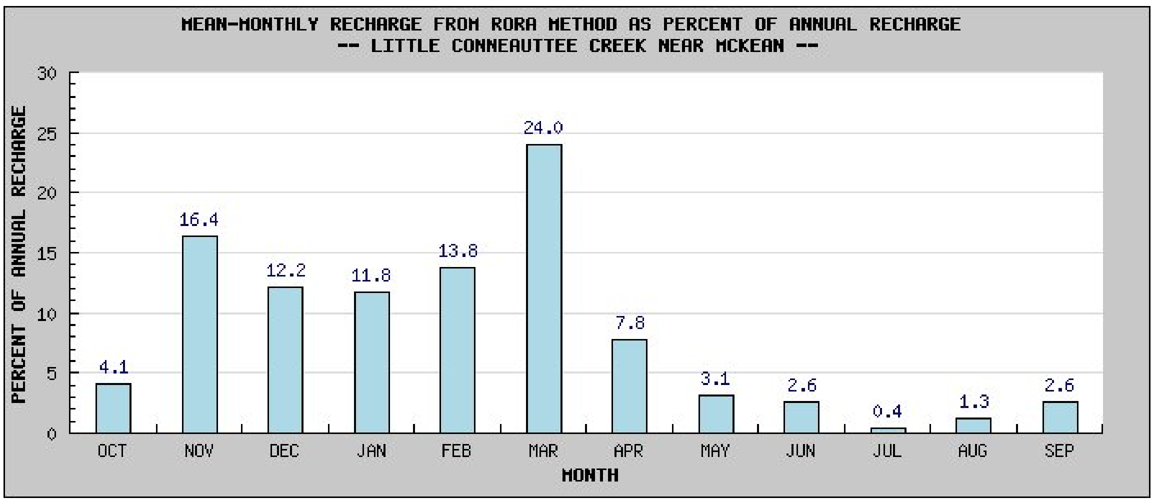
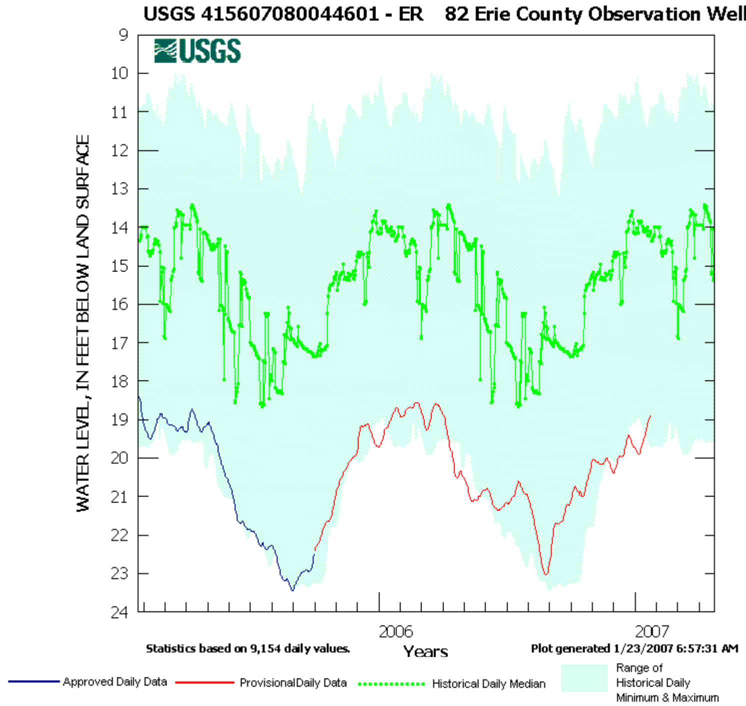
PART 5—WATER USE AND SUSTAINABILTIY

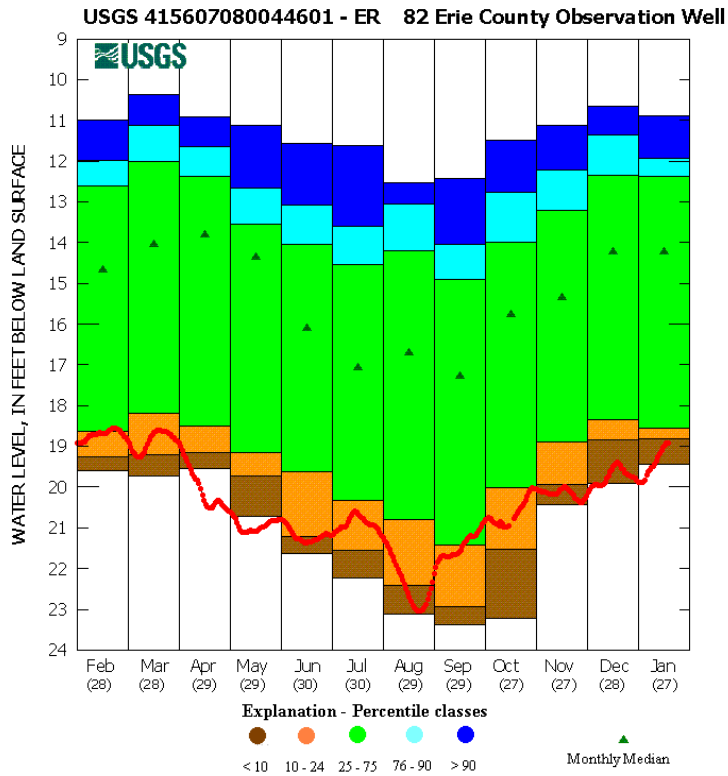
5.1 Groundwater Quantity Assessment

The following U.S. Geological Survey chart shows estimated ground water recharge based on streamflow using hydrograph methods for Little Conneauttee Creek in Erie County. Though some distance from the Walnut Creek watershed, it typifies the seasonal percentage of change in recharge for streams in northwestern Pennsylvania. In short, ground water recharge occurs primarily in the winter months, with a maximum occurring in March. By comparison, recharge is very low in the summer months. This estimate of recharge also corresponds roughly to annual precipitation occurrence, and is most significant in the spring when precipitation and melting snow pack compound the contribution to ground water.



The next two charts represent ground water elevation in the U.S. Geological Survey observation well located in Washington Township, Erie County near Conneauttee Creek. (Latitude 41°56'07", Longitude 80°04'46" NAD27, depth: 82 feet, land surface altitude: 1,419ft ASL, NGVD29, Venango Formation). As with the previous graph, ground water elevation is low in the summer, higher in the winter, and reaches a maximum in February/March.


USGS 415607080044601 - ER 82 Erie County Observation Well
WATER LEVEL, IN FEET BELOW LAND SURFACE
Years
Statistics based on 9,154 daily values.
Plot generated 1/23/2007 6:57:31 AM
Approved Daily Data
Provisional Daily Data
Historical Daily Median
Range of Historical Daily Minimum & Maximum


USGS 415607080044601 - ER 82 Erie County Observation Well
WATER LEVEL, IN FEET BELOW LAND SURFACE
Feb (28) Mar (28) Apr (29) May (29) Jun (30) Jul (30) Aug (29) Sep (29) Oct (27) Nov (27) Dec (28) Jan (27)
Explanation - Percentile classes
< 10 10 - 24 25 - 75 76 - 90 > 90
Monthly Median

The previous information is presented to provide an understanding that the watershed receives much less water from precipitation in the summer months. In addition to reduced precipitation in the summer, significantly more precipitation is consumed through evaporation and transpiration. It may be inferred from this information that the maximum runoff contribution to the stream, and recharge to local aquifers, occurs in the late winter and early spring.

5.2 Surface Water Quantity Assessment

The Q7-10 flow is an estimate or actual measurement of the lowest average stream flow for a consecutive 7-day period that would be expected to occur once during a ten-year period. Typically, the Q7-10 would be calculated based on data from an existing gauge station that measures stream level and discharge. There is no gauge station on Walnut Creek; the closest is is on Brandy Run. The Brandy Run gage station is on a small, rural stream in the Elk Creek watershed. It is not representative of the developed Erie area and does not provide meaningful results for the Walnut Creek watershed. The Q7-10 for Walnut Creek cannot be accurately calculated because too many assumptions would have to be made and no significant results would be obtained.

A limited analysis of stream flow was completed as part of the watershed assessment. Stream depth, width, and water velocity measurements were taken on seven separate days in October and November of 2006. These measurements were made at the same location on each day (the downstream end of the U.S. Highway 5 bridge over Walnut Creek). Measurements were made on relatively high and low stream flow days. In consideration of the previous information relating to local precipitation and aquifer recharge, the time of year for this stream flow measurement was selected to coincide, as much as possible, with the expected average precipitation. The analysis of this information is presented in Appendix F. The methodology used to establish stream flows from these measurements is based on the *U.S. Geological Survey Circular 1123 (Wahl, Thomas, and Hirsch, 1995).* This information is available on the Internet at: http://pubs.usgs.gov/circ/circ1123/collection.html. The mean flow in Walnut Creek was calculated at approximately 58 cubic feet/second.

In addition to the measurements discussed above, an analysis of the total watershed area, average annual precipitation, and average annual evapotranspiration was made. Evapotranspiration is the term applied to the combined effects of evaporation and transpiration, or the consumption of water by plants. In short, it is the total amount of water "lost" from the watershed. Precipitation and evapotranspiration estimates were taken from the Pa. Geological *Survey's Geology of Pennsylvania's Ground Water* (Fleeger, 1999).

***Chart 4* - Walnut Creek Stream Flow Estimate**

44	Average Annual Rainfall in Walnut Creek Watershed (inches)
22	Average Annual Evapotranspiration in Walnut Creek Watershed (inches)
38.2	Watershed Area (Square Miles)
1.53354E+11	Watershed Area (square inches)
3.37378E+12	Annual Water Volume for Watershed (cubic inches)
9,243,224,821	Average Discharge for Watershed (cubic inches / day)
61.91075	**Average Discharge for Watershed (cubic feet / second)**

These calculations resulted in an average discharge of approximately 62 cubic feet/second. Though both methods involve several significant assumptions, and are inarguably “rough” estimates, the results correlate well to each other (the location of the daily measurements was selected to be near the mouth of the watershed, so as to be comparable to the latter estimate using the total watershed area and precipitation information). This average flow of roughly 60 cubic feet/second also correlates well to other streams in comparably sized watersheds.

DEP has been working cooperatively with the U.S. Geological Survey and other agencies to explore the installation of a permanent gauging station on Walnut Creek. Stream discharge rates would be useful for establishing information needed to more clearly understand local conditions.

5.3 Determination of Groundwater Influences on Surface Water Quality and Quantity

Influence of groundwater quality on stream water quality in Walnut Creek and its tributaries is not well understood. Some general conclusions; however, may be made from knowledge of the watershed features and characteristics and the groundwater quality of the watershed:

- Unconsolidated, glacial materials convey water more rapidly, with less time between infiltration and discharge to the stream, than from the consolidated bedrock aquifers.

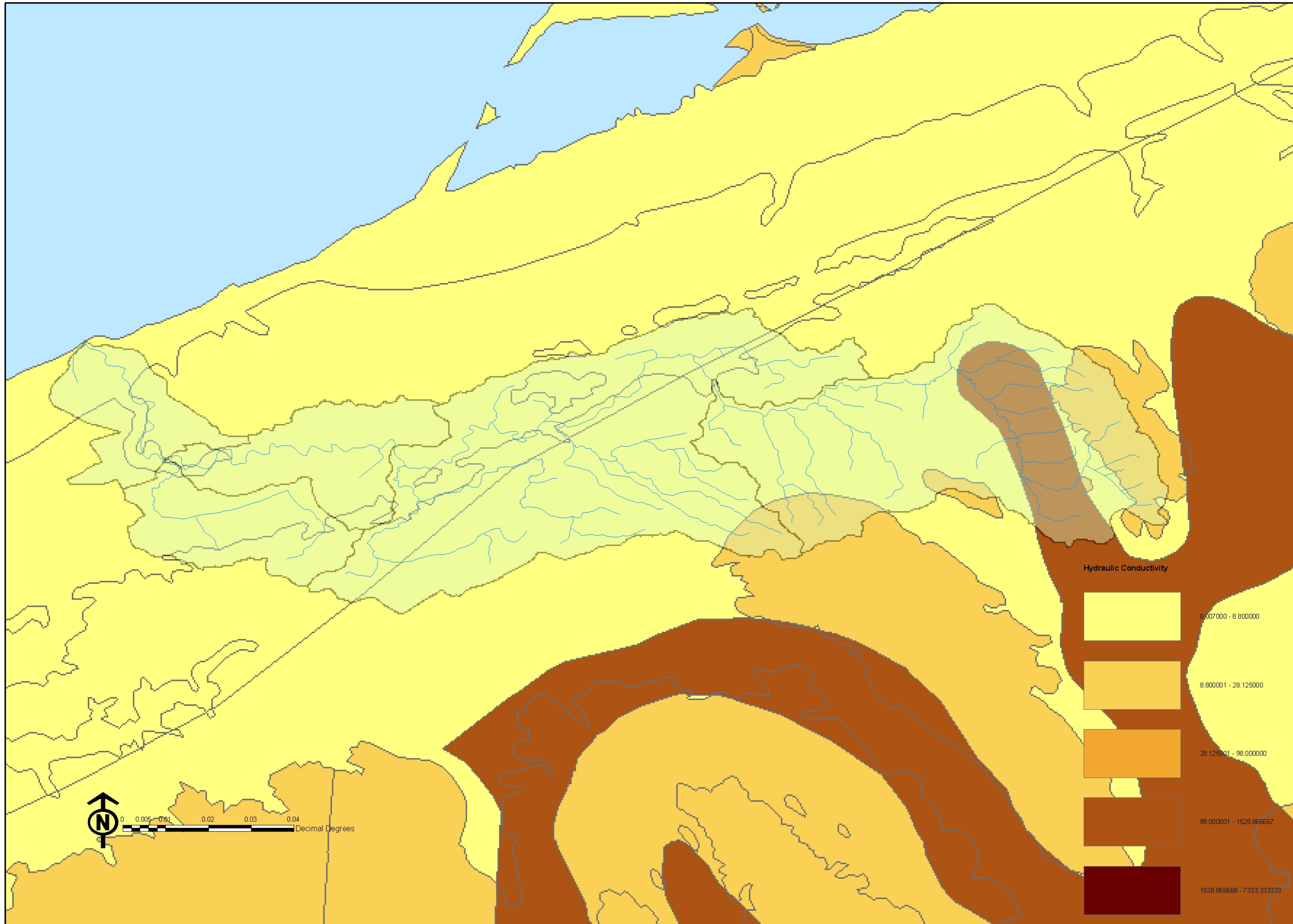
- Consolidated bedrock aquifers provide water to Walnut Creek of lower quality and more slowly than the unconsolidated glacial aquifers.

- The headwaters area of the watershed may be the exception- formations in this area exhibit better water quality and higher hydraulic conductivites.

The following map shows bedrock hydraulic conductivities as noted above. Hydraulic conductivity, in simplest terms, is the capacity for water to move through an aquifer. It is a function of the size of voids in the aquifer material, the degree of interconnectivity of these voids, and the hydraulic gradient. A comprehensive presentation of hydrogeologic science is beyond the scope of this report, suffice to say, that aquifers with higher hydraulic conductivities transmit more water over time. In the Walnut Creek watershed, as depicted in the following map, higher hydraulic conductivities are observed in the southeastern headwaters area. The significance of this observation is that ground water contribution from bedrock to the stream will be greater in this area than further downstream in the watershed, where unconsolidated glacial materials are the dominant contributor. These unconsolidated materials typically exhibit hydraulic conductivities far greater than local bedrock aquifers. This should be considered as part of local ground water use and planning.

This information, coupled with an understanding of the susceptibility analysis of potential sources of contamination presented earlier, demonstrates the susceptibility of the limited, shallow, unconsolidated aquifers that dominate the watershed. Further work in understanding the correlations of local groundwater to surface water within the watershed is warranted.

Hydraulic Conductivity



5.4 Impacts of Surface Water Withdrawals on Watercourses

Known surface water withdrawals within the Walnut Creek watershed include several golf courses, Pennsylvania Fish and Boat Commission facilities, a mobile home park and a landfill. Only one of the golf courses withdraws water directly from Walnut Creek, other withdrawals are taken from ponds, wells, and tributary streams.

Water withdrawal impacts are difficult to quantify. Not all of the facilities with known withdrawals take water year-round. In addition, there are numerous unpermitted or unregistered withdrawals and the effects of these on the Walnut Creek watershed are not clear. However, it is possible that a combination of the withdrawals could have an effect, especially if many of these withdrawals occur during low-flow conditions.

Water withdrawals could have localized impacts on aquatic life. During low flow conditions, Walnut Creek has many isolated pools of water where fish and other aquatic life can become cut off from the main channel. A reduction in the water volume could result in more isolated pools and more trapped organisms. During drought or low-flow conditions, fish mortality in these pools could increase as water temperature rises and the pools begin to evaporate. Although specific data is not available, it can be suggested that during low flow conditions, water withdrawals from Walnut Creek could have localized detrimental impacts to aquatic life.

5.5 Influence of Stormwater Runoff on Stream Quantity and Quality

During precipitation events, Walnut Creek becomes "flashy" and conveys large volumes of water. A stream reach typically several inches in depth can quickly rise to several feet deep. The full range of fluctuations in the stream discharge has not been quantified, but minimum and peak flows calculated during stream measurements were 28 cubic feet/second and 85 cubic feet/second, respectively.

Observations made during the Corridor Assessment revealed areas of accelerated erosion and sedimentation, in part due to stormwater runoff. Sampling during low flow and high flow stream events showed that stormwater runoff is a significant contributor of non-point source pollutants to Walnut Creek and Lake Erie. Creek Sweep results indicated considerably higher *E. coli* loading from stormwater runoff. A comparison of baseline pollutant loads to loading from high stream flow conditions can only be calculated based on limited data. Continuous stream discharge measurement and routine water quality monitoring are necessary to calculate the actual pollutant loading from stormwater runoff to Walnut Creek.