Embro Dam and Conservation Area

Existing Geomorphic Conditions

December 2015, Draft

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1. Existing Conditions

1.1 Fluvial Geomorphology

The intent of the fluvial geomorphic assessment was to characterize channel form and gain insight into channel processes along Youngsville Drain in the vicinity of Embro Pond. Youngsville Drain is a tributary of Mud Creek and flows from a north to southerly direction. The assessment included both a desktop review and data collection through field investigations; data collection completed by ERI was supplemented by UTRCA's topographic survey of the channel bed profile. Findings from the geomorphic assessment are presented by sub-section in this report.

1.1.1 Historical Assessment

A review of historical channel conditions was completed to gain insight into changes that have occurred within the study area. UTRCA provided airphotos dated from 1955, 1972, 1989, 2000, 2010; additional aerial imagery was available from Google Earth (2015). Key observations are summarized in **Table 1-1;** a collection of historical airphotos of the study area is provided in **Figure 1-1**.

Table 1-1. Summary of historical study area changes.

Year	Observation
1955	• Embro pond was not yet constructed south of Road 84 and Youngsville Drain meandered within its floodplain in this area. • Upstream of Road 84, Youngsville Drain was sinuous and appears to be situated in a field (grasses, herbaceous plants) with few trees. A hedgerow separates the creek from the private property.
1972	• Construction of Embro pond was complete • Channel realignment/straightening occurred, beginning at ~ 95 m north of Road 84. • Channel modifications appear to have occurred at the outlet of the dam (widening, deepening, straightening).
1989	• Floodplain vegetation west of Youngsville Drain, and north of Road 84, appears to be naturalizing and increasing in diversity • Some channel planform development appears to be occurring at the upstream limit of the channel straightening
2000	• A row of trees appears to have been planted to the west of Youngsville Drain, north of Road 84. The row of trees to the east of the watercourse appears to have been extended further north. • No change in planform configuration is evident in comparison to the 1989 image.
2010	• Vegetation/tree growth north of Road 84 is notable. Portions of Youngsville Drain are obscured from view on the photo. • Overall, no change in planform configuration is evident in comparison to the 2000 image.

1955

1972

Figure 1-1a. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond.

1989 **2000**

Figure 1-1b. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond.

Figure 1-1c. Overview of historical channel change along Youngsville Drain in proximity to Embro Pond.

1.1.2 Existing Conditions

A geomorphic field investigation was undertaken on June 11, 2015 to assess existing conditions along Youngsville Drain, both upstream and downstream of Embro Pond. The field investigation included both reconnaissance level observations and detailed data collection.

During the field assessment, three reaches were identified. Reaches are defined as lengths of channel along which there is relative homogeneity of controlling and modifying influences and thus channel form and processes are similar. A description of dominant channel characteristics is provided by reach below. Although intended for urban watercourses, the Rapid Geomorphic Assessment (RGA) was applied to gain insight into overall channel stability and to identify dominant channel processes. The focus of field data collection/measurements was predominantly upstream of the dam's backwater influence.

The focus of field data collection/measurements was predominantly upstream of the dam's backwater influence and included cross-section profiles and substrate characterization. A topographic survey of the channel bed morphology was undertaken by UTRCA and provided to the ERI team for analysis and integration into the fluvial geomorphic assessment. The reach delineation is demonstrated on **Figure 1-2** the surveyed channel bed profile is illustrated in **Figure 1-3** which includes a profile through Embro Pond based on 2015 water depth mapping provided by the UTRCA.

Figure 1-2. Reach delineation along Youngsville Drain.

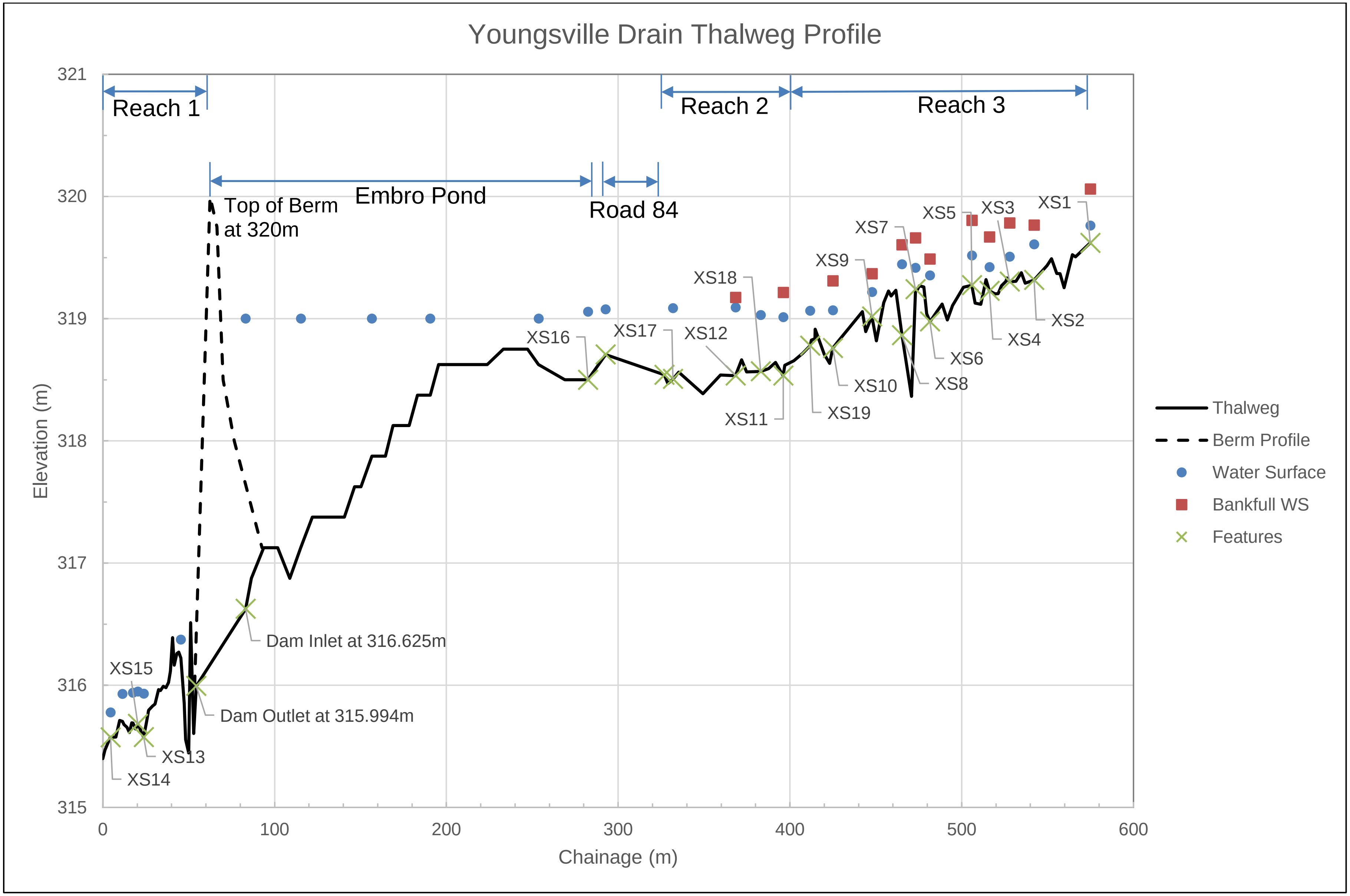

Figure 1-3. Channel bed profile along Youngsville Drain.

1.1.2.1 Reach 1. Downstream of Embro pond

From the outlet of Embro pond to the end of the UTRCA property, the watercourse was relatively straight; a slight meander was beginning to form near the downstream limit of the reach. The creek was likely straightened in conjunction with construction of the dam.

The channel cross-sections were generally symmetrical in shape and trapezoidal. The cross-sections were set within a larger channel. The active channel was ~ 3.70 m wide with an average water depth of 0.29 m. Riparian vegetation consisted of dense grasses and herbaceous plants; roots extended to the bottom of the banks. Towards the downstream end of the reach, shrubs and trees were overhanging into the creek.

A deep pool (0.93 m) occurred within 5 m downstream of the Embro Dam outlet. The dominant bed morphology along the entire reach was riffle/run with shallow pools. A deeper pool where vegetation was overhanging into the watercourse. The channel bed consisted primarily of cobbles and gravel. Glacial till was exposed along the toe of the bank along a pool.

Overall, the Youngsville Drain appeared to be stable throughout the reach.

	
View downstream from dam outlet.	Downstream view along creek, towards property line at trees.

Figure 1-4. Reach 1 photos illustrating site conditions

1.1.2.2 Reach 2. Embro pond inlet to 85 m upstream of Road 84

In this portion of the watercourse, Youngsville Drain appeared to be under backwater conditions and influenced by water levels from Embro Pond. The backwater conditions extended 85 m upstream of Road 84; the channel was straight. Measurements of channel cross-section parameters and substrate materials were made at two locations within this reach **(Table 1-2)**.

The cross-sections were well connected to the floodplain. The cross-section configuration was generally trapezoidal and did include a defined thalweg position. The channel width increased in the downstream direction as expected in a backwater condition; the width:depth ratio for the two cross-sections was relatively narrow and ranged from 6.66 to 9.32. Average water depth was relatively consistent and ranged from 0.25 – 0.30 m.

Channel banks were well vegetated with grasses and herbaceous plants; the fine and dense rooting network extended to the water surface. The bank configuration was generally irregular which is characteristic of banks influenced by backwater conditions in which hydration of bank materials leads to erosion; the rooting network of bankside vegetation holds the banks together in ‘clumps’. Undercutting of the banks occurred near the water surface and was consistently measured as 7 – 8 cm deep. The relatively low banks indicate good floodplain accessibility during high flows.

The channel bed morphology was poorly developed and was relatively uniform in configuration. Channel bed materials consisted primarily of silt and sand sized particles with few gravels. The bed materials were ‘soft’ due to their hydrated condition. Submerged aquatic plants were observed on the channel bed.

Application of the Rapid Geomorphic Assessment (RGA) for this reach indicated that the channel is ‘in regime’. The dominant process within the reach is deposition. Gradual widening of the cross-section is expected due to the hydration effect typically associated with backwater conditions.

	
View downstream along Youngsville Drain to Road 84	Substrate materials within the channel and submerged aquatic vegetation growth.
	
Irregular banks with minor undercutting near the water surface. Banks are subjec to hydration processes.	Some bank undercutting was observed along the banks.

Figure 1-5. Reach 2 photos illustrating site conditions

Table 1-2 . Overview of Reach 2 average cross-section parameters based on measurements at Cross-Sections 11 and 12.

Parameter	Range	Parameter	Range
BANKFULL		**LOW FLOW WATER**	
Width (m)	3.8	**Width (m)**	3.51
Depth (m) **Max.** **Avg.**	 0.66 0.50	**Depth (m)** **Max.** **Avg.**	 0.42 0.27
Width:depth ratio (m/m)	8.0	**Width:depth ratio (m/m)**	13.00
Area (m^2)	1.92	**Area (m^2)**	0.96
Perimeter (m)	6.33	**Wetted perimeter (m)**	3.78
Bank Height (m)	0.38		
Bank undercutting (m)	0.07–0.08		
Bank Vegetation and rooting influence	grasses along both banks		
Floodplain connectivity	well-connected		
Substrate Gradation (mm) **D90** **D84** **D50** **D16** **D10**	All substrate consisted of sand and silt sized materials.		

1.1.2.3 Reach 3. From 85 m to 235 m upstream of Road 84

In Reach 3, Youngsville Drain was a meandering watercourse that was situated towards the west side of a ~ 30 m wide channel corridor that was separated from adjoining agricultural landuses by a row of cedar trees. The watercourse was situated towards the west side of this corridor. Riparian vegetation typically consisted of grasses and herbaceous plants along the east bank, and cedar or willow trees along the west bank. The vegetation and fine dense rooting network typically extended to the water surface.

Along the east side of the channel, two locations were identified at which surface drainage was actively being conveyed over the bank into the creek. The source of water was not investigated.

Field data collection was undertaken at ten cross-sections, which included 4 pools and six riffle/run configurations. A summary of cross-sectional characteristics is presented in **Table 1-3**.

The cross-sections were generally uniform in configuration and well-connected to the channel banks. Average pool width was only slightly wider than riffles and the width:depth ratios were similar **(Table 1-3**). This reflects the control of grassy and herbaceous bankside vegetation on channel form. Although the average channel depth was similar between pools and riffles, pools attained a somewhat higher depth at both bankfull and low flow stages.

Banks were generally steep (i.e. nearly vertical). No active erosion was noted. Undercutting of the banks was generally minimal (up to 8 cm), but measured up to 24 cm underneath a root wad 17 cm and occurred at the bottom of the rooting zone and/or the interface with underlying stratigraphic materials. Along the lower bank, a soft rock was observed which resembled a conglomerate rock type (i.e., round gravels situated within a fine matrix of silt and sand sized particles. The cobble and gravel sized sediment observed on the channel bed consisted of this conglomerate material; pressure exerted onto the particles would cause it to break into smaller pieces.

Table 1-3. Overview of Reach 3 average cross-section parameters based on measurements at Cross-Sections 1 – 10.

Parameter	Riffle		Pool	
	Range	Average	Range	Average
Bankfull				
Width (m)	2.85-4.74	3.90	3.29-5.15	4.09
Depth (m)				
Max.	0.42-0.53	0.44	0.45-0.74	0.56
Avg.	0.33-0.41	0.34	0.31-0.42	0.35
Width:depth ratio (m/m)	8.65-18.05	11.74	9.46-16.82	11.81
Area (m^2)	0.93-1.92	1.33	1.06-1.71	1.44
Perimeter (m)	3.99-6.99	4.96	3.96-5.62	4.64
Low Flow Water				
Width (m)	2.59-3.83	3.28	2.97-4.16	3.34
Depth (m)				
Max.	0.16-0.25	0.21	0.28-0.58	0.40
Avg.	0.11-0.18	0.14	0.18-0.34	0.25
Width:depth ratio (m/m)	14.76-29.24	24.04	9.40-22.88	14.33
Area (m^2)	0.33-0.56	0.46	0.66-1.10	0.83
Wetted perimeter (m)	3.11-4.24	3.53	3.25-4.32	3.76
Substrate Gradation (mm)				
D90	50			
D84	35			
D50	10			
D16	0.5			
D10	0.1			

The channel bed morphology has developed into the soft conglomerate sedimentary rock. Field measurements revealed that from distance from the top of this unit to the channel bed was 30 cm, suggesting that the channel has incised this depth into the materials. The dominance of riffle/run features along the channel bed is a result of this resistant bed material. Shallow pools have formed and occur along the outside bends of meanders. The underlying bedrock controls profile development and reflects the relatively small difference in depth between pool and riffle sections (**Table 1-3**). The deepest pool evident on **Figure 1-3** was 0.87 m deep; in general, all other pool depths were considered to be shallow (i.e.,, residual depths ranged from 0.15-0.28 m). The overall channel bed grade was 0.66%.

The channel bed material was often characterized by fine (sand, silt) sediment deposits with several boulders or large cobbles. Where coarser substrate was evident, then this generally consisted of gravel. Pebble counts were completed to estimate the bed material gradation within the study area. Review of **Table 1-3** confirms that the substrate was within the gravel size. Insight into general channel bed roughness was obtained by measuring the height that substrate materials projected into the water column at each cross-section; measurements revealed that the average maximum, intermediate and minimum protrusion heights were 19, 7 and 1 cm respectively. This suggests that the large cobbles provide roughness

Table 1-4. Channel bed profile characteristics along Reach 3.

Parameter	Range	Average
Max. residual pool depth (m)	0.15-0.28 One pool was uncharacteristically deep at 0.87 m	0.33
Pool area (2D along profile) (m^2)	0.28-1.27	0.79
Pool length (m)	8.28-27.48	16.48
Avg. pool depth	0.10-0.32	0.17
Riffle length (m)	4.91-12.35	9.12
Riffle grade (%)	0.39-2.08	1.32
Inter-riffle spacing	16.35-47.01	27.52

Analysis of the topographic channel bed profile, provided by UTRCA, was undertaken. This revealed that the average water surface grade during the field survey (June 11, 2015) was 0.32 % and the average bankfull grade was 0.43 %. Quantification of riffle and pool parameters, for Reach 3 is provided in **Table 1-4**.

Application of the RGA for this reach indicated that the channel is 'in transition' and is dominated by aggradational processes. Indicators of aggradation include lateral bars of silt and very fine sands which were observed along the channel.

Active drainage channels discharge into the creek.

Channel is well connected to its floodplain

Bank stratigraphy includes a lower unit that provides bedrock control on profile development.

Substrate consisted of cobbles on a gravel-sandy bed

Riparian vegetation includes both grasses/herbaceous plants and trees (cedar/willow)