

## Hec-RAS practical

### MINEHEAD CASE STUDY

The **aim** of this report is to use a Hec-RAS model to determine the flood risk along a reach of Bratton Stream where a new flow gauge is to be constructed. Specific objectives include:

- \* Investigate the effect of the 1 in 50, 100 & 200yr flood return period on water surface levels at the proposed gauging station (node ref. 0.062)
- \* Investigate model sensitivity to flow Q by taking into account +20% change in peak Q over the next 50yrs due to climate change.

Your **report** will:

- \* Briefly describe the flood depths and extents along the reach, with particular emphasis on data at the site of the proposed gauging station.
- \* Discuss the influence of climate change on the hydraulic performance of the reach.
- \* Present a stage–discharge graph for node ref. 0.062 to illustrate the model sensitivity to climate change.
- \* Use correctly referenced figures, tables and appendices where appropriate.

#### How is the survey data (i.e. geometry) represented in the model?

1. Open your model (**Minehead.prj**) and go to **Edit** then **Geometric Data**.

You will see that the model has been split into 3 straight reaches that are joined by junctions (**Jnct 01** and **02**).

Downstream of **Jnct 02** is modelled as two channels (*Bratton Stream* and a *2ndary* channel); this represents bifurcation of flow through the 2 arches of the road bridge.

*Reach 1* is the downstream reach of your model containing the weir and the footbridge.

2. Put your *cursor arrow* over the line referenced 0.014. *Click* the left button of your mouse once. You will see that you are on *Bratton Stream Reach 1 (R1)* at cross-section referenced *River Sta. 0.014*.
3. Click on **Edit Cross Section** to show the cross-sectional survey data (x-y coordinates); this includes Manning's 'n', the downstream distance to the next cross-section and the bank tops of the main channel.
4. Use the *up/down arrows* (next to the River Sta: 0.014 box) to see the other cross-sections on Bratton Stream in Reach 1.
5. Close the *Cross Section Data* screen
6. In the *Geometry Data* window you have a red circle around Reach 1. Go to the toolbar in the left hand margin and click on **Brdg/Culv**. You can now see that the footbridge is modelled as an arch at River Sta. 0.001. Close this screen.
7. Now click **Inline Structure** from the left toolbar; this shows you what the weir looks like at River Sta. 0.013.

You can now perform similar actions to see that:

- *Bratton Stream Reach 2* contains one arch of the road bridge (whilst the second arch is contained in *2ndary Reach 1*).
- *Bratton Stream Reach 3* is dominated by a large floodplain on the left hand side of the channel.

- Close the Geometric Data screen.

### How to model steady-state flow conditions

Given that this catchment is ungauged 3 donor catchments of similar characteristics have been used in the Flood Estimating handbook (FEH) to estimate discharge (Q) for the flood return periods given below (Table 1). To account for climate change over the next 50 years discharges were also increased by 20%.

*Table 1 – Discharge information*

Return Period (yrs)	Design flow (m <sup>3</sup> /s)	Design flow + 20% (m <sup>3</sup> /s)
2	1.30	1.60
5	2.00	2.40
10	2.50	3.00
25	3.50	4.20
<b>50</b>	<b>4.50</b>	<b>5.40</b>
<b>100</b>	<b>5.80</b>	<b>7.00</b>
<b>200</b>	<b>7.40</b>	<b>8.90</b>
500	10.40	12.50

- Within the main *Hec-RAS* menu go to **Edit** then **Steady Flow Data**. You will see that you have to enter/edit 3 profiles corresponding to the 1 in 50, 100 and 200yr R.P.
- Enter the input data given in Table 2.

*Table 2 – Peak discharges (m<sup>3</sup>/s) in each River and Reach for all return periods (no climate change).*

River	Reach	RS	50yr	100yr	200yr
<i>2ndary</i>	R1	0.0331	0.17	0.50	0.99
<i>Bratton Stream</i>	Reach_3	0.062	4.50	5.80	7.40
<i>Bratton Stream</i>	R2	0.033	4.33	5.30	6.41
<i>Bratton Stream</i>	R1	0.014	4.50	5.80	7.40

You can see that the model is steady state as the input to upstream *Reach 3* is the same as the output from downstream *Reach 1* (these values are the discharges presented in Table 1).

It is also evident that conveyance of flow through the *2ndary* channel increases in relative importance during floods of higher R.P.

- In your *Steady Flow Data* screen click on **Reach Boundary Conditions**. This already shows the location of junctions between the reaches in your model.
- Highlight the box for the *upstream* boundary condition for *Bratton Stream Reach\_3*. Click the button for **critical depth** to enter this as your upstream boundary.

As this is an un-gauged catchment we do not have measured water surface data; this is why we use critical depth.

- Highlight the box for the *downstream* boundary condition for *Bratton Stream R1* (Reach 1). Click the button for **normal depth** to enter the slope of your channel as **0.016**.

Again, we do not have any measured water surface data here, so we use the slope (in this case the bed slope from survey data) in calculating normal depth (Manning's equation) at this location.

14. Save your steady-state flow data file.

### **How to run your model**

15. In the main *Hec-RAS* menu go to **Run** then **Steady Flow Analysis**. Press **COMPUTE**. The model will tell you when the computations are complete. **Close**.
16. In the main *Hec-RAS* menu go to **View** and choose **Cross-sections** to visualise your model. Go to **Options**, then **Profiles**, then **Select All** and **OK**; this displays all three of your flow R.P. data on the same graph.
17. Look at *River Sta. 0.062* on *Reach 3* of *Bratton Stream*. This is the site of the proposed gauging station; how does the water level and flood extent change for each of your flood return periods?
18. To view your data in tabulated form, you can find within the View menu the Detailed Output Tables. Go to *RS 0.062* and use the *Profile* button to change between R.P. events; how does the water level (*Max. Chl. Depth (m)*) and flood extent (*Top width (m)*) change for each of your flood return periods?

You will need to save some of the tables and graphs you view; you will analyse this data when you write up your report.

### **How to add climate change to your steady state flow file**

Table 1 gives the discharges +20% to account for the impact of climate change on Bratton Stream; you now need to add these to your steady flow file for each R.P.

19. In the main *Hec-RAS* menu go to **Edit** then **Steady Flow Data**. Change the number of profiles to **6**. Click **Apply Data**.
20. Go to **Options** then **Edit Profile Names**. Rename profiles 4, 5 and 6 as '**50yr + 20%**', '**100yr +20%**' and '**200yr +20%**' respectively. Click **OK**.
21. In the appropriate columns, enter the revised peak discharge data (Table 3):

*Table 3 – Peak discharges (m<sup>3</sup>/s) in each River and Reach for all return periods (including climate change).*

<b>River</b>	<b>Reach</b>	<b>RS</b>	<b>50yr + 20%</b>	<b>100yr + 20%</b>	<b>200yr + 20%</b>
<i>2ndary</i>	R1	0.0331	0.40	0.81	1.50
<i>Bratton Stream</i>	Reach_3	0.062	5.40	7.00	8.90
<i>Bratton Stream</i>	R2	0.033	5.00	6.19	7.40
<i>Bratton Stream</i>	R1	0.014	5.40	7.00	8.90

Again, you can see that the model is steady state as the input to upstream *Reach 3* is the same as the output from downstream *Reach 1* (these values are the discharges presented in Table 1).

22. Click **Apply Data**, then **Save** your flow file.
23. **Run** your model.
24. **View** and **save** your output data for the *max. channel depth* and *top width* for each R.P. at *River Sta. 0.062*.

You now have sufficient data to plot your stage-discharge graph for the site of the proposed gauging station. Write up your report.