THE ROUGE RIVER PROJECT
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BRINGING OUR RIVER BACK TO LIFE

Rouge River National
Wet Weather
Demonstration Project

Wayne County, Michigan

2013 Rouge River Ecosystem Monitoring and Assessment Report

RPO-WMGT-TR76

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Rouge River National Wet Weather Demonstration Project

MISSION STATEMENT

The mission of the Rouge River National Wet Weather Demonstration Project is to demonstrate effective solutions to water quality problems facing an urban watershed highly impacted by wet weather and develop potential solutions and implement projects which will lead to the restoration of water quality in the Rouge River. The project addresses both conventional and toxic pollutants to:

- provide a safe and healthy recreational river resource for present and future generations;
- re-establish a healthy and diverse ecosystem within the Rouge River Watershed;
- protect downstream water resources such as the Detroit River and Lake Erie; and
- help ensure compliance with federal, state and local environmental laws which protect human health and the environment.

This will be accomplished through the development, implementation and financial integration of technical, social and institutional frameworks leading to cost-efficient and innovative watershed-based solutions to wet weather problems. This watershed-based national demonstration project will provide other municipalities across the nation facing similar problems with guidance and potentially effective solutions.

PREFACE

In 2013 the Rouge River National Wet Weather Demonstration Project (Rouge Project) continued to restore and protect designated uses in the Rouge River system through a systematic watershed approach to pollution management. This cost-effective, holistic approach is also providing solutions to other urban watersheds throughout the country on how to restore a polluted urban waterway. The Rouge Project was initiated in 1992 by the Department of the Environment, Wayne County, Michigan and will end on May 30, 2014.

The Rouge River Watershed in Southeast Michigan is largely urbanized, spans approximately 466 square miles, is home to more than 1.4 million people in 48 communities and three counties, and is a tributary to the Detroit River. Multi-year federal grants from the United States Environmental Protection Agency and additional funding from local communities support this cooperative effort between federal, state and local agencies. These grants are managed by Wayne County.

The early focus of the Rouge Project was on the control of combined sewer overflows (CSOs) in the watershed. Although control of pollution from CSOs was identified as a major priority, it was determined that CSO control alone would not provide sufficient improvements to meet water quality standards in the watershed. This is because nonpoint source pollutants — such as storm water runoff, discharges from illicit connections, discharges from failed on-site septic systems, and other sources — would continue to degrade the river. In addition, it was determined that wetlands, habitat restoration, lake restoration, erosion and flow variability all needed to be controlled before full restoration of the river would be achieved throughout the watershed.

Based upon what was learned, the Rouge Project expanded to a holistic approach to consider the impacts from all sources of pollution and use impairments in receiving waters. In 1994, an ad hoc Rouge River Storm Water Advisory Group was formed to develop and guide the implementation of a cooperative strategy to restore the river throughout the watershed. In March of 1995, a storm water management strategy based on the application of watershed-wide management approaches for the Rouge River was developed and implemented. One element of the strategy was to develop a regulatory framework. To fulfill this goal, the Michigan Department of Environmental Quality (MDEQ), the Rouge Project and the communities in the Rouge Watershed worked jointly to develop a watershed based general storm water permit that was issued statewide in 1997 under the National Pollutant Discharge Elimination System (NPDES). This permit, and its successors, has been approved by EPA as meeting the requirements of the Phase II storm water regulations for municipal discharges issued under the Clean Water Act.

Because the Rouge watershed is so large and involves so many stakeholders, the communities chose to subdivide the watershed into seven subwatersheds. Subwatersheds give a means for focusing the local resources to address local problems due to the interest people have in their immediate surroundings. Watershed advisory groups were formed for each subwatershed to develop the watershed management plans required under the general storm water permit. These plans were completed in 2001 and were implemented through a unique partnership of local agencies and communities, state agencies, non-profit organizations, businesses and citizens. The seven subwatershed plans identified alternative steps needed to address remaining problems associated with storm water, combined and sanitary sewers overflows, failing septic systems, and non-point sources. The goals, action steps, and measures tailored to individual subwatersheds established a strong foundation which guided cooperative efforts to fully restore the impaired uses of the river. Coordination of the efforts of the seven subwatershed groups was initially accomplished by a watershed-wide steering committee, which has since evolved into the new Alliance of Rouge Communities (ARC). In 2008, the ARC updated and consolidated the seven subwatershed management plans completed in 2001 into one sustainable Rouge River Watershed Management Plan (WMP). This plan builds on the successes of the past while laying the groundwork for the future. The plan was approved by MDEQ in July 2012 as meeting EPA's Section 319 requirements.

On August 5, 2003, after nearly two years of discussion, the Rouge watershed communities and counties formed the *Rouge River Watershed Local Management Assembly (Assembly of Rouge Communities)* to guide the Rouge River restoration into the future as the federal grant funding diminishes. The Assembly of Rouge Communities (Assembly) was based on a Memorandum of Agreement (MOA), signed by each local community, which outlined voting and funding shares for the new working arrangement. The Assembly successfully operated for 2.5 years, with 38 community members and three county (Wayne, Oakland and Washtenaw) members. The annual budgets, on the order of $600,000 per year, were used to fund: 1) watershed-wide monitoring; 2) sampling data analyses and reports; and 3) the coordination of public education and involvement activities, all of which are required by local units of government under the Michigan watershed based storm water permit. In addition, the funds were used to provide technical guidance and facilitation for the Assembly, its committees and the seven Subwatershed Advisory Groups. Wayne County served as fiduciary for the Assembly during 2003-2005.

In December 2005, the Assembly formally became the ARC when 20 eligible members approved bylaws modeled after the former MOA for operation of the Assembly. The group now acts as a legal public entity under the new Watershed Alliance Act, Public Act 517 of 2004 and is recognized as a 501(c)3 nonprofit agency. In 2013, the ARC had 38 members, two associate members, and six cooperating partners. The annual budgets continued to fund watershed-wide activities such as public education, monitoring, and other technical activities. Much of the work of the ARC continues through the standing committees: Finance, Technical, Public Involvement/Education, Executive, and Organization.

Using the watershed approach requires a number of tools such as a comprehensive sampling and monitoring program, various types of water quality and water quantity modeling, and a geographic information system. The Rouge Project has aggressively invested in these tools and others in order to develop the necessary holistic watershed management strategy. These innovative, readily transferable tools are being shared with other cities and state agencies.

The Rouge Project is an unqualified success, using any of several measures of achievement. Major progress has been made in the control of pollution being discharged to the Rouge River. For example, CSO pollutant loads to the river have been cut by 90 to 100% during most events. In previous years certain water quality standards were violated most of the time at many places in the watershed. Now, the majority of the waters in the Rouge River watershed meet many standards. Coupled with the water quality improvements, the ecosystem health continues to improve as well. This is demonstrated by several measures such as increased sightings of fish and wildlife along the river since 1999. Improvements in the water quality and removal of contaminated sediment in Newburgh Lake resulted in the lifting of the fish consumption advisory for some species of fish in the lake. This is the first time fish caught in the Rouge River systems have been safe for consumption in decades. The Rouge Project has a very extensive website that contains technical reports, maps, and other information about the details of the Rouge Project, available at www.rougeriver.com.

INTRODUCTION

A Five-Year Monitoring Plan conducted by the Alliance of Rouge Communities (ARC) was completed in 2007. Activities that were part of the Five-Year Monitoring Plan started in 2003 and included a rotational schedule of continuous (15 minute intervals) and intermittent water quality sampling through the seven Rouge River Watershed Storm Water Management Areas (SWMAs). Continuous monitoring was conducted for dissolved oxygen (DO), water temperature, and level and flow. Intermittent sampling included water quality parameters like carbonaceous biochemical oxygen demand ($CBOD_5$), ammonia nitrogen (NH_3-N), total phosphorus (TP), total suspended solids (TSS) and *Escherichia coli* (*E. coli*). Additional biological monitoring was also performed and included benthic macroinvertebrate and frog and toad surveys. In 2008 the ARC took a year off from monitoring to update and consolidate the seven subwatershed management plans which were previously prepared in 2001 into one integrated plan, the 2009 Rouge River Watershed Management Plan. This plan was approved by Michigan Department of Environmental Quality (MDEQ) in July 2012.

The overall purpose of the ARC's 2009 Rouge River Watershed Management Plan (WMP) is to build on past successes and to continue to implement a cost-effective approach to improving water quality in the Rouge River as well as meet the requirements of the NPDES Phase II stormwater permit with which each ARC community must comply (Accessed website May 2010 at http://www.allianceofrougecommunities.com). The WMP outlines a five-year monitoring plan which encompasses the years from 2009 through 2013. The monitoring plan identifies several parameters that were collected throughout the watershed to measure the improvements in water quality. Precipitation, streamflow, and biological data were collected each year. Dissolved oxygen and temperature were monitored at each station at least once over 5 years. In 2013, the following monitoring data were collected:

- Precipitation data (15-minute totals) were collected in 2013 at 21 rain gage locations throughout the watershed. Seven of the rain gages were operated by the Wayne County Department of Public Services (WCDPS), 11 rain gages were operated by the Oakland County Water Resources Commissioner's (OCWRC) Office, and the Detroit Water and Sewerage Department (DWSD) operated three rain gages. Since all of the rain gages were heated, the recorded precipitation amounts include rainfall as well as hail, sleet and snow as equivalent inches of water. Additional precipitation data were also collected for the Detroit and Pontiac area by NOAA's National Weather Service Forecast Office.
- Continuous monitoring of level and flow was performed by the United States Geological Survey (USGS) at six locations (US1-US5, US7) throughout the watershed in cooperation with Oakland County and the MDEQ. Additional level and flow monitoring was performed by the USGS at 2 locations (US9 and L05D) from May-October 2013.
- Continuous monitoring of dissolved oxygen (DO) and water temperature was performed by the USGS at one on the Main Branch at Plymouth Road (US7) and one location on the Lower Branch at Military Road (L05D).
- Wayne County Department of Public Health, Environmental Health Division collected water quality samples for *E. coli* at Newburgh Lake in the Middle Rouge River. These *E. coli* samples were collected to characterize the water body and not to determine compliance with the MDEQ *E. coli* total or partial body contact standards. (These results

are not included in this report, but can be obtained by contacting Kathleen McElroy at Wayne County Department of Public Health, Environmental Health Division, 734-727-7444). The 2013 data are also available at MDEQ Beachguard site the link: http://www.michigan.gov/deq/0,1607,7-135-3313_3686_3730---,00.html.

- Frog and toad surveys, benthic macroinvertebrate surveys, and winter stonefly searches were performed by Friends of the Rouge (FOTR) and Wayne County. Complete reports on these surveys can be accessed at http://www.therouge.org.

The Rouge Project data collected between 1994 and 2013 is stored in a Sequel database housed at Wayne County. A subset of the data collected through 2011 can be accessed through the Rouge's Web View database at www.rougeriver.com/database. This online database allows users to query the Rouge Project sampling data from 1994 through 2011 by site, date, and parameter. In preparation of the end of the Rouge Project, Wayne County and the ARC sought assistance from Wayne State University to continue public access to the data. Wayne State University intends to provide online access to data as part of a larger effort to centralize environmental monitoring data in the region; however, the schedule for do so is unknown at this time.

A discussion of the data collected in 2013 follows.

WATER QUALITY MONITORING AND SAMPLING

Dissolved Oxygen (DO) and Water Temperature

A key element of a healthy river ecosystem is adequate DO. Instream DO concentrations (over 5 mg/L) are essential for healthy fish and other aquatic life. Even brief declines in DO concentrations to levels below 5 mg/L can have a detrimental effect on aquatic organisms. In general, DO and temperature are in compliance with minimum water quality standards on a routine basis throughout the watershed and have remained fairly stable at most locations.

DO has been monitored in the river since 1994 and is very useful in determining spatial and temporal water quality trends. Prior to 2006, there was at least one continuous DO and water temperature monitoring location in each of the seven SWMAs in the Rouge River watershed, and two in the Main 3-4 SWMA as shown in **Figure 1**. From 2007 through 2013 continuous DO and temperature were monitored in at least one location in the watershed with the exception of 2009. In 2013, DO and temperature were monitored at Plymouth Road (US7) in the Main Branch and at Military Road (L05D) in the Lower Branch. A comparison of the amount of DO data expected to be collected in 2013 to the DO data actually collected shows a DO percent completeness of 97.3% at US7 and 99.9% at L05D. **Figure 2** shows the mean DO values, the percent of DO values greater than 5.0 mg/L, and the mean temperature values from 1994 through 2013 at Telegraph Road (U05), Hines Drive/Ford Road (D06), Military Road (L05D), and Plymouth Road (US7). The percent of the time dissolved oxygen concentrations were in compliance with the minimum 5 mg/L warm water State standard shows an upward trend. Based on a rating scale developed by the Rouge Project, since 2008 the DO data at the four previously mentioned monitoring locations are all rated good (DO ≥ 5 mg/L, ≥ 95% of the time) with the exception of Plymouth Road (US7) in 2012 when the rating was fair (DO ≥ 5 mg/L, < 95%, but ≥ 5 mg/L, ≥ 75% of the time).

2013 was one of the 5th wettest years since 1960. DO at Plymouth Road (US7) still measured greater than or equal to 5 mg/L for 97% of the time and DO at Military Road (L05D) measured greater than or equal to 5 mg/L for 98% of the time. Air temperatures were just below normal through September in southeastern Michigan. (Accessed website April 2014 at http://www.nws.noaa.gov/climate/index.php?wfo=dtx). Rouge Project rain gages measured rainfall volume at 104 to 119% of the long-term average and flow conditions reflected this increase.

In the Rouge River when the DO falls below the state minimum standard it is typically following a low flow condition after a small rainfall event when the water temperature is well above the average temperature for that stream. In 2013, DO values of less than 5 mg/L occurred also occurred during periods of heavy rain. These periods of low DO occurred at the following locations under the conditions described:

In 2013 at Plymouth Road (US7):

- May 31 (1:15 – 5:45) after a total rainfall on May 30 of 0.67 inches in 5 hours when the water temperature was approximately two degrees above the average water temperature of 17.8ºC.
- June 1 (3:00-5:00) after a total rainfall on May 30 of 0.67 inches and 2 small events on May 31 of 0.09 inches and 0.05 inches when the water temperature was 2.6ºC above the average water temperature of 17.8ºC.
- June 10 (9:00 – 15:45) after a return to baseflow and a medium event on June 10 of 0.86 inches and the water temperature was approximately 0.6ºC below the average water temperature of 17.8ºC.
- June 26 (3:45 – 4:45) following a low flow condition and after a 1 hour small rainfall event of 0.14 inches on June 25 and an additional small rainfall event on June 25 of 0.37 inches, duration 3 hours 30 minutes, when the water temperature was 3.7ºC above the average water temperature of 17.8ºC.
- June 28 (0:45 – 1:30) after a return to baseflow, and after a small event of 0.07 inches over nearly 5 hours followed by a medium event (9 hours later) of 0.57 inches on June 27, duration 3 hours, and the water temperature was 3.9 – 4.3ºC above the average water temperature of 17.8ºC.
- July 15 17:30 after a return to baseflow and after a large 4 hour rainfall event of 1.39 inches when the water temperature was 7.6ºC above the average water temperature of 17.8ºC.
- July 16 0:15 – July 17 11:00 during a high flow condition before the river had been able to recover from the previous rain event and warm temperatures (the water temperature was 6.3 – 7.3ºC above the average water temperature of 17.8ºC).
- July 17 18:30 – July 21 6:00 during a flow condition returning to baseflow with small rainfall events on July 18 (0.04 inches in 2 hours), 19 (0.13 inches in 2 hours), and 20 (0.18 inches, duration 2 hours 15 minutes) and the water temperature was 6.0 – 8.6ºC above the average water temperature of 17.8ºC.
- July 27 (20:45 – 22:00) during a low flow condition after two small rainfall events of 0.18 inches and 0.21 inches, and one medium event of 0.53 inches all on the 27th. The water temperature was 2.1 – 2.6ºC above the average water temperature of 17.8ºC.

- July 28 (2:45 – 3:15) during the peak of the hydrograph, after the 3 rainfall events on the previous day totaling 0.92 inches when the water temperature was 2.2ºC above the average water temperature of 17.8ºC.
- August 28 (6:15 – 9:15) during the rise of the hydrograph following a low flow condition and after a 3 hour small rainfall event of 0.18 inches and a second event 9 hours and 30 minutes later of 0.36 inches in 6 hours and 30 minutes when the water temperature was 4.2ºC above the average water temperature of 17.8ºC.
- September 12 (00:23 – 6:30) during the rise of the hydrograph following a low flow condition and after a 4 hour small rainfall event of 0.24 inches when the water temperature was 4.7ºC above the average water temperature of 17.8ºC.
- October 7 (4:00 – 5:00) at the peak of the hydrograph and after a 3 hour small rainfall event of 0.37 inches when the water temperature was approximately 0.4ºC above the average water temperature of 17.8ºC.

A regression analysis (May - October 1994 – 2013) of the continuous DO daily averages at Plymouth Road (US7) was updated with 2013 data and, as in previous years, shows improvement. The improvement at Plymouth Road (US7) from 1994 through 2013 is calculated as 0.08 mg/L/year **(Figure 3)**. Much of the improvement in DO was observed by the early 2000s when a number of major projects had been completed. A regression analyses calculated at Plymouth Road (US7) for the early years of the project (1994 – 2003) showed an improvement of 0.20 mg/L/year. However, regression analysis calculated from 2000 through 2013 shows an improvement of 0.02 mg/L/year. By the year 2000, the mean DO at Plymouth Road (US7) had improved more than 1.0 mg/L. In every year since 2000, with the exception of 2002, the mean DO has been greater than 6.5 mg/L (7.2 mg/L in 2013) and since 2007 the portion of DO values greater than 5.0 mg/L has been 90% or greater (96.9% in 2013). Simply stated the DO levels have generally been good in recent years and remain good at Plymouth Road (US7).

In 2013 at Military Road (L05D):

- May 10 (10:30 – 11:30) during low flow conditions after a small rainfall event on May 10 of 0.24 inches in 5 hours when the water temperature was 1.4 degrees below the average water temperature of 18.5ºC.
- May 20 (2:15 – 7:45) during low flow conditions with no measured rainfall and the water temperature was 0.7ºC above the average water temperature of 18.5ºC.
- May 21 (0:00 – 8:00) during low flow conditions with no measured rainfall and the water temperature was approximately 2ºC above the average water temperature of 18.5ºC.
- May 21 20:30 – May 22 10:00 during low flow conditions with no measured rainfall when the water temperature was 1.5 – 2.5ºC above the average water temperature of 18.5ºC.
- May 22 18:45 – May 23 8:30 during low flow conditions after a small rainfall event of 0.04 inches over 8 hours and the water temperature was 0.2 – 1.7ºC above the average water temperature of 18.5ºC.
- May 23 14:45 – May 24 7:45 during a rise in the hydrograph after baseflow conditions and during a 9 hour small rainfall event of 0.31 inches when the water temperature was 1.0 – 4.9ºC below the average water temperature of 18.5ºC.

- May 30 (15:45 – 21:30) during a rise in the hydrograph after baseflow conditions following a small 5 hour 30 minute rainfall event of 0.36 inches and the water temperature was 2 – 3ºC above the average water temperature of 18.5ºC.
- May 31 (0:15 – 11:15) after a return to baseflow condition with no additional measured rainfall after May 30 18:15 and the water temperature was 1.8 – 2.2ºC above the average water temperature of 18.5ºC.
- June 10 (2:00 – 5:45) during a rise in flow conditions after 0.31 inches of rainfall in 1 hour 45 minutes, which continued to total 0.91 inches by the end of the event and the water temperature was 0.6 – 1.1ºC below the average water temperature of 18.5ºC. The DO recovered mid-event, after 0.72 inches of rain.
- June 22 (18:15 – 19:30) during a rise in the hydrograph following a low flow condition and after a 4 hour 30 minute small rainfall event of 0.27 inches when the water temperature was approximately 2.8ºC above the average water temperature of 18.5ºC.
- June 23 (2:45 – 6:00) during the return to baseflow conditions and after the 4 hour 30 minute small rainfall event of 0.27 inches on June 22 and the water temperature was 3.5 – 3.9ºC above the average water temperature of 18.5ºC.
- June 24 16:30 – June 25 5:15) during low flow conditions with no measured rainfall when the water temperature was approximately 3.8 – 5.8ºC above the average water temperature of 18.5ºC.
- June 26 (2:30 – 3:15) during an increase in the hydrograph following a low flow condition and after a 4 hour 45 minute small rainfall event of 0.39 inches when the water temperature was approximately 3ºC above the average water temperature of 18.5ºC.
- June 27 (20:00 – 20:15) during an increase in the hydrograph and after a 4 hour small rainfall event of 0.34 inches when the water temperature was 3.9ºC above the average water temperature of 18.5ºC.
- July 6 21:45 – July 7 0:15) during low flow conditions and after a 2 hour small rainfall event of 0.16 inches when the water temperature was approximately 3.1 – 3.7ºC above the average water temperature of 18.5ºC.
- July 18 (15:30 – 16:00) during a slight increase in the hydrograph after a small 15 minute rainfall event of 0.21 inches when the water temperature was approximately 6.7ºC above the average water temperature of 18.5ºC.
- July 19 (22:15) at the beginning of the rise in the hydrograph after a 45 minute small rainfall event of 0.25 inches when the water temperature was 6.7ºC above the average water temperature of 18.5ºC.
- August 27 (8:15 – 9:30) following a low flow condition during an increase in the hydrograph after a 3 hour medium rainfall event of 0.78 inches when the water temperature was 3.7 – 4.2ºC above the average water temperature of 18.5ºC.
- September 20 (5:30 – 6:00) following a low flow condition and during an increase in the hydrograph after a 30 minute small rainfall event of 0.08 inches when the water temperature was approximately 1ºC above the average water temperature of 18.5ºC.

A regression analysis (May - October 1999 – 2013) of the continuous DO daily averages at Military Road (L05D) was updated with 2013 data and, as in previous years, shows improvement. The improvement at Military Road (L05D) from 1999 through 2013 is calculated as 0.083 mg/L/year **(Figure 4)**. Much of the improvement in DO was observed by the early 2000s when a number of major projects had been completed. A regression analyses calculated at

Military Road (L05D) for the early years of the project (1994 – 2000) showed an improvement of 0.40 mg/L/year. Regression analysis calculated from 1994-2003 shows improvement of 0.29 mg/L/year. However, regression analysis calculated from 2000 through 2013 shows an improvement of 0.02 mg/L/year. Although there has been little improvement observed since the early 2000's, the DO measures above 5 mg/L for the vast majority of time (98%). Simply stated the DO levels have generally been good in recent years and remain good at Military Road (L05D).

Water quality monitoring results continue to show that overall pollution control measures implemented throughout the Rouge Watershed by the Rouge Project have brought about improved DO concentrations in the river. Trend analyses were previously performed on historical continuous daily average DO data collected from 1994 to 2011 (data not collected at each location in all years) at the six other continuous monitoring locations and in general they show improvement or no significant trend **(Table 1).** The improvement in dissolved oxygen is due in large part to the control of untreated sewage being discharged to the Rouge River as well as other pollution control measures implemented throughout the Rouge watershed. Further improvements are expected as the remaining combined sewer overflows, located primarily in Dearborn and Detroit, are controlled and as other restoration efforts are completed.

Figure 1
Rouge River Watershed Dissolved Oxygen and Temperature Measurement Locations

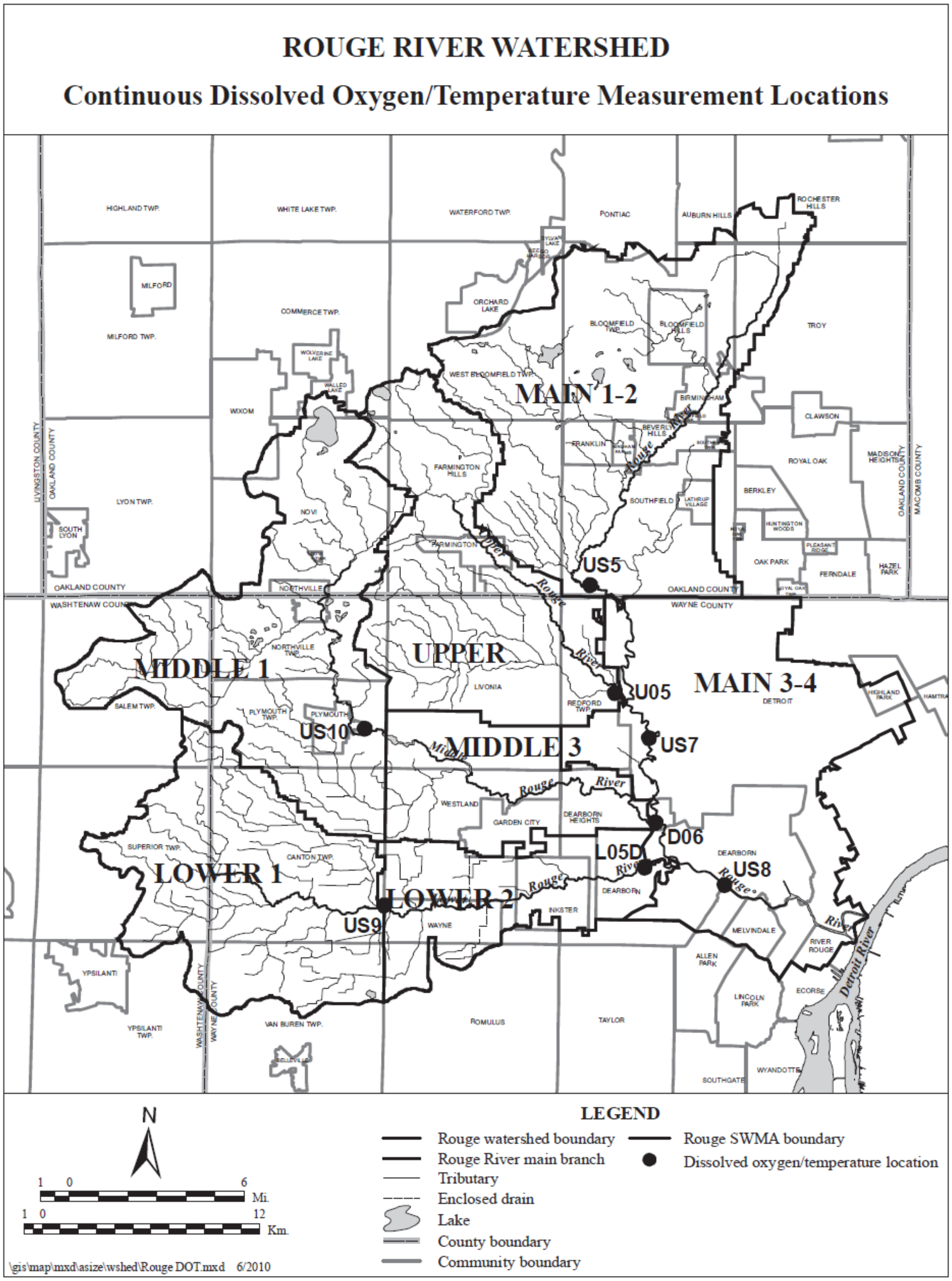
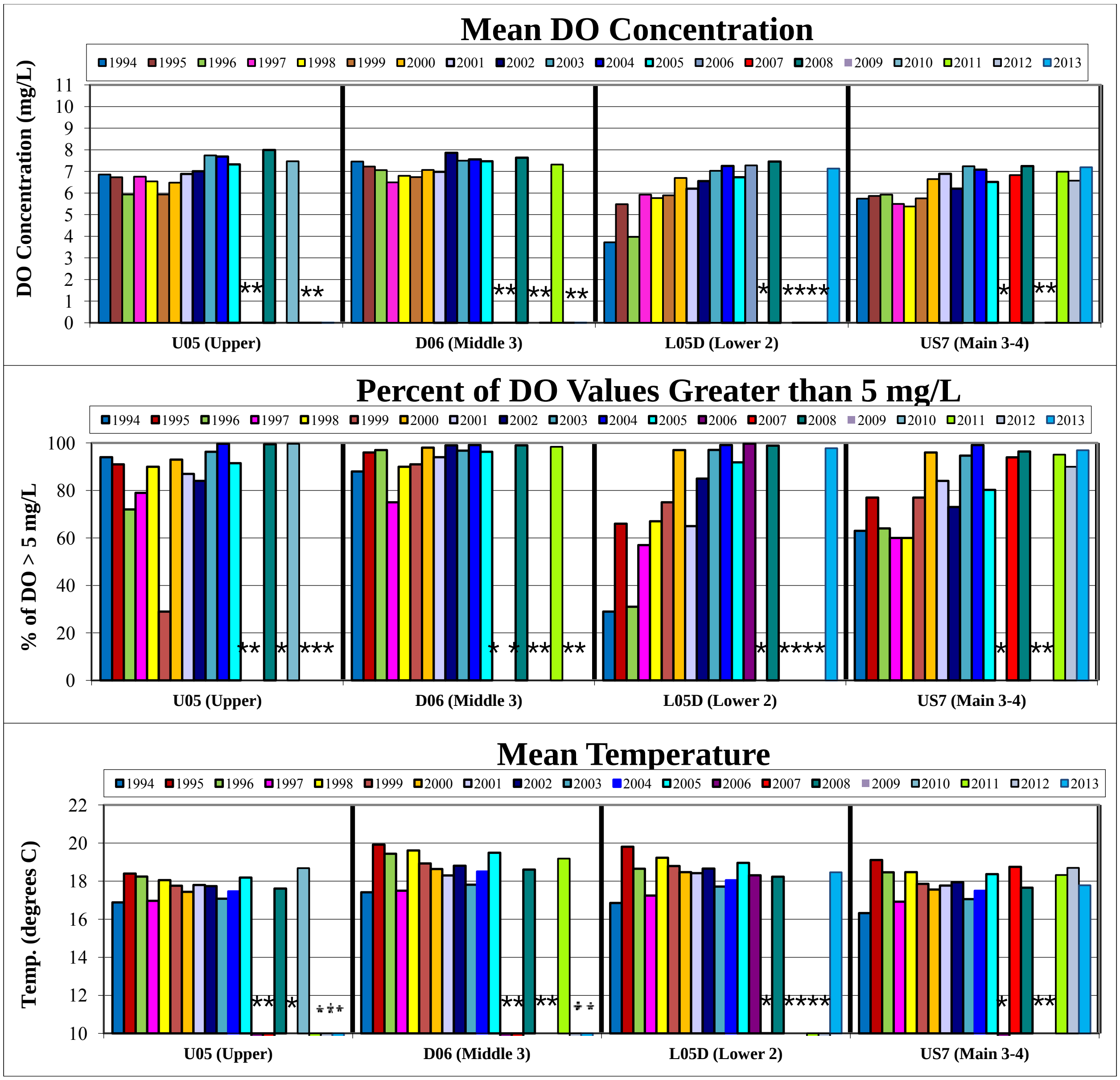
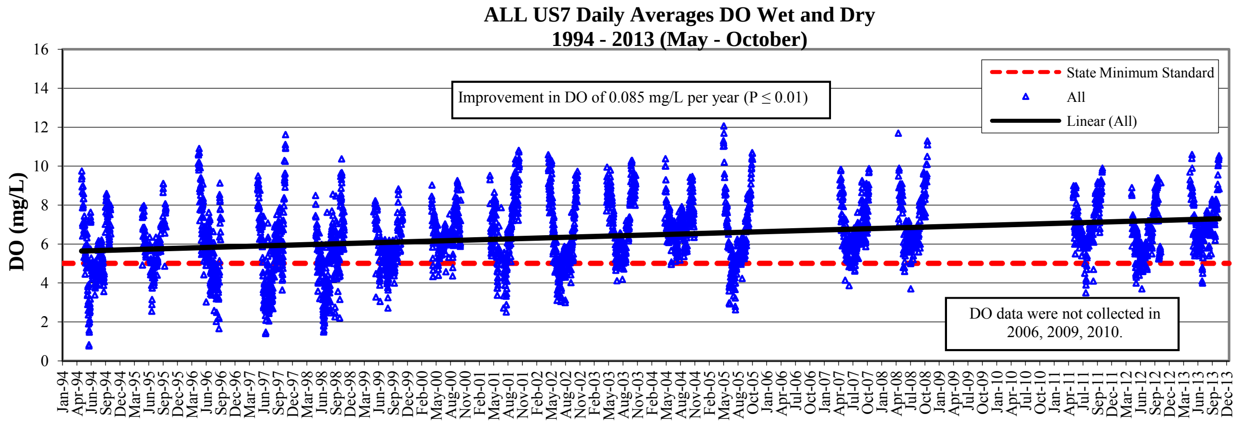


Figure 2
Continuous DO and Temperature Annual Mean Data
May - October 1994 – 2013
Stations U05, D06, L05D, US7



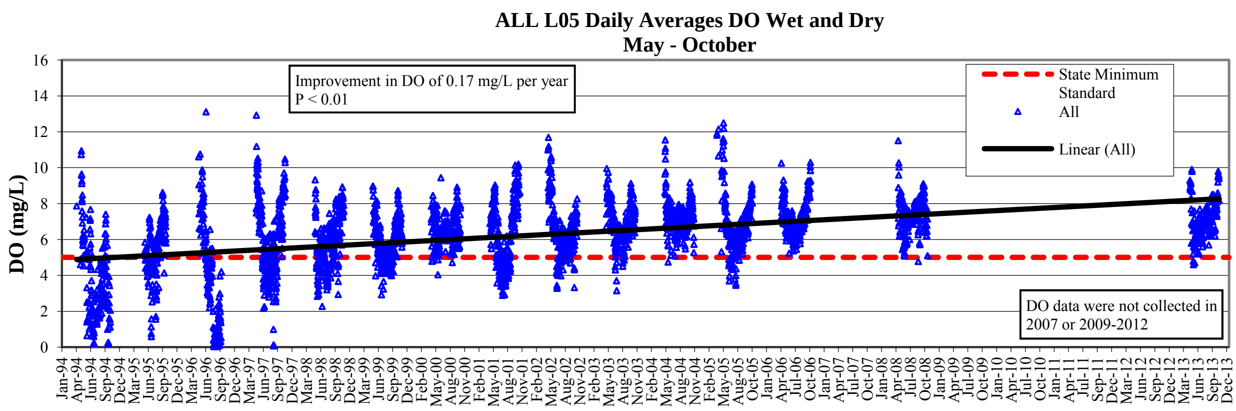
Note: * indicates no data available for year.
2013 DO percent completeness US7=97.3%
2013 DO percent completeness L05D=99.9%

Figure 3
Plymouth Road (US7)
Regression Analysis of DO Daily Averages 1994 – 2013



These data represent the combined effect of dry and wet weather conditions as well as diurnal variations in the river. Continuous data were not collected at US7 in 2006, 2009 and 2010. Note: Linear in legend means a linear trendline.

Figure 4
Military Road (L05D)
Regression Analysis of DO Daily Averages 1994 – 2013



These data represent the combined effect of dry and wet weather conditions as well as diurnal variations in the river. Continuous data were not collected at L05D in 2007, and 2009 – 2010. Note: Linear in legend means a linear trendline.

Table 1
Trend Analyses: Rouge River Daily Average Dissolved Oxygen Concentrations

Daily Average DO Trend Analyses for the Rouge River Watershed			
SWMA	**Site ID**	**Period of Record**	**Trend**
Main 1-2	US5	1997-2005	Improvement of 0.15 mg/L/year
Main 3-4	US7	1994-2005, 2007, 2008, 2011-2013	Improvement of 0.08 mg/L/year
Main 3-4	US8	2001- 2005, 2007	No significant change
Upper	U05	1994-2005, 2008, 2010	Improvement of 0.10 mg/L/year
Middle 1	US10	2003-2005	No significant change
Middle 3	D06	1994-2005, 2008, 2011	Improvement of 0.04 mg/L/year
Lower 1	US9	2002-2006	Degradation of 0.04 mg/L/year*
Lower 2	L05D	1994-2006, 2008, 2013	Improvement of 0.17 mg/L/year**

*Since data collection began at US9 in 2001 (May – Oct) DO mean has been ≥7.7 mg/L and the percent ≥5 mg/L has been 100%.
**Excluding data 1994-1998

HYDROLOGY

Moderate, stable streamflows are generally best for aquatic life and stream habitats. Extreme variation of flow rate and volume during storm events can result in severe bank erosion and sediment resuspension, which can significantly degrade game fish habitats. In 2013, continuous flow and level monitoring data were collected at six locations throughout the watershed by the United States Geological Survey (USGS). Data were collected in cooperation with Oakland County and the Michigan Department of Environmental Quality (MDEQ) at Maple Road (US4), Beech Road (US5), Plymouth Road (US7), Shiawassee Road (US3), Inkster Road (US2), and John Daly Road (US1). Additional continuous flow and level monitoring data were collected May – October at two locations (US9 and L05D) on the Lower Branch by USGS. Note that flow and level monitoring was discontinued by the USGS in October 2009 at Evans Ditch (US6). The level and flow continuous monitoring locations, which include the 2013 locations, are shown in **Figure 5.** The 2013 continuous level and flow data along with historical data, which were used for trend detection, are summarized by SWMA in **Figure 6 through Figure 16**. The Detroit Metro Airport Annual Precipitation Totals (1959 – 2013) are also shown in the figures. The precipitation period of record may not align with the period of record for level and flow data in some of the figures. A tabular summary by SWMA of the streamflow data for the period of record are shown in **Table 2** along with the 2013 precipitation totals (as percent of long-term average from 1994 through 2011). The rainfall monitoring locations are shown in **Figure 17.**

High streamflow variability continues to negatively impact the water quality and ecosystem health of the Rouge River Watershed. Trend analyses since the beginning of the Rouge Project (middle 1990s through 2013) generally indicate that the frequency of peak flow is holding steady in the Middle 3 and Lower Rouge River. However, an increase in the frequency of peak flow was calculated in the Middle 1 Rouge River. In the Main and Upper Rouge River, a decrease in the frequency of peak flow was indicated.

Figure 5

Continuous Level and Flow Measurement Locations

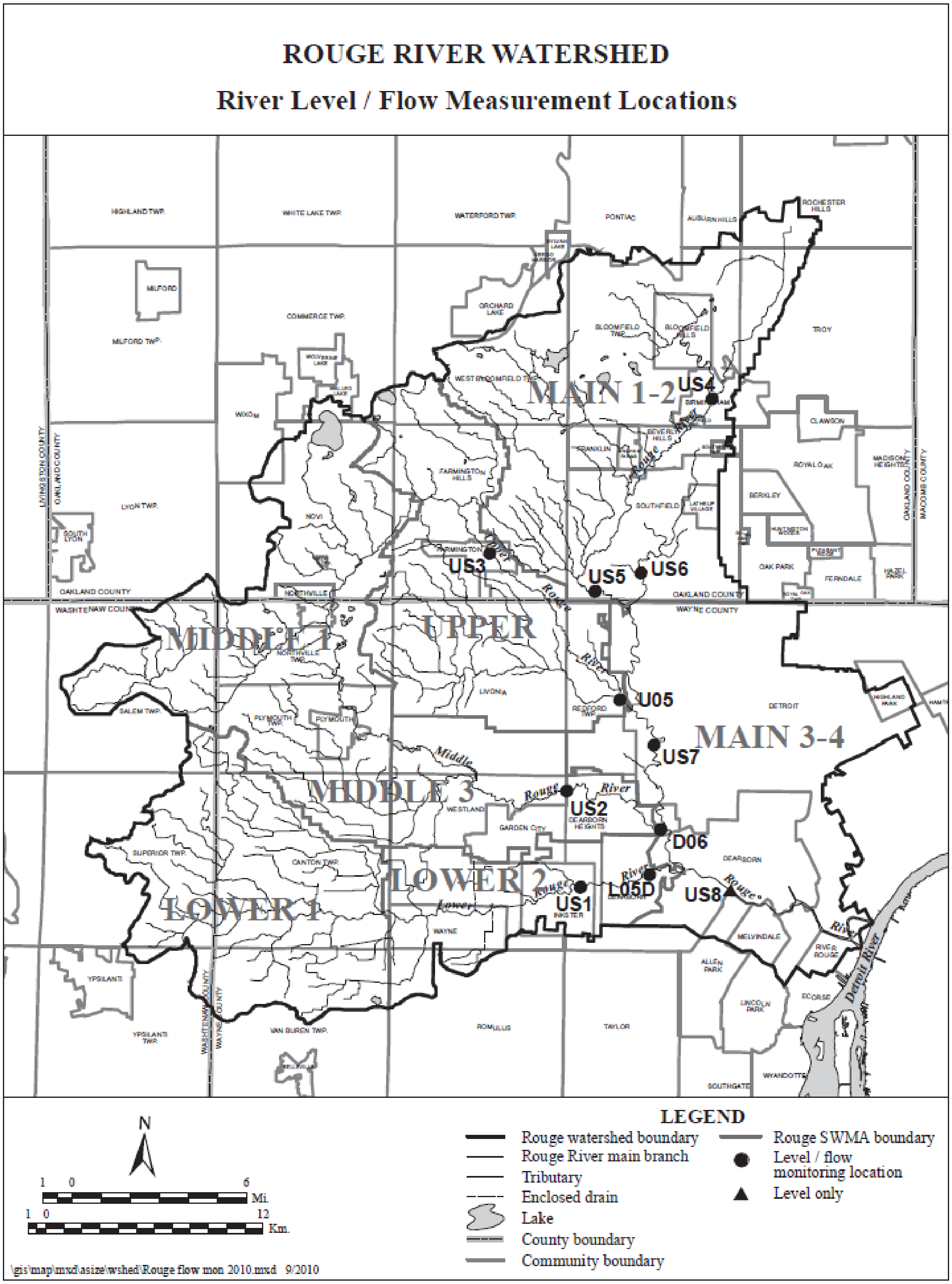
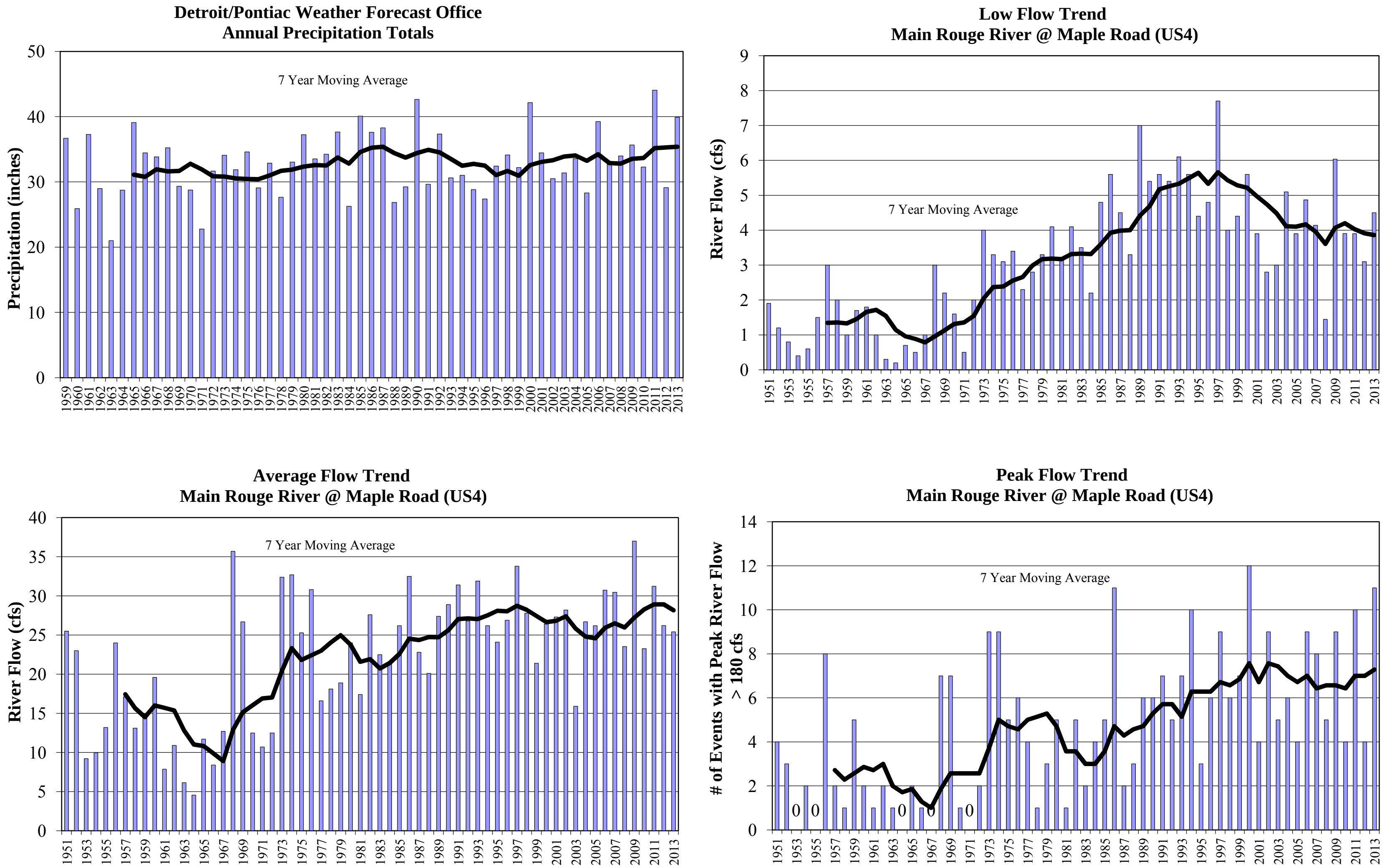
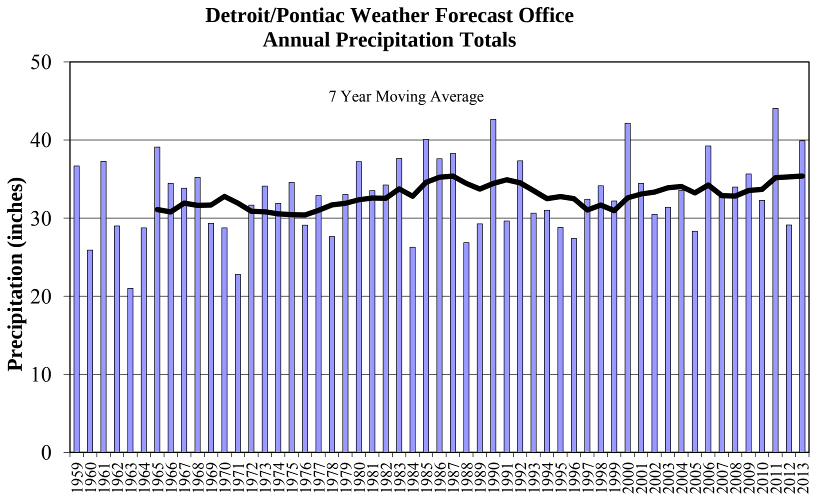


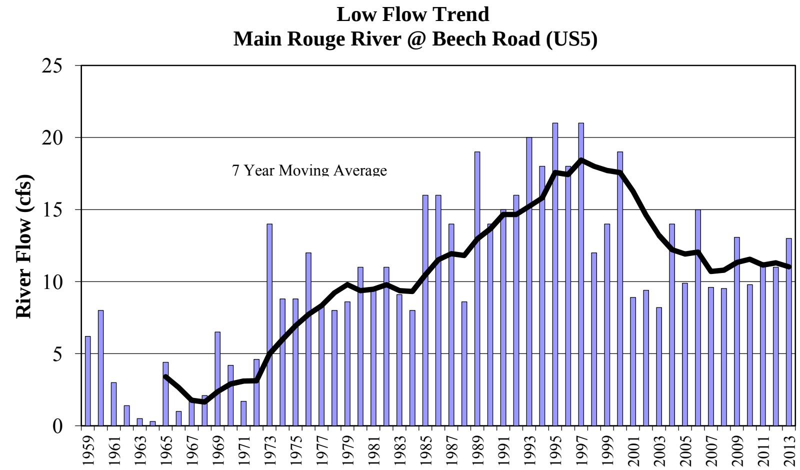
Figure 6
Main 1-2 SWMA Maple Road (US4) Streamflow Data and Trends (1951-2013)

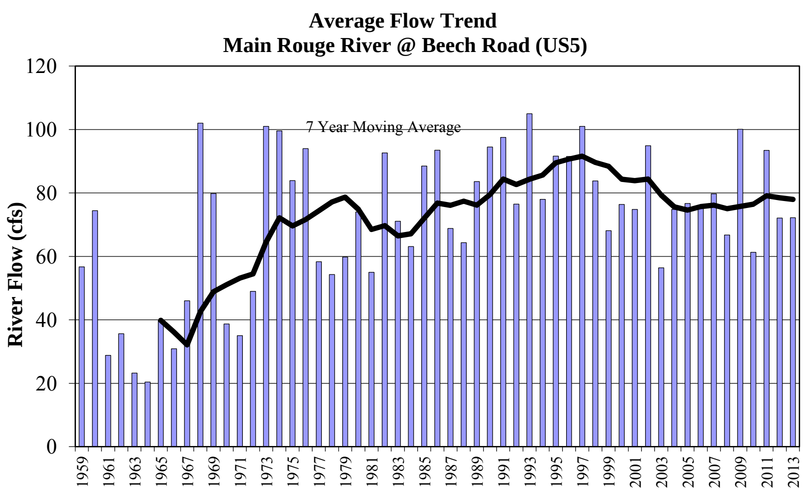


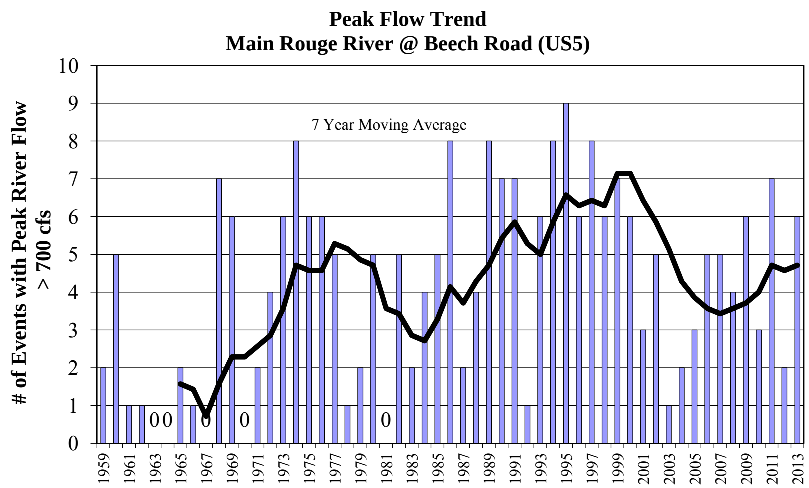
Note: (0) in figure means flow of 180 cfs was not exceeded.

Figure 7
Main 1-2 SWMA Beech Road (US5) Streamflow Data and Trends (1959-2013)



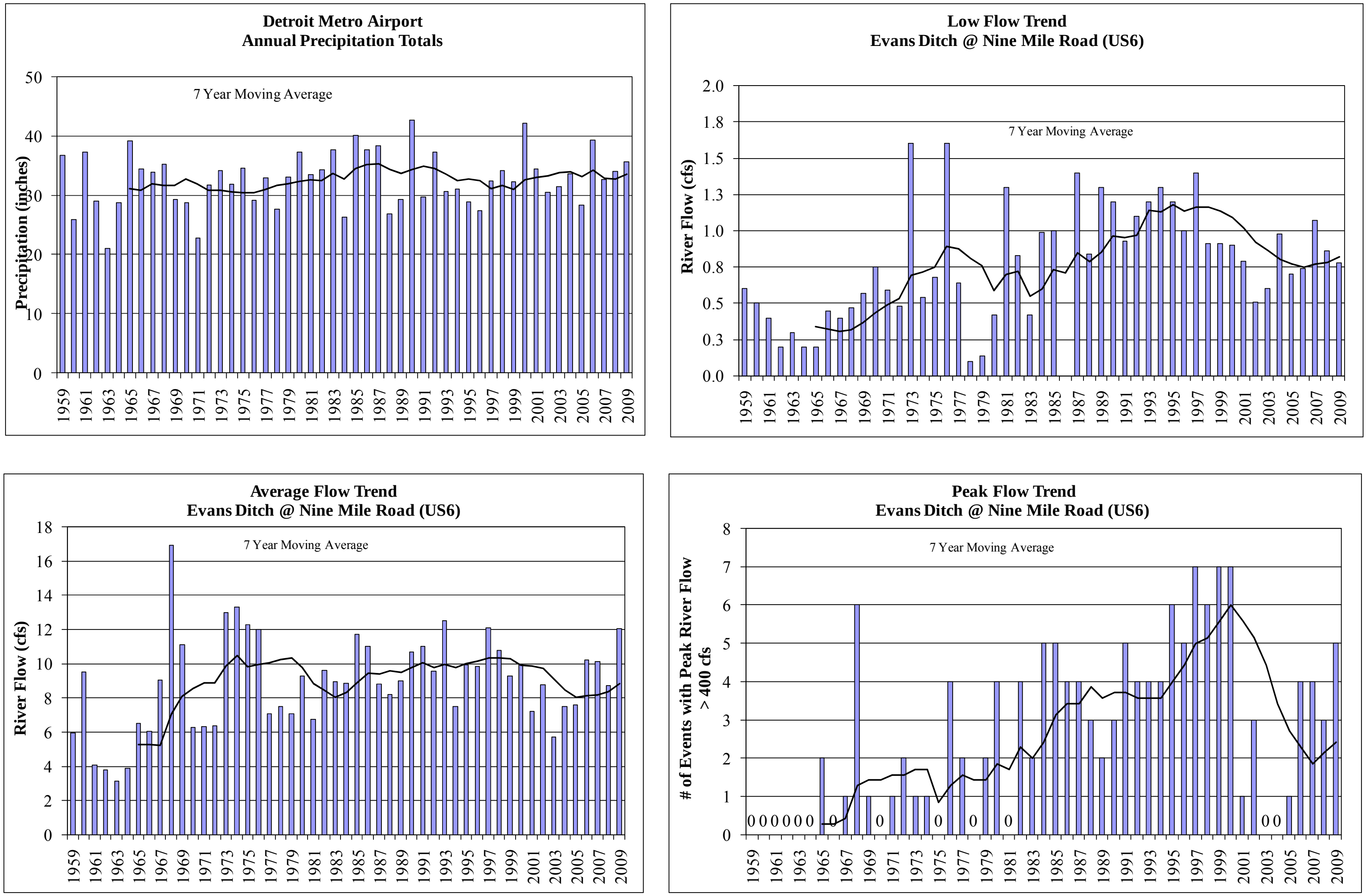






Note: (0) in figure means flow of 700 cfs was not exceeded.

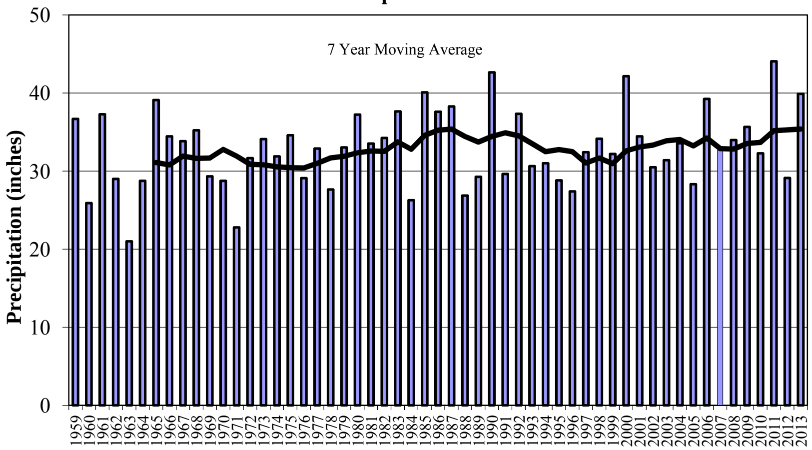
Figure 8
Main 1-2 SWMA Evans Ditch (US6) Streamflow Data and Trends (1959-2009)



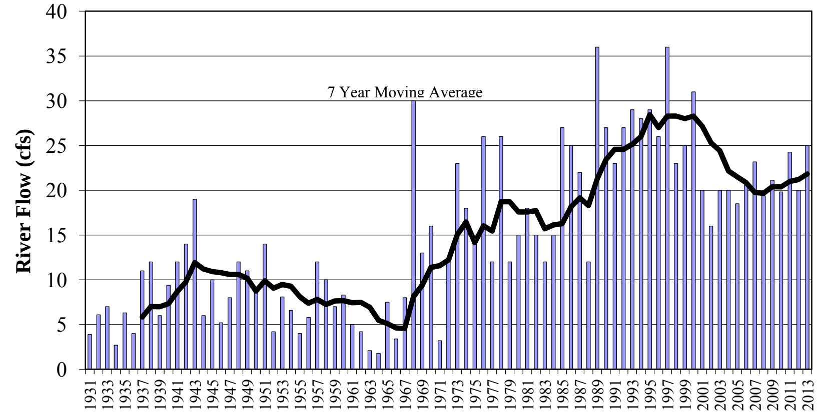
Note: (0) in figure means flow of 400 cfs was not exceeded
USGS discontinued data collection at US6 in October 2009..

Figure 9
Main 3-4 SWMA Plymouth Road (US7) Streamflow Data and Trends (1931-2013)

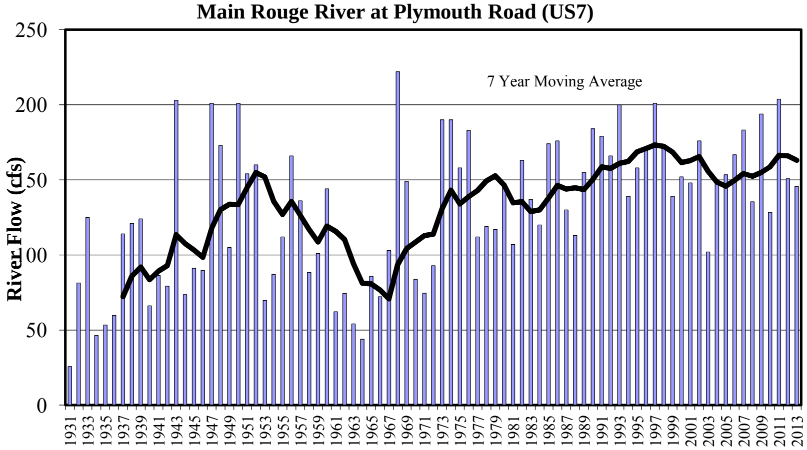
Detroit/Pontiac Weather Forecast Office
Annual Precipitation Totals



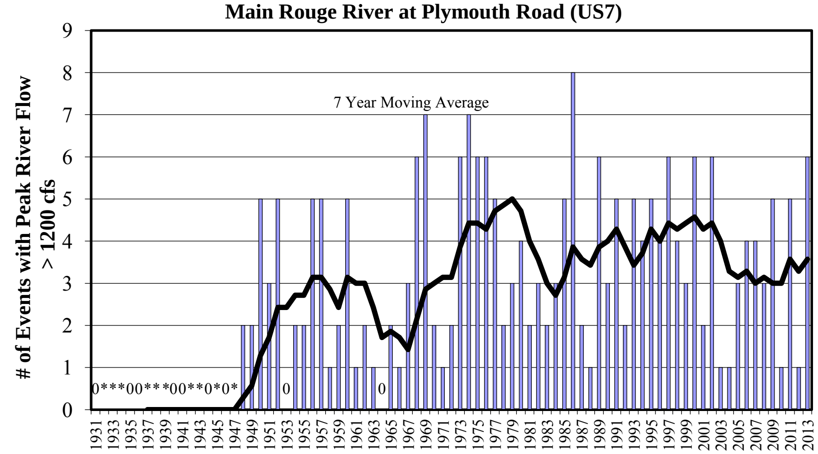
Low Flow Trend
Main Rouge River at Plymouth Road (US7)



Average Flow Trend
Main Rouge River at Plymouth Road (US7)

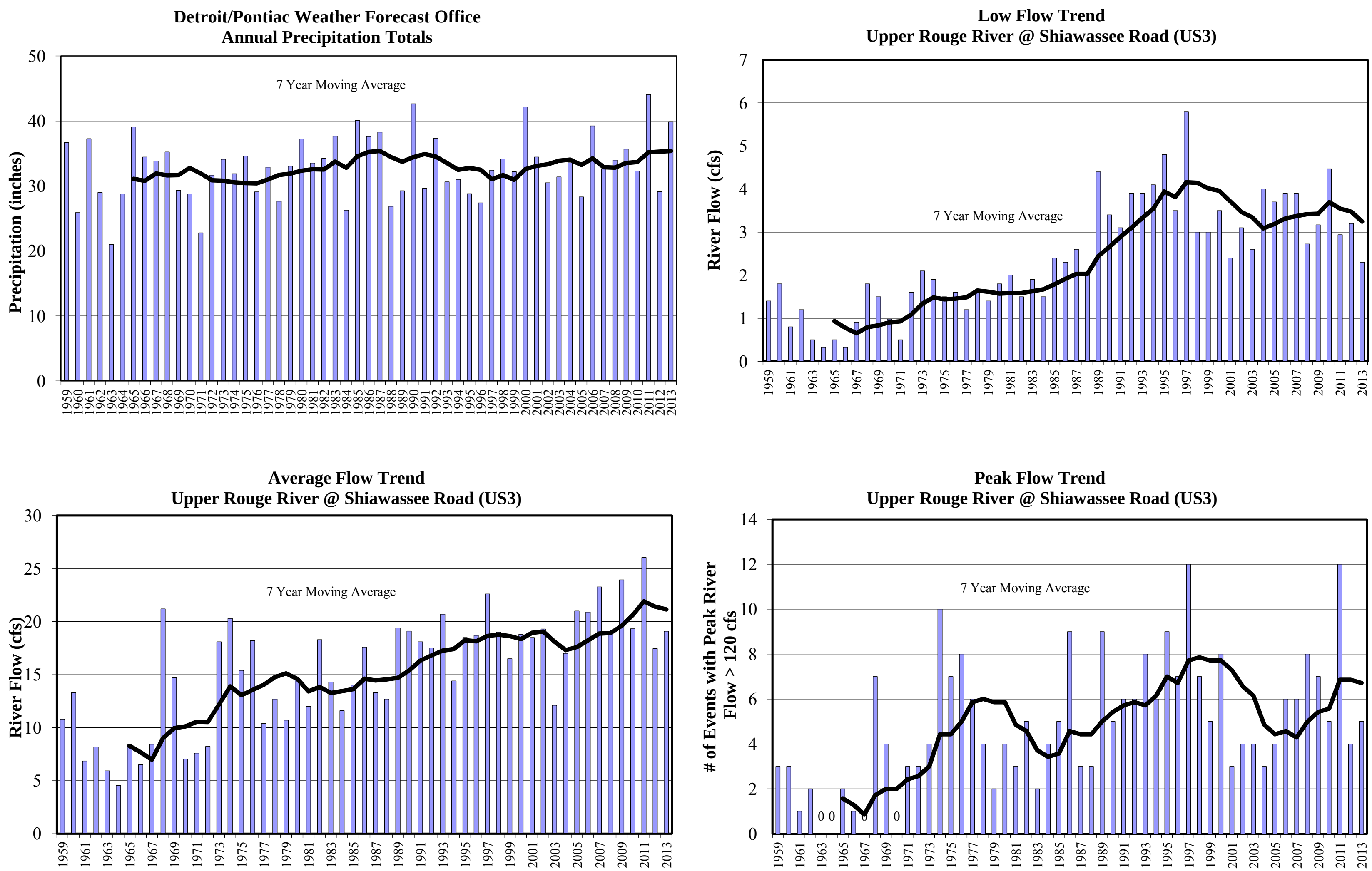


Peak Flow Trend
Main Rouge River at Plymouth Road (US7)



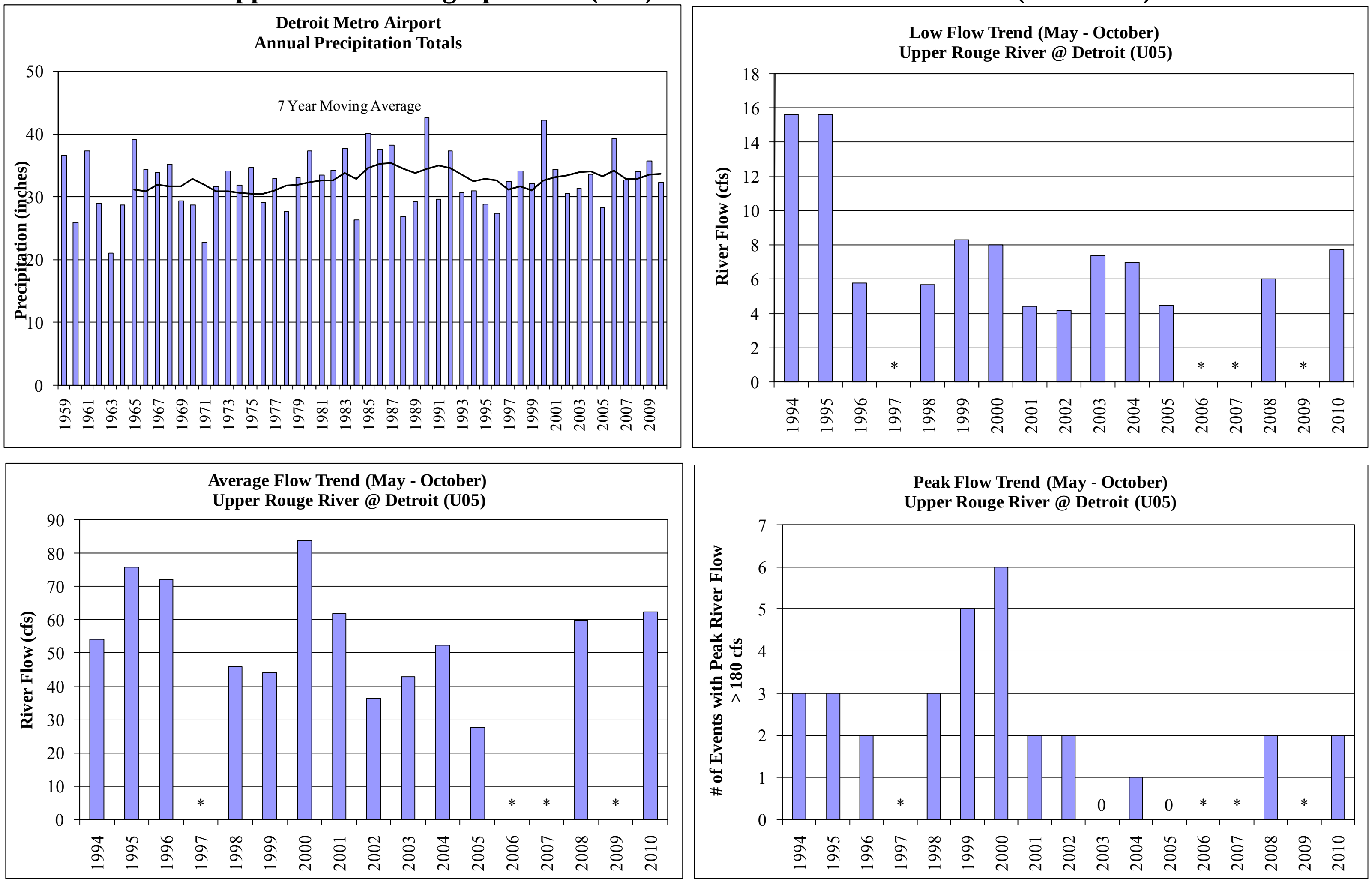
Note: (0) in figure means flow of 1200 cfs was not exceeded.
(*) = no data collected in that year.

Figure 10
Upper SWMA Shiawassee Road (US3) Streamflow Data and Trends (1959-2013)



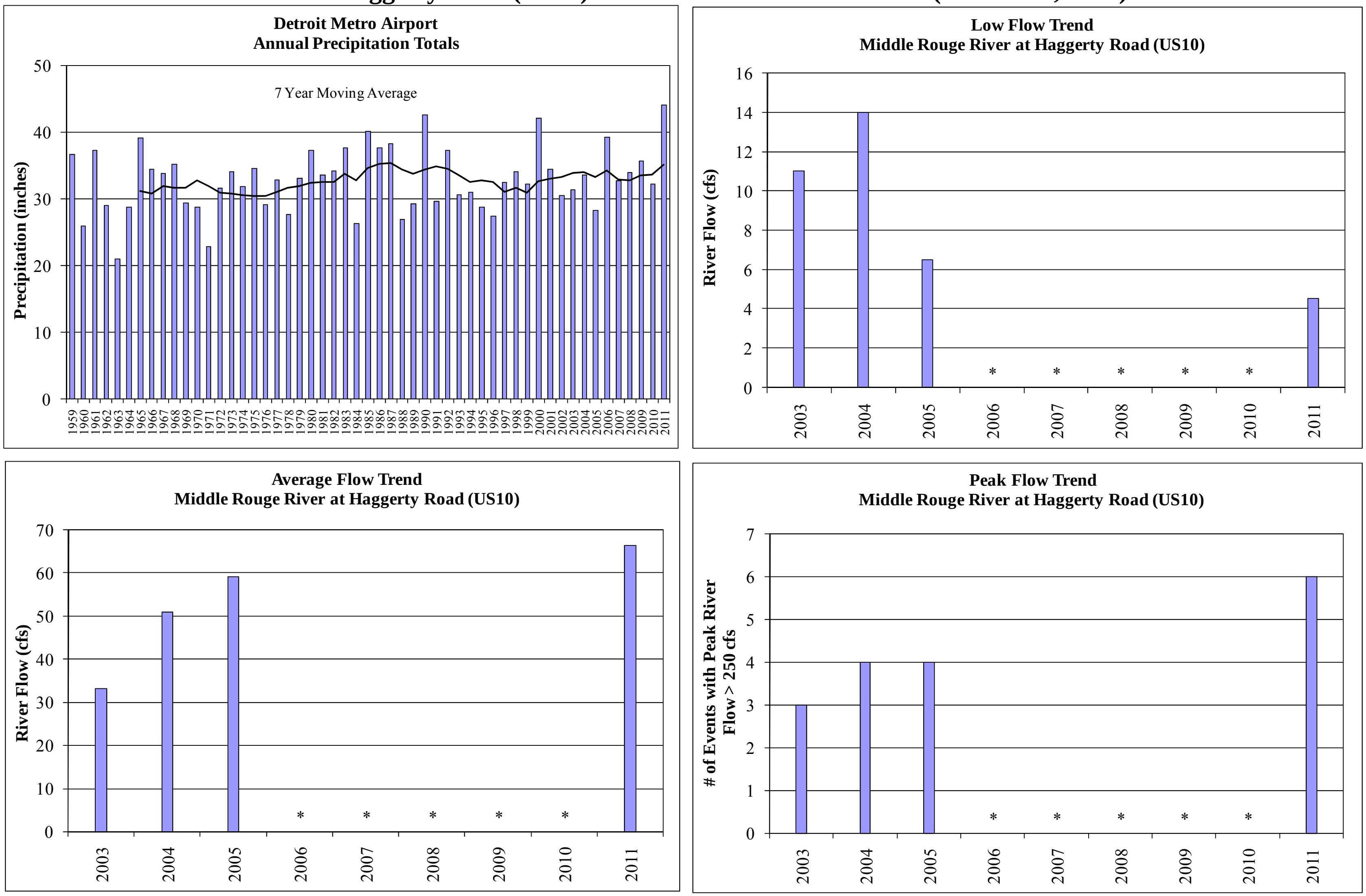
Note: (0) in figure means flow of 120 cfs was not exceeded.
(*) = no data collected in that year.

Figure 11
Upper SWMA Telegraph Road (U05)[1] Streamflow Data and Trends (1994-2010)



Note: (0) in figure means flow of 180 cfs was not exceeded.
(*) = no data collected in that year. (Flow data not available in1997 due to an unstable rating curve from bridge construction.
[1] Level/flow data were not collected at U05 in 1997, 2006, 2007, 2009, 2011, 2012, or 2013.

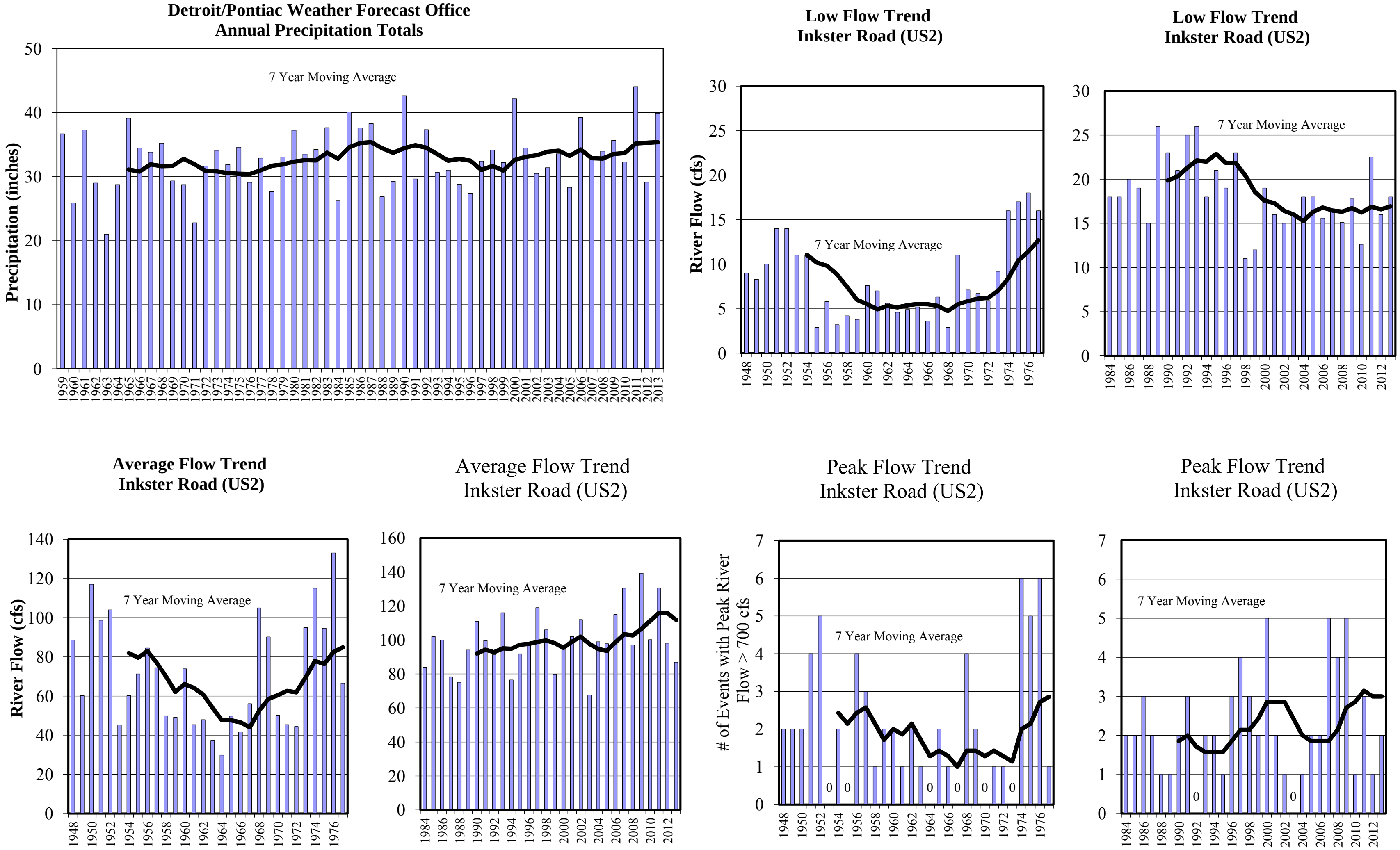
Figure 12
Middle 1 Haggerty Road (US10)[1] Streamflow Data and Trends (2003-2005, 2011)



Note: (*) = no data collected in that year.

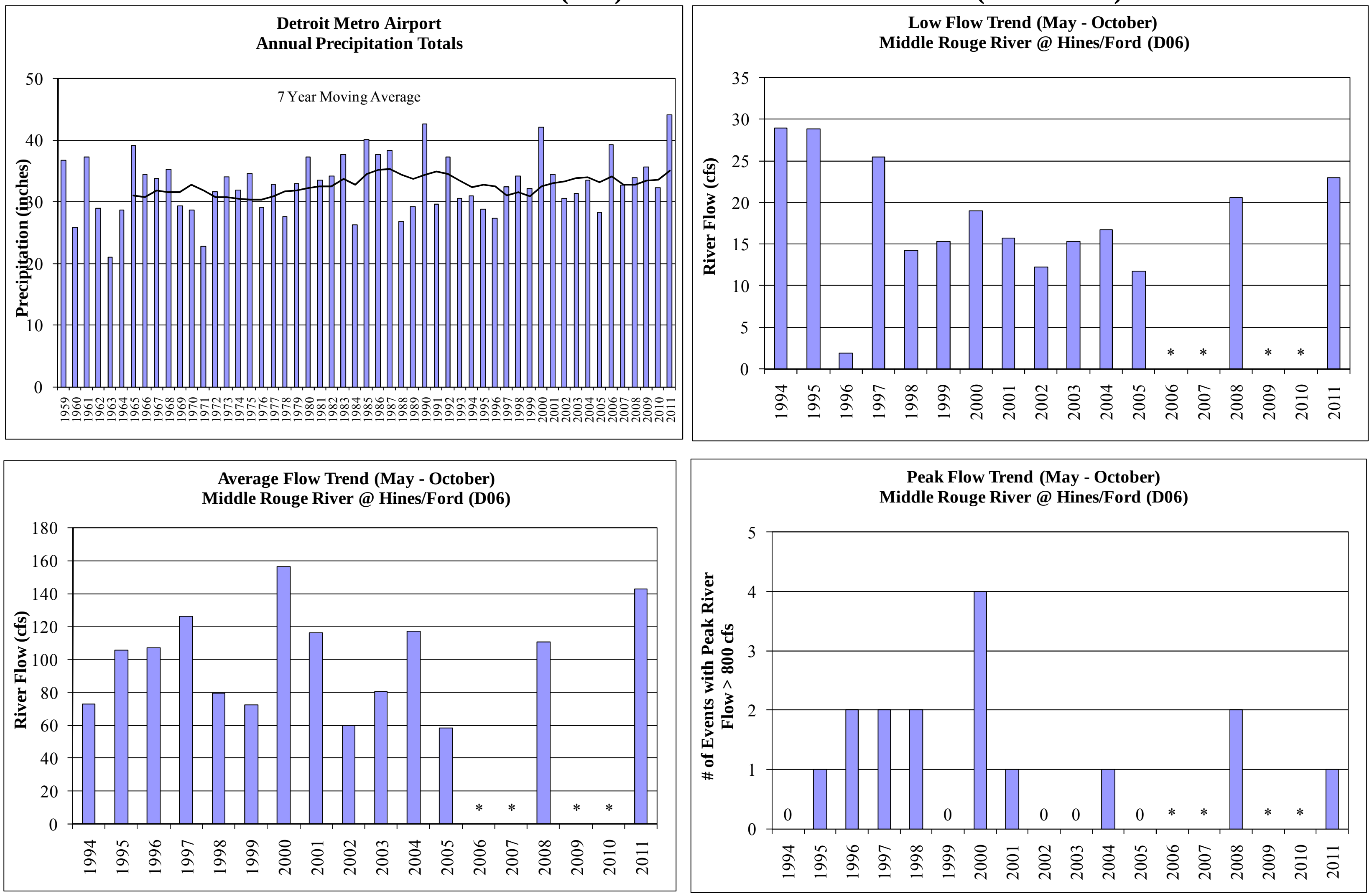
[1] Level/flow data were not collected in 2006, 2007, 2008, 2009, 2010, 2012, or 2013 at this location in the Middle 1 SWMA.

Figure 13
Middle 3 SWMA Inkster Road (US2) Streamflow Data and Trends (1948-2013)



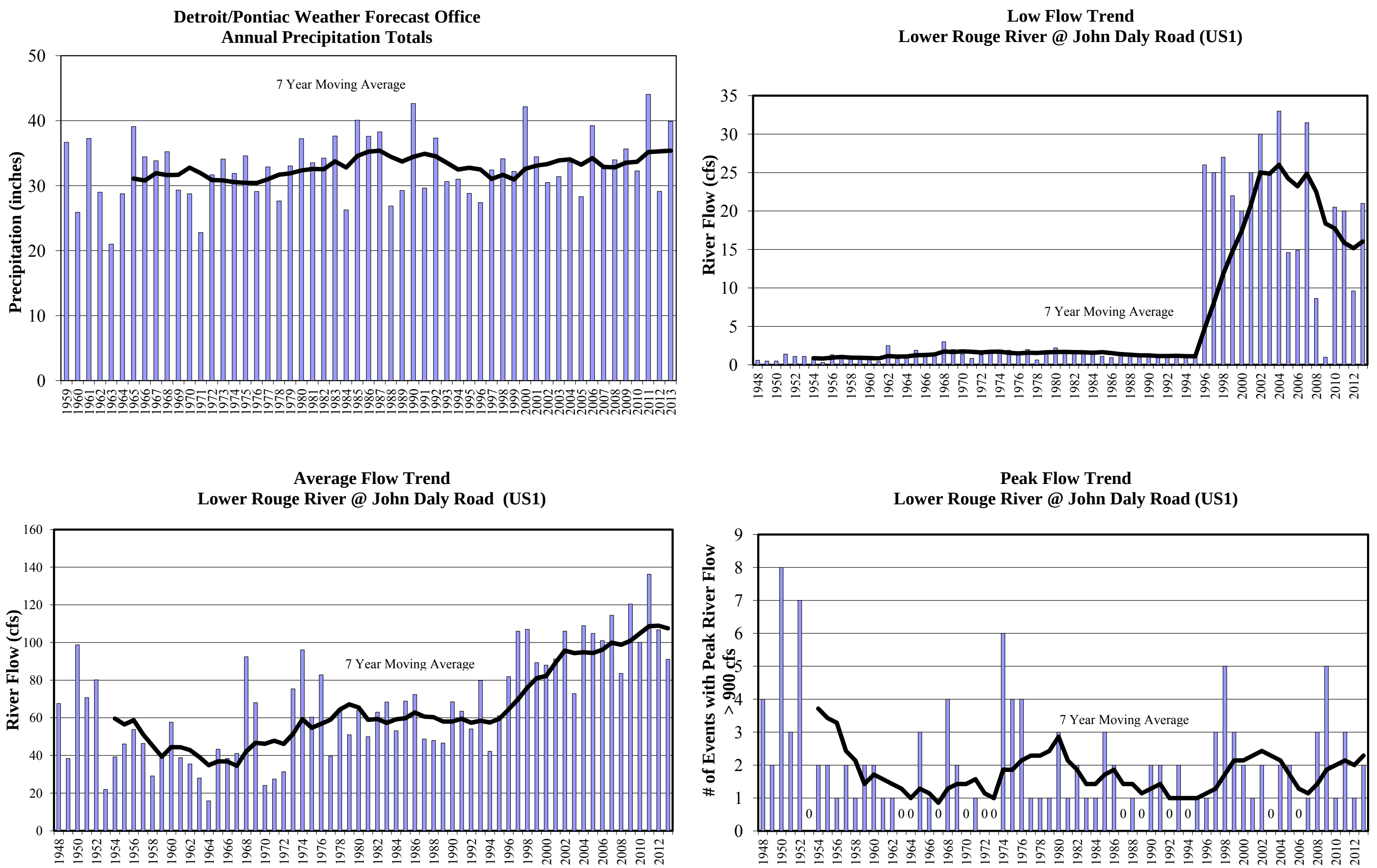
Note: (0) in figure means flow of 700 cfs was not exceeded.

Figure 14
Middle 3 Hines/Ford Road (D06)[1] Streamflow Data and Trends (1994 - 2011)



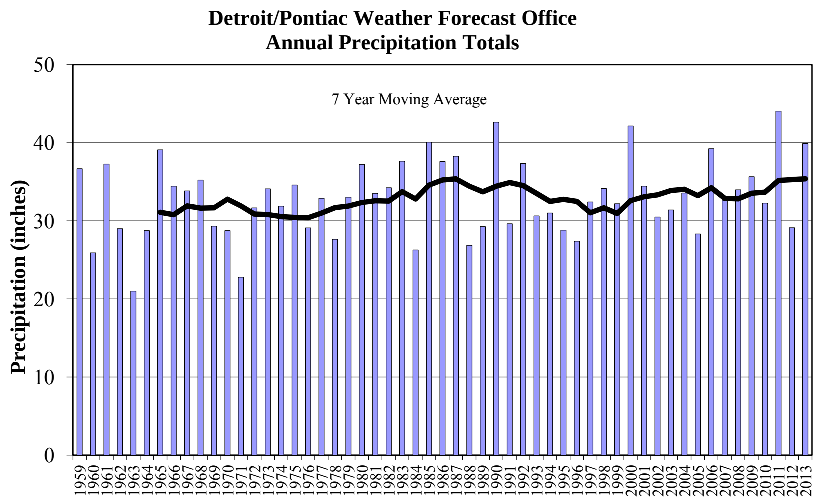
Note: (0) in figure means flow of 800 cfs was not exceeded.
(*) = no data collected in that year.
[1] Level/flow data were not collected in 2006, 2007, 2009, 2010, 2012, or 2013 at this location in the Middle 3 SWMA.

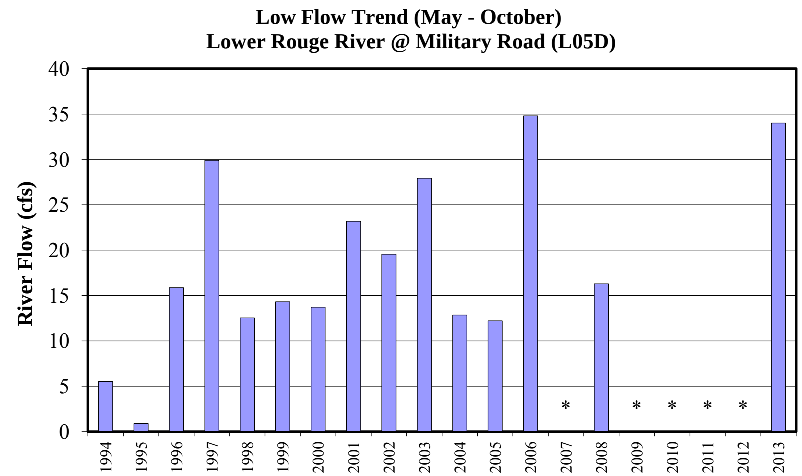
Figure 15
Lower 2 SWMA John Daly Road (US1) Streamflow Data and Trends (1948 - 2013)

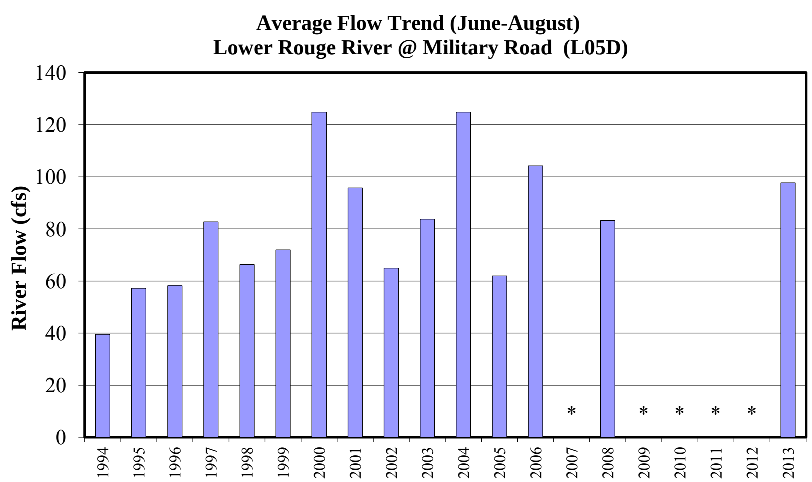


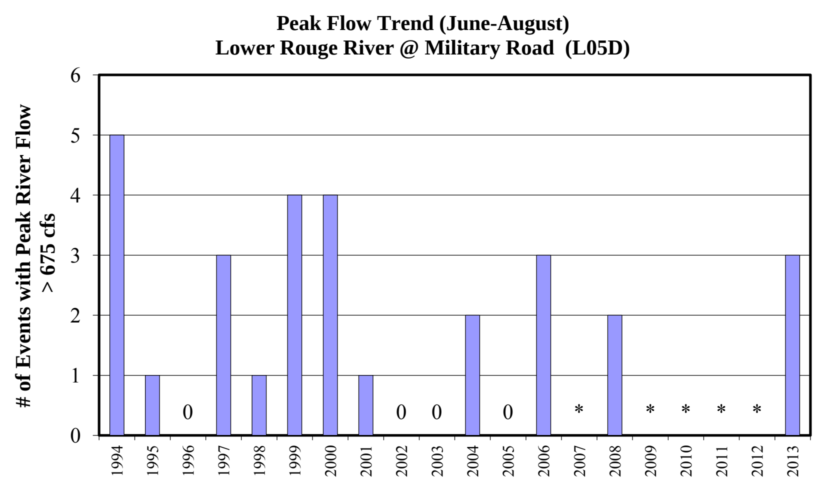
Note: YCUA discharge began in 1996. (0) in figure means flow of 900 cfs was not exceeded.

Figure 16
Lower 2 SWMA Military Road (L05D)[1] Streamflow Data and Trends (1994-2013)









Note: YCUA discharge began in 1996. (0) in figure means flow of 675 cfs was not exceeded. (*) = no data collected in that year.

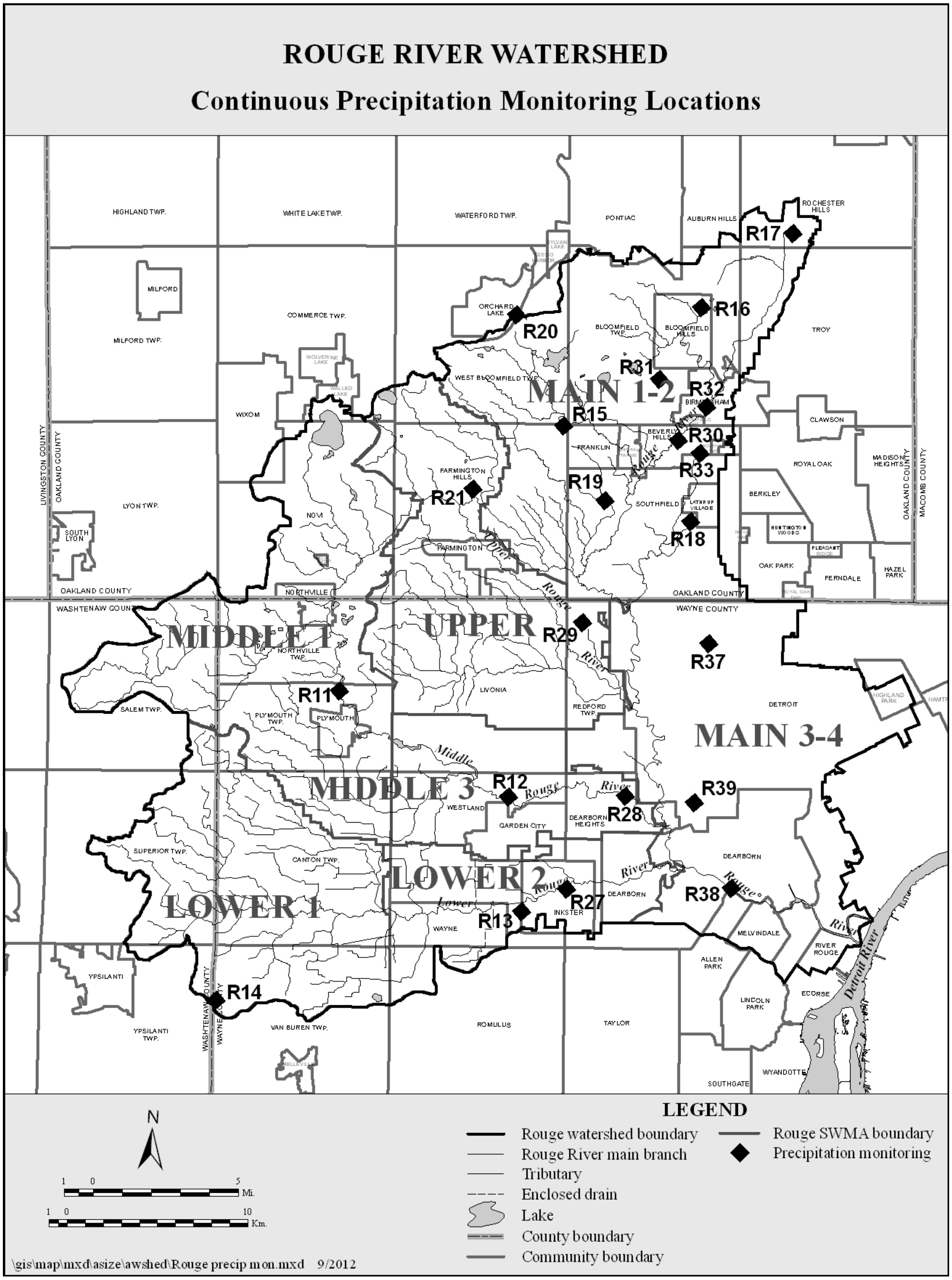
[1] Level/flow data were not collected at this location in the Lower 2 SWMA in 2007, 2009 – 2012 therefore, a 7 year moving average is not shown.

Table 2
Streamflow Trend Analyses Summary and 2013 Precipitation Totals

SWMA	Site ID	Low Flow (Base Flow)	Average Flow	Peak Flow Exceeding Gage-Specific Threshold[2]	Streamflow Period of Record	2013 Precipitation Total (as percent of long-term average, 1994-2013)[1]
Main 1-2	US4	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then no change	⇑ from mid 1960s to mid 1990s, then no change	1951-2013	110.34% (average of gages R15- R20, R30-R33) [3]
	US5	⇑ to mid 1990s, then ⇓ to mid 2000s, then no change	⇑ from mid 1960s to mid 1990s, then no change (cyclical)	⇑ from mid 1960s to mid 1990s, ⇓ begin 2000s, recent cyclical	1959-2013	
	US6	⇑ to mid 1990s, then ⇓	⇑ from mid 1960s to mid 1990s, then no change	⇑ from mid 1960s to mid 1990s, then ⇓	1959-2009	
Main 3-4	US7	⇑ from mid 1960s to mid 1990s, then ⇓ to mid 2000s, then no change	⇑ from mid 1960s to mid 1990s, then cyclical	Cyclical	1931-2013	109.01% (average of gages R37-R39) [3]
Upper	US3	⇑ to mid 1990s, then ⇓ in late 1990s, then no change in recent years	⇑ since data collection began in 1959	Cyclical	1959-2013	104.17% (average of gages R21, R29) [3]
	U05	⇓ since mid 1990s	⇓ since mid 1990s, but no change in recent years	⇓ since mid 1990s	1994-2011	
Middle 1	US10	No change	⇑	⇑	2002-2005, 2011 (2002 partial year)	106.09% (average of gages R11, R12, R28) [3]
Middle 3	US2	⇑ since mid 1980s to mid 1990s, then ⇓ in late 1990s, then no change since mid 1990s	No change to mid 1990s, then ⇑	No change (cyclical) since the mid 1980s	1948-1977 1984-2013	106.09% (average of gages R11, R12, R28) [3]
	D06	No change since mid 1990s	No change	No change	1994-2008, 2011	
Lower 1	US9	No change	No change	No change	2001-2006* (2001 partial year)	104.17% (average of gages R13, R14, R27) [3]
Lower 2	US1	No change 1948 to 1995, then ⇑ in 1996, then ⇓	No change to mid 1990s, then ⇑ since 1995	⇓ 1948 to 1995, then no change (cyclical)	1948-2013*	104.17% (average of gages R13, R14, R27) [3]
	L05D	No change since 1996	No change since 1996	No change since 1996	1994-2006, 2008, 2013*	

Note: ⇑=increasing trend, ⇓=decreasing trend, *YCUA WWTP began discharging in upstream end of Lower Rouge in 1996.
[1]Rouge River Watershed Rain gages used for calculation of precipitation totals.
[2]The discharge exceeded 1% of the time (calculated in the mid-1990s over the period of record).
[3]Partial month not included in calculation of average.

Figure 17
Continuous Precipitation Monitoring Locations



RECOMMENDATIONS FOR FUTURE SAMPLING AND MONITORING

Significant contributors to water quality and ecosystem health impairment in the Rouge River have included: uncontrolled CSOs, Sanitary Sewer Overflows (SSOs), polluted stormwater, illicit connections, failing Onsite Sewage Disposal System (OSDS), and increased runoff resulting in unstable and highly variable streamflow. In the Rouge River Watershed many of the CSOs have been controlled and the plans are underway to control the remaining CSOs. Similarly, those communities with SSOs are working toward their elimination. In addition, communities are identifying and eliminating illicit connections, implementing green infrastructure projects on public properties, and requiring storm water controls for new and redevelopment projects. As a result, the Rouge River is in far better condition in 2013 as compared to 1994. Nonetheless, additional efforts are still needed to further the restoration of the river.

Monitoring of the river system is recommended to continue on a periodic basis in order to assess the progress of meeting the interim streamflow, water quality and biological targets that are identified in the WMP. These recommendations are identified in Table 3.

Table 3. Recommend Monitoring Parameters and Schedule

Parameter	Stations	Frequency	Duration
Stream Flow and Dissolved Oxygen	U05 (Upper Branch) US7 (Main Branch) D06 (Middle Branch) L05D (Lower Branch)	Once every 5 years	Every 15 minutes April - October
E. coli	70 locations as identified in the *E. coli* TMDL	Once every 10 years	Twice a month April - October
Macroinvertebrates	3 to 5 status and trend sites in each SWMA	Once every year	Spring

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