Technical Memorandum

To: R.M. Corman Park
From: Joe Waln, P.Eng., CFM
Subject: Floodway Reduction Feasibility Analysis
Date: October 12, 2020
Project: 61111046.01 R.M. Corman Park Flood Risk Reduction

This memorandum documents the analysis of potential dyke alignments for reducing floodway extents for the South Saskatchewan River floodplain. The objective of the analysis is to provide the Rural Municipality (R.M.) of Corman Park with information needed to understand the planning-level cost and hydraulic impacts of three dyke alternatives.

1.0 Background

In early 2019, Barr Engineering Co. (Barr) completed the South Saskatchewan River Flood Study for the R.M. This study used 2D hydraulic modeling of the river to define in more detail those areas that meet the provincial definition for floodway (1 metre deep or 1 metre per second flow velocity) for the 1:500-year floodplain. Attachment A, Figure A-1 is a map of the floodplain and floodway as defined in the 2019 study.

The R.M. requested this follow-up study to explore alternatives for reducing the floodway extents with infrastructure rather than with policy changes or changes to the definition of the floodway. Outside of the South Saskatchewan River channel, velocities are generally less than 1 metre per second. Therefore, areas in the overbank portion of the floodplain are defined as floodway primarily due to depths greater than 1 metre.

2.0 Alternatives Analysis

Under existing conditions, the South Saskatchewan River floodplain is 5 to 7 kilometres wide through much of the R.M. There are relatively few impediments to flow in the floodplain. The major exception is the Valley Road embankment. During the 1:500-year flood event, water can pass under the roadway through large culverts. There are also some locations where the 1:500-year flood overtops the roadway by over 1.5 metres.

Three dyke alternatives were evaluated for reducing floodway extents by blocking the 1:500-year flood waters from entering areas behind the proposed dykes. The alignments for the three alternatives are shown in Attachment A, Figure A-2.

In the following subsections, profiles are provided showing the existing ground along the proposed dyke centerline (dashed black line), the 1:500-year flood water surface elevation with the proposed dyke in place (dark blue line), the 1:500-year flood water surface elevation without the proposed dyke (i.e., existing condition, light blue line), and the proposed top of the dyke or road (where raised) as a solid black line. The elevation of the top of the dyke was chosen to be 0.5 metres higher than the water surface elevation in the proposed condition. This is consistent with freeboard requirements for newly developed structures in the R.M. The x-axis scale (stationing, or distance horizontally) is kept consistent in all three profile plots for easy comparison of total extent of the proposed dyke in each alternative.

2.1 Alternative 1

With Alternative 1, a 1.5-kilometre-long flood dyke would be constructed by raising two segments of Valley Road. Figure 1 shows a profile along the flood dyke alignment which consists of raising Valley Road and a short portion of Township Road 360. The first segment is relatively short, about 230 metres in length, with less than 0.2 metres of road raise. The second segment is longer, about 1,230 metres in length, with about 1.1 metres of road raise. The road raise would affect Township Road 360 at about station 2,550 metres, raising that intersection about 0.9 metres. At the intersection, Township Road 360 would need to be regraded about 30 metres to the east and Valley Road about 30 metres to the south. Alternative 1 would also affect an estimated 10 driveways. Management of interior drainage for the area protected by the flood dyke could likely be provided by a single pump station, size yet to be determined.

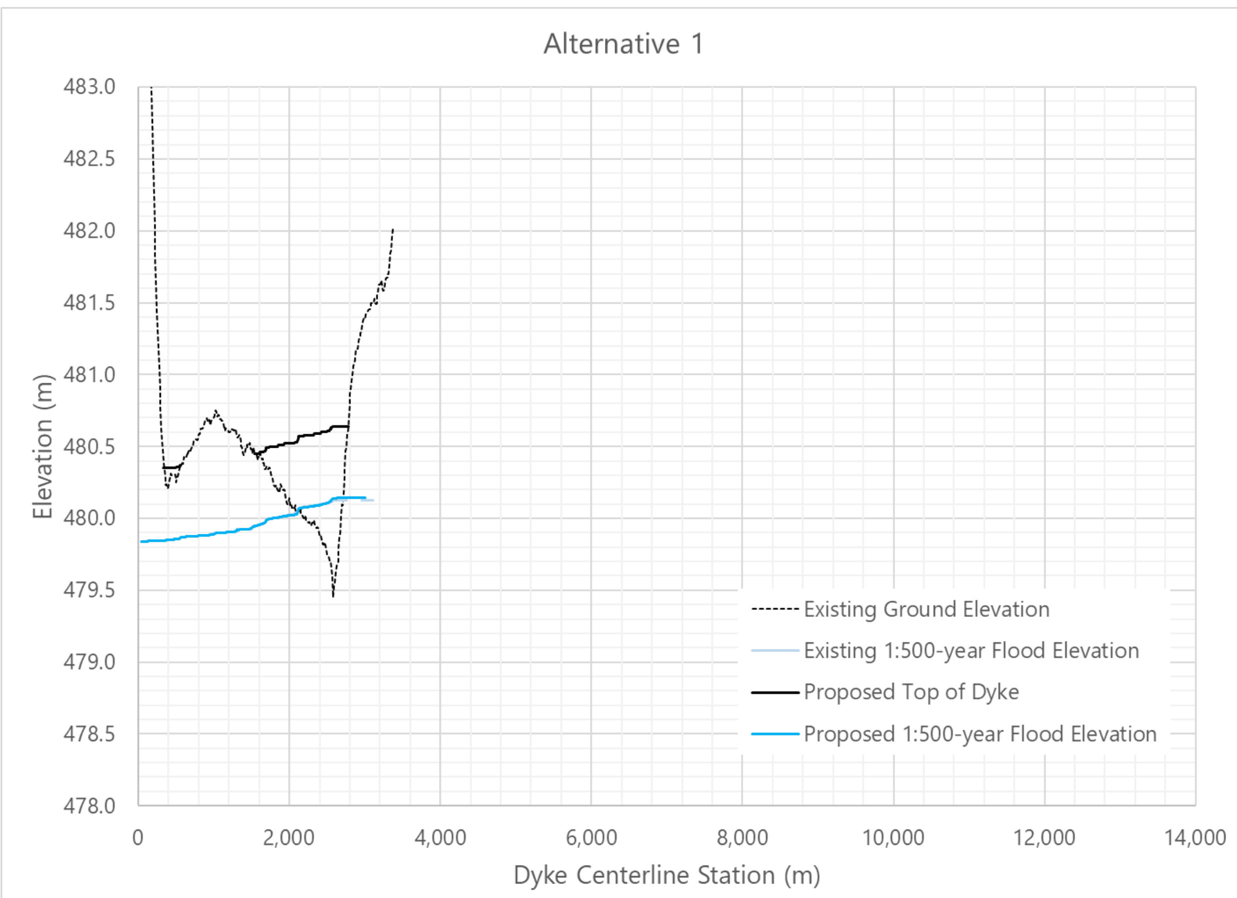

Figure 1 Alternative 1 Profile

2.2 Alternative 2

With Alternative 2, a 4.6-kilometre-long flood dyke would be constructed by raising two segments of Valley Road. Figure 2 shows a profile along the flood dyke alignment which consists entirely of raising Valley Road and a short portion of Township Road 354. The first segment is about 1,040 metres in length, with up to about 1.1 metres of road raise. The second segment is longer, about 3,520 metres in length. Approximately half of this length is a road raise of about 0.5 metres or less. The other half would require a road raise over 1.5 metres (see Station 6,000 metres in Figure 2). The road raise would affect Township Road 354 at about Station 240 metres, raising that intersection about 0.9 metres. At the intersection, Township Road 354 would need to be regraded about 30 metres to the east and Valley Road would need to be regraded about 30 metres to the north. The road raise would also affect Range Road 3062 (0.4 metres at Station 4,980 metres) and Range Road 3063 (0.8 metres at Station 6,620 metres), regrading about 15 metres to the north and 30 metres to the south, respectively. Alternative 2 would also affect an estimated 15 driveways. Management of interior drainage for the area protected by the flood dyke could likely be provided by two new pump stations, size yet to be determined.

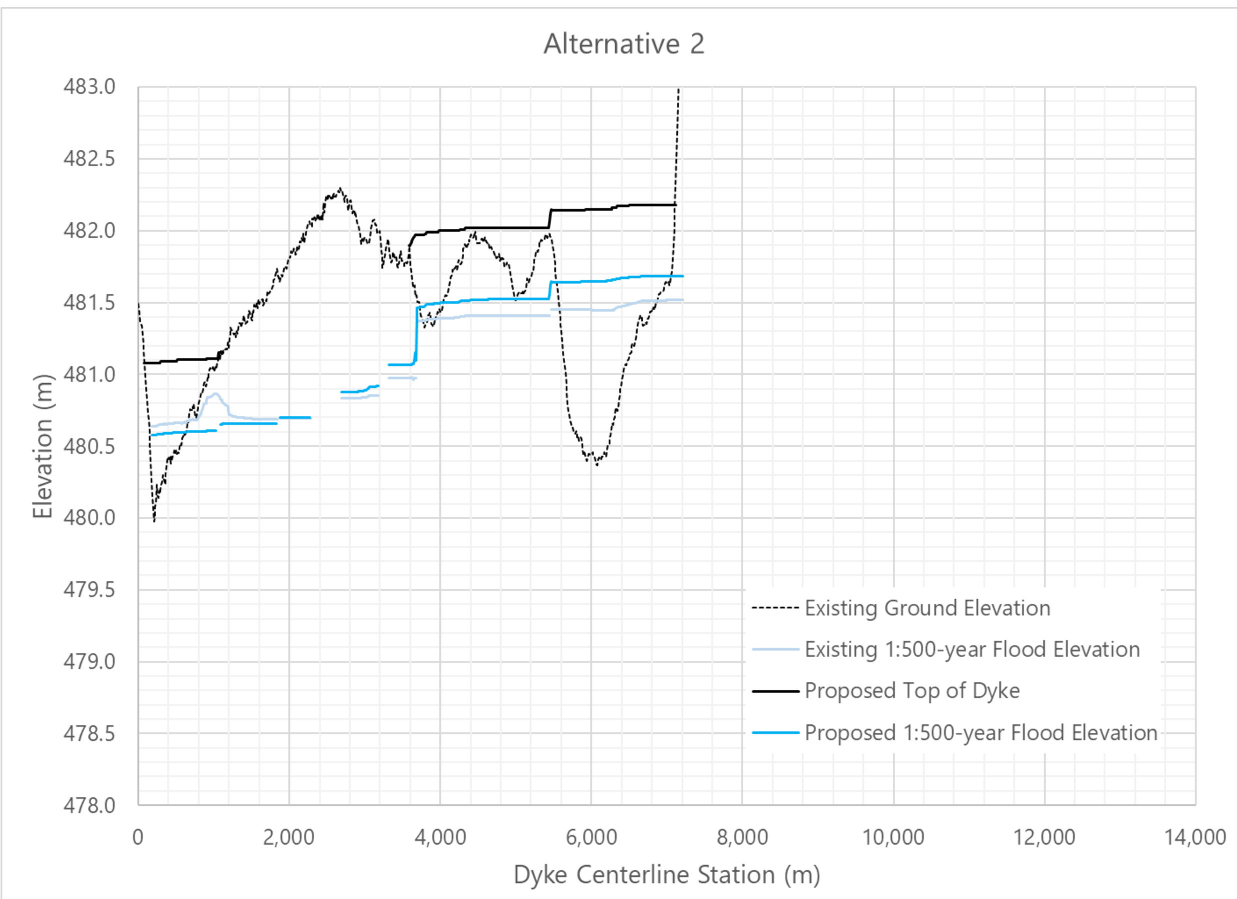

Figure 2 Alternative 2 Profile

2.3 Alternative 3

With Alternative 3, one 12.2-kilometre-long flood dyke would be constructed, consisting of some segments of road raise and some segments of newly constructed dyke. Figure 3 shows a profile along the flood dyke alignment. Road raises are expected along the centerline between Stations 0 and 230 metres (Township Road 360), between Stations 3,870 metres and 4,500 metres (Northwest Road, access to Northwest Manufacturing), between Stations 7,600 metres and 8,460 metres (Township Road 3052 east of Valley Road), and between Stations 8,700 metres and 12,220 metres (Valley Road). The remaining portions of the dyke would be newly constructed, ranging from about 0.5 metres tall to nearly 2 metres tall, and averaging roughly 1 metre tall.

Alternative 3 would affect six road intersections: Township Road 360 (Station 225 metres, about 0.9 metre intersection raise), Township Road 354 (Station 3,870 metres, about 2.0 metre intersection raise), Township Road 3052 (Station 8,460 metres, about 1.0 metre intersection raise), the connection at Valley Road (Station 8,770 metres, about 0.4 metre intersection raise), Range Road 3062 (Station 10,080 metres, about 0.4 metre intersection raise), and Range Road 3063 (Station 11,720 metres, about 0.8 metre intersection raise). Alternative 3 would also affect 20 driveways. Management of interior drainage for the area protected by the flood dyke is expected to require five new pump stations, size yet to be determined.

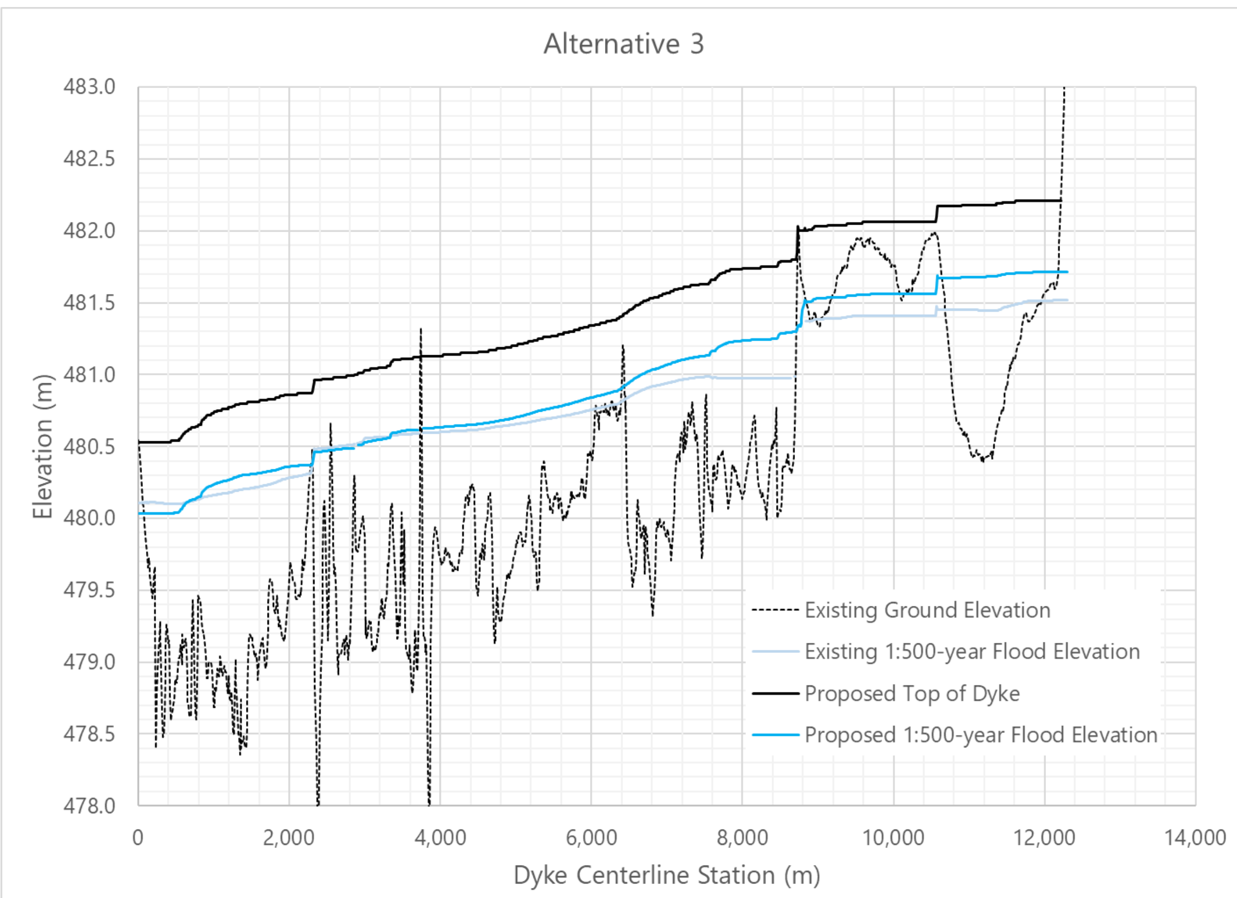

Figure 3 Alternative 3 Profile

2.4 Conceptual Design Assumptions

- Flood dykes need to be engineered to minimize the potential for water to seep through them. Using roadway embankments as flood dykes would require reconstructing the embankment.
- The top of flood dykes would be constructed to at least 0.5 metres above the 1:500-year flood elevations in the proposed condition.
- The minimum top width for newly constructed flood dykes is 3 metres.
- The top width of Valley Road was assumed to be 10 metres under proposed conditions.
- Interior drainage on the protected side of flood dykes will need to be accounted for as part of the design. This means providing a place for interior flooding to occur and pumping capacity to prevent interior flooding from getting too high.
- Roadway closures would not be necessary. Roadways crossed by a flood dyke would be raised to match the top of the dyke.
- Roadways and driveways intersecting the dyke would need to be raised. The maximum slope for reconstruction extents of approach roads at intersections was assumed to be 3 percent.
- Limited property acquisition would be required for Alternatives 1 and 2 because work would primarily occur within the right-of-way for existing roads.
- All three alternatives would involve raising a portion of Valley Road. It is assumed that the embankment was not constructed to function as a flood dyke. The top 0.5 meters of the roadway embankment would be removed (hatched portion in Figure 4), and an engineered flood dyke would be constructed. Then the roadbed would be reconstructed on top of the flood dyke. Ditches along either side would also be reconstructed.

Figure 4 shows a typical section for a raised roadway embankment. Sides slopes of the raised road were assumed to be 4H:1V. Flatter side slopes may be required to meet roadway safety standards for tall embankments.

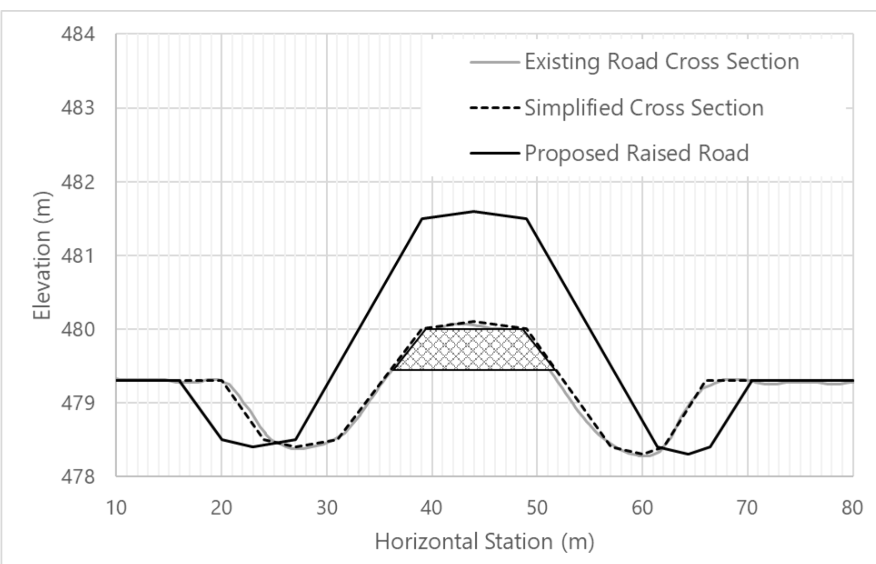

Figure 4 Typical Section for a Road Raise

2.5 Hydraulic Analysis

Each of the alternatives were modeled using the two-dimensional HEC-RAS model developed during the 2019 study. Copies of the existing-conditions model were modified to remove areas that would be protected by a given flood dyke alternative from the floodplain. The results of the alternative model scenarios were mapped to quantify the changes in the floodplain and floodway, as well as changes in depth and velocity for the 1:500-year flood event.

Attachment B, Attachment C, and Attachment D contain the flood map figures for Alternative 1, Alternative 2, and Alternative 3, respectively. Table 1 provides a comparison of how each alternative would affect floodplain extents and flood depths. Alternative 1 has the least impact on the overall floodplain. Most water surface elevation increases are less than 1 cm (Figure B-4), with some isolated locations where the rise is greater, up to a maximum of 13 cm. Alternative 3 has the most impact on the overall floodplain. Significant portions of the floodplain, particularly in the southern half of the study area, have increases in the water surface elevation over 10 cm (Figure D-4), with some isolated locations where the rise is up to a maximum of nearly 40 cm. Significant portions of the floodplain in Alternative 2, particularly in the southern half of the study area, also have increases in the water surface elevation of over 10 cm (Figure C-4), with some isolated locations where the rise is up to nearly 25 cm. In Alternatives 2 and 3, the model domain was not large enough (to the south) to identify where upstream impacts are reduced to zero.

Table 1 Flood Dyke Alternative Comparison

Description	Alternative 1	Alternative 2	Alternative 3
1:500-year floodplain reduction(1)	392 acres	2,470 acres	4,290 acres
1:500-year floodway reduction(1)	191 acres	1,640 acres	2,250 acres
Maximum increase in flood elevations	13 cm	24 cm	38 cm
Floodplain reduction per length of levee	0.27 ac/m	0.53 ac/m	0.35 ac/m
Floodway reduction per length of levee	0.13 ac/m	0.35 ac/m	0.18 ac/m

(1) The calculated floodplain reduction does not account for potential increase in the floodplain extents due to higher water surface elevations. Any such increases are expected to be small for the 1:500-year floodplain because the floodplain extents are at or near the edge of the valley.

3.0 Cost Estimate

The concept level cost range for each alternative is listed below in Table 2. These Class 4 (<10% design completion per ASTM E 2516-11) cost estimates are based on concept-level designs, quantities, and unit prices. Costs will change with further design. Design and permitting are included in the overall cost and are assumed to be 15 percent of the construction cost. The estimated accuracy range is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project, and the uncertainties in the project as scoped. Operation and maintenance and construction administration costs are not included. Time value-of-money escalation costs are not included.

Table 2 Flood Dyke Cost Comparison

Description	Alternative 1	Alternative 2	Alternative 3
High end of cost range (+50%)	$8,700,000	$24,000,000	$39,700,000
Median cost	**$5,800,000**	**$16,000,000**	**$26,400,000**
Low end of cost range (-25%)	$4,300,000	$12,000,000	$19,800,000

A breakdown of the information used to develop the estimated cost ranges is provided in Attachment E.

4.0 Summary

The purpose of this study was to develop conceptual designs for flood dykes that could be used to reduce the extent of the South Saskatchewan River floodplain and floodway. The three alternatives would block floodwaters from reaching the outer edge of the floodplain in some areas. All three of the alternatives would use roadway corridors to create at least a portion of the flood dykes. Using roadways as flood dykes has the advantage of elevating low portions of the roadway to reduce the likelihood of road closures and loss of transportation connectivity during large flood events.

While this study did not complete a cost-benefit analysis for the three alternatives, Table 3 provides a comparison of the cost per acre of floodplain area and floodway removed by each alternative. The data in the table shows that Alternatives 2 and 3 would be more cost effective at removing area from the floodplain and the floodway. As noted in Table 1, Alternatives 2 and 3 would have greater impacts on the 1:500-year flood elevation than Alternative 1.

Table 3 Flood Dyke Cost Per Area of Floodplain/Floodway Reduction

Description	Alternative 1	Alternative 2	Alternative 3
Median cost per acre of **floodplain** reduction	$14,800	$6,480	$6,150
Median cost per acre of **floodway** reduction	$30,400	$9,760	$11,700

Advancing one or more of the alternatives would likely involve the following activities:

- Geotechnical investigation
- Seepage mitigation analysis
- Impacts analysis for individual property owners
- Cost-benefit analysis
- Permitting feasibility evaluation

Constructing flood dykes in the South Saskatchewan River Floodplain would also require coordination with provincial regulatory agencies (at a minimum) and would likely require permit approval.

Attachments

Attachment A	General Figures
Attachment B	Alternative 1 Figures
Attachment C	Alternative 2 Figures
Attachment D	Alternative 3 Figures
Attachment E	Cost Estimates

Attachment A

General Figures

Barr Footer: ArcGIS 10.7.1, 2020-09-17 11:40 File: I:\Projects\61\11\1046\Maps\Reports\Model_Results_Aug2020\Figure A-1 Existing Floodplain.mxd User: EMA


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Highway No. 7
Circle Dr.
SASKATOON
CORMAN PARK
Valley Road
Township Road 362
762
Township Road 360
Range Road 3062
Range Road 3064
Range Road 3063
Township Road 354
Moon Lake Pump Station
Township Road 352
Highway No. 219
Range Road 3055
Range Road 3061
CORMAN PARK
VANSCOY
Township Road 350
CORMAN PARK
DUNDURN
Range Road 3060
Alt 1 Alignment
Alt 2 Alignment
Alt 3 Alignment
Alt 1 Excluded Inundation Area
Alt 2 Excluded Inundation Area
Alt 3 Excluded Inundation Area
0 200 400
Metres
LOCATION MAP
FIGURE A-2
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
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Attachment B

Alternative 1 Figures

Barr Footer: ArcGIS 10.7.1, 2020-09-17 11:39 File: I:\Projects\61\11\1046\Maps\Reports\Model_Results_Aug2020\Figure B-1 Alt 1 Floodplain.mxd User: EMA

Barr Footer: ArcGIS 10.7.1, 2020-09-17 11:45 File: I:\Projects\61\11\1046\Maps\Reports\Model_Results_Aug2020\Figure B-2 Alt 1 Flood Depth.mxd User: EMA


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Alternative 1
Elevation (m)
483.0
482.5
482.0
481.5
481.0
480.5
480.0
479.5
479.0
478.5
478.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Circle Dr
SASKATOON
CORMAN PARK
Township Road 362
Valley Road
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
3,200
762
Township Road 360
Range Road 3062
Range Road 3064
Range Road 3063
Township Road 354
Moon Lake
Pump Station
Township Road 352
CORMAN PARK
VANSCOY
Range Road 3061
Township Road 350
CORMAN PARK
DUNDURN
Highway No. 219
Range Road 30
Range Road 306
Alt 1 Centerline
Alt 1 Footprint
Flood Velocity (m/s)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 4
≥4
N
0
200
400
Metres
ALTERNATIVE 1
FLOOD VELOCITY
FIGURE B-3
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Alternative 1
Elevation (m)
483.0
482.5
482.0
481.5
481.0
480.5
480.0
479.5
479.0
478.5
478.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Circle Dr
SASKATOON
CORMAN PARK
Township Road 362
Valley Road
0
200
400
600
800
762
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
Township Road 360
3,200
3,000
2,800
2,600
Range Road 3062
Range Road 3063
Range Road 3064
Township Road 354
Moon Lake Pump Station
Township Road 352
Highway No. 219
Range Road 3061
Township Road 350
CORMAN PARK
VANSCOY
CORMAN PARK
DUNDURN
Range Road 3060
Alt 1 Centerline
Alt 1 Footprint
WSEL Difference (Metres)
< 0.0
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.10
> 0.10
N
0
200
400
Metres
ALTERNATIVE 1
WATER SURFACE
ELEVATION CHANGE
FIGURE B-4
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
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Attachment C

Alternative 2 Figures


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Alternative 2
Elevation (m)
483.0
482.5
482.0
481.5
481.0
480.5
480.0
479.5
479.0
478.5
478.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Circle Dr
SASKATOON
CORMAN PARK
Township Road 362
Valley Road
762
Township Road 360
Range Road 3062
Range Road 3064
Range Road 3063
Township Road 354
Township Road 352
Moon Lake Pump Station
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
3,200
3,400
3,600
3,800
4,000
4,200
4,400
4,600
4,800
5,000
5,200
5,400
5,600
5,800
6,000
6,200
6,400
6,600
6,800
7,000
7,200
Highway No. 219
Range Road 3061
Township Road 350
CORMAN PARK
VANSCOY
CORMAN PARK
DUNDURN
Range Road 3060
Alt 2 Centerline
Alt 2 Footprint
Flood Fringe (depth < 1 metre & velocity < 1 m/s)
Floodway (depth ≥ 1 metre & velocity < 1m/s)
Floodway (depth < 1 metre & velocity ≥ 1m/s)
Floodway (depth ≥ 1 metre & velocity ≥ 1m/s)
N
0 200 400
Metres
ALTERNATIVE 2 FLOODPLAIN
FIGURE C-1
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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Alternative 2
Elevation (m)
483.0
482.5
482.0
481.5
481.0
480.5
480.0
479.5
479.0
478.5
478.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Circle Dr.
SASKATOON
CORMAN PARK
Township Road 362
Valley Road
762
Township Road 360
Range Road 3062
Range Road 3064
Range Road 3063
Township Road 354
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
2,800
3,000
Moon Lake Pump Station
3,200
3,400
3,600
3,800
4,000
4,200
4,400
4,600
4,800
5,000
5,200
5,400
5,600
5,800
6,000
6,200
6,400
6,600
6,800
7,000
7,200
Township Road 352
Highway No. 219
Range Road 30
Range Road 3061
CORMAN PARK
VANSCOY
Township Road 350
CORMAN PARK
DUNDURN
Range Road 3060
Alt 2 Centerline
Alt 2 Footprint
Flood Velocity (m/s)
0 - 0.25
0.25 - 0.5
0.5 - 1
1 - 2
2 - 4
≥4
N
0
200
400
Metres
ALTERNATIVE 2
FLOOD VELOCITY
FIGURE C-3
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


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Alternative 2
Elevation (m)
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Township Road 362
Valley Road
762
Township Road 360
Range Road 3062
Range Road 3063
Range Road 3064
Township Road 354
Township Road 352
Moon Lake Pump Station
Range Road 3061
Township Road 350
Highway No. 219
SASKATOON
CORMAN PARK
VANSCOY
DUNDURN
Circle Dr
Alt 2 Centerline
Alt 2 Footprint
WSEL Difference (Metres)
< 0.0
0 - 0.01
0.01 - 0.02
0.02 - 0.05
0.05 - 0.10
> 0.10
0 200 400
Metres
ALTERNATIVE 2
WATER SURFACE
ELEVATION CHANGE
FIGURE C-4
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
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Attachment D

Alternative 3 Figures

Barr Footer: ArcGIS 10.7.1, 2020-09-17 11:51 File: I:\Projects\61\11\1046\Maps\Reports\Model_Results_Aug2020\Figure D-1 Alt 3 Floodplain.mxd User: EMA


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Alternative 3
Elevation (m)
483.0
482.5
482.0
481.5
481.0
480.5
480.0
479.5
479.0
478.5
478.0
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Dyke Centerline Station (m)
Existing Ground Elevation
Existing 1:500-year Flood Elevation
Proposed Top of Dyke
Proposed 1:500-year Flood Elevation
Circle Dr
SASKATOON
CORMAN PARK
Township Road 362
Valley Road
762
Township Road 360
Range Road 3062
Range Road 3063
Range Road 3064
Township Road 354
Township Road 352
Moon Lake Pump Station
Range Road 3061
Highway No. 219
Township Road 350
CORMAN PARK
DUNDURN
CORMAN PARK
VANSCOY
Range Road 3060
Alt 3 Centerline
Alt 3 Footprint
Flood Depth (Metres)
<1
1-3
3-5
5-7
≥7
0
200
400
Metres
ALTERNATIVE 3
FLOOD DEPTH
FIGURE D-2
Reference Information:
Horizontal: NAD83(CSRS) UTM Zone 13N (Metres)
Vertical: Canadian Geodetic Vertical Datum of 1928 (CGVD28) (Metres)
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
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Barr Footer: ArcGIS 10.7.1, 2020-09-17 11:51 File: I:\Projects\61\11\1046\Maps\Reports\Model_Results_Aug2020\Figure D-3 Alt 3 Flood Velocity.mxd User: EMA

ALTERNATIVE 3 WATER SURFACE ELEVATION CHANGE

FIGURE D-4

Attachment E

Cost Estimates

BARR

PREPARED BY: BARR ENGINEERING CO.

Option 1 - Short Road Raise

Feasibility Level Concept Design

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: R.M. Corman Park Flood Mitigation Feasibility Study

LOCATION: R.M. Corman Park, Saskatchewan

PROJECT #: 61111046.01

September 2020

ESTIMATED COSTS					
Item No:	Item Description	Units	Quantity	Unit Cost	Total Cost
1	Property Acquisition	AC	0.35	$3,000	$1,038
2	Mobilization (10% of construction cost)	LS	1	$379,702	$379,702
3	Water Control	LS	1	$10,000	$10,000
4	Temporary Erosion Control	M	2,920	$19	$54,020
5	Clearing and Grubbing	AC	4	$9,500	$38,000
6	Dyke Construction	CM	20,000	$10	$200,000
7	Roadway Reconstruction	SM	14,600	$150	$2,190,000
8	Interior Drainage Pump Station	EA	1	$1,000,000	$1,000,000
9	Site Restoration	LS	1	$30,000	$30,000
10	Driveway Modification	EA	10	$20,000	$200,000
11	Major Crossroad Modification	EA	1	$75,000	$75,000
	Construction Cost Subtotal				$4,177,760
	20% Construction Cost Contingency				$836,000
	Engineering and Permitting				$752,000
	TOTAL PROJECT COST (Mid Range Estimate)				$5,765,760
	Low Range Estimate (-25%)				$4,320,000
	High Range Estimate (+50%)				$8,650,000

Notes:

[1] Limited Design Work Completed (<10% concept level).

[2] This concept-level (Class 4, <10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

[3] Contingency is a sum of money allocated to the project at this stage of design. Additional engineering, permitting, and/or discussions with other stakeholders will be necessary to further define costs allocated to these items in future phases of the project.

[4] Engineering and Permitting are assumed to be 15% of the combined sum of the Construction Cost Subtotal and Construction Cost Contingency.

PREPARED BY: BARR ENGINEERING CO.

Option 2 - Long Road Raise

Feasibility Level Concept Design

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: R.M. Corman Park Flood Mitigation Feasibility Study

LOCATION: R.M. Corman Park, Saskatchewan

PROJECT #: 61111046.01

September 2020

ESTIMATED COSTS

Item No:	Item Description	Units	Quantity	Unit Cost	Total Cost
1	Property Acquisition	AC	2.6	$3,000	$7,784
2	Mobilization (10% of construction cost)	LS	1	$1,054,822	$1,054,822
3	Water Control	LS	1	$20,000	$20,000
4	Temporary Erosion Control	M	9,120	$19	$168,720
5	Clearing and Grubbing	AC	11	$9,500	$104,500
6	Dyke Construction	CM	84,000	$10	$840,000
7	Roadway Reconstruction	SM	45,600	$150	$6,840,000
8	Interior Drainage Pump Station	EA	2	$1,000,000	$2,000,000
9	Site Restoration	LS	1	$50,000	$50,000
10	Driveway Modification	EA	15	$20,000	$300,000
11	Major Crossroad Modification	EA	3	$75,000	$225,000
	Construction Cost Subtotal				$11,610,826
	20% Construction Cost Contingency				$2,322,000
	Engineering and Permitting				$2,090,000
	TOTAL PROJECT COST (Mid Range Estimate)				$16,022,826
	Low Range Estimate (-25%)				$12,020,000
	High Range Estimate (+50%)				$24,030,000

Notes:

[1] Limited Design Work Completed (<10% concept level).

[2] This concept-level (Class 4, <10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

[3] Contingency is a sum of money allocated to the project at this stage of design. Additional engineering, permitting, and/or discussions with other stakeholders will be necessary to further define costs allocated to these items in future phases of the project.

[4] Engineering and Permitting are assumed to be 15% of the combined sum of the Construction Cost Subtotal and Construction Cost Contingency.

PREPARED BY: BARR ENGINEERING CO.

Option 3 - Road Raise and Dyke

Feasibility Level Concept Design

ENGINEER'S OPINION OF PROBABLE COST

PROJECT: R.M. Corman Park Flood Mitigation Feasibility Study

LOCATION: R.M. Corman Park, Saskatchewan

PROJECT #: 61111046.01

September 2020

ESTIMATED COSTS

Item No:	Item Description	Units	Quantity	Unit Cost	Total Cost
1	Property Acquisition	AC	31	$3,000	$93,000
2	Mobilization (10% of construction cost)	LS	1	$1,732,814	$1,732,814
3	Water Control	LS	1	$20,000	$20,000
4	Temporary Erosion Control	M	24,440	$19	$452,140
5	Clearing and Grubbing	AC	68	$9,500	$646,000
6	Dyke Construction	CM	230,000	$10	$2,300,000
7	Roadway Reconstruction	SM	52,400	$150	$7,860,000
8	Interior Drainage Pump Station	EA	5	$1,000,000	$5,000,000
9	Site Restoration	LS	1	$200,000	$200,000
10	Driveway Modification	EA	20	$20,000	$400,000
11	Major Crossroad Modification	EA	6	$75,000	$450,000
	Construction Cost Subtotal				$19,153,954
	20% Construction Cost Contingency				$3,831,000
	Engineering and Permitting				$3,448,000
	TOTAL PROJECT COST (Mid Range Estimate)				$26,432,954
	Low Range Estimate (-25%)				$19,820,000
	High Range Estimate (+50%)				$39,650,000

Notes:

1 Limited Design Work Completed (<10% concept level).

2 This concept-level (Class 4, <10% design completion per ASTM E 2516-11) cost estimate is based on concept-level designs, quantities and unit prices. Costs will change with further design. Time value-of-money escalation costs are not included. The estimated accuracy range for the Total Project Cost as the project is defined is -25% to +50%. The accuracy range is based on professional judgement considering the level of design completed, the complexity of the project and the uncertainties in the project as scoped. The contingency and the accuracy range are not intended to include costs for future scope changes that are not part of the project as currently scoped or costs for risk contingency. Operation and Maintenance and Construction Administration costs are not included.

3 Contingency is a sum of money allocated to the project at this stage of design. Additional engineering, permitting, and/or discussions with other stakeholders will be necessary to further define costs allocated to these items in future phases of the project.

4 Engineering and Permitting are assumed to be 15% of the combined sum of the Construction Cost Subtotal and Construction Cost Contingency.