

This spreadsheet was compiled in March 2017 in response to MDEQ request for additional information

The spreadsheet contains thee (3) workbooks:

1. Calculations of stream level changes at SF-1, SF-9 and SF-16
2. Stage-discharge relationships based on 2001 to 2003 data.
3. Cross section plots of channel profiles at SF-1, SF-9, SF-8 and SF-16 in 2016.

Spreadsheet to calculate water level changes near PW-101

Based on
level reduction from 150 gpm to 400 gpm
stage-discharge relationships

	level	flow-gpm	Change in Stage (ft)	
SF-1	1090.491	715		
	1090.479	683	0.012	
	0.012232			
SF-9	1069.733	3029		
	1069.722	2911	0.012	
	0.011539			
SF-16	1049.675	1038		Note: stage discharge poorly defined.
	1049.666	980	0.009	
	0.00907			

These stream levels (stage) changes based on difference between stream level at average flow under pre-pumping conditions and average flows with steady-state pumping

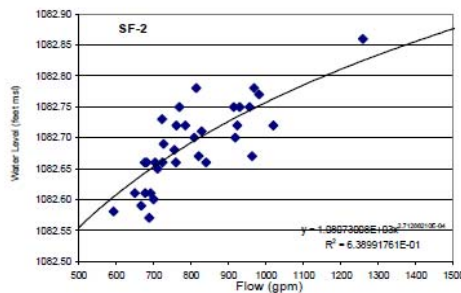
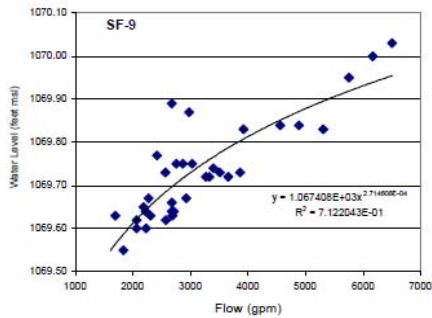
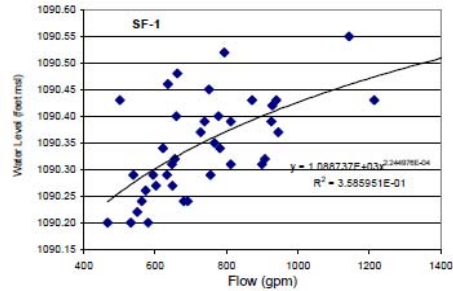
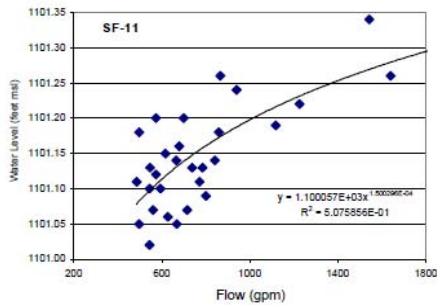
Note: Stage-discharge relationship used in calculations based on 2001 to 2003 data. Refer to accompanying worksheet

Stream Flow and Stream Level

In most streams there is a relationship between the flow of the stream and the elevation of the water surface in the stream, which is referred to as the stage. This relationship is referred to as the stage-discharge relation or the rating curve. The utility of this relationship, once the relationship is established, is that the flow of a stream can be determined by merely measuring the stage, a relatively simple task.

An attempt was made to develop rating curves based on the flow data and water levels recorded approximately every three weeks at gaging stations on Twin Creek and Chippewa Creek. All available data were considered in the analysis for the streams. Generally the period where both flow and water level data are available is from January 2001 to June 2003 with the exception of Chippewa Creek where monitoring of flow began in 2003.

Water levels vs. flow plots are shown for gaging stations on Twin Creek on Figure B-1, and for the gaging stations on Chippewa Creek on Figure B-2. All data available were initially plotted. Based on visual observation, data outliers were excluded from the dataset. A regression analysis was done and a trendline (power) was fitted to each dataset. In a stream with a relatively straight channel where channel friction is significant, hydraulic principles indicate that the relationship between flow and level should be a power relationship (Rantz and others, 1982). The coefficient of determination "R-squared" values was computed for each regression analysis. The R-squared coefficient is a measure of how closely the estimated values for the trendline correspond to the data. A trendline is most reliable when the R-squared value is at or near 1. The trendline equations and the R-squared values are posted on each graph.

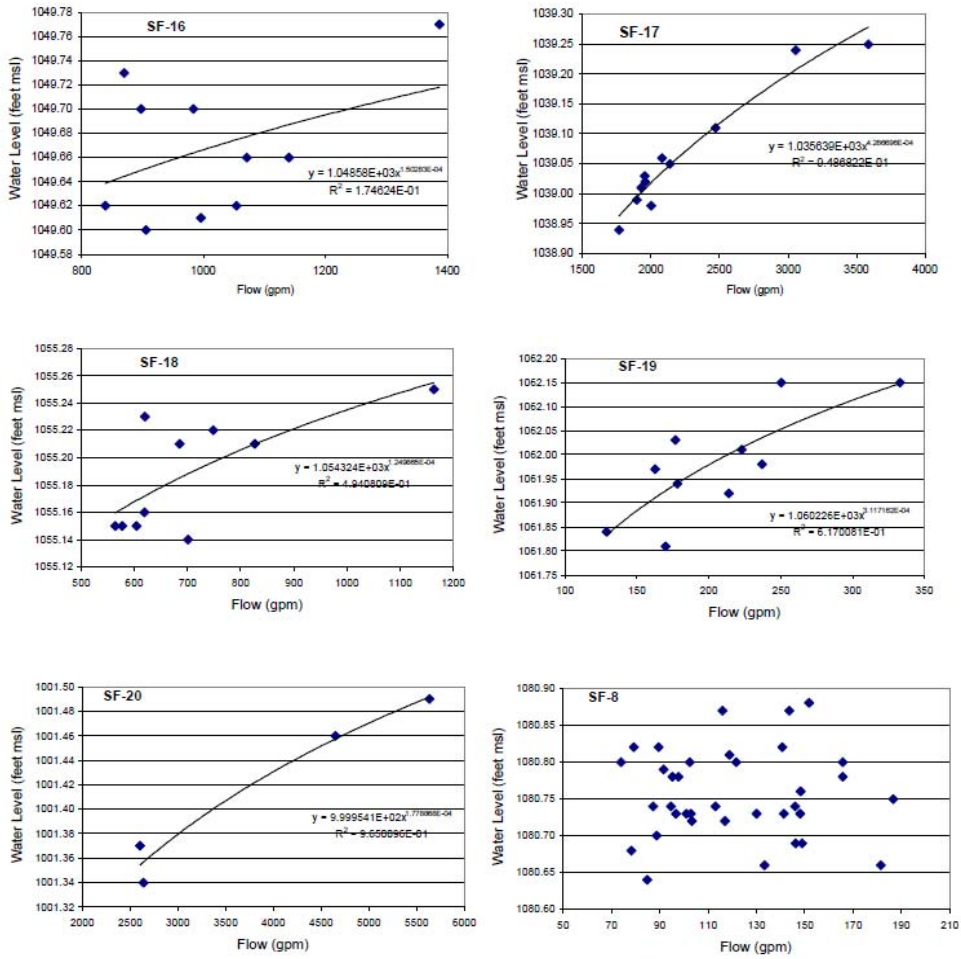


a) Main stem of Twin Creek

a) East Branch of Twin Creek

Note: Water levels adjusted to 4/10/2003 top of casing elevation as reference for complete dataset in SF-11, SF-9, and SF-2. Difference in pre- and post 4/10/2003 top of casing elevation is -0.17, 0.01, and -0.18 feet, respectively, others remained unchanged.

Figure B-1 Stream Flow Rating Curves - Twin Creek



Note: Water levels adjusted to 4/10/2003 top of casing elevation as reference for complete dataset in SF-16, SF-17, SF-18, SF-19, SF-20 and SF-8. Difference in pre- and post 4/10/2003 top of casing elevation is 0.26, 0.22, 0.16, 0.20, 0.29, and 0.01 feet, respectively.

Figure B-2 Stream Flow Rating Curves - Chippewa Creek

Channel Profiles in 2016

Plots of channel cross sections at four of the closest gaging locations to PW-101 were developed for 2016 from the data collected during gaging. The gaging stations for which cross sections were developed were:

SF-16 at flows of 976 gpm and 1038 gpm --- difference of 62 gpm between the two measurements.

SF-1 at flows of 688 gpm and 754 gpm -- a difference of 66 gpm

SF-9 at flows of 2730 gpm and 3112 gpm -- a difference of 382 gpm

SF-8 at flows of 96 gpm, 110 gpm and 123 gpm -- a range in flows spanning 30 gpm

These cross sections illustrate the small changes in the cross section profile that occurs as a result of modest changes in flow. Note that flow at SF-9 is measured at a culvert.

