# Wetted Perimeter Assessment
# Shoal Harbour River
# Shoal Harbour, Clarenville
# Newfoundland

Submitted by:


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## 1.0 INTRODUCTION

The flows in the lower portion of Shoal Harbour River are influenced by water extraction by the town of Clarenville as part of their water supply is based upstream. The Department of Fisheries and Oceans has previously classified the lower portion of Shoal Harbour River as Type III habitat in that it provides migratory habitat to salmonids.

The town of Clarenville has recently identified the need for additional water extraction due to expansion and growth of the community. As such, the Department of Fisheries and Oceans has requested an assessment of the potential impact of additional extraction on the lower portion of Shoal Harbour River. It was recommended by DFO that the Wetted Perimeter hydraulic rating Method (WPM) be conducted.

Detailed transects were constructed within each stream reach which may be affected. They were located in habitat considered to be representative of reaches important for fish utilization with respect to water depth and wetted perimeter and with consideration of sensitive biological time periods. Each transect was used to calculate the relationship of flow to wetted perimeter graphs (WPM). These plots can be used to assess whether flows could be reduced within the streams to meet the additional water demands and still maintain suitable migratory habitat for fish species in the river, specifically anadromous salmonids.

### 1.1 STUDY AREA

Shoal Harbour River is one of two supplies currently used to supply water to Clarenville and Shoal Harbour. The water intake and dam are approximately 1.9km upstream from the mouth of the river. The lower section of Shoal Harbour River (between the dam and the harbour) is relatively uniform in gradient and substrate, with well defined banks through most of its length. The gradient is moderate, with flows generally in riffles, occasionally interspersed with minor sections of white water, and approximately four shallow pools. The river has only one section with a side channel, and one notable inflow (immediately downstream of the dam).

The substrate is predominately rubble-boulder, with minor sand/gravel patches, and occasional outcrops of bedrock. The bank material comprises boulders and bedrock. In one section the left bank comprises boulder-gravel material and shows evidence of erosion. The substrate is fairly loose, and is likely worked by ice and high flows, resulting in a fairly active stream bed.

### 1.2 WETTED PERIMETER METHOD

The WPM is a fixed flow hydraulic rating method based on the hydraulic relationship between flow (i.e. discharge) and wetted river perimeter at a selected transect(s) (Stalnaker *et al*. 1994). Using the relationship, the flow corresponding to the wetted perimeter (wetted width of the stream transect), which is needed to minimally protect all habitats, can be estimated. Figure 1.1 presents a schematic of a wetted perimeter/flow relationship and indicates the point of inflection for that relationship. The point of inflection on each graph is taken as the minimum flow requirement for the represented habitat. That is, it is the flow below which dewatering would take place rapidly. In order for a graph to present a reasonable point of inflection, the wetted perimeter at various flows is required. It is recommended that extremely low and high flows be included in surveys. If this is not possible, the survey data can be used to calculate extreme low and high flows to supplement the survey data using Manning's equation.

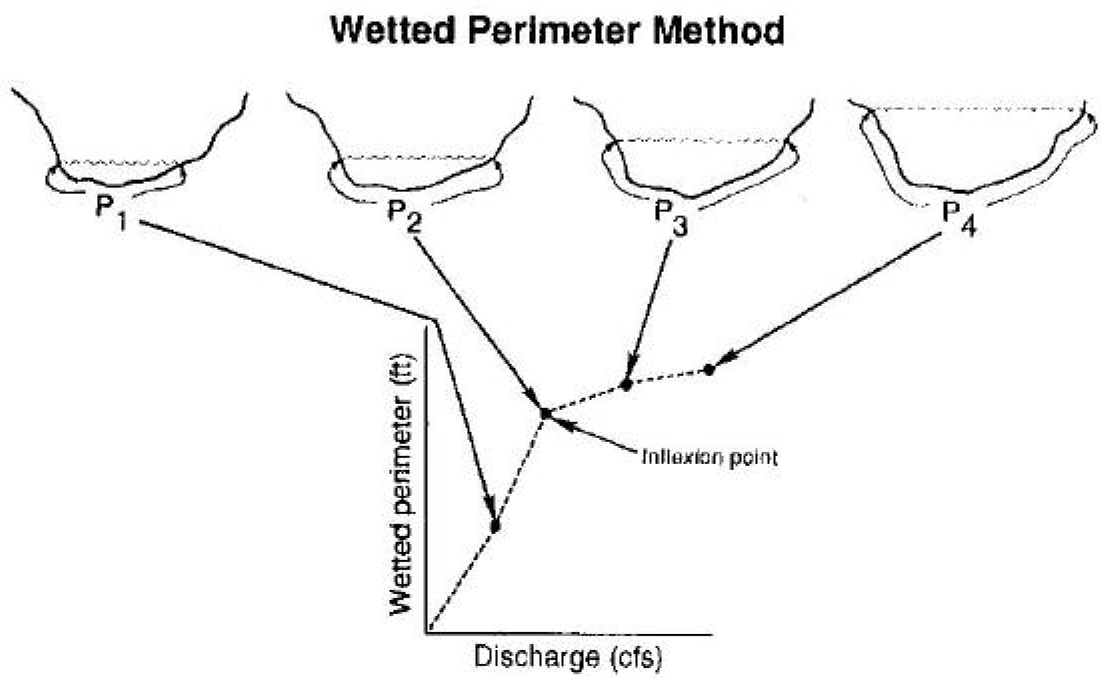



Figure 1.1. Example of wetted perimeter method to estimate instream flows (Nelson 1980).

The cross-sections, or transects, selected to determine the minimum flow for habitat protection is very important in this technique. The selected transects for assessment must stand as an index habitat for the rest of the river or river section being assessed. Riffles are typically selected because cross sections in these areas exhibit sensitivity of width, depth, and velocity to changes in flow. They are usually the shallowest habitat type found and as such, would indicate the critical water level needed to protect all habitats. Therefore, once a minimum level of flow is estimated for a riffle, it is assumed that other habitat areas, such as pools and runs, are also satisfactorily protected. Because the shape of the channel can influence the results of the analysis, transects are usually located in areas that are wide, shallow, and rectangular. The selection of the cross section requires professional judgement of a fish biologist knowledgeable in the requirements of the species of interest. A minimum recommended discharge for a particular study reach is usually based on the average wetted perimeter computed from at least three to ten critical cross-sections.

The WPM results have several assumptions. They are:

- the selected area is a suitable index of habitat for the rest of the river, i.e., if the minimum flow requirement is satisfied at the chosen critical location, it will be satisfied in other habitat types. The greater the number of transect locations, the higher the level of confidence in the minimum flow estimation;
- the point of inflection is a suitable surrogate for acceptable habitat, i.e., flow reductions below that point on the graph will result in loss of habitat quality; and
- all wetted area is equally important as habitat or to satisfy other biological criteria.

## 2.0 STUDY TEAM

AMEC Earth & Environmental (AMEC) has a full support fisheries team with experience in habitat assessment, population assessment, flow needs, and remediation. This project was completed by Jim McCarthy and Bevin LeDrew. All survey work was conducted by SGE-Acres personnel based in Clarenville.

**Jim McCarthy**, M.Sc., is an Environmental Biologist who specializes in fisheries ecology. He has over ten years experience in fisheries work. Mr. McCarthy has conducted over three years of salmonid habitat needs research with the Western Newfoundland Model Forest and Department of Fisheries and Oceans and has conducted numerous fisheries projects with AMEC such as the lower Churchill River fisheries baseline and HADD Determination Methodology, Voisey's Bay Fish Habitat Compensation Plan, and the Granite Canal Fish Habitat Compensation Plan. Mr. McCarthy was responsible for WPM graphing, discharge calculations, point of inflection identification, and report preparation.

**Bevin LeDrew**, M.Sc., is a Principal Biologist with AEE who has over 30 years of fisheries, impact assessment and project management experience. As a fisheries scientist with DFO and subsequently with Newfoundland and Labrador Hydro, Mr. LeDrew was involved in conducting numerous fisheries habitat and population studies throughout Newfoundland and Labrador. Mr. LeDrew is considered an authority on fish habitat assessment and how it relates to fisheries compensation.

## 3.0 METHODS

The WPM technique was used on the lower portion of Shoal Harbour River in order to determine the minimum flow requirements for maintaining the identified migratory characteristic of the habitat.

### 3.1 CRITICAL AREAS (TRANSECTS)

The locations of the cross-sections were identified on July 25, 2002 during the initial site visit by Bevin LeDrew and SGE-Acres surveyors. A total of eight initial transects were selected for survey by SGE-Acres survey personnel. The transects were selected to reflect the DFO concern with respect to fish migration. The selected areas were in wide shallow sections where low flows might be more likely to create obstructions to migration. Figure 3.1 shows the location of all transects used to address potential changes in stream flows and fish habitat.

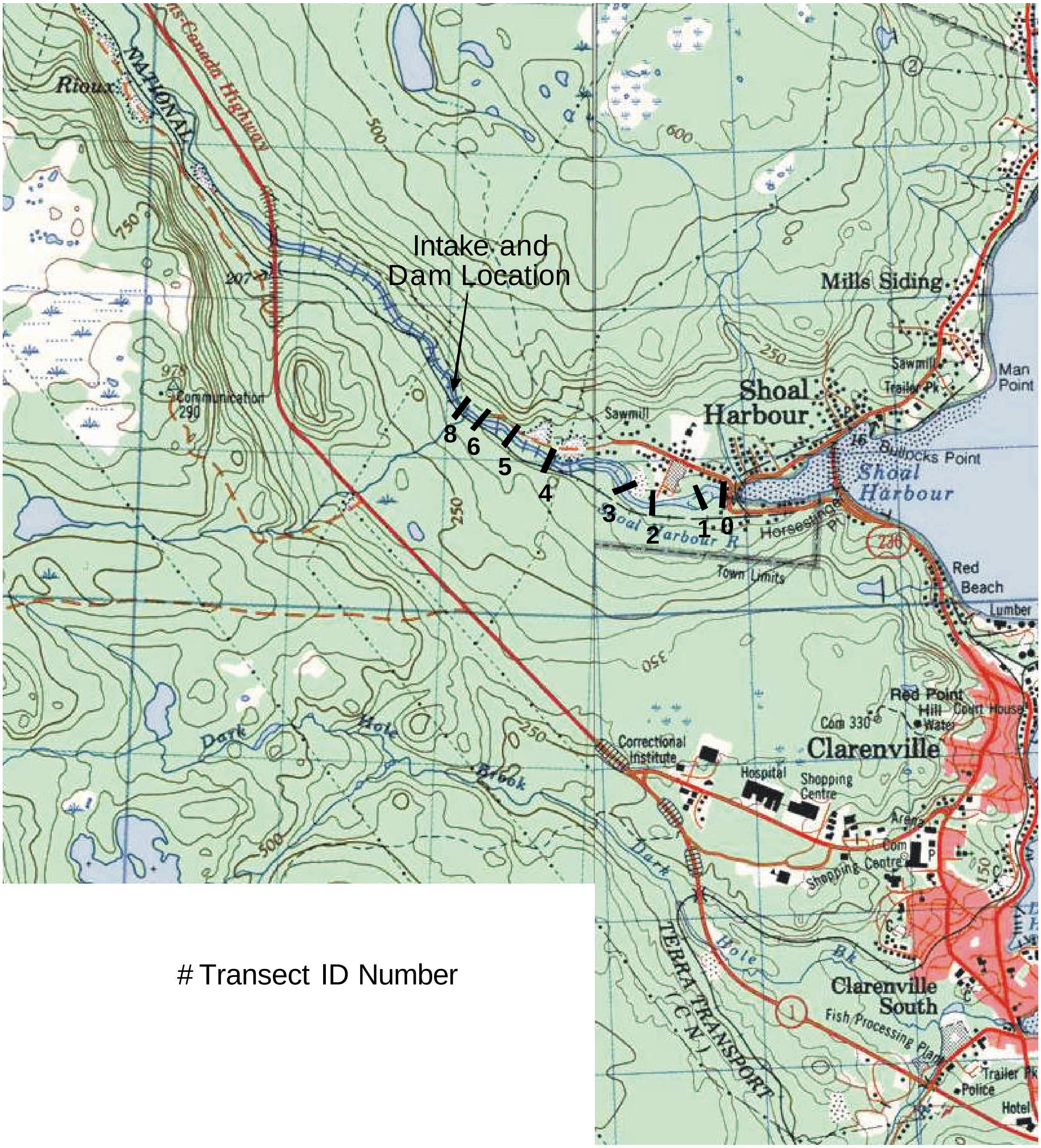
## 3.2 SURVEY DATA

Each transect was surveyed by SGE-Acres personnel on four separate dates; August 1-2, August 12, August 15, and August 28, 2002. Each transect was surveyed across the entire width of the river at 25cm increments. The bottom contour of each transect was surveyed on the first date with surface water elevations measured on all dates. Surveys were conducted such that they represented various flow levels in Shoal Harbour River.

Table 3.1 presents summary data on each survey transect. Estimates of mean discharge on each survey date were acquired from Environment Canada.

Table 3.1. Survey transect summary information.

| Transect ID | Station (m) | Distance between Transects (m) | Average bottom Elevation (m) | Slope % (downstream of transect) | Description |
|---|---|---|---|---|---|
| 0 | 0+0 | - - | 1.20 | 0.47 | Immediately upstream of abutment at bridge |
| 1 | 0+118 | 118 | 1.75 | 0.47 | At boulder on bank in right turn just above bridge |
| 2 | 0+419 | 301 | 6.00 | 1.41 | Below second pool, just upstream of bedrock knob in center of river – wide shallow stretch – 25% boulder; 40% cobble; 30% rubble; <10% gravel. (Note evidence of ice scour – mobile bed material) |
| 3 | 0+689 | 270 | 9.70 | 1.48 | - - |
| 4 | 1+248 | 559 | 17.40 | 1.38 | Under power lines in a left turn (facing downstream) |
| 5 | 1+594 | 346 | 22.50 | 1.47 | wide (200m) stretch below pool – riffle flow, <1% bedrock, 40% boulder; 50% cobble/rubble; < 10% gravel |
| 6 | 1+708 | 114 | 23.30 | 0.70 | at "rapids" above first pool |
| 8 | 1+835 | 127 | 25.50 | 1.73 | near dam in a wide stretch – boulder/cobble |

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| | | SGE-Acres | | | |
| | Reproducedfrom m aps producedbyLGL(1999). | amec | | | |
| | DRAWN JHM | PROJECT ShoalHarbourRiverInstream FlowNeeds | | | |
| | CHECKED A P | DRAWING TransectLocations,2002 | | | |
| | FILENO. Tf05205 | SCALE | DATE 04/12/02 | DWG.NO. FIGURE 3 . 1 | REV. 0 |

## 4.0 RESULTS

Based on the survey data provided by SGE-Acres, the relationship between discharge and surveyed wetted perimeter at each transect was initially plotted to determine if the point of inflection could be determined directly from the measured data.

Because three of the survey dates had very similar discharges, the required upper and lower ranges of discharge could not be measured directly. Using Manning's equation however, the survey data provided by SGE-Acres were used to calculate additional discharges and wetted perimeters at four of the eight transects. These additional data points were combined with the survey data to extend the curves across a broad range of flows. The four transects chosen represent the most shallow and widest of all surveyed. The resultant wetted perimeter graphs for the four transects are presented below (Figures 4.1-4.4).

From the graphs, the point of inflection for all transects is determined to be 0.175$m^3$/s. Below this discharge, rapid decreases in wetted perimeter are realized. This discharge would therefore represent the minimum flow required to protect the migratory habitat in the lower section of Shoal Harbour River. Daily discharge data for 2001 and 2002 from Environment Canada suggests that this discharge level is close, and in some cases exceeds, that currently experienced during the later part of migration (i.e. late-August to early September) (Figure 4.5).

It should be noted that the lower section of Shoal Harbour River is relatively uniform in gradient and substrate, with well defined banks through most of its length. The substrate consists of primarily rubble/cobble substrate and small boulders which may not be very stable during high flow events. The survey data representing the bottom of the river at each transect does not represent the presence of these larger, mobile substrates. That is, the surveyed bottom represents the more compacted substrate upon which the less-stable rubble and boulders rest. Unless a boulder was large enough to be considered immobile (i.e. approximately 0.5m), it was not used as the bottom contour. As such, the wetted areas are generally over-estimated. Therefore, in order to remain conservative, any additional water extraction should maintain at least 0.25$m^3$/s for maintenance of migratory habitat. It is also recommended that the river be field surveyed at 0.25$m^3$/s to ensure the maintenance of migratory habitat at that discharge.

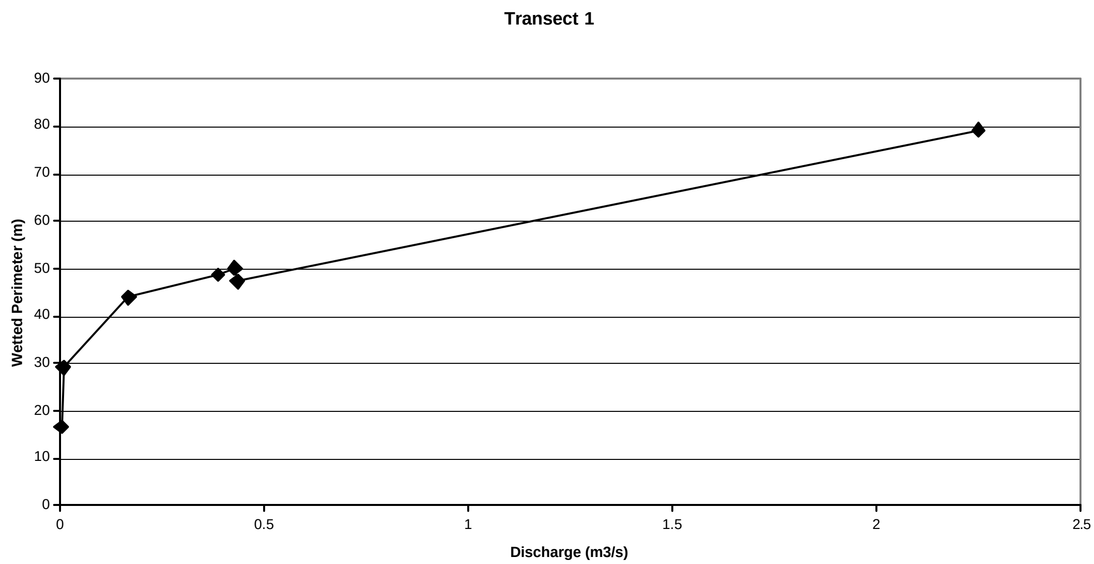



Figure 4.1. Wetted perimeter-discharge relationship, Transect One.

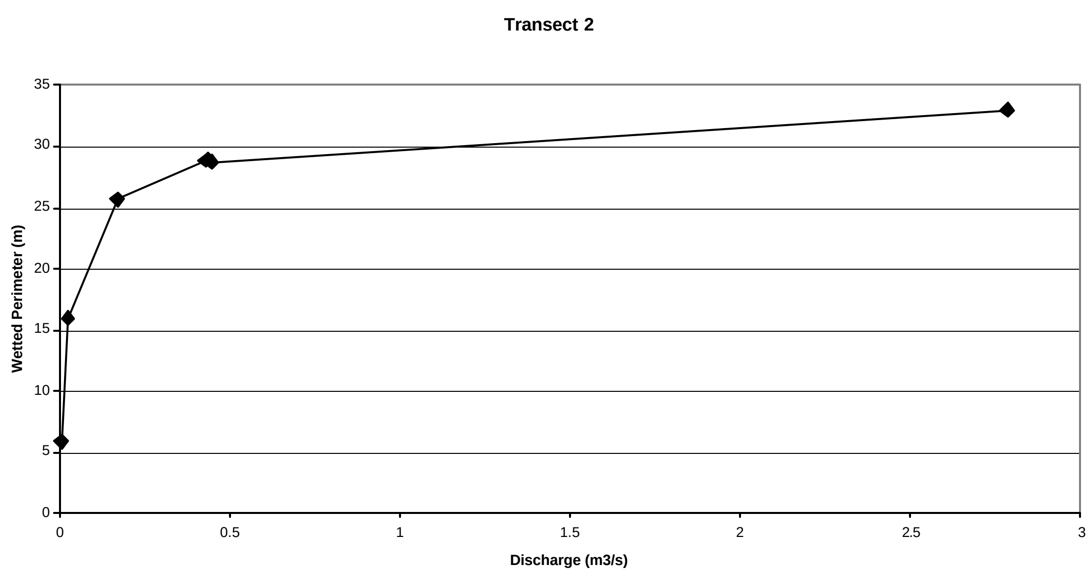



Figure 4.2. Wetted perimeter-discharge relationship, Transect Two.

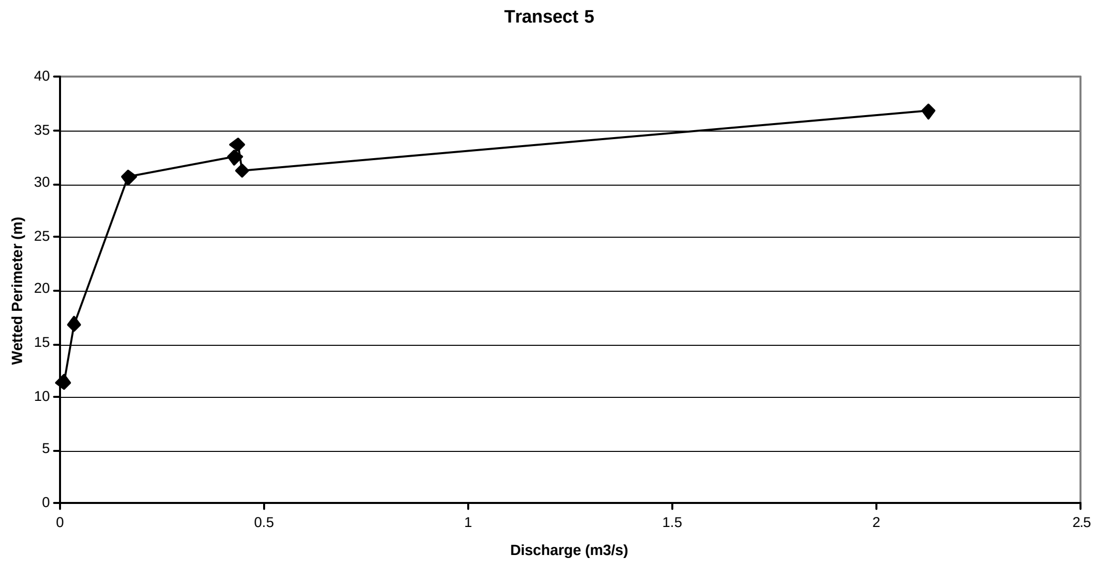



Figure 4.3. Wetted perimeter-discharge relationship, Transect Five.

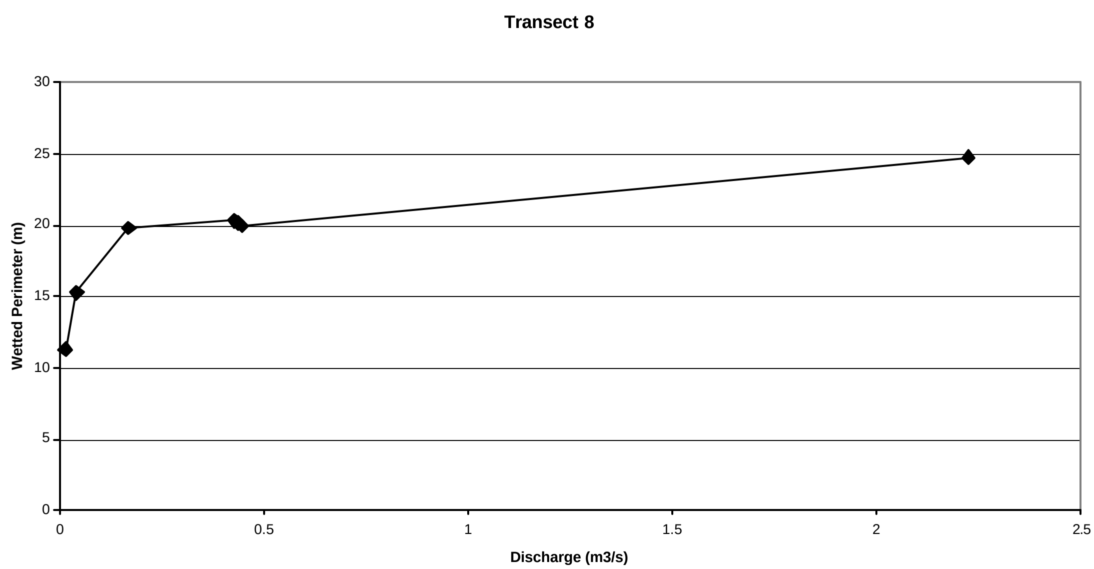



Figure 4.4. Wetted perimeter-discharge relationship, Transect Eight.

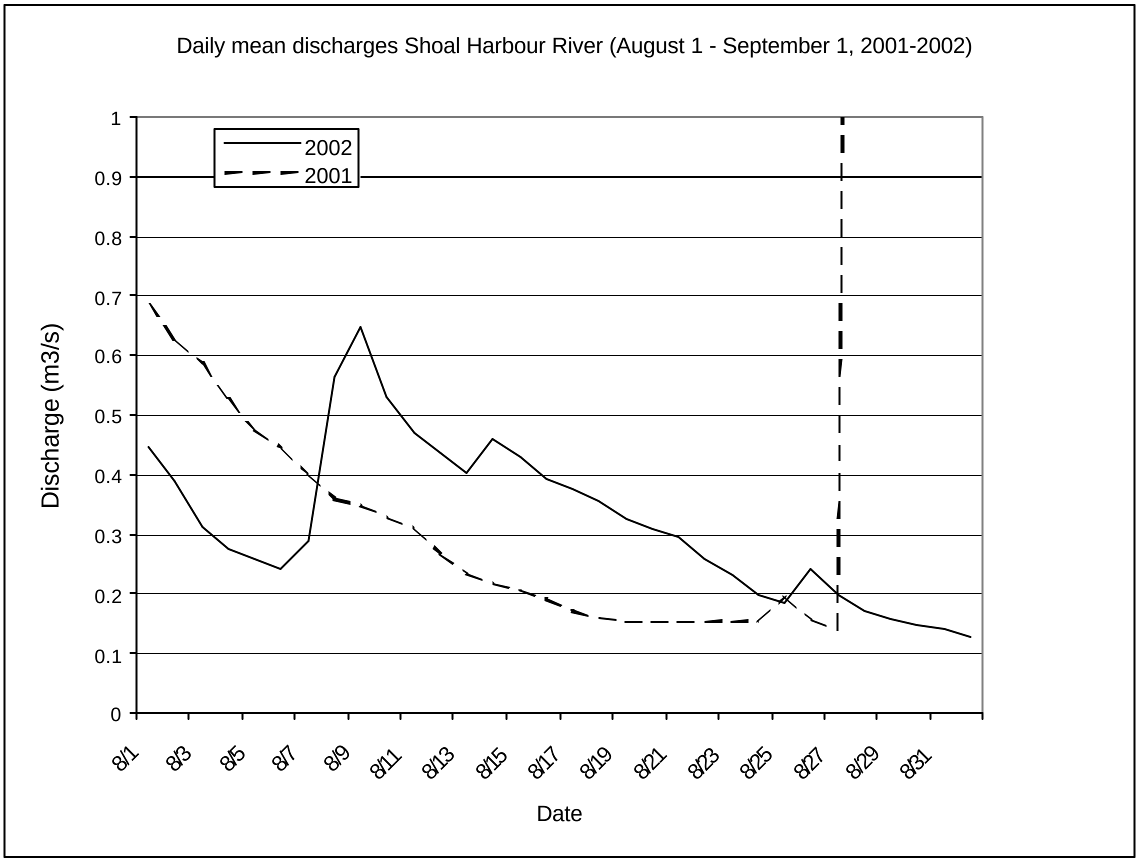



Figure 4.5. Mean daily discharge, Shoal Harbour River, August 1 – September 1, 2002.

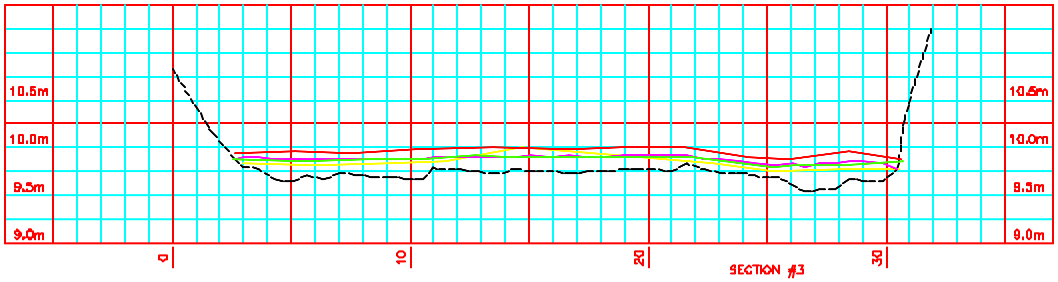
## References

Stalnaker, C., B.L. Lamb, J. Henriksen, K. Bovee, J. Bartholow. 1994. The Instream Flow Incremental Methodology: A Primer for IFIM. National Ecology Research Center, Internal Publication. National Biological Survey. Fort Collins, Colorado. 99pp.

Nelson, F.A. 1980. Evaluation of selected instream flow methods in Montana. Proceedings of the Annual Conference of the Western Association of Fish and Wildlife Agencies: 412-432.

# APPENDIX A

## Survey data from each transect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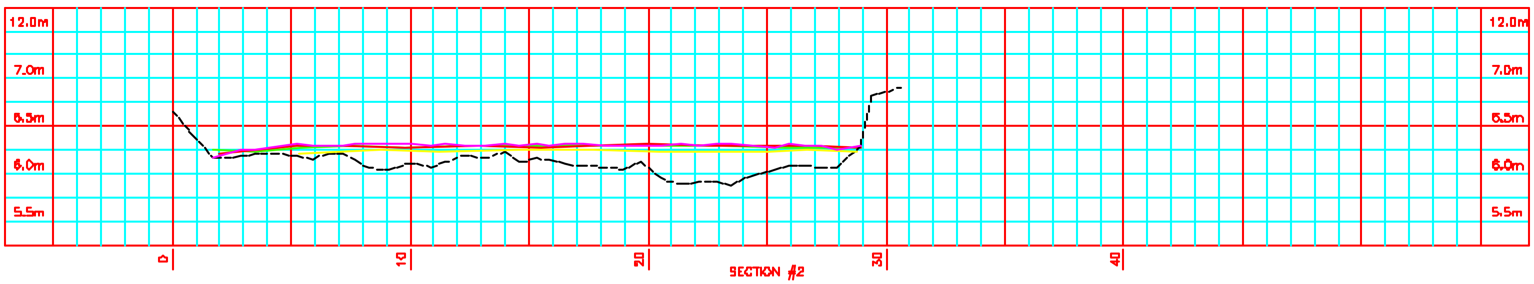
| % GRADE | SECTION # | AVERAGE BOTTOM ELEV. | STATION | DISTANCE BETWEEN SECTIONS | WET WIDTH AUG 1st / 2nd | WET WIDTH AUG 12th | WET WIDTH AUG 10th | WET WIDTH AUG 28th |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1.20m | 0+0 | | 4.55<br>50.43 | 29.46 | 29.71 | 8.35<br>16.51 |
| 0.478 | | | | 118 | | | | |
| | 1 | 1.787 | 0+118 | | 1.42<br>1.41<br>42.45 | 1.34<br>44.26 | 49.38 | 41.51 |
| 1.412 | | | | 301 | | | | |
| | 2 | 6.05m | 0+419 | | 27.48 | 27.14 | 26.62 | 26.65 |
| 1.462 | | | | 270 | | | | |
| | 3 | 9.70m | 0+689 | | 27.88 | 28.09 | 27.89 | 27.6 |
| 1.383 | | | | 459 | | | | |
| | 4 | 17.40m | 1+248 | | 25.81 | 26.04 | 26.13 | 25.79 |
| 1.472 | | | | 346 | | | | |
| | 5 | 22.50m | 1+594 | | 15.63<br>12.29 | 31.13 | 11.81<br>12.82 | 15.18<br>12.21 |
| 0.783 | | | | 114 | | | | |
| | 6 | 28.33m | 1+708 | | 4.89 | 11.63 | 11.67 | 10.53 |
| 0.782 | | | | 427 | | | | |
| | 8 | 26.50m | 1+835 | | 17.38 | 16.01 | 20.13 | 16.58 |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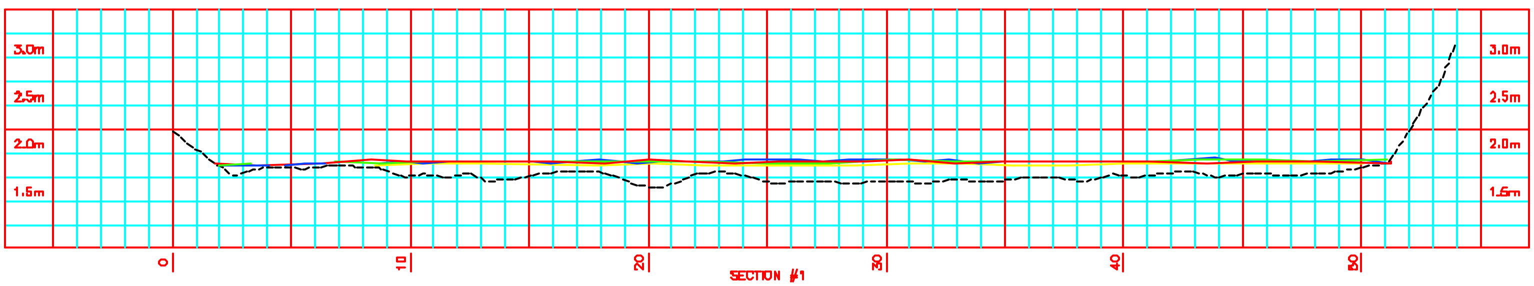
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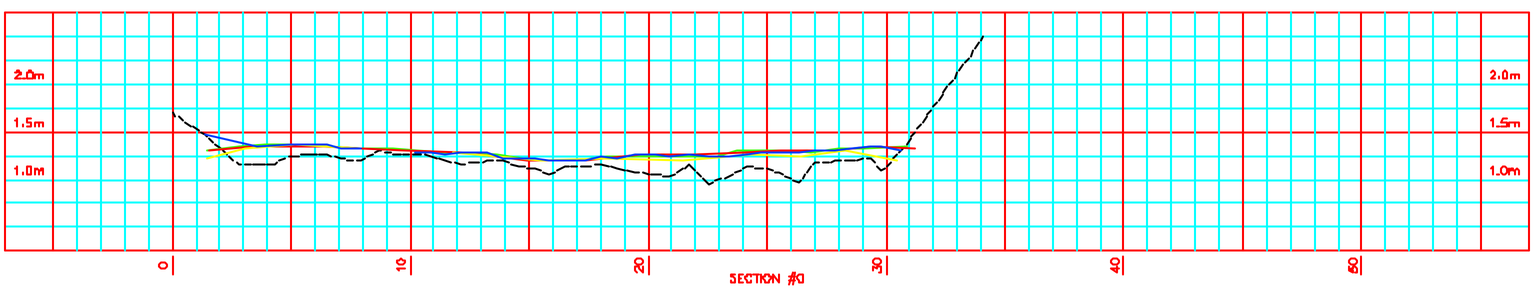
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## NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. ALL ELEVATIONS ARE IN METRES UNLESS OTHERWISE NOTED.

## LEGEND

- TOP OF WATER – AUGUST-01
- TOP OF WATER – AUGUST-02
- TOP OF WATER – AUGUST-12
- TOP OF WATER – AUGUST-18
- TOP OF WATER – AUGUST-28
- EXISTING GROUND

| No. | Description | Date | By |
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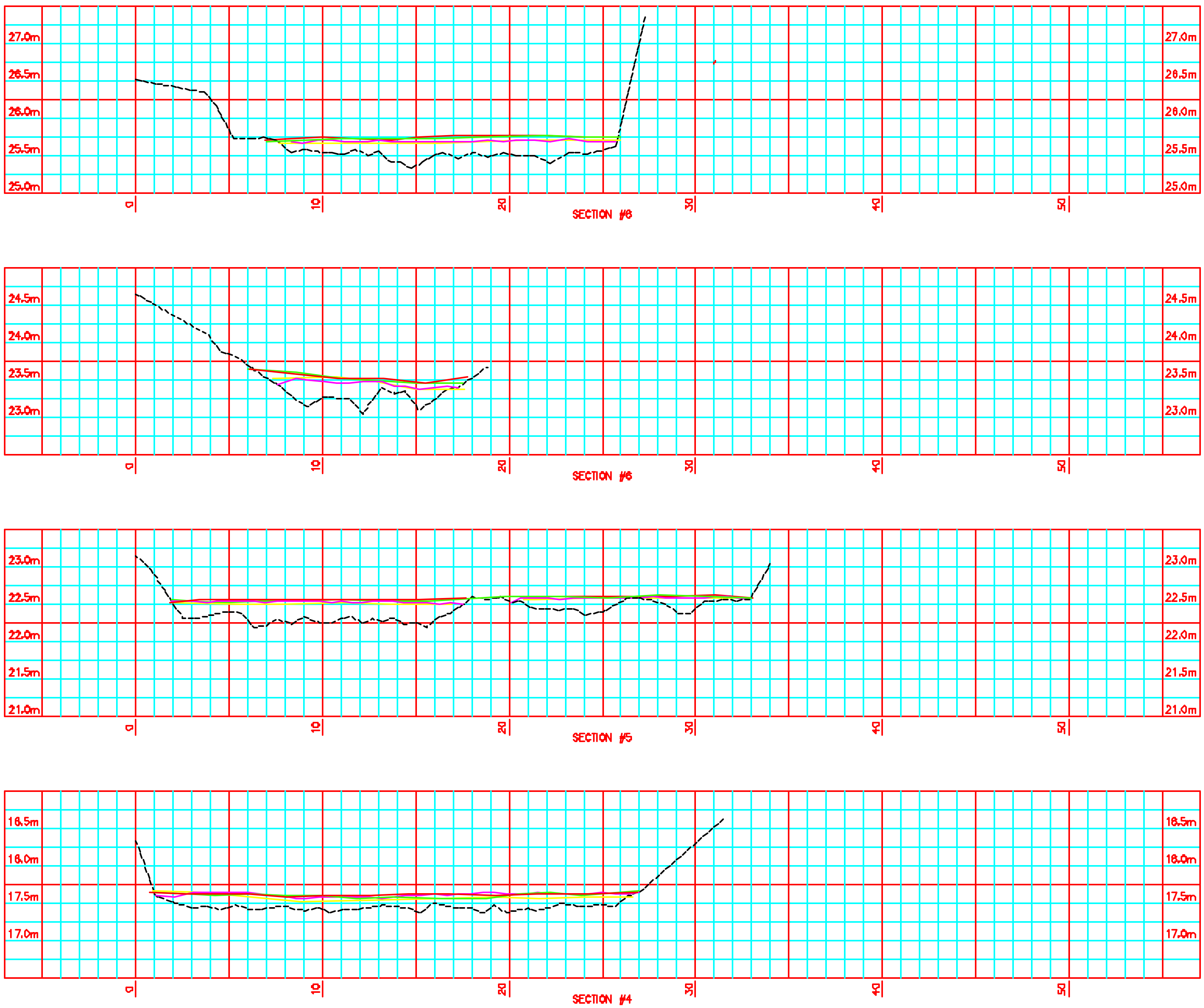


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## LEGEND

- TOP OF WATER - AUGUST-01
- TOP OF WATER - AUGUST-02
- TOP OF WATER - AUGUST-12
- TOP OF WATER - AUGUST-19
- TOP OF WATER - AUGUST-28
- EXISTING GROUND

| No. | Description | Date | By |
|---|---|---|---|
| 0 | ISSUED FOR APPROVAL | ---- | ---- |

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