision to be made based on it, are the responsibility of such third parties. CIMA+ accepts no responsibility for any damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

CIMA+ reserves the right to amend the report if new information is collected or if the information provided to CIMA+ used in this analysis is found to be inaccurate.

6. CLOSING

CIMA+ trusts that the information contained in this memo meets your requirements. Please do not hesitate to contact the undersigned if you have any questions or require additional information.

Prepared By	Reviewed By
	
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APPENDIX A:
North Linden ASP Concept Plan

LINDEN ASP - NW AREA - CONCEPT DESIGN

Statistics

Land Use	Area (acres)	Area (ha)	%
R2 - Residential - detached	8.77	3.55	17.2
R3 - Residential - attached	4.13	1.67	8.1
M1 - Industrial	13.35	5.40	26.2
C2 - Ind / Com Flex	4.28	1.73	8.4
P2 - Storm ponds	3.86	1.56	7.6
P1 - Municipal reserve / parks	5.18	2.10	10.2
M1 / ROW	0.60	0.24	1.2
Roads	10.74	4.35	21.1
Total	50.93	20.61	100

Notes

- 4.9 acres of MR can be taken (deferred reserve owing)
- Land against the coulee is considered Environmental Reserve (ER)
- Storm pond sized as per engineering calculations. Outer edges of P2 areas could be MR, but require further design work.
- Existing service road to be stubbed
- Intersection with Hwy 806 would require redesign
- Large park buffer used to separate impacts from industrial and residential areas

LEGEND

- West Area Boundary
- Existing Parcel
- Existing Road
- Proposed Local Road

Propsed Parcels

- C1 Commercial
- C2 Commercial / Industrial Flex
- M1 Industrial
- M1+ Industrial Expansion or ROW
- R2 Single-Detached Residential
- R3 Attached Residential
- P1 Park
- P2 Public Infrastructure

NORTH LINDEN ASP

LINDEN, ALBERTA

CONCEPTUAL STORM SEWER SERVICING

LEGEND

- PROP. MINOR STORM SEWER
- PROP. STORM MANHOLE
- EXISTING CULVERT
- PROP. STORMWATER MANAGEMENT FACILITY

HYW 860

400 PICCI CT

PICCI CT

PICCI CT

PICCI CT

COULEE

1 ST NW

6 ST NW

5 ST NW

1 AVE NW

ST 300

DATE :	JUNE 12, 2024	SCALE :	1:1250

PROJECT No :	CA000928	FIGURE ST-1