100/100

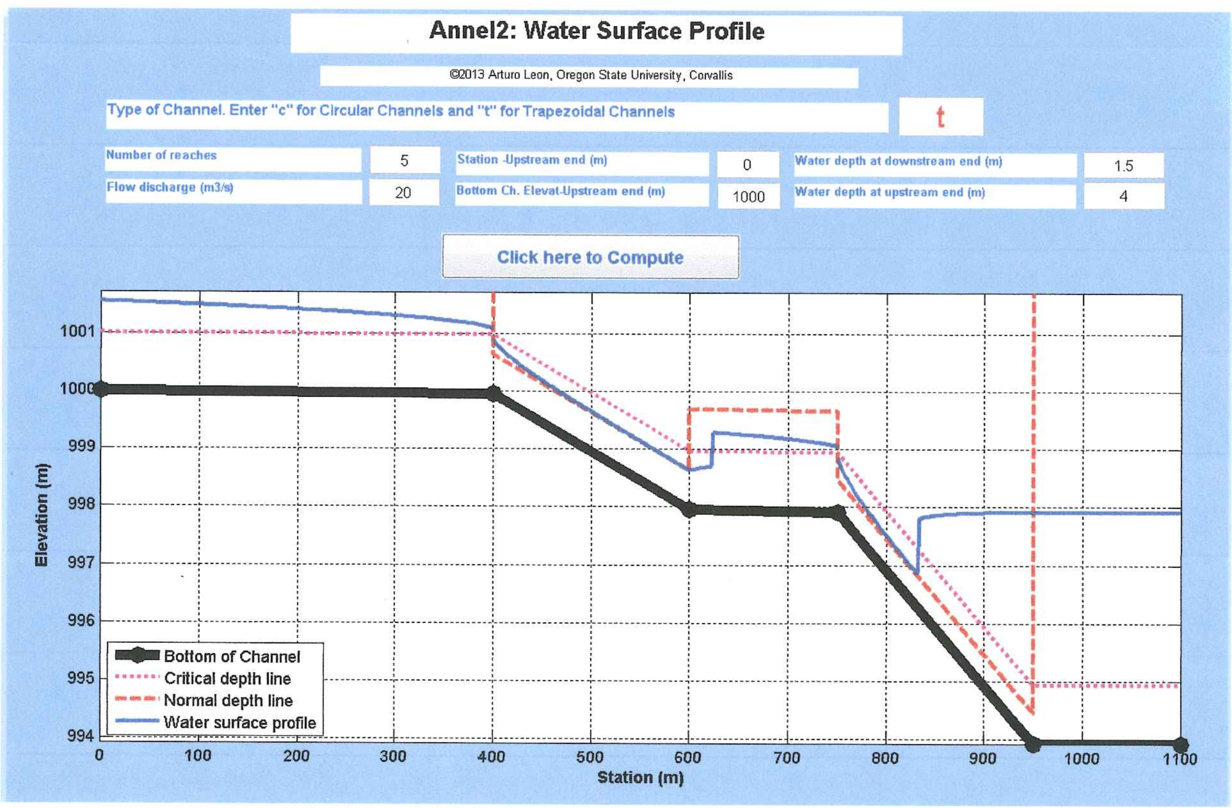
CE 313 Hydraulic Engineering, Winter 2013
Take Home Quiz 8

Instructor: Arturo Leon, Ph.D., P.E. **TA:** YunJi Choi

Student Name: Shane Prohaska

Due Date: March 8 (In class)

In the 5-reach trapezoidal channel shown below, the flow can vary from 1 to 150 m^3/s. The bottom width of the channel is 5m, the side slope (z) is 2, and the Manning's roughness coefficient is 0.014 (concrete, unfinished). The channel, at the downstream end, connects a lake with constant water surface elevation. The water depth in the channel at the downstream end (at lake entrance) is 4 m. The lengths of reaches 1 to 5 (from upstream to downstream), are 400, 200, 150, 200, and 150 m, respectively. The channel bottom slopes of reaches 1 to 5, are 0.0001, 0.01, 0.0003, 0.02, and 0 (horizontal), respectively. For channel protection purposes, you are asked to determine the location of all hydraulic jumps for various flow discharges (at least 5 discharges). For the at least 5 discharges, report (1) approximate values of location of hydraulic jumps with reference to the most upstream station (e.g., 0 in this case), and (2) plots of water surface profiles. Also, explain (3) why the location of a hydraulic jump changes with flow discharge, and (4) why for larger flows (e.g., Q =140 m^3/s), there is not hydraulic jump in 'reach 3' (from upstream to downstream).



Quiz 8

Matlab Data Setup:

The table below shows the excel data that the matlab codes used to compute the hydraulic jumps. The values are the same as specified in the problem statement.

Table 1: Matlab Excel Data

	A	B	C	D	E	F
1	1	400	0.0001	5	0.014	2
2	2	200	0.01	5	0.014	2
3	3	150	0.0003	5	0.014	2
4	4	200	0.02	5	0.014	2
5	5	150	0	5	0.014	2
6						
7						
8						
9						

PART 1: Approximate the values of location of hydraulic jumps with reference to the most upstream station (e.g. 0 in this case).

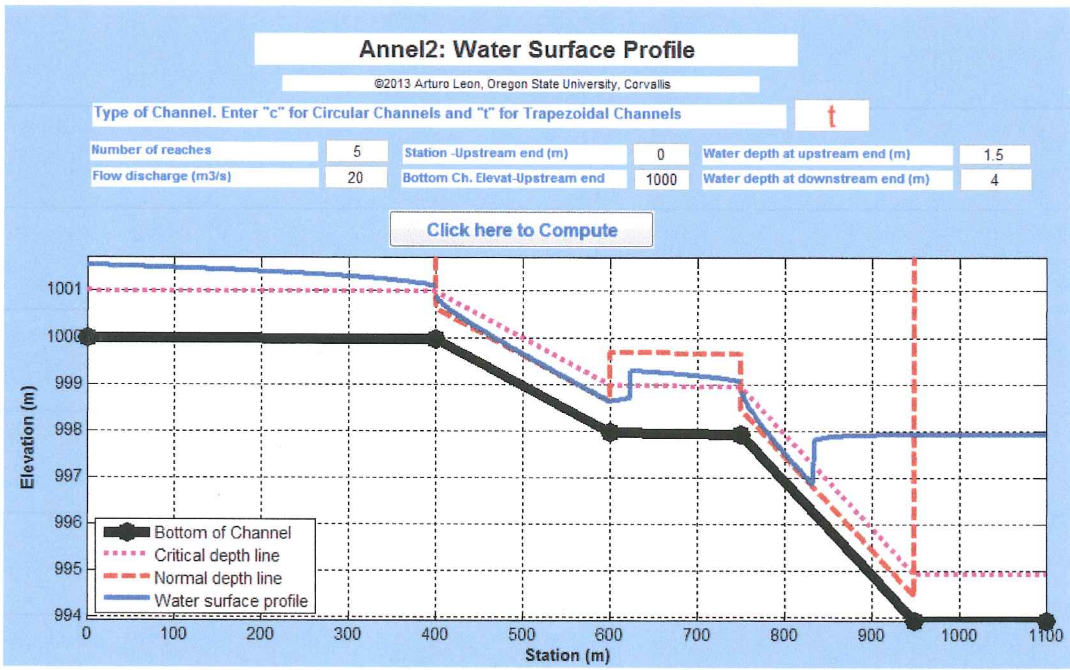
The table below contains values of the approximate location of the hydraulic jumps for five different flow discharges. The locations of the jumps are in reference to the most upstream station (0 m). Part 2 includes the actual water surface profiles for the different discharges, which were used to approximate the hydraulic jump locations.

Table 2: Hydraulic Jump Locations

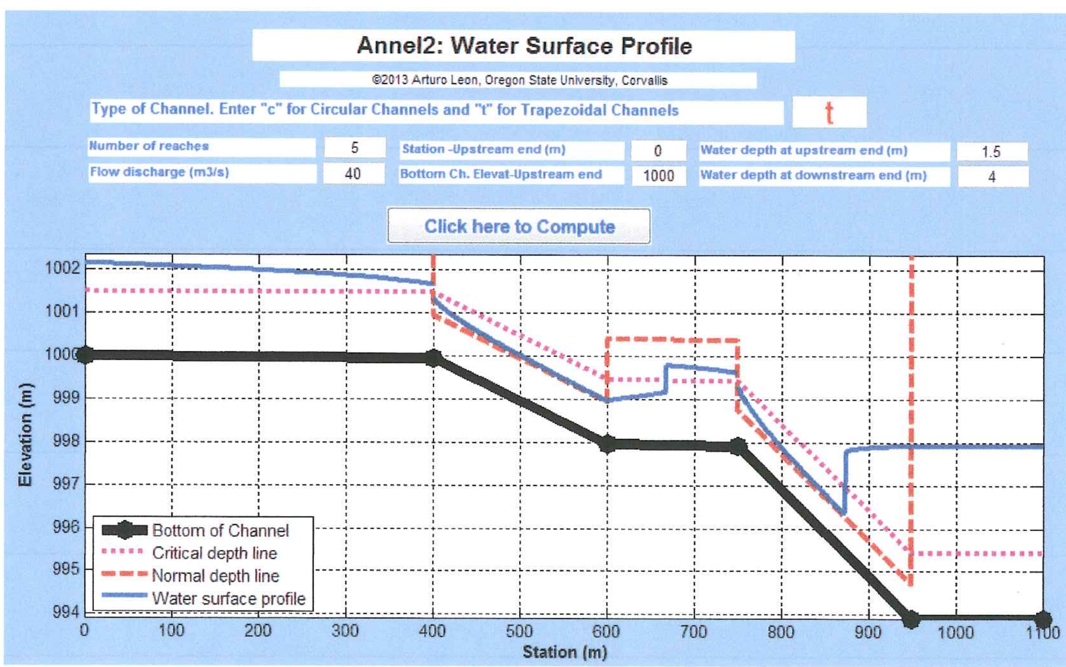
Water Surface Profile	Flow Discharge (m^3/s)	Hydraulic Jump (1) Location	Hydraulic Jump (2) Location
1	20	625	830
2	40	670	870
3	60	700	800
4	80	740	925
5	100	-	940

PART 2: Report the plots of water surface profiles

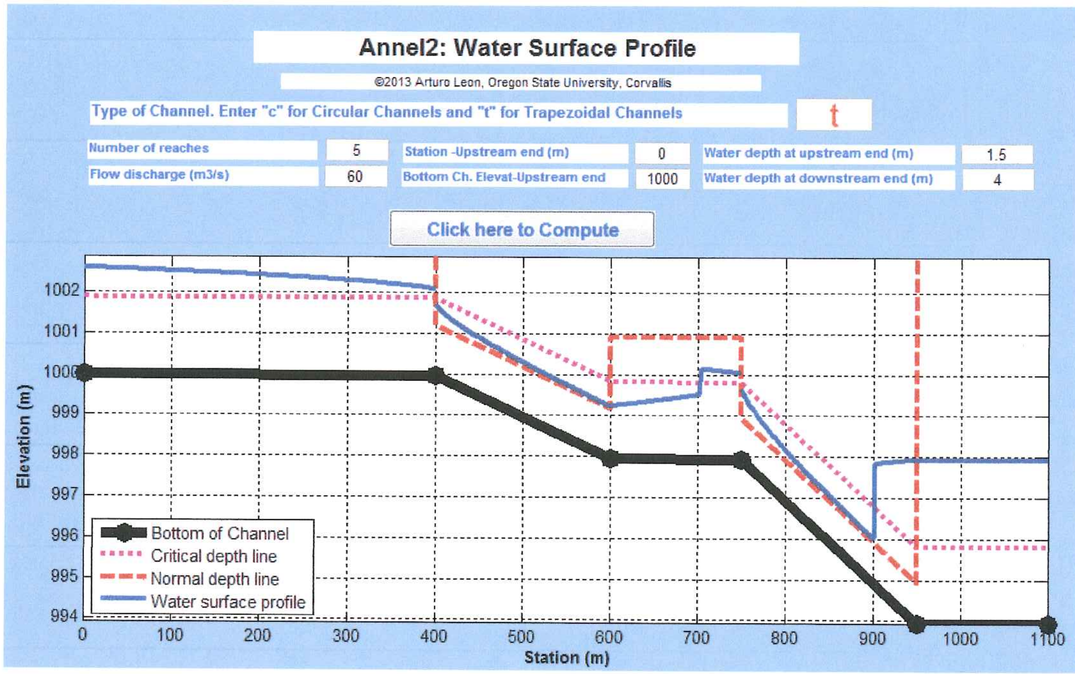
Water Surface Profile 1:



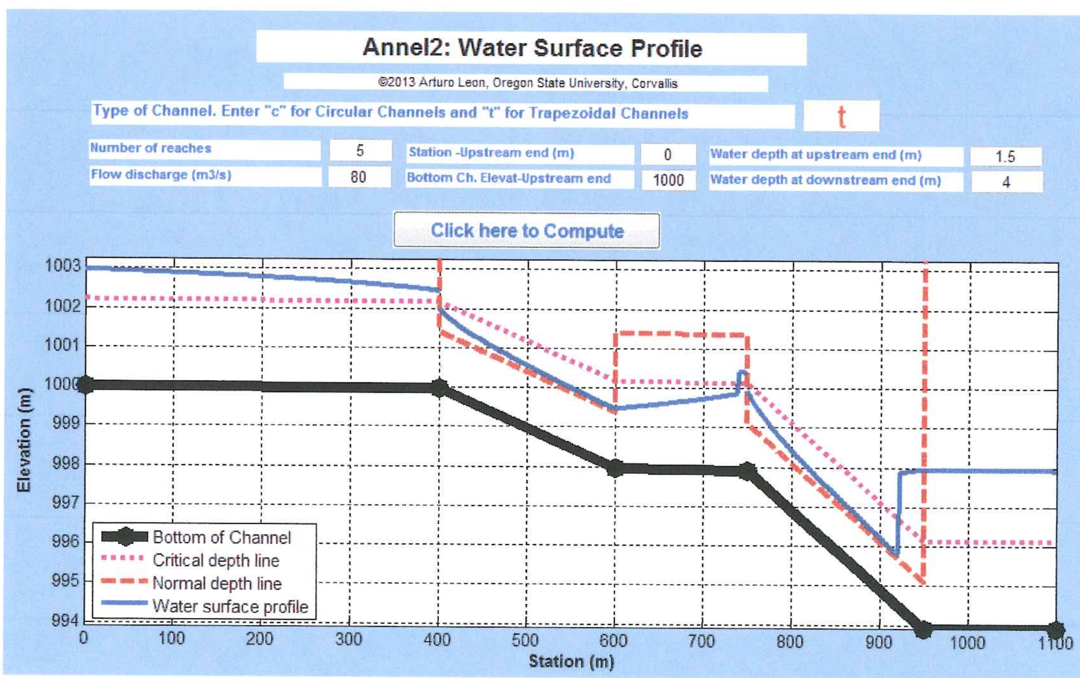
Water Surface Profile 2:



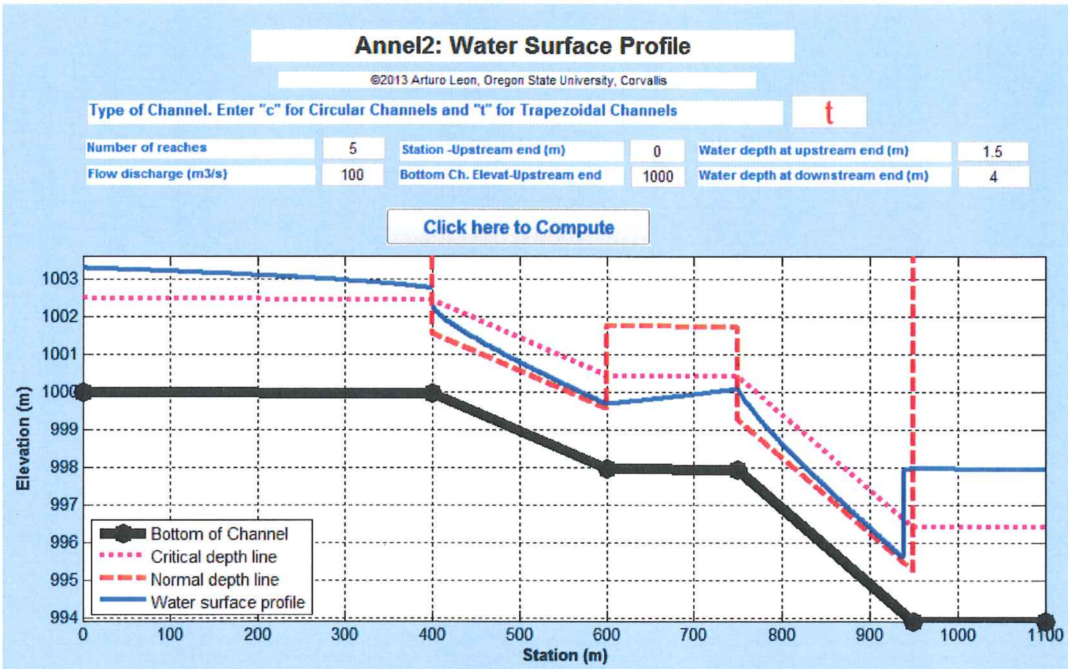
Water Surface Profile 3:



Water Surface Profile 4:



Water Surface Profile 5:



PART 3: Explain why the location of a hydraulic jump changes with flow discharge.

The location of a hydraulic jump changes with flow discharge because the flow discharge influences the type of flow (e.g., subcritical, supercritical) and the Froude number, which is dependent on flow velocity. As the discharge increases, the velocity of the flow will increase (along with the volume of water), which will increase the momentum of the upstream and downstream sections. As the upstream momentum increases, the flow velocity downstream increases as well giving it more force, preventing the velocity from slowing down and producing the hydraulic jump. The greater the flow momentum, the greater the distance is required to slow the flow down for a hydraulic jump to happen. The smaller the discharge, the sooner the hydraulic jump will occur because the momentum of the flow is low and the larger the discharge, the further on the hydraulic jump will occur because the momentum of the flow is large. This can be seen in the progression of the hydraulic jumps for various discharges in the water surface profiles in part 2.

PART 4: Explain why for larger flows (e.g., Q = 140 m³/s), there is not hydraulic jump in 'reach 3' (from upstream to downstream).

There are no hydraulic jumps for large flows in reach 3 because the momentum of the flow is too great from the upstream section to the downstream section for the flow to be able to slow down. The flow type remains constant, because of the greater amount of momentum the flow has, which prevents a hydraulic jump from occurring. The larger flow discharge prevents the change in flow types (supercritical flow is not reached) which is needed for a hydraulic jump to occur. This can be seen in the water surface profile (with Q = 140 m³/s) shown below.

<u>Water Surface Profile with Q = 140 m³/s:</u>