Report Title: Open Water Survey of Athabasca River at Embarras (Reach #2)

Working Group: Surface Water Working Group (SWWG)

Final/Approved Report Date: January 31st, 2005

Contract Number: 2004-0001

CEMA Disclaimer

Contract Name: Bathymetric Surveys on the Lower Athabasca River, 2004

Consultant Name: Trillium Engineering and Hydrographics Inc.

This report was commissioned by the Instream Flow Needs Task Group of the Surface Water Working Group of the Cumulative Environmental Management Association (CEMA), in its tasks of developing a defensible, science based IFN recommendation that provides full, long-term protection to the aquatic ecosystem of the lower Athabasca River. Specifically, this report was intended to collect open water bathymetry for Embarras (reach #2) of the lower Athabasca River.

This report has been completed in accordance with the terms of reference issued by the Instream Flow Needs Task Group. The Surface Water Working Group has closed this project and considers this report final.

The Surface Water Working Group or its Task Groups do not fully endorse all of the contents of this report, nor does the report necessarily represent the views or opinions of CEMA, the Surface Water Working Group or any of its Task Group Members.

The conclusions and recommendations contained within this report are those of the consultant, and have neither been accepted nor rejected by the Surface Water Working Group.

Until such time as the Surface Water Working Group issues correspondence confirming acceptance, rejection, or non-consensus regarding the conclusions and recommendations contained in this report, they should be regarded as information only.

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January 31, 2005

Cumulative Environmental Management Association
Wood Buffalo Region
Attention: Project Officer
Box 5656
Fort McMurray, Alberta
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Dear Sir/Madam:

RE: Open Water Survey of Athabasca River at Embarras (Reach #2).

We have completed our open water survey of Reach #2 of the Lower Athabasca River Fish Habitat Survey Program. Reach #2 is located near the Embarras Airport on the Athabasca River between 165 and 171 km north of Fort McMurray. This survey is part of a larger program to collect open water and winter river bathymetry at four locations on the Lower Athabasca River downstream of Fort McMurray. The following report describes the survey methodology and summarizes the results of this survey.

1.0 SURVEY METHODOLOGY

The survey was collected using a structured approach which followed the shape of the channel to provide better input data for the River2D numerical model. The data structure consisted of 12 river cross-sections surveyed approximately 550 m apart; longitudinal bed profiles measured at approximately 20 to 30 m intervals across the channel; top and bottom of bank of the channel and islands; and water's edge at the banks, islands and bars. Large structures in the bed such as scour holes were also delineated using this data collection procedure. Additional bed elevation data was collected upstream of islands and bars so that the flow divisions at these locations could be simulated more accurately.

1.1 Benchmarks and Cross-section Markers

Two permanent reference points were installed to establish a baseline and reference elevation for the site. The elevation reference point, TEH04-01, was constructed by drilling a 1.2 m deep hole

into the ground; driving a 2.4 m length of rebar into the hole; backfilling the hole with sand; and capping the sand with a thickness of at least 0.1 m of concrete. A secondary benchmark, TEH04-02, was used to establish direction. This benchmark consisted of a 1.2 m length of rebar driven into the ground. Both benchmarks were identified with red and yellow T-bar marker posts. The UTM coordinates and geodetic elevations (NAD83) of these benchmarks given in Table 1 were established using a survey-grade GPS which provides an accuracy of ±0.02 m. The positions were not referenced to an existing Alberta Survey Control Marker or Geodetic Survey of Canada benchmark so the quoted accuracy only applies to the data relative to the local benchmarks.

Table 1 Benchmark location data.

Description	Northing (m)	Easting (m)	Elevation (m)
Benchmark TEH04-01	6,451,688.56	476,960.00	229.30
Benchmark TEH04-02	6,452,565.78	473,683.50	216.85

Each cross-section was marked with a permanent reference pin on each bank to establish the location and orientation of each cross-section. The pins consisted of 1.2 m lengths of rebar driven into the ground. The pins were located on the top of bank to minimize exposure to ice and erosion damage. The cross-sections were numbered from 1 to 12 from upstream to downstream.

1.2 Position and Depth

Each three-dimensional position on both land and water was established using a survey-grade Topcon HIPER RTK GPS total station which provides an accuracy of ±0.02 m both horizontally and vertically. This GPS system enables the surveyors to collect accurate three-dimensional positions on-the-fly, that is, the system is not required to be stationary when the position is established. This feature is critical when surveying bed elevations from a boat. The Topcon GPS system was selected because it is able to access the Russian GPS satellites which improved the satellite coverage and reduced the time when insufficient satellite data was available.

A Raytheon fathometer mounted in the bottom of the boat directly below the GPS antenna was used to measure water depths. This fathometer has an accuracy of ±0.05 m. The fathometer and GPS data were coordinated so that depth data was collected simultaneously with the GPS position data.

A laser range finder with onboard azimuth and bearing was also used to establish some bank positions where the GPS could not be used to establish position due to dense foliage or high, steep banks. The location of the range finder was first established with the GPS system and then bank positions relative to this location were established with the range finder. The range finder provided bank positions with an accuracy of about ±1.0 m horizontally and ±0.1 m vertically.

1.3 Velocity

Flow velocities were measured at 60 locations in the reach to provide calibration data for the River2D numerical model. These velocity measurements were collected at the locations of the main cross-sections. Approximately 10 velocity measurements were collected across each cross-section but where the channel was split the measurements were distributed over both channels. At the upstream section, 20 velocity measurements were taken so that the discharge could be determined.

The velocity measurements were collected using a Price 1201 AA (Gurley) type current meter. This current meter has been calibrated to an accuracy of 0.002 m/s. Velocities were measured at 20% and 80% of the depth (or at 60% of the depth in shallow water less than 1.0 m deep). The average of the two spot velocities at these depths provides a good estimate of the depth-averaged velocity.

1.4 Substrate

Substrate at the site was assessed visually if possible or by sounding with a hollow aluminum pole when visibility was poor. The bed material was classified into silt, sand, gravel, cobble, boulder, or bedrock. Where possible, to indicate the presence of more complex substrates, two part combinations of substrate (e.g. sand/cobble) were recorded with the dominant substrate listed first. The substrate classifications may be converted to grain sizes using standard the ASTM grain size ranges given in Table 2.

The substrate mapping was carried out by defining a primary and secondary substrate type at discrete points at 20-40 m intervals both across and along the channel. Large areas of sand were visually identified and mapped by defining the area boundaries. Each substrate location was assigned a two digit numeric code defining the primary and secondary substrate types. These codes are listed in Table 2. For example, the code for cobbles (primary) with sand (secondary) is 42. The boundaries between the substrate types were determined by interpolating between the discrete points.

Table 2 Substrate codes and size ranges.

Substrate type	Code	Size Range
Silt	1	< 0.075 mm
Sand	2	0.075 mm – 4.75 mm
Gravel	3	4.75 mm – 75 mm
Cobble	4	75 mm – 300 mm
Boulders	5	>300 mm

2.0 DISCHARGE VARIATION

The discharge during the survey was determined from preliminary discharges from Water Survey of Canada (WSC). This data is classified as tentative and should be treated as such. The discharges reported for the Athabasca River below Fort McMurray (07DA001) have been adjusted for inflows by prorating the discharges from four gauged tributaries over the entire drainage area between the McMurray gauge and Embarras. The drainage areas of the four gauged tributaries, Steepbank River near Fort McMurray (07DA006), Muskeg River near Fort MacKay (07DA008), Mackay River near Fort Mackay (07DB001), and Firebag River near the mouth (07DC001) account for 65% of the total drainage area of 22,000 km^2 between Fort McMurray and Embarras. The discharge from Fort McMurray from two days previous was combined with the tributary flows from the previous day to account for the travel time between the gauges and the survey reach.

The daily discharges estimated at the upstream end of the reach for the duration of the survey are shown in Figure 1. The discharge decreased over the course of the survey, from 812 m^3/s on the start of the survey on Aug 5 to 700 m^3/s at the end of the survey on Aug 10.

The discharge measured during the survey was virtually the same as the discharge estimated from the WSC data. A discharge of 706 m^3/s was measured at the upstream section on Aug 9 while the WSC based discharge on this date was 708 m^3/s. The difference between these discharges is only 0.3%.

3.0 SURVEY RESULTS

An *EXCEL* file containing the survey data is provided on the enclosed CD. The survey data in this file has been separated into cross-section data, velocity data, substrate data, water's edge data, top of bank data and bottom of bank data to facilitate analysis. All the elevation data required to generate a contour model of the reach has also been grouped together.

The 6.2 km reach contains one island as well as a number of sand bars. The island and bars caused the river to split into as many as three channels at some cross-section locations. These channels varied from as little as 60 m wide in a side channel to as much as 600 m wide where a single channel carried all the flow. The bankfull width of the channel (not including the island) varied from 340 m to 600 m.

The mean flow depth in the reach was 2.2 m and the maximum flow depth was 7.9 m. This maximum depth was measured near the east bank between Section 4 and 5. Other scour holes were detected at the outside of the downstream bend on the west bank and on the inside of the upstream bend near Section 2. The mean and maximum measured velocities were 0.67 and

1.06 m/s respectively. Velocities were not measured with the same frequency as depth so the actual peak velocity in the reach may be somewhat higher than this measured maximum.

The substrate in the reach is mostly sand with some silt found along the banks. No gravel, cobble or boulders were evident in the reach.

If you have any questions or comments about the survey, please call me at 780-496-7671.

Sincerely,

Gary Van Der Vinne, M.Sc., P. Eng.
Trillium Engineering and Hydrographics Inc.

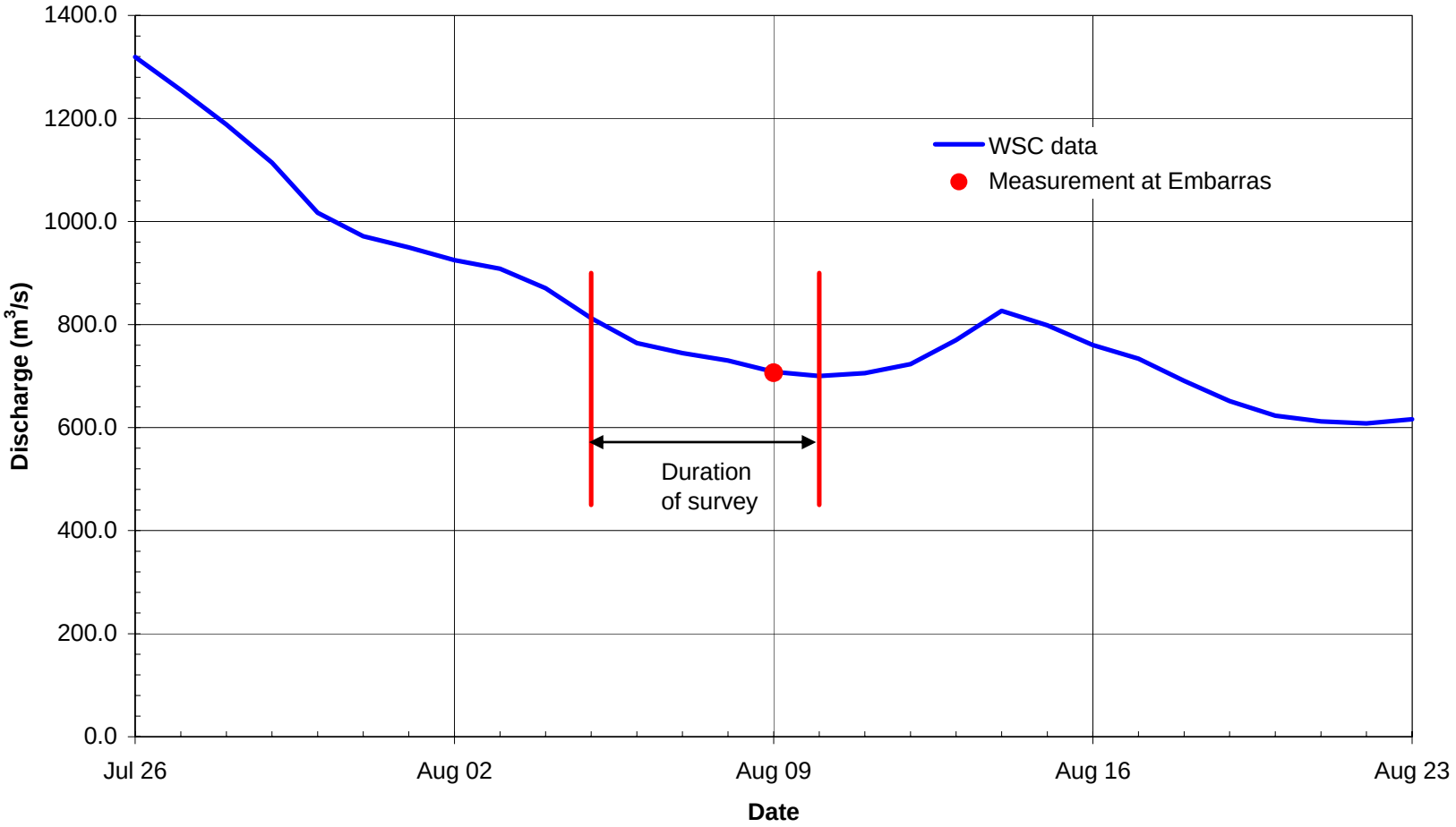

Figure 1 Variation of discharge during survey