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Engineer's Report:
Sunrise River Water Quality & Flowage Project

April 18, 2012

water | ecology | community

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5 EXECUTIVE SUMMARY

The Sunrise River Water Quality and Flowage Project was initiated by a petition from Chisago County to the Comfort Lake Forest Lake Watershed District (CLFLWD). This project is a water quality and quantity improvement effort located within the drainage area to a branch of the Sunrise River (also known as Judicial Ditch 1) between the City of Forest Lake and Comfort Lake. The Sunrise River is a tributary to the St. Croix River. The primary project goal is to reduce nutrient and sediment loading to Comfort Lake from the Sunrise River drainage area and secondarily to reduce seasonal flooding along portions of this branch of the Sunrise River upstream of Comfort Lake.

The first feasibility analysis phase of this project included an initial screening of potential components that aligned with overall project objectives. The results of this effort included a February 23, 2011 Memo submitted to the Board for their review. Included in that memo was an evaluation and ranking matrix for each of the feasible project components. The Board carefully considered all feasible components and recommended several be carried forward to this Engineer's Report.

The process of developing the Engineer's Report included a number of steps that lead to the preliminary design and evaluation of feasible options. This process included collection and analysis of hydrologic data, water quality data and fisheries data. Historical information including utility and ditch records were collected along with field data such as topographic surveys, wetland determinations, wetland hydrology, soils and stream channel stability. Existing hydrologic/hydraulic models were updated to be utilized and water quality models were built for the evaluation of various scenarios. Public outreach and landowner coordination were conducted to gauge the acceptance of the potential project components with the agencies and citizens.

Preliminary designs were developed for the project components found to be most feasible and suitable for accomplishing project goals. Factors utilized in the cost/benefit analysis included permitting requirements, land acquisition, ecological tradeoffs, passive and active recreation opportunities, project constructability/risk, water quality impact, and estimated cost.

This Engineer's Report is consistent with the requirements of MN Statute 103D.711. The Engineer's Report provides discussion on the feasibility analysis, identifies public education and recreation benefits, land acquisition needs, permitting requirements, and cost for each related recommended project component. The Engineer's Report also provides a description and designs for the recommended project components being described as *Bixby Park Water Quality Improvement Wetland, Wyoming Wetland Enhancement* (*Banta, Ducharme & District Tax Forfeit), Shallow Pond Restoration, and McCullough Property.* This project also includes an evaluation of retrofits within the urban areas of Forest Lake. Preliminary designs of all identified opportunities are included in the report and described as the *Forest Lake Urban Area Retrofits*. Carp are known to exist in the system and therefore a *Carp Management Plan* is recommended for the project along with specific carp management considerations for each of the project components.

Bixby Park Water Quality Improvement Wetland

The Bixby Park component to the project targets treatment for phosphorus-laden runoff from the urban portions of the City of Forest Lake. In combination with urban retrofit, this component will provide treatment for dissolved and particulate phosphorus through wetland enhancement and iron-enhanced sand filtration. The flows currently channelized in the ditch will be routed through an enhanced wetland, ponded and a portion slowly filtered through an engineered outlet berm designed to capture dissolved phosphorus. This component is estimated to provide 206 lbs/yr of phosphorus removal at a cost of $396,000 (construction cost only).

Wyoming Wetland Enhancement (Banta/Ducharme & District Tax Forfeit)

The purpose of the Wyoming Wetland Enhancement component is to create, on a sub-regional scale, water quality improvements that would address the higher pollutant concentrations from the Heims Lake area of Wyoming. In addition, this component will divert flows upstream of the confluence with outflows from Forest Lake and into a restored wetland flowage located on the Ducharme property. The main focus of the Wyoming project is to restore wetland functions, thereby restoring the natural treatment capacity of the wetland system. This is achieved by diverting flows from Heims Lake out of the existing ditch at the Highway 61 culvert and diffusing it into the District's Tax Forfeit property wetland complex and then easterly through the Banta property. This component takes advantage of the wetland vegetation's evapotranspiration abilities that were identified during wetland water level monitoring. Secondly, diverting flows into the restored wetland flowage will provide additional treatment for the JD#1 flows while allowing the relatively cleaner flows from Forest Lake to go directly downstream. This component is estimated to provide 109 lbs/yr of phosphorus removal at a cost of $2,036,000 (construction cost only).

Shallow Pond Restoration

The main focus of the Shallow Pond component is to increase the stream interaction with the floodplain to allow for improved settling of particulate phosphorus (and other sediments) and uptake of dissolved phosphorus by the wetland vegetation rather than their transport within the channel. Based on the review of historic survey information, the historic outflow elevation of Shallow Pond was lowered approximately 4-ft by the construction of Judicial Ditch No. 1. This project design attempts to restore the outflow elevation through construction of a series of four grade control structures (rock checks) to raise the outlet elevation of Shallow Pond approximately 2-ft to 4-ft restoring the historic function of the shallow pond. This component is estimated to provide 234 lbs/yr of phosphorus removal at a cost of $107,000. (construction cost only).

McCullough Property Future Water Quality Improvement

The McCullough Property component to the project also targets treatment for phosphorus-laden runoff from the urban portions of the City of Forest Lake. The main focus of the recommended projects is to enhance water quality treatment and storage capabilities of the McCullough Property wetlands. *These project components should only be implemented if needed following implementation and monitoring of the Bixby Park, Tax Forfeit and Shallow Pond projects components.* This component is estimated to provide 54 lbs/yr of phosphorus removal at a cost of $392,800(construction cost only).

Forest Lake Urban Area Retrofits

Much of the urbanized portions of the City of Forest Lake were developed prior to full consideration for stormwater treatment and typically have higher concentrations of phosphorus in the runoff. The investigation of potential project locations involved the review of background information as well as field visits throughout the targeted subwatersheds to identify locations and types of practices that would address areas of runoff concern. A total of 66 potential areas for treatment were identified as part of this project. Phosphorus loadings were calculated using the delineated drainage areas as well as the unit area loads and land uses prepared for the Comfort Lake Forest Lake Watershed Six Lakes TMDL. Total suspended solids loadings were calculated based on the residential runoff event mean concentration of 101 mg/L measured through the EPA's National Urban Runoff Program (NURP) program. Water quality modeling was conducted using the estimated phosphorus and suspended solids loads and the proposed stormwater practice size and type to determine estimated removals by each practice. It was determined that the total potential phosphorus load reduction from all identified potential BMP retrofit sites was 168 pounds per year. The average annual cost per pound of phosphorus removed with these practices ranges from $561 to $3,083 over 50 years.

Carp Management

This project included an evaluation of the fisheries data for Comfort and Forest Lake as well as an assessment of carp in the system. Carp presence was confirmed throughout the system and each of the project components considered management strategies to prohibit the creation of additional carp spawning habitat. An overall carp management plan is recommended to determine current population and evaluate the need for barriers and removals.

The CLFLWD Board will consider the findings in this Engineer's Report and proceed with implementation of recommended projects as opportunities arise and funding becomes available. Final plans and specifications, construction details, project permitting and land acquisition will be necessary prior to implementation. The CLFLWD will actively pursue partners and outside funding opportunities to reduce the District's financial burden.

6 PROJECT HISTORY AND PROCESS

6.1 Project Purpose and Need

The Sunrise River Water Quality and Flowage Project was initiated by a petition from Chisago County. The petition outlines the basis for the project as well as the project goals and approximate location. The petition discusses excess phosphorus load to Comfort Lake as identified in the District's water quality study and the Six Lakes TMDL and also mentions seasonal flooding occurring along portions of the Sunrise River between Forest Lake and Comfort Lake. The project objectives are identified as:

- Reducing nutrient, sediment and other pollutant loads to Comfort Lake from the Sunrise River as a result of stormwater runoff,
- Reducing seasonal flooding issues along portions of the river.

The project is described in the petition as a "water quality and quantity improvement project". The project goal is primarily to reduce nutrient and sediment loading to Comfort Lake from the Sunrise River drainage area between Forest Lake and Comfort Lake and from the former Judicial Ditch 1 and secondarily to reduce seasonal flooding along portions of the Sunrise River upstream of Comfort Lake.

6.2 Project Location

The project location, as identified in the petition, is "within the drainage area to the Sunrise River between the City of Forest Lake and Comfort Lake including all District lands that drain to Comfort Lake via the Sunrise River" and more specifically to "provide treatment of stormwater runoff coming from the developed and commercial areas of the City of Forest Lake around the 35W and US 8 area". The project location is shown in Figure 1. The project includes a series of components spread across the contributing watershed.

6.3 Project Background

The project petition defines the primary project purpose as reducing pollutant loads to Comfort Lake. The Six Lakes TMDL and the District's Watershed Plan set the goals for nutrient reduction to restore the lake to a swimmable condition. To meet the state water quality standard for total phosphorus content of 40 μg/l, the total phosphorus loading to the lake must be reduced by at least 126 lb/yr. To attain the District's long-term goal of 30 μg/l in-lake summer average total phosphorus concentration, a load reduction of at least 395 lb/yr is needed.

Drainage to Comfort Lake enters through two primary inflows. One inflow is the Sunrise River (Judicial Ditch 1) draining Forest Lake and the area investigated in this project. The second drainage is through Little Comfort Lake and the upstream series of lakes including School, Birch, Bone and Moody Lakes. This second drainage is by other District projects that focus first on Moody and Bone Lakes and will progress downstream from there.

The TMDL load reduction of 126 lb/yr could be achieved through the attainment of state water quality standards in the series of upstream lakes draining through Little Comfort Lake. To further support load reductions that may be achieved through water quality improvement in the Little Comfort-School-Birch-Bone-Moody series of lakes and to attain the District's long-term goal of

395 lb/yr load reduction, reduction in loads is needed from the Sunrise River and Forest Lake drainage. Load reductions from the Sunrise River drainage are the primary focus of this project. Flooding was identified as the secondary project purpose; however flooding issues are not as clearly defined in the Sunrise River corridor. One property owner has a flowage easement granted to Chisago and Washington Counties to address flooding concerns raised in the past. This branch of the Sunrise River between Forest Lake and Comfort Lake was excavated as Judicial Ditch 1 (JD1) in the early 1900s in an attempt to provide drier conditions for farming along this large area of wetlands. The ditch expanded south across Highway 8, through the current Bixby Park, south across Broadway Avenue, and west under I-35 extending to the current Menards site. The ditch was legally abandoned in 1997, but the physical infrastructure of the ditch still remains on the landscape. The District conducted a hydraulic capacity study in 2005[1] that identified 100-year flood elevations. This branch of the Sunrise River and much of the area of the adjacent wetlands were identified as within the floodplain.

The physical characteristics of the Sunrise River watershed within the CLFLWD are such that many conventional water quality treatment options may not be feasible. The relatively flat, broad wetland basins provide ample opportunity for wetland restoration but also significant challenges for some types of water quality improvement projects. Often, ditched wetlands can be enhanced through either obstructing the ditch or converting it to a broader wetland flowage or even a highly sinuous stream channel. In the case of this watershed, the shallow water table, local flooding concerns and extensive wetlands make large-scale water quality improvement projects challenging to implement. The physical characteristics of the drainage system as well as land use are important factors in selecting suitable implementation projects.

6.4 Feasibility Process

In the fall and winter of 2010, the Board heard presentations outlining the types of options available to decrease the phosphorus load to Comfort Lake. The presentations focused on wetland management, stream management, water quality treatment options for the built environment and considerations for construction. The process was designed to inform the Board of the types of project components that might be applicable in the project area, to make sure that all of the ideas for the project were captured, and to identify a preliminary list of potential project components.

Nine potential components were identified and proposed for an initial evaluation to assist the Board in determining which project components to move forward with for a full feasibility evaluation and engineer's report (Appendix). These components were evaluated and ranked against the following factors: stakeholder coordination effort, permit needs and permitting process, feasibility study evaluation needs, project design needs, land acquisition, construction of structures, land disturbance, passive and active recreation opportunities, level of risk, water quality impact, ecological tradeoffs, and estimated project cost.

The top components derived from this screening process include:

- a water quality feature in the District's tax forfeit land
- a water quality feature in Bixby Park

[1] SRF, 2005. Hydraulic Capacity and Model Calibration Report. Prepared for Comfort Lake-Forest Lake Watershed District.

- increases in stream interaction with the floodplain
- retrofits in the developed area of Forest Lake
- carp management
- iron filtration

The approach for the feasibility analysis as summarized in this Engineer's Report is tailored to address the specific characteristics of the watershed. There is no one strategy that can address all conditions contributing to the high nutrient loading being delivered to Comfort Lake. There are unique circumstances related to flow regime, nutrient concentrations, pollutant characteristics (dissolved phosphorus or particulate), and other types of environmental factors such as channel stability and fisheries that are factors that require thorough consideration during the feasibility stage. Physical constraints such as topography, wetlands, and land ownership are also important factors that have to be evaluated during the feasibility analysis. The multiple activities proposed for feasibility analysis are targeted in locations that provide the best opportunity to meet nutrient removal objectives and work in concert with the other proposed activities.

This feasibility study guiding the Engineer's Report investigates the combined implementation of these efforts with an in-depth focus on regional and sub-regional scale projects and an identification of specific sites for implementation of practices on the local scale. The feasibility study includes a number of steps that led to the preliminary design of feasible options. The project steps include data collection and analysis, site surveys, wetland delineation, water quality and hydrologic/hydraulic modeling, public outreach and landowner coordination, feasibility analysis and preliminary design, and preparation of the Engineer's Report consistent with the requirements of MN Statute 103D.711.

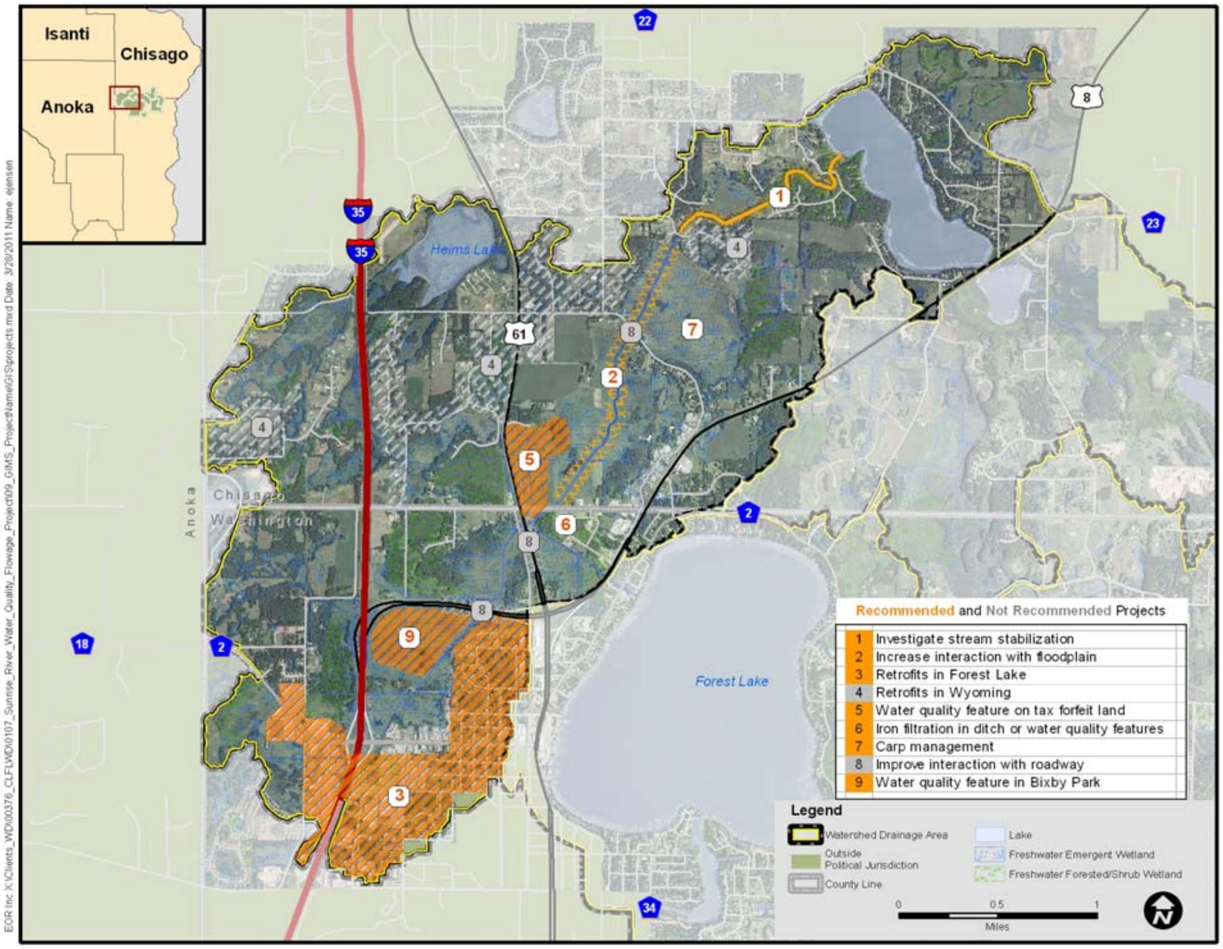

Figure 1. Sunrise River Water Quality and Flowage Project Location Map

7 SURFACE WATER DATA AND PROJECT SITE IDENTIFICATION

7.1 Hydrologic Data

For the past few years, the CLFLWD has been collecting data on water surface elevation, flow, sediment and nutrients at certain points along the Sunrise River and the former JD1. Data was compiled and analyzed as needed to identify feasible project components and to inform project design. The year and types of data available at locations shown in Figure 2 are summarized in Table 1. Monitoring was conducted by the Washington Conservation District as guided by the Board of Managers and the District Administrator. Monitoring typically occurred between March and October and included water level loggers to determine flow rates using gauged flow data and included grab samples to determine water quality. A summary of the data is provided here and additional graphs are included in Appendix B.

Table 1. Hydrologic Monitoring Data along the Sunrise River and Former JD1

Monitoring Station Name	Water Level	Flow	Velocity	Total Suspended Solids	Total Phosphorus	Dissolved Phosphorus
Comfort Lake Inlet	2007-2011	2004-2011	2007-2011	1994, 1996, 2000-2011	1994, 1996, 2004-2011	2005-2011
Greenway Avenue	2008, 2011	2008, 2011	2008	2008, 2011	2008, 2011	2008, 2011
County Line Ditch	2007-2011	2007-2011	2007, 2009	2007-2011	2007-2011	2007-2011
Forest Lake Outlet	2007-2011	2003-2011	2007, 2009, 2010	2003-2006	2003-2006	2005-2006
Bixby Park	2009-2011	2009-2011	2009	2009-2011	2009-2011	2009-2011

Flow rates in the system range from annual averages of about 1 cfs at upstream stations in low flow years to averages of about 20 cfs at downstream stations in wetter years (Figure 3 - Figure 7). Peak flows range from 10 cfs to 74 cfs depending on the year and the location in the watershed (Figure 3 - Figure 7).

Monitoring was also conducted at Bixby Park, the tax forfeit site, and at Shallow Pond between July and November of 2011 to evaluate changes in water level at the sites of potential project components. The minimum water level measured at Bixby Park was 891.13 ft. At the tax forfeit site, the minimum water level measured was 889.56 ft. Shallow Pond water level was measured at a minimum of 889.18 ft. Graphs are included in Appendix B.

Analysis of the water quality data show that total phosphorus loads generally increase moving downstream from Bixby Park to the Comfort Lake Inlet (Figure 8). However, the actual concentration of total phosphorus in the Sunrise tends to be highest at Bixby Park (Figure 9) and the total phosphorus load normalized by drainage area also indicates the highest normalized loading rate at Bixby Park (Figure 10). Higher concentrations and higher normalized loading rates indicate treatment is more effective through physical deposition and filtration methods. As phosphorus concentrations decrease, or as the proportion of dissolved phosphorus increases, the methods available to treat runoff become limited, and often the cost to provide treatment becomes higher. Thus, the monitoring data suggest that Bixby Park and its drainage area is a location to focus on for providing deposition-based and filtration runoff treatment.

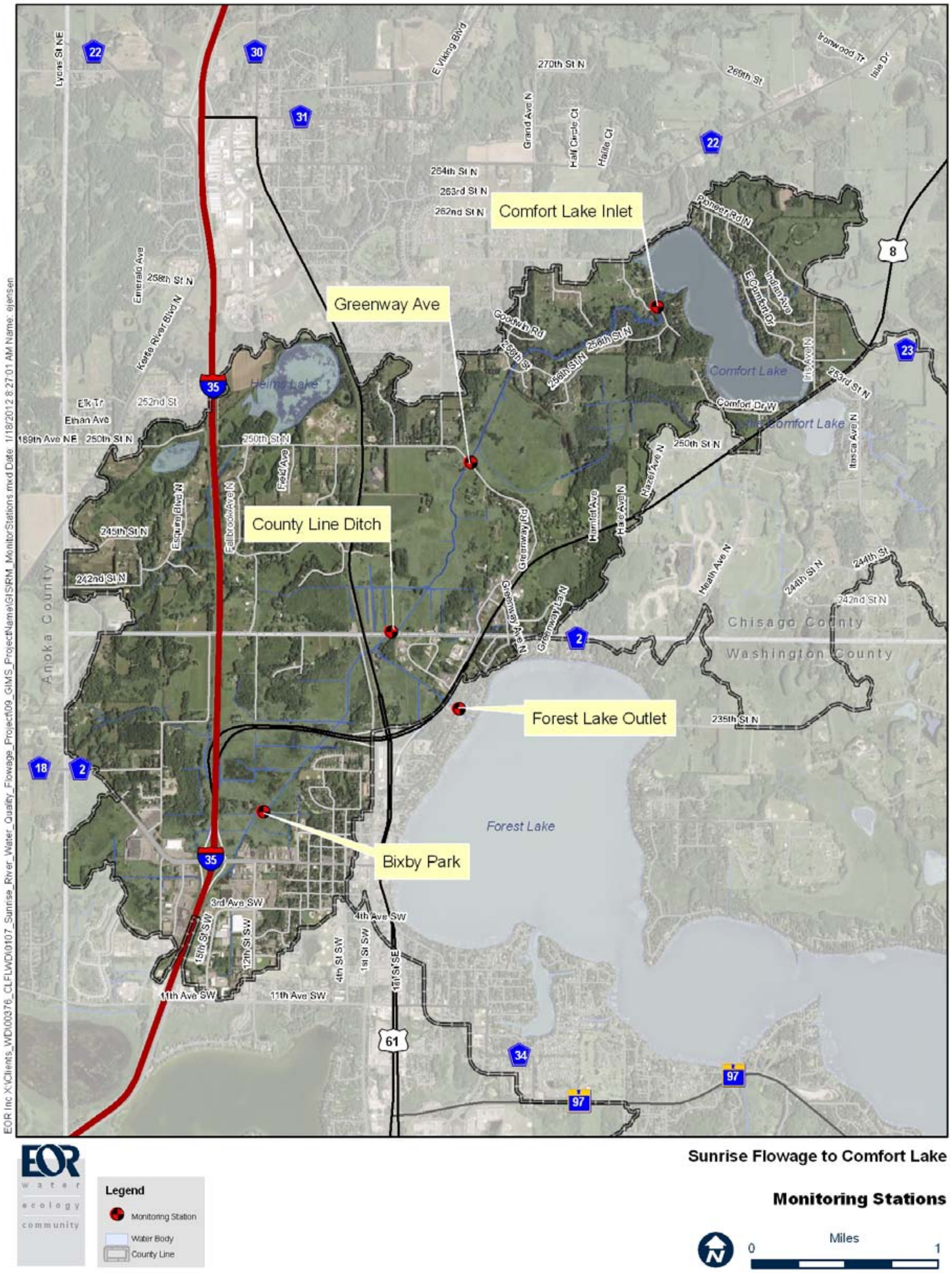

Figure 2. Sunrise Hydrologic Monitoring Stations

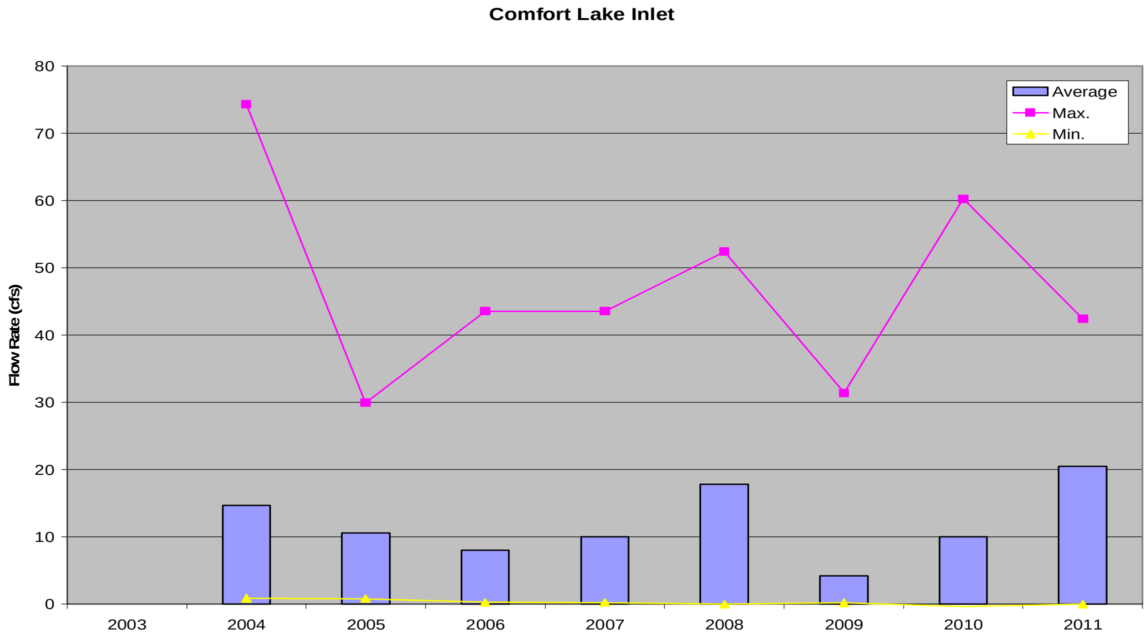

Figure 3. Average, Maximum, and Minimum Flow Rates (cfs) at Comfort Lake Inlet Station

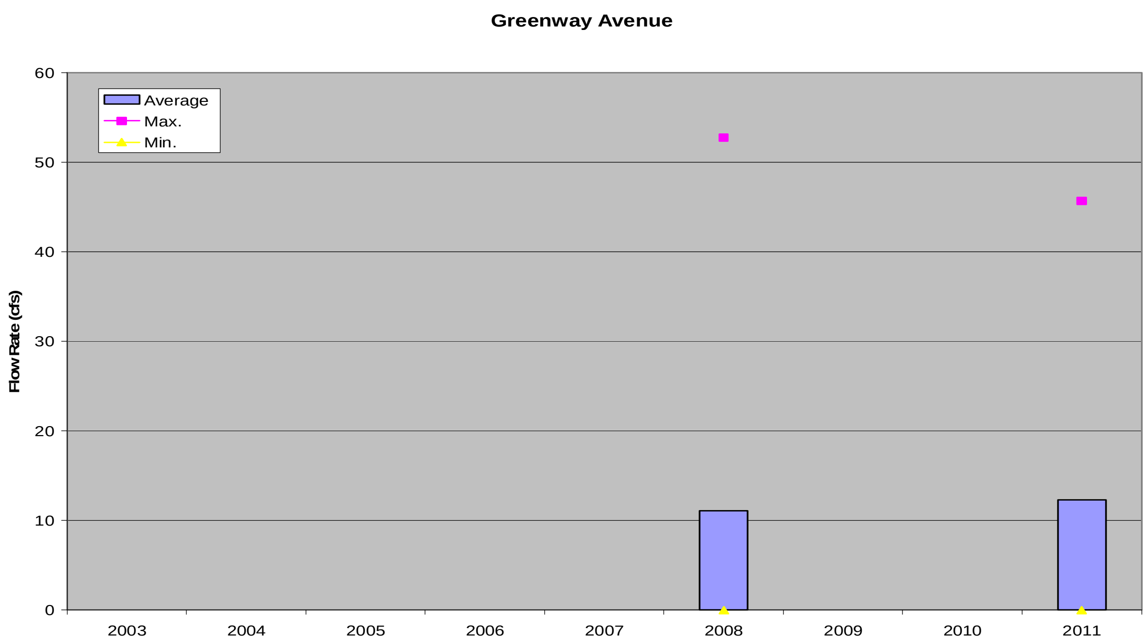

Figure 4. Average, Maximum, and Minimum Flow Rates (cfs) at Greenway Avenue Station

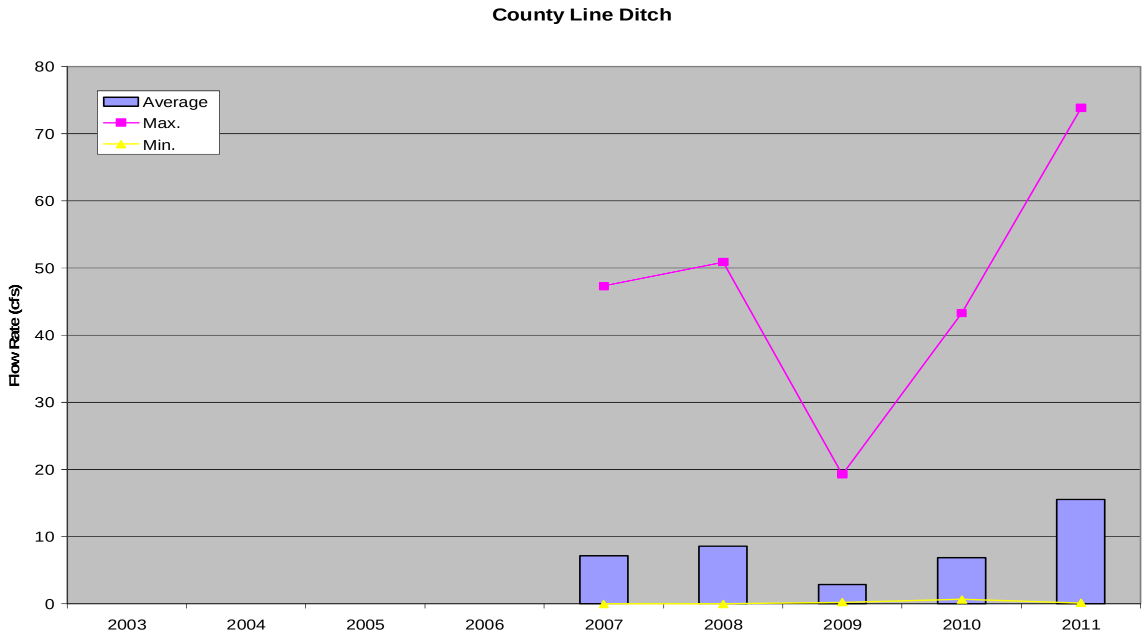

Figure 5. Average, Maximum, and Minimum Flow Rates (cfs) at County Line Ditch Station

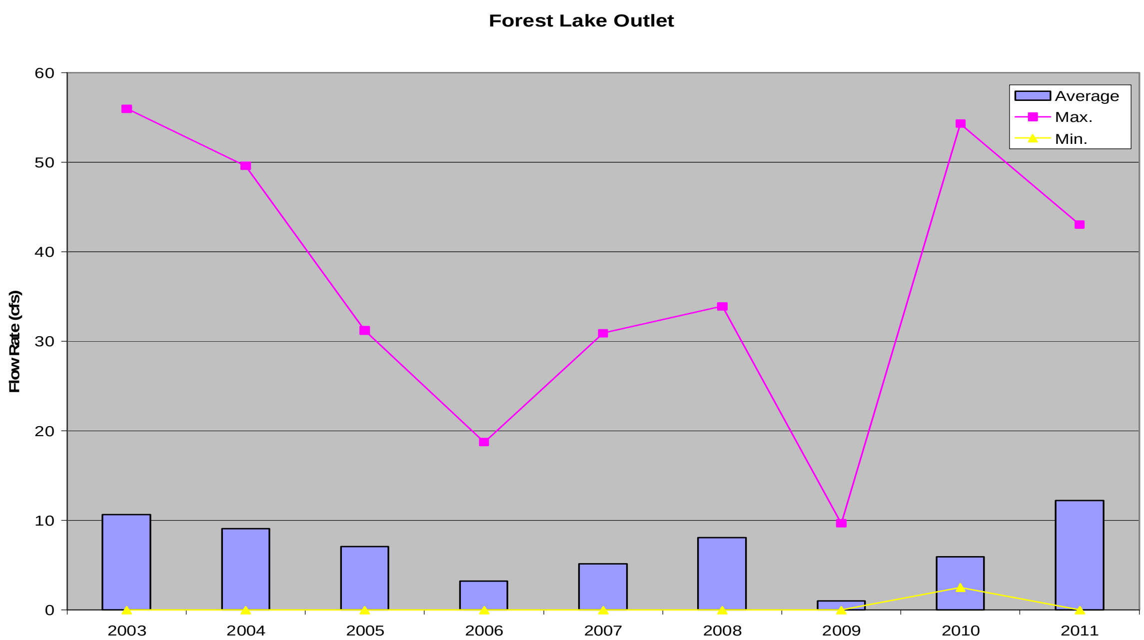

Figure 6. Average, Maximum, and Minimum Flow Rates (cfs) at Forest Lake Outlet Station

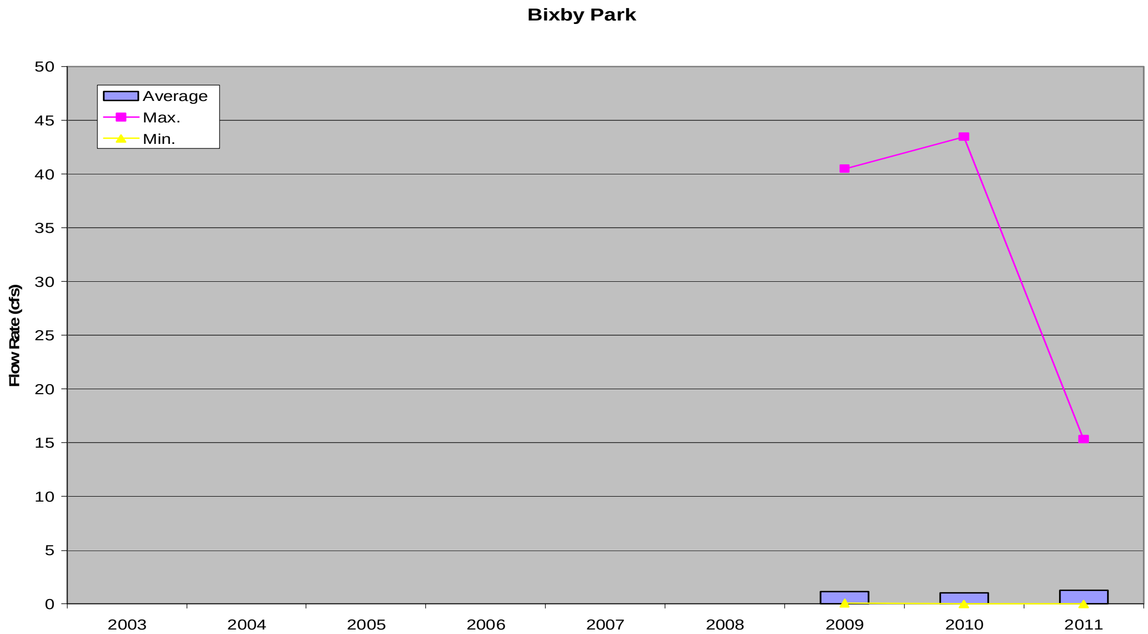

Figure 7. Average, Maximum, and Minimum Flow Rates (cfs) at Bixby Park Station

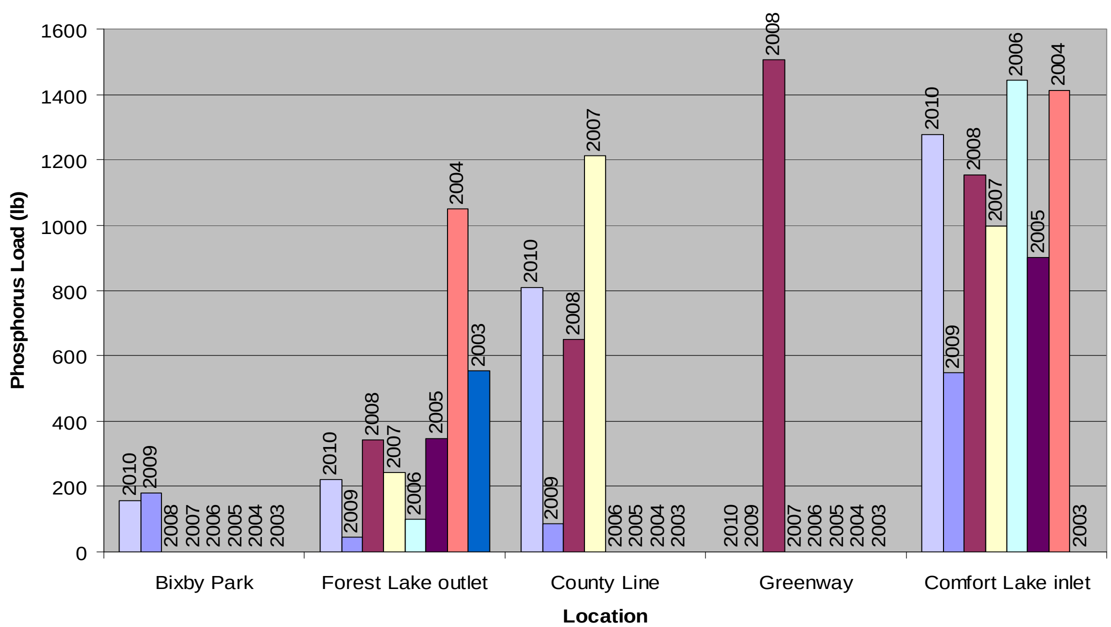

Figure 8. Annual Total Phosphorus Loading along the Sunrise River and Former JD1

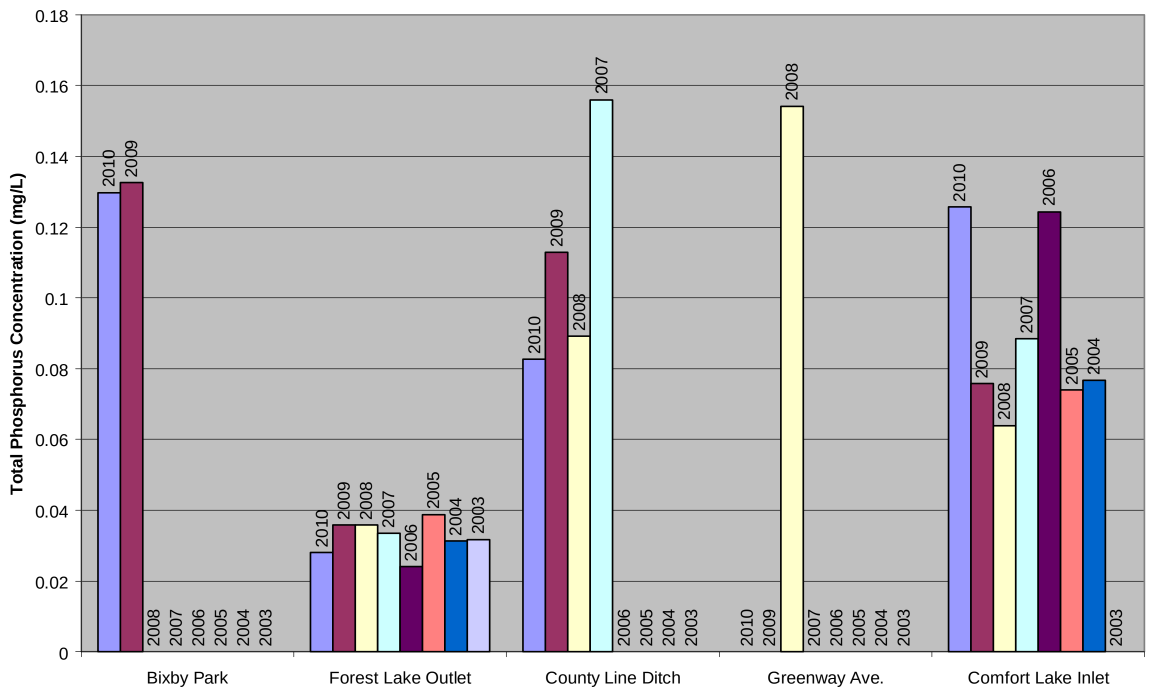

Figure 9. Annual Average Concentrations of Total Phosphorus in the Sunrise River

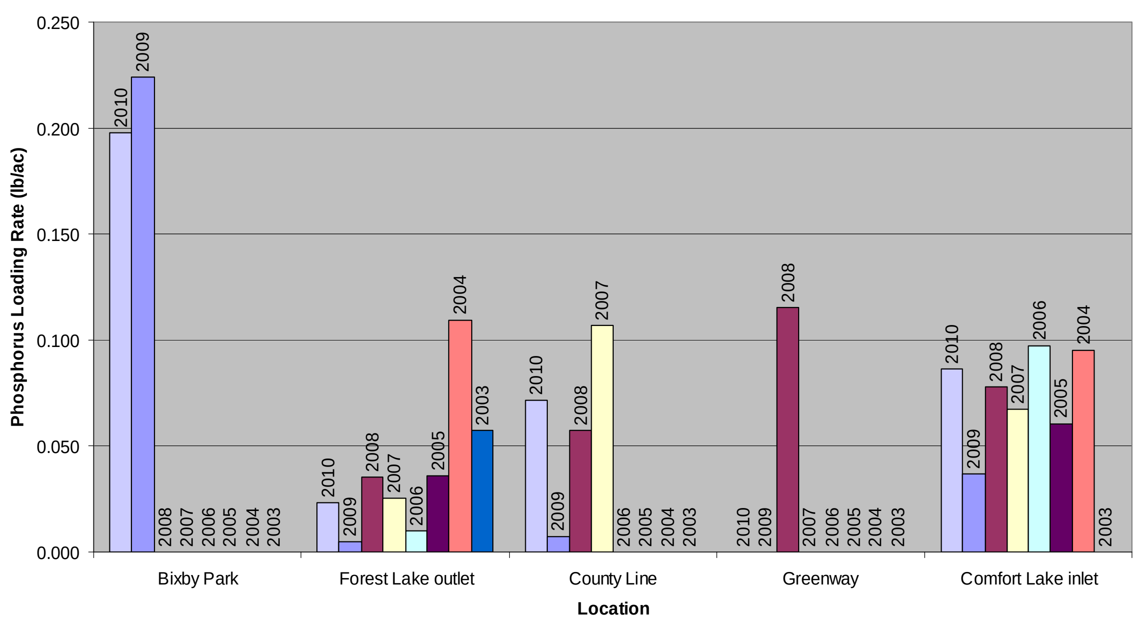

Figure 10. Normalized Annual Total Phosphorus Loading to the Sunrise River

Comparing total phosphorus over time between 2005 and 2011 (Figure 11), the total phosphorus concentrations as measured vary between 0.018 mg/l and 0.637 mg/l in the four Sunrise River/former JD1 stations. Dissolved phosphorus averages about 40% to 45% of total phosphorus at the stations monitored consistently (not Greenway station) but varies considerably ranging from 6% to 100% of total phosphorus. There is no clear relationship between high dissolved phosphorus proportions and flow conditions or total phosphorus concentration.

The Bixby Park station shows total phosphorus concentrations that are often higher than at the County Line Ditch site. This behavior seems to point to a “dilution” effect due to the low concentration drainage from Forest Lake. The Forest Lake Outlet site (based on in-lake data for Forest Lake total phosphorus) had, on average, the lowest phosphorus concentrations when compared to the other monitored sites in 2007-2011. When the Forest Lake Outlet was monitored at the actual outlet (2003-2006), measured high concentrations appear to correspond to low outflow from the lake, perhaps suggesting that water sitting stagnant in the channel upstream of the weir may cause an increase in phosphorus concentration.

During the late spring and summer of 2008, the Greenway Avenue station showed some higher phosphorus concentrations than the County Line Ditch station (Figure 11) suggesting a possible water quality concern between the County Line Ditch and Greenway. However, the two data points collected in 2011 at the Greenway Avenue station are consistent in concentration to the County Line Ditch station and the Comfort Lake Inlet station. It is therefore difficult to determine if high concentrations at Greenway are an ongoing issue.

The Comfort Lake Inlet usually shows lower phosphorus concentrations than Bixby Park (Figure 11). In addition, Comfort Lake Inlet frequently shows lower phosphorus concentrations than the County Line Ditch site and Greenway Avenue site, indicating that water quality improves after Greenway Avenue or the County Line Ditch and suggesting that the area downstream of the County Line Ditch or Greenway Avenue (e.g. Shallow Pond, upstream wetlands) could be a natural location for enhancing the treatment that may already occur in these locations.

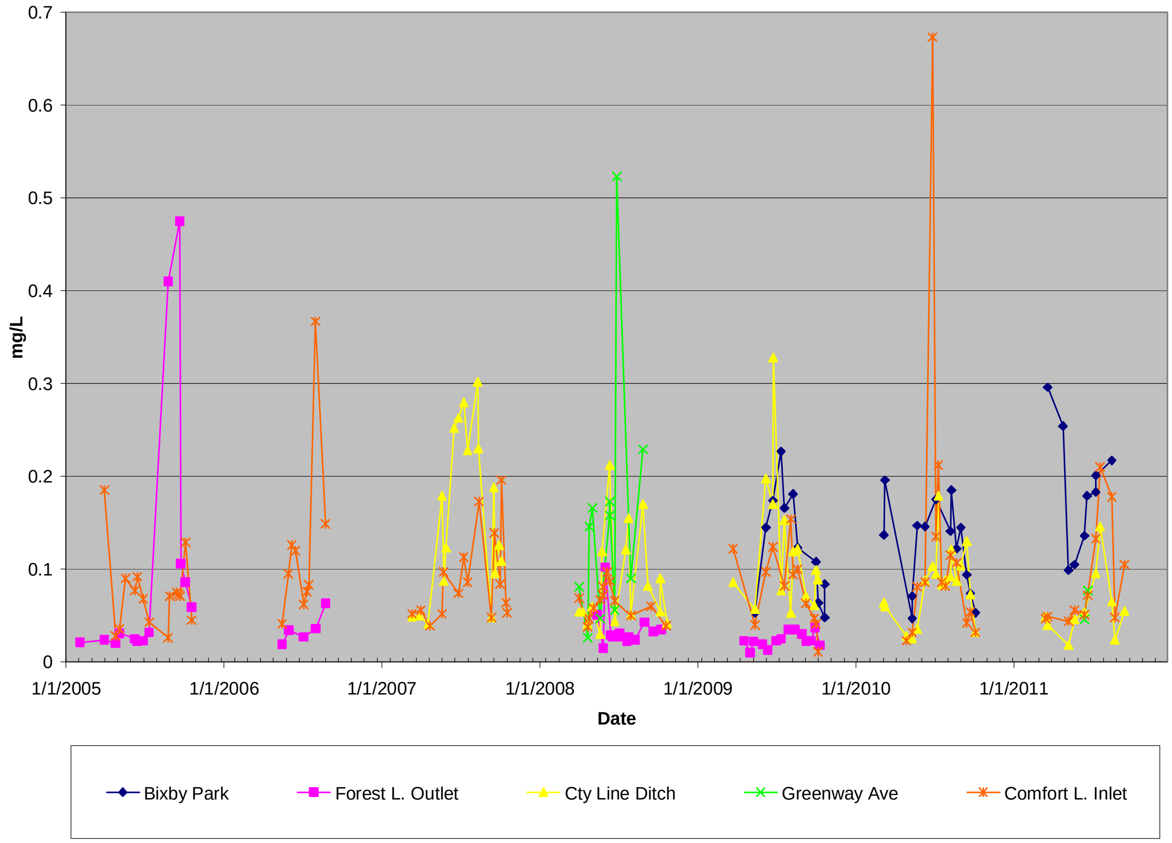

Figure 11. Total Phosphorus Concentration over Time, 2005-2011

However, a number of dramatic spikes in concentration have been noted at various stations since 2005 (Figure 11). In 2005, spikes in concentration were observed at the Forest Lake Outlet station on August 26th and September 21st. Prior to the outflow event on August 26th there had been little (less than 0.1 cfs) or no outflow since August 21st. A rainfall event of 0.94 inches on August 26th resulted in outflow from the lake with a peak flow of about 6 cfs. Similar conditions are apparent for the event on the 21st of September, smaller outflow events occurred on September 12th (peak flow 6 cfs) and 19th (peak flow 3.6 cfs) with little to no flow between or after. The event on September 21st resulted in peak outflow of 11.6 cfs. Outflow concentrations were lower for events where the outflow between events was higher (Figure 12). These high total phosphorus concentrations also tend to correspond to high total suspended solids concentrations. This appears to suggest that dry periods were leading to higher outflow total phosphorus and total suspended solids concentrations, perhaps from the build up and wash off of pollutants on surrounding roadways and impervious surfaces or because of stagnant water upstream of the dam building up with phosphorus and increased flows causing erosion of settled sediments in the stream. However, in 2006, flows were often low with periodic rainfall events causing outflow from the lake and high concentrations were not measured, so the theory is not fully supported by the data.

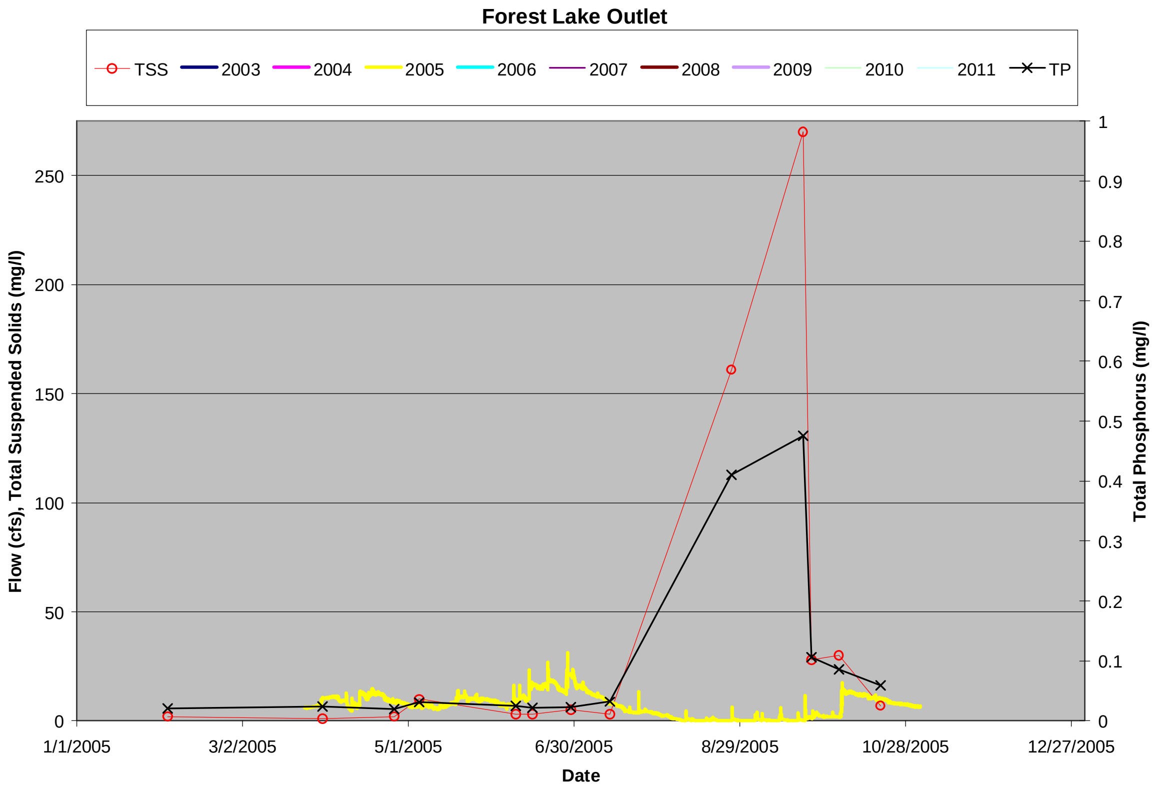

Figure 12. Forest Lake Outlet, 2005 Flow, Total Phosphorus and Total Suspended Solids

The Bixby Park station didn't show any distinct spikes in total phosphorus concentration, but higher total phosphorus concentrations were noted at the Bixby Park station in the spring of 2010 and 2011 (Figure 11). The Bixby Park site often shows higher concentrations of total phosphorus than the other stations, but in 2010 and 2011 the concentrations were particularly high in the early spring (March and April) when compared to the total phosphorus concentrations measured at the other stations. Dissolved phosphorus concentrations were similar to the other monitoring stations in the early spring of 2011 but were somewhat elevated in 2010. Early spring measurements were not taken in 2009; water quality monitoring that year started in May. This may suggest that areas upstream of Bixby Park (primarily the more urbanized portions of the City of Forest Lake) are contributing more phosphorus-laden runoff during snowmelt that other portions of the watershed. In fact, early spring total suspended solids and total volatile solids were very high at Bixby Park site in the spring of 2011 (Figure 13). The construction that was occurring along Broadway Avenue at the time may have contributed to these high total suspended solids and total volatile solids measurements.

In contrast to the observations at Bixby Park, the County Line Ditch site shows somewhat lower total phosphorus and total suspended solids concentrations in the spring. This may be due to the contribution of outflow from Forest Lake that is low in total phosphorus and total suspended solids concentrations. However, the County Line Ditch site showed higher concentrations of total phosphorus on a number of dates in 2007 (June 18 through August 13) and showed a spike on June 25th in 2009 (Figure 11). These dates of higher total phosphorus concentrations tend to correspond to dates of high total suspended solids concentrations as well (Figure 14). In 2007, these were times of low (less than 1.5 cfs) or no flow followed by an event peaking on August 15, 2007 with a flow of 15 cfs. The 0.51 inch rainfall event on June 25, 2009 resulted in a peak flow of 1.7 cfs. Prior to that event, flows have been less than 0.4 cfs since midday on June 12th. These results suggest that low flow/low rainfall periods may result in a release of phosphorus from upstream wetlands after dry periods that is transported into the Sunrise River with the higher flows resulting from a rainfall event. Low water conditions, particularly in ditched and drained wetlands with high levels of stored dead plant matter such as peat, can allow rapid degradation of that plant matter under the oxic conditions that occur with low water levels. Under the anoxic conditions of higher water, plant matter breaks down more slowly and may not release phosphorus as rapidly. When a rainfall event occurs, the phosphorus released into the soil pore water through plant matter degradation can be washed into the ditch and transported downstream.

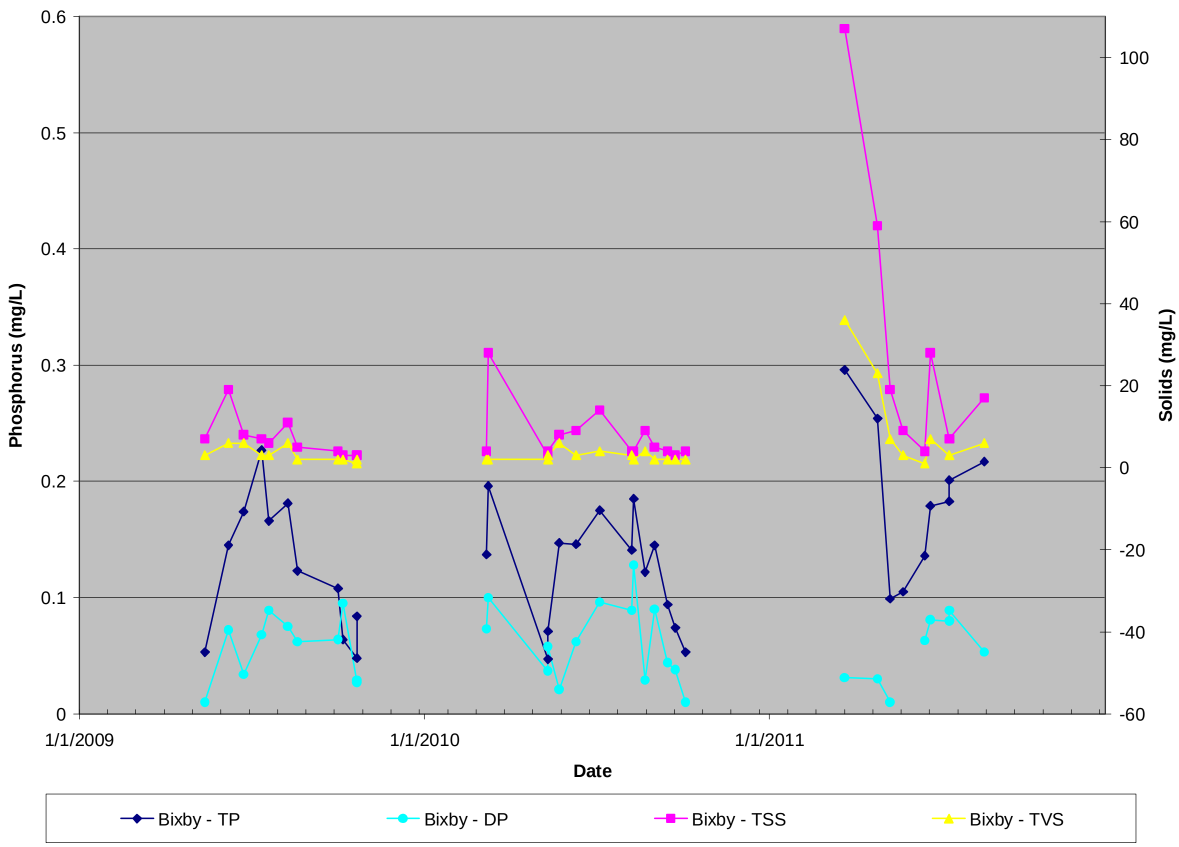

Figure 13. Bixby Park Station Phosphorus and Solids Monitoring Results

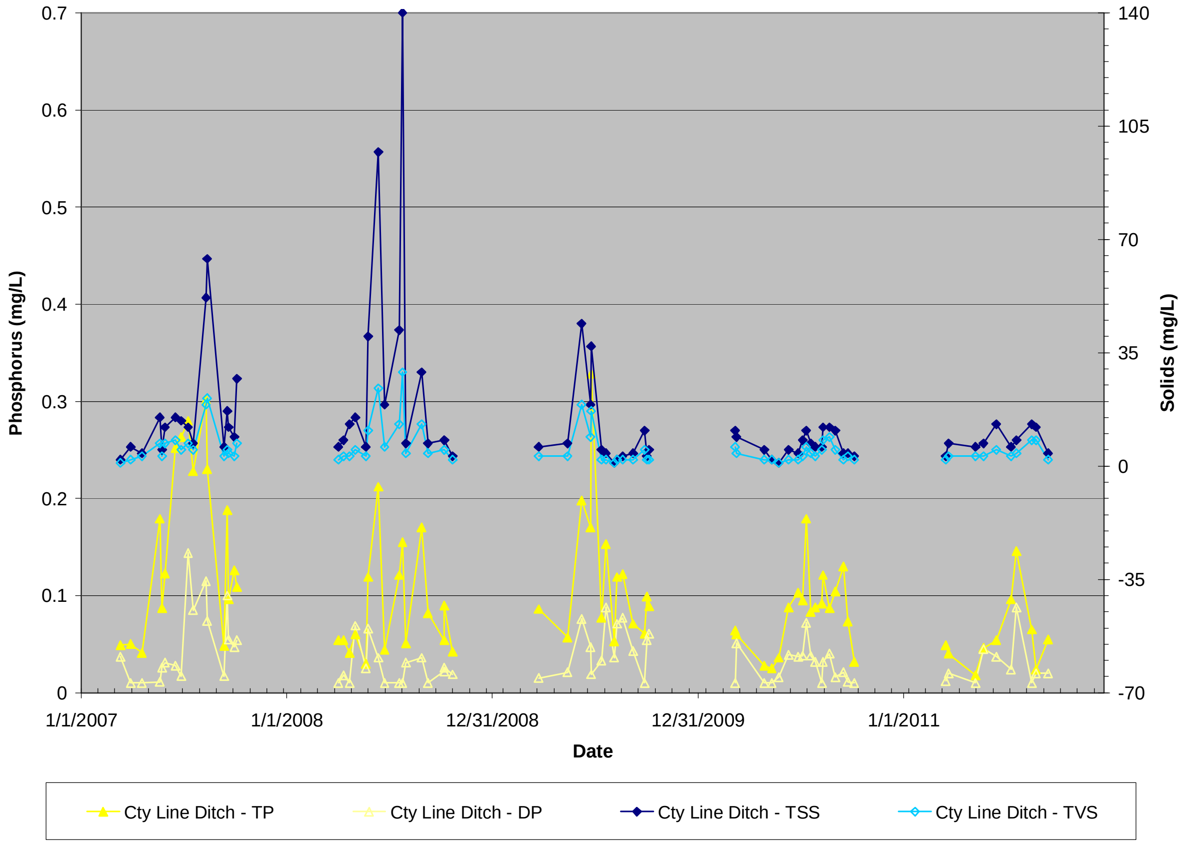

Figure 14. County Line Ditch Station Phosphorus and Solids Monitoring Results

The Greenway Avenue site displays a dramatic spike in total phosphorus (0.523 mg/l) and total suspended solids (422 mg/l TSS) concentration on June 28, 2008 (Figure 11). This total suspended solids concentration is well higher than any others observed at the Sunrise River sites over the recorded monitoring period. The next highest measured total suspended solids concentration was 140 mg/l at the County Line Ditch site in 2008. This total phosphorus concentration is the second highest measured with 0.673 mg/l measured at the Comfort Lake Inlet in 2010. This spike in total phosphorus and total suspended solids corresponded to a 1.8 inch rainfall event. The preceding rainfall event was 0.14 inches on June 21st, seven days prior to the measured spike. The peak flow on June 28th was about 17 cfs. Flows prior to the spike on June 28th were consistently over 9.6 cfs. It appears that the spike in phosphorus and sediment observed at Greenway Avenue in 2008 was a result of runoff from a somewhat larger rainfall event. However, no other monitoring sites were sampled that day, so concentrations cannot be compared across sites.

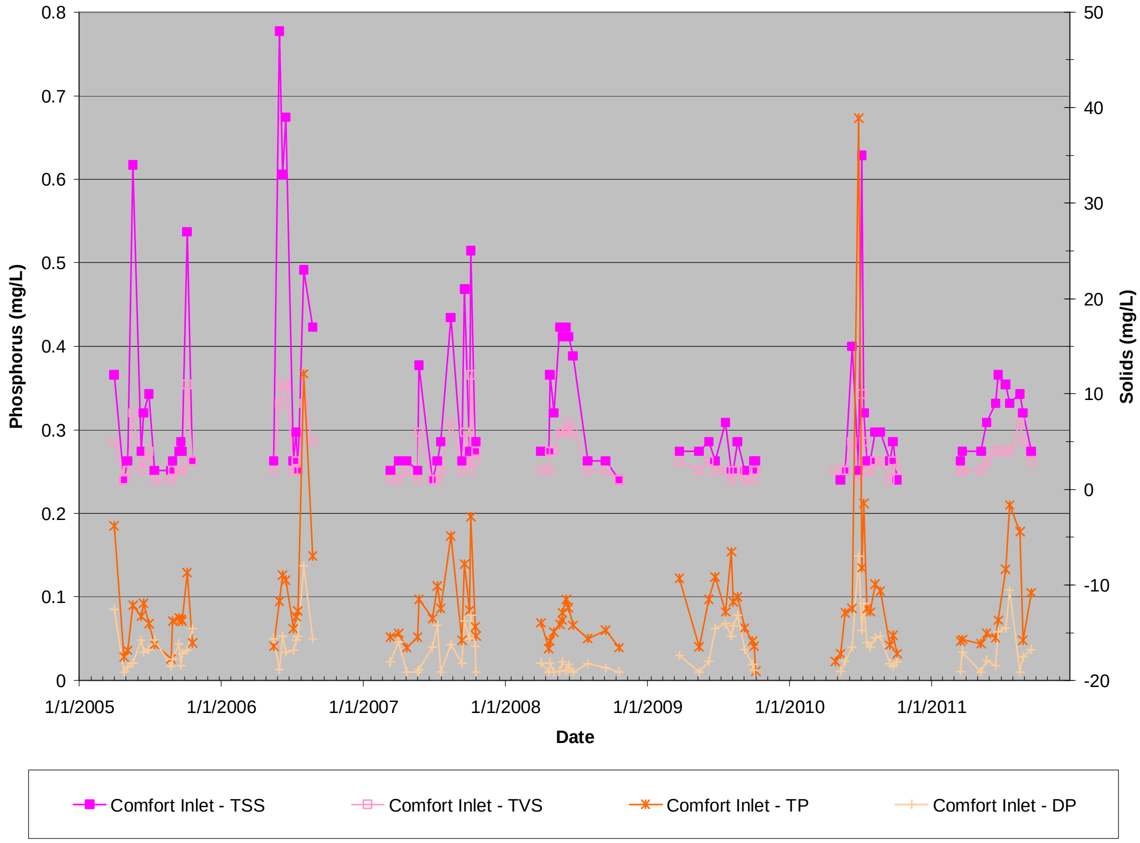

Figure 15. Comfort Lake Inlet Station Phosphorus and Solids Monitoring Results

In general, elevated total phosphorus concentrations corresponded with elevated total suspended solids through the years of monitoring at the Comfort Lake Inlet station (Figure 15). Spikes in total phosphorus concentration were noted at the Comfort Lake Inlet station on August 1, 2006 and on June 28, 2010 (Figure 11). The elevated total phosphorus on August 1, 2006 was measured during a 1.49 inch rainfall event that was followed the next day by a 1.85 inch event. The total suspended solids concentration was elevated on August 1st, but not as high as measured earlier in the season (Figure 15). Prior to the event on the 1st, there had been no rainfall for five days, suggesting possible release of phosphorus from wetlands after degradation during dry conditions. However, a longer period of fairly dry weather occurred later in August of 2006 with no measured spike in concentration. The spike in total phosphorus on June 28, 2010 occurred on a day with no rainfall event, although 1.38 inches was recorded on June 27th and 0.43 on June 26th. The increased total phosphorus also corresponded with a dramatic decrease in measured total suspended solids concentration. Flows on June 28th peaked at about 9.5 cfs from the previous days' rainfall. It is unclear what caused this spike in measured total phosphorus.

These findings of a number of occurrences of elevated phosphorus levels after dry weather may indicate that water quality treatments that keep wetland soils well saturated throughout the season may provide a benefit of limiting spikes in total phosphorus during low flow periods, particularly upstream of the County Line Ditch site. In addition, control of runoff during spring snowmelt appears particularly important upstream of the Bixby Park site.

7.2 Ditch Records

Ditch records were collected from District files and from files in storage with Chisago County. As JD1 was initially a county ditch in Chisago County, Chisago County has the most comprehensive record of ditch plans and proceedings. The District's records include:

- Plat of JD1 from 1904
- Plat of JD1 from 1944
- Ditch profile from 1944
- Ditch profile (undated)
- Investigation report from 1995
- Investigation report from 1997

Numerous boxes of information are available at Chisago County, only a few records were copied for this study. The records acquired from Chisago County in support of the historical analysis of the Sunrise River (see Section 7.7) included:

- Written summary of ditch actions from 1904 to 1966
- Ditch profile from 1995 with written notes on 1996 cleanout
- Plan view of ditch showing sediment, culvert and high water level elevations from 1994

No as-built plans were found for the ditch. See Appendix C for copies of the ditch plat and profiles.

7.3 Fisheries

A review of the DNR Fisheries Reports[2] was conducted to obtain information on the type of deep water fisheries found in the study area. The fish netting and trapping activities recorded in the fisheries survey reports focused on game fish, but when rough fish like the common carp are captured, the data is also recorded. Comfort Lake and Forest Lake were reviewed because of their direct connection to the project area.

Comfort Lake

Comfort Lake is a relatively deep lake not readily susceptible to winter kill that is managed for walleyes and northern pike. During the survey they also found black bullhead, black crappie, dogfish, muskellunge, white sucker, yellow perch, common carp and bluegill. Most notable from this report is the presence of common carp in the catch and the fact that the sampled bluegill numbers are in the upper end of the normal range. Carp can be a water quality problem in lakes because carp stir up sediments during feeding causing the associated nutrients to re-enter the water column, and reduce the presence of aquatic vegetation that can stabilize bottom sediments.

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[2] Minnesota DNR Comfort Lake Information Report
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=13005300
Minnesota DNR Forest Lake Information Report
http://www.dnr.state.mn.us/lakefind/showreport.html?downum=82015900

Bluegill are a known predator of carp eggs, suggesting that the carp are finding spawning areas outside of Comfort Lake where bluegill are less prevalent and then returning.

Table 2. Comfort Lake Fish Survey Results 2010

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range*		
Black Bullhead	Gill net	0.67	2.5 - 45.0	0.09	0.3 - 0.7
Black Crappie	Trap net	34.33	1.8 - 21.2	0.19	0.2 - 0.3
	Gill net	22.33	2.5 - 16.5	0.13	0.1 - 0.3
Bluegill	Trap net	54.22	7.5 - 62.5	0.18	0.1 - 0.3
	Gill net	2.83	N/A	0.20	N/A
Bowfin (dogfish)	Trap net	0.11	0.4 - 1.3	3.58	2.3 - 4.1
Common Carp	Gill net	0.17	0.3 - 3.0	10.03	1.9 - 5.2
Muskellunge	Gill net	0.17	0.2 - 1.0	19.74	1.9 - 4.0
Northern Pike	Trap net	0.11	N/A	0.89	N/A
	Gill net	3.00	1.5 - 7.3	2.69	2.0 - 3.5
Walleye	Gill net	2.00	1.2 - 6.3	2.81	1.2 - 2.7
White Sucker	Gill net	0.17	0.4 - 2.2	1.50	1.5 - 2.4
Yellow Perch	Gill net	37.33	2.0 - 27.9	0.12	0.1 - 0.2

*Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Forest Lake

Forest Lake is a relatively deep lake that is currently managed for walleye and muskellunge. The latest fishery survey showed sustained populations of walleye, muskellunge and northern pike representing the top predators found in the lake. Pan fish populations were above the median level with the bluegills showing relatively high numbers. Rough fish were also captured with bowfin and yellow bullhead noted in the catch. Carp were not captured during this survey but personal communications with anglers indicate there are carp in Forest Lake and carp are listed on the Forest Lake fish consumption advisory.

Table 3. Forest Lake Fish Survey Results 2010

Species	Gear Used	Number of fish per net		Average Fish Weight (lbs)	Normal Range (lbs)
		Caught	Normal Range*		
Black Crappie	Trap net	3.12	1.8 - 21.2	0.19	0.2 - 0.3
	Gill net	10.25	2.5 - 16.5	0.13	0.1 - 0.3
Bluegill	Trap net	118.47	7.5 - 62.5	0.16	0.1 - 0.3
	Gill net	17.50	N/A	0.09	N/A
Bowfin (dogfish)	Trap net	0.24	0.4 - 1.3	8.10	2.3 - 4.1
Golden Shiner	Trap net	0.76	0.2 - 0.8	0.04	0.1 - 0.1
Green Sunfish	Trap net	0.12	0.2 - 1.3	0.04	0.1 - 0.2
Hybrid Sunfish	Trap net	14.94	N/A	0.29	N/A
Largemouth Bass	Trap net	0.12	0.2 - 0.7	0.85	0.2 - 0.9
	Gill net	0.62	0.3 - 0.8	0.91	0.4 - 1.0
Muskellunge	Trap net	0.06	0.4 - 0.5	0.26	1.5 - 7.0
	Gill net	0.38	0.2 - 1.0	13.30	1.9 - 4.0
Northern Pike	Trap net	0.35	N/A	1.83	N/A
	Gill net	6.75	1.5 - 7.3	2.05	2.0 - 3.5
Pumpkinseed	Trap net	17.94	0.7 - 4.2	0.21	0.1 - 0.2
	Gill net	2.75	N/A	0.12	N/A
Rock Bass	Trap net	2.35	0.1 - 0.8	0.46	0.2 - 0.5
Walleye	Trap net	0.18	0.3 - 1.2	3.56	0.8 - 2.8
	Gill net	3.25	1.2 - 6.3	2.67	1.2 - 2.7
White Crappie	Trap net	0.06	0.5 - 6.6	0.23	0.2 - 0.4
	Gill net	0.25	0.7 - 10.4	0.70	0.2 - 0.3
Yellow Bullhead	Trap net	2.00	0.9 - 5.7	0.67	0.5 - 0.8
Yellow Perch	Trap net	0.35	0.3 - 1.7	0.23	0.1 - 0.2
	Gill net	7.12	2.0 - 27.9	0.11	0.1 - 0.2

*Normal Ranges represent typical catches for lakes with similar physical and chemical characteristics.

Carp Management

Carp can be a contributor to water quality problem in lakes, wetlands, and streams. Carp stir up bottom sediments as they feed. This sediment is then re-suspended in the water column, decreasing water clarity and making the associated nutrients more available to algae. Through their feeding, carp can also reduce the presence of the aquatic vegetation that stabilizes bottom sediments from wave action. When carp migrate to spawning areas in the spring, they may often move en masse to the streams and wetlands connected to the lake and can cause the same issues in these streams and wetlands as they cause in the lake.

During field work and area investigation, EOR staff observed carp at the fish barrier on the outlet of Forest Lake attempting to enter the lake. Also, during this time testimony was given by an adjacent landowner near the outlet that in the spring of the year there is a migration of carp through the outlet heading to the Sunrise River. Another resident of the area gave testimony that during the spring of the year they successfully fish the Sunrise River but didn't specify what species they were catching.

The primary reason for investigating the fisheries in this area is to avoid the creation of habitat that may be advantageous to carp for spawning and nursery. Recent studies by Dr. Peter Sorensen at the University of Minnesota[3] provide evidence that carp aggressively migrate to spawn in outlying wetland areas with fluctuating water elevations that don't support perennial predator fish populations. Sorensen's work has also shown that carp populations excluded from these unstable areas do not have successful recruitment from spawning in the deep water habitats where established predator populations, primarily bluegills, exist. Fisheries surveys show that both Comfort Lake and Forest Lake have bluegill populations in the high end of the normal range. Due to predation by the bluegills on the carp eggs, bluegills can limit carp production in spawning areas immediately adjacent to Comfort and Forest Lakes. Therefore, if high carp populations do become an issue in Comfort and Forest Lakes, increased recruitment is most likely occurring in unstable wetland habitats that are connected to the lakes and not in the lakes themselves. In addition, all projects along the Sunrise River and former JD1 will need to be evaluated so as not to create potential spawning and rearing habitat for carp or strong consideration must be given to exclude the carp from accessing these areas.

In the Sunrise River drainage basin, carp are present in the deep water habitat, like Comfort and Forest Lakes, but currently their populations are not noted as a problem in these areas. There are good predator populations established in the deep water habitats that could be responsible for the limitation of recruitment to the carp populations. To prevent carp numbers from becoming an issue in this system, priority attention needs to be given to the connecting habitat that has the potential of presenting fluctuating, seasonal water elevations. Water storage projects that are considered along the Sunrise River between Forest and Comfort Lakes or along ditch or tributary that are connected to the deep water habitat need to be evaluated and designed to avoid creating spawning and nursery habitat that could be utilized by carp. Operation and maintenance of the improvements would also need to be designed to avoid carp usage.

7.4 Utilities

Public utility information was requested from the City of Forest Lake and the City of Wyoming. The City of Forest Lake provided paper copies of stormsewer maps, as built plans for 19th Street, and electronic CAD files on sanitary sewer and water service locations in the project area. The City of Wyoming provided GIS files of the city's stormsewer, sanitary sewer and water service. See Appendix D for copies of the maps provided electronically.

Private utilities such as electric, telephone, cable, and gas will be included with final construction plans. Information on private utilities was received from Access Communications, AT&T, Northern Natural Gas, Qwest/Century Link, Midcontinent Communications, and Xcel. Overhead power lines are present through the McCullough/Bixby Park area. Underground utilities are primarily confined to existing right-of-way, especially along Highway 61.

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[3] Bajer, P. G., & Sorensen, P. W. (2009, July 8). Recruitment and abundance of an invasive fish, the common carp, is driven by its propensity to invade and reproduce in basins that experience winter-time hypoxia in interconnected lakes. *Biological Invasions*

7.5 Retrofit Site Identification

The developed portions of the City of Forest Lake were identified during the scoping of this Sunrise River Water Quality and Flowage Project as an area to be targeted for additional treatment of stormwater runoff. Much of the urbanized portions of Forest Lake were developed prior to full consideration for stormwater treatment and typically have higher concentrations of phosphorus in the runoff. Incorporation of water quality treatment practices close to these sources increases the removal efficiency and ensures that identified sources are directly targeted leading to reductions in phosphorus load downstream. In addition, treatment in this area will help address the high concentrations of total phosphorus and total suspended sediments observed through water quality monitoring at Bixby Park.

The goal for this portion of the investigation is to identify locations to reduce nutrient and sediment loading to Comfort Lake from the more urbanized portions of the City of Forest Lake. The Watershed District also acknowledges the additional benefits these types of projects provide to the community and the environment. Retrofit projects can provide educational, ecological, and aesthetic benefits among others, these additional benefits will be highlighted throughout this report.

Investigation Methods

The investigation of potential project locations involved the review of background information as well as field visits throughout the targeted subwatersheds. Background information on land use, land cover, drainage areas, storm sewer, and areas treated through existing or planned stormwater facilities were gathered and reviewed to identify locations and types of practices that would address areas of runoff concern.

Field visits were conducted to identify potential sites for stormwater management features within the developed portions of the City of Forest Lake that drain to Comfort Lake (Figure 16). Geo-referenced photographs were taken at the investigated sites to document site conditions. Notes on likely types of suitable practices and on the contributing drainage area were made while in the field. The drainage area contributing to each practice was delineated based on available two foot topography and on field notes.

Phosphorus loading rates were calculated using the delineated drainage areas as well as the unit area loads and land uses used for the Comfort Lake Forest Lake Watershed Six Lakes TMDL. Phosphorus sources in stormwater include fertilizers applied to landscapes and vegetated areas, soils that enter runoff, and vegetation that enters runoff.

Total suspended solids loading rates were calculated based on the residential runoff event mean concentration of 101 mg/L measured through the EPA's National Urban Runoff Program (NURP) program. Suspended solids sources include soils and vegetation in runoff from vegetated areas and disturbed soils, solids in runoff from streets and paved areas (e.g. sand and leaves along curb) along with particles from vehicles and the breakdown of roadways.

Water quality modeling was conducted using the estimated phosphorus and suspended solids load and the stormwater practice size and type to determine estimated removals by each practice. In addition, the estimated stormwater practice size and type was used to evaluate estimated construction and maintenance costs of each stormwater treatment practice over a 50 year time period.

Summary of Investigated Sites

A total of 66 potential areas for treatment were identified through this study. The types of potential BMPs identified include raingardens, iron enhanced sand filtration, bio-filtration, rainwater harvesting, permeable pavement, ponding, pond maintenance, and tree trenches. A summary of the identified retrofit projects is provided in Section 10.6.

7.6 Land Elevation Surveys

Survey data collected for this project included wetland topography, ditch and lateral profiles, spoils piles, berms, and structures from the south end of the Bixby site (Broadway Avenue) to 256th Avenue near Comfort Lake. Where applicable, utilities, staff gauges, and monitoring well elevations were also surveyed to compliment the hydrologic model. All survey data were collected using a survey grade Trimble R6 GPS unit. Survey data were calibrated to nearby Minnesota Department of Transportation benchmarks to verify elevation accuracy. In addition to GPS surveying, leveling derived cross section data were collected in the wooded reach of the Sunrise River between 256th Avenue and West Comfort Drive to determine channel entrenchment and floodplain accessibility. These data were useful in determining the degree of entrenchment and the feasibility of restoration options. Appendix F includes the stream profiles generated using the collected survey data.

7.7 Historical Assessment of the Sunrise River

The Sunrise River and adjacent wetlands have been impacted by past ditching. An evaluation of the historical conditions of the Sunrise was conducted to establish a baseline understanding of the changes that have occurred in the system. Not unlike other areas of the Watershed, the landscape of the study area has been significantly altered by development and drainage. The conversion of land cover types for agriculture and development, in concert with the associated drainage, has altered local and downstream resources. To more thoroughly understand the study area and better predict the return-on-investment of watershed improvement options being vetted, a historical analysis of land cover and drainage was completed.

Pre-settlement Landscape

The land area that is now known as the State of Minnesota was surveyed by the federal government between 1848 and 1907. The survey was done in order to divide the vast public domain into salable-sized lots that could be sold, or otherwise divested, to raise funds for the federal government and to encourage settlement. The work was done using the Public Land Survey System (PLSS)[4] which divides land into six-mile square townships and one-mile square sections (Figure 16). As part of the PLSS, surveyors noted tree species and size for azimuth or "bearing" purposes. To some extent, references to land cover and water bodies were also recorded along the traverse of section lines. These records can provide valuable information about pre-settlement vegetation and hydrology. However, it is important to emphasize that the purpose of the PLSS was not to sample the vegetation, but was a means of raising revenue for the government through the sale of public lands to private individuals of companies.

[4] Minnesota Department of Administration, MN Geospatial Information Office. 2011. General Land Office Historic Plat Map Retrieval System. http://www.mngeo.state.mn.us/glo/History.htm

The PLSS maps and original field notes for each section of the study area (sections 27-29, 31-33 of T33R21 within Chisago County and sections 5-8 of T32R21 within Washington County) were reviewed. The product of this effort can be seen in Figure 16. Findings of note from this research include:

- The identification of a discernable Sunrise River channel. Since the survey is linear and only conducted along section lines, it does not define the sinuosity of the river, but does indicate that there was a defined channel through many of these large wetland complexes;
- There is no note of a channel between sections 28 & 33 (Township 33 Range 22), which may indicate that there was no discernable channel within present day *Shallow Pond*;
- A discernable outlet from present day *Forest Lake* was identified;
- Present day *Shallow Pond* was described as a lake, rather than than the shallow marsh/meadow that it is now;
- Individual trees and stands of Tamarack were more prevelent at the time of the survey than at present.

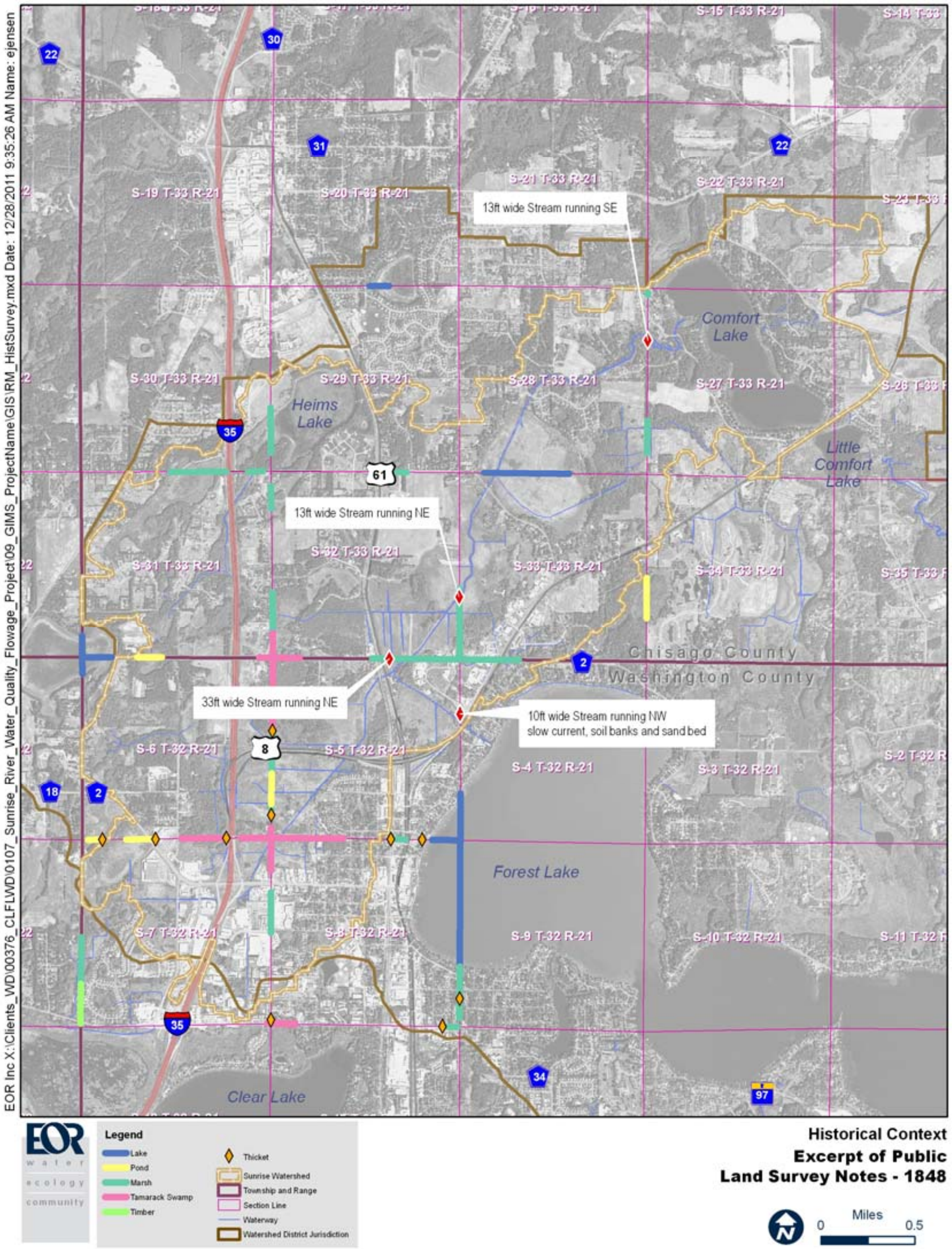

Figure 16. Visual Excerpt of Public Land Survey System in the Study Area

Post-Settlement Landscape

Most of the significant landscape alterations (stream ditching, drainage, land clearing, etc.) occurred prior to the earliest available aerial photography of the study area (1942) so the investigation was more reliant on other resources. Ditch records, although sporadic, yielded some of the most telling insights.

The alteration of the main branch of the Sunrise River and establishment of Judicial Ditch No 1 in the early 1900's has likely had the biggest impact on the water resources of the study area. According to the original design profile (Figure 17) and plan sheets (Figure 18), the natural outlet from Shallow Pond was lowered by 4 feet ±. In addition to the characteristic impacts on local hydrology and water quantity and quality, this alteration has likely had the following compounding and lasting effects on the system:

- Shallow Pond was altered from predominately a Type 4/5 wetland to the Type 2/3 it is today;
- The natural outlet to Shallow Pond appears to have been a natural grade control in the system. The dewatering of Shallow Pond and upstream ditching permitted more effective drainage of the wetlands above the system;
- In order to drain Shallow Pond, the outlet profile of the Sunrise River had to be lowered all the way to present day Comfort Lake. The initial ditching and subsequent geomorphic response drained local wetlands and the water table and also likely resulted in the entrenchment of the Sunrise River (see Section 7.8).

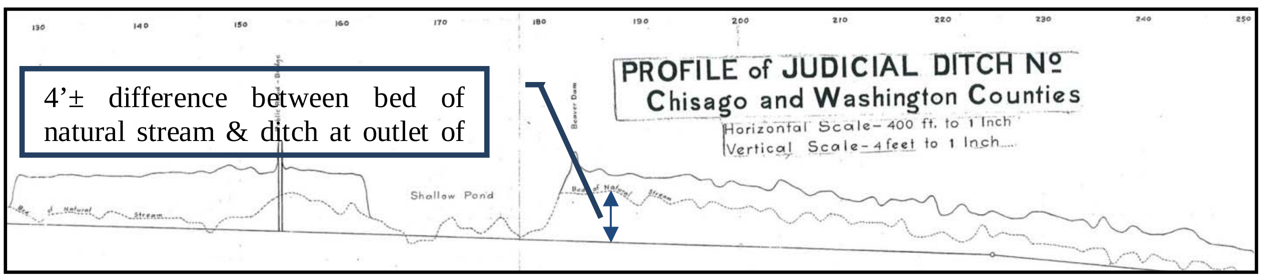

Figure 17. Judicial Ditch No 1 Original Design Profile

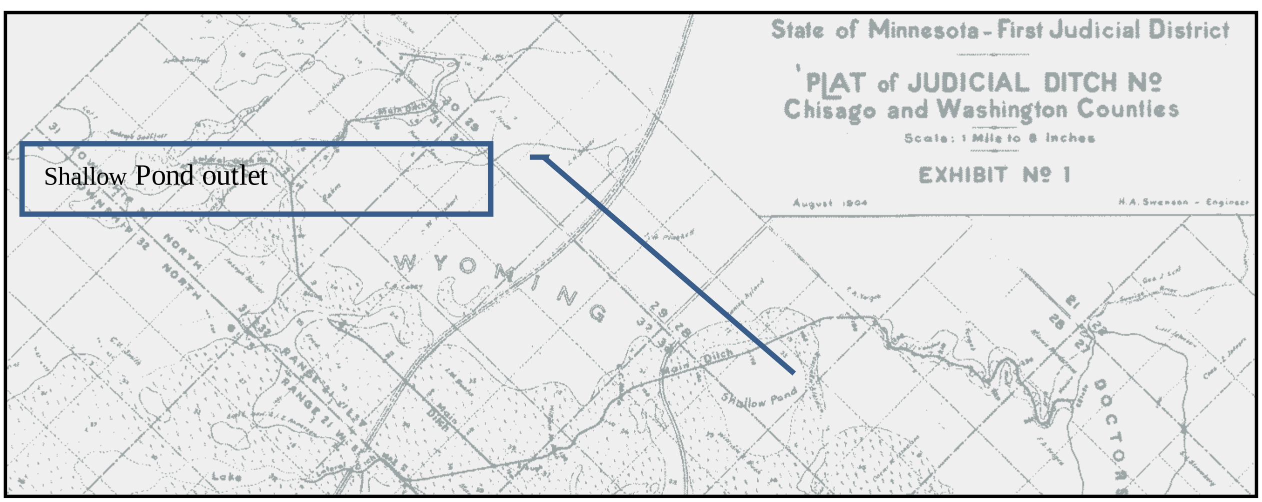

Figure 18. Judicial Ditch No 1 Original Design Plan

7.8 Lower Reach Stream Assessment

As part of the *Sunrise River Water Quality Flowage Project* the lower reach of the Sunrise River was assessed to evaluate the impact of past ditching and evaluate the current stability of the stream. The extent of the lower reach and limits of this investigation includes a stream length of 1.25 +/- miles, stretching from the Comfort Lake confluence upstream to the outlet from a wetland referred to as Shallow Pond (approximately 300' upstream of the 256th Street crossing).

Original intentions were to employ the Stream Visual Assessment Protocol, authored by the United States Department of Agriculture, Natural Resource Conservation Service (Technical Note 99-1) for this study reach. This assessment protocol provides a basic level of stream health evaluation based primarily on physical conditions within the assessment area. The protocol is an introductory level assessment in hierarchy of stream assessments. During reconnaissance we found the reach to be too homogenous to yield any informative results from this relatively course assessment and deviated from plan to provide the Board the most useful information.

The following observations are based on reconnaissance of the entire study area completed on July 21, 2011 and a geomorphic survey completed on September 20, 2011.

Historical Context

Not unlike many streams throughout this region this reach of the Sunrise River was ditched for intended drainage benefits in the late 19th Century or early 20th Century. Segments of the former abandoned channel are still present, most readily apparent within and downstream of Site 1 (see Figure 19). See Section 7.7 for more information on the pre-settlement condition of this resource and historical alterations.

Current Condition

Entrenchment is prominent throughout this reach. Entrenchment (frequently synonymous with incision) is a vertical description of the stream. Flood flows in an entrenched stream are contained within the streambanks. Whereas flood flows in a stream that is not entrenched are spread out over a floodplain.

There are likely three compounding causes for entrenchment here. When the ditch was constructed the resulting profile of the ditch was significantly lower than the natural channel. Unfortunate placement of spoil created a dike between the ditch and floodplain, thus exacerbating the artificial separation. Lastly, degradation (the lowering of stream bed by steam erosion with the sediment being transported downstream) is frequently a direct response to ditching and likely occurred following ditch construction. Note that the stream does not appear to be actively degrading at this time.

Two representative cross-sections of the stream were surveyed (see Figure 20 - Figure 23). At both locations a historic channel was present; an example of this can be seen in Figure 24. The elevation difference between the former and current channel is roughly 3.5'. It should be noted that due to decades of floodplain deposition (accumulation of sediment, organics and other detritus associated with flooding) the elevation of the historic channel has likely risen, therefore the 3.5' of separation is not entirely due to entrenchment.

Both cross-sections also reflect the additional floodplain separation that is caused by the placement of the ditch spoil, which has essentially created a dike between floodplain and stream.

There are eroded low points and ‘saddles’ in the dike which provide connectivity. It is unknown whether these intermittent connections are sufficient to provide floodplain connectivity. Regardless, the stream is isolated from its floodplain. In entrenched systems, it takes larger magnitude floods to inundate the floodplain, thus they are less frequently flooded. This containment of flows commonly results in instability and habitat degradation.

The common outcomes of channel incision are accelerated streambank erosion, aquatic habitat loss and lowering of water tables. Excessive streambank erosion was not witnessed at this time. This is likely due in part to the shallow gradient and associated lower velocities of this reach. In-stream and floodplain aquatic habitat loss is clear and localized lowering of the water table is probable. During the low flow conditions witnessed on September 20, 2011 significant groundwater discharge to the stream was observed (Figure 25).

Figure 19. Lower Reach Stream Assessment Study Area (Lower Sunrise River)

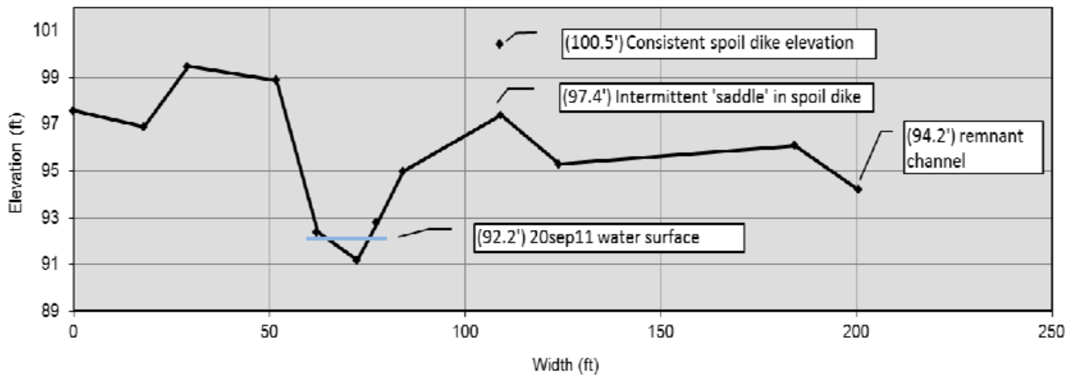

Figure 20. Surveyed Cross-Section of Site 1 (elevations are not tied to datum and are relative)

Figure 21. Representative Photograph of Site 1

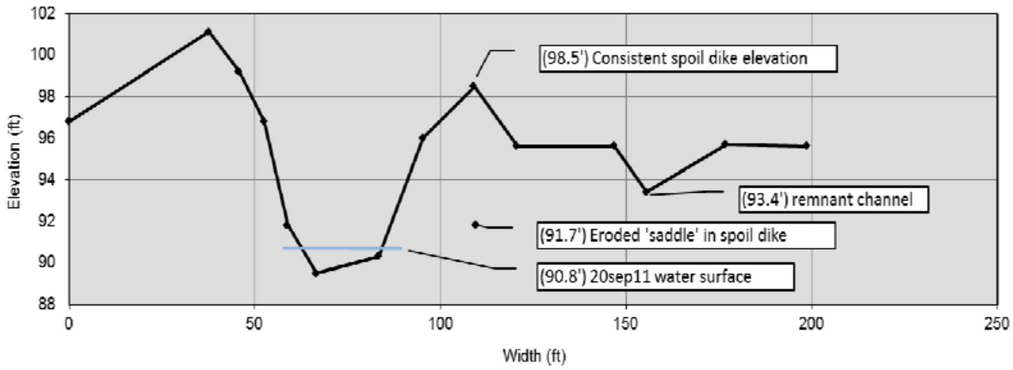

Figure 22. Surveyed Cross-Section of Site 2 (elevations are not tied to datum and are relative)

Figure 23. Representative Photograph of Site 2

Figure 24. Remnant Stream Channel at Site 1 Cut Off by Historic Ditching

Figure 25. Images of Groundwater Discharge Directly to Stream from Site 2 (note the height of bank spoil in the left image)

Improvement Opportunities Warranting Further Consideration

Due to residential development that has occurred adjacent to the reach, it is not feasible to restore the system to its historic condition. The number of landowners that would be 'affected' by a restoration of that scale poses a challenge. More importantly, it appears that some of the homes occupy the former floodplain (this is an observation based on professional expertise and was not validated through modeling or surveying). Reconnecting the stream to its historic floodplain would likely result in an unacceptable rise in flood elevations.

Option 1 - Decrease Artificial High-Bank (Remove Spoil)
As discussed previously, the placement of spoil from historic ditching and maintenance has exacerbated the disconnect from a floodplain. This option improves floodplain connectivity by reducing the partial confinement of the spoil from ditch construction and maintenance. Currently the spoil is creating an artificially high low-bank, which is partially containing channel forming flows. Presently there are breaks in the spoil berm, which are permitting floodplain connection at lower elevations, but these connections are infrequent and constricted. Option 1 explores removing spoil at strategic points for increased floodplain connectivity.

Option 2 - Create New Floodplain Below the Historical Floodplain Elevation within same stream alignment (2-Stage Channel)
This option does not reconnect to the original floodplain lost due to incision, but creates a new floodplain at a lower elevation. The new channel typically follows the general alignment of the incised channel, but with a stable plan-form. The excavation of a new floodplain results in significant excavation that increases disposal requirements.

See Table 4 for general cost benefits of the two options.

Other Observations

Minor bank instability on the downstream side of the 256th Street Crossing was identified. Visually dating the instability and the construction of the crossing the instability is likely associated with the crossing replacement/construction.

A debris jam was identified immediately upstream of the 256th Street crossing. The debris jam, which appears to have been in place for some time is only slightly impounding flow, but could be a potential future blockage problem. The District Administrator was notified of the condition via a July 22, 2011 email.

Per the direction of the District Administrator the outlet from a stormwater pond at 25524 Goodwin Road was investigated (Figure 26). The condition was not overly alarming, but should be addressed. The outfall could possibly be stabilized by adding additional inputs, but it would be best to start over (reusing existing materials and importing additional rock and vegetation).

The study area currently has a high density of large wood debris (Figure 27). Large woody debris (LWD) is trees (whole or part) that fall into a watercourse due to floods, erosion, wind-throw, disease, beaver activity or natural mortality. LWD was formerly removed from systems for "improvement purposes," but we now know that it is a key habitat component in many stream systems. LWD removal should only be considered when there is compelling evidence that it is causing flooding of private/public infrastructure, significant erosion or other hazard. It does not appear that LWD is currently causing issues. Per observation #2 above, the LWD density is much lower above 256th Street.

Table 4. Qualitative Cost & Benefits of Improvement Options

QUALITATIVE COST:BENEFITS	OPTIONS	
	REMOVE SPOIL	2-STAGE
Cost	Minor	Significant
In-stream habitat improvement	Minor	Moderate - may have better substrate sorting
Floodplain habitat improvement	Moderate - restores some connectivity to historic floodplain	Significant - connects channel to new floodplain w/ limited area
Water quality improvement	Minor - due to lower low bank height and associated connection to floodplain	Minor - associated with more frequent access to floodplain
Risk of failure	Low - no real risk of failure	Moderate - minimum design and execution skill required
Stability	Minor - reduces shear stress of channel forming flows	Moderate - lacking stable stream length/roughness/gradient
Change in flood storage elevation	Unchanged	Reduced
Moderation of downstream channel forming flows	Minor	Moderate - associated with more frequent access to floodplain, larger stream cross-section

Figure 26. Representative Photographs of the Outlet Instability at 25524 Goodwin Road

Figure 27. Representative Photograph of Large Woody Debris in the System at Site 2

8 WETLAND DELINEATION AND ASSESSMENT

8.1 Introduction

Wetland delineation and analysis reports for each site[5] were based on field data collected during the summer growing season and hydrologic monitoring performed until the end of the growing season. The purpose of the hydrologic monitoring was to characterize seasonal plant community hydrologic regime, not to delineate wetland boundaries. Concurrence from the WCA TEP was requested[6] for the purpose of general consensus on the wetland boundaries within which activities could potentially be planned and for which all required permit applications would be prepared.

Level 1 wetland delineation and field verification consisted of wetland boundary mapping using offsite methods and onsite data collection forms from the 2008 U.S. Army Corps Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual[7]. Onsite and offsite data were used to refine National Wetlands Inventory (NWI) boundaries between upland and wetland areas.

Wetland hydrology monitoring was initiated on July 18, 2011. Shallow wells were installed in accordance with USACE procedures[8] (PVC wells with wells screens set approximately two feet below the ground surface).

Hydrologic monitoring data collection for the 2011 season was performed through remote retrieval of data from Solinst leveloggers installed at the bottom of the wells to automatically collect static water elevations. The water level findings are in Appendix G, and well location soil characteristics are in Appendix H.

The precipitation conditions compiled by the Minnesota Climatology Working Group[9] showed normal precipitation conditions at the start of the hydrologic monitoring.

8.2 Bixby Park

The Bixby site is approximately 80 acres with an immediate drainage area of 260 acres. It is classified hydro-geomorphically as a depressional/flow-through wetland, with a combination discharge/recharge groundwater interaction. Drainage alteration is not estimated to have occurred. Data show saturated to surface water at all sample points. MnRAM Assessment was performed using the most recent assessment software version. Vegetation assessment was based upon dominant species data generated at sample points on the delineation data sheets. The sedge

[5] EOR. 2011. Sunrise Corridor Level 1 Delineation Reports for Bixby Park, Tax Forfeit, and Channel Corridor. October 28, 2011.

[6] EOR. 2011. Memo CLFLWD Sunrise River Flowage – Delineation Reports. Jason Naber to WCA TEP and USACE. October 28, 2011.

[7] U. S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Midwest Region (Version 2.0), ed. J. S. Wakeley, R. W. Lichvar, and C. V. Noble. ERDC/EL TR-10-16. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

[8] U. S. Army Corps of Engineers. (2005). “Technical Standard for Water-Table Monitoring of Potential Wetland Sites,” WRAP Technical Notes Collection (ERDC TN-WRAP-05-2), U. S. Army Engineer Research and Development Center, Vicksburg, MS.

[9] http://climate.umn.edu/HIDradius/radius.asp; 212881 FOREST LAKE – about three miles from each site.

meadow, shallow marsh and fresh meadow communities assessed ranked moderate to low for vegetative diversity/integrity.

New onsite data collection included the following at points shown in Figure 28:

- USACE three-parameter data
- Color aerial imagery photo-signature ground-truth
- Shallow hydrology monitoring wells

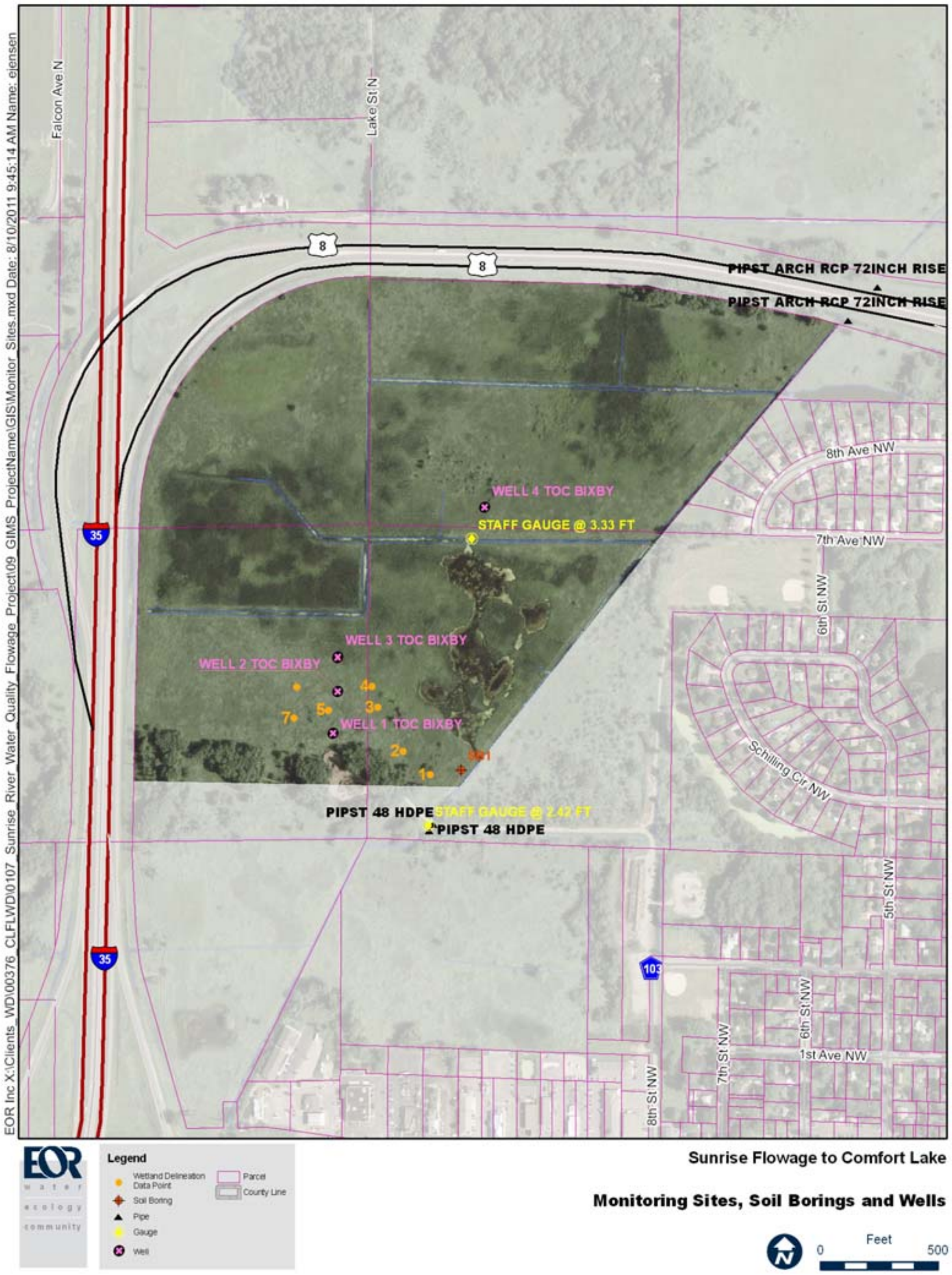

Figure 28. Bixby Park Data Collection Points

Offsite boundary interpretation used existing elevation data, soil map units, NWI mapping, and color aerial imagery in a GIS setting. The GIS and onsite data were used to evaluate existing NWI wetland boundaries and adjust wetland boundaries according to manual visual interpretation. All areas evaluated are within a large unit of organic soil, principally Seeleyville muck, except for a few peripheral locations.

Wetland plant communities were generally mapped using color aerial imagery signature interpretation to establish boundaries between areas with different dominant vegetative cover. Onsite vegetation identification was used to classify the plant community cover types.

Bixby Park is all wetland (Figure 29). No upland inclusions were identified. In general, the wetland-upland boundary follows the 894-foot contour.

Both Type 2 and Type 3 wetlands were identified at the site. This is slightly different from the PEMBd (a hydrologic regime closer to Type 2) characterization in the NWI map. This discrepancy could be due to a difference in the hydroperiod conditions when the NWI interpretations were made. The conditions at the time of wetland delineation sample point data collection were of surface or near surface water throughout the sedge meadow and shallow marsh zones, and absence of surface water in the reed canary grass zone.

Shallow well logs from the time of delineation and into September show a seasonal decline in water level. These data were compared on a 24-hour cycle to precipitation events and suggest a measureable effect of evapotranspiration on the water level. The lateral and main channels had standing or near standing water throughout the time of the Level 1 delineation.

At the Bixby Park area, Seeleyville muck is the predominant soil type, with a lobe of Rifle muck extending in from the east across the channel. Various other mucks and loamy soils fringe the site. Soil boring logs show fibric peat over less dense hemic or sometimes sapric peat down to 5 feet (Appendix H).

8.3 District Tax Forfeit Land

The Tax-forfeit site is approximately 92 acres with an immediate drainage area of 400 acres. It is classified hydrogeomorphically as a depressional/flow-through wetland, with a combination discharge/recharge groundwater interaction. Drainage alteration is estimated to have occurred on 8 acres of an original 100-acrea wetland. MnRAM Assessment was performed using the most recent assessment software version. The shallow marsh and fresh meadow communities assessed rank low for vegetative diversity/integrity.

New onsite data collection included the following at sample points shown in Figure 30:

- USACE three-parameter data
- Color aerial imagery photo-signature ground-truth
- Shallow hydrology monitoring wells

Offsite boundary interpretation used existing elevation data, soil map units, NWI mapping, and color aerial imagery in a GIS setting. The GIS and onsite data were used to evaluate existing NWI wetland boundaries and adjust wetland boundaries according to visual interpretation. All areas evaluated are within a large unit of organic soil, principally Seeleyville muck.

Wetland plant communities were generally mapped using color aerial imagery signatures interpretation to establish boundaries between areas with different dominant vegetative cover. Onsite vegetation identification was used to classify the plant community cover types.

Figure 29. Bixby Park Wetland Plant Communities

Figure 30. Tax Forfeit Site Data Collection Points

The Tax-forfeit Site is mostly wetland (Figure 31). In general, the wetland-upland boundary follows the 891-foot contour.

Both Type 1 and Type 3 wetlands were identified at the site. Delineation sample point locations 1 and 2 are nonwetland according to NWI codes but found to have all three wetland characteristics upon inspection. Point 3 was found to be wetland and is coded by NWI as PEM/SS1B and ditched. The onsite findings for the sample point location old field goldenrod were non-wetland, just as mapped by NWI.

The current conditions show surface or near surface water levels throughout much of the area. Direct observations were made in two sections; one near the lowland hardwood forest stand adjacent to the main channel, and one further upstream and south of 240th Street. Reed canary grass monotypes are unlikely to persist in chronic long-term hydrologic conditions like those observed July 2011[10]. This suggests that the current hydrologic conditions are not indicative of the past conditions in the last few years. Shallow well logs from the time of delineation and into September show a seasonal decline in water level. These data were compared on a 24-hour cycle to precipitation events and suggest a substantial effect of evapotranspiration on the water level. The lateral ditch channels contain dense zones of cattail vegetation and standing water in places. This suggests that the system of lateral ditches impedes flow of surface water from this site. However, the main channel has unimpeded flow.

The Tax forfeit site is almost solely composed of Seeleyville muck. The soil boring logs all show fibric peat over less dense hemic or sometimes sapric peat down to 5 feet.

8.4 River Channel Corridor

The Channel Corridor site (which includes Shallow Pond) is defined as the 50-acre 400 foot wide portion of a larger wetland complex with an immediate drainage area of 650 acres. It is classified hydrogeomorphically as a depressional/isolated wetland, with a combination discharge/recharge groundwater interaction. MnRAM Assessment was performed using the most recent assessment software version. Vegetation assessment was based upon dominant species data generated in the upper section of the site associated with the Tax-forfeit area. The shallow marsh and fresh meadow communities ranked low for vegetative diversity/integrity.

For the Channel Corridor site onsite data collection relied on soil borings records, hydrology monitoring, and limited ground-truth of color aerial imagery photo-signatures.

Offsite boundary interpretation used 1-foot LIDAR elevation data, NWI maps, county soil map units, and color aerial imagery in a GIS setting. Visual analysis was performed to evaluate existing NWI wetland boundaries and adjust wetland boundaries according to indications from onsite data.

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[10] Sheaffer, Craig C. et al. 1990. University of Minnesota Extension Station Bulletin 595 – 1990. http://www.extension.umn.edu/distribution/livestocksystems/DI5533.html (accessed January 31, 2012)

Wetland plant community boundaries were not interpreted for the Channel Corridor site. NWI map adjustments were made within a corridor 100 feet on either side of the channel. The NWI map units showed Type 2 and 3 wetland. This was validated during the upstream area site visit. Wetland vegetation signatures for the Channel Corridor Site were consistent with the field-validated reed canary grass meadow and cattail marsh at the Tax-forfeit site.

Monitoring wells were not installed in the channel corridor site. Soil boring logs validated the Seeleyville muck soil map units.

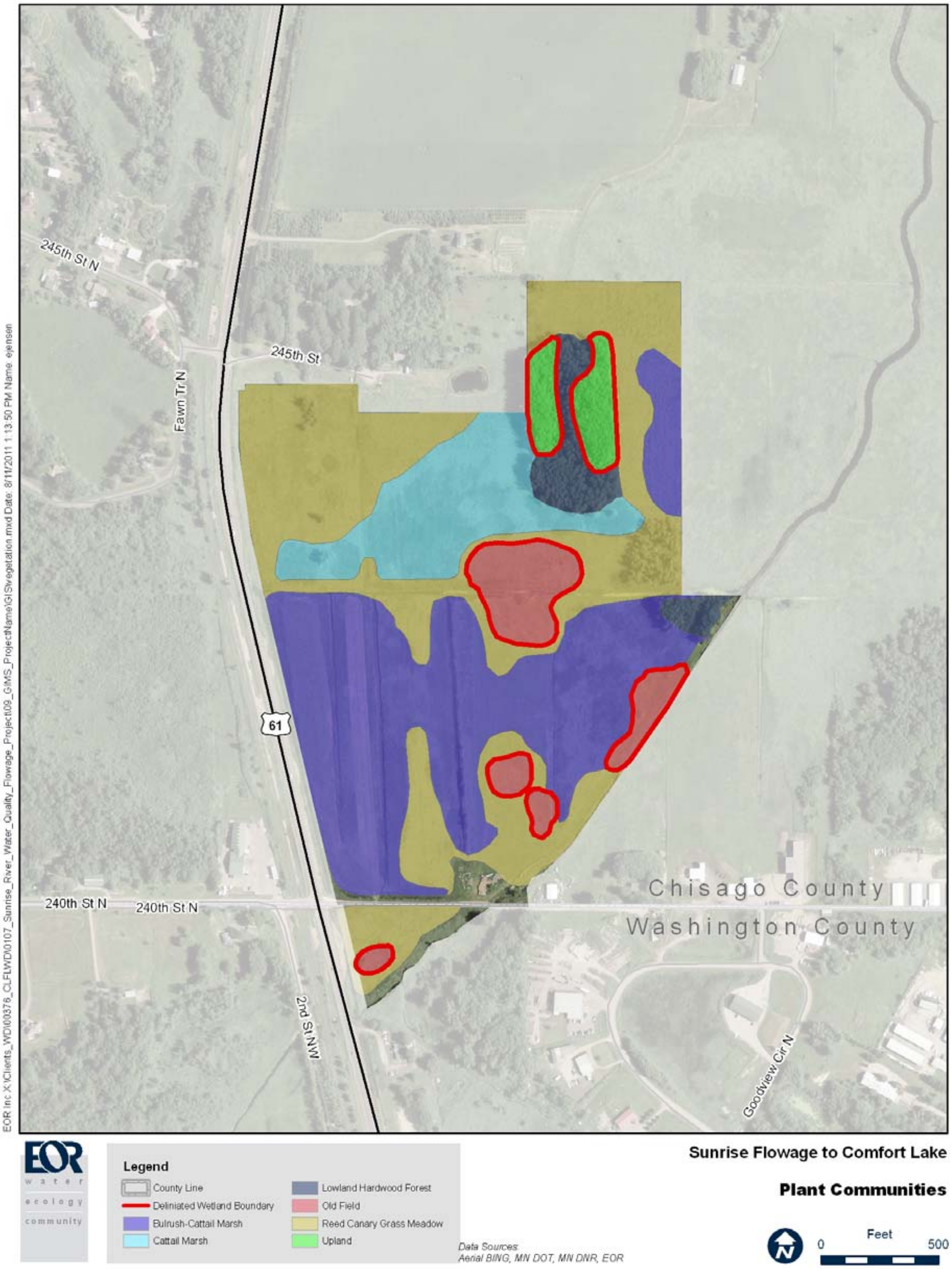

Figure 31. Tax Forfeit Site Wetland Plant Communities

8.5 Conclusions

Level 1 wetland delineation identified all three sites as wetland, predominantly of herbaceous cover, in a geomorphically depressional basin setting. The wetlands have a history of hydrologic disturbance from ditching and partial drainage, and provides a conduit for wetland water flow to the Sunrise channel. Ditching has not effectively drained these wetlands, although predominance of reed canary grass in some portions indicates a history of hydrologic alteration.

Soils were at least 5 feet deep organic material. The Seeleyville series of soil mapped and verified onsite is estimated to contain 10-25 percent mineral material in an otherwise highly decomposed organic soil, with a 5.6 – 7.3 pH range[11]. It is likely that this soil would have relatively low phosphorus sorption compared to hydric mineral soils, partly due to the high organic matter content and partly due to the somewhat acid soil conditions[12].

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[11] Vinar, Kenneth R. 1977. Soil Survey of Washington and Ramsey Counties, Minnesota. Unites States Department of Agriculture, Soil Conservation Service in cooperation with the Minnesota Agricultural Experiment Station.
[12] Janardhanan, L. 2007. Phosphorus Sorption by Soils of the Everglades Agricultural Area. A thesis presented to the University of Florida.

9 SURFACE WATER AND DITCH MODELING

9.1 Updated H/H model

The District's XPSWMM hydrologic/hydraulic (H/H) model was used to evaluate the impact of water quality improvement designs on high water levels. An updated H/H model was developed using survey data collected in this project (see Section 7.6) and integrating this into the most recent District's model versions. Two existing H/H models were combined to establish the base to be updated with the project's survey data. The District's H/H model as updated in 2007 for the Water Quality Study[13] was used as the base model for all parts of the District except those areas upstream of Bixby Park. The H/H model submitted with CLFLWD Permit application #10-009 was used to model areas upstream of Bixby Park because this model incorporated the changes made to drainage and treatment along Broadway Avenue in the City of Forest Lake. These two models were combined and updated with the collected survey data.

Survey data was used to update culvert locations, culvert sizes and invert elevations as well as roadway overtop elevations. Ditch and stream cross-sections and profiles collected in the field were used to update the natural channel cross-sections used in the H/H model and to update channel elevations along the profile. Channel cross sections were established based on survey data from the channel centerline to the top-of-bank and extended to the edge of wetland and adjacent upland based on two foot topography with distances measured in GIS. Modeled channel profiles were established using the surveyed elevations of the channel at the upstream and downstream end of each modeled section.

No other changes were made to the base model except for minor modifications to assist in reducing excessive spikes in flow and peak water surface elevation caused by runoff conditions and runoff node location in the model. The modifications made were: to change the modeled average width of subwatershed CL38 to better reflect actual width and to add dry storage volume in subwatershed FL81 to reflect wetland storage.

The initial conditions of the model were established with lake water levels at the outlet elevation and with wetlands and ditches along the Sunrise River storing water to their outlet elevations. To establish this initial condition, the model was run with no rainfall over 2 months with a constant 0.05 cfs flow through the culvert for the former JD1 under Broadway Avenue (just east of the intersection with I-35). This small constant flow was used only to establish the starting condition and was not included in the rainfall event or continuous event modeling.

Running the updated model for the existing conditions 100-year event, results in water levels along the Sunrise River of ±0.7 feet of the high water levels reported in the original Hydraulic Capacity and Model Calibration Report[14]. The original H/H model reported five water surface elevations in the written report: out of Comfort Lake but upstream of the weir, at the West Comfort Drive Crossing, at the Sunrise River channel midway between 256th and West Comfort Drive, at the 256th Street crossing, and at the Ducharme driveway crossing. The 100-year high water level in the updated model is higher by 0.4 feet at the Sunrise River channel midway

[13] Wenck. 2007. Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capital Improvement Plan. Prepared for the Comfort Lake-Forest Lake Watershed District.
[14] SRF. 2005. Hydraulic Capacity and Model Calibration Report. Prepared for the Comfort Lake-Forest Lake Watershed District

between 256th and West Comfort Drive and is 0.7 feet higher out of Comfort Lake. The modeled 100-year high water level is lower by 0.1 feet at West Comfort Drive, by 0.3 feet at 256th Street crossing, and by 0.4 feet at the Ducharme driveway. These changes represent less than a 1% change in elevation. In addition, the updated model takes into account the current depths of sediment in the culverts and channel and includes culverts along the Sunrise River which were not included in the previous model. This updated model is used to establish the baseline for comparison of the impact of proposed water quality improvements along the Sunrise River and former JD1 (Table 5).

Table 5. Existing Conditions Hydrologic/Hydraulic Model Results

Location*	1-inch Event		2-year Event		10-year Event		100-year Event	
	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)
Comfort Lake Inlet (us)	886.2	39.7	888.0	156.1	889.3	241.1	890.6	344.9
Greenway Avenue (ds)	888.7	41.0	890.3	122.1	891.0	140.7	891.7	156.0
County Line Ditch (ds)	890.3	44.6	891.1	128.5	891.5	156.6	892.1	180.0
Forest Lake Outlet (ds)	899.5	4.0	900.1	23.7	900.6	44.7	901.3	71.8
Bixby Park (us)	893.2	37.5	894.6	72.9	895.1	84.2	895.7	92.5

* Location consistent with monitoring stations: noted as upstream (us) or downstream (ds) side of culvert

9.2 Project Scenario H/H Modeling

The project components were modeled to determine capacity and impact on flood elevations. To support the design process, a number of interim design scenarios were modeled to evaluate which designs best maintain desired water level condition through the system. The results presented in this section combine the McCullough Wetland Enhancement, Bixby Park Water Quality Improvement Wetland, and the Wyoming Wetland Enhancements (Tax Forfeit, Banta, and Ducharme properties). The Shallow Pond component was modeled separately. The following is a summary of modeled scenarios and results as compared to the baseline existing condition (see Section 9.1).

Shallow Pond Scenario

This scenario modeled a weir at the outlet to Shallow Pond with:

- a lowest elevation of 887.5 ft with two foot width,
- expanding to a 10 foot wide opening at 888.5 ft,
- expanding further to a 28-foot opening at 890.0 ft ,
- a 36-foot wide opening at 892.0 ft.

The most noticeable change in this scenario is the higher normal water level set by the lowest elevation of the weir. The expected normal water level in Shallow Pond would increase almost two feet to 897.5 ft from the current control elevation of 885.9 ft.

The few changes in high water level for this scenario as compared to existing conditions were decreases in peak water surface elevation for the 100-year event of 0.1 ft downstream of 256th Street. Within Shallow Pond, peak water surface elevations are modeled as increasing by 0.1 feet for the 2-year and 10-year events. See Table 6 for additional results.

Table 6. Sloping Weir Outlet for Shallow Pond Scenario Hydrologic/Hydraulic Model Results

Location*	2-year Event		10-year Event		100-year Event	
	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)
Comfort Lake Inlet (us)	887.9	142.0	889.2	237.1	890.5	335.3
Greenway Avenue (ds)	890.4	119.1	891.1	138.9	891.8	155.2
County Line Ditch (ds)	891.1	128.4	891.5	156.6	892.1	179.8
Forest Lake Outlet (ds)	900.1	23.7	900.6	44.6	901.3	72.0
Bixby Park (us)	894.6	72.9	895.1	84.2	895.7	92.5

* Location consistent with monitoring stations: noted as upstream (us) or downstream (ds) side of culvert

Wyoming, Bixby & McCullough Project Components Scenario

This scenario modeled the proposed project components of the McCullough Wetland Enhancement, Bixby Park Water Quality Improvement Wetland, and the Wyoming Wetland Enhancements (Tax Forfeit, Banta, and Ducharme properties).

The most noticeable changes under this scenario would be higher normal water levels in the McCullough wetland, Bixby Park, and the Wyoming wetlands. The normal water level in the McCullough site would increase by almost three feet to 893.5 ft. The normal water level in the wetland on the west side of the ditch in Bixby Park would have a normal water level of 891 ft, about two feet over the current estimated normal water level. The northern Tax Forfeit site would have a normal water level of 891, an increase of about three feet.

This scenario shows decreases in peak elevations along the Sunrise River and JD1 as a combined effect of the project. The model predicts a decrease of about 1.5 feet in peak water surface elevation during a 100-year event at a number of points along the former JD1 and Sunrise River between Highway 8 and the Ducharme driveway culvert. A 0.2 foot decrease in 100-year high water levels is also estimated for the former JD1 between Broadway and the south end of Bixby Park. A 0.3 foot increase in peak water surface elevation is estimated for the 100-year event for the western portion of the Ducharme property component of the Wyoming Wetland Enhancements. See Table 7 for additional results.

Table 7. Project Conditions Hydrologic/Hydraulic Model Results

Location*	1-inch Event		2-year Event		10-year Event		100-year Event	
	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)	Peak Water Elevation (ft)	Peak Flow Rate (cfs)
Comfort Lake Inlet (us)	886.0	30.7	887.9	148.9	889.2	233.3	890.5	338.0
Greenway Avenue (ds)	888.4	21.1	889.7	92.3	890.8	149.5	891.7	187.4
County Line Ditch (ds)	889.5	11.4	890.9	57.1	891.4	96.9	892.1	123.5
Forest Lake Outlet (ds)	899.5	4.0	900.1	23.7	900.6	44.7	901.3	72.0
Bixby Park (us)	892.7	25.8	894.1	64.9	894.9	77.6	895.5	86.9

* Location consistent with monitoring stations: noted as upstream (us) or downstream (ds) side of culvert

9.3 Water Quality Modeling

Water quality modeling was conducted to evaluate the impact of the proposed project components toward reducing the nutrient and sediment load to Comfort Lake. The water quality modeling effort for this feasibility study and engineer's report uses both the District's existing water quality model and a water quality model called P8.

The District has a spreadsheet-type water quality model that evaluated the watershed and internal loading to the six main recreational lakes in the District[15]. The model was used to determine load reductions needed to attain goal water quality in Comfort Lake and a number of other lakes in the District. This watershed-wide model was also used as the basis for the Total Maximum Daily Load study conducted by CLFLWD and the Minnesota Pollution Control Agency to support the MPCA's regulatory programs for impaired waters[16]. The District model defines watershed loading rates using unit area loads that differ for various land use types. The total load in a subwatershed is estimated as the sum of the pounds of phosphorus estimated for each contributing land use type. The model then sums the total load to each lake and uses lake phosphorus dynamics equations to estimate the impact on the lake and the downstream outflow from each lake. Shallow Pond is incorporated into this model as a small shallow lake. The District-wide model was used in this study to estimate the water quality impact of modifications to Shallow Pond and to "calibrate" loading rates for the P8 model.

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[15] Wenck, 2007. Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capital Improvement Plan. Prepared for the Comfort Lake-Forest Lake Watershed District.

[16] Emmons & Olivier Resources Inc., 2010. Comfort Lake-Forest Lake Watershed District Six Lakes Total Maximum Daily Load Study. Prepared for the Comfort Lake-Forest Lake Watershed District and the Minnesota Pollution Control Agency.

The Shallow Pond Restoration project component was modeled as an increase in average depth in the wetland of 1.5 feet. In the existing District-wide model, Shallow Pond is modeled as having an average depth of 1 foot. The restoration model increases the average depth to 2.5 feet. The resulting increase in total phosphorus load reduction is 234 lb/yr in an average year. Upstream project components were not included in this model, so this reduction estimate would likely be somewhat lower within Shallow Pond if the upstream project components were taken into account. The District-wide model does not include suspended solids in the model, so the total suspended solids reduction from the Shallow Pond portion of the project was not estimated.

The P8 model was developed for this study to evaluate the impact of project components that were not included in the existing District-wide model: the Bixby Park Water Quality Improvement Wetland, the Wyoming Wetland Enhancement, and the McCullough Wetland Enhancement. The P8 model estimates the runoff of nutrients, metals, and solids from watersheds and estimates the capture of these compounds in ponds, swales, and infiltration basins. The impervious surface coverage of each contributing watershed was used as the “calibration” factor to define the watershed phosphorus loads in the P8 model. The total phosphorus load to each project component was calibrated to within 5% of the load estimated in the District-wide unit area loading model. For the project scenario, the calibration assumed that 20% of the load through the former JD1 from upstream of Broadway Avenue was directed to the McCullough site and 80% was directed to the Bixby Park site. Each project component was modeled as a pond with the outlet as the primary weir designed.

For the existing condition P8 model, the calibration assumes all load from JD1 upstream of Broadway is directed to the Bixby Park site and that the Forest Lake outflow does not interact with the sites of project components. The sites of future project components are modeled with wide weirs as outlets at the lowest storage elevation in the pond.

Existing and project component results were compared to determine the additional benefit expected with the project. The results of these modeling efforts are summarized in Table 8.

Table 8. Water Quality Modeling Results

Project Component	Estimated TP reduction lb/yr (above existing reductions)	Estimated TSS reduction lb/yr (above existing reductions)
Shallow Pond Restoration	234 lb/yr	not calculated by model
Wyoming Wetland Enhancement	109 lb/yr	52,477 lb/yr
Bixby Park Water Quality Improvement Wetland	206 lb/yr	55,458 lb/yr
McCullough	54 lb/yr	24,232 lb/yr

9.4 Lateral Effect of Ditches

Lateral effect modeling was planned in order to evaluate the impact of water level changes on wetland hydrology. However, the wetland monitoring results showed that a lateral effect model is not applicable to the conditions observed in these wetlands. Typically, the effect of a ditch functions to drain the adjacent wetlands by lowering the water surface profile through the wetland and into the ditch. In this typical situation the observed water levels decrease closer to the ditch. The wetlands in Bixby Park and the tax forfeit property were monitored for groundwater level in a number of shallow wells (see also Section 8). These wells often showed water levels that were higher in the ditch than in the adjacent wetland, the opposite of what would be expected in a ditch that was functioning to drain the adjacent wetlands.

In Bixby Park the four monitored wells (Figure 28) indicated a number of instances in late August through November where the water level in well #4, located just north of a branch of the ditch, had lower water levels than the adjacent ditch. Late in the monitoring season (October – November) there were a few instances where water levels in the monitoring wells south of the branch ditch were also slightly lower than the water level in the ditch itself (Figure 32).

The four monitored wells installed at the tax forfeit property (Figure 30) had water levels that were regularly lower than those measured in the ditch (Figure 33 - Figure 35). Wells 5, 6, and 8 didn't show any monitored water levels that were higher than those in the nearest ditch. In July and August when water levels were above the ground surface at well 5, water levels in the lateral ditch itself were still a bit higher than those in the wetland (Figure 33). Well 7, nearer to the east-west running lateral ditch than well 8, showed times in July and August where water levels were higher in the wetland than in the ditch (as would be expected by lateral effect), but later in the season (late August – November) water levels in the wetland were lower than in the ditch (Figure 34).

The monitoring results indicate that these wetland-ditch systems are not functioning as would be expected under a lateral effect model. The results demonstrate that water that is confined to the ditch under existing conditions and that the adjacent wetlands are utilizing available water for evapotranspiration resulting in reduced water levels in the wetland than in the ditch. This situation implies that if the water that is currently confined to the ditch were distributed through the adjacent wetlands, the wetlands would be able to uptake the water through evapotranspiration.

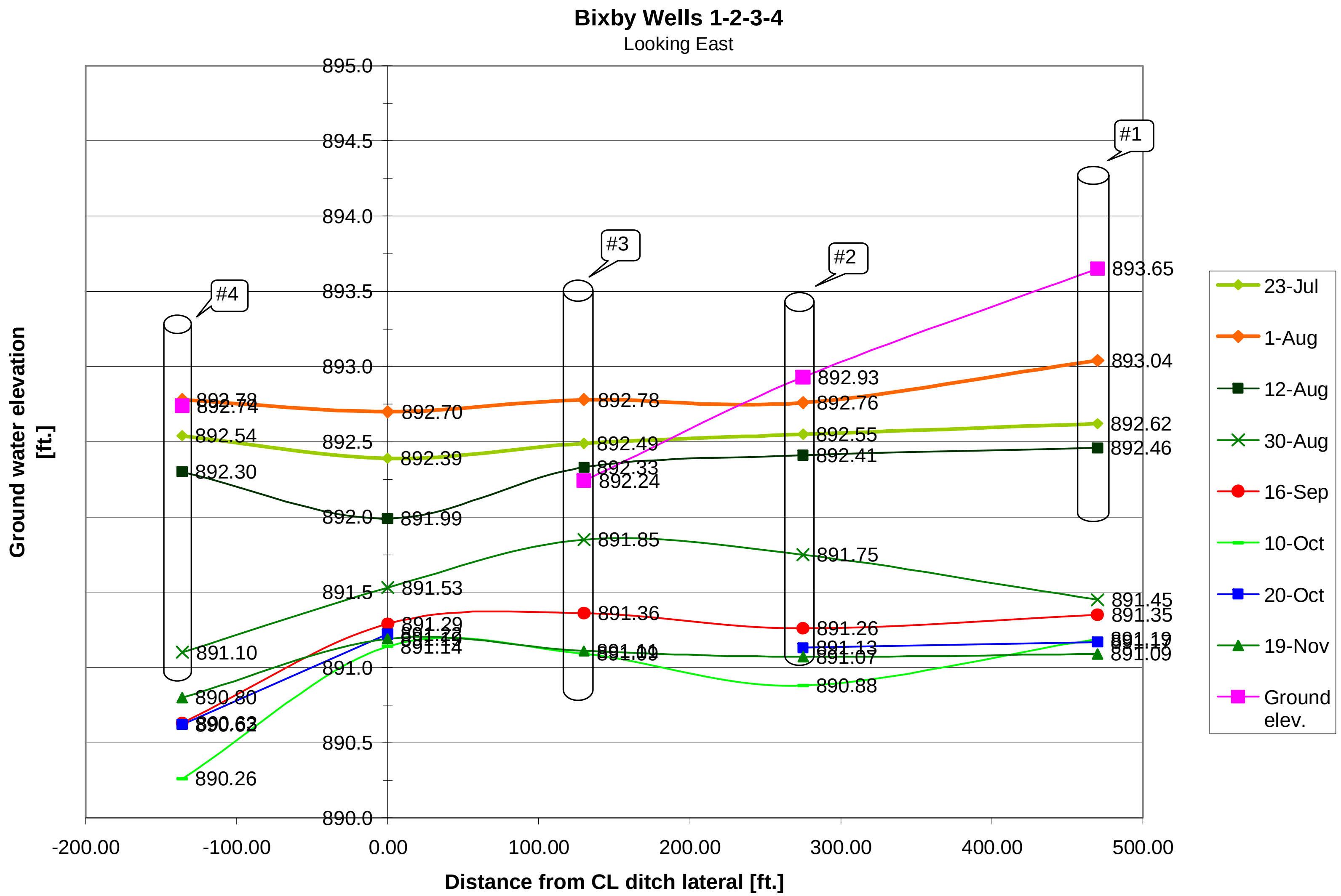


Figure 32. Bixby Park Ditch Lateral Effect Cross-Section from Monitored Water Levels

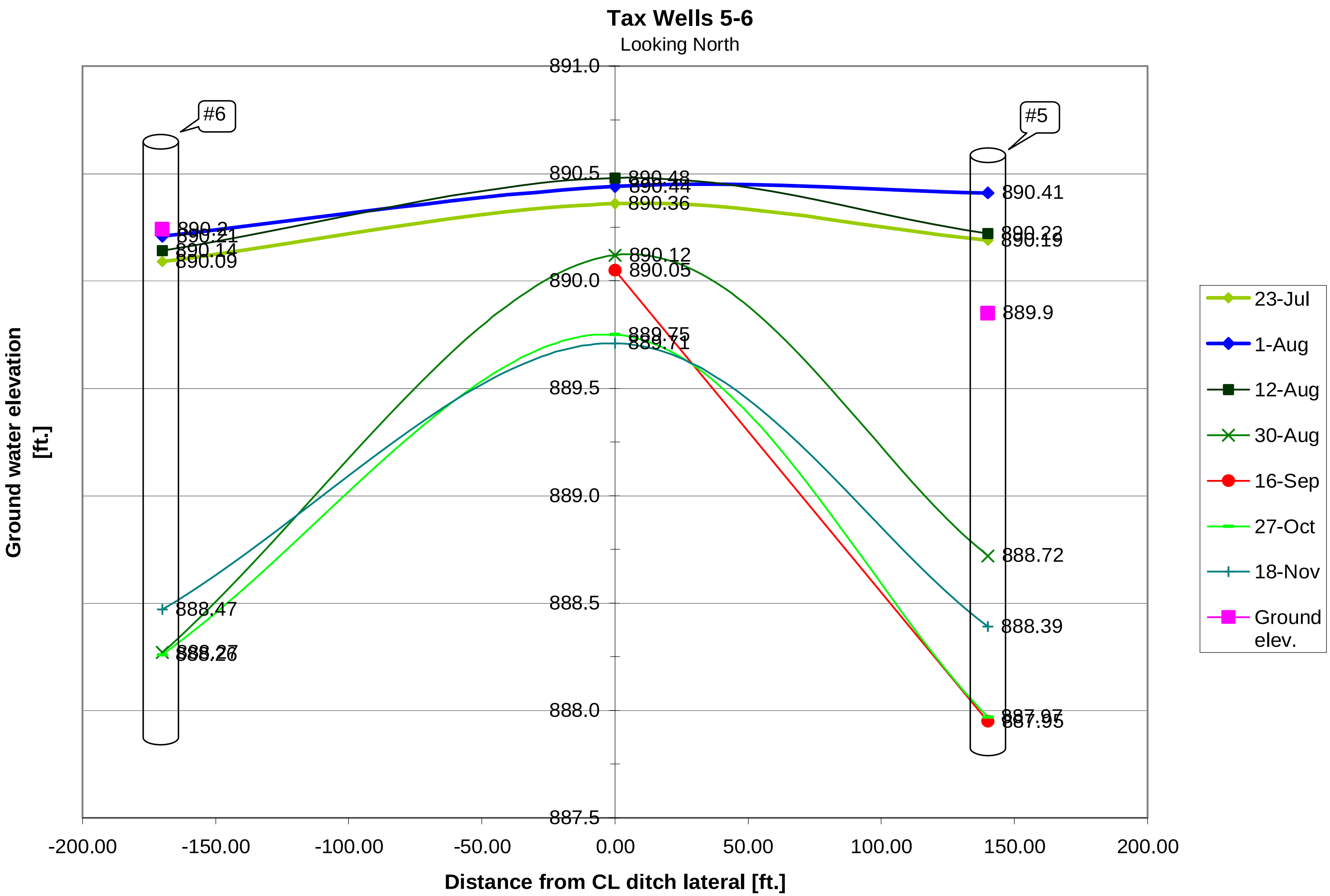


Figure 33. Tax Forfeit Property Ditch Lateral Effect Cross-Section for Wells 5 & 6 from Monitored Water Levels

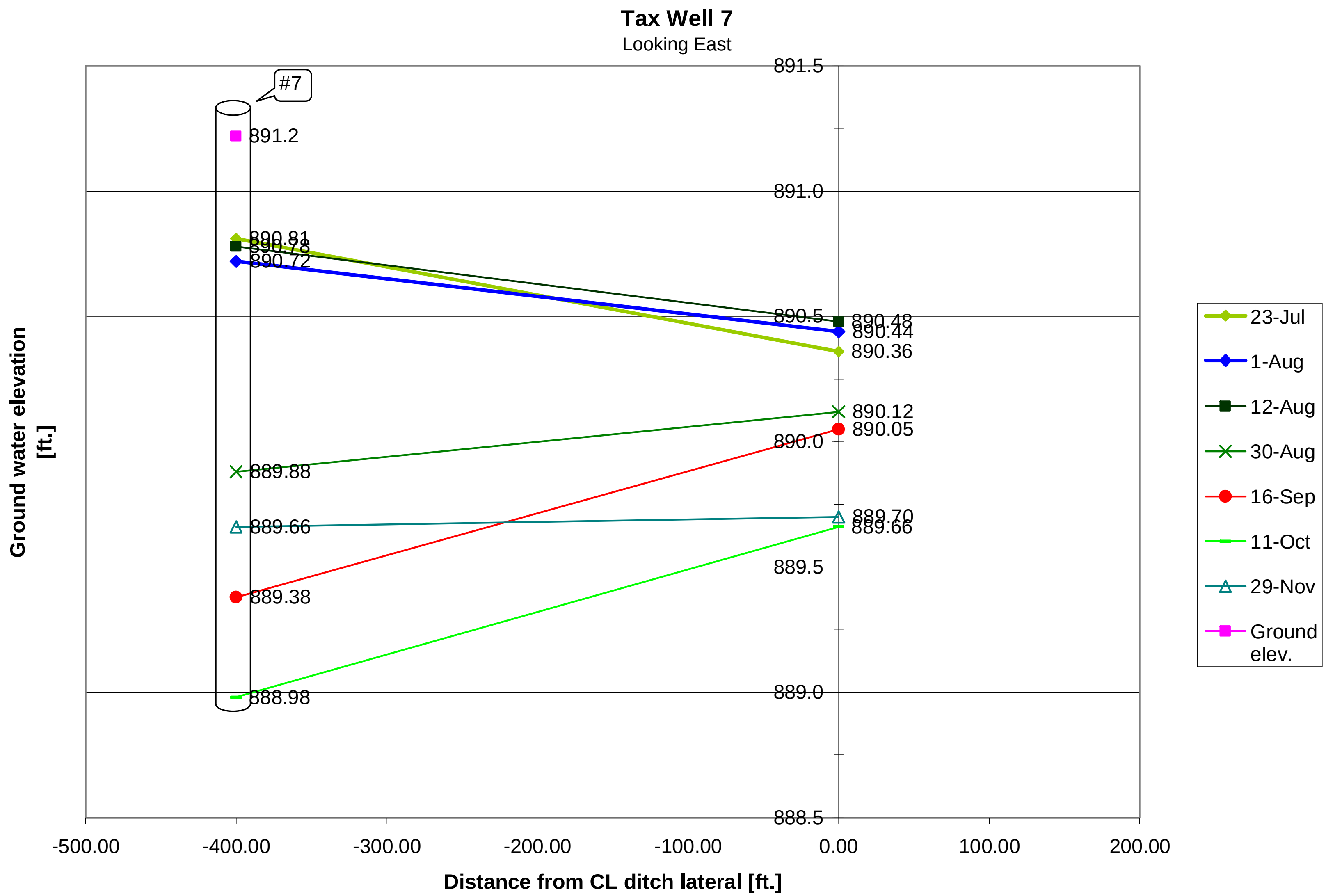


Figure 34. Tax Forfeit Property Ditch Lateral Effect Cross-Section for Well 7 from Monitored Water Levels

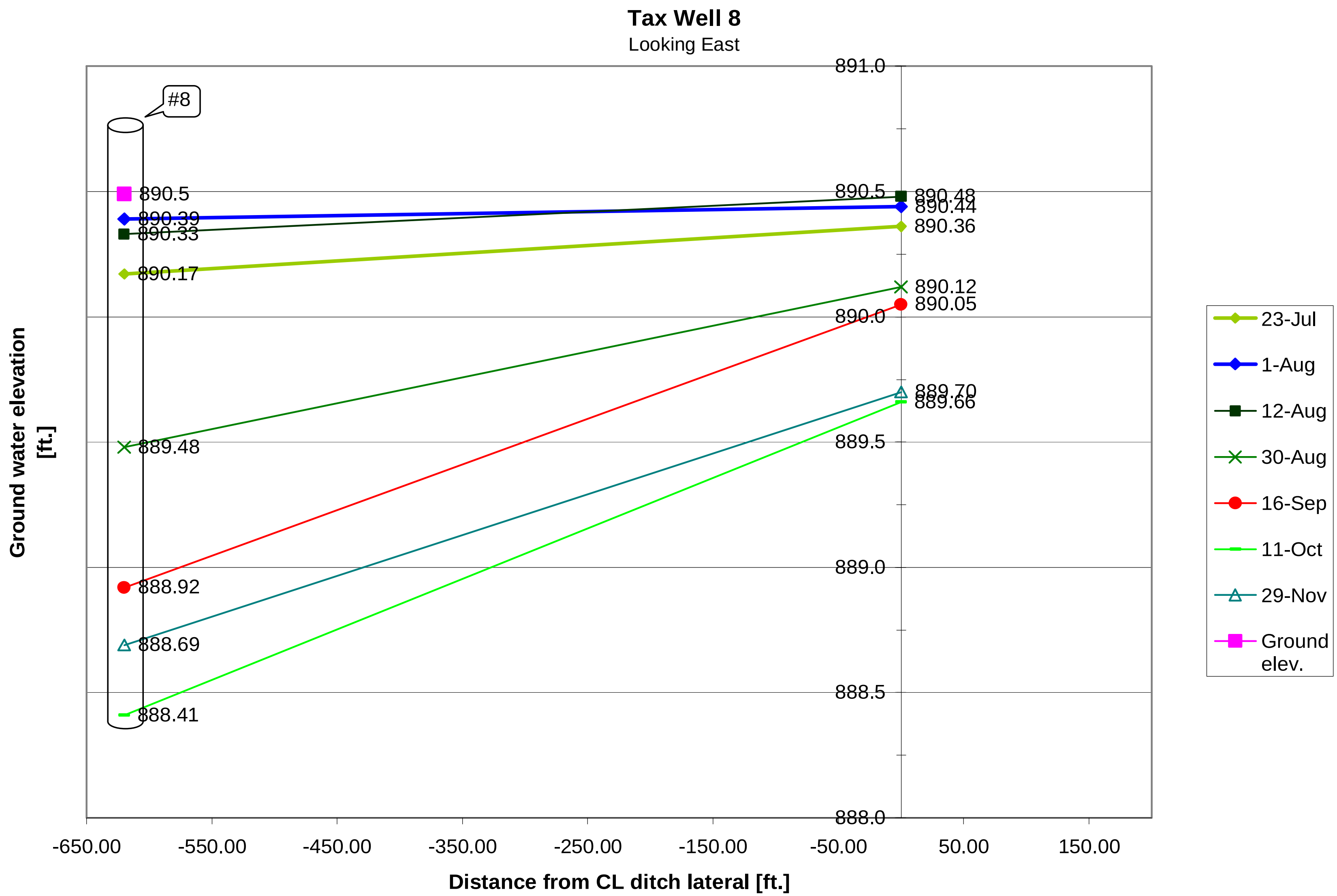


Figure 35. Tax Forfeit Property Ditch Lateral Effect Cross-Section for Well 8 from Monitored Water Levels

10 FEASIBILITY ANALYSIS RECOMMENDED PROJECT COMPONENTS AND PRELIMINARY DESIGN

The scope of work for the feasibility analysis and design phase of this project included an evaluation of several components including modifications to the floodplain corridor between Greenway Avenue and Highway 61, water quality improvements at the District Tax Forfeit Property (including adjacent private properties south and east of Tax Forfeit property) and Bixby Park as well as consideration for carp management throughout the project area. The floodplain corridor area was expanded downstream to 256th Street to include the Shallow Pond Area. This was done as a result of observations during the investigations into the flood plain corridor noting that restoration of Shallow Pond Outlet would likely be the most cost effective option for accomplishing the objectives of the flood plain corridor portion of the project. Subsequent hydrologic modeling indicated that the outlet restoration could be accomplished with minimum impacts to the upstream 100-yr flood elevations. Likewise, the analysis for the Bixby Park Area was expanded upstream to include the McCullough Property when the property owner indicated an interest in selling the property to the District. The preliminary designs for the project components proposed at the added Shallow Pond and McCullough areas are not as fully developed as the project components defined in the original work scope. Figure 36 identifies the locations of the four project areas which are described as *Bixby Park Water Quality Improvement Wetland (also includes McCullough Property), Wyoming Wetland Enhancement (Banta, Ducharme & District Tax forfeit), Shallow Pond Restoration*. The various data collection and analysis efforts previously described in this report were used to both develop various project alternatives for each of the project sites and to help evaluate the feasibility of each. Criteria considered in analysis of the feasibility and prioritization of each of the options considered included the following:

- Reduction in nutrient, sediment and other pollutant loads to Comfort Lake.
- Project should not significantly increase the 100-yr 24-hr flood profile outside of the project areas. *The existing condition ditch profile (included surveyed sediment depths at culverts) was used to establish the existing 100-yr flood profile.*
- Maintain the normal water level of the main channel to not adversely impact flood storage and treatment capacities of upstream stormwater facilities. *Critical elevations upstream of Broadway Avenue are the 891.3 invert elevation at the upstream end of the Broadway Avenue culvert and 891.7-ft, which is the normal water level for the Wal-Mart ponds. The 894.0 invert elevation of the perforated subsurface drain outlet of the 8th Street Filtration Basin was also a constraint. Impacts to the function of other proposed project components were also considered.*
- Expected water quality benefit
- Expected flood reduction benefits
- Constructability of proposed project component
- Positive or negative impacts to wetlands
- Relative costs of project (i.e. excavated storage volume is typically more expensive than storage volume created by constructing impoundments).
- Current public land ownership of project and affected areas.
- Potential for habitat enhancement.

EOR water ecology community

Legend

County Line

Parcel

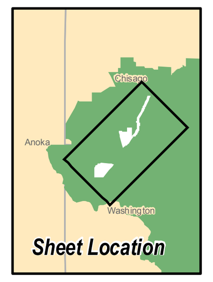
Public Parcel by Owner

Comfort Lake Forest Lake Watershed District

Duluth Audubon Society and Wild River Audubon Society

City of Forest Lake

Data Sources:
Comfort Lake forest Lake Watershed District
Emmons & Olivier Resources, Inc.
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Land Management Information Center
Date of Photography: 2010



Sunrise Flowage to Comfort Lake

Concept Design

Index Sheet

Feet
0 500 1,000

Figure 36

Once a project component idea was developed and a sketch plan prepared, it was reviewed with the appropriate project team members and qualitatively evaluated against the criteria mentioned above. Based on this evaluation, components were either dropped or modifications were made to the concept design and another iteration of review and analysis was conducted. This process continued until the most feasible components for each of the sites were determined. The following describes the recommended projects components, listed in order from downstream to upstream:

10.1 Shallow Pond Restoration

Project Summary

The purpose of project components considered for the Shallow Pond Restoration is to address on a regional scale the physical condition and biological properties of the system of wetlands between Forest Lake and Comfort Lake. The main focus of the recommended project component, (refer to Figure 37), includes modifications to increase the stream interaction with the floodplain to allow for improved settling of particulate phosphorus (and other sediments) and uptake of dissolved phosphorus by the wetland vegetation rather than their transport within the channel. The recommended project components help restore the flow interaction with the stream and riparian wetlands upstream of 256th Street by raising the stream profile through restoration of Shallow Pond's outlet to its approximate historic outflow elevation (limited by upstream flooding concerns) and to a lesser extent blocking existing lateral ditches that are no longer needed.

Preliminary Design of Recommended Project Components

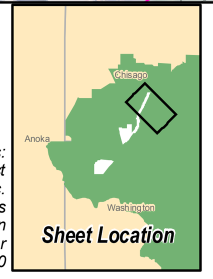
Based on the review of historic survey information presented in Section 7.7, the historic outflow elevation of Shallow Pond was lowered approximately 4-ft by the construction of Judicial Ditch No. 1. The recommended design will restore the outflow elevation through construction of a series of grade control structures (rock checks) to raise the outlet elevation of Shallow Pond, at the existing trail culvert, approximately 2-ft to 4-ft to elevation 887.5 to 889.5. The rock grade control structures were chosen for their more natural look and ability to maintain fish passage through the structure. An alternative to this design would be a simple sheet pile weir if a fish barrier was found to be more suitable. A low flow outlet is provided to allow Shallow Pond to slowly drain down a maximum of approximately 2-ft between storm events. This outlet scenario will force interaction of runoff flows with the Shallow Pond Wetland vegetation, causing sediments to be trapped and filtered out. Allowing the wetland to drain down somewhat between events lets treated water pass downstream providing storage in Shallow Pond to accommodate the next runoff event. The net 2-ft raise in the Shallow Pond outlet elevation will help keep wetland soils from drying out between summer rain events, minimizing the potential for wetland soils to oxidize and release nutrients in subsequent precipitation events. The majority of the Shallow Pond wetland ground elevations are between elevation 888.5 and 889.5, with access to the wetlands starting once the ditch water surface elevations exceed 887.5 to 888.0. Therefore, the proposed outlet structure will allow more frequent summer rainfall events to access the Shallow Pond wetland vegetation but not result in significant fluctuations in water levels and duration for the majority of the Shallow Pond wetland area. In addition to the 2-ft drain down, a pipe and valve could be incorporated into the outlet structure to allow draining down the ditch to the existing bottom elevation, if required for future maintenance needs.

EOR water ecology community

Legend

Surface Waterway	**Existing**	**Future**	**Proposed**
Parcel	DITCH-TOP	10' Index Contour	Rock Check
10' Index	DITCH	2' Intermediate Contour	Ditch Centerline
2' Intermediate	Utility STORM		River Centerline
Existing Culvert			10' Index Contour
			2' Intermediate Contour
			Utility Storm

Data Sources:
Comfort Lake forest Lake Watershed District
Emmons & Olivier Resources, Inc.
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Land Management Information Center
Date of Photography: 2010



Sunrise Flowage to Comfort Lake

Shallow Pond Area

Concept Design

Feet
0 200 400

Figure 37

Additional project components include plugging of lateral ditches that no longer have drainage benefits or only have limited drainage benefits and removal of targeted spoil embankments along main channel and lateral ditches as needed to improve interaction with riparian wetlands. These components are also incorporated into Wyoming Wetland Enhancement, Bixby Park and McCullough project areas.

Anticipated Water Quality Benefits

The anticipated water quality benefits for the Shallow Pond project component are increased stream interaction with the wetland vegetation, allowing for improved settling of particulate phosphorus (and other sediments) and uptake of dissolved phosphorus by the wetland vegetation rather than their transport within the channel. This component is estimated to provide 234 lbs/yr of phosphorus removal, assuming an average depth of about 2.5-ft.

Carp Management

The Shallow Pond area is located relatively close and is directly connected to Comfort Lake. According to 2010 Minnesota Department of Natural Resources fish surveys, carp were present in Comfort Lake. The potential of a water depth increase resulting from outlet modifications to Shallow Pond may enhance fish spawning potential and most notably carp. Therefore, a fish barrier may be a consideration in the final structure design to exclude the carp from the project area during their spawning season. If the control structure for this project is designed to allow fish passage, a temporary fish barrier with an operation plan can be designed so it is only in place during the specific times of the year coinciding with the carp spawning period. Otherwise, a permanent fish barrier can be designed as part of the control structure.

Education and Recreation Opportunities

Currently Shallow Pond has relatively limited public access. A large portion of the site is owned by the Audubon Society and access is limited to walking trail and small overlook point. Connecting Shallow Pond to a regional trail corridor will take future planning efforts by local authorities. More immediate educational and recreational opportunities for the site include walking paths and wildlife viewing. Depending on the future design of the Shallow Pond outlet, a fisheries amenity may be incorporated which could increase public interest in the area. Due to the “neighborhood” park feel of the residential area and limited parking, this site does not likely support high human use. From an educational perspective, shallow pond restoration and resulting water quality improvements to Comfort Lake, could be an interesting public signage topic.

Land Acquisition Needs

Final land acquisition will be determined after final design. In general, modeling efforts for the Shallow Pond project component show no increase in 100-yr 24-hr flood elevations upstream of the Greenway Avenue monitoring station. The project component will increase the depth and duration of flooding from the more frequent storm events (2-yr and less). The 890.0 contour outlines this area. Upstream of Highway 61 that area is contained within the existing ditch banks and there is no increase in the 2-yr event.

Costs

The estimated cost for construction of the Shallow Pond project component is $107,000. An additional $205,000 is assumed for land and flowage easement acquisition. Legal, engineering final design, construction administration, and permit related expenses are estimated as $43,500. These costs for the project total as $355,500. Not included in this estimate are anticipated costs for administrator time and future maintenance and operations.

Permit Requirements

The Permits will be required from the MNDNR, Corps of Engineers, MPCA, County and Township/City for implementation of the Shallow Pond project component.

10.2 Wyoming Wetland Enhancement

Project Summary

The purpose of project components considered for the Wyoming Wetland Enhancement (Banta, Ducharme & District Tax Forfeit) is to address on a sub-regional scale water quality improvements for the Heims Lake area drainage. An additional project component is to divert flows from JD#1 upstream of the confluence with outflows from Forest Lake and into a restored wetland flowage located on the Ducharme property boarding the south property line of the District Tax Forfeit property. The main focus of the recommended activities (refer to Figure 38) is to restore the natural treatment capabilities of the wetland system. The recommended activity diverts flow from Heims Lake out of the existing drainage ditch system at the Highway 61 culvert and diffuses the flow into the wetland complex located on the District Tax Forfeit property. Included in the project is an enhancement of the existing spoil berm along the south property line separating flows from the existing lateral ditch and a constructed berm along the east property line. Both of these help retain water on the Tax Forfeit Wetland complex upslope from the main channel of JD#1. This project also takes advantage of the wetland vegetation's evapotranspiration abilities that were identified during wetland water level monitoring. The second project component diverting JD#1 flows into the restored wetland flowage on the Durcharme property will provide additional treatment for the JD#1 flows while allowing the relatively cleaner flows from Forest Lake to go directly downstream.

Preliminary Design of Recommended Projects

Divert flows out of the existing ditch from Heims Lake at the Highway 61 culvert and into the wetland complex on the Tax Forfeit Land by modifying the existing ditch to remove spoil piles and spread out flows across the wetland. The existing spoil berm along the south property line will be enhanced and a new berm along the east property line will be constructed to complete the impoundment of water on the Tax Forfeit Land. The top of the berm is set at elevation 892.0 with an overflow section at 891.0.

The next part of this project component is to extend the separation berm east to the main channel and then north along the west side of the JD#1 channel on portions of the Banta, Vandaalen and Carlson properties, eventually tying back into high ground. This phase proposes one-way flow structures to allow flows from the JD#1 channel into the wetlands and then a restricted outlet back into the main channel along the alignment of what appears from some aerial photos to be a remnant stream channel. Outflow from the Tax Forfeit property would also filter through this wetland and outlet. If the private properties for this phase can be obtained prior to construction on the Tax Forfeit property there is a potential to eliminate the proposed berm on the east property line of the Tax Forfeit property.

Legend

Parcel	**Existing**	**Future**	River Centerline
County Line	Ditch Top	10' Index Contour	10' Index Contour
Proposed Berm	Culvert	F-LF-C-MNR	2' Intermediate Contour
Iron Enhanced Sand Filter	Ditch	**Proposed**	Utility Storm
10' Index	Spoil Berm	Ditch Centerline	
2' Intermediate		Ditch Top	

Data Sources:
Comfort Lake forest Lake Watershed District
Emmons & Olivier Resources, Inc.
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Land Management Information Center
Date of Photography: 2010

Sheet Location

Sunrise Flowage to Comfort Lake

Wyoming Wetland Enhancement Area

Concept Design

Feet
0 200 400

Figure 38

The other component of this project includes diverting a portion of the flows from the main channel of JD#1 at the point just upstream from the confluence with the channel delivering Forest Lake outlet flows. Flows are diverted into a restored wetland flowage located on District owned property and the Ducharme Property for treatment and storage. This option allows the relatively cleaner flows from Forest Lake to go downstream while providing additional treatment for the relatively higher nutrient concentration flows from the City of Forest Lake. The diversion structure is sized to restrict (but not totally prevent) main channel flows from passing downstream, causing them to flow north into the restored wetland flowage previously mentioned. This is to allow the upstream main channel to still drain down between storm events and to minimize potential impacts to function of proposed projects for Bixby Park. Portions of the Durcharme property are occasional hayed during periods of dryer weather. This project will require about half of the Ducharme Property on the west side of the ditch for restoration of the wetland flowage and potentially make the remaining property somewhat wetter for longer periods of time. The remaining property could then be used as a working wetland. The project also proposes to enhance (slightly raise) the existing north south ridge on the east half of the property to create a berm keeping water in the restored wetland flowage and preventing flows from short circuiting across the field and back into JD#1. One example (not included in this project) of how the working wetland concept could be implemented is by installing filter trenches and a sump pump to allow the fields to be pumped down through the filter trenches in the fall to allow harvesting of grass hay (removing the associated nutrients from the system). The District could also use this area as an outdoor laboratory to test different methods for using the wetland to produce a harvestable income-producing crop while still removing nutrients from the system.

Anticipated Water Quality Benefits

The anticipated water quality benefits for the Wyoming Wetland Enhancement project component are due to a restoration of the natural treatment capabilities of the wetland system allowing for increased interaction with the wetland vegetation, improved settling of particulate phosphorus (and other sediments) and uptake of dissolved phosphorus by the wetland vegetation rather than their transport within the ditch channel. This component is estimated to provide 139 lbs/yr of phosphorus removal.

Carp Management

It is unknown if there are carp present in Heims Lake but because they are found in other connected waters it must be assumed that carp could be found in Heims Lake. This project will diffuse the water coming from Heims Lake through the existing ditch over the Tax Forfeit wetland complex. The present design will only allow for ponding of 1-ft of water on the site with interruptions due to the natural topography of the site. This project should interrupt any possible movement of carp that may be in Heims Lake.

Part of the project operation plan should involve monitoring if carp are present in the project area. If it is found that carp are still able to pass through the project site or utilize the project area, fish barriers may need to be added to the project.

Education and Recreation Opportunities

This site provides an excellent opportunity for passive park use and potentially a loop trail off of the adjacent regional trail on the west side of Highway 61. Primary uses of this area are projected to be walking paths and wildlife viewing in the restored wetland basins. Parking currently does not exist for this site so use may be limited until accessibility is enhanced. Since these wetlands are being restored and enhanced to provide water quality improvement and wildlife habitat, an interpretive sign would be a recommended addition to a designated trail head if constructed in the future.

Land Acquisition Needs

Final land acquisition will be determined after final design. The major project components will be constructed on the existing Wyoming wetland properties, the Ducharme property, the Banta Property, the Vandaalan property and the Carlson property. Blockage of an existing lateral ditch is also proposed on the property owned by Wyoming Enterprises, LLC. Modeling indicates that there is an existing building that appears to be constructed within the existing 100-yr. floodplain in the area upstream and west of the Hwy. 61 culvert. Verification of building's floor elevations is needed as part of the construction of this component. If the building is verified to be constructed bellow the existing 100-yr. floodplain in the area, it is recommended to upgrade the existing culvert under the trail (immediately upstream of the Hwy. 61 culvert) as part of this project component.

Costs

The estimated cost for construction of the various Wyoming Wetland Enhancement project components is $2,036,000. An additional $245,000 is assumed for land and flowage easement acquisition. Legal, engineering, final design, construction administration, and permit related expenses are estimated as $113,500. The cost to complete the project totals an estimated $2,394,500. Not included in this estimate are anticipated costs for administrator time and future maintenance and operations.

Permit Requirements

Permits will be required from the MNDNR, Corps of Engineers, MPCA, County and Township/City for implementation of the Wyoming Wetland Enhancement project component.

10.3 Bixby Park Water Quality Improvement Wetland

Project Summary

The purpose of activities considered for the Bixby Park Area is to address on a sub-regional scale water quality improvements that address the somewhat more concentrated flows from the Bixby/McCullough area drainage (primarily from the City of Forest Lake) that was identified in the modeling and monitoring results. The main focus of the recommended project (refer to Figure 39) is to enhance the water quality treatment and storage capabilities of the existing Bixby Park Ponds and associated wetlands.

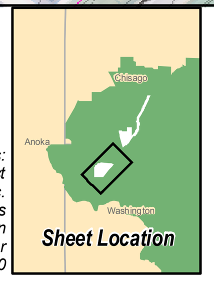
Critical elevations for this design are upstream of Broadway Avenue, the 891.3 invert elevation at the upstream end of the Broadway Avenue culvert and 891.7-ft, which is the normal water level for the Wal-Mart ponds. 890.7 is the invert of the 48-in culvert just upstream of the diversion. The 894.0 invert elevation of the perforated subsurface drain outlet of the 8th Street Filtration Basin was also a constraint.

EOR water ecology community

Legend

	Existing	Future	
Parcel	Ditch Top	10' Index Contour	River Centerline
County Line	Culvert	F-LF-C-MNR	10' Index Contour
Proposed Berm	Ditch	**Proposed**	2' Intermediate Contour
Iron Enhanced Sand Filter	Spoil Berm	Ditch Centerline	Utility Storm
10' Index		Ditch Top	
2' Intermediate			

Data Sources:
Comfort Lake forest Lake Watershed District
Emmons & Olivier Resources, Inc.
Minnesota Department of Natural Resources
Minnesota Department of Transportation
Minnesota Land Management Information Center
Date of Photography: 2010



Sunrise Flowage to Comfort Lake

Bixby Park - McCullough Area

Concept Design

Feet
0 200 400

Figure 39

Preliminary Design of Recommended Projects

The preliminary design of recommended projects includes the following items:

- Plug existing lateral ditch out-letting the Bixby Park Pond.
- Construct new secondary main ditch diversion berm at connection with existing lateral ditch outlet from Bixby Pond.
- Enhance existing spoil embankment between new diversion into Bixby Park Pond and the Highway 8 road embankment to prevent short circuiting of flows, and to the provide additional water quality treatment and storage (contained on the west side of the JD#1 channel while not impacting private property drainage on the east side of the main channel).
- Install a control structure with an adjustable weir at the northern ditch lateral outlet connecting back into the main channel. The Control structure will provide the ability to control Bixby Park Pond Elevations between 890.0 and 893.0 as well as control discharge rates for the smaller storm events. Normal operation of the control structure will have all stop logs in at least one bay, removed prior to winter freeze up. Stop logs would then be replaced following spring runoff to the desired summer operation level. Pervious stop logs can be incorporated into the control structure to provide a slower draw down allowing more time for water quality treatment in the wetland.
- Install experimental filtration trench on back (west) side of enhanced embankment. Use an iron enhanced sand filter media. Outlet ends of drain pipes will have check valves (Tideflex or equal) to allow flows out of the pond but not back into the filter from the ditch. The control structure would be used to pond water in Bixby Park Pond following the spring runoff event, providing a head on the filter trench to force flows through the filter for treatment prior to discharge back into the main channel. This effectively makes the primary outlet of Bixby Pond a combination of evapotranspiration and filtered flows.
    - (Initial normal summer operation of control structure at 892.0 to 892.5 depending on effectiveness of evapotranspiration and the filter to maintain a normal water surface elevation of 891.3 or below between rain events.
    - Primary concern for the filter media and operation will be to minimize filter blinding (plugging) from algae and fines. The purpose of the filter will be to remove soluble phosphorus and provide base flows out of pond. Treatment by filtering of fines is **<u>not</u>** a purpose or function for this filter. The coarsest possible iron enhanced sand filter media should be used, that still provides sufficient contact time to remove the soluble phosphorus.
- Scrape lateral ditch edge and spoil embankments west and north of Bixby Pond to remove consolidated materials, provide a more natural looking stream edge and enhance interaction with wetland vegetation. This will function to route flows through the northern lateral ditch to increase flow length and residence time.

Anticipated Water Quality Benefits

The anticipated water quality benefits for the Bixby Park Water Quality Improvement Wetland project component are due to enhancements to the existing Bixby Park ponds that increase their function and enhance the natural treatment capabilities of the wetland system as well as increased storage and the ability to modify storage elevations. Also, included is an experimental iron-enhanced sand filter that provides the ability to remove soluble phosphorus. This component is estimated to provide 206 lbs/yr of phosphorus removal.

Carp Management

The modifications to the Bixby Park Site should not create additional habitat to be utilized by carp. If through investigation of the carp movements in the project area show that the existing potential carp habitat, mainly Bixby Pond, is being used by the carp for spawning, methods for exclusion from these areas can be added to the project at a later date.

Education and Recreation Opportunities

Bixby Park is in close proximity to the urbanized portions of Forest Lake and adjacent to existing active City parks. This site provides access for urban residents and travelers utilizing Interstate 35. Activities envisioned include a trail head at the old compost site and a loop trail along the upland border of the property. This park area is expected to be a pet friendly environment where users can experience the restored wetlands and open space. The trail head provides an excellent location for an interpretive sign addressing wetland and water quality topics of interest.

Land Acquisition Needs

Final land acquisition will be determined after final design. All project components will be constructed on property currently owned by the City of Forest Lake. Based on the operational scenario modeled the Bixby Park Water Quality Improvement Wetland component will result in a slight decrease in flood elevations upstream of Bixby Park. Installing additional stoplogs in the outlet control structure will increase the treatment efficiency for the system but could result in water being ponded for longer periods of time upstream of Bixby park but within the existing ditch banks.

Costs

The estimated cost for construction of the various Bixby Park Water Quality Improvement Wetland project components is $396,000. It is assumed that no additional cost is needed for land and flowage easement acquisition. Legal, engineering, final design, construction administration, and permit related expenses are estimated as $44,000. The estimated project cost totals to $440,000. Not included in this estimate are anticipated costs for administrator time and future maintenance and operations.

Permit Requirements

Permits will be required from the MNDNR, Corps of Engineers, MPCA, County and Township/City for implementation of the Bixby Park Water Quality Improvement Wetland project component.

10.4 McCullough Property Water Quality Improvement

Project Summary

The purpose of the designs considered for the McCullough Property Site are to address, on a sub-regional scale, water quality improvements from the Bixby/McCullough drainage area identified in the modeling and monitoring. The main focus of the recommended projects shown on Figure 39 are to enhance water quality treatment and storage capabilities of the McCullough Property wetlands. These project components should only be implemented if needed following implementation and monitoring of the Bixby Park, Tax Forfeit and Shallow Pond projects components. Critical elevations for the McCullough Property design were the same as those identified for Bixby Park.

Preliminary Design of Recommended Projects

The preliminary design of recommended projects includes the following items:

- Enhance spoil embankment along the west side of the main channel by removing spoil embankments from the east side of the main channel located on the McCullough Property and Bixby Park Property.
- Create one way flood flows from JD#1 into the new embankment storage area allowing flow back into JD#1 as water elevations in the ditch recede through a controlled outlet. (Note if monitoring proves that the Bixby Park iron-enhanced sand filter is effective then this facility could easily be retrofitted with a similar filter in the future).
- Create additional treatment and storage by scraping a depression, approximately 1 to 2 ft deep, intersecting lateral ditch flows from the west side of Hwy 35W.

Designs will be modified as needed based on monitoring results from implemented Bixby Park project.

Anticipated Water Quality Benefits

The anticipated water quality benefits for the McCullough Property Water Quality Improvement Wetland project component are increased stream interaction with the wetland vegetation, allowing for improved settling of particulate phosphorus (and other sediments) and uptake of dissolved phosphorus by the wetland vegetation rather than their transport within the channel. This component is estimated to provide 54 lbs/yr of phosphorus removal.

Carp Management

The modifications to the McCullough Property should not create additional habitat to be utilized by carp. If through project monitoring it is found that the project area is being used by the carp for spawning, methods for exclusion from this area can be added to the project at a later date.

Education and Recreation Opportunities

The McCullough site could be added onto the Bixby Park site with a loop trail skirting the upland portions of the site along the freeway. Similar recreational and educational benefits as described for Bixby Park apply here.

Land Acquisition Needs

Final land acquisition will be determined after final design. Utilizing the operational scenario modeled for the Bixby Park Water Quality Improvement Wetland component, the McCullough component will not result in an increase in flood elevations upstream of the McCullough property. It was noted during review of upstream properties that the plans for the Wal-Mart pond indicate a HWL (high water level) that is below the existing conditions 100-yr 24-hr flood elevations for the McCullough area.

Costs

The estimated cost for construction of the project components on the McCullough property is $392,800. An additional $190,000 is assumed for land and flowage easement acquisition. Legal, engineering, final design, construction administration, and permit related expenses are estimated as $36,000. The total estimated project cost is $618,800. Not included in this estimate are anticipated costs for administrator time and future maintenance and operations.

Permit Requirements

Permits will be required from the MNDNR, Corps of Engineers, MPCA, County and Township/City for implementation of the McCullough Property Water Quality Improvement Wetland project component.

10.5 Carp Management Plan

Project Summary

This project has evaluated carp populations as well as known movements and carp activities throughout the project area. Future activities will evaluate carp management through a spawning habitat assessment and carp population estimate. Through harvesting and carp exclusion a reduction of carp population will protect and enhance of the native aquatic plant community, and improve concentrations of chemical and physical surface water pollutants, such as total phosphorus.

Recommended Projects

Future actions will focus on determining the extent of the water quality problem realated to carp. This will involve two actions – first, determining the present population of carp in the system, and second, determining the potential for carp to propagate through the system Populations can be determined through a tagging and recapture study. By comparing the ratio of tagged to non-tagged carp in the second catch with the number of carp that were tagged in the initial catch, a population estimate can be made. Carp propagation potential is the capacity of the population to replenish itself after a decline. Research shows that this propagation potential is correlated with the diversity of the system. In particular, lakes interconnected by streams in which some lakes experience winter fish kills are at risk of sudden explosions of carp population. Systems in which young carp are consistently exposed to predators every year have a much lower likelihood of dramatic population increases. Radio tracking of representative carp to track movements and an analysis of existing habitat to determine how closely the Sunrise River and contributing drainages matches this ideal carp reproductive habitat, is the second element in determining the scope of the problem. In addition, locating the spawning areas where winter kills remove predators is essential to effectively managing the population.

Before implementing carp management options, the District must have a clear goal in mind, to avoid unnecessary expenditures. Once the current carp concentration is determined, a realistic goal for reduction can be set. Recent research at the University of Minnesota indicates 30 lb/acre is an appropriate target[17]. Regardless of the exact number, high concentrations of carp have been shown to cause significant water quality and ecosystem issues in lake systems similar to Comfort Lake and Forest Lake. Depending on the results of the investigation of the present concentration, an interim goal of a carp concentration higher than the indicated 30 lb/acre may be set as a project goal with the 30 lb/acre concentration being the long range goal for the project area.

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[17] Bajer, P. G., & Sorensen, P. W. (2009, July 8). Recruitment and abundance of an invasive fish, the common carp, is driven by its propensity to invade and reproduce in basins that experience winter-time hypoxia in interconnected lakes. *Biological Invasions.*

Once the current carp concentration, reproductive potential is known, and a population goal is set, management of population becomes the focus. If carp concentrations and proliferation potential are beneath established goals, then minimal management is required. If present concentrations or proliferation potential are high, then more aggressive action will be required. The two primary methods of carp management identified are fish passage barriers and physical removal of carp. The former reduces propagation potential; the latter reduces the existing population. Designs for both methods will be developed for areas of need identified by the assessments to be done as part of a long term carp management plan for the district.

Anticipated Water Quality Benefits

The movement of carp in the wetlands and the stream channel can to stir up sediment and muck and allow it to flow downstream to Comfort Lake. This project would reduce phosphorus loads to Comfort Lake from upstream wetlands and watercourses.

Education and Recreation Opportunities

Carp management and carp research related to water quality are a very hot topic in water resource management. Carp harvests and related education about exotic species and the ecological harm caused by them can be very powerful messages for water resource managers to share with the public. Educational opportunities from this project could include newspaper and newsletter articles reporting on the progress and results of the project activities in relation to water quality. These articles would heighten the awareness of the residents on the exotic species and the detrimental effects they have on the environment.

Costs

The following table provides a very preliminary estimate for developing and implementing a Carp Management Plan. The basic premise behind this plan will be to assess population and where population levels are found to be problematic, initiate a systematic removal and barrier construction starting from the top of the watershed working downstream to Comfort Lake.

Activity	Lake (s)	Year 1	Year 2	Year 3	Year 4
Planning/Permitting	All	$5,000	$3,000	$3,000	$3,000
Evaluate/Monitor Spawning Areas	Heims, Forest, Comfort	$5,000	$5,000		
Carp Capture/Tagging	Forest		$7,000		
Carp Capture/Tagging	Heims		$7,000		
Carp Capture/Tagging	Comfort			$7,000	
Compile Tagging Data	All		$2,000	$1,000	
Carp Harvest	Forest			$6,000	
Carp Harvest	Heims			$6,000	
Carp Harvest	Comfort				$6,000
Population Estimate	All			$1,000	$1,000
Evaluate/Install Barriers				$20,000	$10,000
Annual Cost		$10,000	$24,000	$44,000	$17,000

10.6 Stormwater Treatment Retrofit Projects in City of Forest Lake

Summary of Investigated Sites

A total of 66 potential areas for treatment were identified through this study. The types of potential BMPs identified include raingardens, iron enhanced sand filtration, biofiltration, rainwater harvesting, permeable pavement, ponding, pond maintenance, and tree trenches. On many of the sites a number of BMP types could be used to accomplish water quality treatment, however for clarity in this report, the figures and text indicate only the type of practice used to estimate phosphorus load reductions and costs. The construction costs presented include the actual construction cost, as well as engineering design and inspection costs in addition to a contingency. Costs to coordinate with landowners and costs for legal support were not specifically included in the cost estimates. Maintenance cost includes general operation and maintenance needed to maintain initial function as well as periodic reconstruction as appropriate to each type of practice. A 50 year timeframe was used for all practices to ensure that the comparison of costs and phosphorus removals are consistent among all types of practices identified.

Figure 40 displays all identified sites, the likely suitable type of BMP, and the contributing drainage area. Potential BMPs are grouped in Figure 40 in the categories of Big Box, Green Streets, Pond Retrofit, CIP, and Maintenance. "Big Box" sites address runoff off highly developed sites. The "Green Streets" projects address sites where the primary focus of the project would be on treating street drainage. Pond Retrofit projects would modify existing wet detention ponds to provide additional treatment through iron enhanced sand filtration. The projects identified as CIPs include projects with a larger drainage area or with more intensive project needs. Maintenance sites are shown for reference and work on these sites can be coordinated with the City of Forest Lake as desired. Appendix E includes the photographs taken during the site visits. The set of identified projects is discussed below as grouped by location (Figure 41).

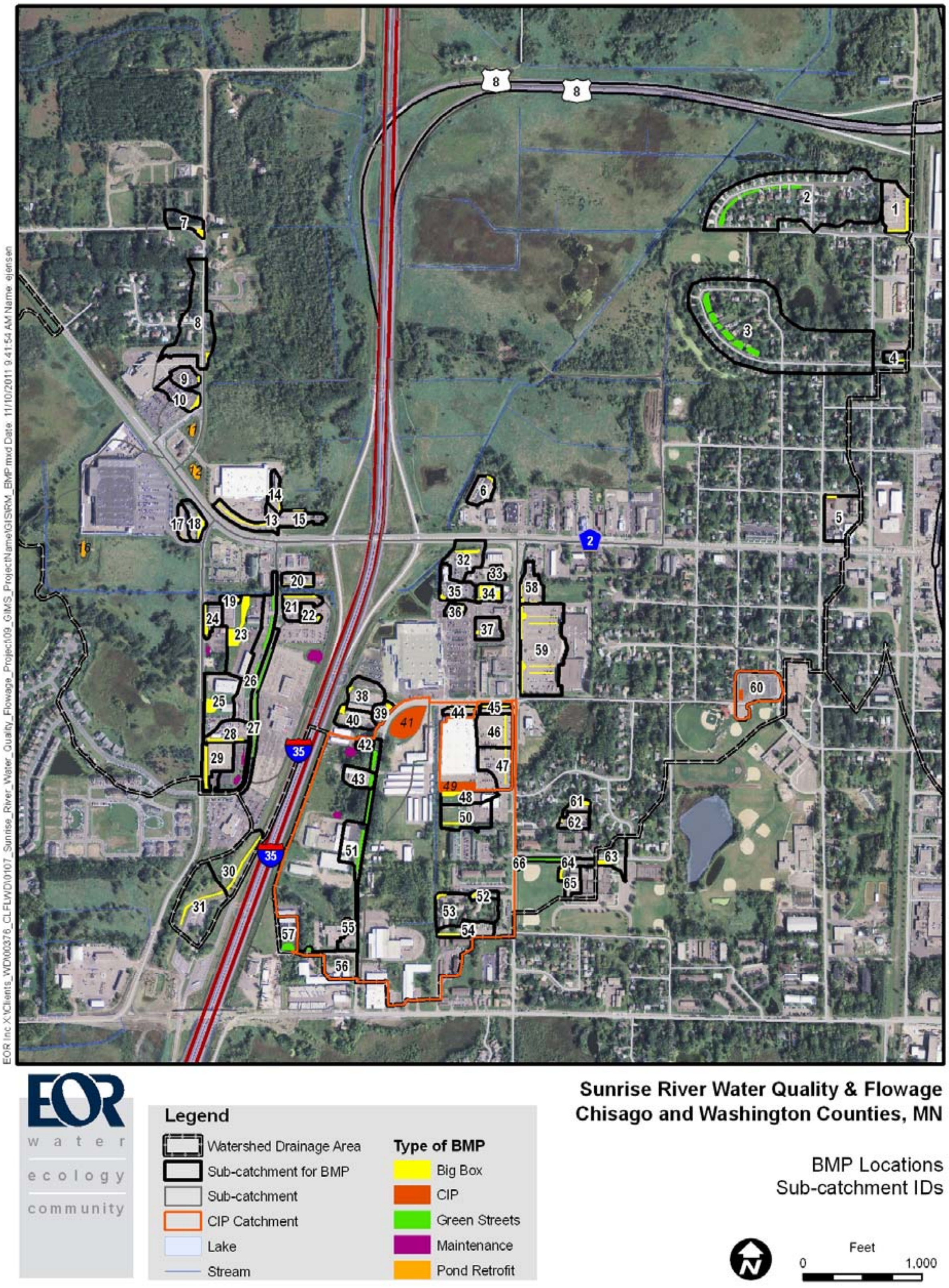

Figure 40. Location of Retrofit Sites for Potential Stormwater Management Enhancements

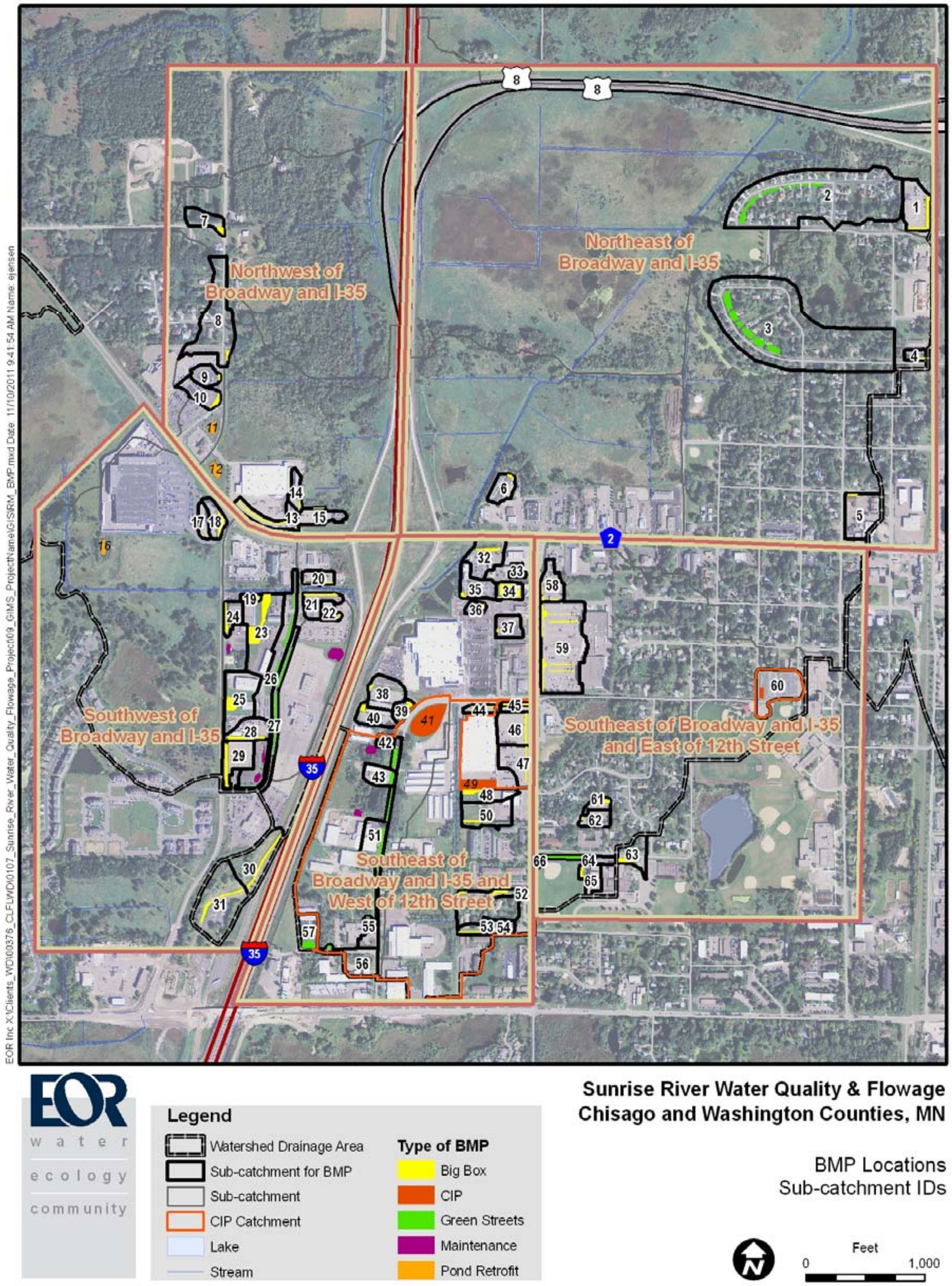

Figure 41. Retrofit Site Groups

Sites Northeast of Broadway and I-35

Six sites were identified in the area northeast of Broadway and I-35. These sites include five areas of potential raingardens and one area for filtration (Table 9, Figure 42). Of particular interest are areas 2 and 3 where drainage from the residential neighborhood and roadways could be treated through raingardens to provide treatment for about 31 acres. Implementation of these retrofits is estimated to result in a total phosphorus reduction of 23 pounds per year. The raingarden projects could be completed through a partnership with the City of Forest Lake. In addition, the filtration practice identified for site 5 is estimated to treat 2.4 acres at a cost effective lifetime average cost of $956 per pound of phosphorus removed from the runoff.

Table 9. Potential BMP sites in the area northeast of Broadway and I-35

ID	BMP Type	Site Photo-graphs	Drainage Area (ac)	Total Phosphorus Removal (over 50 years) (lb)	Total Sediment Removal (over 50 years) (cy)	Estimated Construction Cost ($)	Estimated Maintenance Cost (over 50 years) ($)	Cost per Pound of Total Phosphorus Removed ($/lb)
1	Raingarden	929, 930	1.99	72	24	$ 122,235	$ 158,906	$ 3,923
2	Raingardens	na	13.68	471	83	$ 114,840	$ 149,292	$ 561
3	Raingardens	na	17.48	701	114	$ 406,145	$ 527,989	$ 1,332
4	Raingarden	928	0.35	11	4	$ 14,355	$ 18,662	$ 2,872
5	Filtration	932	2.39	53	22	$ 24,246	$ 26,670	$ 956
6	Raingarden	927	0.90	24	9	$ 14,355	$ 18,662	$ 1,390

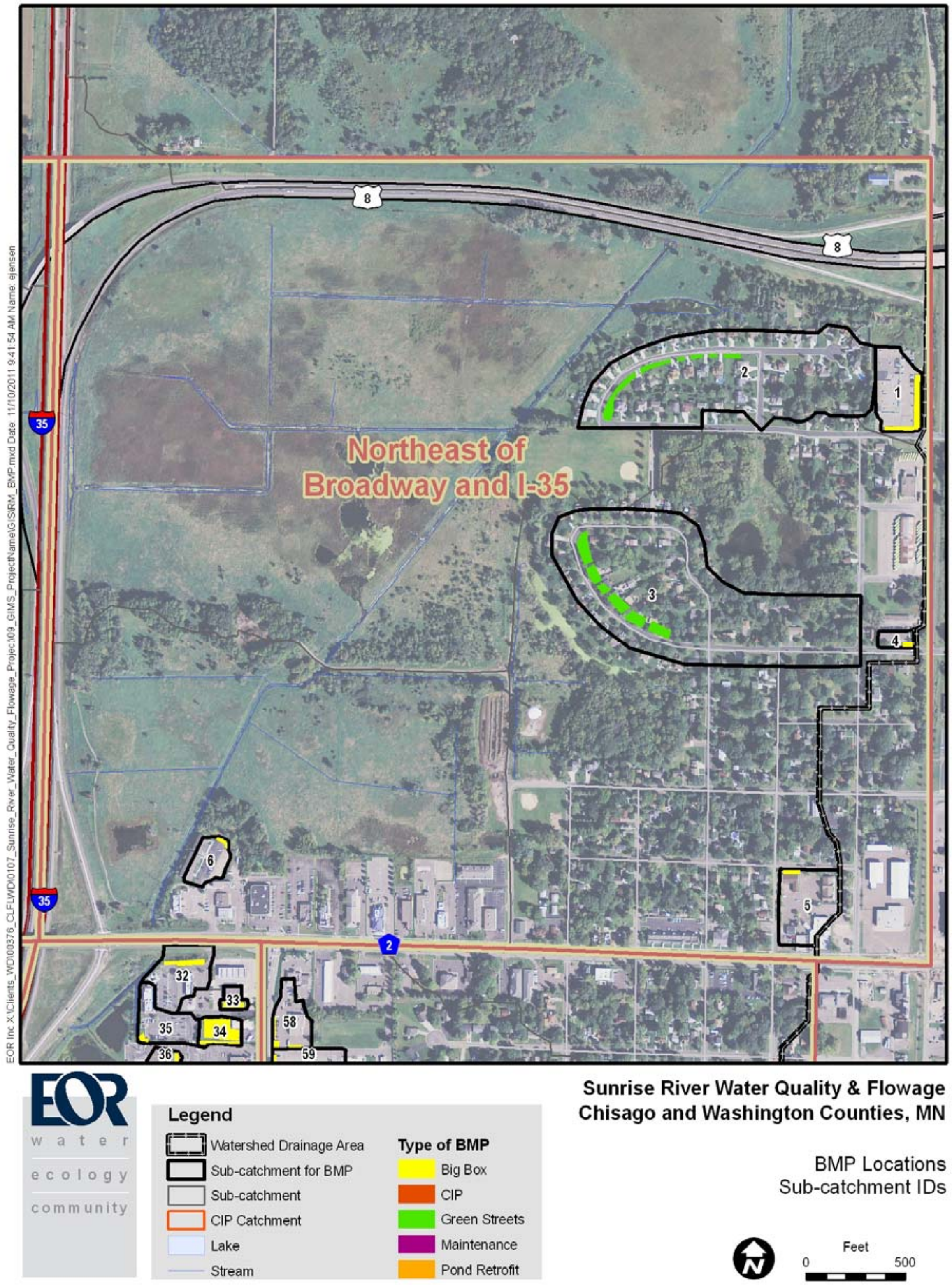

Figure 42. Map of Sites Northeast of Broadway and I-35

Sites Northwest of Broadway and I-35

Nine sites were identified in the area northwest of Broadway and I-35. These sites include seven raingardens, two pond modifications for iron enhanced filtration and one site for porous pavement. The drainage areas treated by these potential stormwater management practices along with the estimated pollutant removal and estimated construction cost and maintenance costs are summarized in Table 10 and shown in Figure 43. The four sites that are estimated to provide the most phosphorus removal per dollar are the raingardens at sites 8, 9, and 15 along with the pond retrofit to add an iron enhanced sand treatment to an existing pond at site 11. These four practices together are estimated to provide a 9.8 pound reduction in total phosphorus loads per year at a total initial construction cost of about $151,000 or an average annual cost of $3,029 per pound of phosphorus removed over 50 years.

Table 10. Potential BMP sites in the area northwest of Broadway and I-35

ID	BMP Type	Site Photo-graphs	Drainage Area (ac)	Total Phosphorus Removal (over 50 years) (lb)	Total Sediment Removal (over 50 years) (cy)	Estimated Construction Cost ($)	Estimated Maintenance Cost (over 50 years) ($)	Cost per Pound of Total Phosphorus Removed ($/lb)
7	Raingarden	864	0.99	49	11	$ 29,725	$ 38,643	$ 1,397
8	Raingarden	867	4.19	105	22	$ 19,865	$ 25,825	$ 437
9	Raingarden	865	0.80	39	10	$ 16,385	$ 15,566	$ 826
10	Raingarden	866	1.11	36	12	$ 40,600	$ 52,780	$ 2,607
11	Iron enhanced sand pond retrofit	na	10.70	323	126	$ 105,328	$ 157,992	$ 816
12	Iron enhanced sand pond retrofit	na	6.75	204	80	$ 135,624	$ 203,436	$ 1,666
13	Raingarden	856, 857, 858, 859, 860, 861, 862, 863	1.30	86	19	$ 74,240	$ 96,512	$ 1,979
14	Pervious Pavement	855	0.62	17	6	$ 14,210	$ 7,105	$ 1,254
15	Raingarden	854	1.05	23	9	$ 9,570	$ 12,441	$ 950

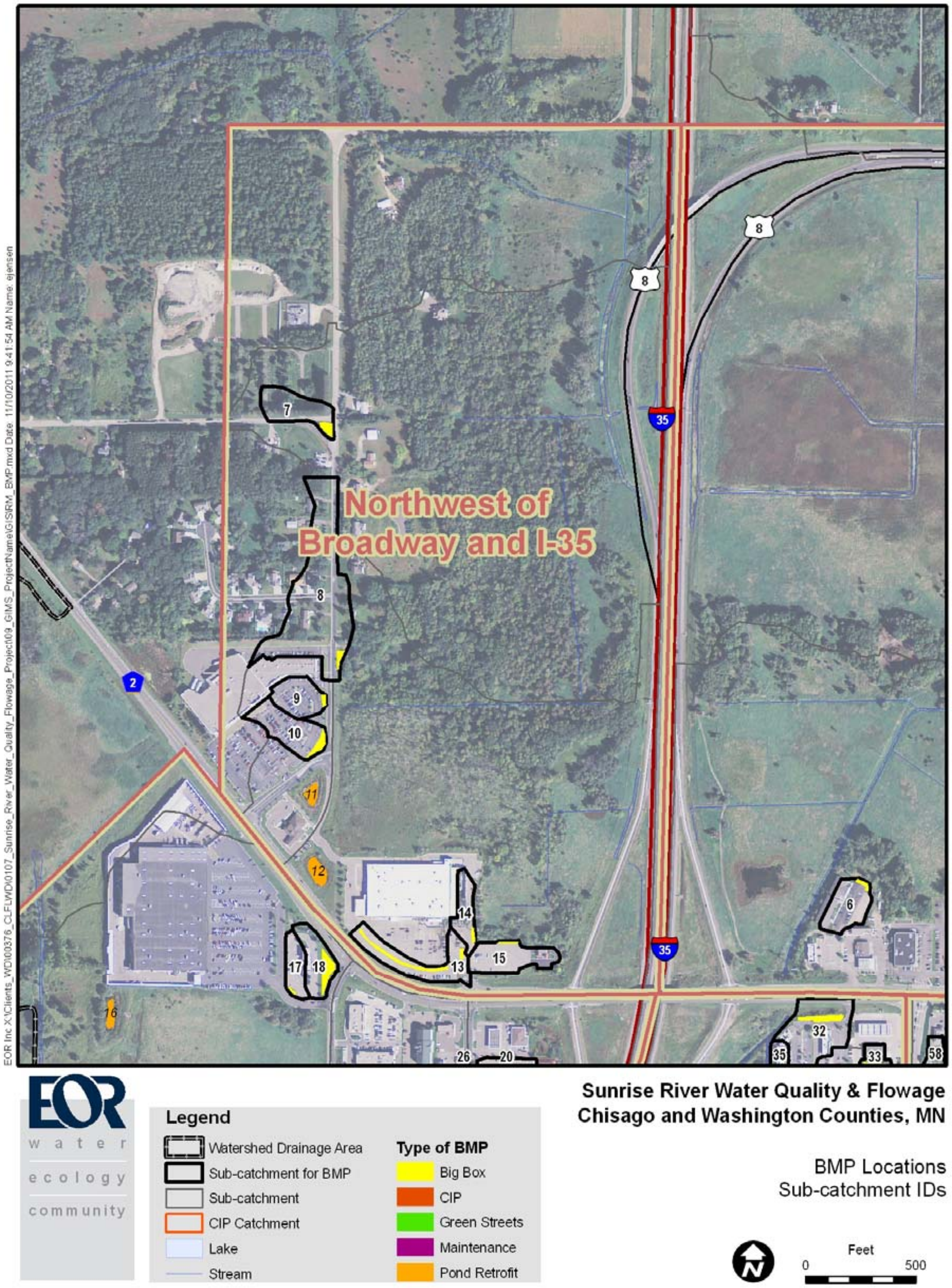

Figure 43. Map of Sites Northwest of Broadway and I-35

Sites Southwest of Broadway and I-35

A total of 16 sites for water quality treatment enhancement were identified in the area southwest of Broadway and I-35. These sites include six raingarden sites, three areas for tree trenches, four sites for filtration practices, and one site for a pond retrofit to incorporate iron enhanced sand filtration (Table 11, Figure 44). The projects estimated to be the most cost effective for phosphorus reduction are the raingarden at site 17 and a pond retrofit to incorporate iron enhanced sand filtration at site 16. The raingarden project would provide treatment for about 0.6 acres of drainage for a total phosphorus reduction of 0.5 pounds per year at an initial construction cost of about $6,000. The pond retrofit is estimated to provide treatment for about 15 acres of drainage resulting in 8.8 pounds per year removal of total phosphorus from the offsite runoff. The estimated initial construction cost of this project is about $208,000. The potential tree trench projects along 19th Street (sites 26 and 27) together would provide treatment for a drainage area of over five acres to provide a phosphorus reduction of 5.5 pounds per year. The costs of this project could be reduced if raingardens or wide swales were used for treatment in lieu of the tree trenches.

Table 11. Potential BMP sites in the area southwest of Broadway and I-35

ID	BMP Type	Site Photo-graphs	Drainage Area (ac)	Total Phosphorus Removal (over 50 years) (lb)	Total Sediment Removal (over 50 years) (cy)	Estimated Construction Cost ($)	Estimated Maintenance Cost (over 50 years) ($)	Cost per Pound of Total Phosphorus Removed ($/lb)
16	Iron enhanced sand pond retrofit	na	14.60	440	173	$ 208,416	$ 312,624	$ 1,184
17	Raingarden	869	0.56	23	6	$ 5,945	$ 7,729	$ 602
18	Tree Trench	868	0.87	58	13	$ 120,205	$ 114,195	$ 4,038
19	Filtration	872	0.22	7	2	$ 11,160	$ 12,276	$ 3,213
20	Pavers	884	0.66	22	8	$ 36,830	$ 18,415	$ 2,479
21	Raingarden	880, 881	0.99	35	12	$ 57,565	$ 74,835	$ 3,761
22	Raingarden	882	0.48	14	5	$ 11,165	$ 14,515	$ 1,855
23	Filtration	871, 876	3.97	149	49	$ 355,672	$ 391,239	$ 4,996
24	Raingarden	873	0.81	29	10	$ 46,400	$ 60,320	$ 3,716
25	Filtration	877	2.65	165	37	$ 119,238	$ 131,161	$ 1,519
26	Tree Trench	see 853	3.69	111	39	$ 142,680	$ 135,546	$ 2,507
27	Tree Trench	852, 853	1.49	63	20	$ 336,980	$ 320,131	$ 10,416
28	Raingarden	850	1.29	47	16	$ 83,520	$ 108,576	$ 4,098
29	Raingarden	878, 879	1.71	60	20	$ 93,380	$ 121,394	$ 3,570
30	Filtration	894-2	2.60	87	30	$ 126,791	$ 139,470	$ 3,066
31	Filtration	894-1	4.42	127	46	$ 111,408	$ 122,548	$ 1,836

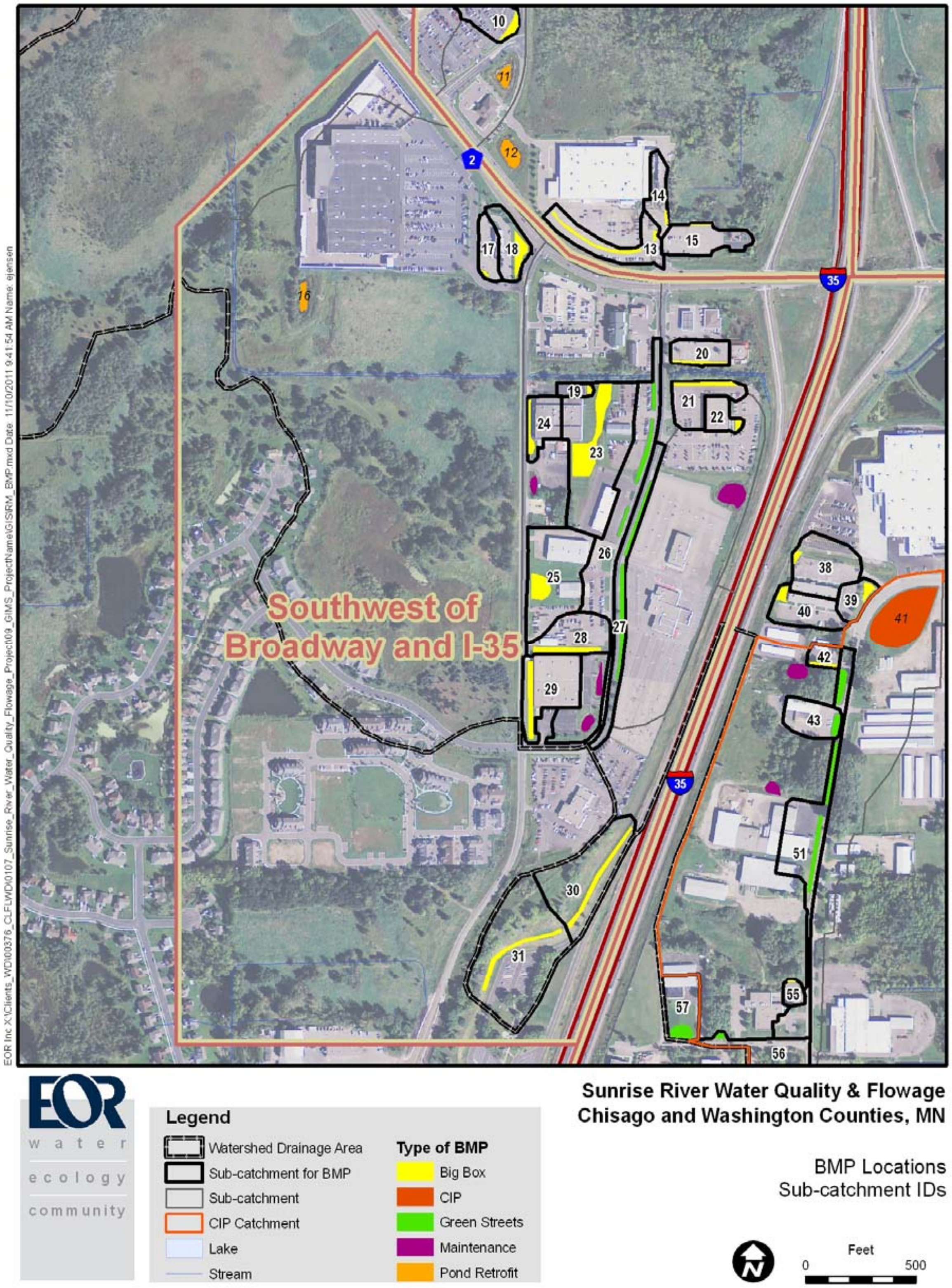

Figure 44. Map of Sites Southwest of Broadway and I-35

Sites Southeast of Broadway and I-35 and West of 12th Street

Twenty-six potential BMP retrofit sites were identified in the area of the City of Forest Lake located southeast of Broadway and I-35 and west of 12th Street (Table 12, Figure 45). In this area, a larger drainage area could be treated through one sizeable facility, or through a number of smaller distributed facilities. A larger facility such as the potential iron sand filtration practice at site 41 could be constructed to treat about 90 acres of drainage for an estimated total phosphorus reduction of about 64 pounds per year. The estimated cost to construct this practice is about $1.1 million, or a per pound of phosphorus cost including ongoing maintenance over 50 years of about $839/lb. A number of smaller sites for potential BMPs were also identified in the same drainage area as site 41. The fifteen smaller sites within the drainage area to site 41 include eight potential raingarden sites, three tree trench sites, two areas for filtration, one area of porous pavement, one pond expansion, and a pond filtration retrofit (sites 42 – 57). Together these sites would provide an estimated 11 pounds of phosphorus reduction annually for a total drainage area of 19 acres at an initial construction cost of $700,000. Additional practices outside the drainage area to site 41 that are estimated to be the most cost-efficient include the raingardens at sites 35, 37 and 38.

Table 12. Potential BMP sites in the area southeast of Broadway and I-35 and west of 12th Street

ID	BMP Type	Site Photo-graphs	Drainage Area (ac)	Total Phosphorus Removal (over 50 years) (lb)	Total Sediment Removal (over 50 years) (cy)	Estimated Construction Cost ($)	Estimated Maintenance Cost (over 50 years) ($)	Cost per Pound of Total Phosphorus Removed ($/lb)
32	Raingarden	912, 913, 914, 915	1.83	57	20	$ 56,840	$ 73,892	$ 2,289
33	Raingarden	918	0.29	12	4	$ 31,755	$ 41,282	$ 6,326
34	Raingarden	910, 916	0.68	22	8	$ 27,985	$ 36,381	$ 2,863
35	Raingarden	911	1.34	32	13	$ 14,500	$ 18,850	$ 1,052
36	Raingarden	909	0.36	11	4	$ 11,455	$ 14,892	$ 2,360
37	Raingarden	908	0.94	22	9	$ 9,570	$ 12,441	$ 1,022
38	Raingarden	887	1.63	37	15	$ 14,935	$ 19,416	$ 936
39	Raingarden	888	0.54	19	6	$ 29,580	$ 38,454	$ 3,593
40	Raingarden	889	1.08	32	12	$ 28,130	$ 36,569	$ 2,004
41	Iron enhanced sand filtration	903	90.00	3,208	864	$ 1,076,813	$ 1,615,220	$ 839
42	Raingarden	891	0.33	12	4	$ 18,995	$ 24,694	$ 3,754
43	Raingarden	886	0.89	28	10	$ 31,610	$ 41,093	$ 2,554
44	Raingarden	906	0.38	14	5	$ 25,085	$ 32,611	$ 4,180
45	Tree Trench	907	0.13	6	2	$ 54,955	$ 52,207	$ 17,712
46	Tree Trench	see 905	1.88	54	20	$ 61,625	$ 58,544	$ 2,215
47	Tree Trench	905	1.81	52	19	$ 59,885	$ 56,891	$ 2,233
48	Pond	904	1.11	40	13	$ 51,543	$ 28,349	$ 1,982
49	Filtration retrofit	na	3.00	35	13	$ 30,450	$ 39,585	$ 1,991
50	Raingarden	902	1.98	58	21	$ 45,965	$ 59,755	$ 1,831
51	Raingarden	na	2.97	106	35	$ 172,695	$ 224,504	$ 3,753
52	Filtration	901	0.33	12	4	$ 30,227	$ 33,249	$ 5,108
53	Filtration	899, 900	2.79	58	24	$ 22,308	$ 24,538	$ 814
54	Pavers	895	1.21	37	13	$ 41,325	$ 20,663	$ 1,687
55	Raingarden	893	0.24	6	2	$ 3,915	$ 5,090	$ 1,466
56	Raingarden	na	1.69	34	15	$ 11,310	$ 14,703	$ 763
57	Raingarden	885	1.03	37	12	$ 61,915	$ 80,490	$ 3,861

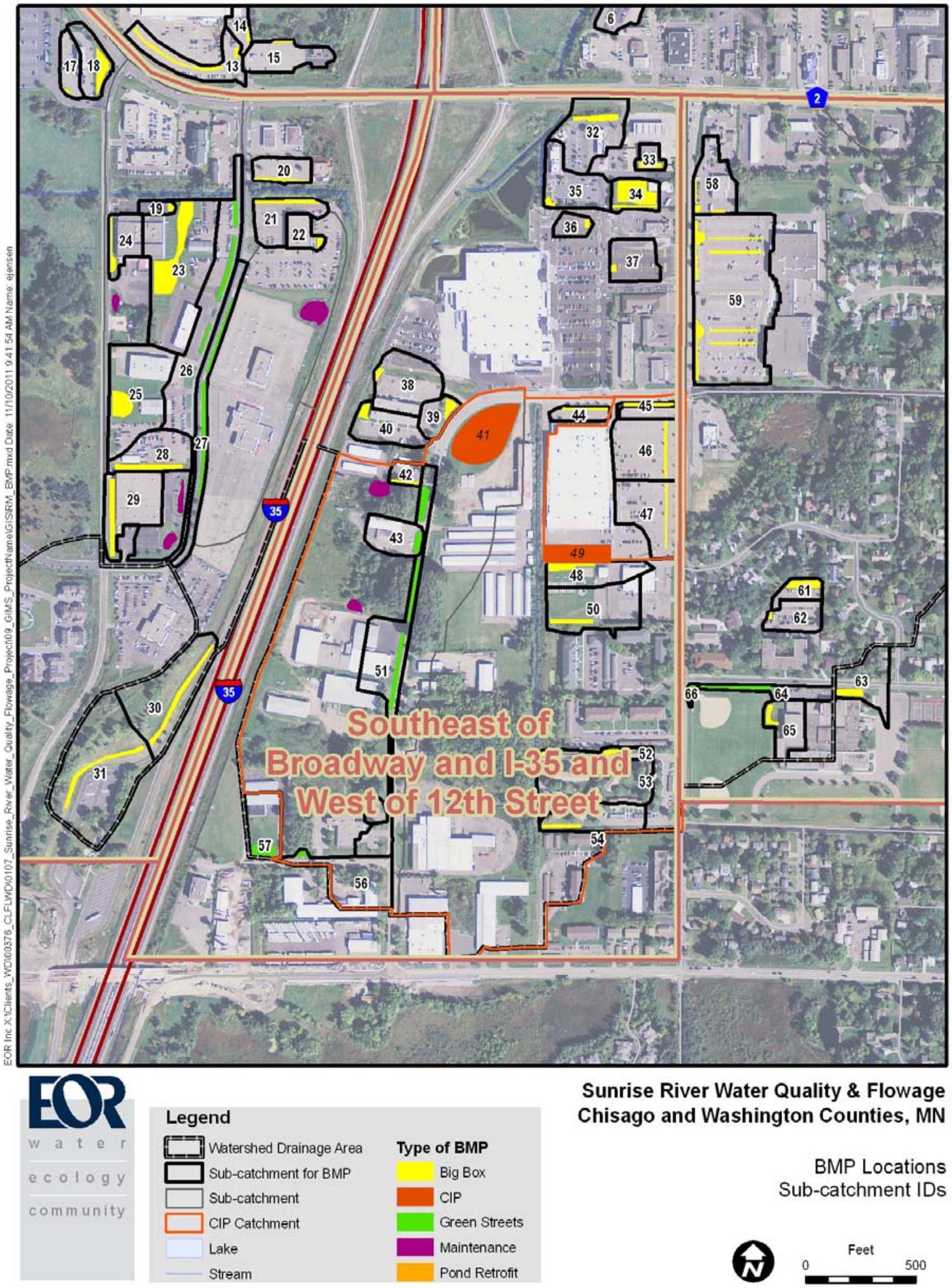

Figure 45. Map of Sites Southeast of Broadway and I-35 and West of 12th Street

Sites Southeast of Broadway and I-35 and East of 12th Street

Nine potential BMP sites were identified in the area east of 12th Street and southeast of Broadway and I-35. These sites include seven raingardens, one tree trench and one site for water harvesting and reuse (Table 13, Figure 46). The raingarden proposed for site 62 would treat drainage from a 1.7 acre drainage area and would provide 0.6 pounds per year of total phosphorus removal at a total cost of about $6,500. The other identified sites have somewhat higher costs per pound of total phosphorus removal than in other areas investigated.

Table 13. Potential BMP sites in the area southeast of Broadway and I-35 and east of 12th Street

ID	BMP Type	Site Photo-graphs	Drainage Area (ac)	Total Phosphorus Removal (over 50 years) (lb)	Total Sediment Removal (over 50 years) (cy)	Estimated Construction Cost ($)	Estimated Maintenance Cost (over 50-years) ($)	Cost per Pound of Total Phosphorus Removed ($/lb)
58	Raingarden	919, 920, 921	1.18	35	13	$ 30,450	$ 39,585	$ 1,991
59	Tree Trench	922, 923, 924, 925	6.28	203	70	$ 321,755	$ 305,667	$ 3,083
60	Harvesting	933, 934	2.59	56	21	$ 53,102	$ 79,653	$ 2,386
61	Raingarden	940	0.45	30	7	$ 55,970	$ 72,761	$ 4,286
62	Raingarden	939	1.67	29	11	$ 6,525	$ 8,483	$ 520
63	Raingarden	935	1.18	38	13	$ 44,080	$ 57,304	$ 2,648
64	Raingarden	937	0.62	23	8	$ 48,285	$ 62,771	$ 4,771
65	Raingarden	936	0.90	23	8	$ 27,695	$ 36,004	$ 2,827
66	Raingarden	938	0.07	3	1	$ 10,440	$ 13,572	$ 8,235

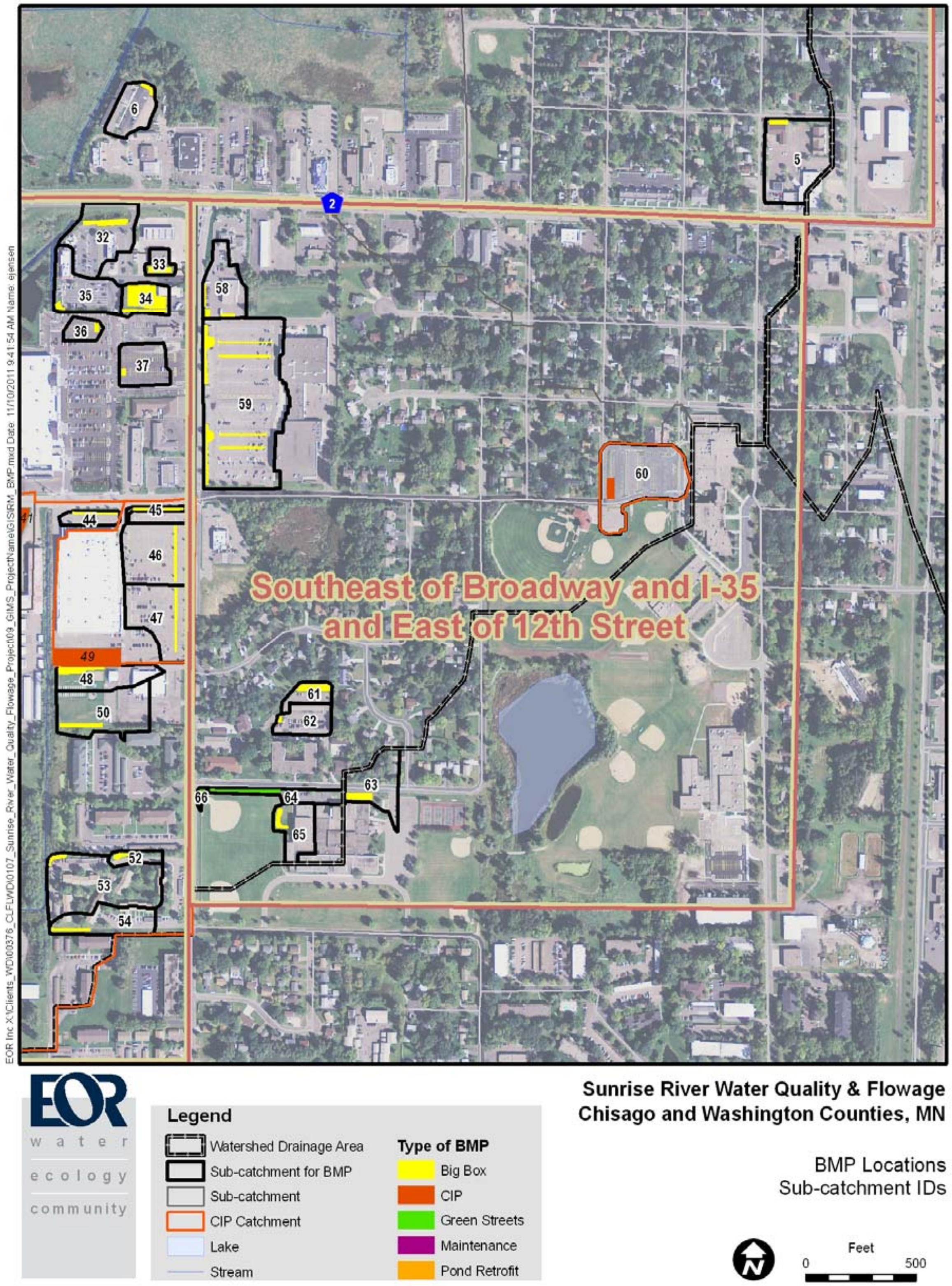

Figure 46. Map of Sites Southeast of Broadway and I-35 and East of 12th Street

Anticipated Water Quality Benefits

The total potential phosphorus load reduction from all identified BMP sites is 168 pounds per year. The actual downstream phosphorus load reduction would be lower if sites that drain to another nearby treatment facility are implemented or if only a portion of the sites are implemented. The sites all drain eventually to Comfort Lake which requires a load reduction of 126 pounds of total phosphorus per year to meet the established Total Maximum Daily Load (TMDL). The CLFLWD has also set a longer-term goal to reduce phosphorus loading to the lake by 395 pounds per year to attain high in-lake water quality.

Carp Management

The identified potential retrofit projects are not expected to create additional habitat that could be utilized by carp.

Education and Recreation Opportunities

The retrofit projects, particularly those along public roadways with sidewalks, could be used as demonstration sites with signage informing the public of the benefits and goals of the projects. Recreation opportunities may be limited since these are typically smaller sites utilizing open areas and altering existing paved areas, but there is the potential to set up a raingarden tour or stormwater treatment tour for interested citizens after a number of projects have been implemented.

Land Acquisition Needs

Some projects, particularly the Green Streets projects, have the potential to be implemented within public right of way. The majority of identified projects, however, are likely on private property and will require access and/or easement agreements with the landowners.

Costs

A number of highly cost-effective practices were identified through the study. There are 12 projects with less than $1,000 as the estimated annual cost per pound of phosphorus removed over the 50 year period of practice function (in order of lowest cost to higher: sites 8, 62, 2, 17, 56, 53, 11, 9, 41, 38, 15, and 5). There are an additional 18 projects with less than $2,000 as the estimated annual cost per pound of phosphorus removed over 50 years (in order of lowest cost to higher: sites 37, 35, 16, 14, 3, 6, 7, 55, 25, 12, 54, 50, 31, 22, 13, 48, 49, and 58). These projects may be an excellent area of focus for the District. However, to limit costs associated with easements and landowner negotiation, we recommend that the District focus first on sites that address larger drainage areas. These sites will require less coordination with landowners and fewer sites to inspect and maintain in the future. Sites 2, 3, 11, 12, 16, 41, and 59 are estimated to capture a drainage area of 6 acres or more. The average annual cost per pound of phosphorus removed with these practices ranges from $561 to $3,083 over 50 years.

Green streets projects (Figure 40) that could be completed in partnership with the City of Forest Lake to address untreated runoff from roadways is another recommended area of focus. Sites 2 and 3 address streets in an untreated residential area, sites 43, 51, 55, and 57 address drainage along 15th Street and 9th Avenue, sites 64 and 66 address drainage from 7th Avenue and 12th Street and sites 26 and 27 address drainage along 19th Street.

Permit Requirements

The retrofit projects will likely require a permit from the City of Forest Lake. The projects are not expected to impact wetlands and would not require a WCA, DNR or ACOE permit.

11 APPENDICES

Appendix A.	Project Scoping
Appendix B.	Water Quality, Flow, Water Surface Elevation Data
Appendix C.	Ditch Records
Appendix D.	Utilities
Appendix E.	Retrofit Photographs
Appendix F.	Elevation Survey Data
Appendix G.	Wetlands Well Data
Appendix H.	Wetlands Soils Data
Appendix I.	H/H Model Updates
Appendix J.	Water Quality Model

Appendix A. Project Scoping

651 Hale Avenue North Oakdale, Minnesota 55128 telephone: 651.770.8448 facsimile: 651.770.2552 www.eorinc.com

Date | January 12, 2011

To | Doug Thomas **Contact info |** CLFLWD

cc | Board of Managers **Contact info |** CLFLWD

From | Brett Emmons, P.E. & Lisa Tilman, P.E. **Contact info |** EOR

Regarding | Sunrise River Water Quality and Flowage Project: Project Charter and Initial Feasibility Evaluation

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Background

The Sunrise River Water Quality and Flowage Project was initiated by petition of Chisago County. The petition outlines the basis for the project as well as the project goals and approximate location. The petition discusses the excess phosphorus load to Comfort Lake as identified in the District's water quality study and the Six Lakes TMDL and also mentions seasonal flooding occurring along portions of the Sunrise River. The project purpose and benefits are identified as:

- Reducing nutrient, sediment and other pollutant loads to Comfort Lake from the Sunrise River as a result of stormwater runoff
- Reducing seasonal flooding issues along portions of the river

The project is described in the petition as a water quality and quantity improvement project. The project location, as identified in the petition, is "within the drainage area to the Sunrise River between the City of Forest Lake and Comfort Lake including all District lands that drain to Comfort Lake via the Sunrise River" and more specifically to "provide treatment of stormwater runoff coming from the developed and commercial areas of the City of Forest Lake around the 35W and US 8" area.

Goal

The project goal is primarily to reduce nutrient and sediment loading to Comfort Lake from the Sunrise River drainage area and secondarily to reduce seasonal flooding along portions of the Sunrise River upstream of Comfort Lake.

Budget

The project budget for 2011 was defined as $329,000 in the District's Operations Budget.

Schedule

Feasibility Study & Engineer's Report: 2011
Final Design and Construction: 2012-2013

Staff and Roles

District Board: Project Owner
District Administrator: Project oversight
District Engineer: Feasibility analysis and design
District Attorney: Legal counsel

Stakeholders

The key project stakeholders are Chisago County and CLFLWD. Depending on the selected project option, other local stakeholders may include the City of Forest Lake, the City of Wyoming, Washington or Chisago County, road authorities, state agencies, and landowners and residents near the project locations.

Project Options

In the fall and winter of 2010, the Board heard presentations outlining the types of options available to decrease the phosphorus load to Comfort Lake. The presentations focused on wetland management, stream management, and various water quality treatment options for the built environment. Nine potential projects have been identified through staff discussions and as projects that are expected to result in water quality and flood attenuation improvements. Additional detail on the projects is included below under "Project Summaries". The nine projects are:

A. Reestablish Sunrise River meander pattern
B. Increase stream interaction with floodplain
C. Forest Lake developed -area retrofits
D. Wyoming developed-area retrofits
E. Water quality treatment feature at tax forfeit property
F. Iron filtration within ditch
G. Carp Management
H. Interaction of road embankments on surface flow
I. Water quality treatment feature at Bixby Park

These projects are proposed for an initial basic evaluation at this time in order to assist the Board in determining which projects to move forward with for a full feasibility evaluation and engineer's report. A future work order would specify a limited number of projects for full feasibility evaluation and engineer's report.

Initial Evaluation Method

Each potential project will undergo an initial basic evaluation of key project factors. The projects will be compared using an evaluation matrix to assist in deciding which alternatives to pursue for a full feasibility study and engineer's report. The matrix will compare factors that influence the scope, timeline, feasibility, cost, and impact of the project. Specifically, the evaluation matrix will include:

- Listing of stakeholders (e.g. city, private landowners)
- Qualitative evaluation of level of effort needed for stakeholder coordination process
- Listing of permits needed (e.g. NPDES, WCA)
- Qualitative evaluation of level of effort needed for permitting process
- Listing of considerations or evaluations needed for feasibility study (e.g. site survey, soils analysis)
- Listing of considerations for or aspects of implementation (e.g. land acquisition, construction of structures)
- List of nutrient reduction benefits for Comfort Lake (e.g. concentrated sources targeted, nutrient reduction estimate where possible, ecological tradeoffs)
- List of volume reduction benefits (e.g. infiltration, evapotranspiration)
- Qualitative evaluation of if the project addresses localized flooding concerns (addressed or not)
- List of cost considerations (e.g. low, medium, or high costs relative to the other projects for design, land acquisition, construction, etc.)
- Estimated cost range for feasibility and construction

The results of this evaluation will be summarized in a memo to the Board to assist in the Board's decision of which projects to advance for feasibility evaluation and engineer's report. This initial evaluation is estimated to cost $7,100.

Project Summaries

Each potential project is summarized below.

A. Reestablish Sunrise River meander pattern

Project concept

Reestablish a natural meander pattern of the Sunrise River. Prior to ditching projects, the natural conveyance feature may have been a stream with a more sinuous flow pattern. The inclusion of additional meanders in the current ditched sections of this watercourse will increase the overall flow length, residence time, and enhance connectivity to the surrounding wetlands.

Potential benefits

The increased flow length will more closely mimic a stable, naturalized stream that can enhance overall ecosystem function. Stable stream channels transport less sediment than those experiencing erosion caused by bed and bank instability. Other benefits of a naturalized channel include habitat enhancement, aesthetics and in some cases provide greater recreation opportunities.

Analysis needed for full feasibility study

Review of historical photos and other historical documents (e.g. ditch plans). Collection of soils data along current and potential future stream location. Survey of current and potential future stream locations. Modeling of in-stream conditions to evaluate erosive conditions. Analysis of cost and phosphorus or flooding reduction benefit.

B. Increase stream interaction with floodplain

Project concept

Many watercourses similar to this reach of the Sunrise River have built up mounds of sediment along the bank of stream either from past dredging activity or as a result of sedimentation during flood conditions. These mounds limit the access of water to the surrounding wetland and confine flows to the stream that could otherwise have spread out into the wetland. This project would reshape the stream channel to increase the stream's interaction with the floodplain. Designs such as a two stage channel or simply the removal of any mounds would be evaluated. Another option, installing a weir in the channel will also be considered.

Potential benefits

The increased interaction with the floodplain will allow the settling of materials in the floodplain rather than their transport within the channel. By providing the stream access to a broader floodplain, flood storage is increased. Increasing flood storage slows and attenuates peak flows that typically cause the most transport of sediment-bound pollutants downstream. Additionally, flood waters routed into the floodplain are typically filtered through dense vegetation were sediment and nutrients can be absorbed. In some cases, a total volume of stormwater routed downstream can be reduced through evapotranspiration. Naturally functioning floodplains with seasonal wet-dry periods provide critical habitat for many wildlife species and support native plant species uniquely adapted for this hydrologic regime.

Analysis needed for full feasibility study

Survey of stream corridor. Collection of soils data in and along stream. Modeling of in-stream conditions to evaluate erosive conditions. Evaluation of stream modification designs. Analysis of cost and phosphorus or flooding reduction benefit.

C. Forest Lake developed-area retrofits

Project concept
The highest phosphorus concentrations in runoff appear to be originating in the more densely developed portions of the City of Forest Lake. This finding is consistent with the results of the District-wide water quality model. This project would identify and evaluate specific options for stormwater management to reduce the phosphorus concentration and load leaving subwatersheds CL61, CL82, CL33, CL32, CL04, CL03, CL05, CL06, CL07, and CL02.

Potential benefits
If feasible, the project would incorporate BMPs into the landscape of the subwatersheds with the highest concentration of phosphorus in runoff, lowering the contributed load.

Analysis needed for full feasibility study
Subwatershed studies to identify potential sites for practices and identify potential types of practices (subwatersheds CL61, CL82, CL33, CL32, CL04, CL03, CL05, CL06, CL07, and CL02). Landowner and City discussions. Site and soils surveys. Analysis of cost and phosphorus or flooding reduction benefit.

D. Wyoming developed-area retrofits

Project concept
Higher phosphorus concentrations in runoff were also identified from the residential development areas of Wyoming. This project would identify and evaluate specific options for stormwater management to reduce the phosphorus concentration and load leaving subwatersheds CL43, CL49, CL50, CL51, CL52, CL38, and CL39.

Potential benefits
If feasible, the project would incorporate BMPs into the landscape of the subwatersheds with the highest concentration of phosphorus in runoff, lowering the contributed load.

Analysis needed for full feasibility study
Subwatershed studies to identify potential sites for practices and identify potential types of practices (subwatersheds CL43, CL49, CL50, CL51, CL52, CL38, and CL39). Landowner and City discussions. Site and soils surveys. Analysis of cost and phosphorus or flooding reduction benefit.

E. Water quality treatment feature at tax forfeit property

Project concept
The District owns properties along and adjacent to the Sunrise River which could be used for water quality treatment. The District-owned land is located downstream of where the Sunrise River and the ditch system join together and therefore treatment at this site would include drainage from Forest Lake itself as well as drainage from the City of Forest Lake through the ditch system. The project would evaluate re-routing the ditch to the treatment feature while allowing the runoff with low phosphorus concentration from Forest Lake to move downstream through the Sunrise River. Depending on available capacity in the proposed feature, a portion of the drainage through the ditch may need to bypass the treatment system. The project would also evaluate the feasibility of implementing a filtration feature at the District's tax-forfeited parcels.

Potential benefits

If feasible, the project would reduce the phosphorus load from the City of Forest Lake.

Analysis needed for full feasibility study
Landowner discussions. Site and soils surveys. Flow data analysis. Analysis of cost and phosphorus or flooding reduction benefit.

F. Iron filtration within ditch

Project concept
Many water quality treatment options are effective primarily for the capture of particulate-bound phosphorus, not dissolved phosphorus. Iron-enhanced filtration removes dissolved phosphorus from the water column in situations where oxygen is present. This project would evaluate the feasibility of filtering the flow through the ditch.

Potential benefits
If feasible, the project would reduce phosphorus loading from the City of Forest Lake.

Analysis needed for full feasibility study
Flow data analysis. Ditch water level evaluation. Landowner discussions. Site and soils surveys. Analysis of cost and phosphorus or flooding reduction benefit.

G. Carp Management

Project concept
Carp may be causing spikes in downstream loading from their activity within watercourses and wetlands upstream of Comfort Lake. The movement of carp in the wetlands and the stream channel can to stir up sediment and muck and allow it to flow downstream to Comfort Lake. This project would evaluate carp activities throughout the open water season and evaluate which areas are being used for spawning and investigate the feasibility of managing the carp population through harvesting and fish barriers.

Potential benefits
Reduce phosphorus loads to Comfort Lake from upstream wetlands and watercourses.

Analysis needed for full feasibility study
Evaluation of carp movement throughout the open water season including areas used for spawning. Fish barrier location and design analysis. Landowner discussions. Site and soils surveys. Analysis of cost and phosphorus or flooding reduction benefit.

H. Interaction of road embankments on surface flow

Project concept
The large wetland complex upstream of Comfort Lake extends from Shallow Pond to the more densely developed portions of the City of Forest Lake. This wetland complex is intersected by a number of large roadways including I-35, US 8, CSAH 61 as well smaller roadways such as Greenway Avenue. These road crossings may alter the flow dynamics through the wetland by restricting sub-surface flow and constricting surface flow to one location. This alteration of flows would reduce the diffuse nature of flow through the wetland and limit the ability of flows to spread out across the wetland – limiting the settling of particulate phosphorus and uptake of dissolved phosphorus. This project would evaluate the likely impact of road embankments on flow through the

wetland and would evaluate the feasibility of altering flow patterns through road embankments to allow more diffuse flow.

Potential benefits
Increasing diffuse flow through the wetlands may increase the capture and retention of phosphorus in the wetlands affected by ditches and road embankments. Pulses of phosphorus are known to be exported from wetlands that are subjected to certain artificial hydrologic manipulations. Wetland hydrologic manipulations often favor invasive plant species that can outcompete native, more desirable plant species. Nonnative invasives such as reed canary grass have much less dense root structure which causes soil destabilization and generally reduces overall biomass that is available to absorb nutrients.

Analysis needed for full feasibility study
Landowner discussions. Site and soils surveys. Shallow well and piezometer installation, monitoring and data analysis, analysis of cost and phosphorus or flooding reduction benefit.

I. Water quality treatment feature at Bixby Park

Project concept
The District Water Quality study identified Bixby Park as a location for water quality treatment through two large ponds to settle out materials in runoff through subwatersheds CL61, CL29 and CL12 (which includes upstream drainage from a large area). Bixby Park is located downstream of the City of Forest Lake's most developed areas, but also includes drainage from less developed areas west of I-35 and north of Broadway. Much of the park is ditched wetland. The project would evaluate the feasibility of providing water quality treatment within Bixby Park.

Potential benefits
If feasible, the project would reduce the phosphorus load from the City of Forest Lake.

Analysis needed for full feasibility study
Site and soils surveys. Flow data analysis. Evaluation of effectiveness of existing ponding. Analysis of cost and phosphorus or flooding reduction benefit

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Date |	February 23, 2011		
To |	Doug Thomas	**Contact info |**	CLFLWD
cc |	Board of Managers	**Contact info |**	CLFLWD
From |	Lisa Tilman P.E.	**Contact info |**	EOR
	Jason Naber		EOR
Regarding |	Sunrise River Water Quality and Flowage Project Initial Evaluation and Recommendation		

Project Purpose

The Sunrise River Water Quality and Flowage Project was initiated by a petition from Chisago County. The petition outlines the basis for the project as well as the project goals and approximate location. The petition discusses excess phosphorus load to Comfort Lake as identified in the District's water quality study and the Six Lakes TMDL and also mentions seasonal flooding occurring along portions of the Sunrise River. The project purpose and benefits are identified as:

- Reducing nutrient, sediment and other pollutant loads to Comfort Lake from the Sunrise River as a result of stormwater runoff
- Reducing seasonal flooding issues along portions of the river

The project is described in the petition as a water quality and quantity improvement project. The project location, as identified in the petition, is "within the drainage area to the Sunrise River between the City of Forest Lake and Comfort Lake including all District lands that drain to Comfort Lake via the Sunrise River" and more specifically to "provide treatment of stormwater runoff coming from the developed and commercial areas of the City of Forest Lake around the 35W and US 8" area.

Water Resource Objectives

The project goal is primarily to reduce nutrient and sediment loading to Comfort Lake from the Sunrise River drainage area and secondarily to reduce seasonal flooding along portions of the Sunrise River upstream of Comfort Lake. The Watershed District also acknowledges the additional benefits this type of project provides to the community and the environment. Activities such as wetland and stream restorations provide many ecological benefits but also support recreational opportunities and can serve as a strong educational platform.

Project Approach

The approach for this project is tailored to address the specific characteristics of the watershed. There is not one project or strategy that can address all conditions contributing to the high nutrient loading being delivered to Comfort Lake. There are unique circumstances related to flow regime, nutrient concentrations, pollutant characteristics (dissolved phosphorus or particulate), and other types of environmental factors such as channel stability and fisheries that are factors that require thorough consideration during the feasibility stage. Physical constraints such as topography, wetlands, and land ownership are also important factors that have to be evaluated during the feasibility analysis. The multiple activities proposed for feasibility analysis are targeted in locations that provide the best opportunity to meet nutrient removal objectives and work in concert with the other proposed activities.

System Description and Understanding

The physical characteristics of the Sunrise River watershed are such that many conventional water quality treatment options are not feasible. The relatively flat, broad wetland basins provide ample opportunity for wetland restoration but also significant challenges for some types of water quality improvement projects. Often, ditched wetlands can be enhanced through either obstructing the ditch or converting it to a broader wetland flowage or even a highly sinuous stream channel. In the case of this watershed, the shallow water table, local flooding concerns and extensive wetlands make large-scale water quality improvement projects challenging to implement. The physical characteristics of the drainage system as well as land use are important factors in selecting suitable implementation projects.

In the fall and winter of 2010, the Board heard presentations outlining the types of options available to decrease the phosphorus load to Comfort Lake. The presentations focused on wetland management, stream management, various water quality treatment options for the built environment and considerations for construction and project management. The process was designed to inform the Board of the types of projects that might be applicable in the project area, to make sure that all of the ideas for projects were captured, and to identify a preliminary list of potential projects to be evaluated further. Nine potential projects were identified and proposed for an initial evaluation to assist the Board in determining which projects to move forward with for a full feasibility evaluation and engineer's report.

Evaluation Process

The recommended solutions to be included in the feasibility analysis have been vetted through a multidisciplinary team of professionals. The team evaluated the nine previously identified projects:

1. establishment of a meandering stream in the Sunrise River,
2. increases in stream interaction with the floodplain,
3. retrofits in the developed area of Forest Lake,
4. retrofits in the developed area of Wyoming,
5. water quality feature in the District's tax forfeit land,
6. iron filtration in the ditch,
7. carp management,
8. improved interaction of the road embankments with the wetlands, and
9. a water quality feature in Bixby Park.

The projects were evaluated against the following factors and ranked for each set of categories:

- Identified stakeholder groups and the relative level of effort needed for the stakeholder coordination effort
- Identified permit needs and the relative level of effort needed for the permitting process
- The need for various evaluations in the feasibility study:
  - A site survey, soils testing, in-stream, modeling, water quality modeling, hydraulics modeling, water quality data evaluation, flow data evaluation, wetland delineation, and other needs
- The need for various aspects of implementation
- Project design, land acquisition, construction of structures, land disturbance, passive and active recreation opportunities, and relative level of risk
- The water quality impact of the project:
  - Whether or not the project targets concentrated sources of nutrients
  - The estimated phosphorus load reduction and reduction efficiency
- Ecological tradeoffs faced with the project
  - Whether or not the project addresses volume reductions through infiltration or evapotranspiration or addressed localized flooding concerns
  - The estimated project cost
- The relative cost for feasibility, design, land acquisition, construction and maintenance

- The estimated cost range for feasibility and construction

The attached figure shows the approximate locations of the projects and highlights which projects are recommended for further investigation at this time. The appendix to this memo provides detailed descriptions of the projects included in the initial screening process and provides a matrix used in selecting projects to promote to the feasibility-level analysis.

Recommended Projects

The process by which the aforementioned projects were evaluated allowed a differentiation of certain components or concepts within each project that provided the most benefit. Adaptations to the original projects have been considered for further evaluation, particularly those with considerable cost and constructability constraints. The top concepts derived from the initial project screening process include;

- a water quality feature in the District's tax forfeit land,
- carp management,
- iron filtration,
- a water quality feature in Bixby Park,
- increases in stream interaction with the floodplain,
- and retrofits in the developed area of Forest Lake.

The team also felt that this set of projects would work well together as a process to address goals within the Sunrise River drainage to Comfort Lake. The combination of projects focuses on improvements that comprehensively address issues through the system at a regional, sub-regional, and localized scale. In this case we're considering the regional scale to be the whole system between Forest Lake and Comfort Lake. The sub-regional scale addresses a somewhat smaller area that considers drainage from a number of subwatersheds together. The local scale addresses runoff at the scale of one subwatershed or a portion of a subwatershed. Educational opportunities are available at each of these scales. Educational and recreation opportunities would be coordinated with the relevant cities and counties to integrate with park, open space, and recreational plans for the area, especially for the regional scale projects.

The recommended regional scale projects address the physical condition and biological properties of the system of wetlands between Forest Lake and Comfort Lake. These include a main focus on modifications to increase the stream interaction with the floodplain and carp management and data collection to evaluate the impact of road crossings on the wetland systems and to evaluate the presence of erosion problems in the Sunrise River upstream of Comfort Lake. Past ditching activities have likely increased the channelized nature of the system and decreased the ability of flows to access the broader wetland – limiting the settling of particulate phosphorus and uptake of dissolved phosphorus. A project that would increase interaction with the floodplain would allow the settling of materials in the floodplain rather than their transport within the channel. In addition, the road crossings may alter the flow dynamics through the wetland by restricting sub-surface flow and constricting surface flow to one location and again reducing the diffuse nature of flow through the wetland. By providing the stream access to a broader floodplain, flood storage is increased. Increasing flood storage slows and attenuates peak flows that typically cause the most transport of sediment-bound pollutants downstream. Additionally, flood waters routed into the floodplain are typically filtered through dense vegetation were sediment and nutrients can be absorbed. In some cases, a total volume of stormwater routed downstream can be reduced through evapotranspiration. Naturally functioning floodplains with seasonal wet-dry periods provide critical habitat for many wildlife species and support native plant species uniquely adapted for this hydrologic regime. Another regional scale issue is the impact of fisheries, particularly carp, on the sediment and phosphorus load to Comfort Lake. Carp have been observed in the Sunrise River all the way to the Forest Lake outlet. A project that limits the movement of carp in the wetlands and the stream channel can limit the amount of stirred up sediment and muck that flows downstream to Comfort Lake. The regional evaluation will also consider the need for stabilization or a remeander of the portion of the Sunrise River just upstream of Comfort Lake to limit sediment transport through excessive stream erosion if the current channel is found to be unstable.

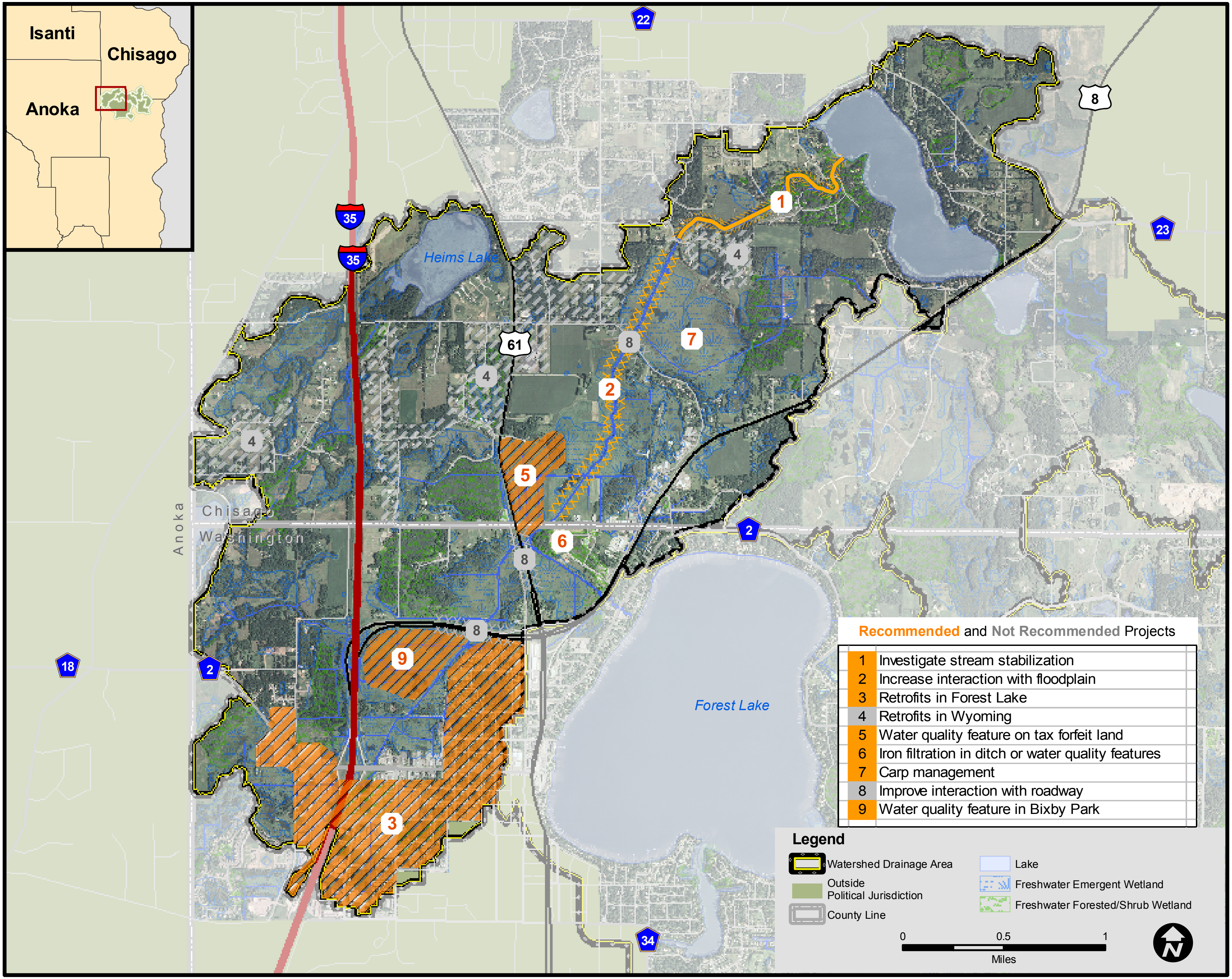
On the sub-regional scale, opportunities exist for improvements in water quality that address the somewhat more concentrated flows through the ditch system feeding the Sunrise River. The drainage through Bixby Park and the drainage from the area around Heims Lake are expected to have higher concentrations of runoff based on modeling and monitoring results. Water quality treatment through restorations of the flowage and wetland systems in these areas are likely to provide a benefit for water quality. Pulses of phosphorus are known to be exported from wetlands that are subjected to certain artificial hydrologic manipulations, reversing these manipulations and restoring wetland function can restore the natural treatment capabilities of the wetland system.

Further benefits in water quality are expected if actions are targeted directly to the most concentrated sources: the urbanized areas of Forest Lake. Retrofit projects could include a number of practices as suitable for the conditions of the area to be treated. Fully developed sites with little green space could be modified to include practices such as raingardens, biofiltration, and tree boxes if additional green space is desired, or below ground facilities such as infiltration or filtration galleries if green space isn't desired. The more open areas could incorporate practices such as raingardens and filtration or infiltration basins, and wetland treatment systems. Incorporation of water quality treatment practices close to the source increases the removal efficiency and ensures that identified sources are directly targeted leading to reductions in phosphorus load downstream. Since the system was developed prior to full consideration for stormwater treatment, it may be difficult to identify sites to provide local treatment for all of the drainage from developed areas at this time. Loads to downstream resources would be reduced and the regional and sub-regional modifications would be expected to provide the additional treatment needed with input nutrient levels that would better support wetland health. In this way, the local, sub-regional, and regional projects work together to address the excess phosphorus loads to Comfort Lake while also supporting the health of the wetland and stream systems.

The Feasibility Study and Engineer's Report will investigate the combined implementation of these efforts with an in-depth focus on the regional and sub-regional scale projects and an identification of specific sites for implementation of practices on the local scale. Regional and sub-regional scale feasibility analysis will emphasize floodplain enhancements, carp management, wetland restoration and water quality treatment. Supportive data will be collected to evaluate if road embankments are impacting flow through the system so that recommendations can be made to road authorities when future road modifications are planned. Data will also be collected to evaluate the need for stabilization or remeander of the Sunrise River between 256th Street and Comfort Lake so that future modifications could be planned as a later phase or later project. Site specific evaluations will consider incorporation of iron enhanced filtration in weirs and other systems where the use appears feasible, but the incorporation of iron enhancements will not be a primary focus of the feasibility study. The investigations on the local scale will identify potential project sites. A future project or later phase of this project will be needed to complete the implementation of identified retrofit projects.

Next Steps

In order for the CLFLWD to move forward with the Sunrise River Water Quality and Flowage Project the next step is for the Board of Managers to order an Engineer's Report be prepared for the Recommended Projects identified in this memo. The feasibility study guiding the Engineer's Report will include a number of steps that lead to the preliminary design of feasible options. The project steps will include data collection and analysis, site surveys, wetland delineation, water quality and hydrologic/hydraulic modeling, public outreach and landowner coordination, feasibility analysis and preliminary design, and preparation of the Engineer's Report consistent with the requirements of MN Statute 103D.711. A detailed scope and cost estimate for the Feasibility Study and Engineer's Report is included as a separate document. This Scope of Work details recommended activities and itemizes costs to complete each.



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Appendix: Initial Project Screening

Each of the following projects were considered as part of an initial screening process. Some of these projects have been selected for further analysis in the Feasibility Study and Engineer's Report. In some cases, only certain components of the project have been recommended for further consideration. The "Recommended Solutions" section of this memo includes a hybrid of these distinct projects and a rationale for promoting certain concepts to the feasibility analysis level.

Reestablish Sunrise River meander pattern

Project concept: Reestablish the historic meander pattern of the Sunrise River. Prior to ditching projects, the natural conveyance feature may have been a stream with a more sinuous flow pattern. The inclusion of additional meanders in the current ditched sections of this watercourse will increase the overall flow length and enhance connectivity to the surrounding wetlands.

Potential benefits: The increased flow length will more closely mimic a stable, naturalized stream that can enhance overall ecosystem function. Stabile stream channels transport less sediment than those experiencing erosion caused by bed and bank instability. Other benefits of a naturalized channel include habitat enhancement, aesthetics and in some cases provide greater recreation opportunities.

Analysis needed for feasibility study: Review of historical photos and other historical documents (e.g. ditch plans). Collection of soils data along current and potential future stream location. Survey of current and potential future stream locations. Modeling of in-stream conditions to evaluate erosive conditions. Cost and phosphorus or flooding reduction benefit analysis.

Initial Screening Evaluation Summary: The likely stakeholders in a remeander or relocation of the Sunrise River include a number of private landowners and the Department of Natural Resources. The level of effort expected to coordinate this type of project through a stakeholder process is high. The effort for coordinating the permitting process is also expected to be high when relocating a river. The permits expected to be needed include NPDES, WCA, ACOE, and DNR. A feasibility study would include surveys along the future location of the river, soil testing, instream modeling to evaluate flow conditions and stability, a careful evaluation of monitored flow data, a wetland delineation, and an in-depth review of ditch records along with current and historical aerial photographs. Passive educational aspects could be incorporated into the project (e.g. signs at crossings). Because of the scale of this effort and the potential for high flows to disrupt construction and site establishment phases of the project, this project will require careful planning and close observation to manage the high level of risk. A nutrient reduction benefit cannot be easily estimated for this type of project, but fish and wildlife benefits would be expected. It is possible that the project could reduce flooding. A review of historical aerial photographs do not show a readily apparent former channel. Historical ditch records show a historical meandering pattern in the section of the river between 256th Street and Comfort Lake. This project would be expected to range in cost from $200,000 to $500,000 with significant variables such as length of stream being considered.

Recommendation: Conduct evaluation of section between 256th Street and Comfort Lake to evaluate stability and need for stabilization or remeander. Recommended for data collection and analysis only at this time.

Increase Sunrise River interaction with floodplain

Project concept: Many watercourses similar to this reach of the Sunrise River have built up mounds of sediment along the bank of stream either from past dredging activity or as a result of flood conditions. These mounds limit the access of water to the surrounding wetland and confine flows to the stream that could otherwise have spread out into the wetland. One strategy for this project would be to reshape the stream channel to increase the stream's interaction with the floodplain. Designs such as a two stage channel, baffles in the ditch that divert high flows or simply the removal of any flow-constraining spoil piles would be evaluated. Another strategy to enhance floodplain interaction would be to identify areas that could retain elevated floodwaters after the flows in the main branch of the drainage system recede. This approach would target subtle topographic depressions or "pockets" very close to the flood elevation that could be modified to retain runoff from high flow events.

Potential benefits: The increased interaction with the floodplain will allow the settling of materials in the floodplain rather than their transport within the channel. By providing the stream access to a broader floodplain, flood storage is increased. Increasing flood storage slows and attenuates peak flows that typically cause the most transport of sediment-bound pollutants downstream. Additionally, flood waters routed into the floodplain are typically filtered through dense vegetation were sediment and nutrients can be absorbed. In some cases, a total volume of stormwater routed downstream can be reduced through evapotranspiration. Naturally functioning floodplains with seasonal wet-dry periods provide critical habitat for many wildlife species and support native plant species uniquely adapted for this hydrologic regime.

Analysis needed for feasibility study: Survey of stream. Collection of soils data in and along stream. Modeling of in-stream conditions to evaluate erosive conditions. Evaluation of stream modification designs. Cost and phosphorus or flooding reduction benefit analysis.

Initial Screening Evaluation Summary: The stakeholders in a project to increase the interaction of the Sunrise River with its floodplain would include a number of private landowners and the Department of Natural Resources. The level of effort to coordinate this type of project through a stakeholder process is expected to be high. The effort for coordinating the permitting process is expected to be moderate with WCA, ACOE, and DNR permits needed. Passive educational aspects could be incorporated into the project (e.g. signs at public locations where the river is visible, newspaper articles). Implementing activities that accomplish this project objective are expected to have a moderate level of risk. For example, simple reshaping of the ditch channel to eliminate constraints caused by spoil piles would be low risk but creating additional floodplain storage through impoundments or excavations would present a higher level of risk. A phosphorus reduction benefit of 25 pounds per year was estimated by just assuming flows routed through wetlands will be reduced to the phosphorus outflow concentrations typical of wetland enhancement projects. Additionally, the project would provide phosphorus load reductions by retaining and evapotranspirating stormwater retained in the "pockets". At this time it is difficult to estimate phosphorus removal without knowing the extent of storage available. The project location is expected to focus primarily on the wetland between the county line and Greenway Ave, but could also include Shallow Pond depending on field observations and the results of data analysis. This project would be expected to range in cost from $100,000 to $300,000 with minor spoil pile removals being significantly lower in cost than increasing floodplain storage through creation or enhancement of topographic depressions.

Recommendation: Conduct full feasibility study.

Forest Lake area developed area retrofits

Project concept: The highest phosphorus concentrations in runoff appear to be originating in the more densely developed portions of the City of Forest Lake. This finding is consistent with the results of the District-wide water quality model. This project would identify and evaluate specific options for stormwater management to reduce the phosphorus concentration and load leaving subwatersheds CL61, CL82, CL33, CL32, CL04, CL03, CL05, CL06, CL07, and CL02.

Potential benefits: If feasible, the project would incorporate BMPs into the landscape of the subwatersheds with the highest concentration of phosphorus in runoff, lowering the contributed load.

Analysis needed for feasibility study: Subwatershed studies to identify potential sites for practices and identify potential types of practices (subwatersheds CL61, CL82, CL33, CL32, CL04, CL03, CL05, CL06, CL07, and CL02). Landowner discussions. Site and soils surveys. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The stakeholders in a project to incorporate stormwater treatment in the developed areas of the City of Forest Lake that drain to Comfort Lake through the Sunrise River would likely include the city and a number of private landowners. The level of effort to coordinate this set of projects through a stakeholder process is expected to be high. The effort for coordinating the permitting process is expected to be moderate with NPDES and city permits needed. Interactive and passive educational aspects are possible (e.g. tour of constructed facilities, signs at the facilities, newspaper articles). Because retrofit projects have to work with existing infrastructure and the challenges associated with working in densely developed areas, these projects are expected to have a moderate level of risk. A phosphorus reduction benefit of 138 pounds per year was estimated based on treatment of half the area of the target subwatersheds. It is possible that the projects could reduce volumes through increased evapotranspiration. This project would be expected to range in cost from $1.7 million to $2.6 million.

Recommendation: Identify sites for future projects. Recommended for site identification and analysis at this time. Revisions to the project scope can be made after completion of identification and analysis to add feasibility and design work for specific projects as desired by the Board.

Wyoming area retrofits

Project concept: Higher phosphorus concentrations in runoff were also identified from the residential development areas of Wyoming. This project would identify and evaluate specific options for stormwater management to reduce the phosphorus concentration and load leaving subwatersheds CL43, CL49, CL50, CL51, CL52, CL38, and CL39.

Potential benefits: If feasible, the project would incorporate BMPs into the landscape of the subwatersheds with the highest concentration of phosphorus in runoff, lowering the contributed load.

Analysis needed for feasibility study: Subwatershed studies to identify potential sites for practices and identify potential types of practices (subwatersheds CL43, CL49, CL50, CL51, CL52, CL38, and CL39). Landowner discussions. Site and soils surveys. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The stakeholders in a project to incorporate stormwater treatment in the developed and agricultural areas of the City of Wyoming that drain to Comfort Lake through the Sunrise River would likely include the city and a number of private landowners. The level of effort to coordinate this set of projects through a stakeholder process is expected to be high. The effort for coordinating the permitting process is expected to be moderate with NPDES and city permits needed. Interactive and passive educational aspects are possible (e.g. tour of constructed facilities, signs at the facilities, newspaper articles). The projects are expected to have a moderate level of risk for similar reasons described above for retrofit projects. A phosphorus reduction benefit of 92 pounds per year was estimated based on treatment of half the area of the target subwatersheds. It is possible that the projects could reduce volumes through infiltration or increased evapotranspiration and may therefore reduce any downstream flooding concerns. This project would be expected to range in cost from $690,000 to $920,000.

Recommendation: Not recommended for full feasibility study at this time – drainage to be addressed to an extent though recommended tax forfeit property modifications.

Water quality treatment feature at tax forfeit property

Project concept: The District owns properties along and adjacent to the Sunrise River which could be used for water quality treatment. The District-owned land is located downstream of where the Sunrise River and the ditch system join together and therefore treatment at this site would include drainage from Forest Lake itself as well as drainage from the City of Forest Lake through the ditch system. The project would evaluate re-routing the ditch to the treatment feature while allowing the runoff with low phosphorus concentration from Forest Lake to move downstream through the Sunrise River. Depending on available capacity in the proposed feature, a portion of the drainage through the ditch may need to bypass the treatment system. The project would evaluate the feasibility of implementing a filtration feature at the District's tax-forfeited parcels.

Potential benefits: If feasible, the project would reduce the phosphorus load from the City of Forest Lake.

Analysis needed for feasibility study: Landowner discussions. Site and soils surveys. Flow data analysis. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The likely stakeholders in a project to incorporate water quality improvements on the District's tax forfeited lands would include the Department of Natural Resources and two private landowners. The level of effort to coordinate this project through a stakeholder process is expected to be moderate. The effort for coordinating the permitting process is expected to be moderate with NPDES, WCA, ACOE, and DNR permits needed. Interactive and passive educational aspects are possible (e.g trails, signs at the facility, newspaper articles). The project is expected to have a low level of risk due to the limited number of stakeholders and the project's low susceptibility to problems during construction and site establishment. A phosphorus reduction benefit of 531 pounds per year was estimated based on water quality modeling. It is possible that the project could limit downstream flooding by storing water. This project would be expected to range in cost from $4.9 million to $6.2 million.

Recommendation: Conduct full feasibility study.

Iron filtration within the ditch

Project concept: Many water quality treatment options are effective primarily for the capture of particulate-bound phosphorus, not dissolved phosphorus. Iron-enhanced filtration removes dissolved phosphorus from the water column in situations where oxygen is present. This project would evaluate the feasibility of filtering the flow through the ditch.

Potential benefits: If feasible, the project would reduce phosphorus loading from the City of Forest Lake.

Analysis needed for feasibility study: Flow data analysis. Ditch water level evaluation. Landowner discussions. Site and soils surveys. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The stakeholders in a project to incorporate iron filtration within the ditch would likely include the Department of Natural Resources and the city. The level of effort to coordinate this project through a stakeholder process is expected to be low. The effort for coordinating the permitting process is expected to be moderate with WCA, ACOE, and DNR permits needed. Passive educational aspects are possible for most potential sites, but interactive educational opportunities may be available if iron filtration is incorporated into other projects such as a water quality treatment feature at a tax forfeit property. The project is expected to have a low level of risk because of its limited construction footprint and relatively short construction and site reestablishment period. A phosphorus reduction benefit of 44 pounds per year was estimated based on an evaluation of ditch flows and nutrient concentrations. The project may limit fish movement through the ditch and is not expected to provide flooding benefits. One filtration weir approximately 15-20 feet long on peat soils approximately 15 feet deep with relatively reasonable access is expected to cost approximately $150,000.

Recommendation: Evaluate as suitable to specific project designs.

Carp management

Project concept: Carp may be causing spikes in downstream loading from their activity within watercourses and wetlands upstream of Comfort Lake. The movement of carp in the wetlands and the stream channel can to stir up sediment and muck and allow it to flow downstream to Comfort Lake. This project would evaluate carp activities throughout the open water season and evaluate which areas are being used for spawning and investigate the feasibility of managing the carp population through harvesting and fish barriers.

Potential benefits: Reduce phosphorus loads to Comfort Lake from upstream wetlands and watercourses.

Analysis needed for feasibility study: Evaluation of carp movement throughout the open water season including areas used for spawning. Fish barrier location and design analysis. Landowner discussions. Site and soils surveys. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The stakeholders in a project to manage carp within the Sunrise River system would primarily be the Department of Natural Resources. Permits from the DNR would likely be required for any fish barriers installed. The level of effort to coordinate this project through a stakeholder process is expected to be low. The effort for coordinating the permitting process is expected to be low as well. Passive educational aspects are possible for this project (e.g. newspaper articles). Since the carp management strategy has limited impact on land surface are and is focused on key locations for barriers or other types of population control practices, the project is expected to have a low level of risk The phosphorus reduction benefit could not be easily quantified for this type of project. The project may have fisheries impact and limit fish movement through the ditch. Typically fish barriers require a moderate level of at least seasonal maintenance. The project is not expected to provide flooding benefits. This project would be expected to range in cost from $100,000 to $300,000.

Recommendation: Conduct full feasibility study.

Interaction of road embankments on surface flow

Project concept: The large wetland complex upstream of Comfort Lake extends from Shallow Pond to the more densely developed portions of the City of Forest Lake. This wetland complex is intersected by a number of large roadways including I-35, US 8, CSAH 61 as well smaller roadways such as Greenway Avenue. These road crossings may alter the flow dynamics through the wetland by restricting sub-surface flow and constricting surface flow to one location. This alteration of flows would reduce the diffuse nature of flow through the wetland and limit the ability of flows to spread out across the wetland – limiting the settling of particulate phosphorus and uptake of dissolved phosphorus. This project would evaluate the likely impact of road embankments on flow through the wetland and would evaluate the feasibility of altering flow patterns through road embankments to allow more diffuse flow.

Potential benefits: Increasing diffuse flow through the wetlands may increase the capture and retention of phosphorus in the wetlands affected by ditches and road embankments. Pulses of phosphorus are known to be exported from wetlands that are subjected to certain artificial hydrologic manipulations. Wetland hydrologic manipulations often favor invasive plant species that can out-compete native, more desirable plant species. Nonnative invasives such as reed canary grass have much less dense root structure which causes soil destabilization and generally reduces overall biomass that is available to absorb nutrients.

Analysis needed for feasibility study: Landowner discussions. Site and soils surveys. Shallow well and piezometer installation, monitoring and data analysis, cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The likely stakeholders in a project to manage the interaction of road embankments on flow through the wetland complexes within the Sunrise River system would be cities of Wyoming and Forest Lake, the DNR, MnDOT, and Washington and Chisago Counties. The level of effort to coordinate this project through a stakeholder process is expected to be high. The effort for coordinating the permitting process with local road authorities and permitting agencies is expected to be moderate. Passive educational aspects are possible for this project (e.g. newspaper articles). Actually installing new road crossing carries considerable risk when structural and transportation issues are considered. For the District to work with road authorities during reconstruction project to incorporate more suitable crossings is low risk. The phosphorus reduction benefit could not be easily quantified for this type of project. Depending on how the new crossings are configured, flooding benefits may be provided. Assuming no construction costs for the District, the costs for data collection and coordination with the road authorities is approximately $50,000.

Recommendation: Not recommended for full feasibility study at this time.

Water quality treatment feature at Bixby Park

Project concept: This project has been carried forward from previous work conducted by Wenck in the 2008 Water Quality Study. The concept is to create a water quality treatment pond to treat stormwater runoff from the urban parts of Forest Lake.

Potential benefits: If feasible, the project would reduce the phosphorus load from the City of Forest Lake.

Analysis needed for feasibility study: Landowner discussions. Site and soils surveys. Flow data analysis. Cost and phosphorus reduction benefit analysis.

Initial Screening Evaluation Summary: The likely stakeholders in a project to improve water quality treatment in the ditches and wetland complexes within the Bixby Park would be City of Forest Lake and the DNR. The level of effort to coordinate this project through a stakeholder process is expected to be moderate. Coordination with the City of Forest Lake will be needed to ensure that the project meshes well with City plans for the land. The effort for coordinating the permitting process is expected to be moderate with WCA, ACOE, DNR and city permits needed. Passive educational aspects are possible for this project (e.g. newspaper articles) with some potential for more interactive education within Bixby Park. The project is expected to have a moderate level of risk because of the large project scale and temporary impacts to aquatic resources. The phosphorus reduction benefit was previously estimated in the District's Water Quality Study (Wenck, 2008) to be 315 pounds for two large excavated ponds. The project is not expected to provide flooding benefits. This project would be expected to range in cost from $3.6 million to $5.6 million. If the project concept was adapted more towards a wetland restoration than a treatment pond, project costs could be reduced likely by 50% and phosphorus reductions would also be less than estimated for the ponding features.

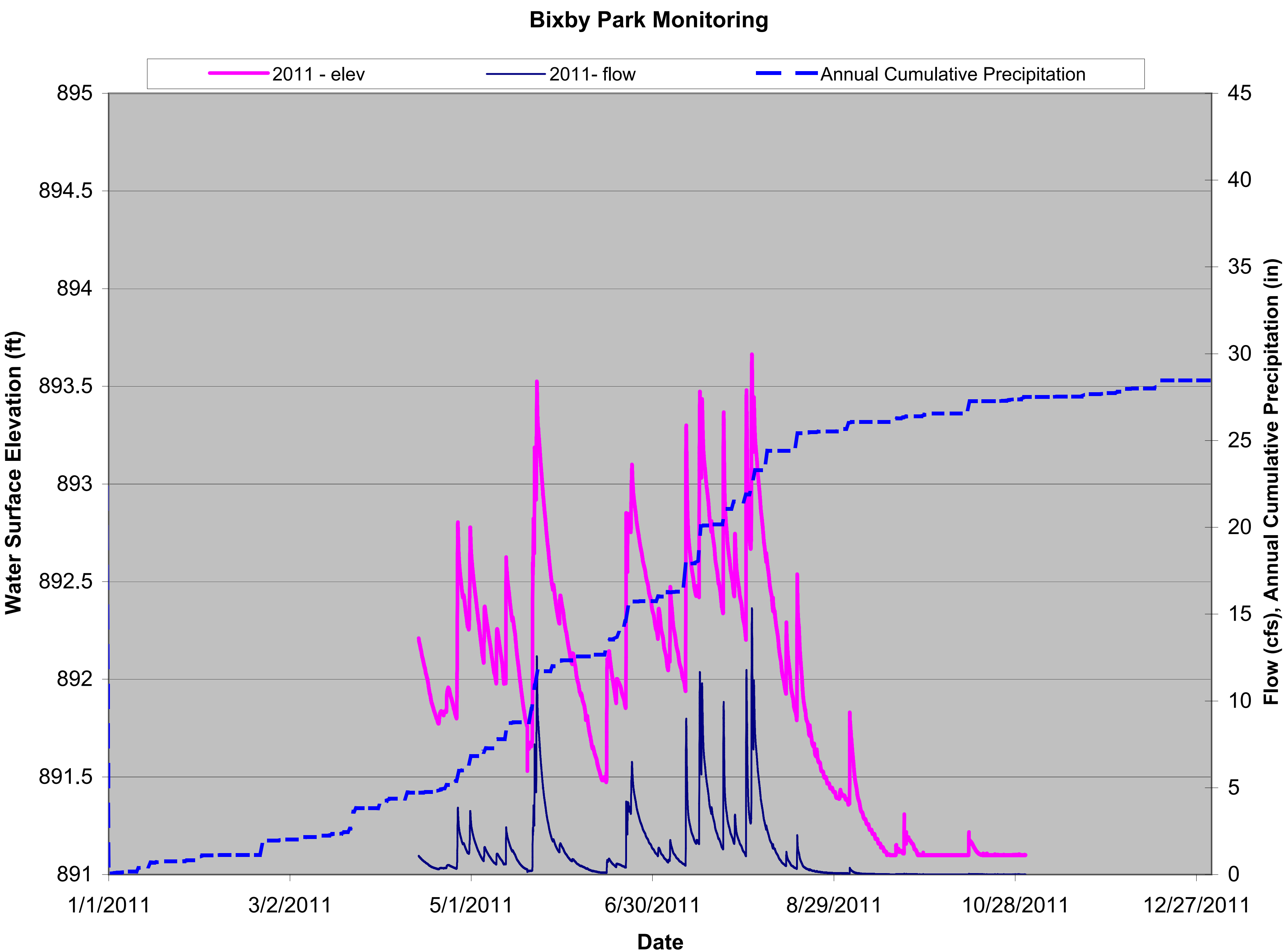
Recommendation: Conduct full feasibility study for a wetland restoration rather than a ponding system to reduce project costs and in consideration of future upstream retrofits.

Project Option	Stakeholders						Permitting							Feasibility Study Considerations								
	City	Private landowner	DNR	MnDOT	County	Level of coordination effort	NPDES	WCA	ACOE	DNR –Waters/fisheries	Municipal	Other	Permitting Process Level of effort	Site Survey	Soils testing	Modeling – in stream	Modeling – water quality	Modeling - hydraulics	Evaluation of water quality data	Evaluation of flow data	Wetland Delineation	Other
Reestablish Sunrise River meander pattern		✓	✓			H	✓	✓	✓	✓		401 cert.	H	✓	✓	✓				✓	✓	Review of historical data: ditch records, current and historical aerial photos
Increase stream interaction with floodplain		✓	✓			H		✓	✓	✓		401 cert.	M	✓	✓	✓					✓	
Forest Lake area developed -area retrofits	✓	✓				H	✓				✓		M	✓	✓		✓		✓	✓		Subwatershed studies to identify locations for practices
Wyoming area developed-area retrofits	✓	✓				H	✓						M	✓	✓		✓		✓	✓		Subwatershed studies to identify locations for practices
Water quality treatment feature at tax forfeit property		✓	✓			M	✓				✓		L	✓	✓		✓		✓	✓	✓	
Iron filtration within ditch			✓			L		✓	✓	✓			M	✓	✓					✓		Water level analysis in ditch
Carp Management			✓			M				✓			L	✓	✓		✓			✓		Evaluation of carp movement
Interaction of road embankments on surface flow	✓		✓	✓	✓	H		✓	✓	✓			M	✓	✓			✓			✓	Shallow well and piezometer installation, monitoring & data analysis
Water quality treatment feature at Bixby Park	✓		✓			L	✓	✓	✓	✓	✓		L	✓	✓							Evaluation of effectiveness of existing ponds

Project Option	Implementation Considerations							Nutrient Reduction Benefits				Volume/Flood Reduction Benefits			Estimated Cost					
	Design	Land Acquisition	Construction of structures	Land disturbance	Level of risk	Passive Education Opportunities (e.g. signs)	Interactive Education Opportunities (e.g. trails)	Targets Concentrated Sources	Estimated Phosphorus reduction efficiency	Estimated Load Reduction	Ecological tradeoffs	Infiltration – vol. reduction	Evapotranspiration – vol. reduction	Addresses localized flooding concerns	Feasibility	Design	Land	Construction	Maintenance	Total cost range
Reestablish Sunrise River meander pattern	✓	✓		✓	H	✓			3	25	Stream vs wetland disturbance			possible	H	H	H	H	L	$200,000-$500,000
Increase stream interaction with floodplain	✓			✓	L	✓			3	25	Wetland disturbance		✓	possible	L	L	L	M	L	$100,000-$300,000
Forest Lake area developed -area retrofits	✓	✓	✓	✓	M	✓	✓	✓	60	138			✓	possible	H	M	M	H	M	$1.7M – $2.6M
Wyoming area developed-area retrofits	✓	✓	✓	✓	M	✓	✓	✓	60	92		✓		possible	H	M	M	M	M	$690,000 – $920,000
Water quality treatment feature at tax forfeit property	✓		✓	✓	L	✓	✓		37	531	May have wetland impact			possible	M	M	L	M	M	$4.9M – $6.2M
Iron filtration within ditch	✓	✓	✓	✓	L	✓			90	44	May block fish movement				M	M	L	L	L	$150,000
Carp Management	✓	✓	✓	✓	L	✓			*	*	Fisheries impacts				L	M	L	M	H	$100,000-$300,000
Interaction of road embankments on surface flow	✓		✓	✓	H	✓			*	*				possible	L	L	L	L	L	$50,000
Water quality treatment feature at Bixby Park	✓		✓	✓	L	✓		✓	50	315	May have wetland impact				M	M	L	H	M	$3.6M – $5.6M

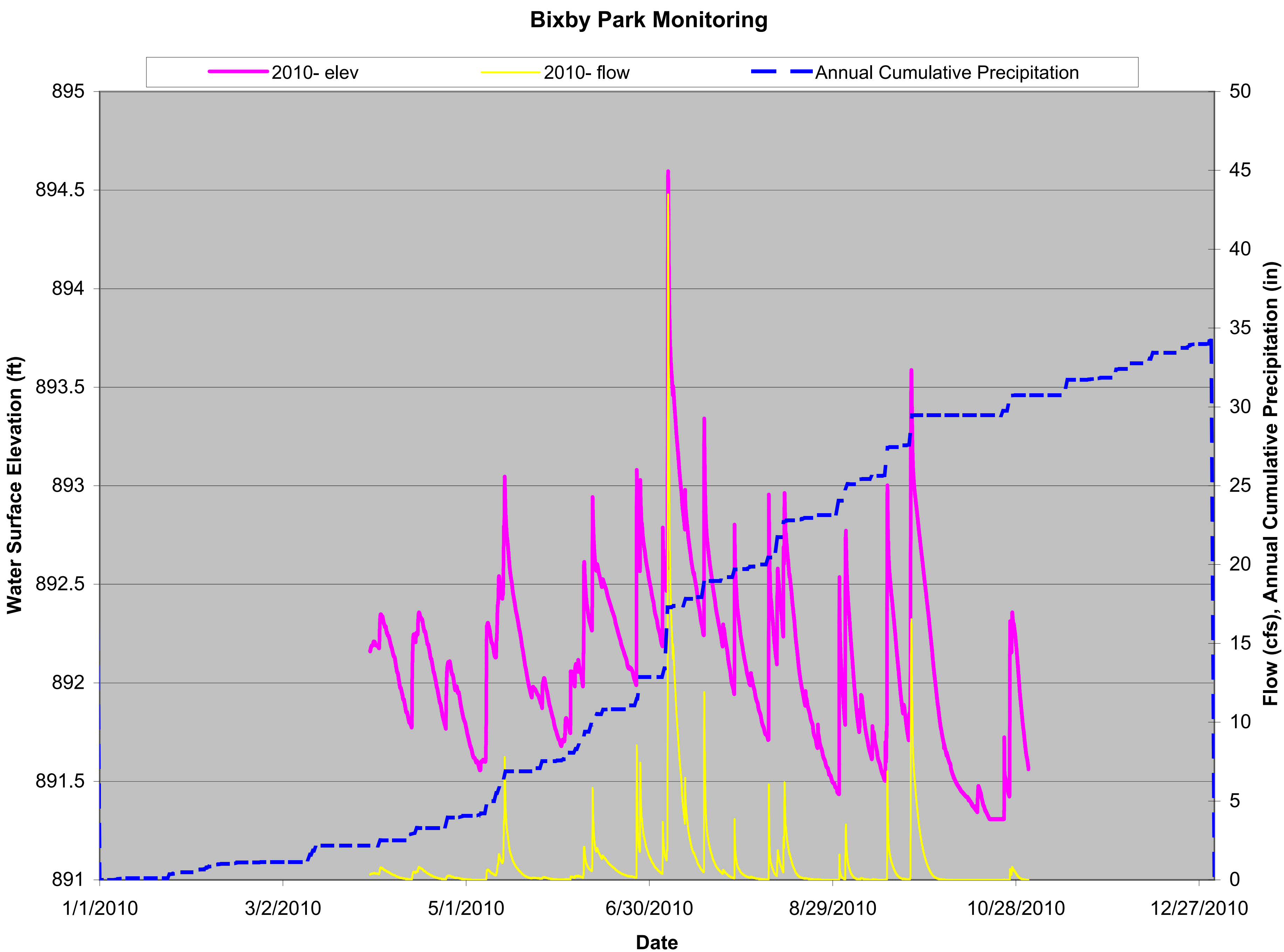
* Not possible to estimate without more design specificity or data.

Appendix B. Water Quality, Flow, Water Surface Elevation Data



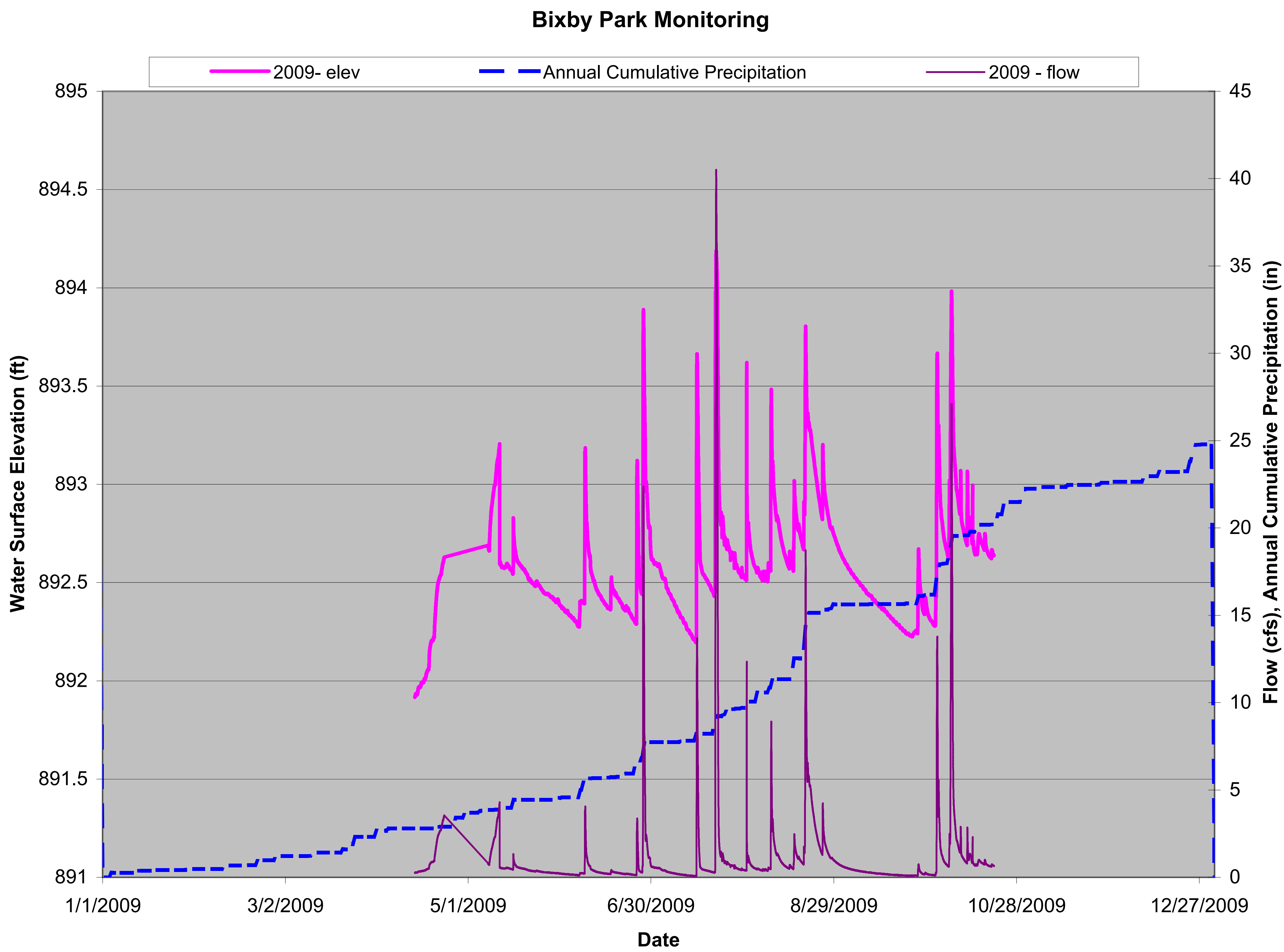
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph flow elev 2011



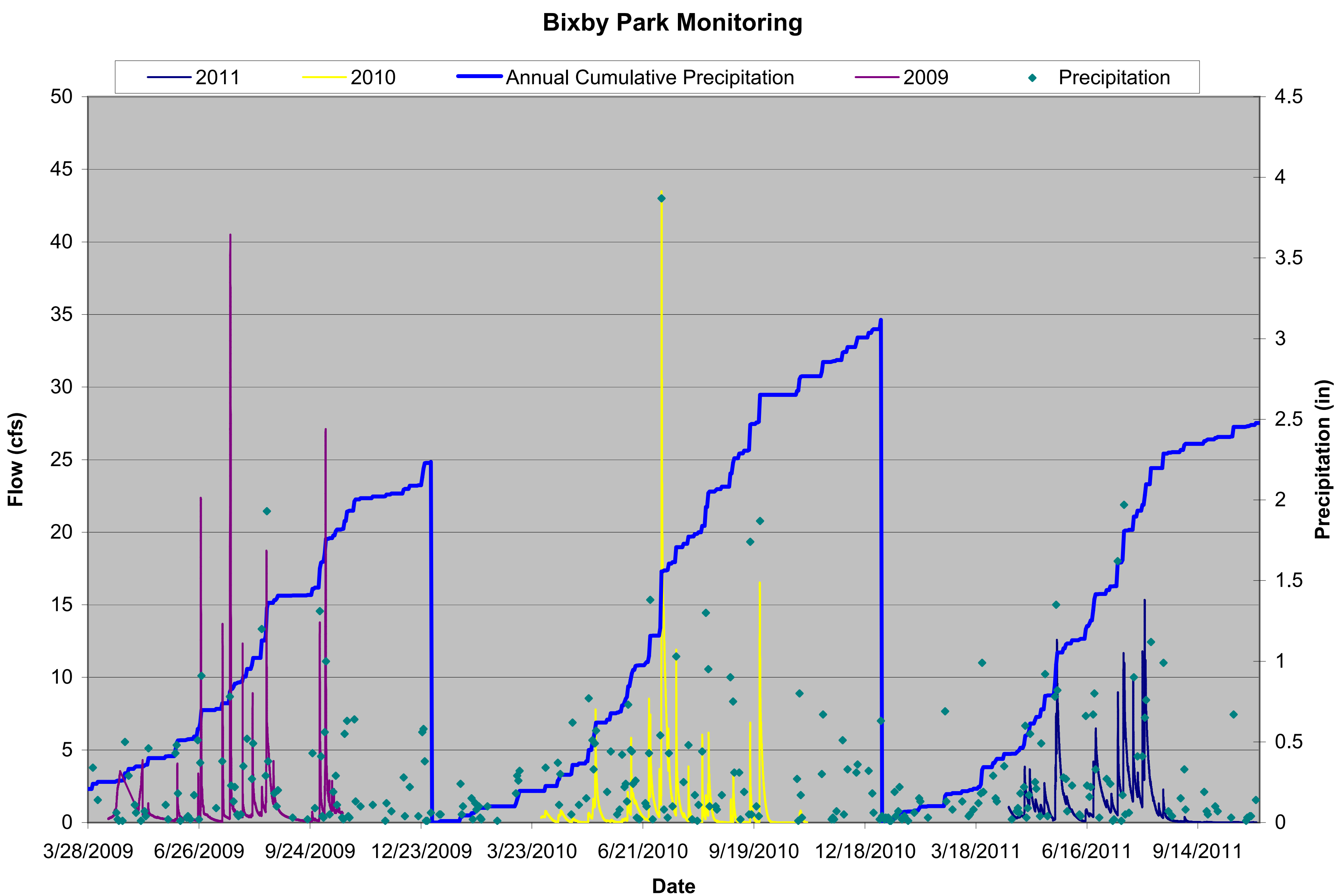
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph flow elev 2010



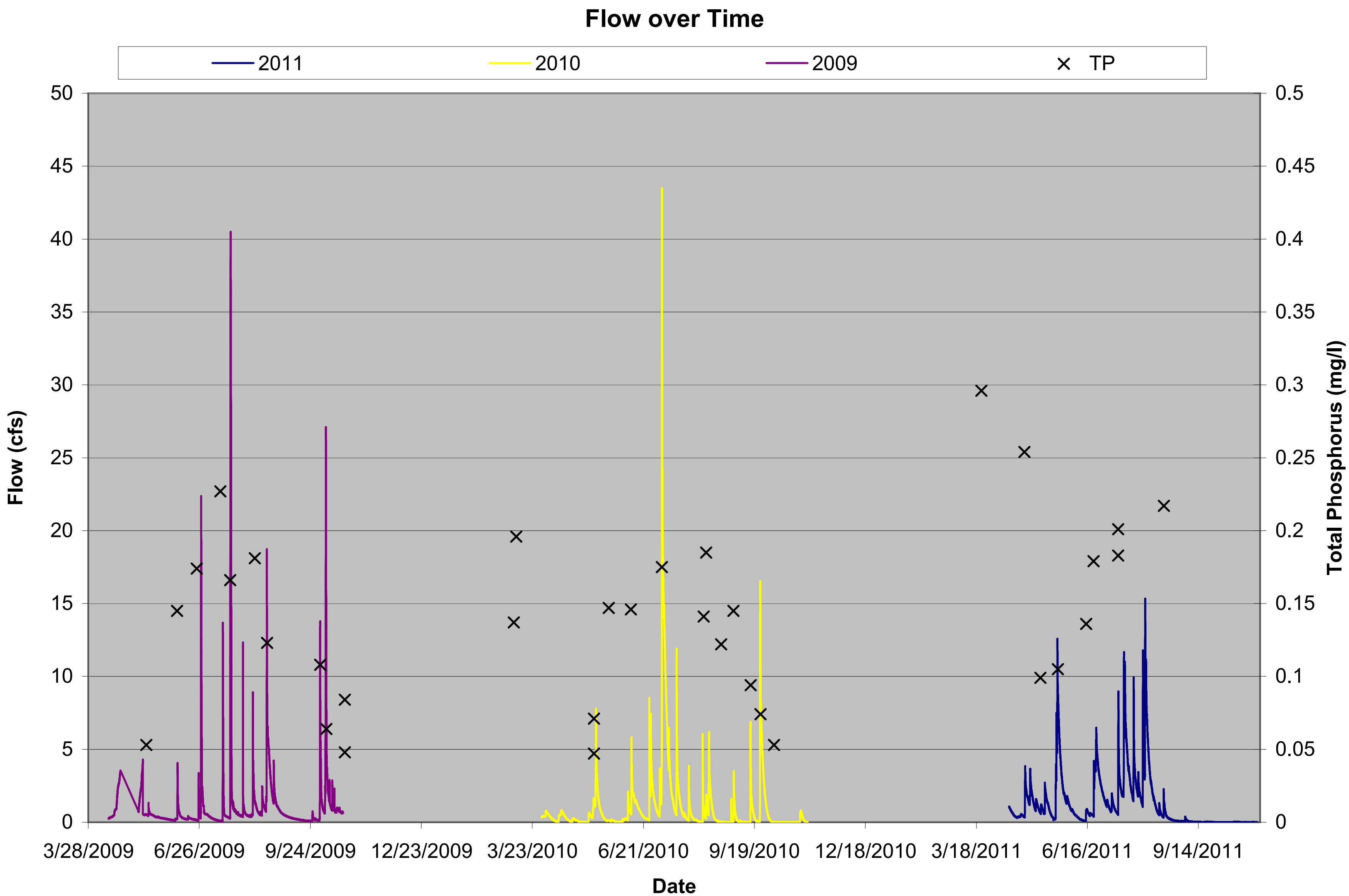
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph flow elev 2009

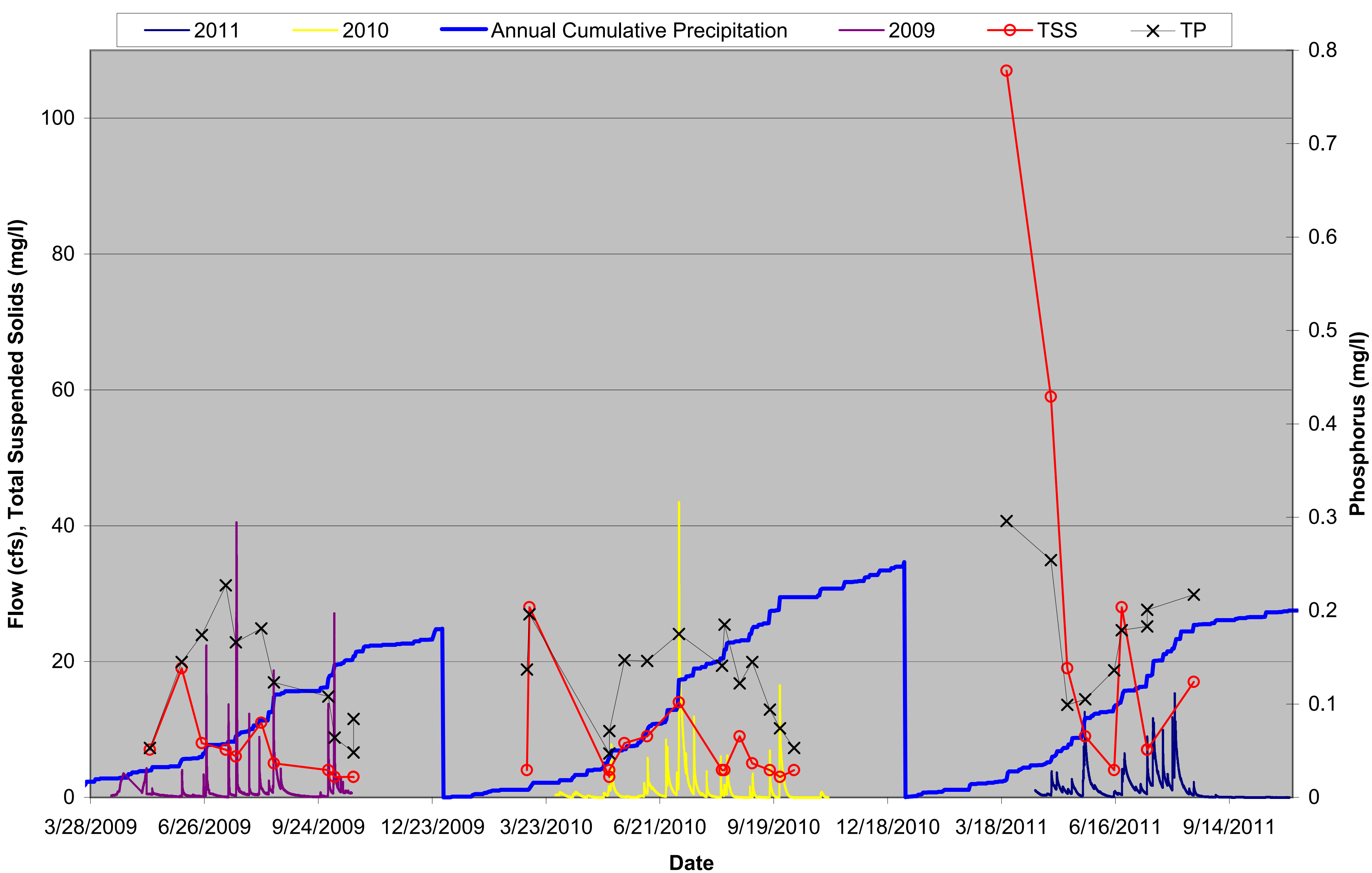


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph (Flow +Precip)

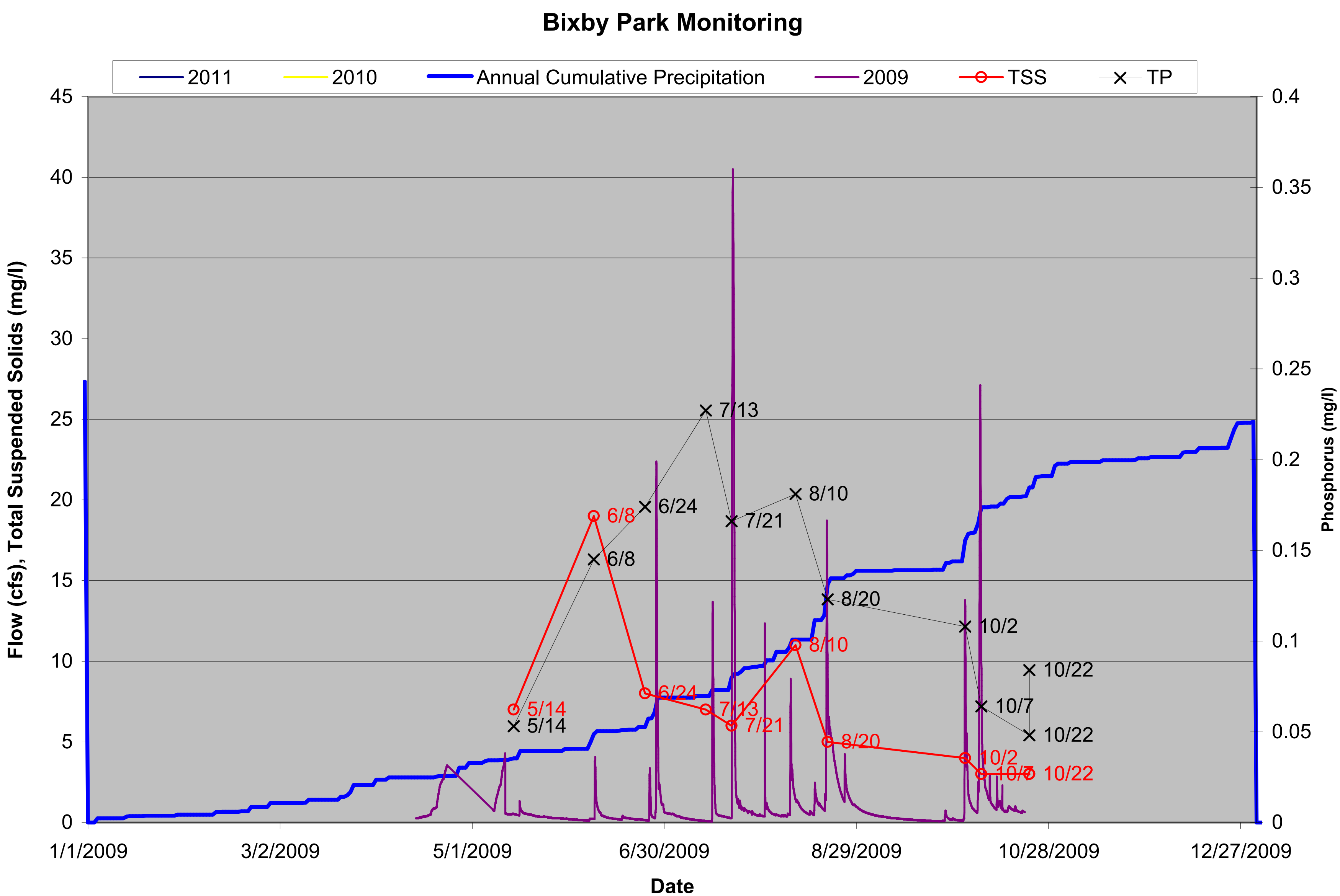

Flow over Time
2011
2010
2009
TP
Flow (cfs)
0
5
10
15
20
25
30
35
40
45
50
Total Phosphorus (mg/l)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
3/28/2009
6/26/2009
9/24/2009
12/23/2009
3/23/2010
6/21/2010
9/19/2010
12/18/2010
3/18/2011
6/16/2011
9/14/2011
Date

Bixby Park Monitoring



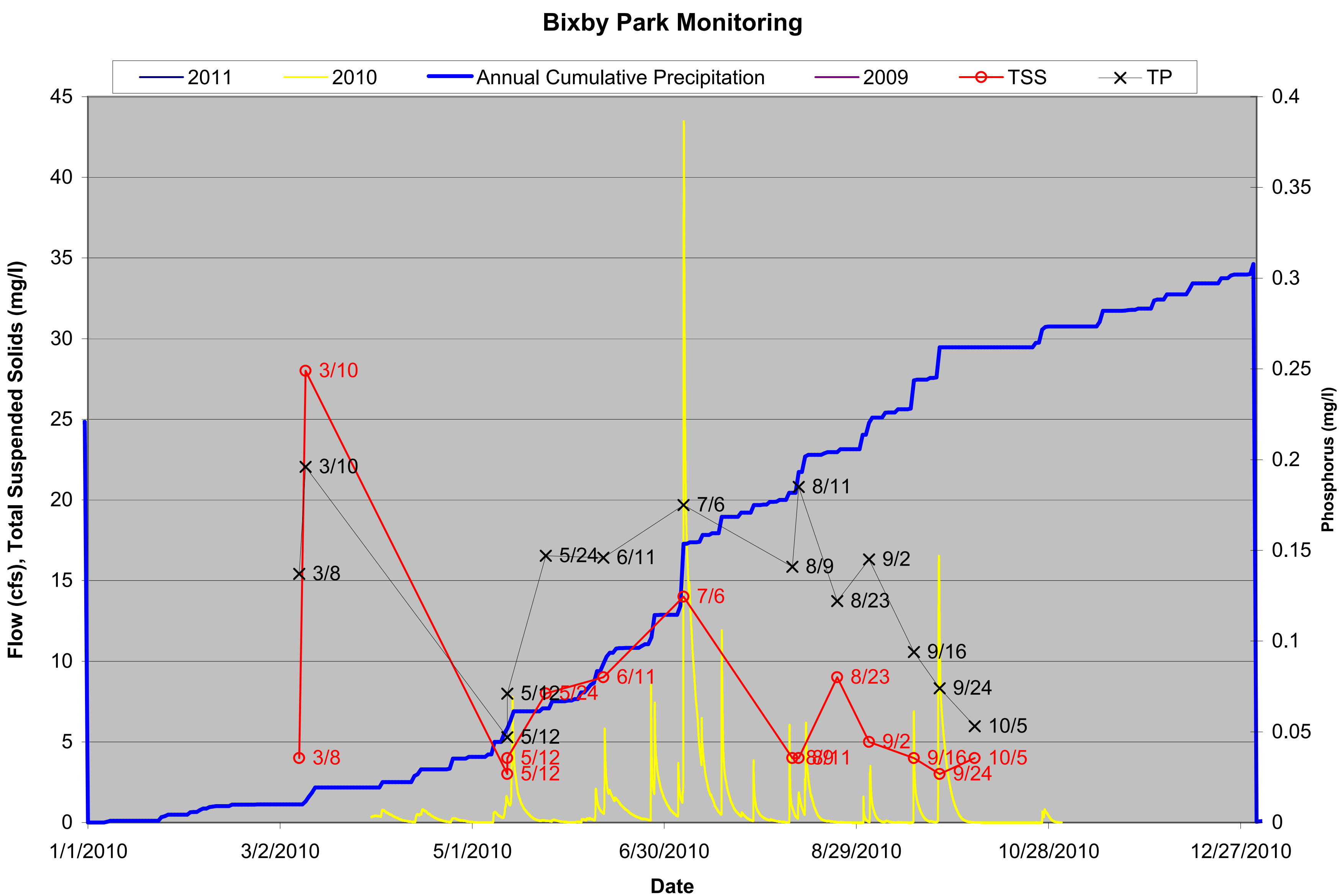
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph (TP+TSS)



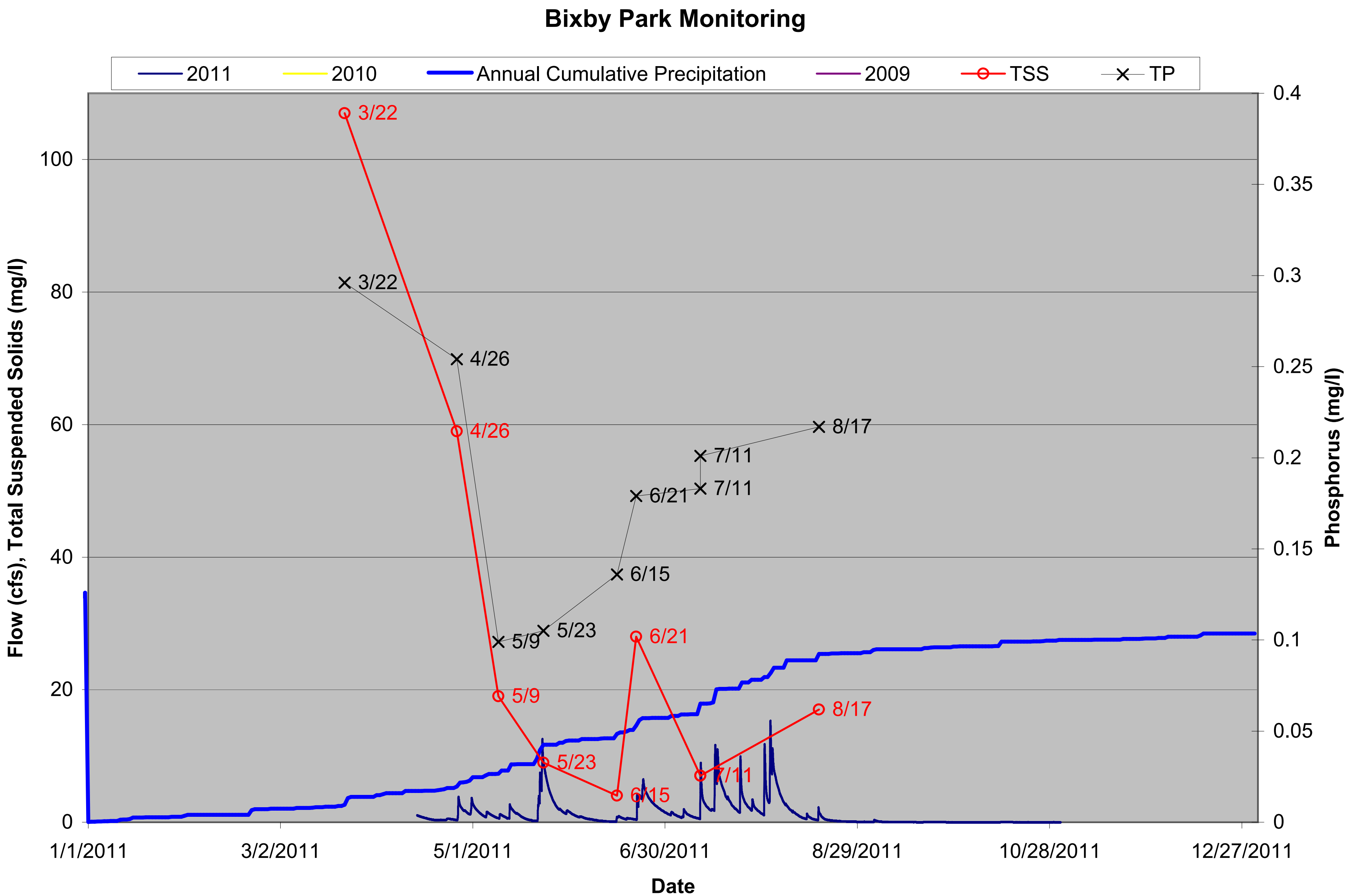
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

Graph (TP+TSS) 2009



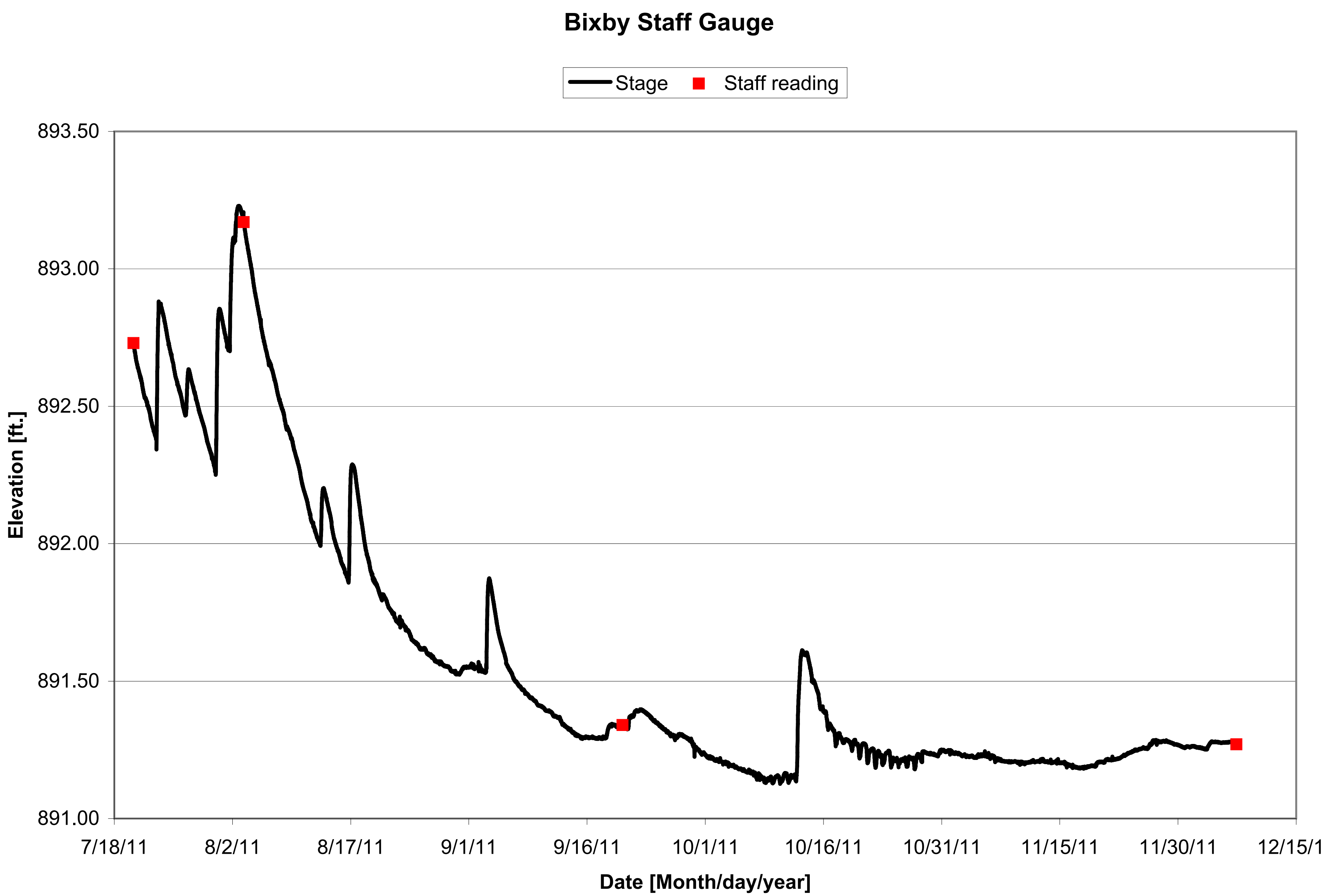
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

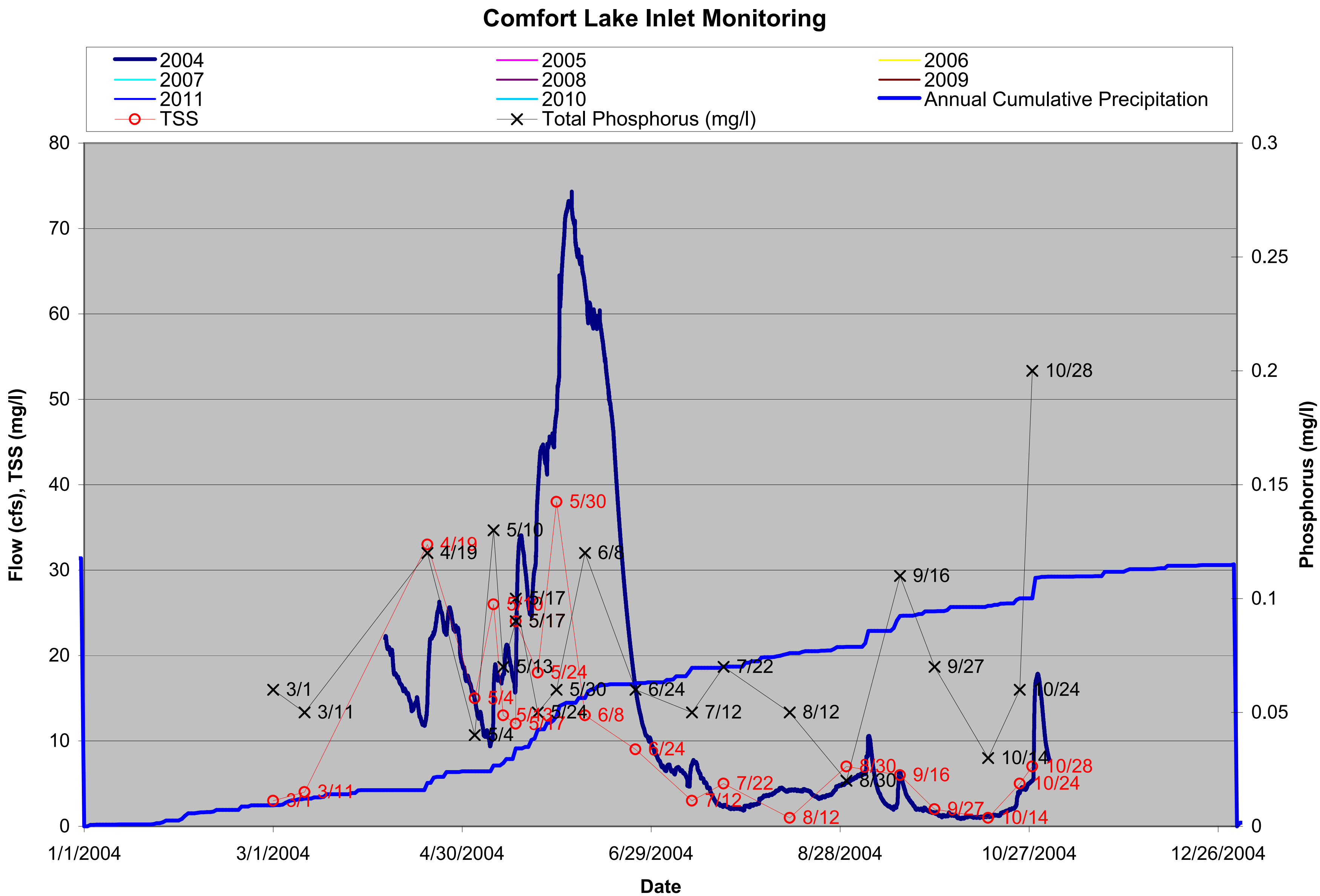
Graph (TP+TSS) 2010



X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Bixby Park.xls

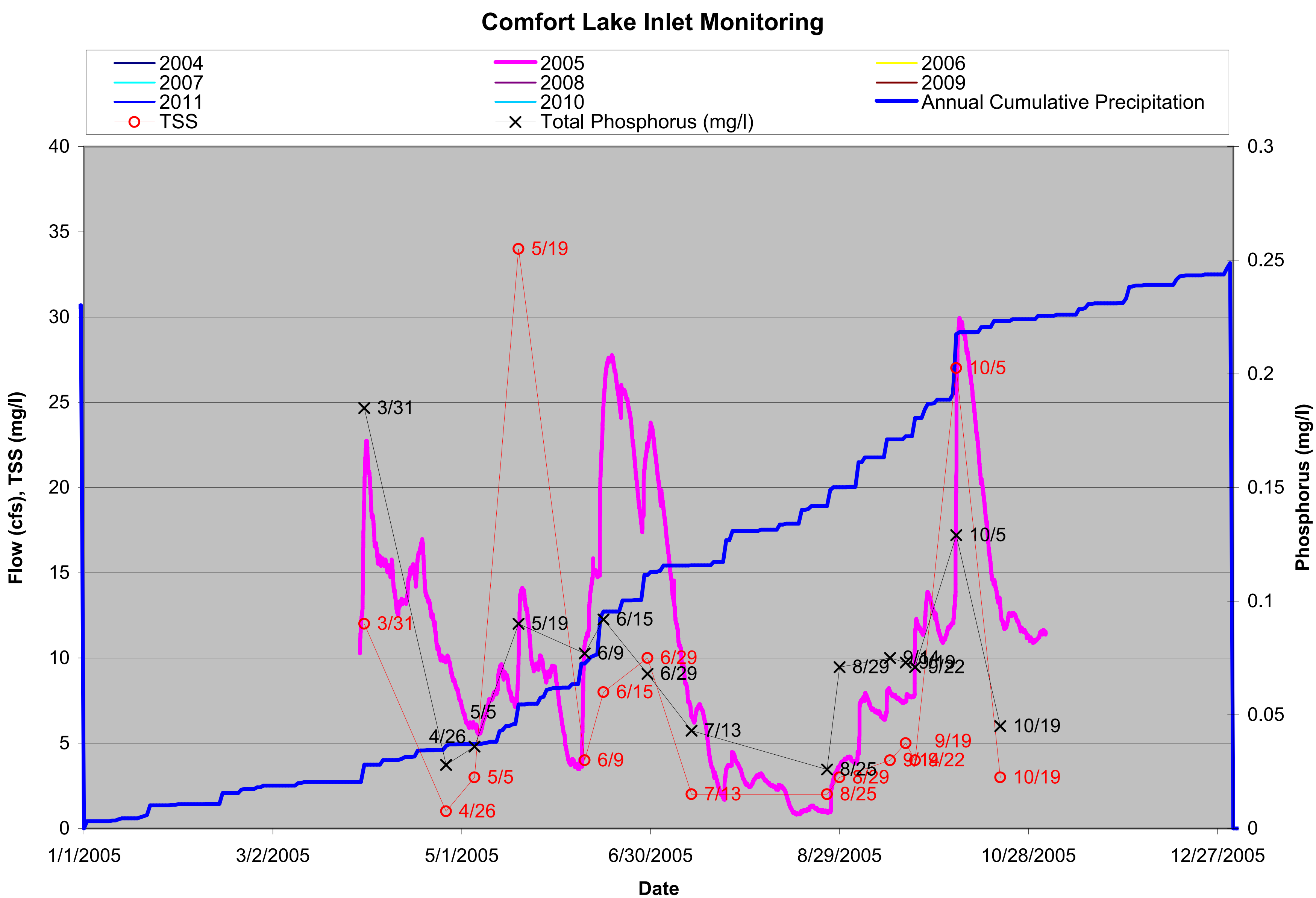
Graph (TP+TSS) 2011


Bixby Staff Gauge
Stage
Staff reading
893.50
893.00
892.50
892.00
891.50
891.00
Elevation [ft.]
7/18/11
8/2/11
8/17/11
9/1/11
9/16/11
10/1/11
10/16/11
10/31/11
11/15/11
11/30/11
12/15/11
Date [Month/day/year]



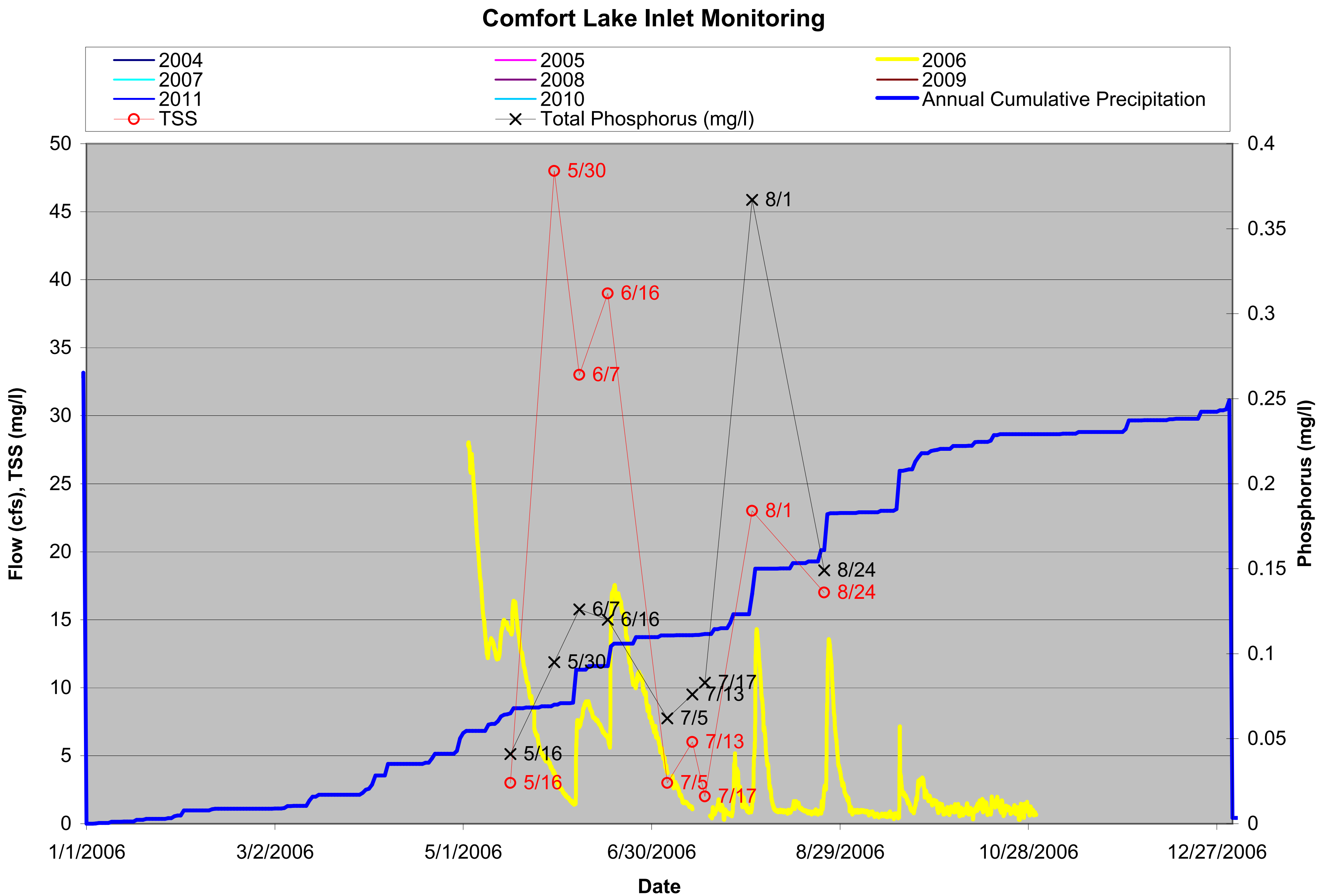
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2004)



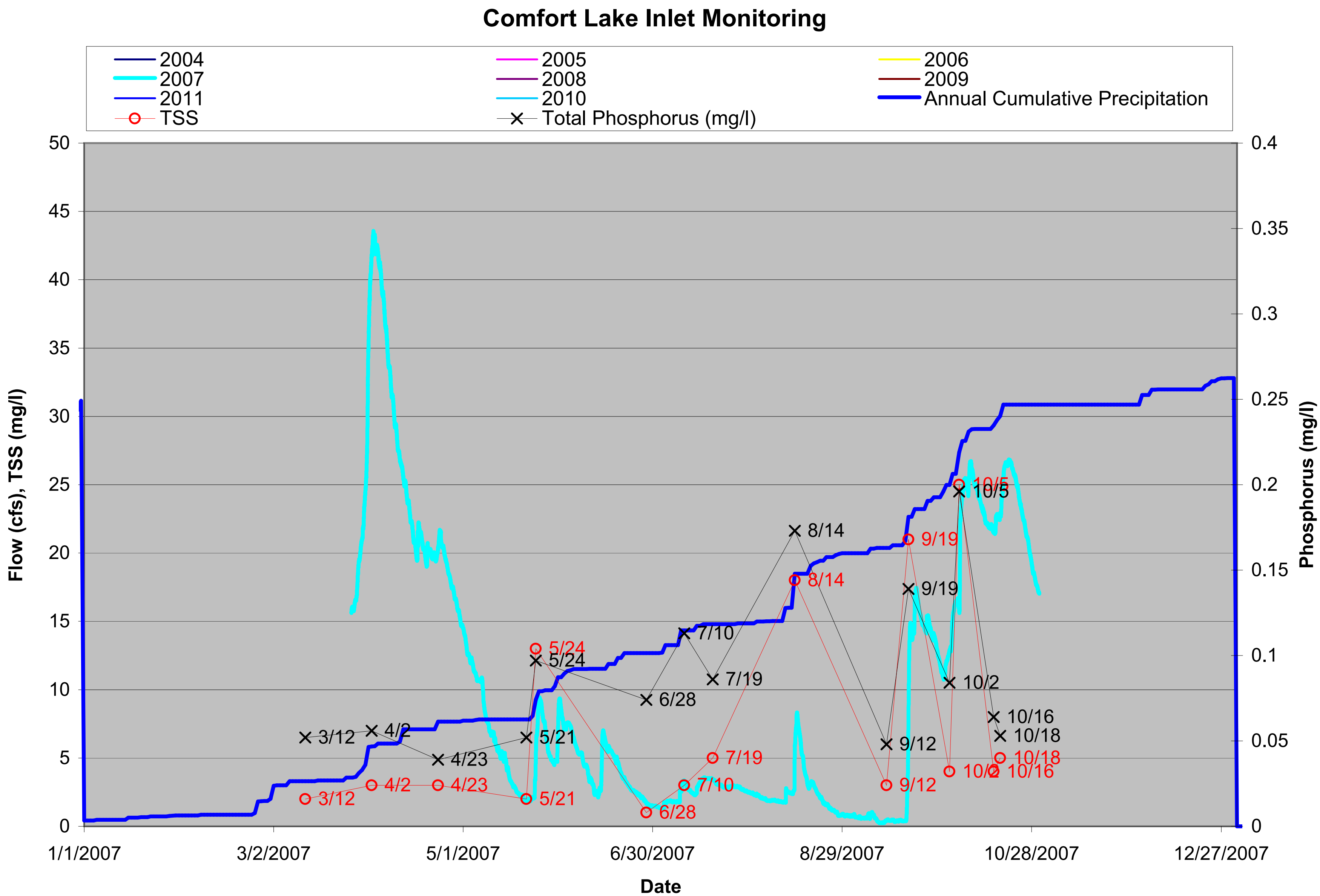
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2005)



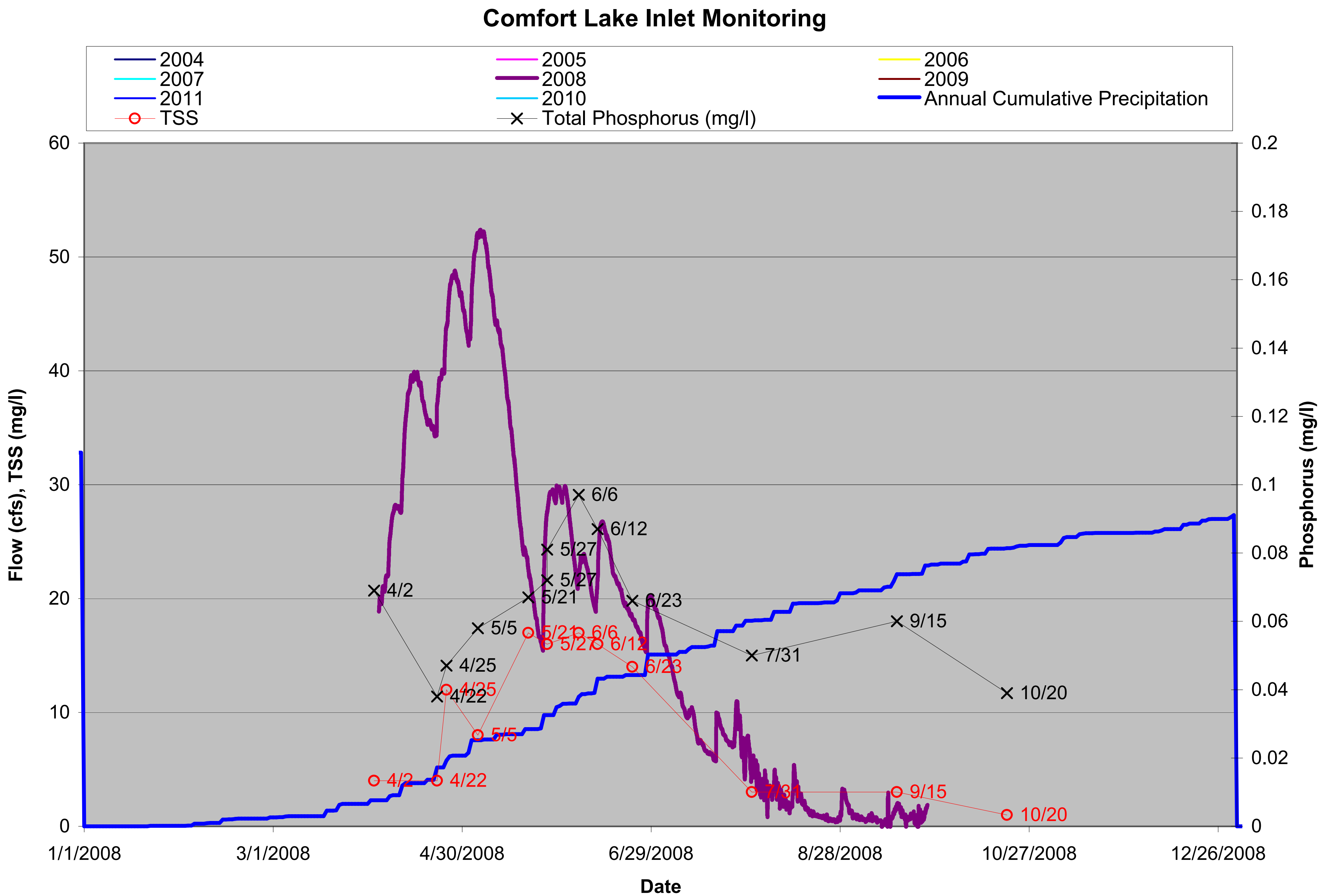
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2006)



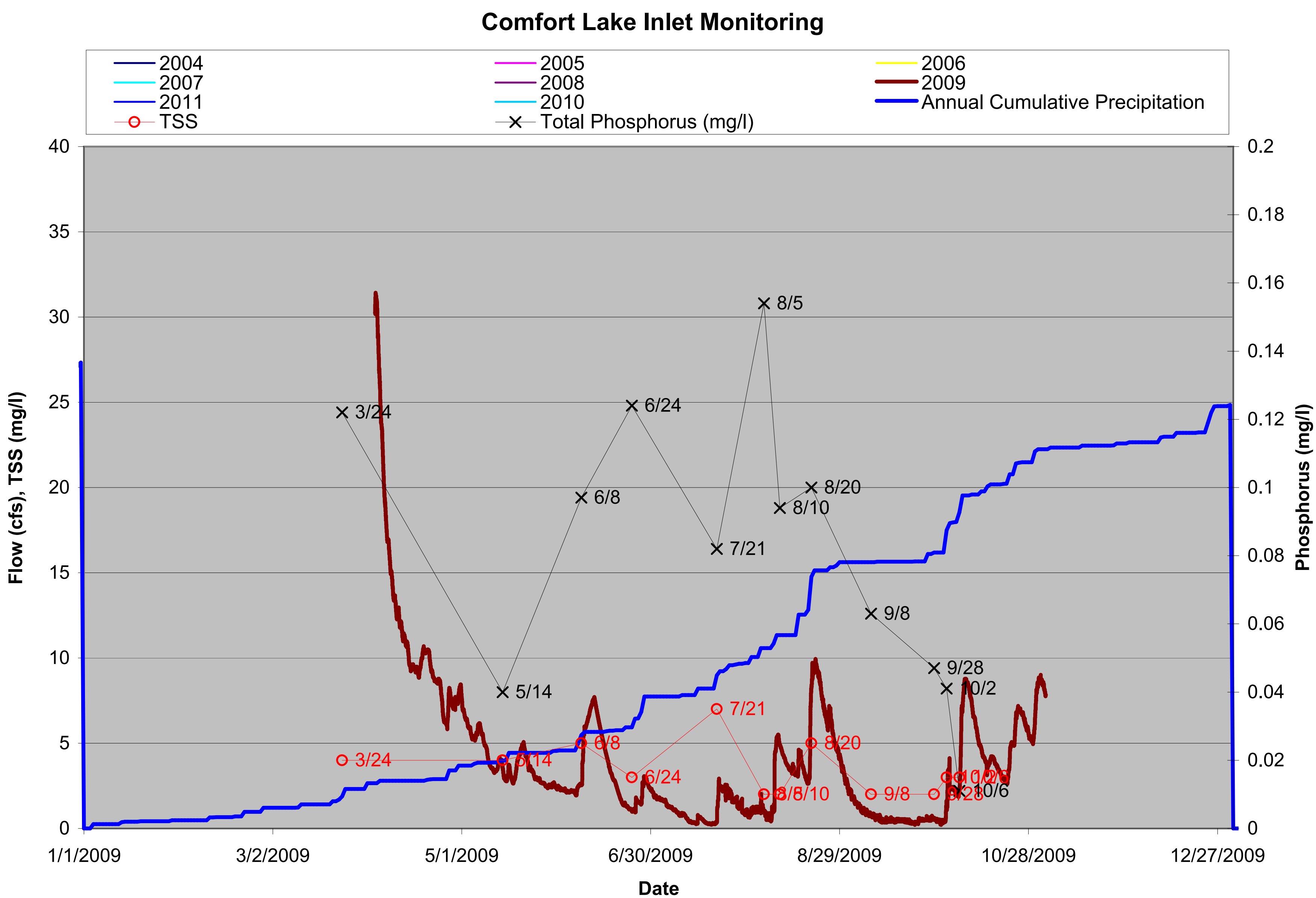
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2007)



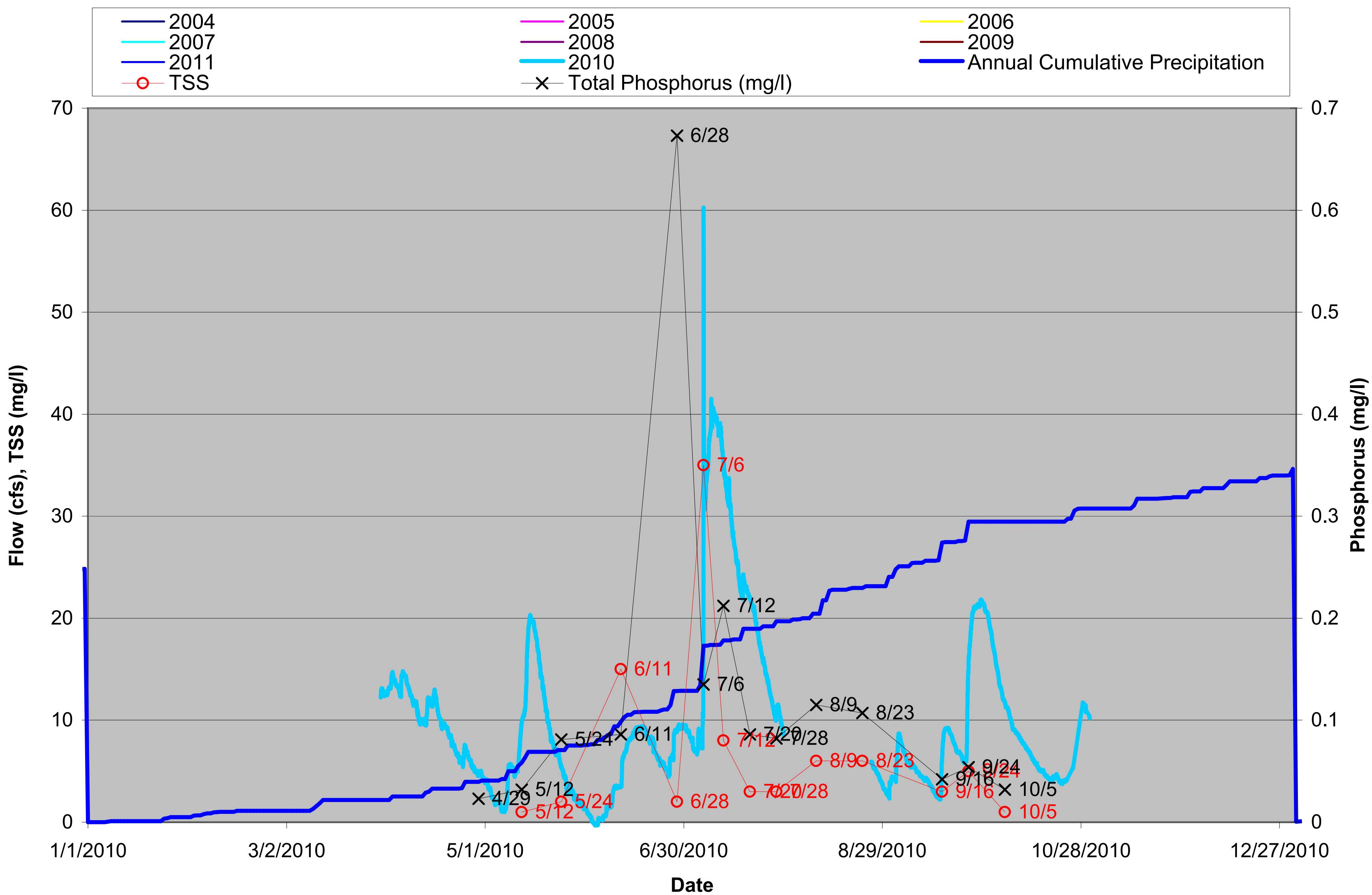
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2008)



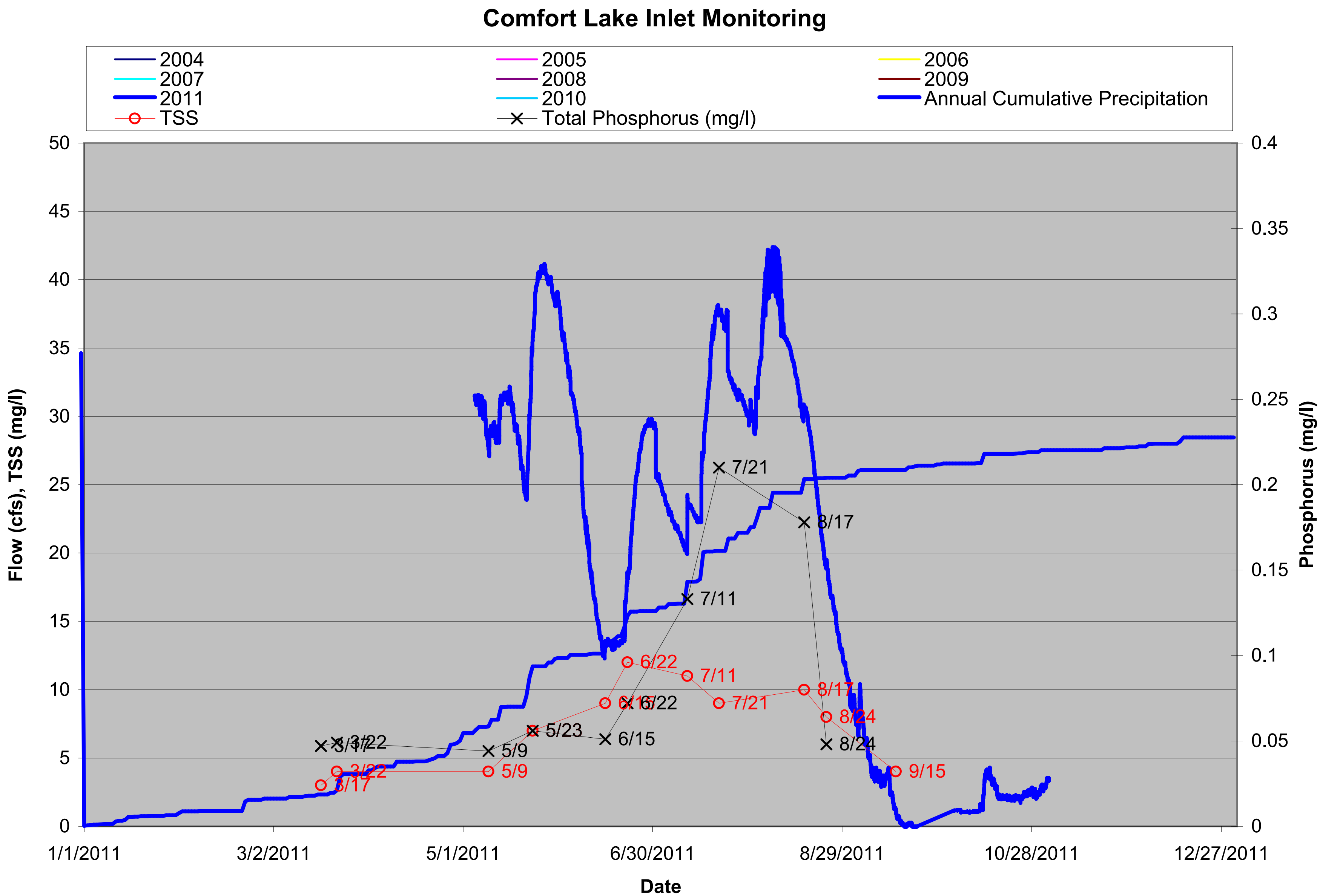
Comfort Lake Inlet Monitoring
2004
2005
2006
2007
2008
2009
2011
2010
Annual Cumulative Precipitation
TSS
Total Phosphorus (mg/l)
Flow (cfs), TSS (mg/l)
Phosphorus (mg/l)
Date
0
5
10
15
20
25
30
35
40
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
1/1/2009
3/2/2009
5/1/2009
6/30/2009
8/29/2009
10/28/2009
12/27/2009
3/24
5/14
6/8
6/24
7/21
8/5
8/10
8/20
9/8
9/28
10/2
10/6

Comfort Lake Inlet Monitoring



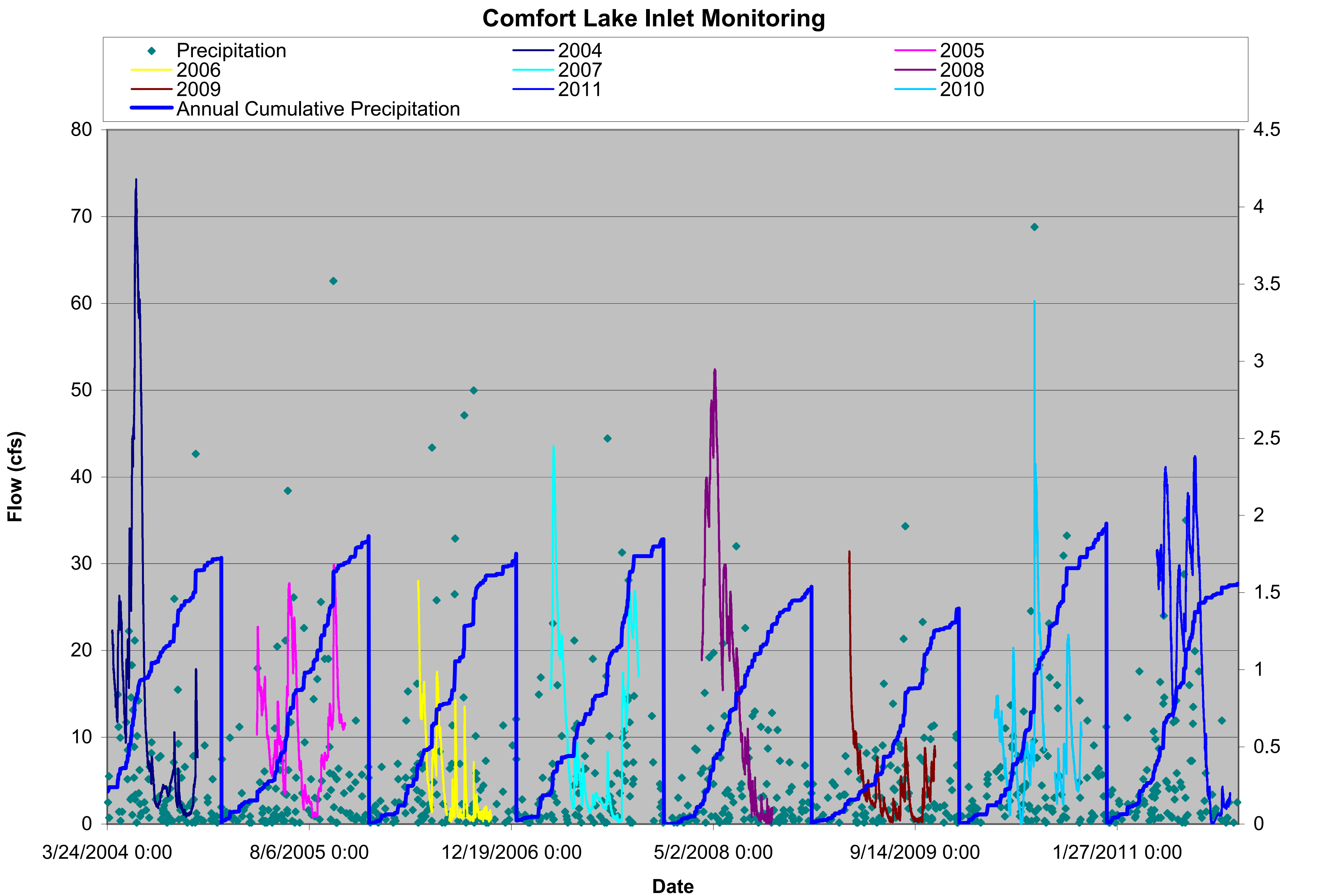
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2010)



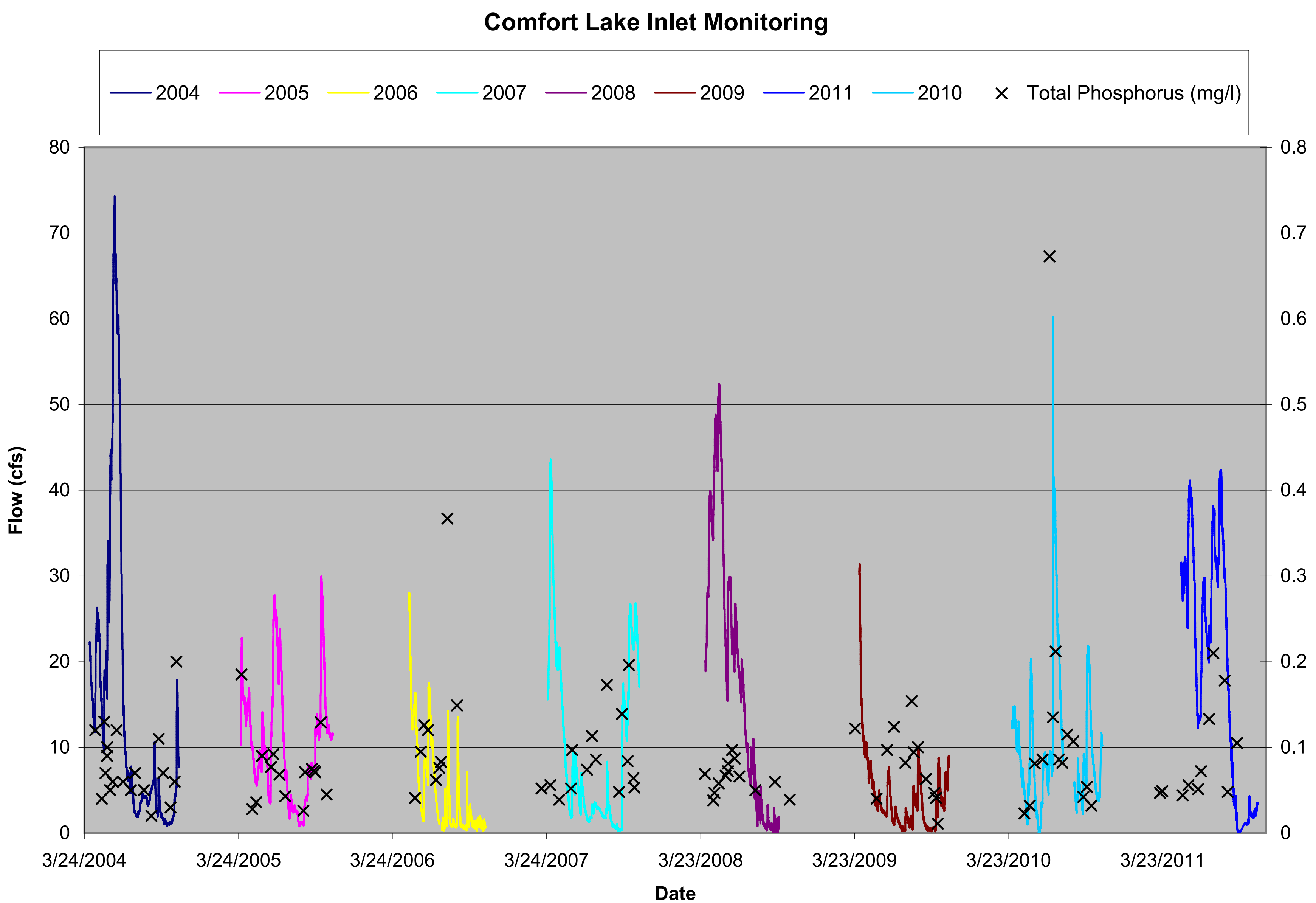
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

Chart (TP+TSS) (2011)

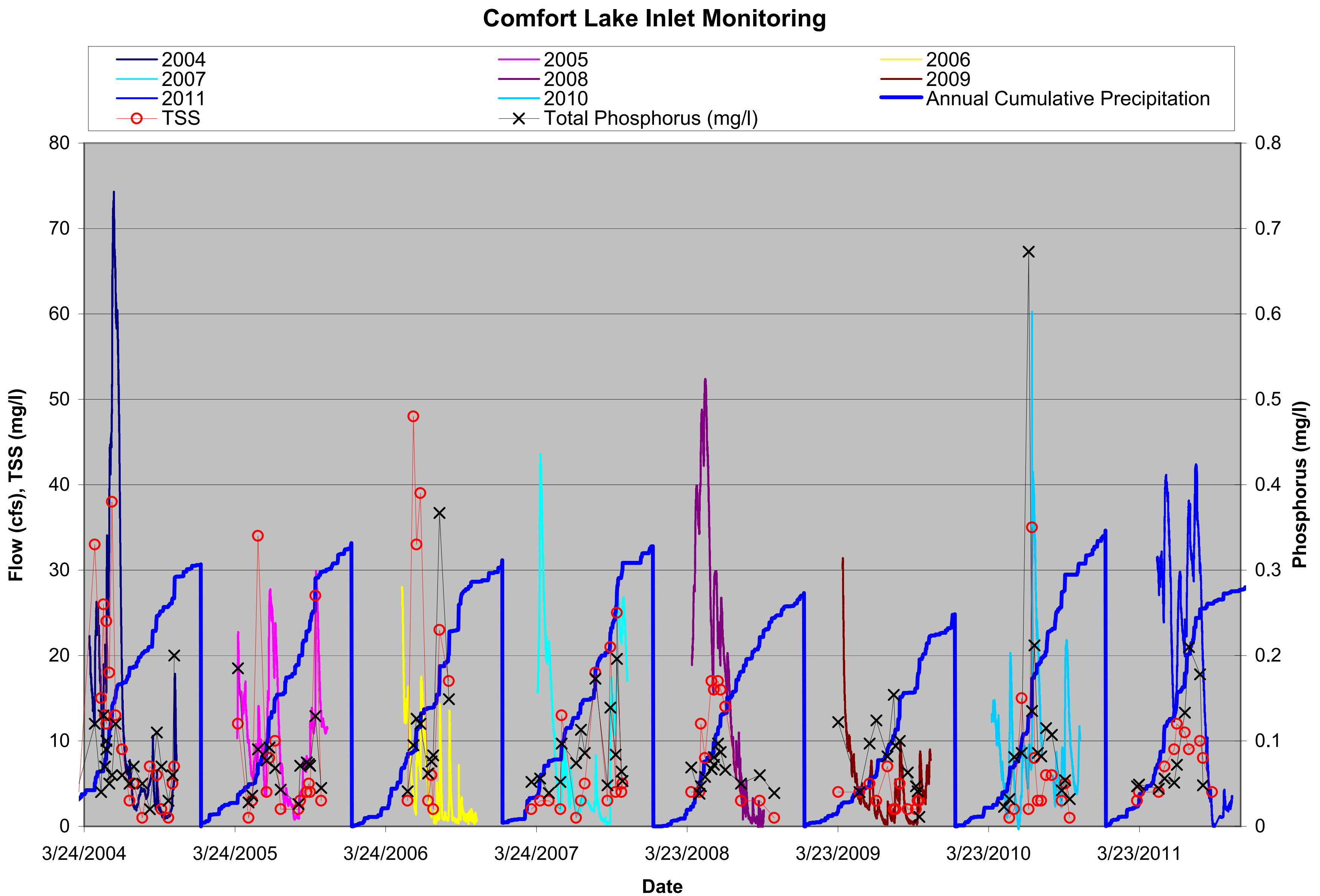


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Comfort Inlet.xls

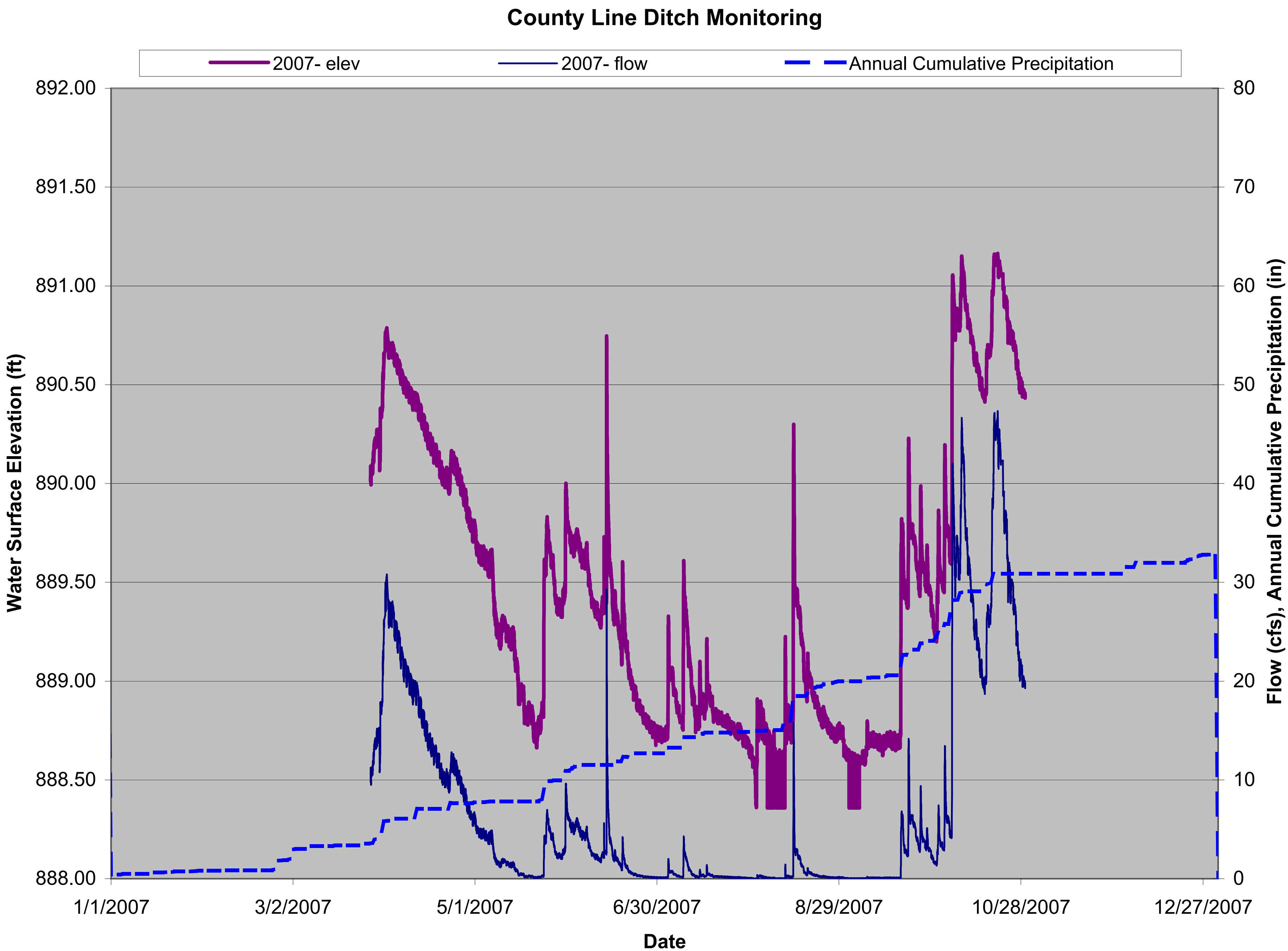
Chart (Flow+Precip)



Comfort Lake Inlet Monitoring
2004
2005
2006
2007
2008
2009
2011
2010
Total Phosphorus (mg/l)
Flow (cfs)
80
70
60
50
40
30
20
10
0
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3/24/2004
3/24/2005
3/24/2006
3/24/2007
3/23/2008
3/23/2009
3/23/2010
3/23/2011
Date

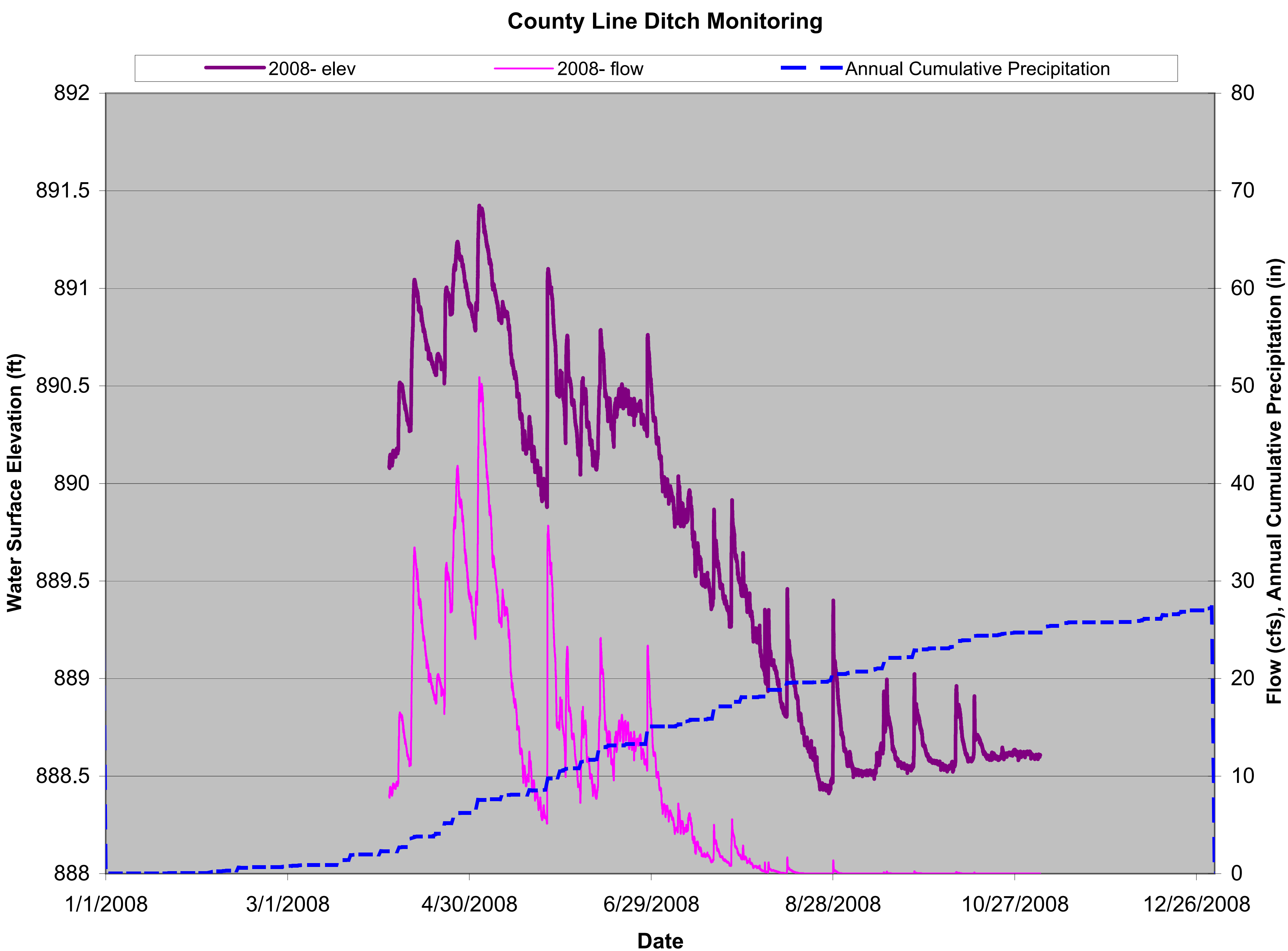


Comfort Lake Inlet Monitoring
2004
2005
2006
2007
2008
2009
2011
2010
Annual Cumulative Precipitation
TSS
Total Phosphorus (mg/l)
Flow (cfs), TSS (mg/l)
Phosphorus (mg/l)
Date
0
10
20
30
40
50
60
70
80
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
3/24/2004
3/24/2005
3/24/2006
3/24/2007
3/23/2008
3/23/2009
3/23/2010
3/23/2011



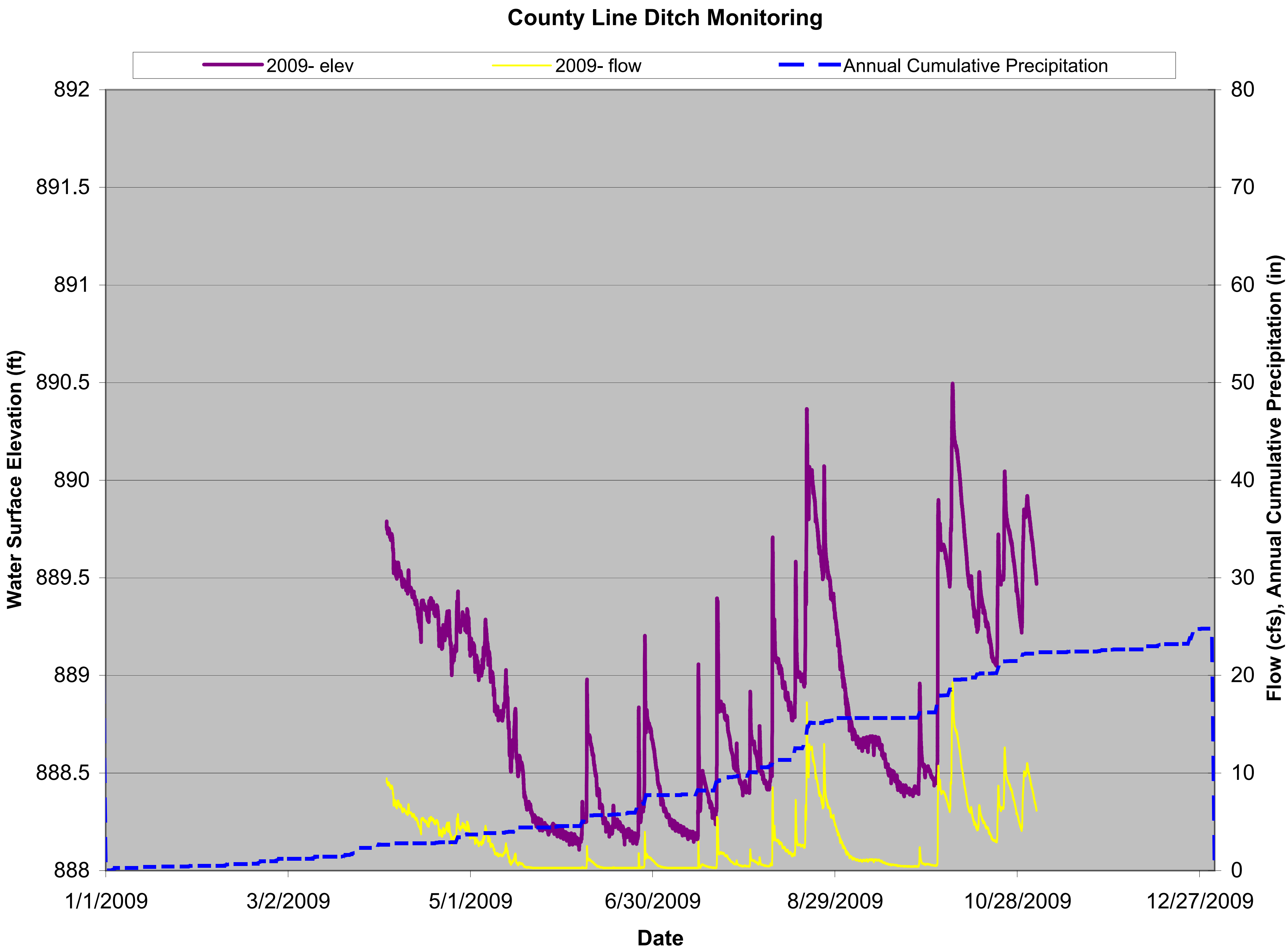
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph elev flow 2007



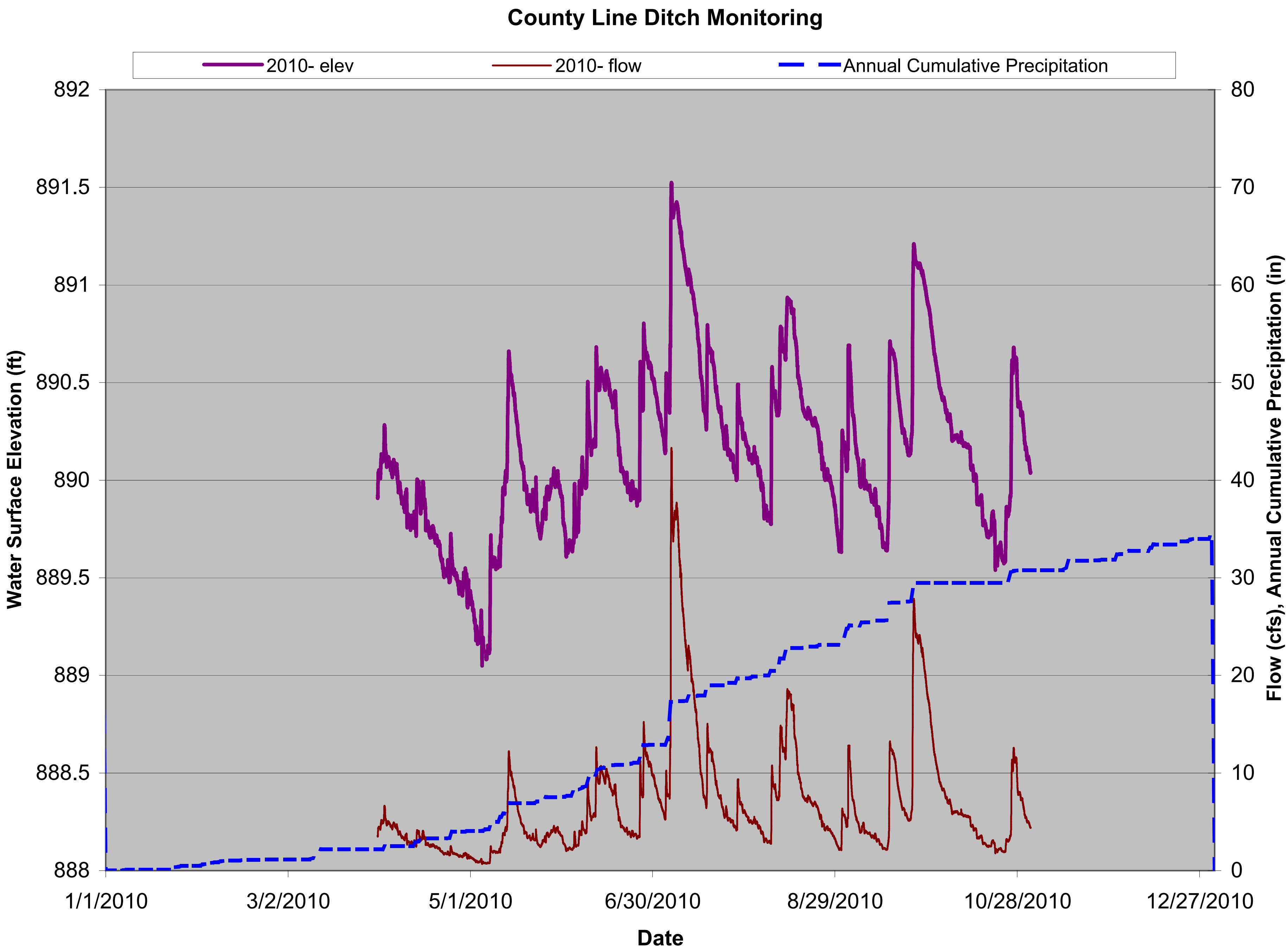
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph elev flow 2008



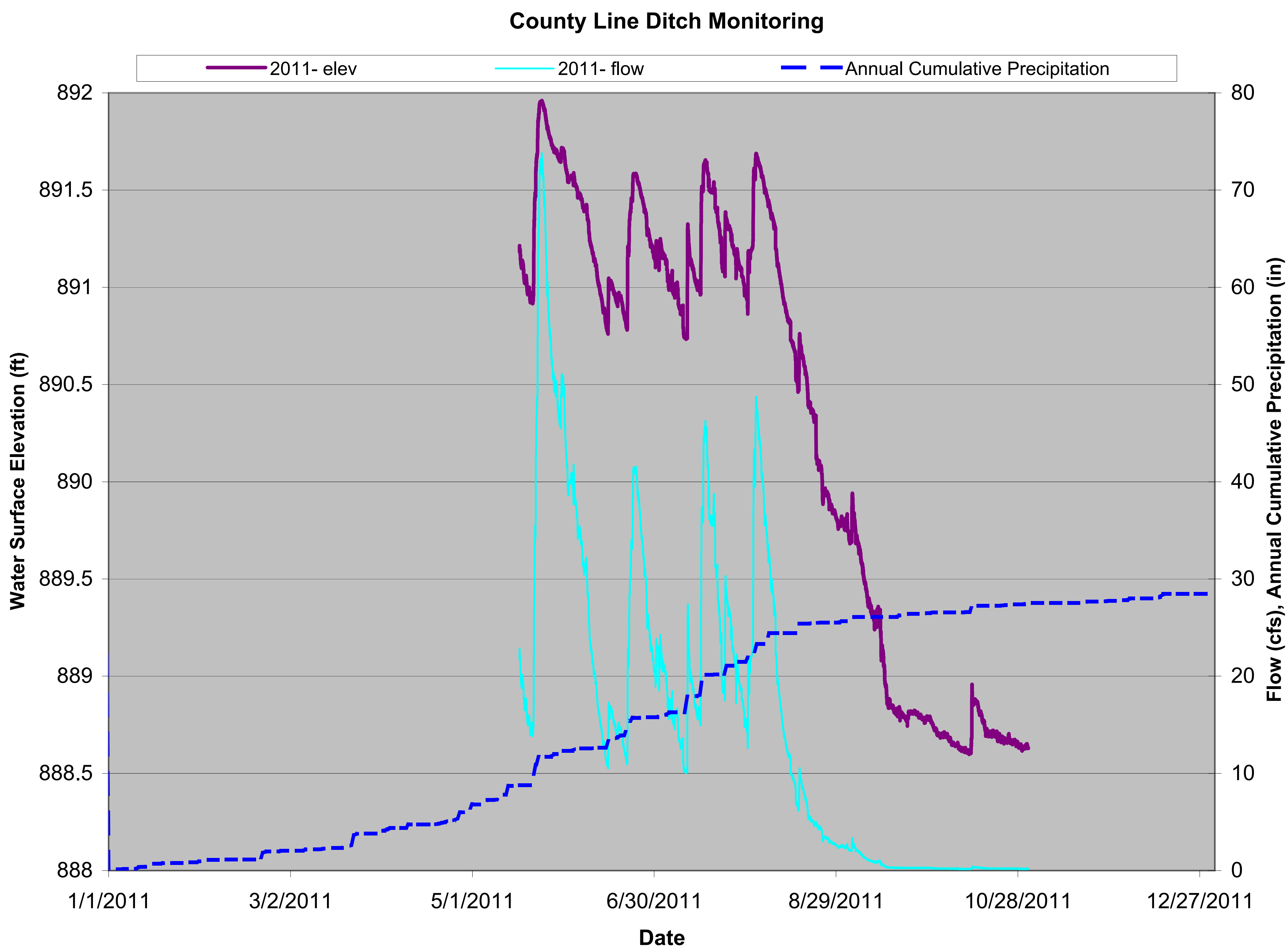
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph elev flow 2009



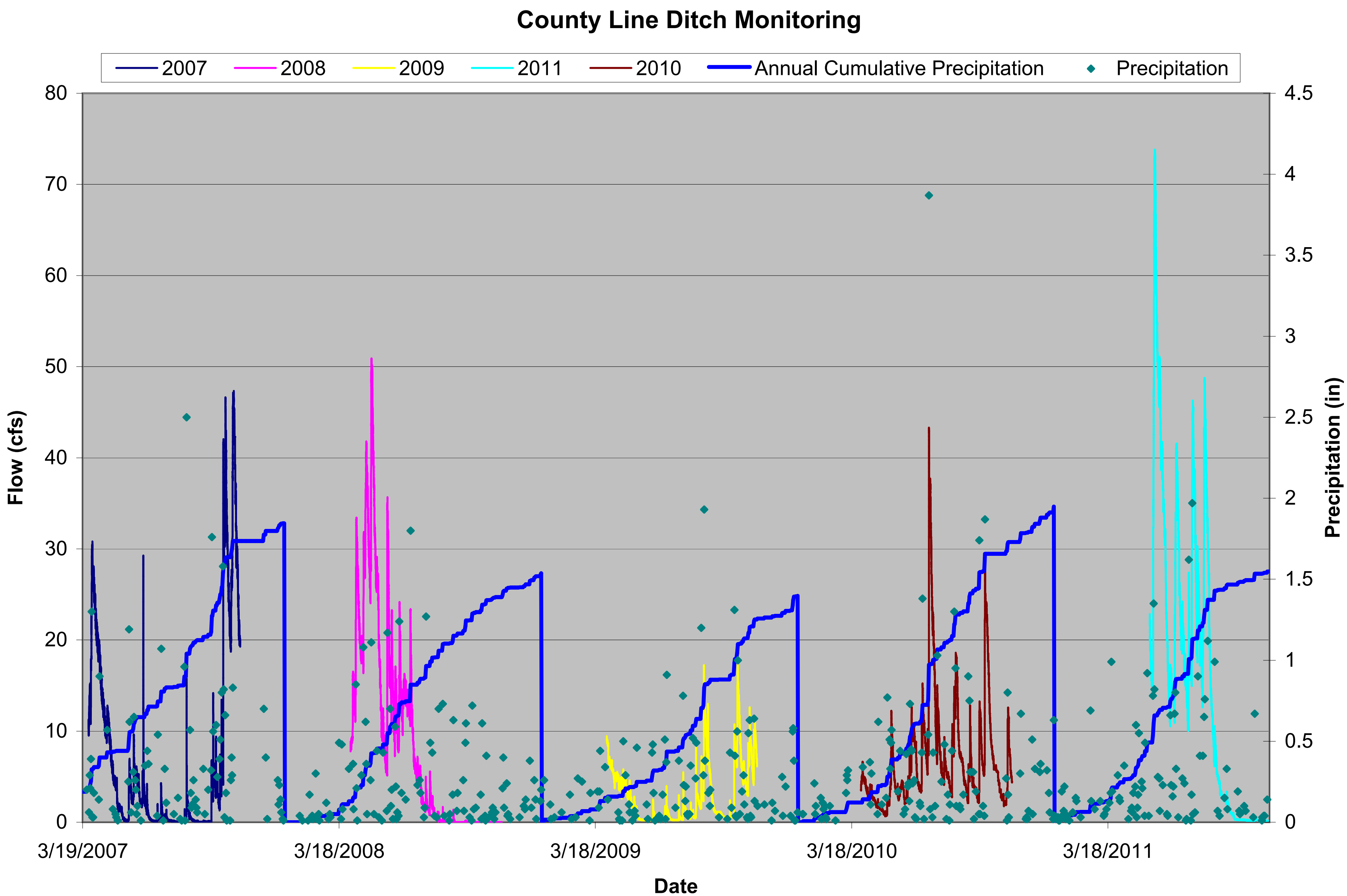
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph elev flow 2010



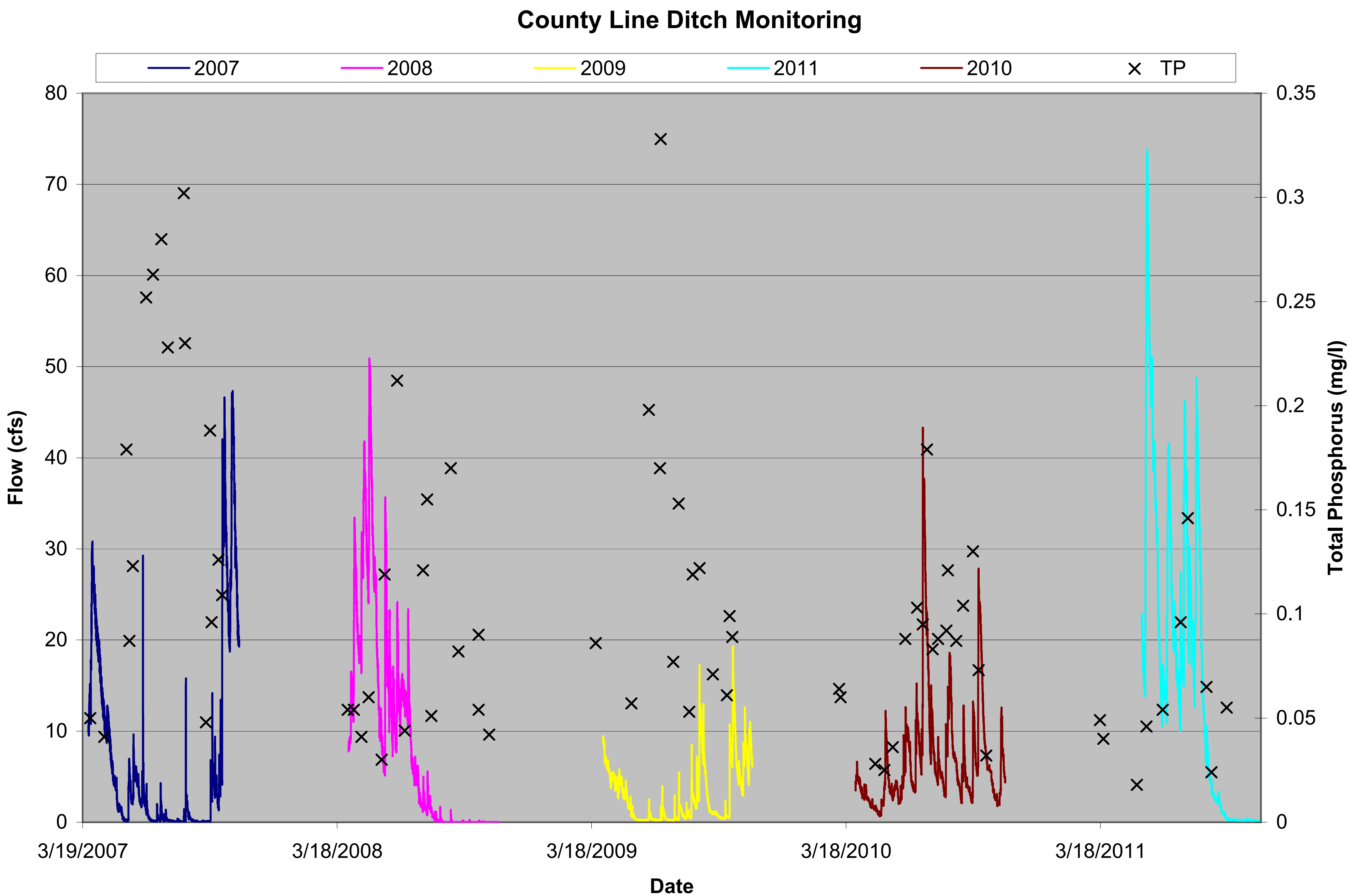
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph elev flow 2011



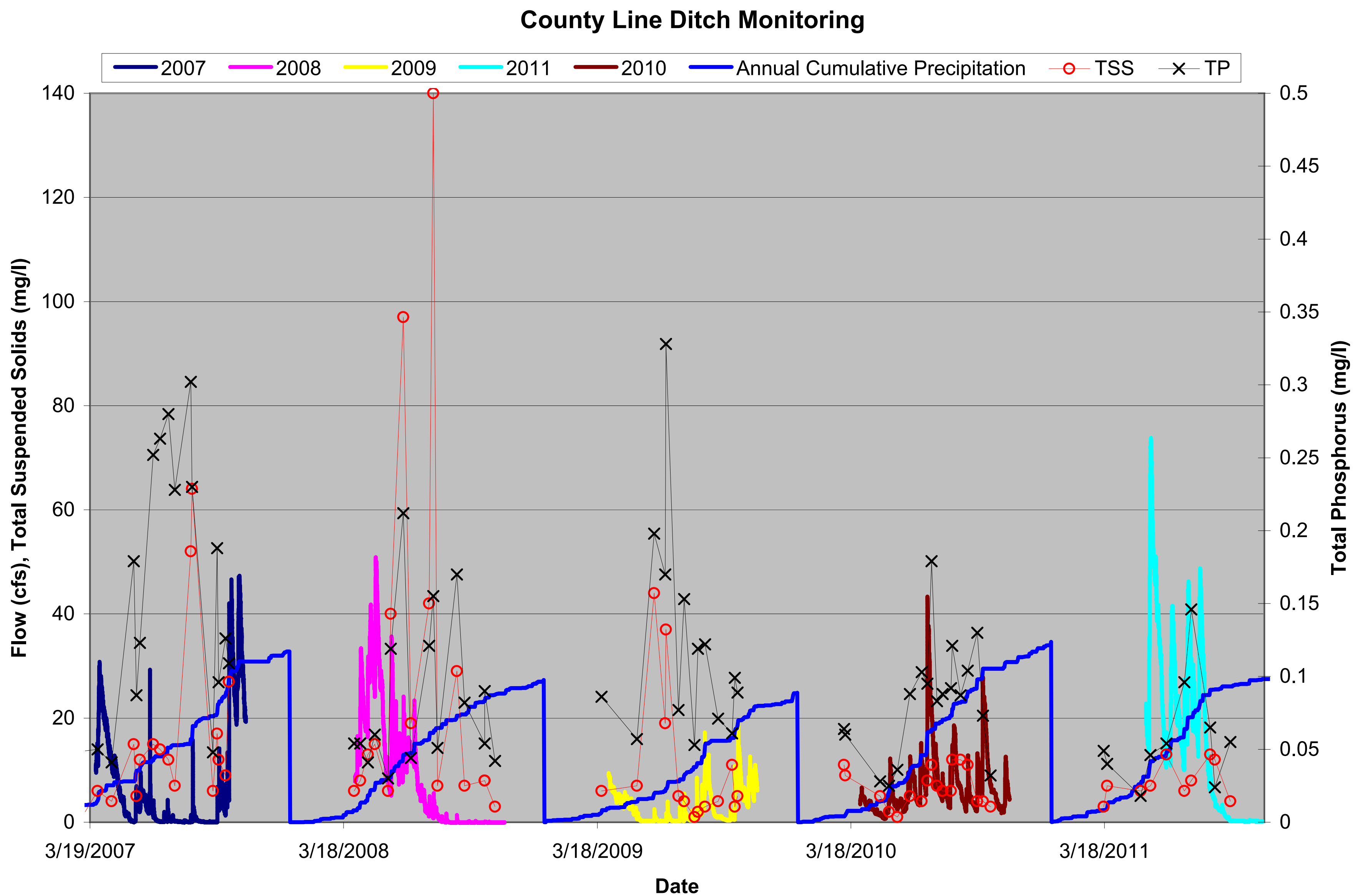
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph (Flow+Precip)



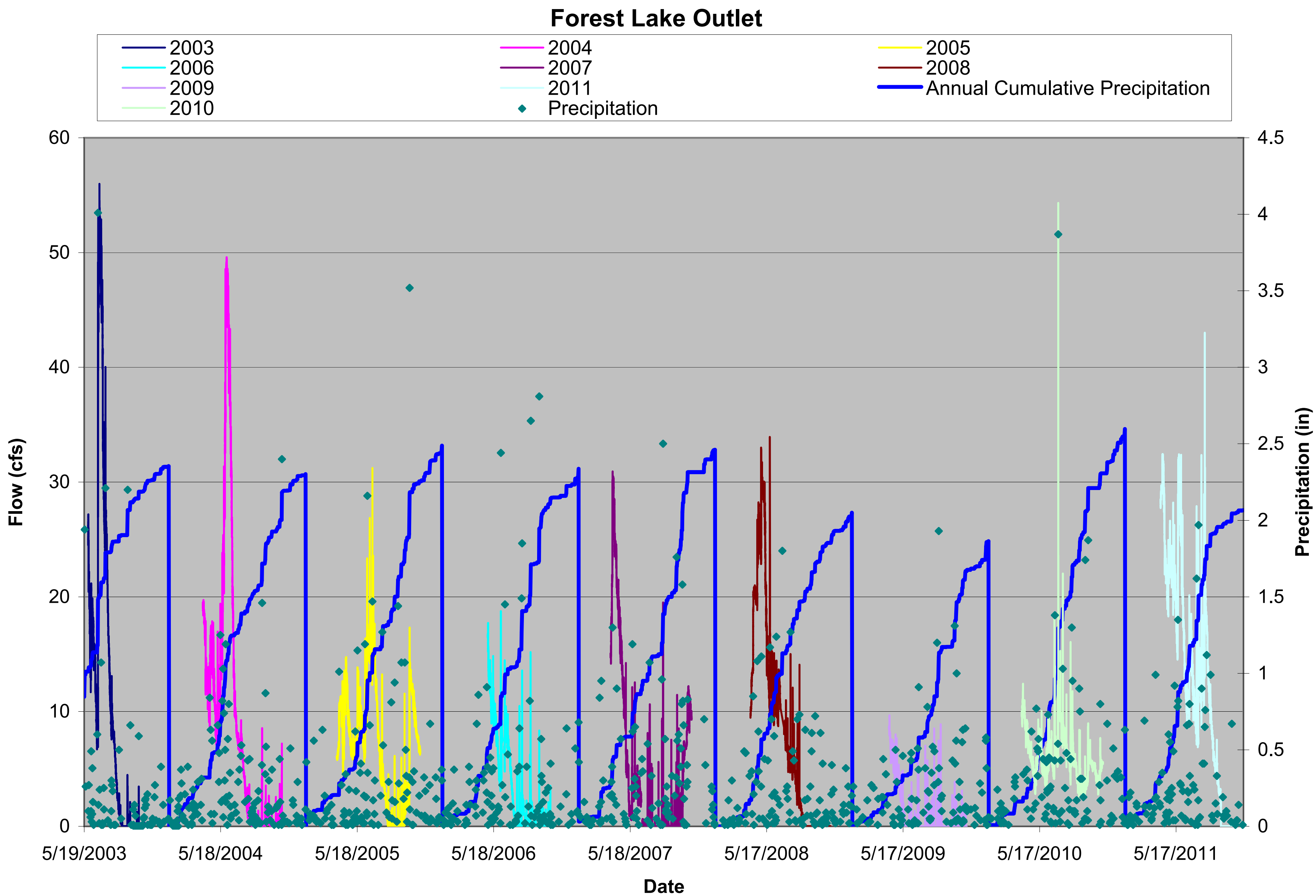
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph (TP)

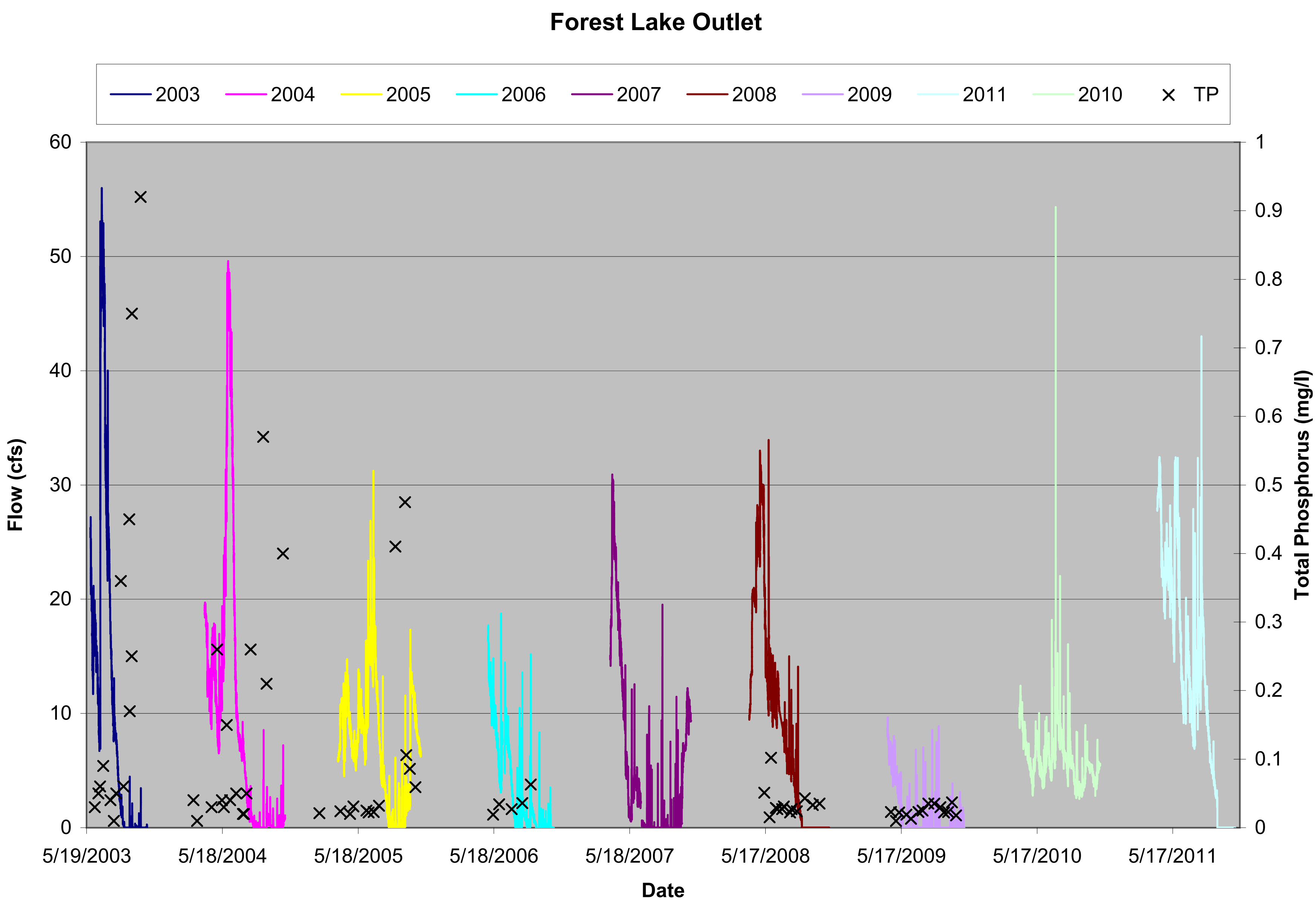


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\County Line Ditch.xls

Graph (TP+TSS)

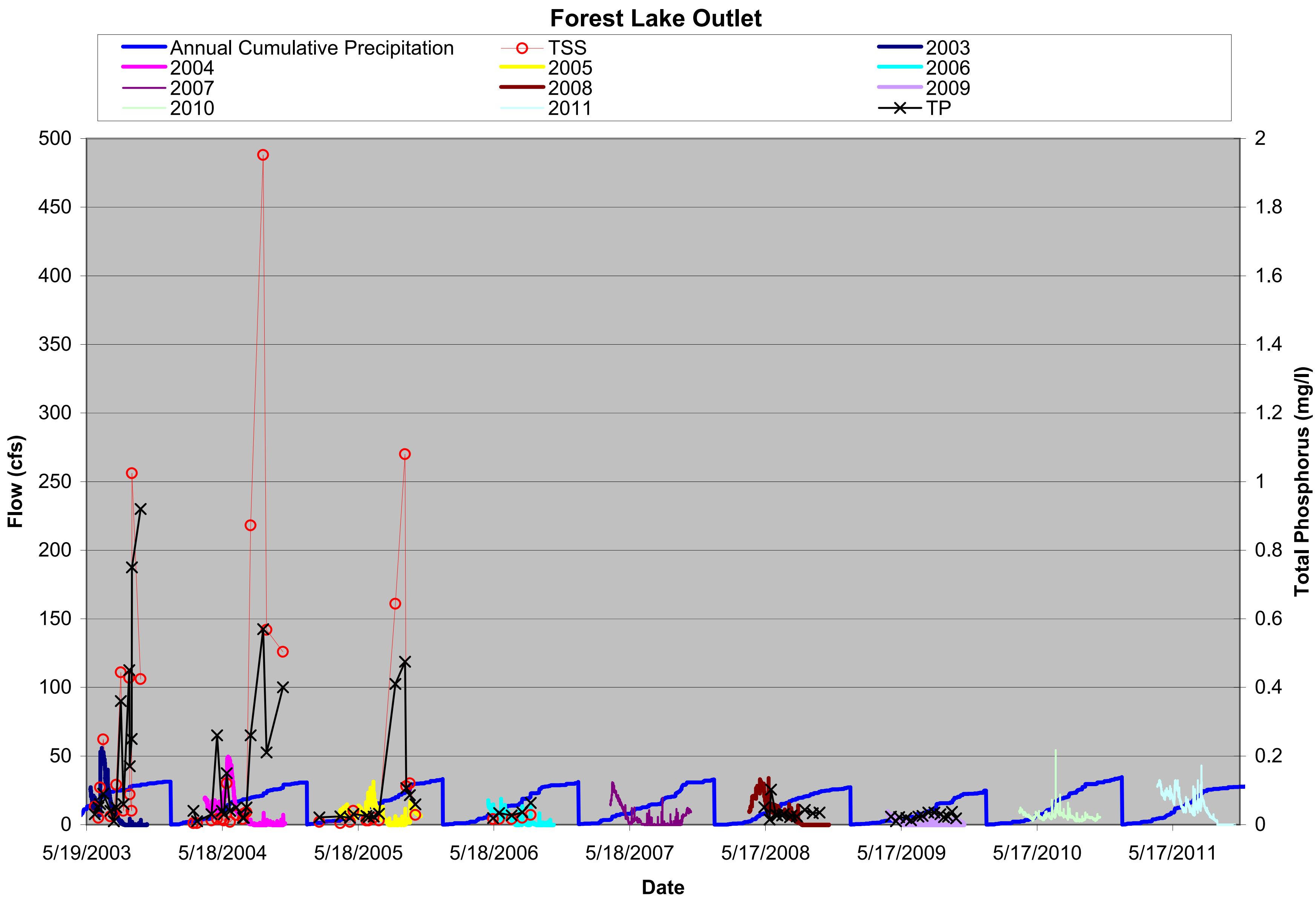


Forest Lake Outlet
2003
2004
2005
2006
2007
2008
2009
2011
Annual Cumulative Precipitation
2010
Precipitation
Flow (cfs)
Precipitation (in)
Date
0
10
20
30
40
50
60
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5/19/2003
5/18/2004
5/18/2005
5/18/2006
5/18/2007
5/17/2008
5/17/2009
5/17/2010
5/17/2011

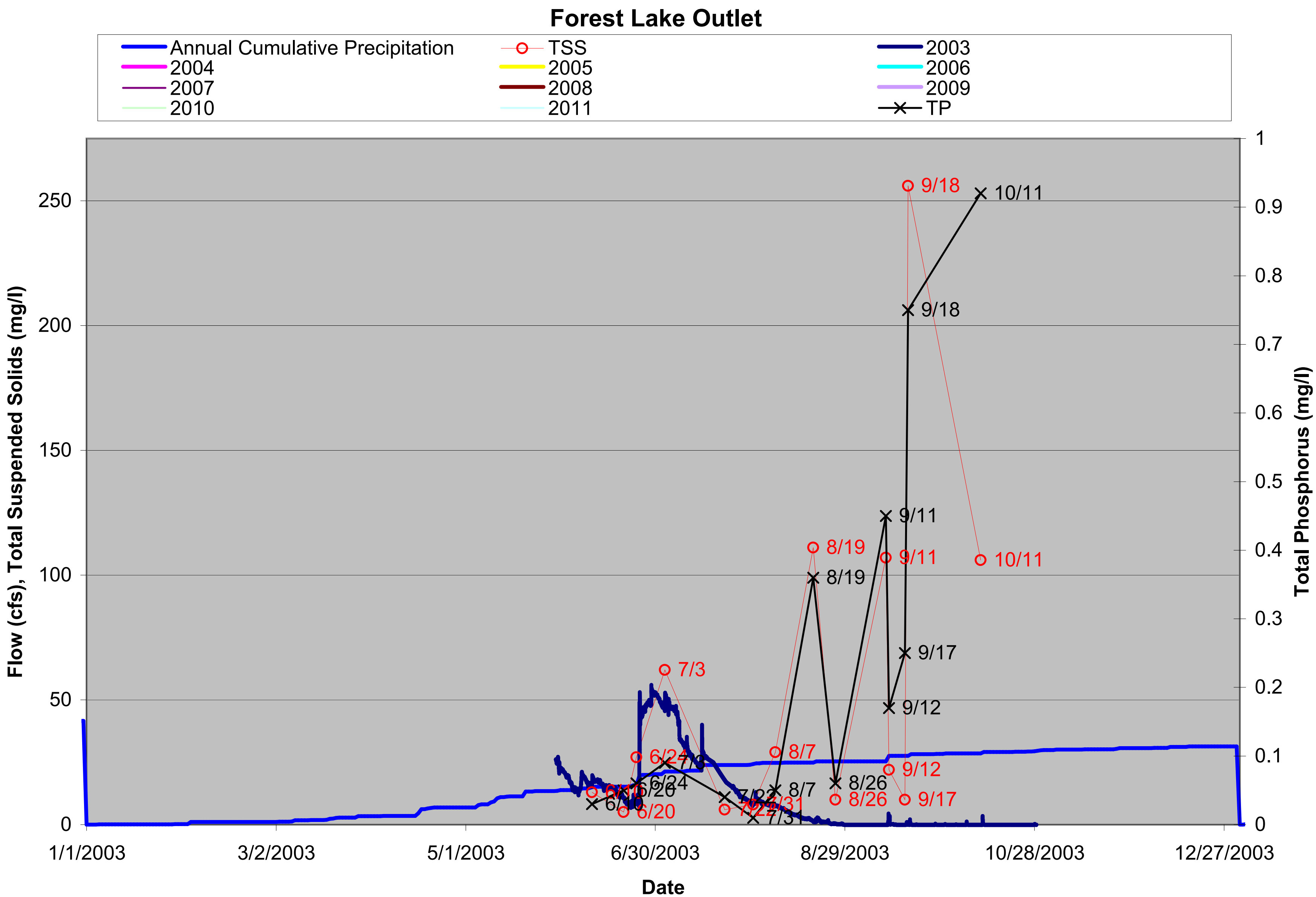


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP)

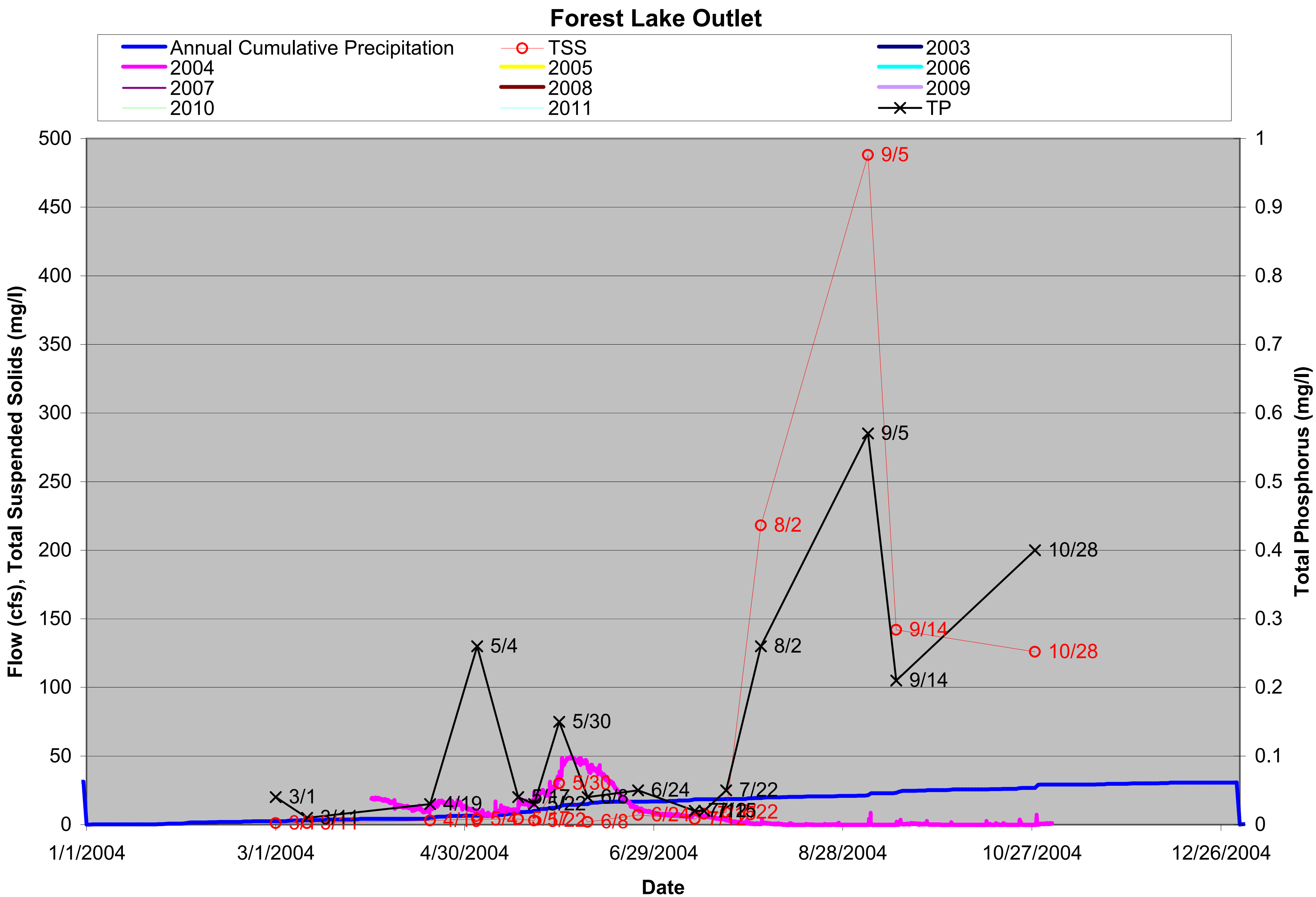


Forest Lake Outlet
Annual Cumulative Precipitation
TSS
2003
2004
2005
2006
2007
2008
2009
2010
2011
TP
500
450
400
350
300
250
200
150
100
50
0
Flow (cfs)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Total Phosphorus (mg/l)
5/19/2003
5/18/2004
5/18/2005
5/18/2006
5/18/2007
5/17/2008
5/17/2009
5/17/2010
5/17/2011
Date



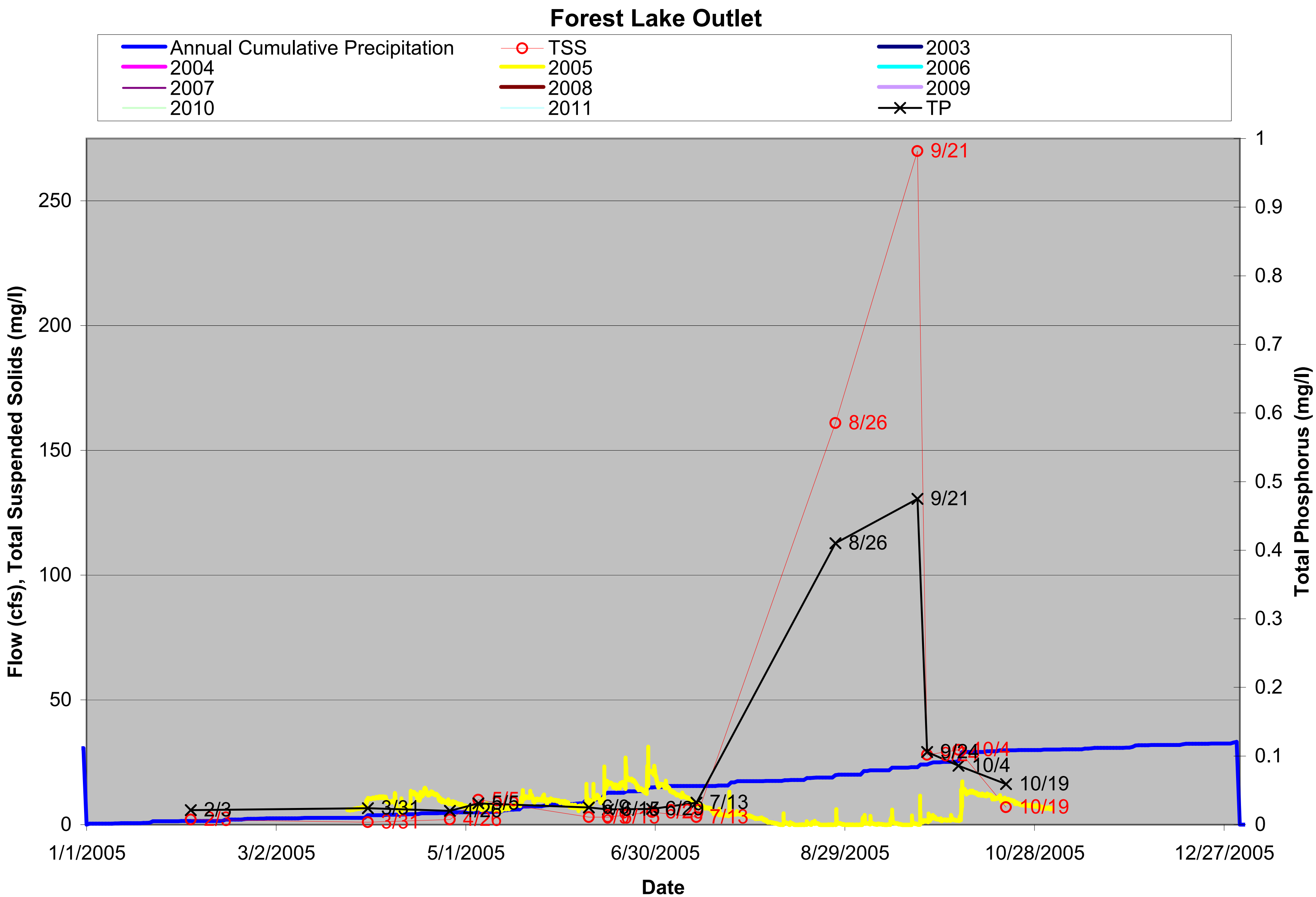
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2003



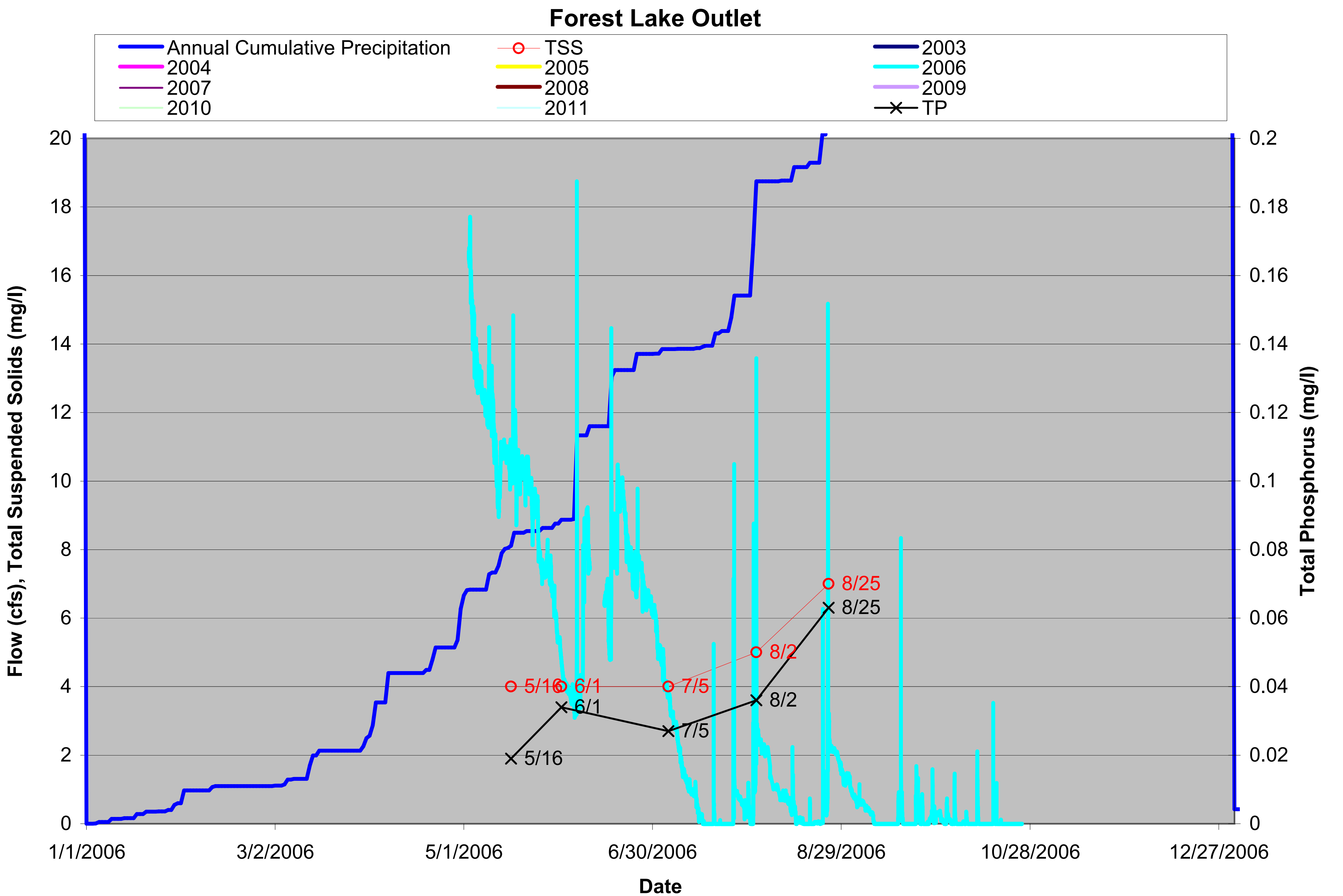
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2004



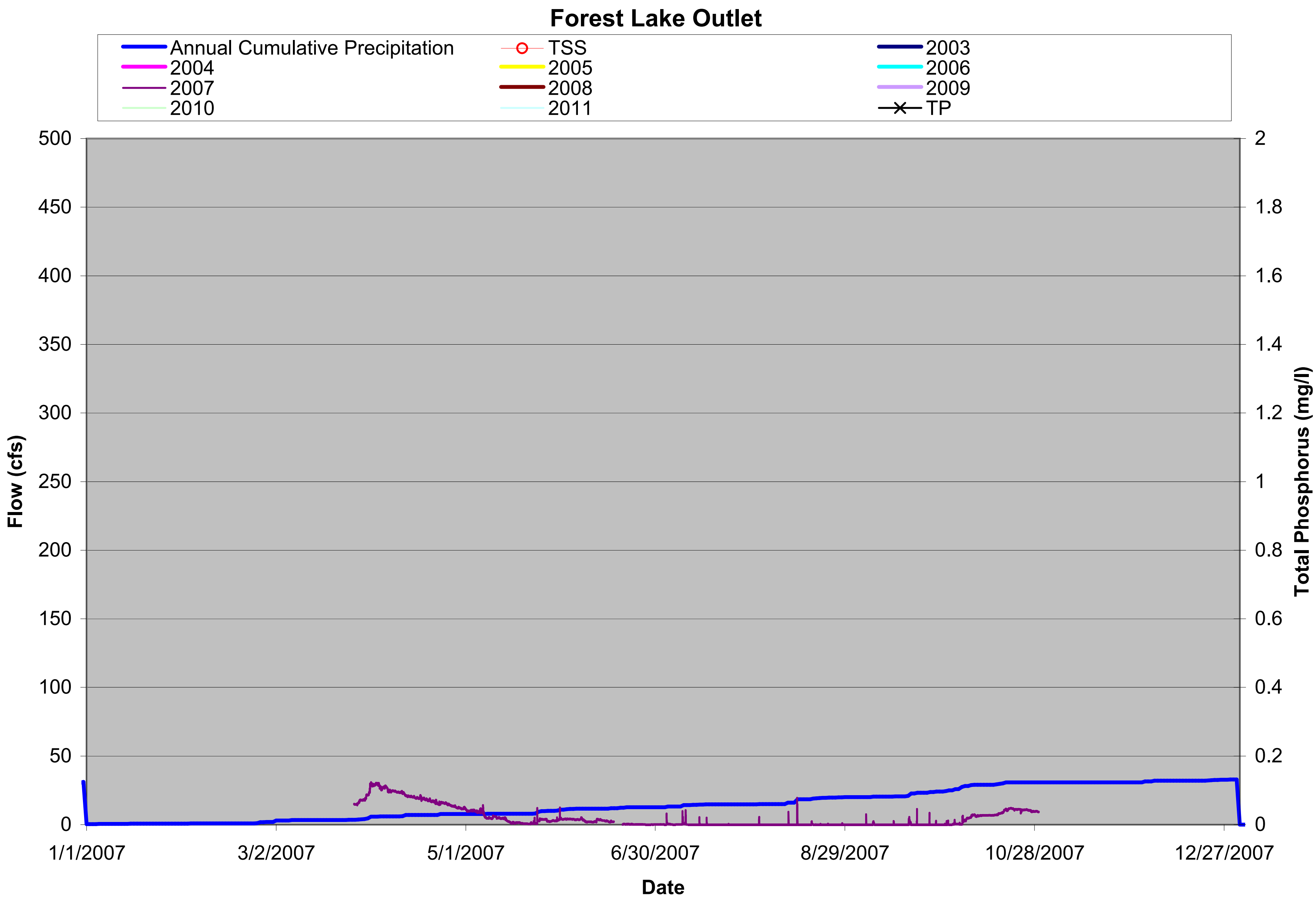
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2005

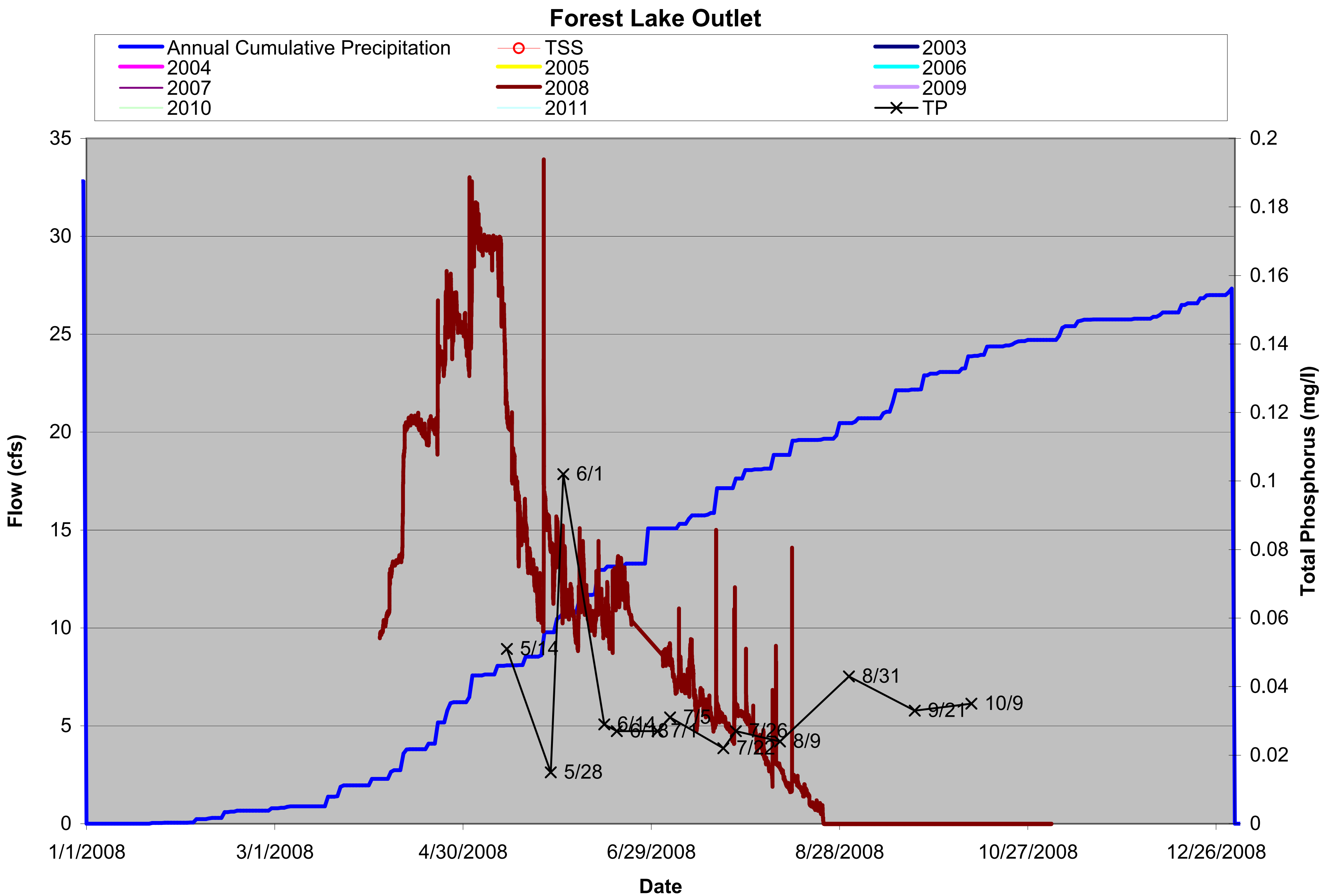


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

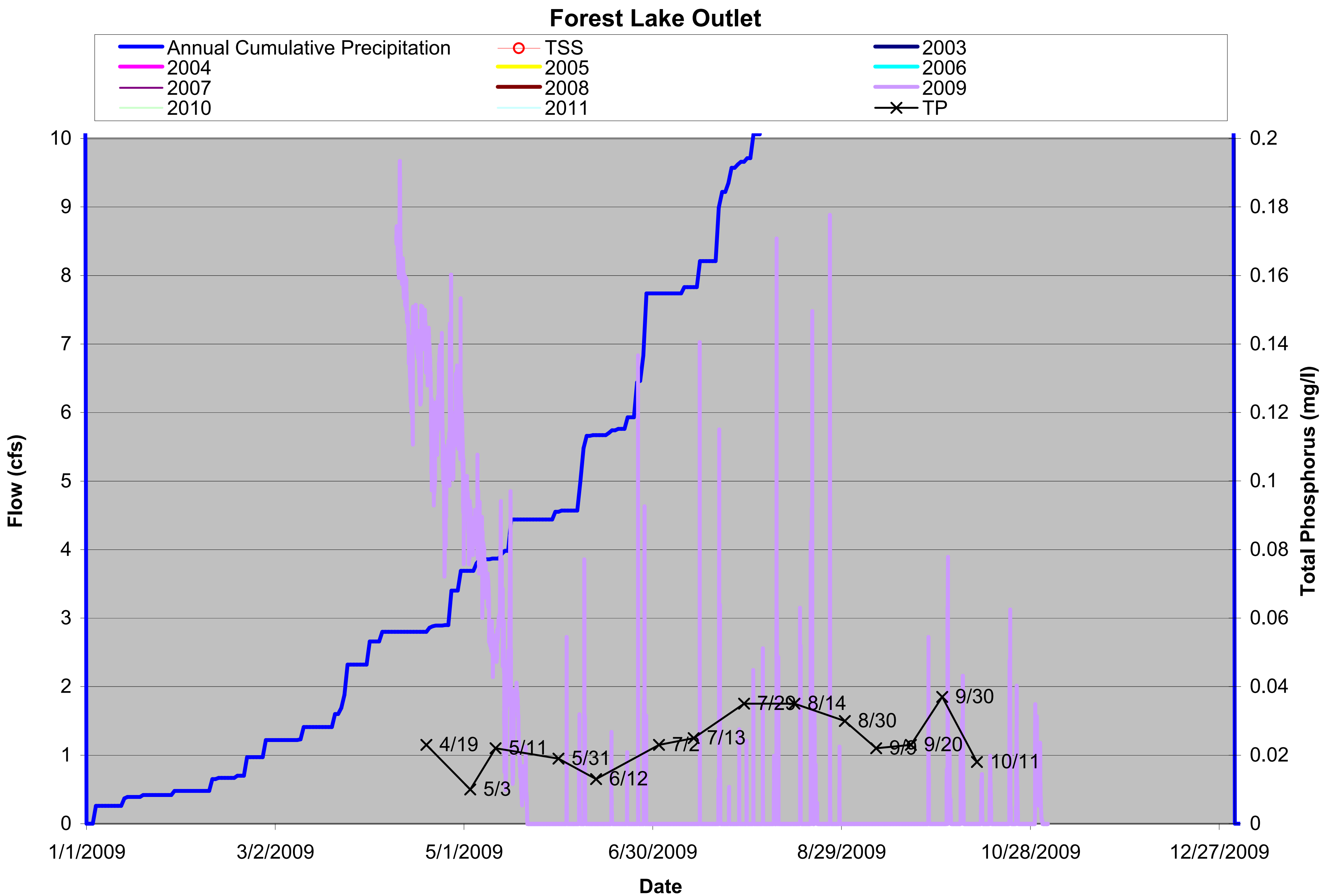
Graph (TP+TSS) 2006



Forest Lake Outlet
Annual Cumulative Precipitation
TSS
2003
2004
2005
2006
2007
2008
2009
2010
2011
TP
Flow (cfs)
Total Phosphorus (mg/l)
500
450
400
350
300
250
200
150
100
50
0
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1/1/2007
3/2/2007
5/1/2007
6/30/2007
8/29/2007
10/28/2007
12/27/2007
Date

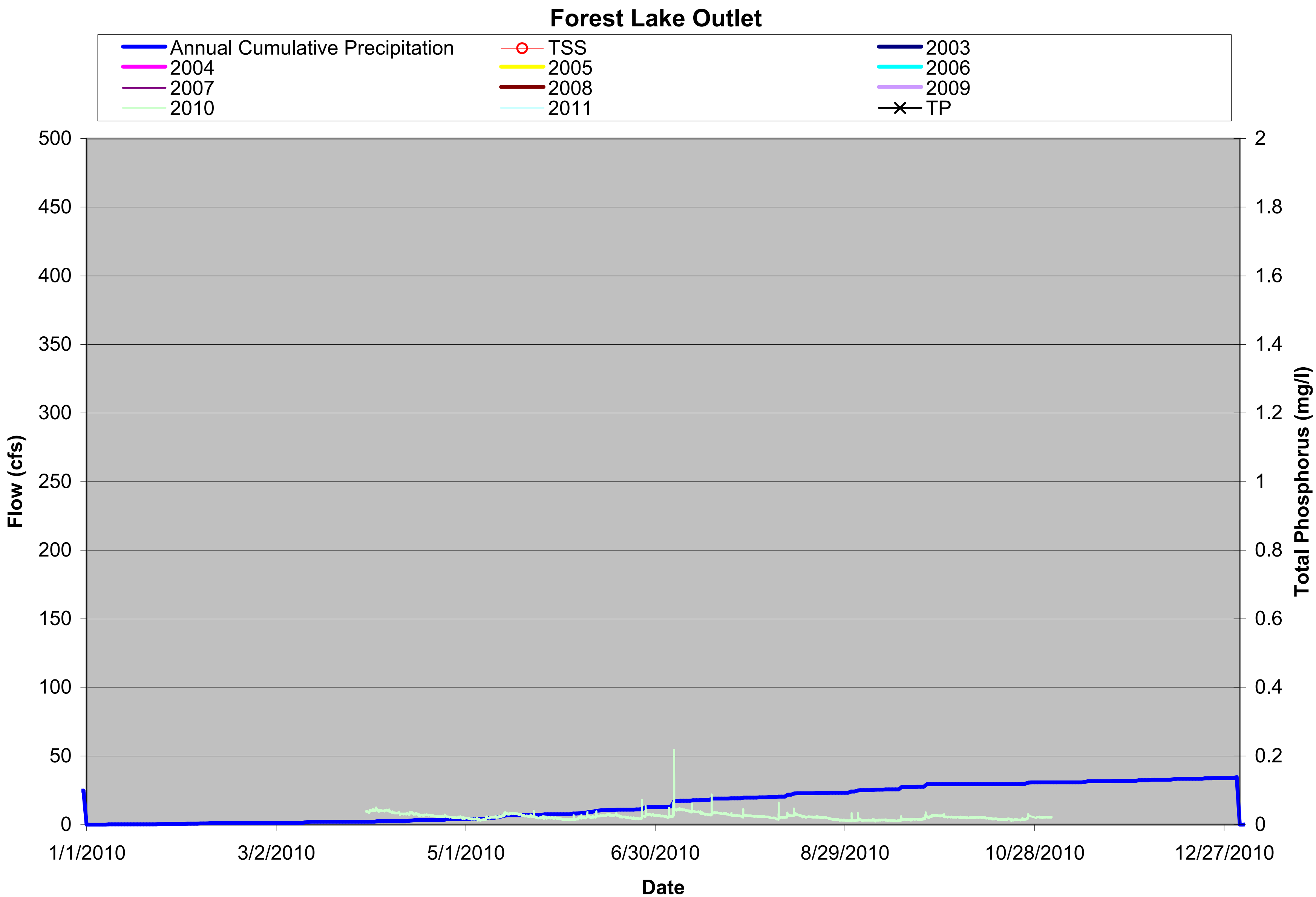


Forest Lake Outlet
Annual Cumulative Precipitation
TSS
2003
2004
2005
2006
2007
2008
2009
2010
2011
TP
Flow (cfs)
Total Phosphorus (mg/l)
Date
35
30
25
20
15
10
5
0
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1/1/2008
3/1/2008
4/30/2008
6/29/2008
8/28/2008
10/27/2008
12/26/2008
5/14
5/28
6/1
6/14
6/18
7/1
7/5
7/22
7/26
8/9
8/31
9/21
10/9



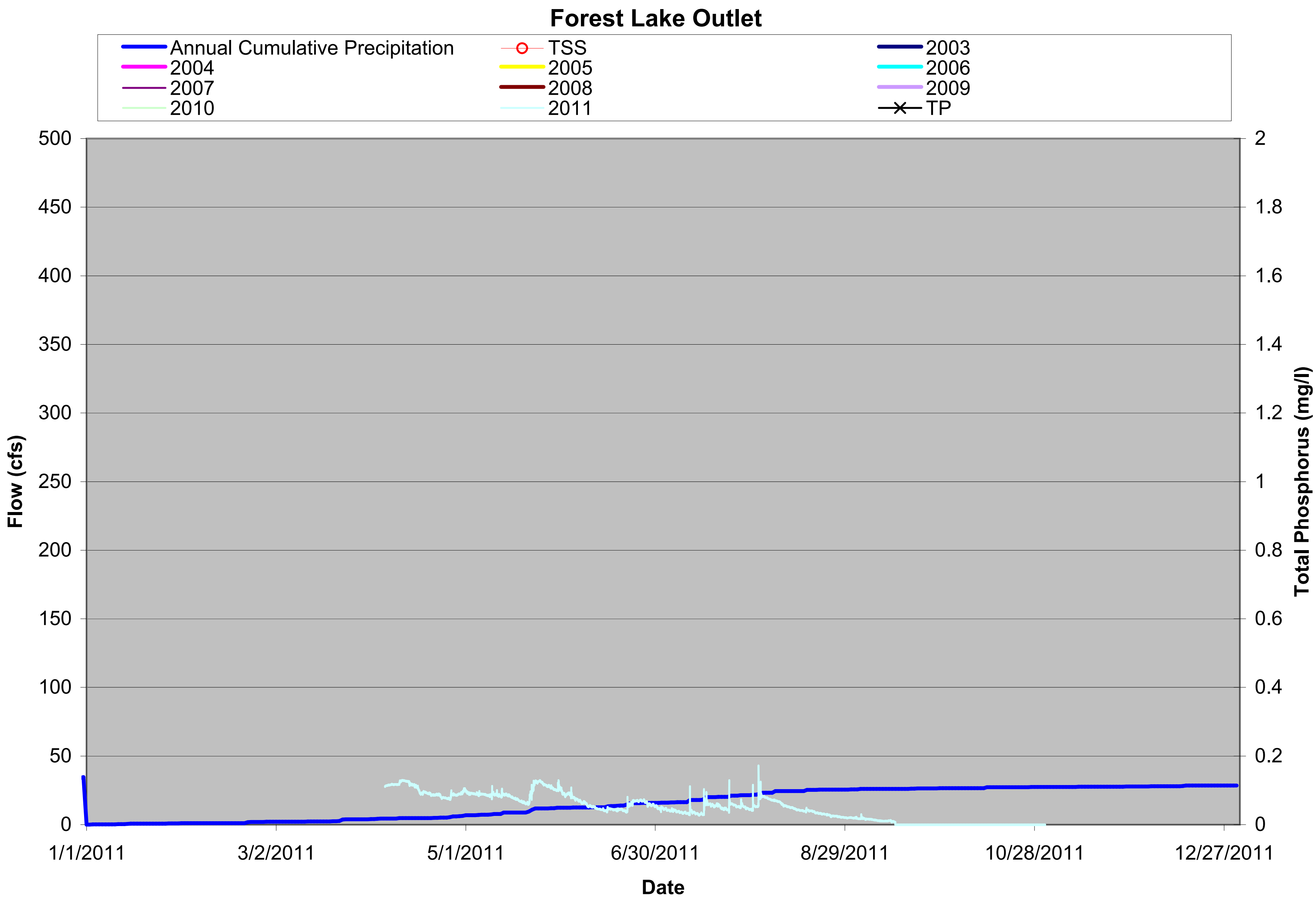
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2009



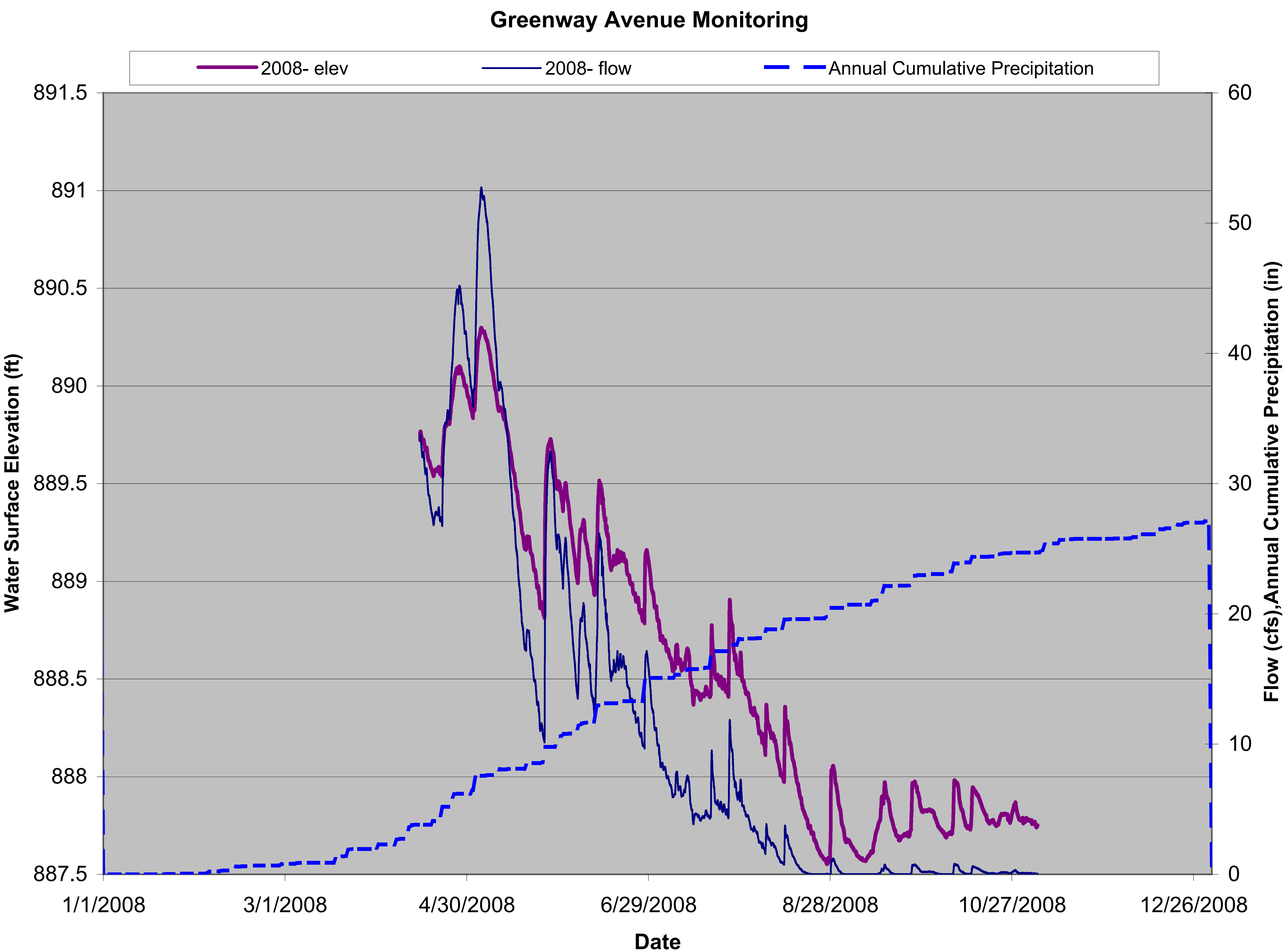
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2010



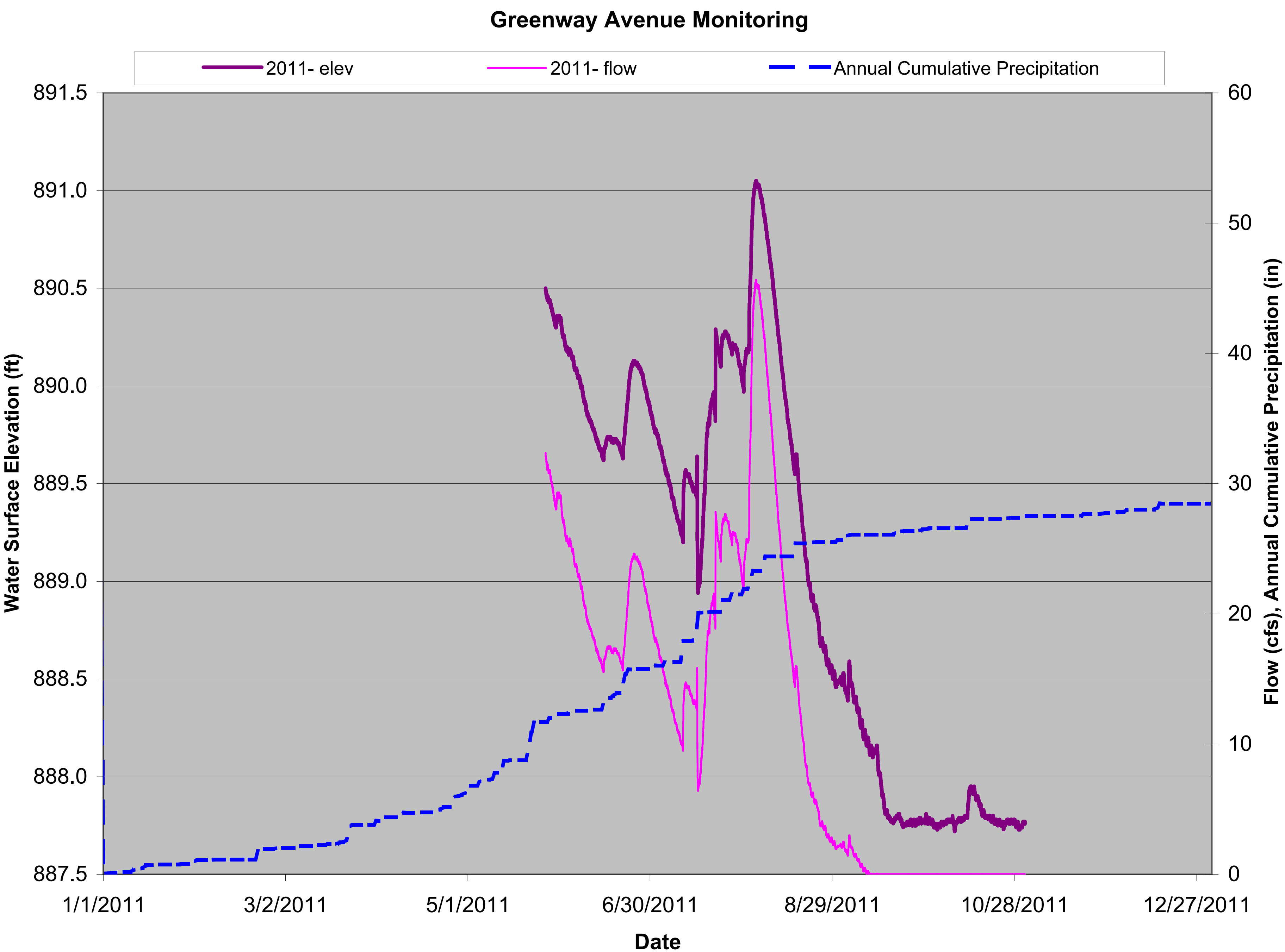
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Forest Lake Outlet.xls

Graph (TP+TSS) 2011



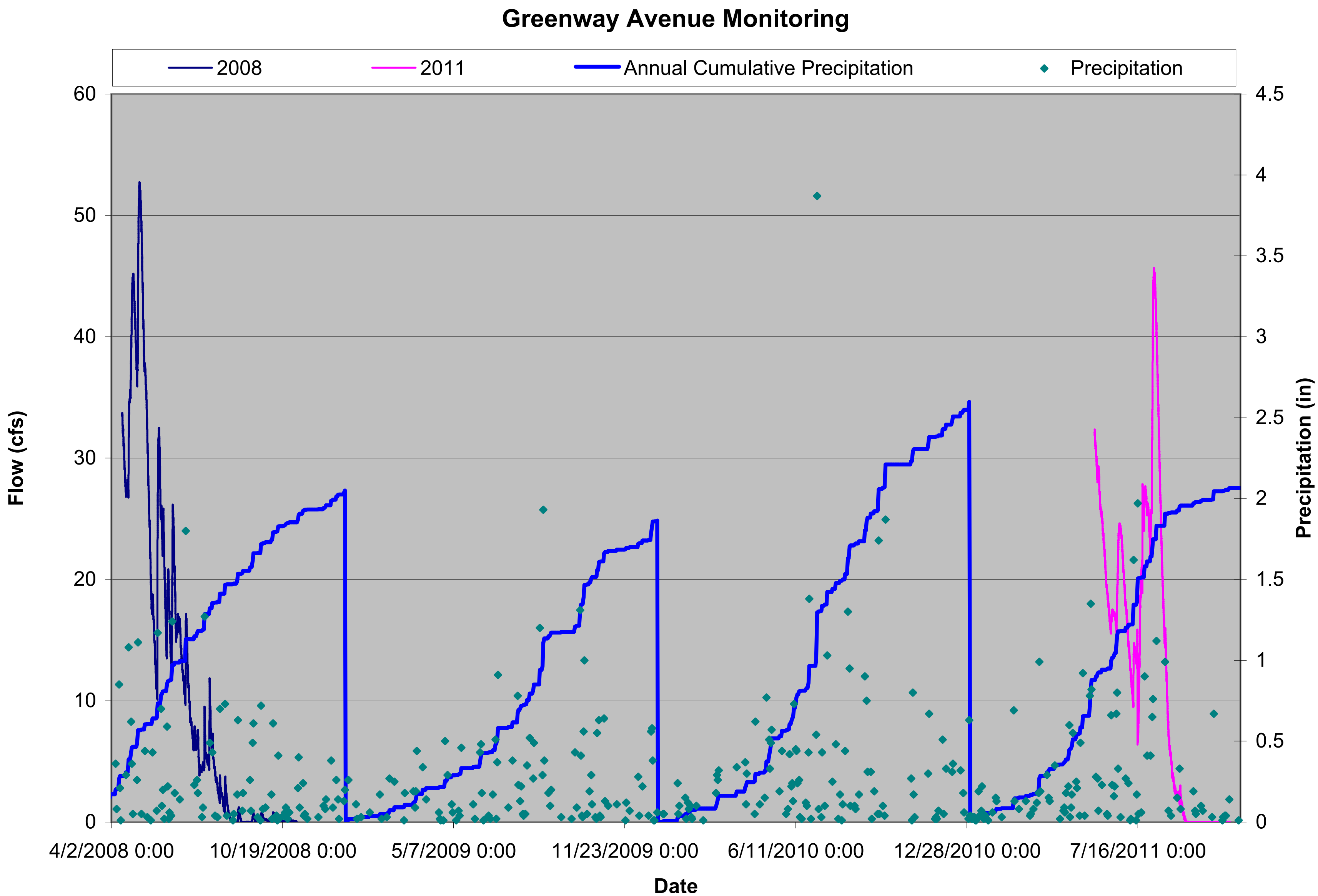
X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Greenway Ave.xls

Graph elev flow 2008

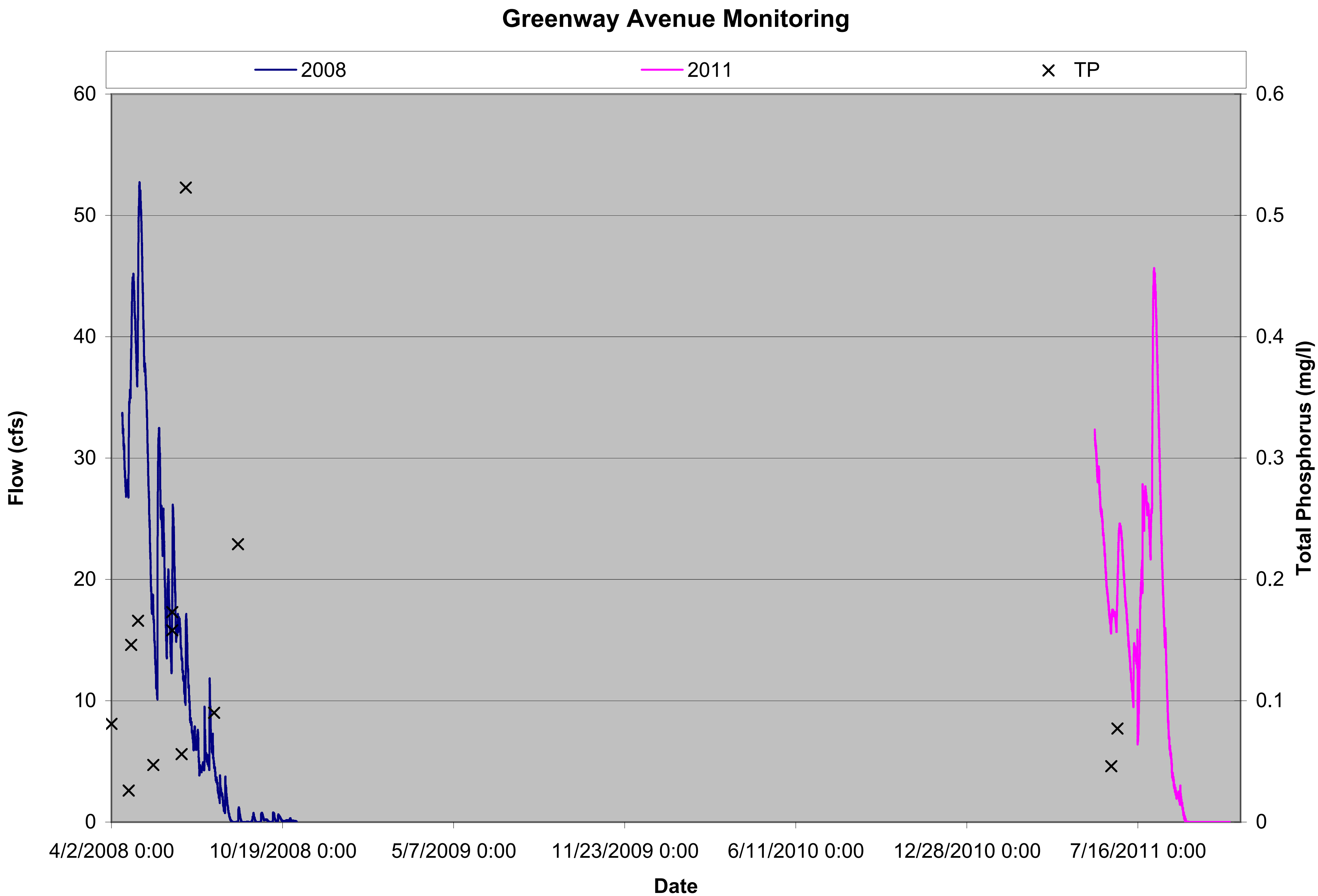


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Greenway Ave.xls

Graph elev flow 2011

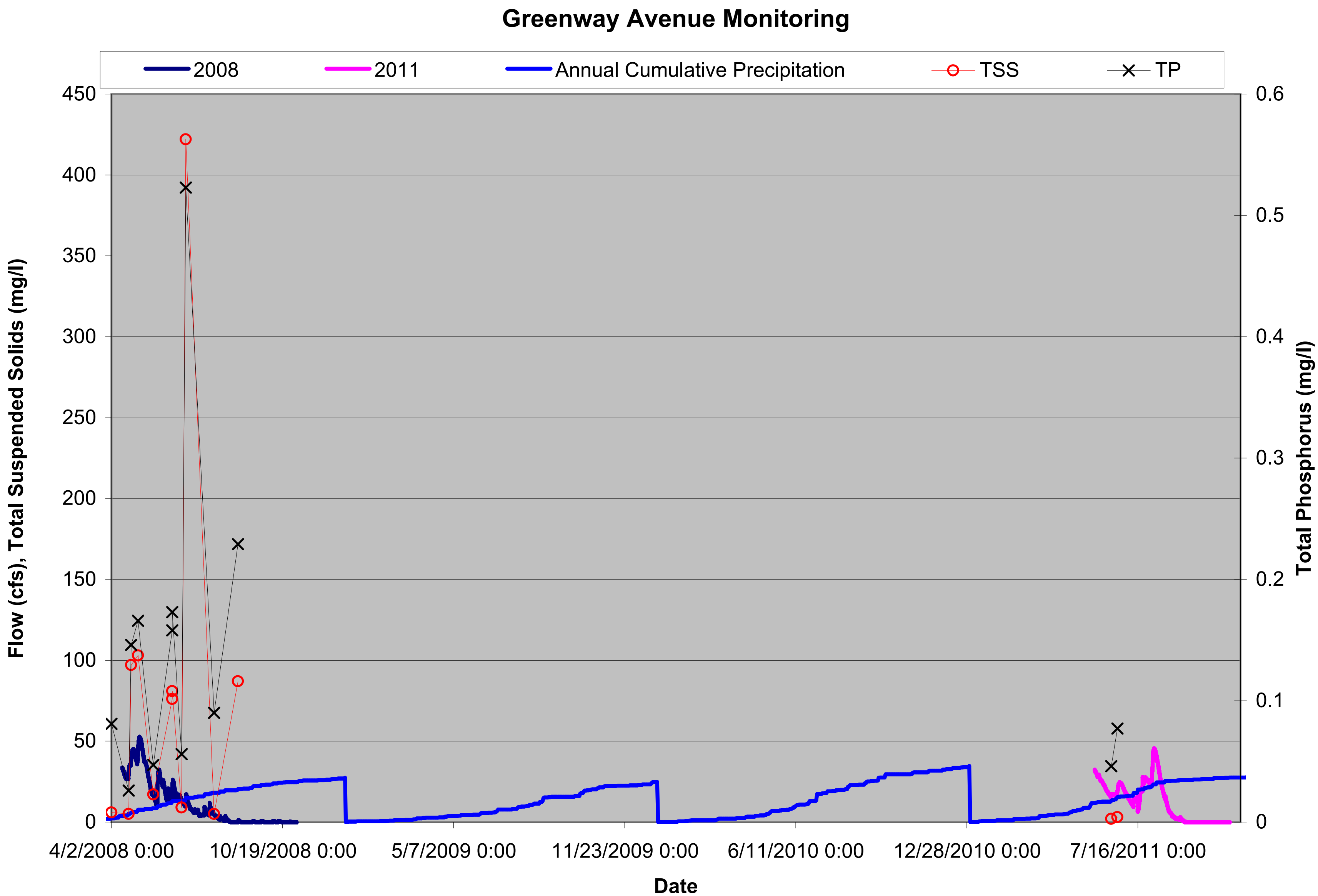


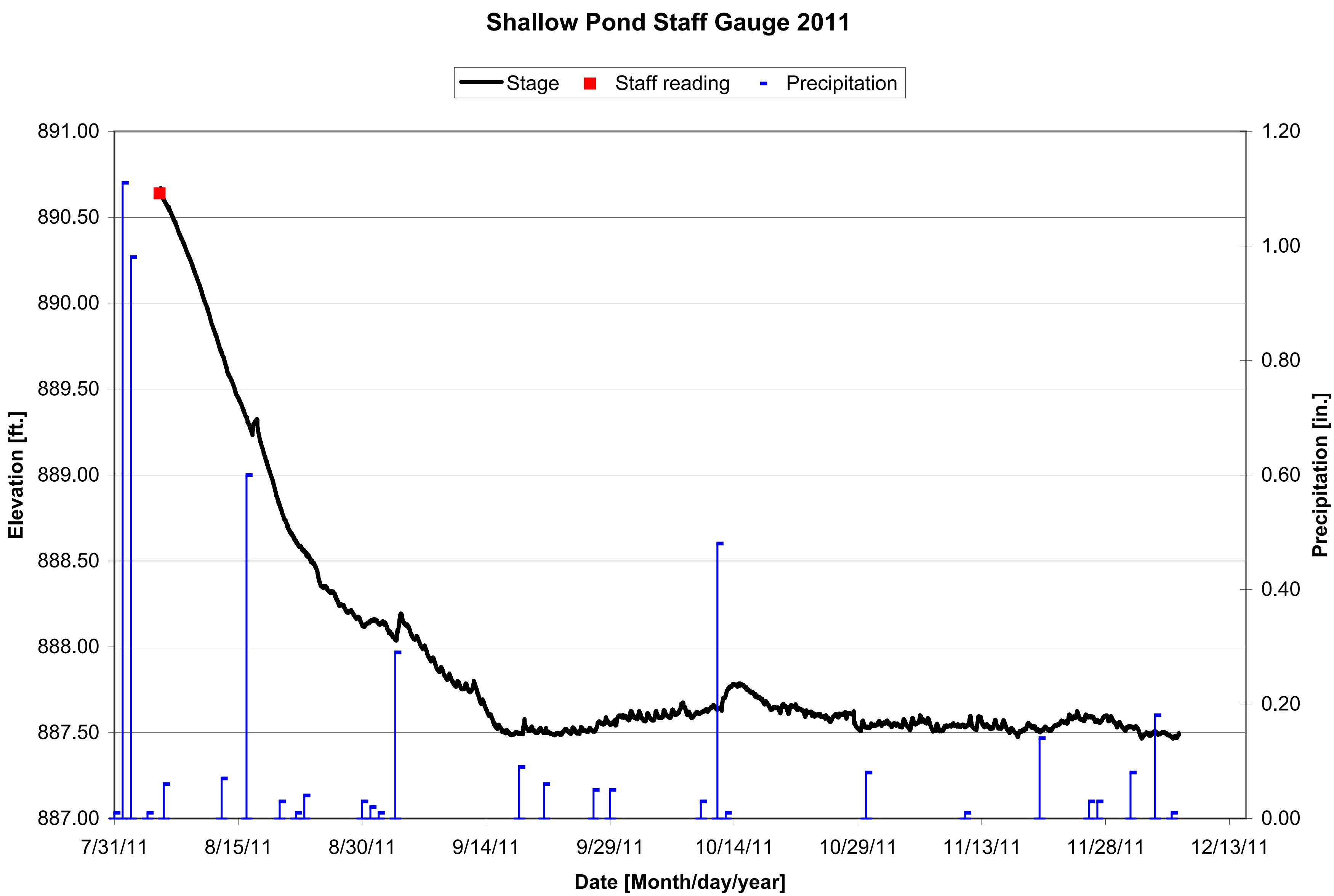
Greenway Avenue Monitoring
2008
2011
Annual Cumulative Precipitation
Precipitation
Flow (cfs)
Precipitation (in)
60
50
40
30
20
10
0
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
4/2/2008 0:00
10/19/2008 0:00
5/7/2009 0:00
11/23/2009 0:00
6/11/2010 0:00
12/28/2010 0:00
7/16/2011 0:00
Date

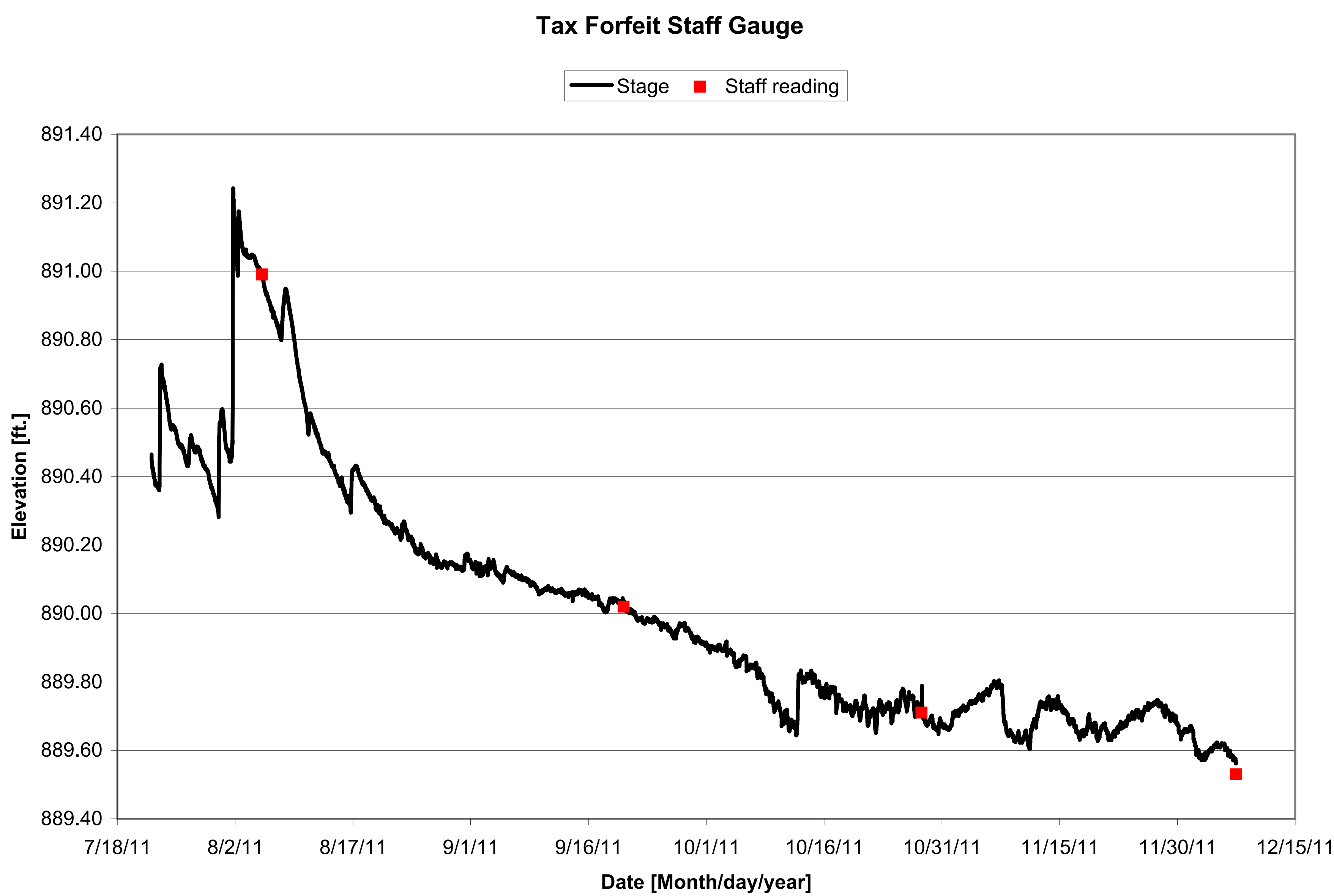


X:\Clients_WD\00376_CLFLWD\LIBRARY\Water Monitoring\CLFLWD flow data\Flow Summaries\Greenway Ave.xls

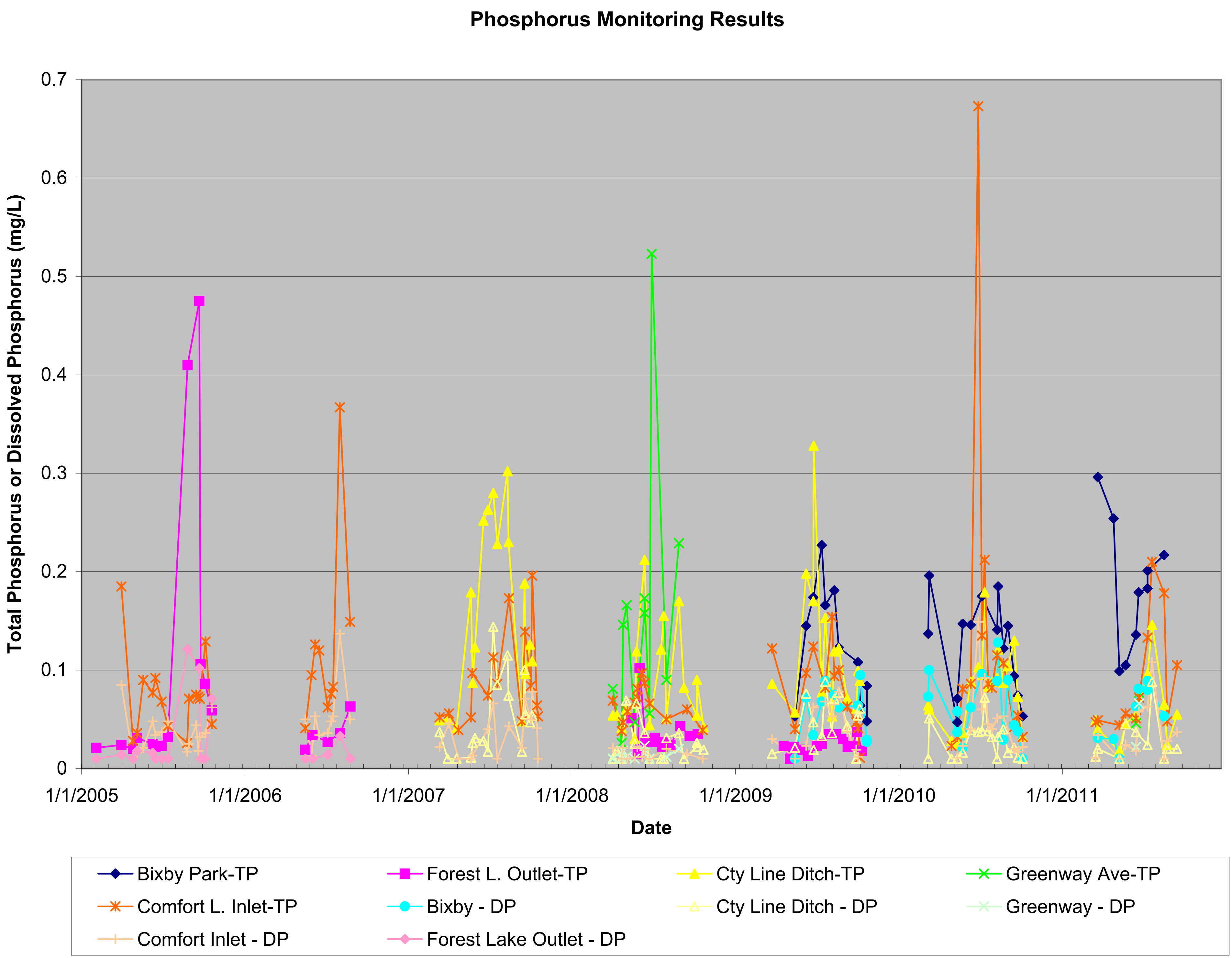
Graph (TP)


Greenway Avenue Monitoring
2008
2011
Annual Cumulative Precipitation
TSS
TP
Flow (cfs), Total Suspended Solids (mg/l)
Total Phosphorus (mg/l)
450
400
350
300
250
200
150
100
50
0
0.6
0.5
0.4
0.3
0.2
0.1
0
4/2/2008 0:00
10/19/2008 0:00
5/7/2009 0:00
11/23/2009 0:00
6/11/2010 0:00
12/28/2010 0:00
7/16/2011 0:00
Date


Shallow Pond Staff Gauge 2011
Stage
Staff reading
Precipitation
891.00
890.50
890.00
889.50
889.00
888.50
888.00
887.50
887.00
Elevation [ft.]
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Precipitation [in.]
7/31/11
8/15/11
8/30/11
9/14/11
9/29/11
10/14/11
10/29/11
11/13/11
11/28/11
12/13/11
Date [Month/day/year]

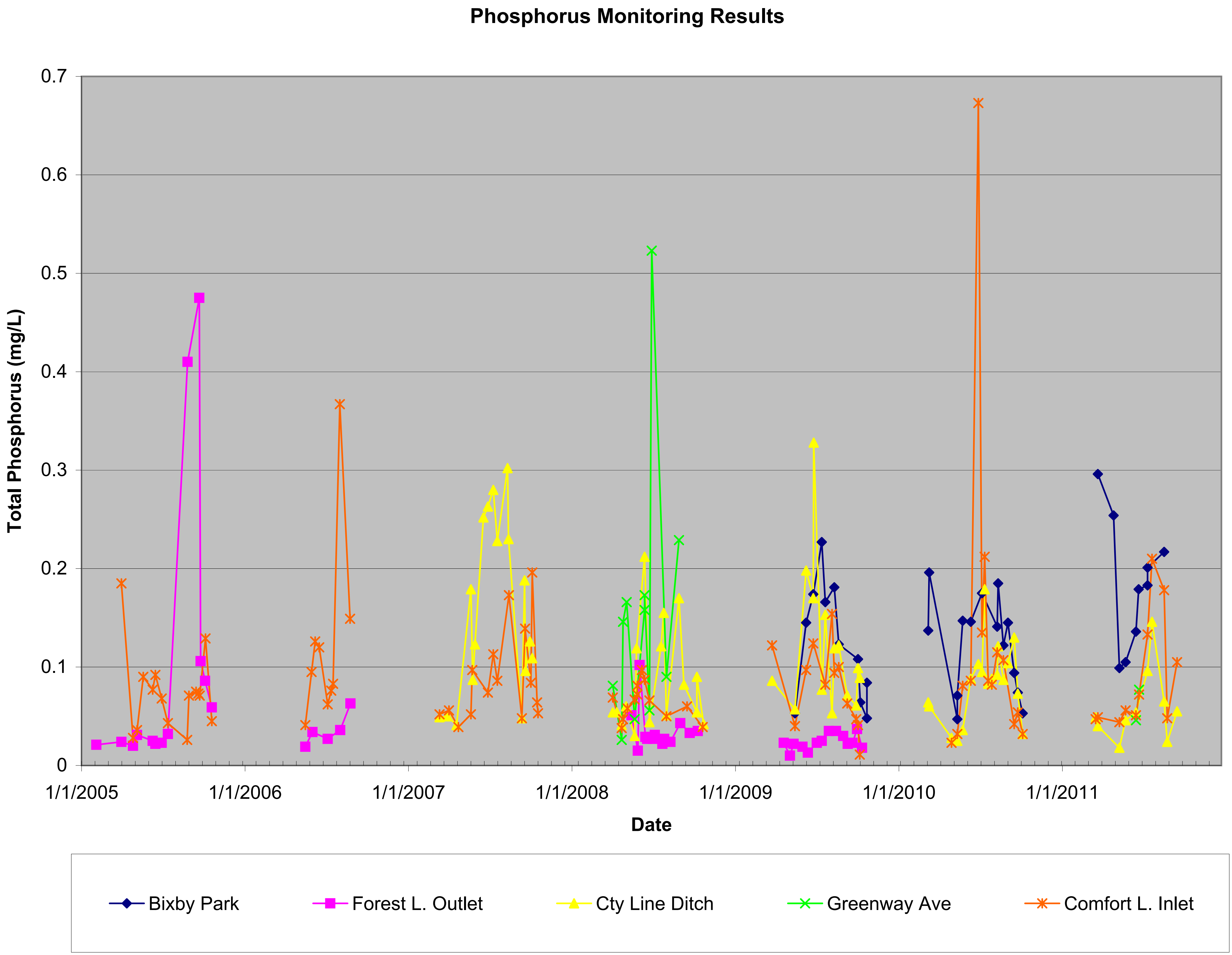


Tax Forfeit Staff Gauge
Stage
Staff reading
891.40
891.20
891.00
890.80
890.60
890.40
890.20
890.00
889.80
889.60
889.40
Elevation [ft.]
7/18/11
8/2/11
8/17/11
9/1/11
9/16/11
10/1/11
10/16/11
10/31/11
11/15/11
11/30/11
12/15/11
Date [Month/day/year]



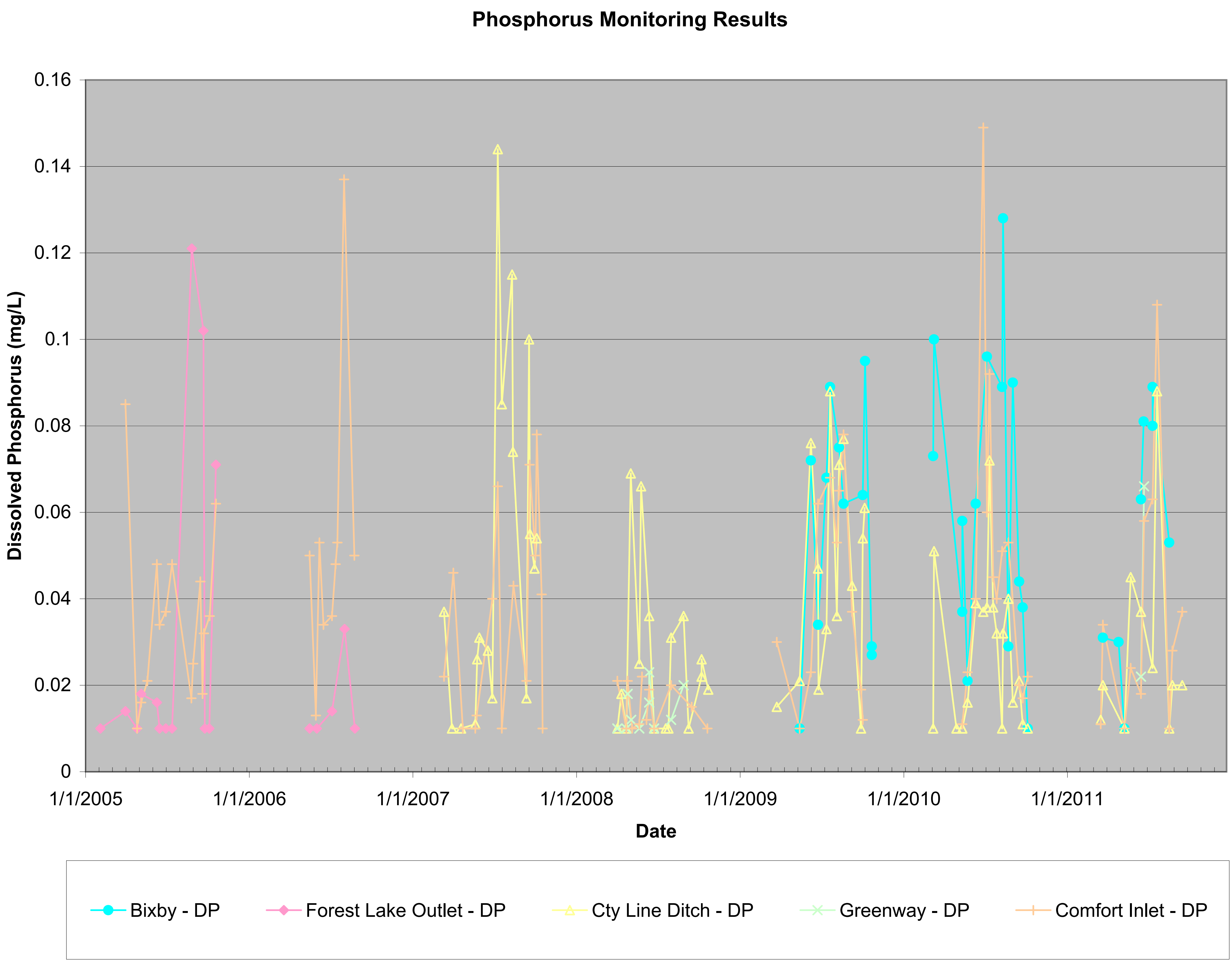
X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

08-11 chart



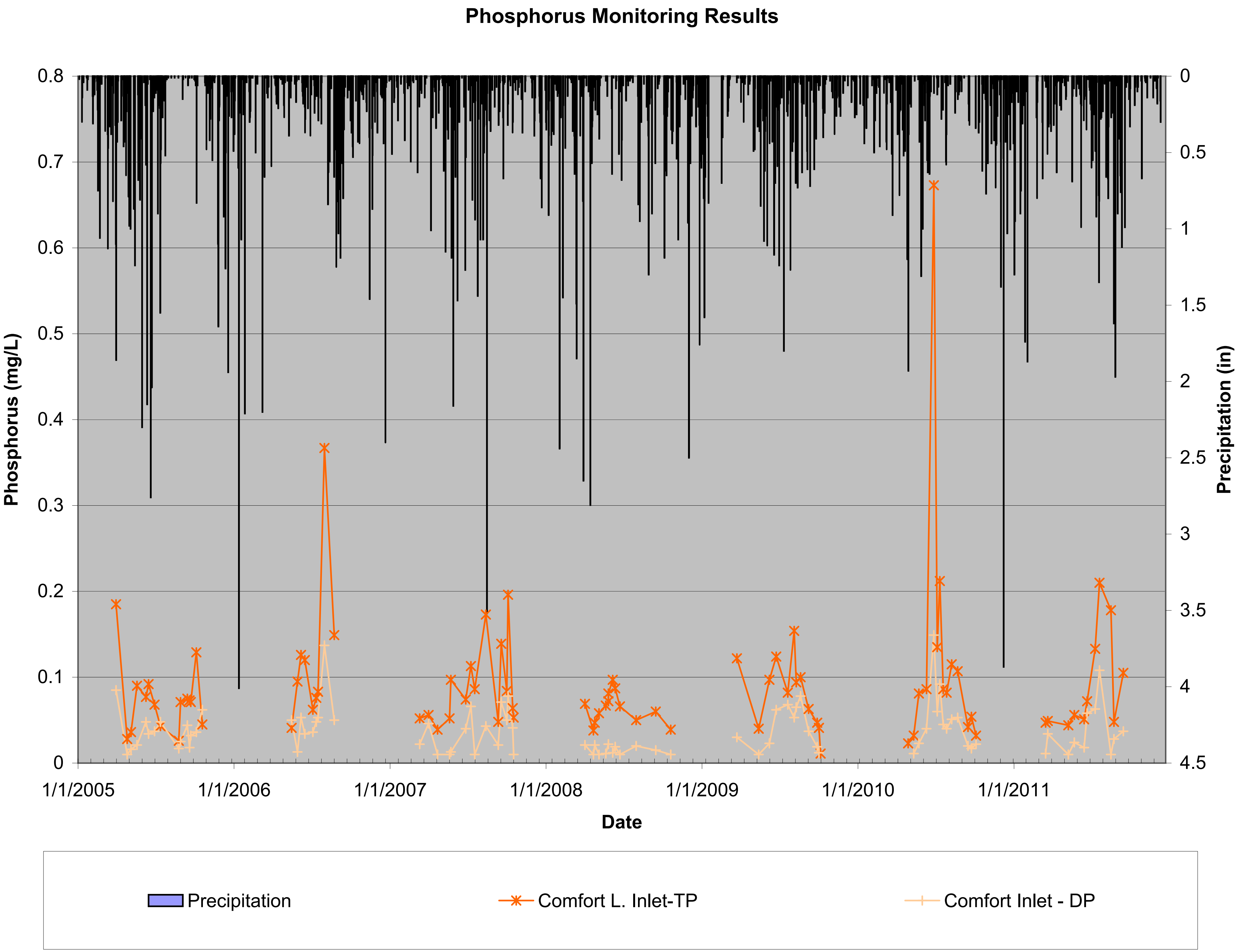
X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

08-11 chart (TP)



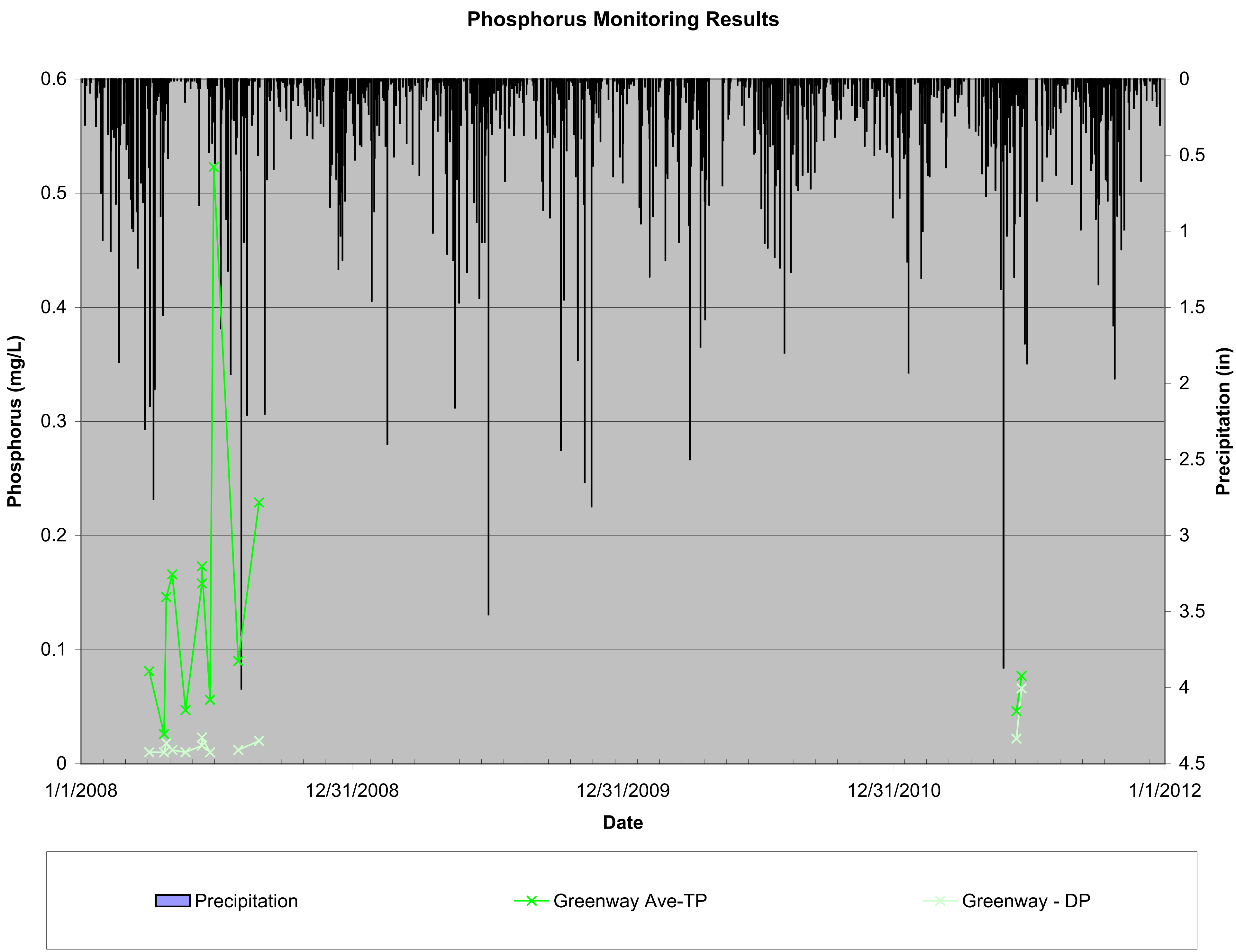
X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

08-11 chart (DP)



X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

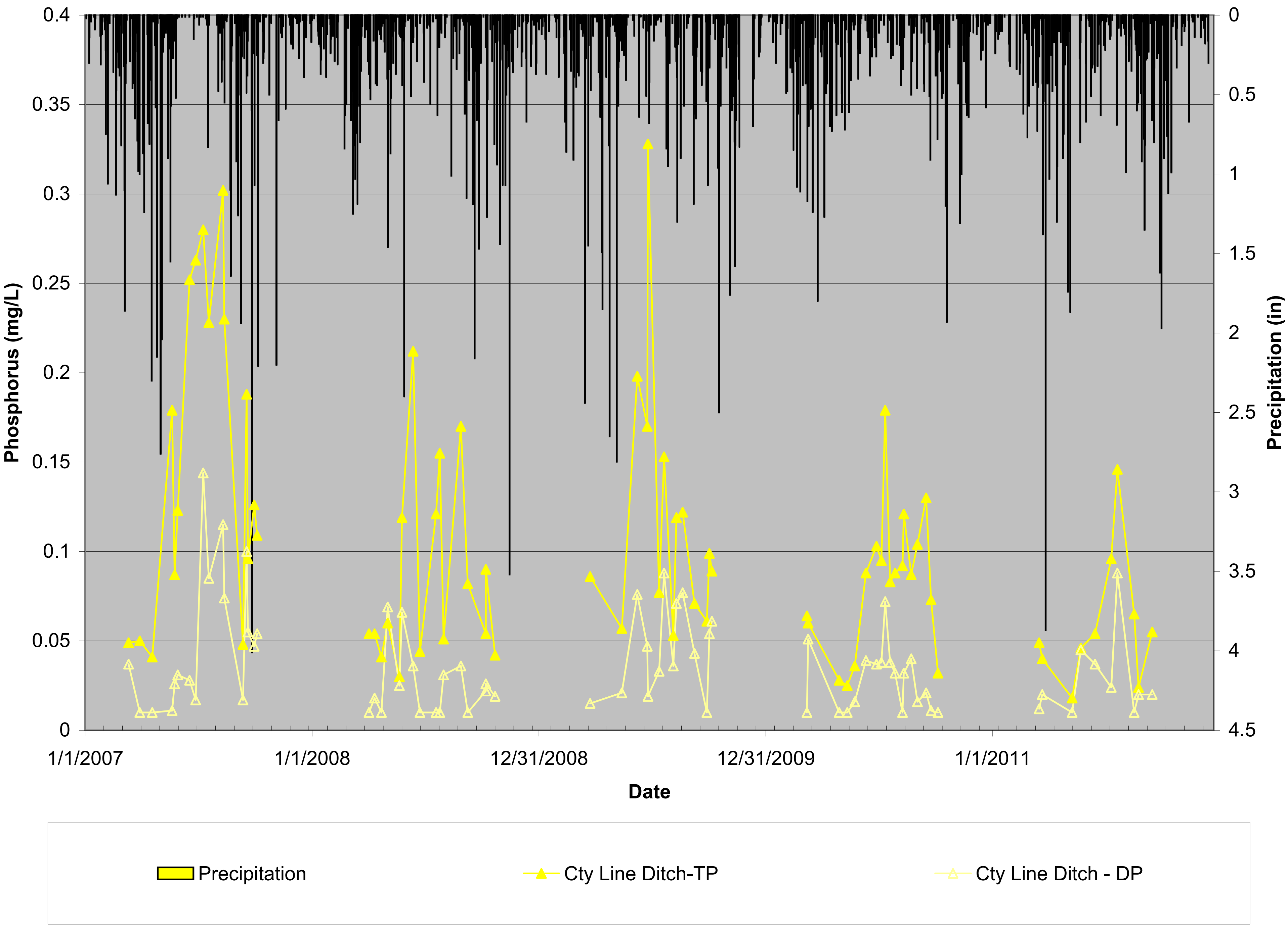
08-11 chart (CLinlet)



X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

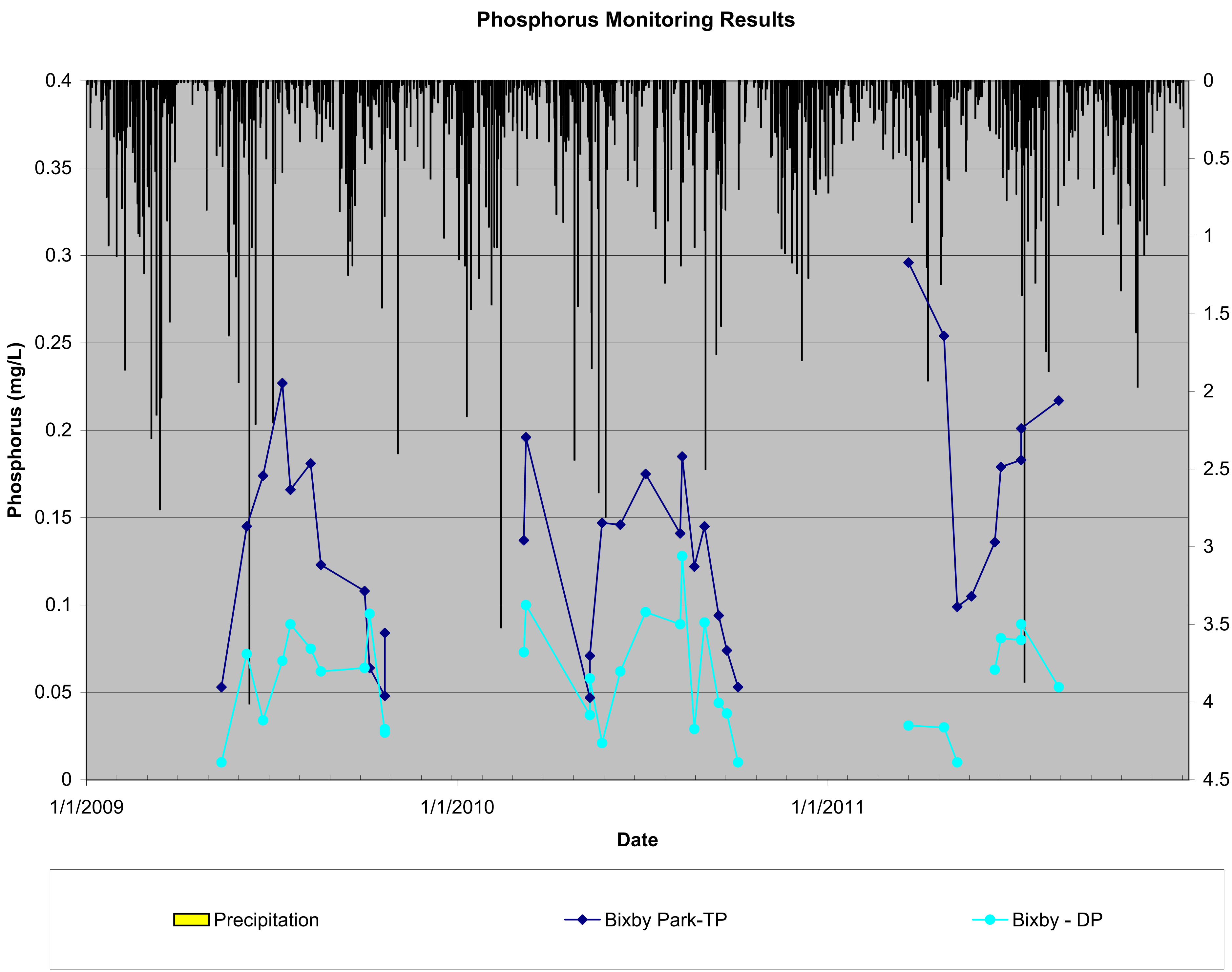
08-11 chart (Greenway)

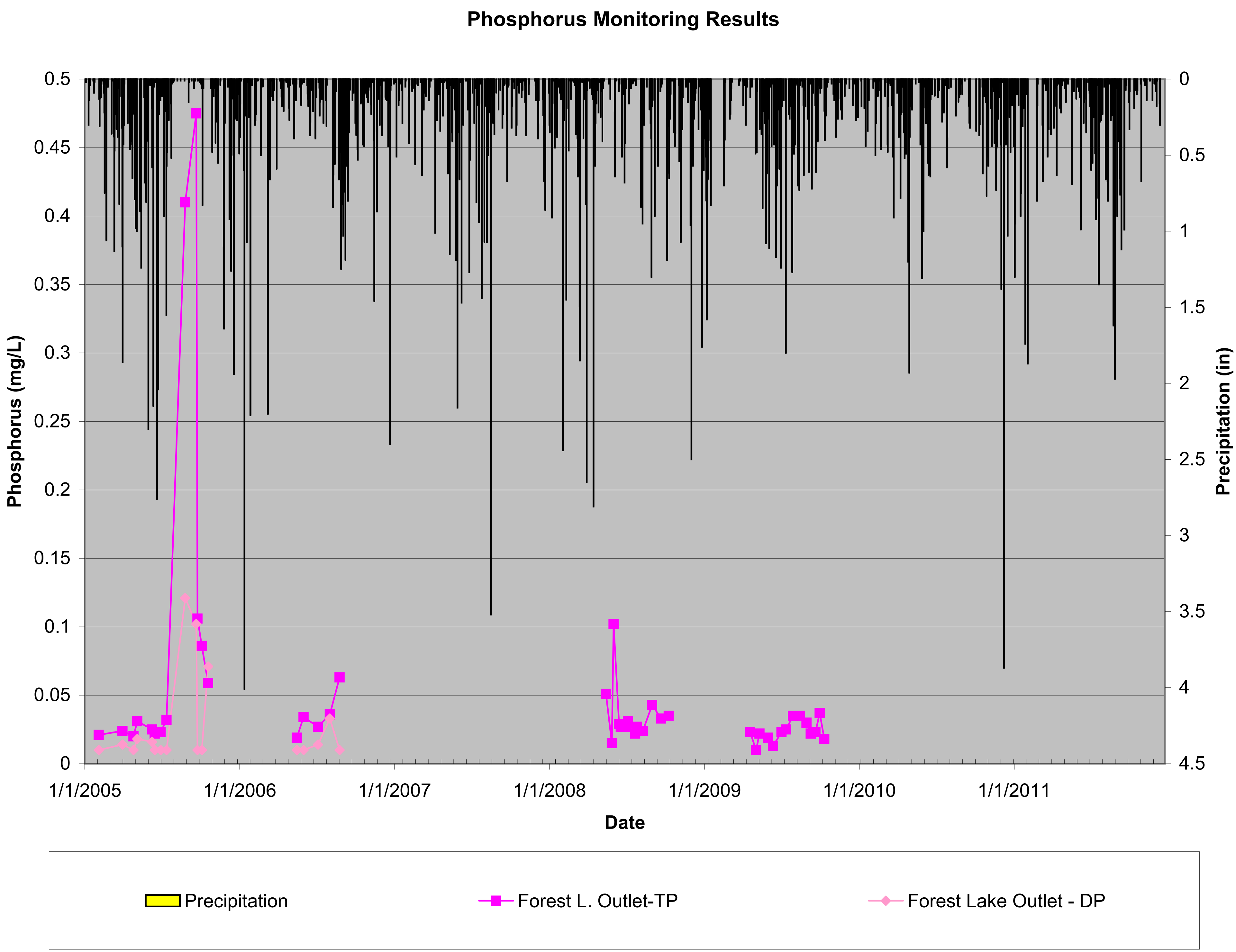
Phosphorus Monitoring Results

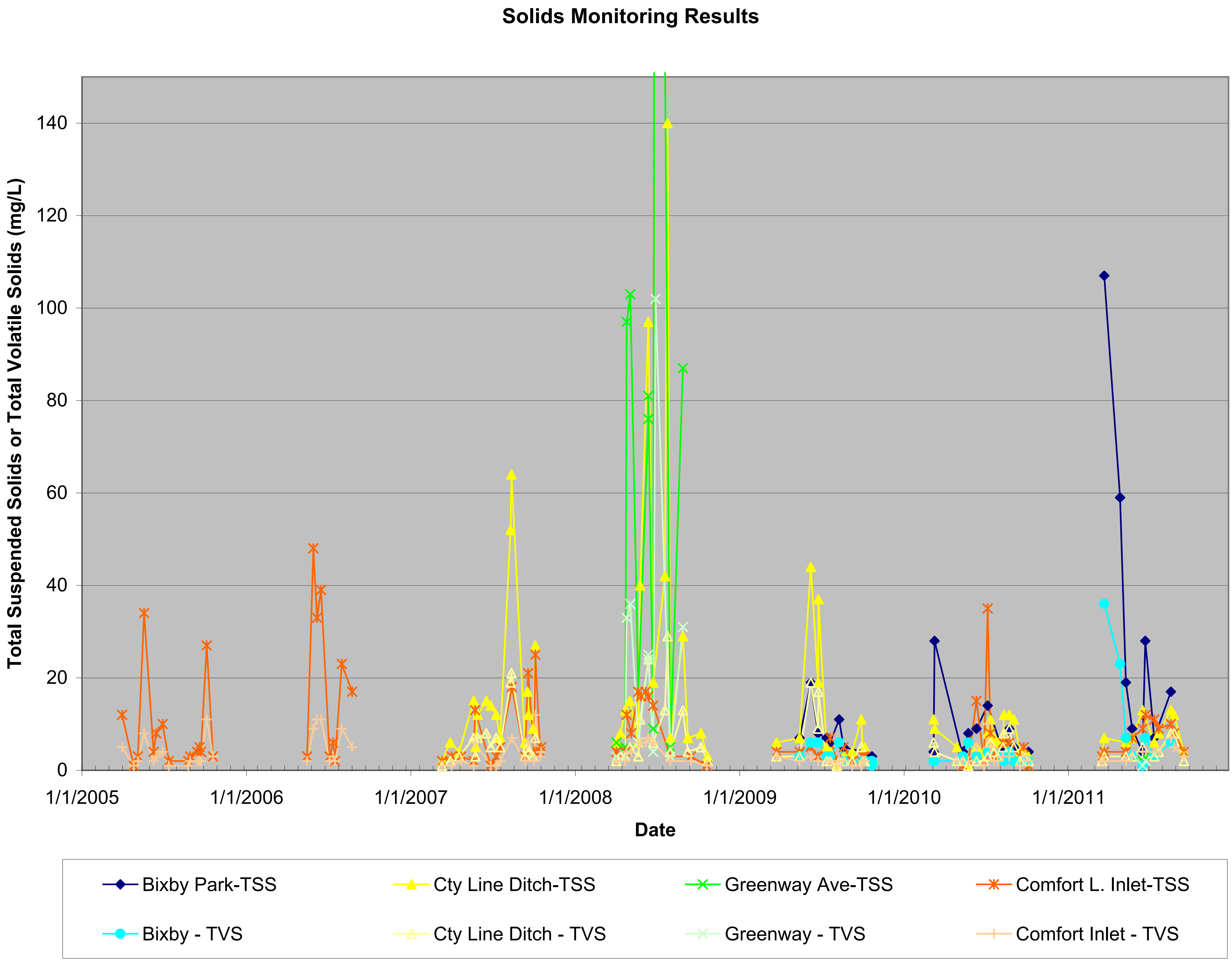


X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP.xls

08-11 chart (Cty Line)

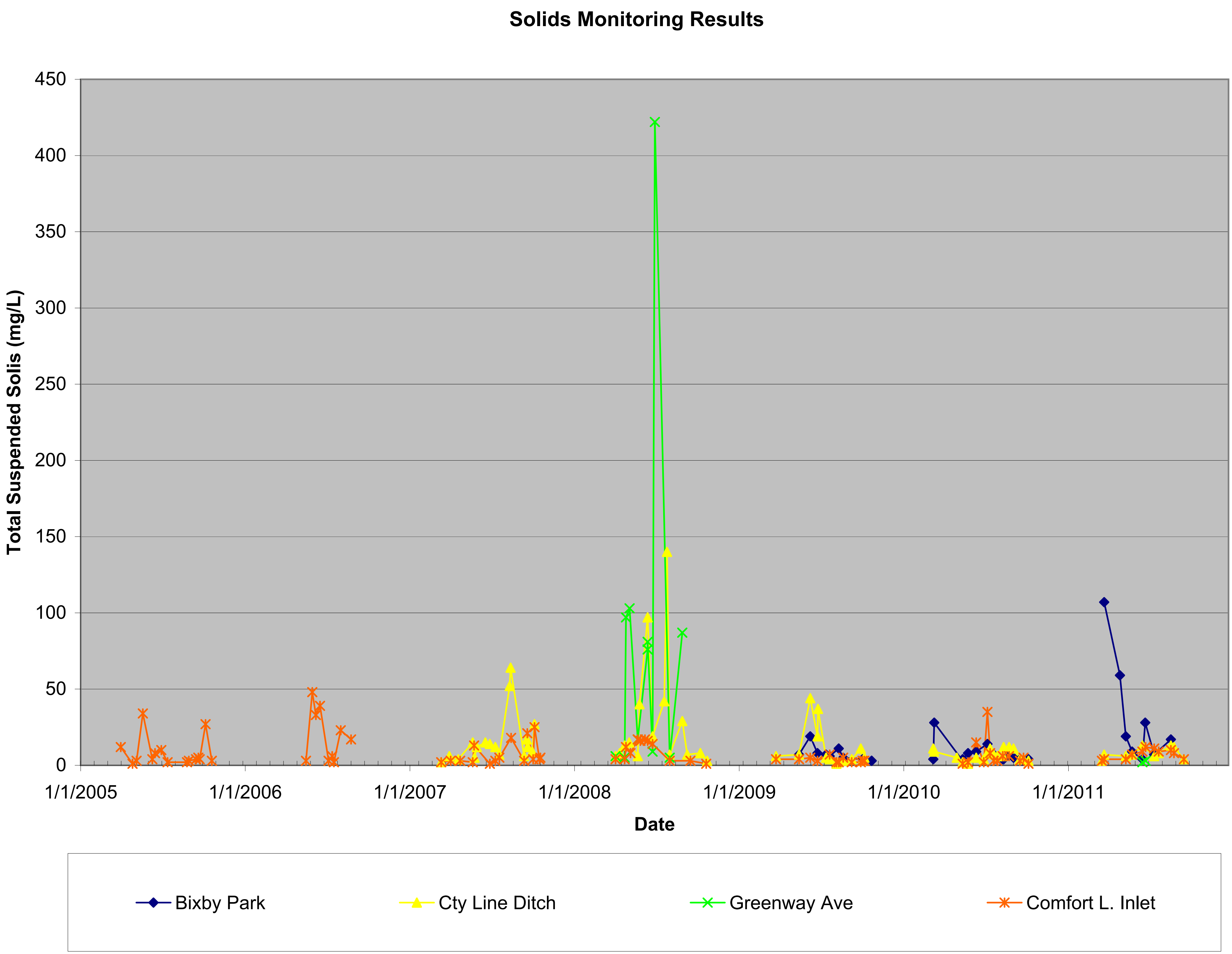

Phosphorus Monitoring Results
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Phosphorus (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Precipitation (in)
1/1/2009
1/1/2010
1/1/2011
Date
Precipitation
Bixby Park-TP
Bixby - DP


Phosphorus Monitoring Results
Phosphorus (mg/L)
Precipitation (in)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
Date
Precipitation
Forest L. Outlet-TP
Forest Lake Outlet - DP

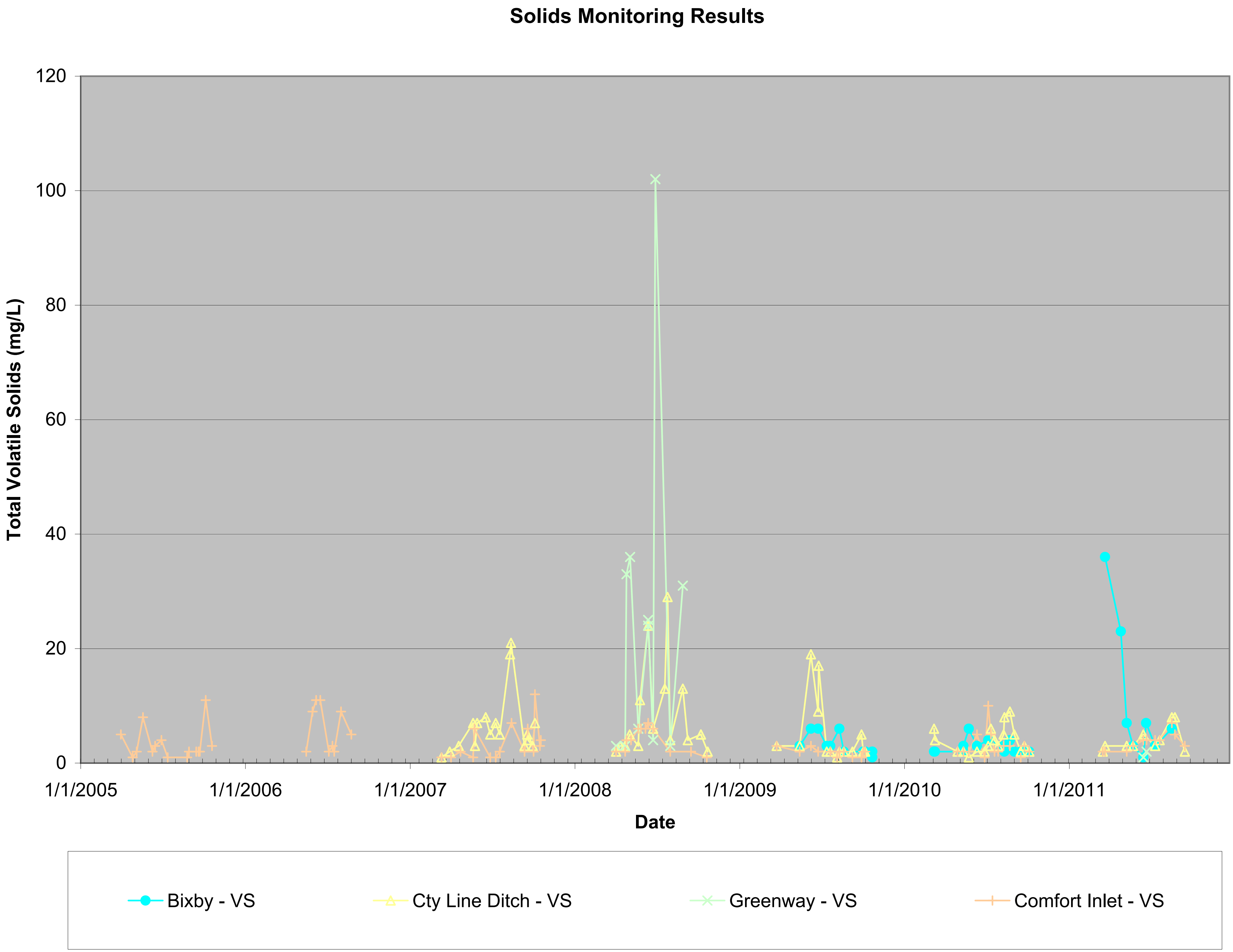


X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

08-11 chart

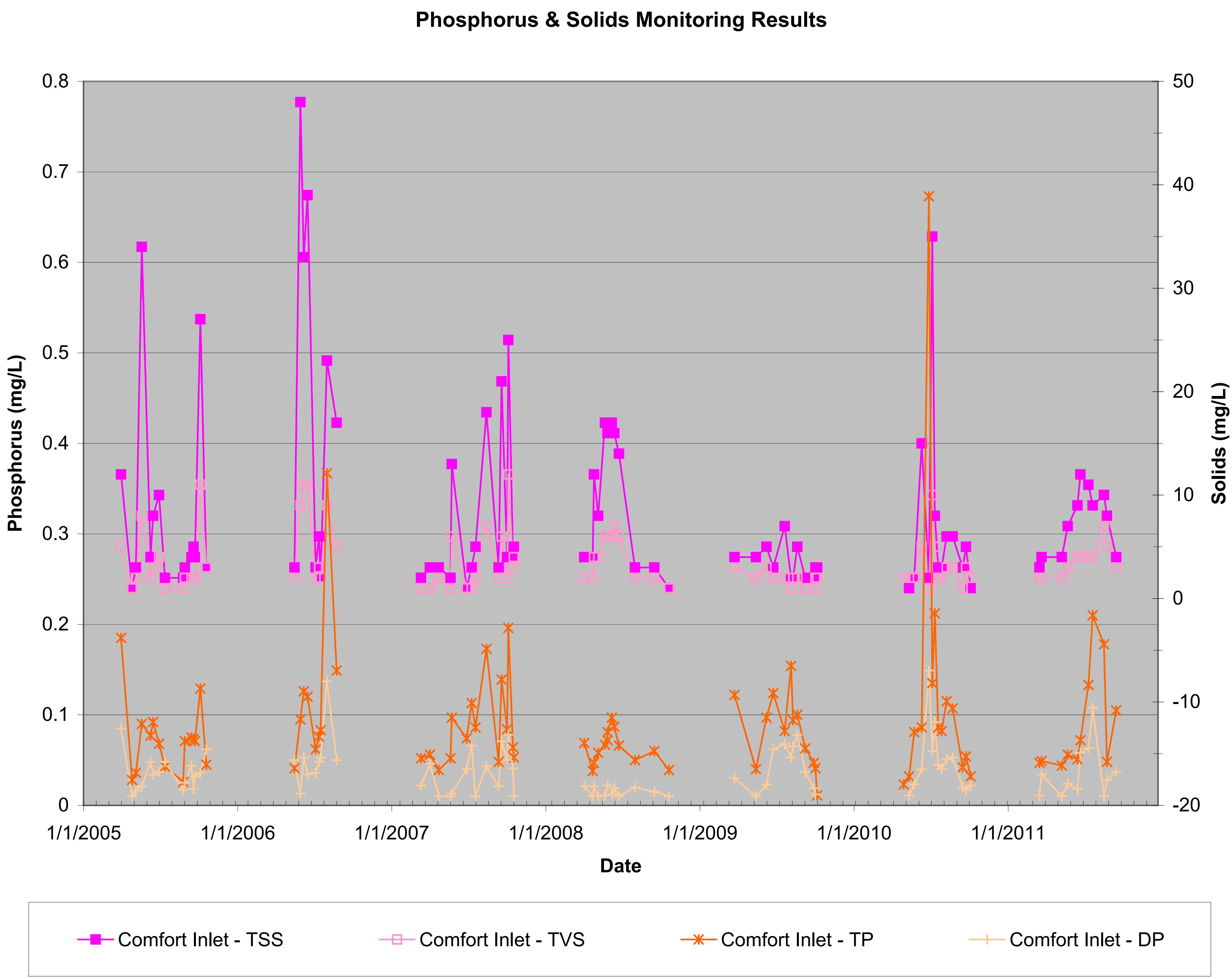


Solids Monitoring Results
Total Suspended Solis (mg/L)
450
400
350
300
250
200
150
100
50
0
1/1/2005
1/1/2006
1/1/2007
1/1/2008
1/1/2009
1/1/2010
1/1/2011
Date
Bixby Park
Cty Line Ditch
Greenway Ave
Comfort L. Inlet



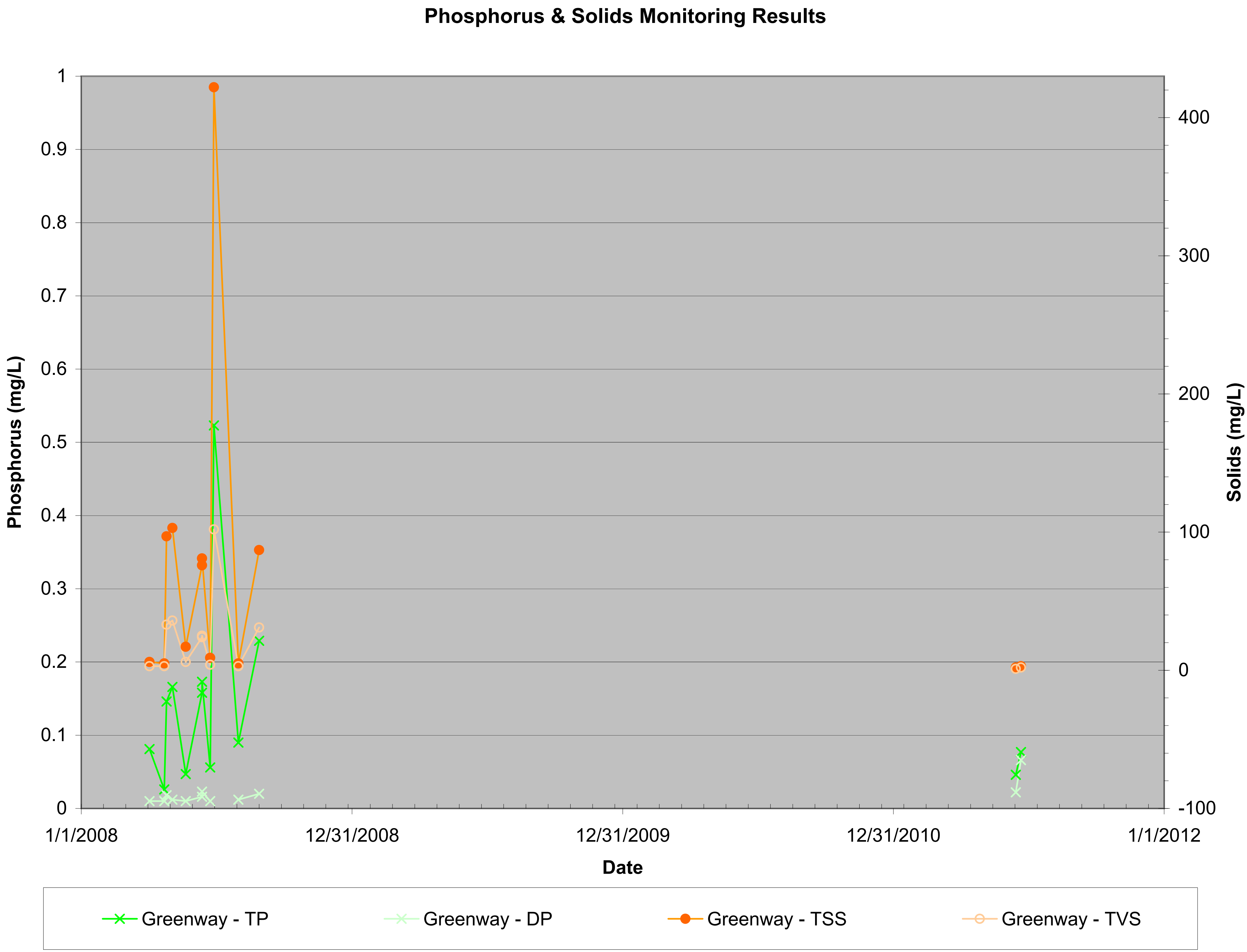
X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

08-11 chart (TVS)



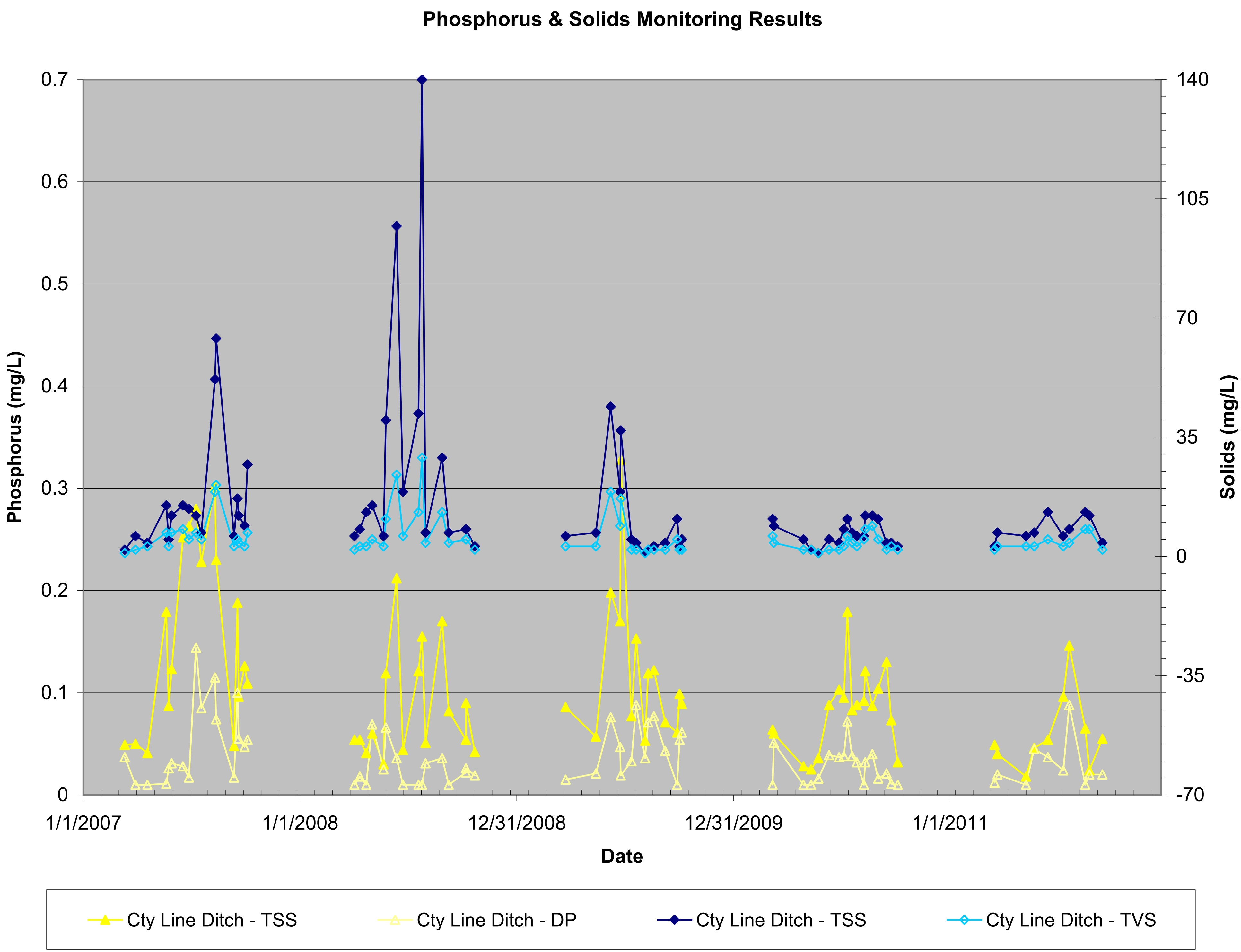
X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

08-11 chart (CLinlet)



X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

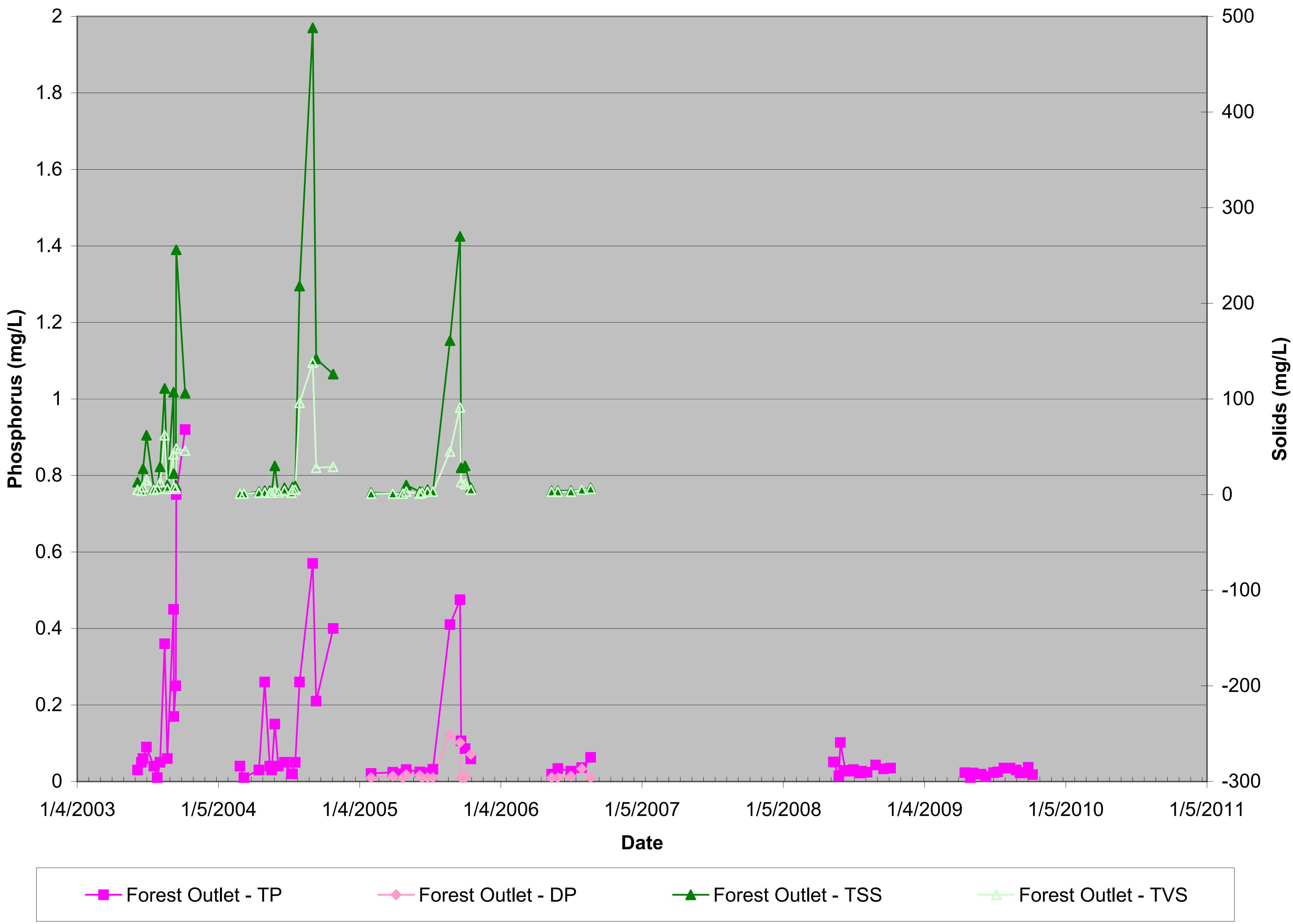
08-11 chart (Greenway)



X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

08-11 chart (Cty Line)

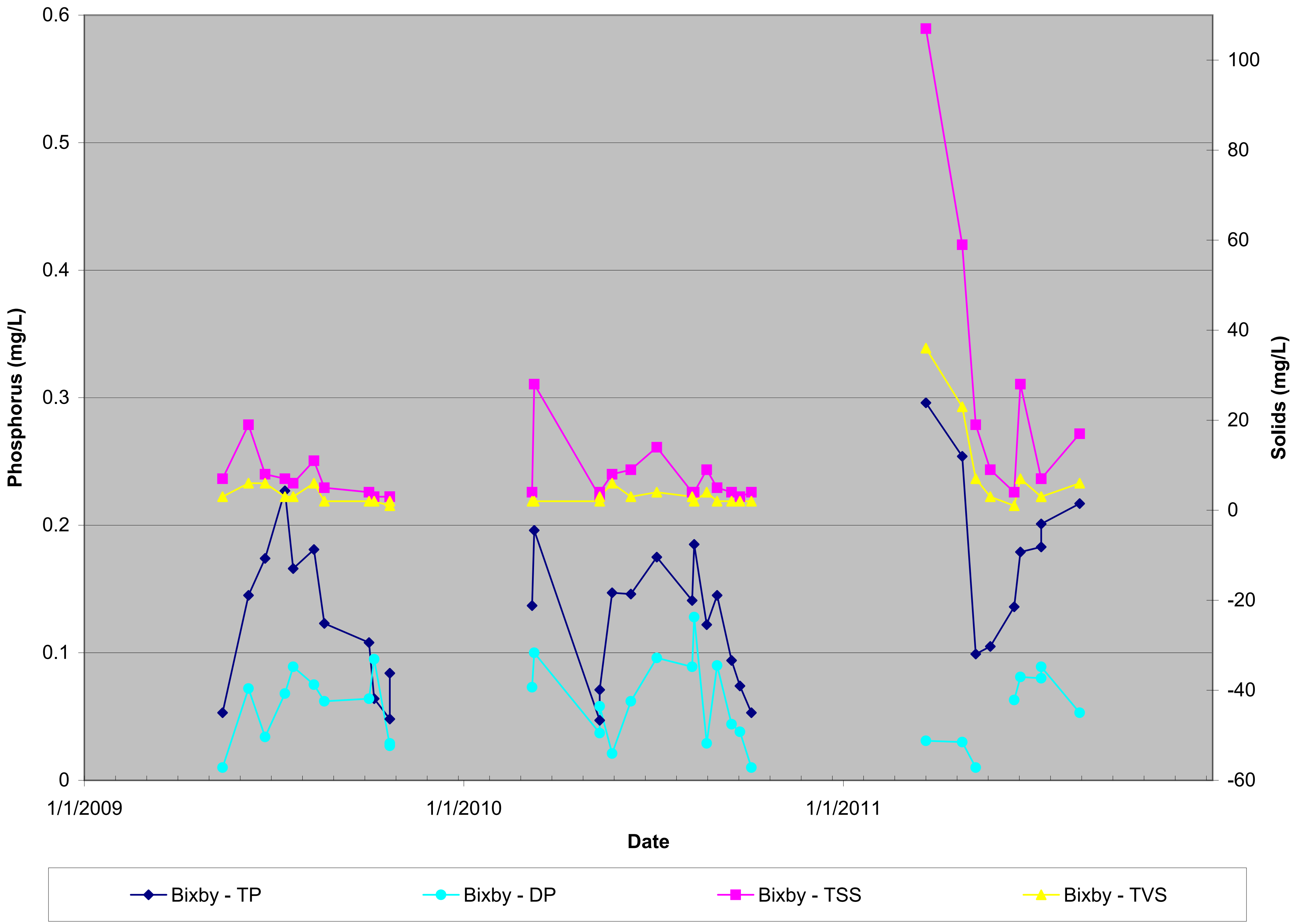
Phosphorus & Solids Monitoring Results



X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\06_Data Analyses\Water Quality Monitoring Data Analysis\WQ Data Summary-All sites-TP_DP_TSS.xls

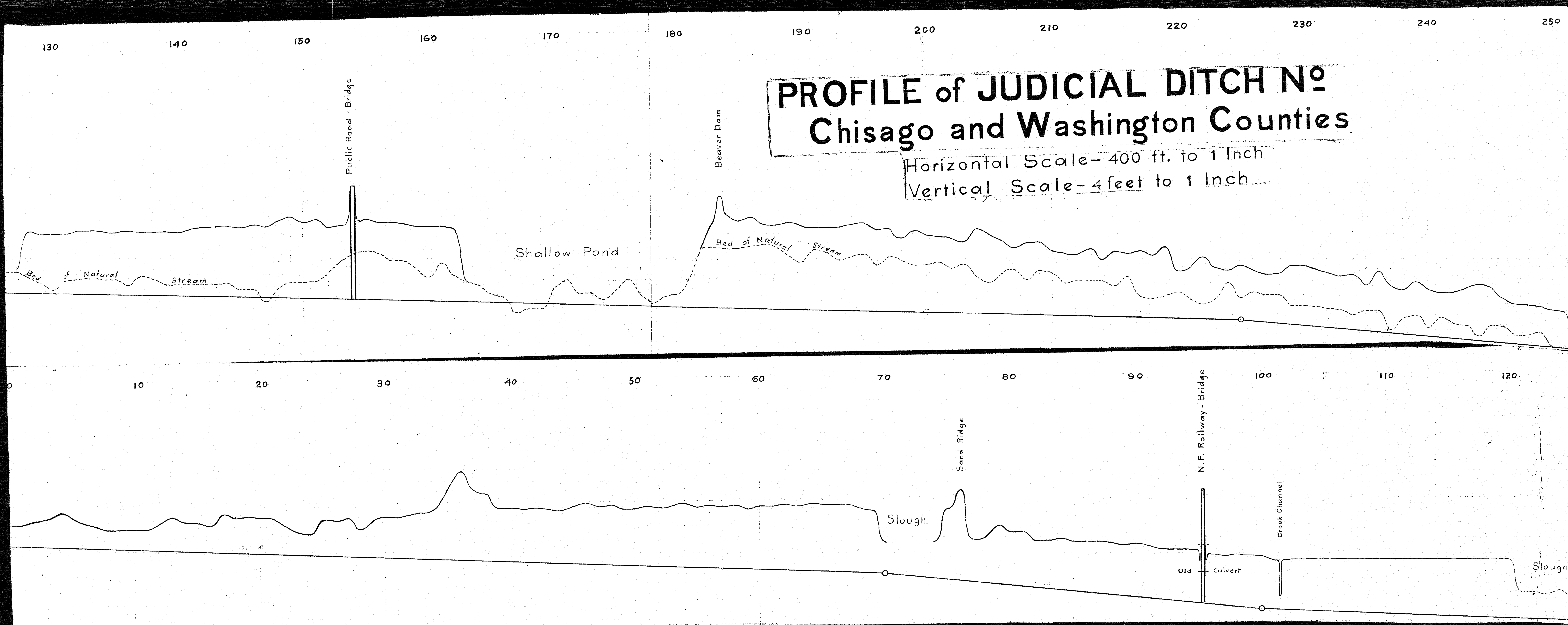
08-11 chart (Forest Lake Out)

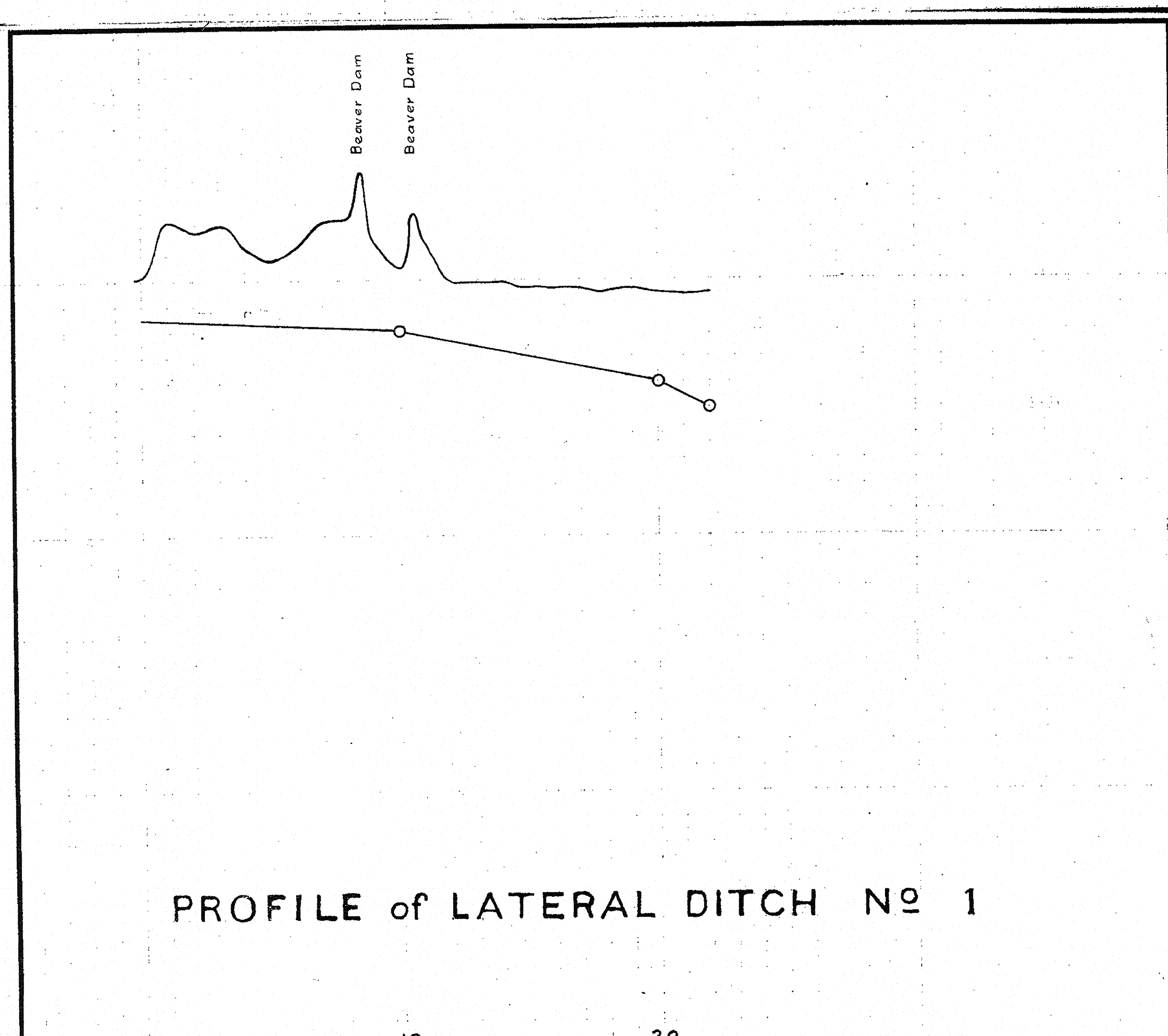
Phosphorus & Solids Monitoring Results

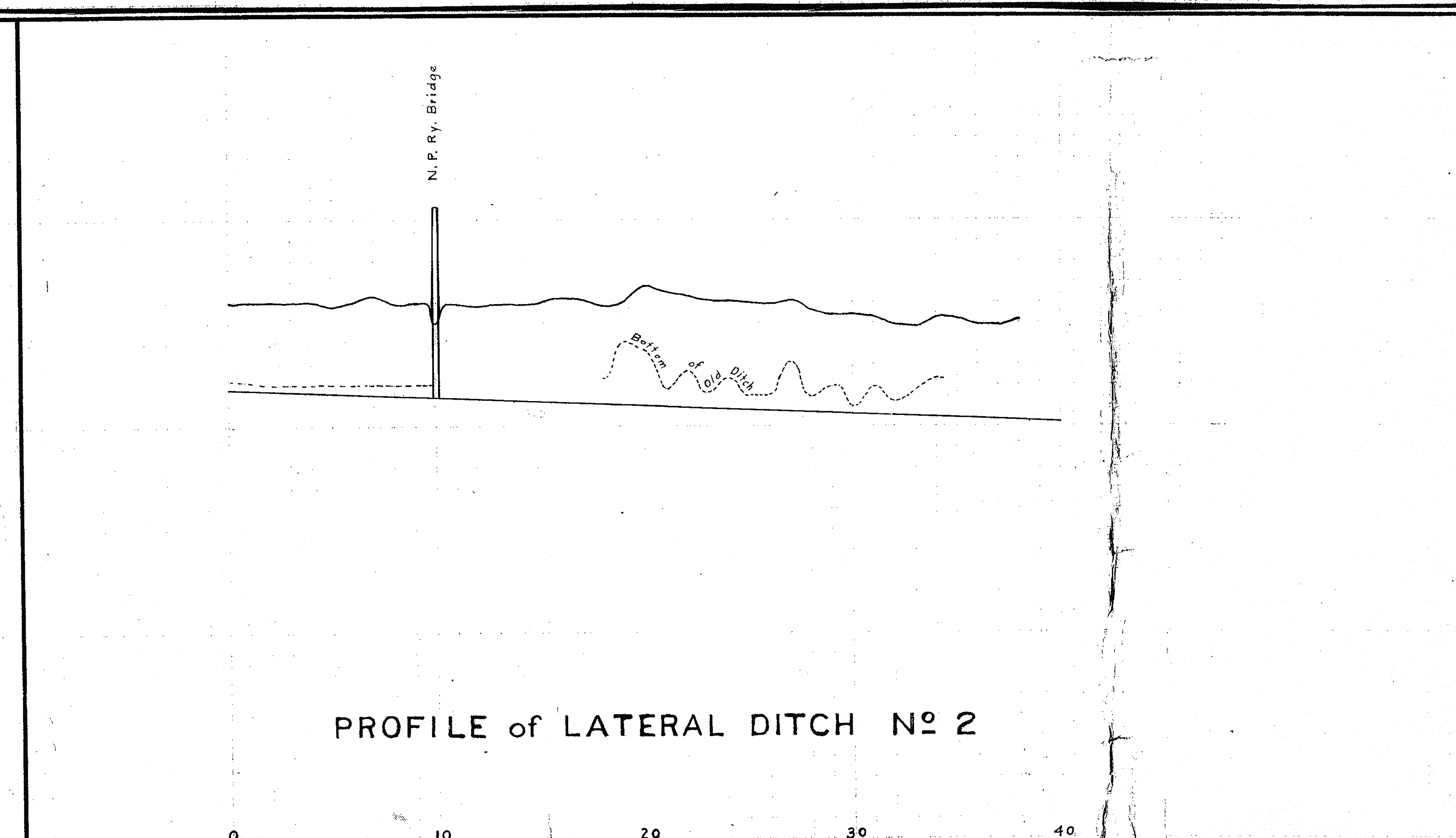


Appendix C. Ditch Records


State of Minnesota - First Judicial District
PLAT of JUDICIAL DITCH No
Chisago and Washington Counties
Scale: 1 Mile to 8 Inches
EXHIBIT No 1
August 1904
H. A. Swenson - Engineer
WYOMING
TOWNSHIP 33 NORTH
TOWNSHIP 32 NORTH
RANGE 21 WEST
RANGE 21 WEST
Main Ditch
Lateral Ditch No. 1
Lateral Ditch No 2
Shallow Pond
Slough
Lake
Northern Pacific Railway
VILLAGE OF FOREST LAKE
FOREST LAKE
CHISAGO COUNTY
WASHINGTON CO.
DOCTORS LAKE
Sunrise River
Meadow
Bluff
N
John Sanftner
Martin Green
Henry M. Heim
K. Heim
Ambrose Sanftner
Harvey Sauer
J. H. Sauer
A. W. Reinhart
J. B. Plunkett
Joseph Rainer
C. A. Covey
C. V. Smith
I. M. Banta
Axel V. and A. J. E. Anderson
William H. Bush
Marcus D. Munn
Henry G. Ide
James Hyland
F. A. Verges
Minnie Nordstrom
Geo. J. Lent
Carl Johnson
Chas. E. Johnson
Oscar W. Israelson
F. Israelson
Elof Swenson
John Delahanty
Frank A. Thomas
Gust. Rahm
Gust A. Bloomgren
Schiffman
August Kosanke
B. M. Eustis
S. J. Stromberg
C. J. Israelson
E. L. Anderson


PROFILE of JUDICIAL DITCH No
Chisago and Washington Counties
Horizontal Scale- 400 ft. to 1 Inch
Vertical Scale- 4 feet to 1 Inch
130
140
150
160
170
180
190
200
210
220
230
240
250
Public Road - Bridge
Beaver Dam
Bed of Natural Stream
Shallow Pond
Bed of Natural Stream
0
10
20
30
40
50
60
70
80
90
100
110
120
Sand Ridge
N. P. Railway - Bridge
Creek Channel
Slough
Old Culvert
Slough


Beaver Dam
Beaver Dam
PROFILE of LATERAL DITCH No 1
0
10
20


N. P. Ry. Bridge
Bottom of Old Ditch
PROFILE of LATERAL DITCH No 2
0
10
20
30
40

PLAT OF

JUDICIAL DITCH No. 1.

CHISAGO COUNTY, MINN.

March 1944. Scale 1" = 1200'
V. H. Caneday, Engineer, Taylors Falls, Minn.

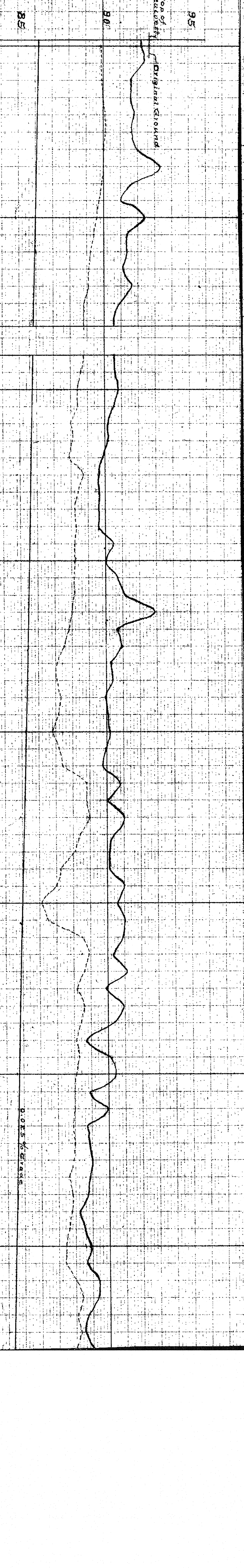
PROFILE OF
CHISAGO COUNTY JUDICIAL DITCH Nº 1.

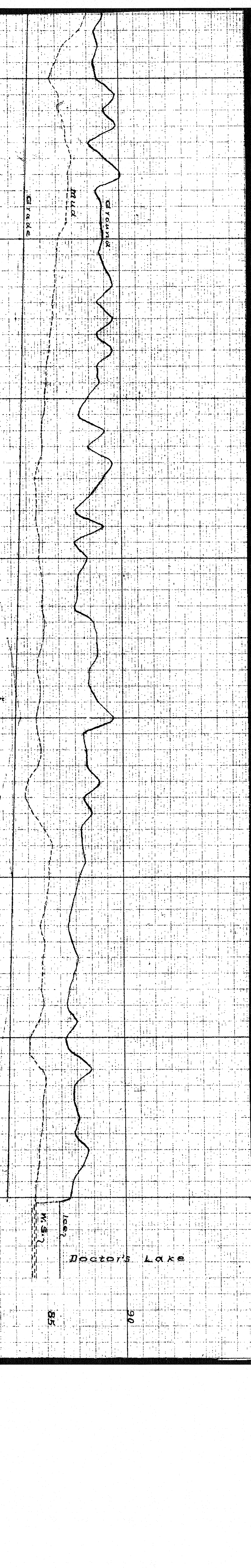
V. H. Caneday, Engineer.
Taylors Falls, Minn.

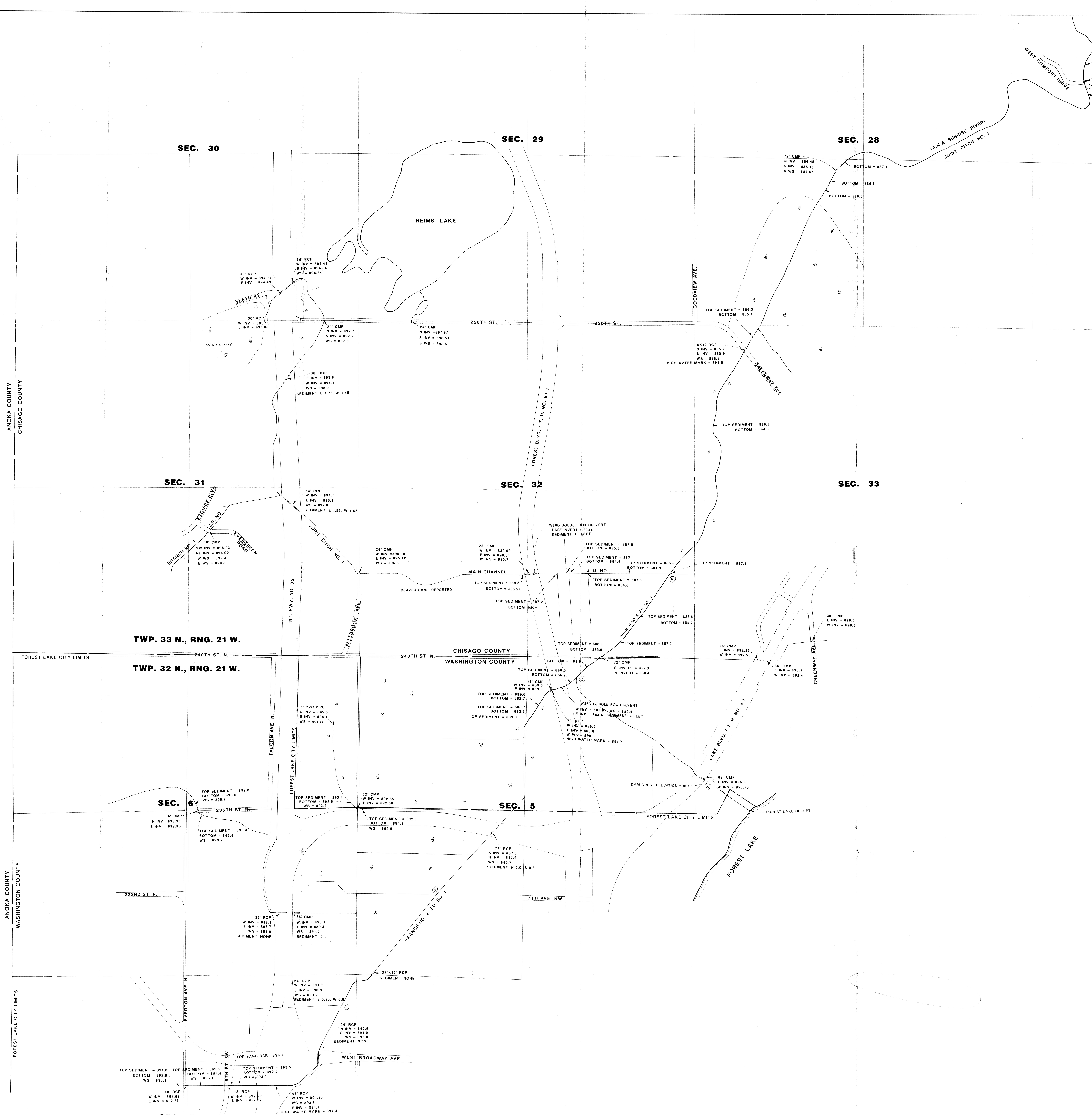
Jan. 1944.

Sta.	Cut	Mud	Bot W.	Top W.	Cu. yds	
19+84 / 20	6.0	3.7	10'	17.4	30	Washington County / Chisago County
21	6.2	3.7	"	17.4	188	
22	5.4	3.8	"	17.6	190	B.M. on tree @ Sta. 17 18" Cottonwood Elev. 95.05'
23	5.5	3.9	"	17.8	191	
24	5.7	4.0	"	18.0	204	
25	5.6	4.0	"	18.0	208	B.M. on Old Bridge Post Sta. 25+15 Elev. 94.24
26	5.8	3.9	"	17.8	204	
27	7.3	3.9	"	17.8	201	
28	5.7	3.8	"	17.6	197	
29	5.0	3.7	"	17.4	191	
30	6.4	3.7	"	17.4	188	
31	5.4	3.5	"	17.0	181	
32	5.4	3.3	"	16.6	167	
33	5.2	3.2	"	16.4	160	
34	5.7	3.2	"	16.4	157	
35	5.1	3.0	"	16.0	151	
36	4.7	3.0	"	16.0	145	
+30						36+30 = 118 Equation
118	4.7				44	Junct. Bra. "2"
119	4.2	2.8	"	15.6	139	B.M. on Rock @ Outlet Sta. 118, Elev. 91.11
120	5.0	2.6	"	15.2	125	
121	4.8	2.6	"	15.2	121	
122	4.5	2.3	"	14.6	113	
123	4.5	2.4	"	14.8	108	
124	4.1	2.2	"	14.4	166	
125	4.0	3.1	"	16.2	122	
126	4.2	2.8	"	15.6	139	
127	4.2	2.4	"	14.8	121	
128	4.2	2.6	"	15.2	110	
129	5.0	2.7	"	15.4	125	
130	4.5	2.7	"	15.4	128	
131	5.2	2.6	"	15.2	125	
132	5.6	2.7	"	15.4	125	
133	5.7	2.6	"	15.2	126	
134	5.2	2.4	"	14.8	116	
135	5.5	2.1	"	14.2	97	
136	4.9	1.7	"	13.4	84	
137	5.0	1.8	"	13.6	77	
138	4.6	2.0	"	14.0	84	
139	4.8	1.9	"	13.8	86	
140	4.8	1.6	"	13.2	76	
141	4.7	2.0	"	14.0	79	
142	4.5	2.2	"	14.4	94	
143	5.5	3.7	"	17.4	144	
144	4.9	3.8	"	17.6	191	
145	5.9	3.9	"	17.8	198	
146	5.3	3.3	"	16.6	182	
147	5.0	3.0	"	16.0	154	B.M. Nail in Light Pole @ 147+30 El. 92.37
148	5.1	2.2	"	14.4	122	
149	6.0	2.0	"	14.0	94	
150	5.6	1.1	"	12.2	67	
151	6.0	1.5	"	13.0	54	
152	5.9	3.6	"	17.2	181	
153	5.3	4.0	"	18.0	208	
154	6.2	3.7	"	17.4	130	
155	5.0	3.3	"	16.6	175	
156	6.0	3.7	"	17.4	175	
157	5.5	3.6	"	17.2	185	
158	3.9	3.4	"	16.8	191	
159	5.4	3.6	"	17.2	98	B.M. on Old Br. Abut. Hy #1. Elev. 97.00
160	5.6	3.4	"	16.8	182	
161	4.2	3.3	"	16.6	166	
162	5.2	3.4	"	16.8	166	
163	4.0	3.2	"	16.4	163	
164	4.2	3.4	"	16.8	163	
165	4.4	3.3	"	16.6	166	
166	4.3	3.0	"	16.0	154	
167	4.1	3.2	"	16.4	151	
168	3.6	3.3	"	16.6	160	
169	4.0	3.1	"	16.2	156	
170	4.3	2.9	"	15.8	144	
171	4.1	3.0	"	16.0	142	
172	4.9	3.6	"	17.2	163	B.M. on F.R. near Bridge Elev. 92.85
173	4.9	4.0	"	18.0	195	
174	4.3	3.8	"	17.6	201	
175	4.1	4.0	"	18.0	201	
176	4.6	3.7	"	17.4	196	
177	4.2	3.2	"	16.4	173	
178	4.4	2.1	"	14.2	125	
179	4.1	1.8	"	13.6	87	
180	4.3	1.4	"	12.8	69	
181	5.6	2.0	"	14.0	74	
182	4.8	2.1	"	14.2	92	
183	5.6	2.5	"	15.0	105	B.M. on Br. Post Elev. 92.75
184	3.9	2.6	"	15.2	119	
185	5.1	2.9	"	15.8	130	
186	6.1	2.7	"	15.4	130	
187	4.4	2.8	"	15.6	129	
188	4.8	2.7	"	15.4	130	
189	4.8	2.7	"	15.4	128	
190	4.9	2.1	"	15.2	111	
191	4.7	2.1	"	14.2	94	
192	5.1	1.8	"	13.6	87	
193	5.7	2.0	"	14.0	84	B.M. on 4" Elm Elev. 89.57
194	4.6	1.8	"	13.6	84	
195	5.6	1.8	"	13.6	79	
196	4.6	1.8	"	13.6	79	
197	5.7	1.7	"	13.4	77	
198	4.7	1.5	"	13.0	69	
199	4.8	1.6	"	13.2	67	
200	4.1	1.5	"	13.0	67	
201	3.6	1.4	"	12.8	62	
202	5.3	1.3	"	12.6	56	
203	4.2	1.4	"	12.8	56	
204	5.8	1.2	"	12.4	55	
205	5.2	0.9	"	11.8	39	
206	4.6	1.0	"	12.0	39	
207	3.5	1.1	"	12.2	43	
208	5.3	1.1	"	12.2	44	
209	3.5	1.3	"	12.6	50	
210	4.3	1.2	"	12.4	52	
211	3.8	1.4	"	12.8	54	
212	3.7	1.6	"	13.2	64	
213	3.6	1.5	"	13.0	67	B.M. on 6" Cottonwood Elev. 89.43
214	4.8	1.7	"	13.4	69	
215	5.0	1.6	"	13.2	72	
216	5.0	1.4	"	12.8	64	
217	4.6	1.3	"	12.6	61	
218	4.6	1.5	"	13.0	59	
219	5.1	1.5	"	13.0	64	Double B.M. on 8" Elm Top Elev. 89.48
220	6.2	1.3	"	12.6	59	
221	4.3	1.4	"	12.8	57	
222	4.5	1.6	"	13.2	64	
223	4.5	1.5	"	13.0	67	
224	5.4	0.9	"	11.8	45	
225	4.4	0.7	"	11.4	33	
226	4.9	1.2	"	12.4	39	
227	4.2	2.0	"	14.0	70	B.M. on 24" Willow Elev. 90.14
228	4.3	2.5	"	15.0	102	
229	4.6	2.3	"	14.6	111	
230	4.2	2.3	"	14.6	105	
231	4.0	2.2	"	14.4	102	
232	3.7	2.0	"	14.0	94	
233	3.7	1.8	"	13.6	84	
234	3.8	2.1	"	14.2	87	
235	4.2	2.0	"	14.0	92	
236	3.9	2.0	"	14.0	89	
237	3.8	1.9	"	13.8	86	
238	3.6	2.1	"	14.2	89	
239	4.2	1.8	"	13.6	86	B.M. on Stub Elev. 90.61
240	3.5	1.2	"	12.4	64	
241	4.1	1.3	"	12.6	52	
242	5.2	2.1	"	14.2	74	
243	4.1	2.3	"	14.6	80	
244	4.1	2.1	"	14.2	99	
245	4.5	2.2	"	14.4	97	
246	4.2	2.1	"	14.2	97	
247	5.1	1.9	"	13.8	92	B.M. on 14" Elm Elev. 89.69
248	4.7	2.0	"	14.0	87	
249	4.1	1.8	"	13.6	84	
250	4.0	1.8	"	13.6	79	
+25	0.0	0.0	"	0.0	10	

17,075 Cu. yds.







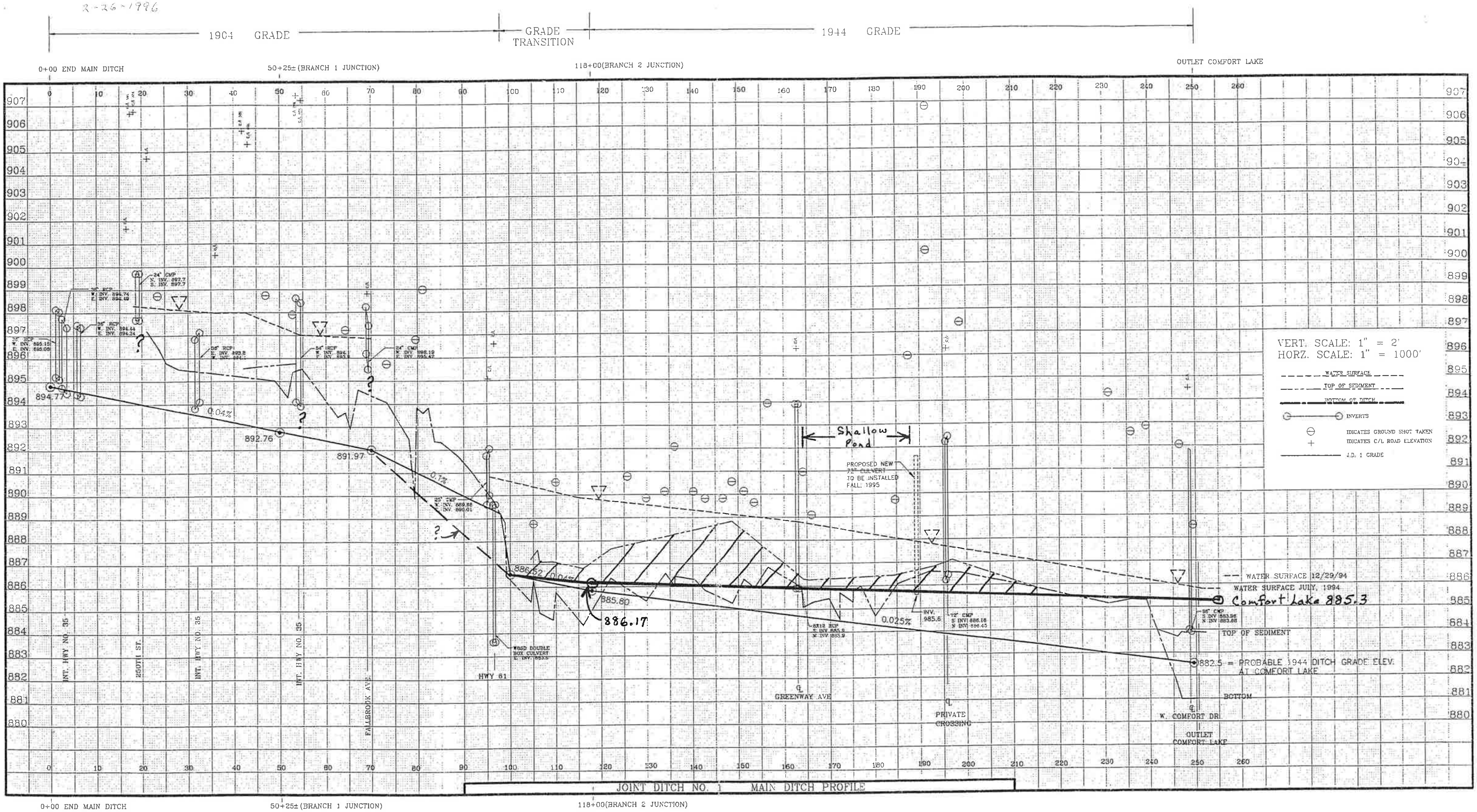
DRAWN BY: CHISAGO COUNTY SURVEYOR

SCALE: 1 INCH = 500 FEET

JULY 1994
UPDATED: AUGUST 1994
AMENDED: SEPT. 2, 1994

JOINT DITCH NO. 1

ELEVATIONS ARE IN N.G.V.D. 1929 ADJUSTMENT
MOST ELEVATIONS SHOWN WERE OBTAINED ON JULY 6,7,8, 1994



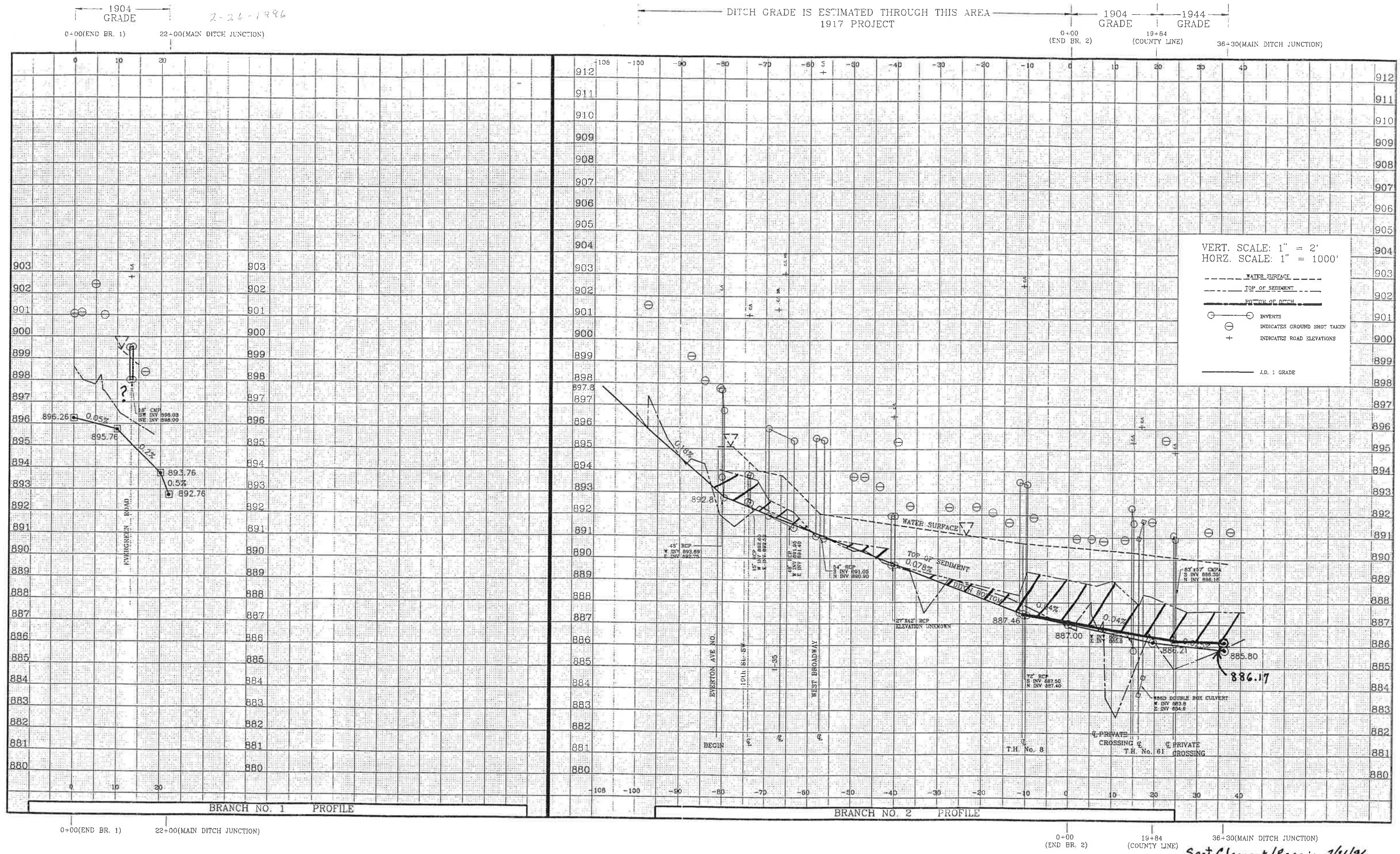
ENGINEERS DETERMINATION OF J.D. 1 SYSTEM DITCH GRADES

SEPTEMBER 14, 1995

Spot Clean-out/Repair 2/26/96

rieke carroll muller associates inc.
architects engineers land surveyors

SHEET 1 OF 2



ENGINEERS DETERMINATION OF J.D. 1 SYSTEM DITCH GRADES

SEPTEMBER 14, 1995

(PRINTED OCT. 25, 1995)

rieke
carroll
muller
associates inc.
o architects o engineers o land surveyors o

Judicial Ditch No. 1 Chisago-Washington Counties

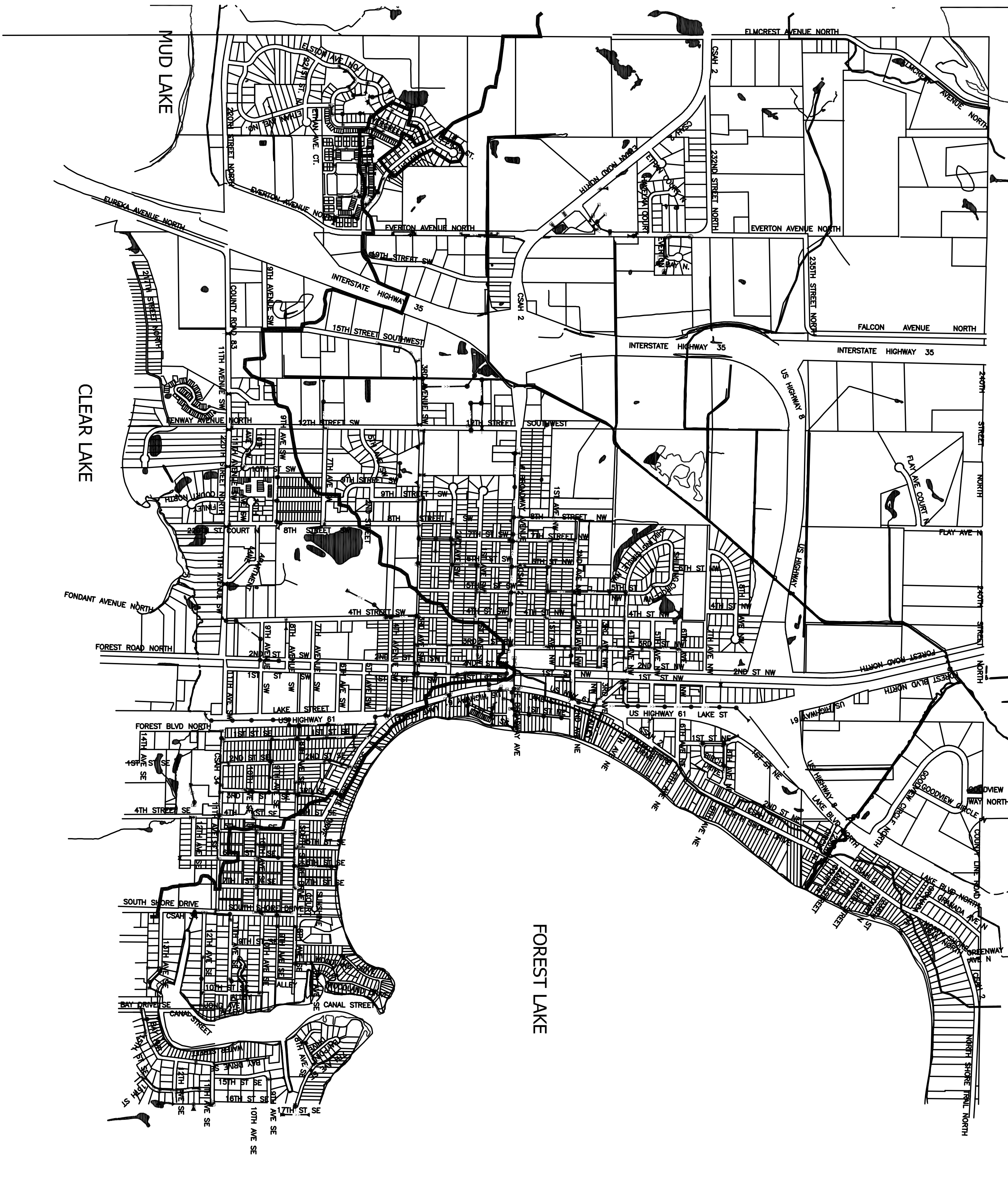
PETITION	DITCH (Court file #)	PLAT + ENG. REPORT	LOCATION
5-19-1904	J.D. No. 1. (6804)	9-6-1904 HENRY A. SWENSON map is heavy dark blue reproducible (Surveyor's Office copy is in better condition than auditor's)	CHISAGO COUNTY MAIN DITCH: Sec 27, 28, 30, 31, 32 + 33; 33-2 LATERAL DITCH 1: SEC 31, T33-R21 LATERAL DITCH 2: SEC 5, 32-21 (WASH. Co) + 32, 33-21 (CHIS. Co) LATERAL DITCH 2A: SEC 5, 32-21
ly 17-19, 1913	Co. Ditch No 1	J. M. Oldham notes in his fieldbook B, pages 55 + 56, old ditch and new work in Sec. 5, T32-R21	
7-9-1915	EXTENSIONS of Branch No 2 of J. D. No. 1 (#8496)	8-21-1916 + 2-3-1917 HENRY A. SWENSON NO PLAT OR MAP OF LOCATION FOUND IN FILE 3/15/82 mlw	EXTENSION OF LATERAL DITCH 2, J.D. 1: WASH. Co. Sec 5, 7 + 8, T32-R21 (AKA BRANCH NO 2, J.D. 1) ~~EXT. OF MAIN DITCH OF J.D. 1: CHIS. Co. Sec 31, T33-R21~~ 2-1-1917 ordered to abandon part of proposed work
10-12-1915	WIDEN + REPAIR Br 2, J.D. No. 1 (#8498)	8-21-1916 + 2-3-1917 HENRY A. SWENSAN found 2 sheets of Eng profiles (dated 8-21-1916) NO PLAT OR MAP 3/15/82 mlw	

OVER

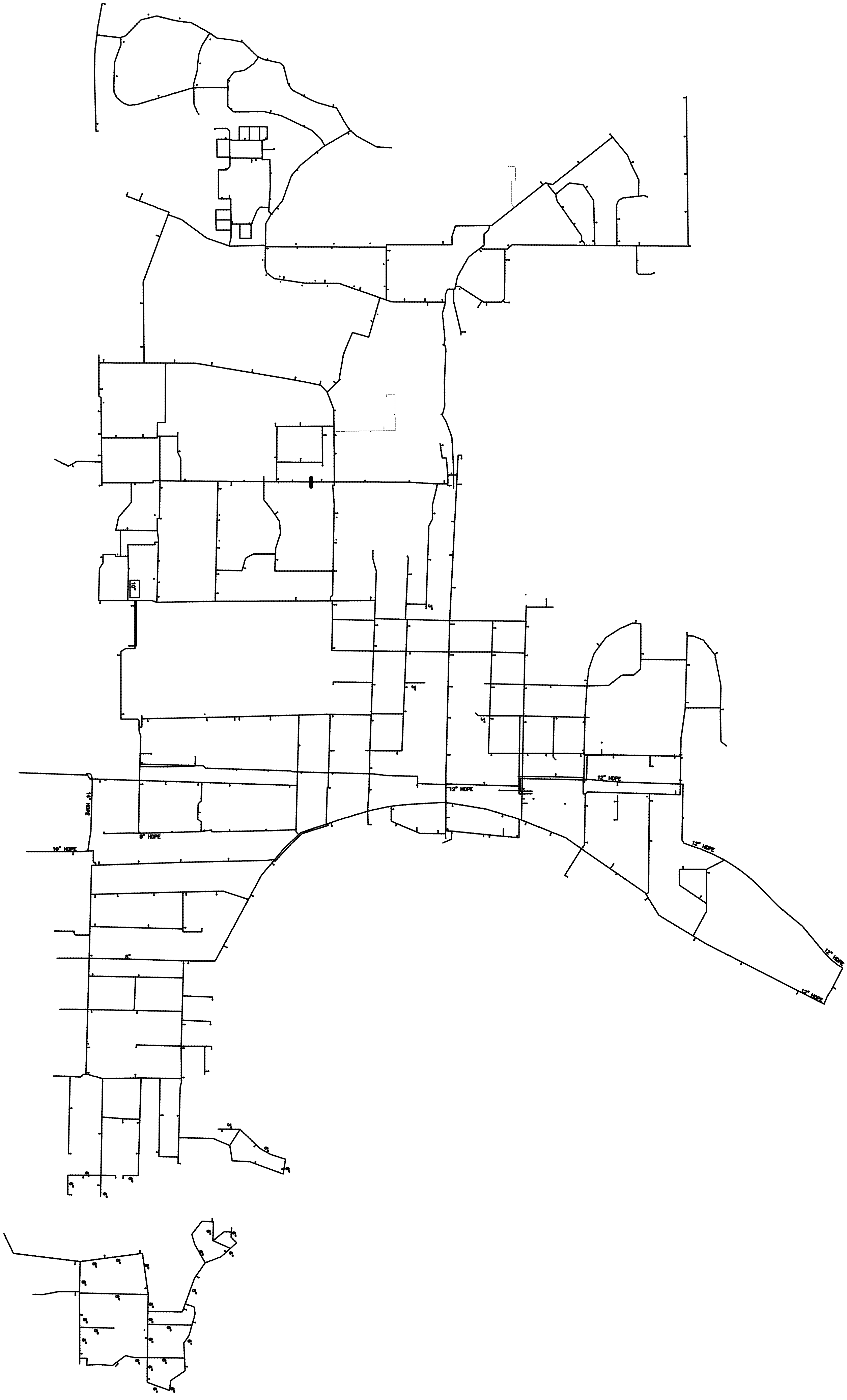
DATE OF PETITION	DITCH	Wash. Count File	PLAT & REPORT	LOCATION
6-28-1963	Br. No 2 of J.D. 1	(32996)	Mn Hwy R/W map S.P. 8280-06 (35=390) ORDER filed 10-28-1963	Change location of ditch within the NE1/4 7, 32-21
3-18-1966	Branch 2, J.D. no 1	(#35698)	Exhibit "A" (plan) ~~not in file~~ ~~found out of place~~ Legal desc is included in petition Order filed 5-9-1966 (S.P. 8213-05 (8=98)	Alter location of ditch in SW1/4 Sec. 5, T32-R21 (in area of Hwy no.

Appendix D. Utilities

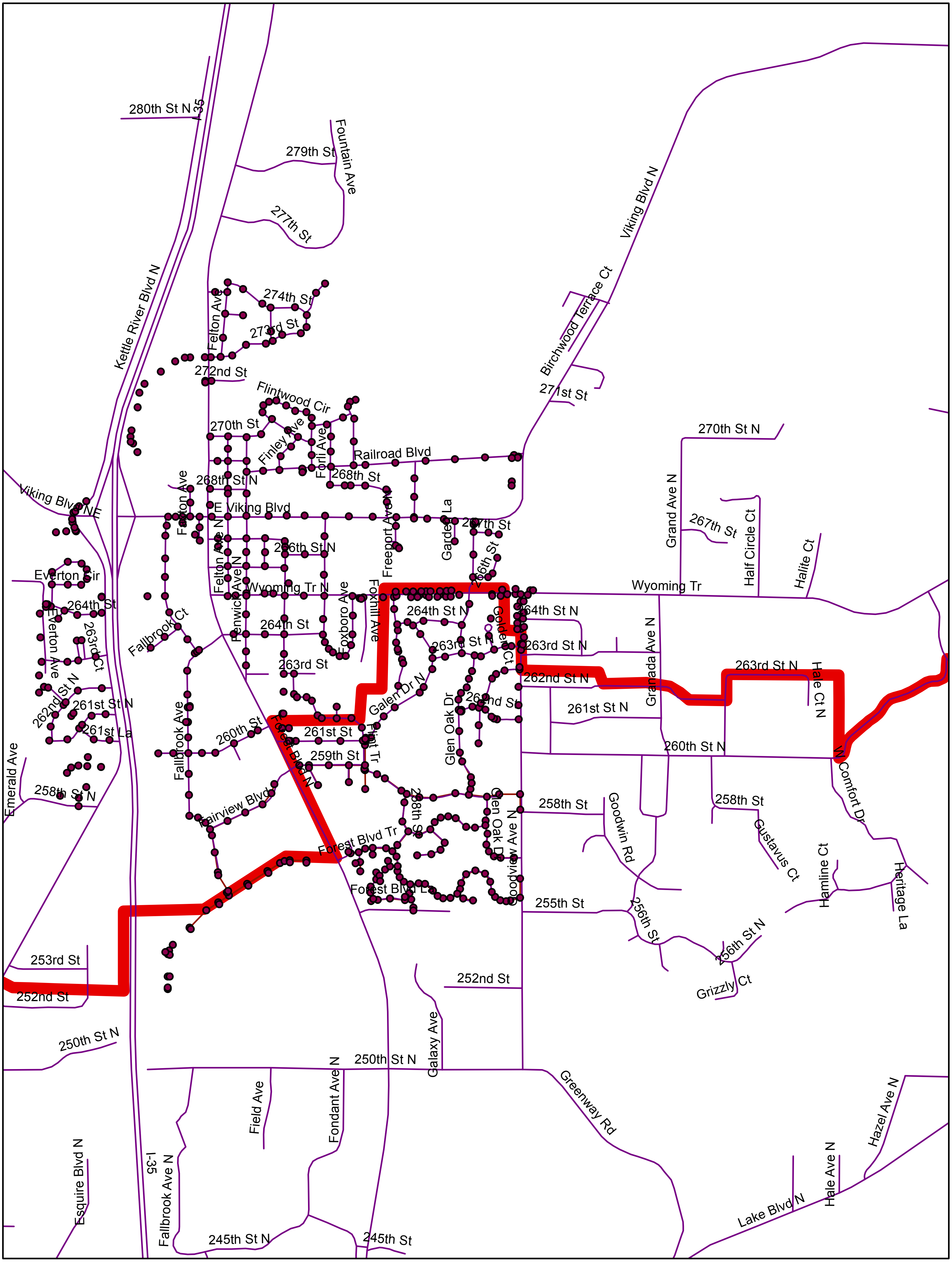
LS 1C
LS 2C
LS 8C
LS 10C
LS 4C
LS 3C
LS 5C
LS21T
LS 6T
LS 5T
LS 4T
LS 3T
LS 2T
LS28T
LS 1T



MUD LAKE
CLEAR LAKE
FOREST LAKE
ELMCREST AVENUE NORTH
EVERTON AVENUE NORTH
EUREKA AVENUE NORTH
INTERSTATE HIGHWAY 35
FALCON AVENUE NORTH
15TH STREET SOUTHWEST
COUNTY ROAD 83
CSAH 2
232ND STREET NORTH
235TH STREET NORTH
240TH STREET NORTH
220TH STREET NORTH
217TH STREET NORTH
US HIGHWAY 8
FENWAY AVENUE NORTH
12TH STREET SW
12TH STREET SOUTHWEST
FLAY AVE N
FONDANT AVENUE NORTH
4TH STREET SW
FOREST ROAD NORTH
FOREST BLVD NORTH
LAKE STREET
US HIGHWAY 61
US HIGHWAY 61 LAKE ST
4TH STREET SE
SOUTH SHORE DRIVE
CANAL STREET
BAY DRIVE SE
GOODVIEW CIRCLE N
LAKE BLVD NORTH
NORTH SHORE TRAIL NORTH



12" HDPE
12" HDPE
12" HDPE
12" HDPE
12" HDPE
10" HDPE
10" HDPE
8" HDPE
8"
10"


280th St N
I-35
Fountain Ave
279th St
277th St
Viking Blvd N
Kettle River Blvd N
Felton Ave
274th St
273rd St
Birchwood Terrace Ct
272nd St
271st St
Flintwood Cir
270th St
Finley Ave
Forli Ave
Railroad Blvd
270th St N
268th St
268th St N
Fallon Ave
Viking Blvd NE
E Viking Blvd
Freeport Ave N
Garden La
267th St
Grand Ave N
267th St
Half Circle Ct
Halite Ct
266th St N
266th St
Everton Cir
Felton Ave N
Fenwick Ave N
Wyoming Tr N
Foxhill Ave
Wyoming Tr
264th St
264th St N
Foxboro Ave
Golden Ct
264th St N
Everton Ave
263rd Ct
Fallbrook Ct
264th St
263rd St N
263rd St N
Granada Ave N
263rd St N
Hale Ct N
263rd St
262nd St N
262nd St N
Galen Dr N
262nd St
261st St N
261st St N
261st La
260th St
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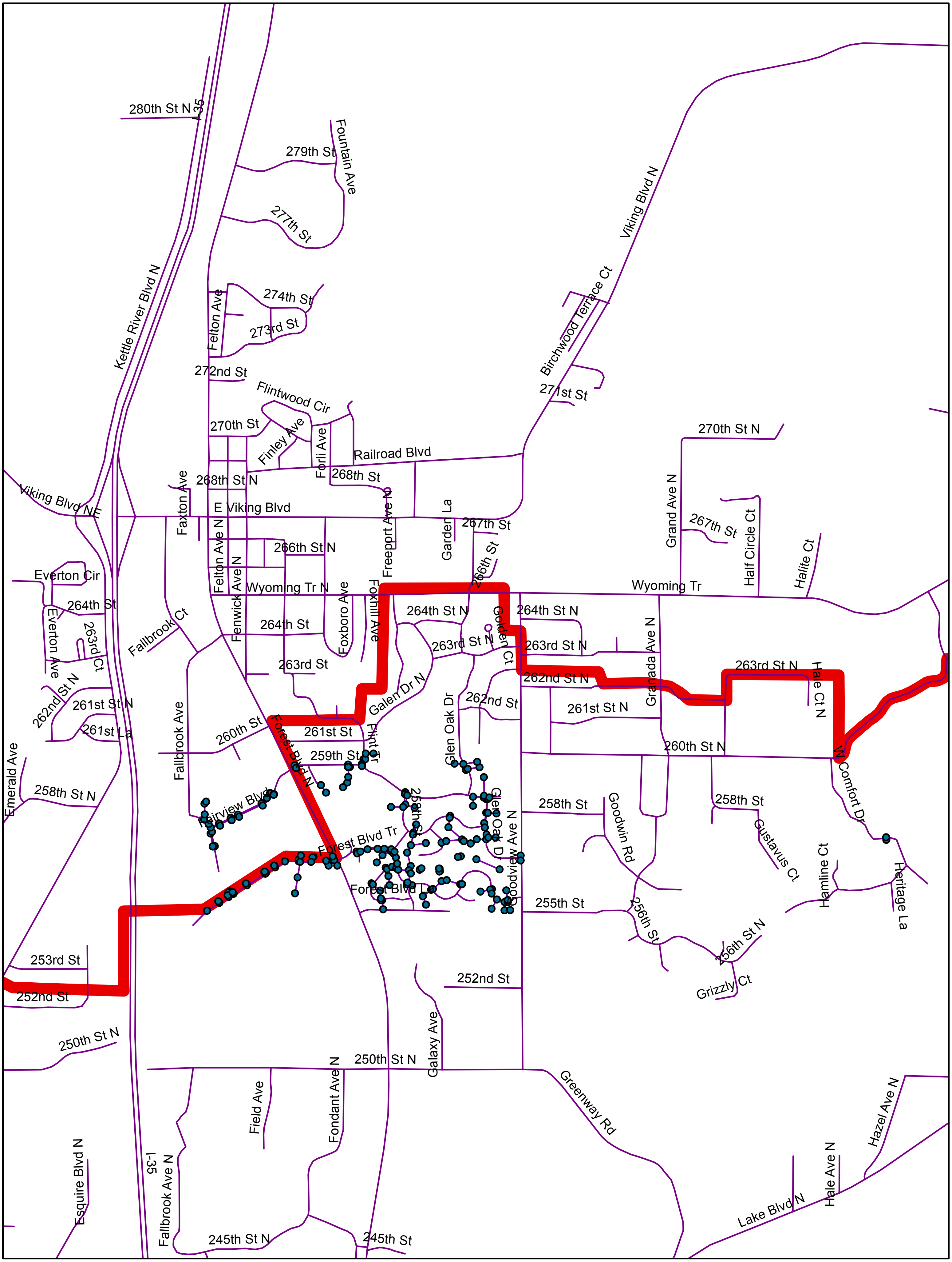
Forest Blvd N
261st St
Flint Tr
Glen Oak Dr
259th St
260th St N
W Comfort Dr
Emerald Ave
258th St N
Fairview Blvd
258th St
Glen Oak Dr
Goodview Ave N
258th St
Goodwin Rd
258th St
Gustavus Ct
Forest Blvd Tr
Forest Blvd La
255th St
Hamline Ct
Heritage La
256th St
256th St N
253rd St
252nd St
252nd St
Grizzly Ct
Galaxy Ave
250th St N
250th St N
Fondant Ave N
Greenway Rd
Field Ave
Hazel Ave N
Esquire Blvd N
I-35
Fallbrook Ave N
Hale Ave N
Lake Blvd N
245th St N
245th St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Viking Blvd N
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Birchwood Terrace Ct
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Viking Blvd NE
Faxton Ave
E Viking Blvd
Freeport Ave N
Garden La
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Granada Ave N
263rd St
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Hale Ct N
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Fallbrook Ave
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261st St
Flint Tr
Glen Oak Dr
260th St N
Emerald Ave
259th St
258th St N
Fairview Blvd
258th St
Glen Oak Dr
258th St
Goodwin Rd
258th St
W Comfort Dr
Gustavus Ct
Forest Blvd Tr
Goodview Ave N
Forest Blvd La
Hamline Ct
Heritage La
255th St
256th St
256th St N
253rd St
252nd St
252nd St
Grizzly Ct
Galaxy Ave
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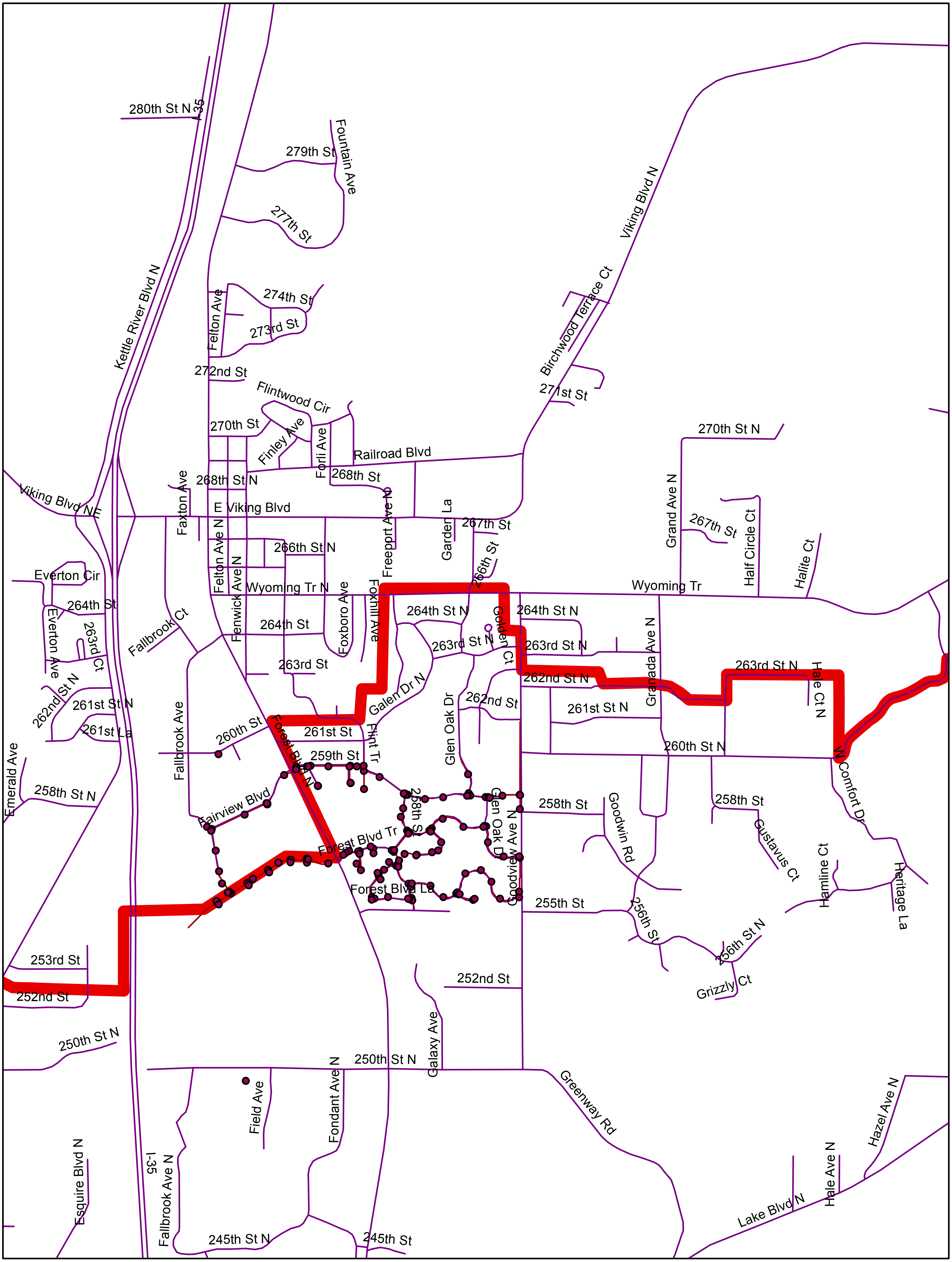
Fondant Ave N
Greenway Rd
Field Ave
Hazel Ave N
Esquire Blvd N
I-35
Fallbrook Ave N
Hale Ave N
Lake Blvd N
245th St N
245th St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272nd St
Flintwood Cir
271st St
270th St
Finley Ave
Forli Ave
270th St N
Railroad Blvd
268th St N
268th St
Faxton Ave
Viking Blvd NE
E Viking Blvd
Freeport Ave N
Garden La
267th St
Grand Ave N
267th St
Half Circle Ct
Felton Ave N
266th St N
266th St
Halite Ct
Everton Cir
Fenwick Ave N
Wyoming Tr N
Foxboro Ave
Foxhill Ave
Wyoming Tr
264th St
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Granada Ave N
263rd St N
Hale Ct N
263rd St
Galen Dr N
262nd St N
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Glen Oak Dr
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Forest Blvd N
Flint Tr
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Hamline Ct
Heritage La
Forest Blvd La
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Galaxy Ave
Greenway Rd
Fondant Ave N
Field Ave
Hazel Ave N
Esquire Blvd N
I-35
Fallbrook Ave N
Hale Ave N
Lake Blvd N
245th St N
245th St

Appendix E. Retrofit Photographs

Site ID 1

929

Site ID 1

930

Site ID 4

928

Site ID 5

932

Site ID 6

927

Site ID 7

864

Site ID 8

867

Site ID 9

865

Site ID 10

866

Site ID 13

856

Site ID 13

857

Site ID 13

858

Site ID 13

859

Site ID 13

860

Site ID 13

861

Site ID 13

862

Site ID 13

863

Site ID 14

855

Site ID 15

854

Site ID 17

869

Site ID 18

868

Site ID 19

872

Site ID 20

884

Site ID 21

880

Site ID 21

881

Site ID 22

882

Site ID 23

871

Site ID 23

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Site ID 24

873

Site ID 25

877

Site ID 26

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Site ID 27

852

Site ID 27

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Site ID 28

850

Site ID 29

878

Site ID 29

879

Site ID 30

894-2

Site ID 31

894-1

Site ID 32

912

Site ID 32

913

Site ID 32

914

Site ID 32

915

Site ID 33

918

Site ID 34

910

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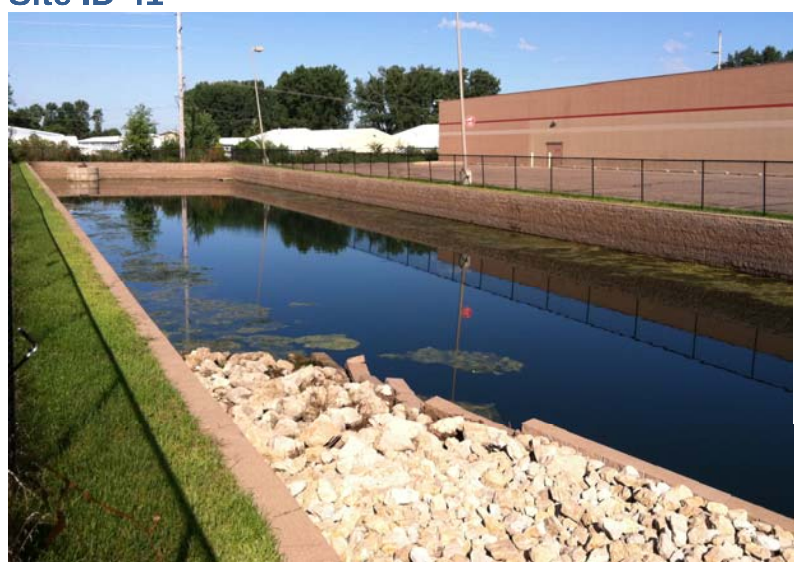
888

Site ID 40

889

Site ID 41



903

Site ID 42

891

Site ID 43

886

Site ID 44

906

Site ID 45

907

Site ID 46

905

Site ID 47

905

Site ID 48

904

Site ID 50

902

Site ID 52

901

Site ID 53

899

Site ID 53

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Site ID 54

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Site ID 55

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Site ID 57

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Site ID 58

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Site ID 58

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Site ID 58

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Site ID 59

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Site ID 59

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Site ID 60

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Site ID 60

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Site ID 61

940

Site ID 62

939

Site ID 63

935

Site ID 64

937

Site ID 65

936

Site ID 66

938

Appendix F. Elevation Survey Data

ID	Y	X	Z	desc_
2000	95586.369	521624.228	895.368	WELL 1 TOC BIXBY
2001	95586.158	521624.409	893.556	GS
2002	95586.553	521626.339	893.371	BARO LOCATION
2003	95762.335	521642.846	894.631	WELL 2 TOC BIXBY
2004	95762.339	521643.242	892.835	GS
2005	95905.313	521641.540	894.137	WELL 3 TOC BIXBY
2006	95905.713	521641.810	892.143	GS
2007	95905.583	521641.001	892.690	WTS
2008	95224.760	522051.238	892.547	WTS
2009	95232.846	522056.838	888.355	CLDT
2010	95324.895	522120.727	889.471	CLDT
2011	95521.180	522223.032	889.774	CLDT
2012	95696.130	522290.517	889.481	CLDT
2013	96401.247	522215.290	892.631	STAFF GAUGE @ 3.33 FT
2014	96532.209	522267.743	894.475	WELL 4 TOC BIXBY
2015	96532.446	522267.914	892.642	GS
2016	96394.856	522248.082	889.274	CLDT
2017	96394.297	522363.051	889.644	CLDT
2018	96393.456	522524.102	888.115	CLDT
2019	96393.001	522650.524	888.087	CLDT
2020	96391.380	522841.410	888.971	CLDT
2021	96390.487	522956.382	889.043	CLDT
2022	96401.880	523001.964	889.110	CLDT
2023	96510.833	523089.553	888.753	CLDT
2024	96676.701	523231.419	889.048	CLDT
2025	96728.671	523282.654	888.580	CLDT
2026	96341.377	522945.814	889.480	CLDT
2027	96246.832	522866.090	889.610	CLDT
2028	96183.116	522816.539	889.476	CLDT
2029	95986.854	522668.367	889.355	CLDT
2030	95223.735	522051.044	890.427	PIPST 48 HDPE
2031	95197.062	522033.062	890.617	PIPST 48 HDPE
2032	95197.517	522030.825	892.789	STAFF GAUGE @ 2.42 FT
2033	95210.657	522040.977	897.028	CLRD
2034	97337.186	523815.454	887.594	PIPST ARCH RCP 72INCH RISE
2035	97336.040	523815.549	892.356	WTS
2036	97336.151	523814.811	888.397	SED
2037	97400.357	523868.232	903.876	CLRD
2038	97478.114	523938.359	889.442	SED
2039	97477.768	523939.172	887.685	PIPST ARCH RCP 72INCH RISE
1000	97107.695	520542.807	919.686	STA VARY MNDT
2040	100869.526	525567.051	891.542	WELL 5 TOC TAX
2041	100869.759	525567.575	889.753	GS
2042	100869.299	525569.436	890.231	WTS 7-22-11
2043	100608.556	525286.109	891.727	WELL 6 TOC TAX
2044	100609.062	525286.131	890.148	GS
2045	100608.883	525284.991	890.209	WTS 7-22-11
2047	100875.839	525288.923	889.910	GS
2048	100876.799	525288.531	890.178	WTS 7-22-11
2050	101462.323	525352.228	890.118	WTS 7-22-11
2051	100150.396	525575.805	887.147	PIPST 60 CMP

ID	Y	X	Z	desc_
2052	100170.513	525598.506	886.939	PIPST 60 CMP
2053	100171.376	525599.130	891.250	WTS 7-22-11
2054	100161.146	525588.246	894.577	CLDW
2055	100202.224	525652.003	890.945	STAFF GAUGE @ 3.33 FT
2057	101289.252	524748.835	890.474	GS
2058	101290.430	524746.514	890.428	WTS 7-22-11
2059	105020.296	527811.516	896.459	CLRD
2060	105038.489	527828.060	886.441	PIPST 96 RCP
2061	104996.882	527806.429	886.100	PIPST 96 RCP
2062	104996.682	527806.007	889.996	WTS 7-22-11
1001	97290.596	524757.415	932.473	STA HULT MNDT
2063	101481.481	524593.343	890.352	STAFF GAUGE @ 3.00 FT
2064	101865.915	524679.903	892.792	WELL 7 TOC TAX
2065	101866.584	524679.444	891.119	GS
2066	102087.092	525233.115	892.381	WELL 8 TOC TAX
2067	102087.740	525232.769	890.396	GS
2068	95403.637	522210.332	892.131	TOB
2069	95404.329	522209.819	892.036	POS
2070	95405.757	522208.331	891.366	POS
2071	95406.397	522208.046	889.478	TOE
2072	95407.059	522207.212	889.175	DIT BOTTOM
2073	95408.012	522206.285	888.962	CLDT
2074	95408.620	522204.363	889.158	DIT BOTTOM
2075	95411.279	522202.669	888.954	DIT BOTTOM
2076	95411.971	522201.361	889.254	TOE
2077	95413.015	522201.070	891.278	POS
2078	95414.847	522199.466	890.491	TOB
2079	96396.259	522209.740	893.182	WTS 8-3-11
2080	95431.849	522171.654	892.339	SB1
2081	99666.970	524901.022	885.894	PIPST 78 CMP
2082	99667.107	524901.662	892.283	WTS 8-3-11
2083	99676.279	524930.008	883.858	PIPST INV BOX UNDER WATER
2084	99675.147	524929.710	886.259	SED
2086	99656.658	524888.559	896.006	CLT
2087	99655.432	524867.237	885.842	PIPST 78 CMP
2088	99635.434	524808.904	894.736	CLRD
2089	99645.327	524836.426	885.834	PIPST 72 RCP
2090	99645.690	524836.852	887.924	SED
2091	99630.610	524774.815	886.609	PIPST 72 RCP
2092	99631.455	524774.340	892.372	WTS 8-3-11
2093	99327.400	524571.190	891.174	TOB
2094	99327.114	524570.125	887.797	TOE
2095	99329.840	524566.777	887.661	DIT BOTTOM
2096	99330.272	524564.542	887.779	CLDT
2097	99330.752	524559.600	887.866	DIT BOTTOM
2098	99333.279	524553.923	888.070	DIT BOTTOM
2099	99336.403	524547.675	889.432	TOE
2100	99337.677	524547.615	890.879	POS
2101	99338.407	524545.844	891.051	TOB
2102	99344.619	524533.354	891.417	GS
2103	99350.996	524507.846	891.058	SB2

ID	Y	X	Z	desc_
2104	98337.378	524400.262	891.546	TOB
2105	98337.446	524399.605	891.132	POS
2106	98337.507	524398.161	888.885	TOE
2107	98336.294	524394.655	888.177	DIT BOTTOM
2108	98335.908	524391.818	887.787	CLDT
2109	98337.566	524387.212	888.531	DIT BOTTOM
2110	98339.079	524383.796	888.948	TOE
2111	98337.992	524381.968	890.545	TOB
2112	98338.018	524378.821	891.382	GS
2113	98334.411	524368.434	892.077	SB3
2114	97604.142	524056.826	889.302	CLDT
2115	97681.102	524128.840	889.665	CLDT
2116	97715.232	524154.053	888.573	CLDT
2117	97807.736	524233.051	888.742	CLDT
2118	97922.029	524338.553	888.537	CLDT
2119	98090.497	524385.863	887.944	CLDT
2120	98326.465	524392.493	887.840	CLDT
2121	98526.548	524388.419	888.056	CLDT
2122	98766.097	524390.239	887.763	CLDT
2123	99044.634	524392.335	887.575	CLDT
2124	99226.525	524493.466	887.384	CLDT
2125	99478.570	524664.881	887.521	CLDT
2126	100201.330	525676.493	888.458	CLDT MINERAL
2127	100301.349	525785.749	887.691	CLDT MINERAL
2128	100426.421	525931.805	886.802	CLDT MINERAL
2129	100535.198	525994.120	890.069	TOB
2130	100534.832	525994.918	889.251	POS
2131	100533.828	525996.007	888.363	TOE
2132	100532.503	525996.783	887.655	DIT BOTTOM
2133	100530.421	525998.595	887.460	DIT BOTTOM
2134	100529.023	525999.381	887.847	CLDT
2135	100527.844	526001.214	887.744	DIT BOTTOM
2136	100526.720	526001.732	888.282	TOE
2137	100525.667	526002.591	887.902	POS
2138	100524.243	526004.201	889.571	POS
2139	100522.831	526006.178	890.358	TOB
2140	100523.935	526001.629	891.253	WTS 8-3-11
2141	100621.094	525977.143	890.360	SB4
2142	100685.237	526107.074	887.621	CLDT
2143	100864.465	526227.393	887.720	CLDT MINERAL
2144	101088.235	526381.575	887.010	CLDT MINERAL
2145	101321.649	526553.184	888.513	CLDT MINERAL
2146	101520.654	526713.945	889.469	TOB
2147	101521.195	526713.385	889.200	POS
2148	101522.177	526712.261	888.188	TOE
2149	101523.874	526710.435	887.734	DIT BOTTOM
2150	101526.827	526707.947	887.867	DIT BOTTOM
2151	101529.574	526704.731	887.992	DIT BOTTOM
2152	101532.987	526700.622	888.258	CLDT MINERAL
2153	101534.888	526696.931	888.067	DIT BOTTOM
2154	101536.448	526692.936	887.933	DIT BOTTOM

ID	Y	X	Z	desc_
2155	101538.843	526690.406	887.677	DIT BOTTOM
2156	101542.048	526686.966	887.719	TOE
2157	101542.513	526686.134	889.584	TOB
2158	101544.977	526682.507	890.098	GS
2159	101543.432	526688.313	890.722	WTS 8-3-11
2160	101585.528	526664.417	889.618	SB5
2161	101585.083	526664.962	890.875	WTS 8-3-11
2162	101791.476	526898.113	887.738	CLDT MINERAL
2163	101978.265	527086.963	886.808	CLDT
2164	102245.443	527182.633	886.298	CLDT
2165	102501.340	527338.859	886.519	CLDT
2166	102735.536	527392.091	886.038	CLDT
2167	103041.000	527341.099	886.160	CLDT
2168	103324.080	527455.462	888.790	TOB
2169	103323.615	527454.699	888.403	POS
2170	103323.663	527454.213	886.673	TOE
2171	103323.386	527451.848	886.441	DIT BOTTOM
2172	103324.026	527447.704	886.260	DIT BOTTOM
2173	103322.437	527440.685	886.266	DIT BOTTOM
2174	103321.910	527432.678	886.036	CLDT
2175	103321.598	527427.422	886.404	DIT BOTTOM
2176	103321.967	527424.257	886.294	DIT BOTTOM
2177	103324.009	527418.416	886.464	TOE
2178	103323.897	527417.451	888.675	POS
2179	103323.931	527415.969	888.918	TOB
2180	103356.430	527381.449	888.815	SB6
2181	103626.612	527330.999	885.829	CLDT
2182	103928.458	527351.452	885.857	CLDT
2183	104241.987	527381.642	885.838	CLDT
2184	104531.807	527540.588	885.864	CLDT
2185	104699.791	527639.405	886.123	CLDT MINERAL
2186	104882.954	527743.205	885.531	CLDT MINERAL
2187	105109.797	527869.307	886.609	CLDT MINERAL
2188	105294.613	527997.184	888.566	TOB
2189	105294.736	527996.837	887.714	POS
2190	105295.125	527996.239	886.869	TOE
2191	105296.315	527991.551	885.929	DIT BOTTOM
2192	105298.623	527988.006	886.095	DIT BOTTOM
2193	105303.305	527981.579	886.093	CLDT
2194	105305.383	527977.704	886.131	DIT BOTTOM
2195	105307.207	527973.124	886.044	DIT BOTTOM
2196	105309.598	527968.862	886.518	TOE
2197	105310.519	527967.011	887.011	POS
2198	105311.486	527965.855	888.537	TOB
2199	105335.986	527945.115	889.371	SB7
2200	105538.325	528105.803	885.966	CLDT
2201	105824.100	528197.530	886.267	CLDT
2202	106099.708	528329.986	886.412	CLDT
2203	106366.656	528471.518	885.994	CLDT
2204	106685.867	528606.775	885.806	CLDT
2205	107005.634	528755.861	885.957	CLDT

ID	Y	X	Z	desc_
2206	107156.186	528819.602	886.185	CLDT
2207	107639.245	529061.360	889.581	WTS
2208	107639.146	529061.282	885.226	PIPST 72 CMP OS 13 FT W
2209	107594.012	529042.473	898.043	CLRD
2210	107555.790	529020.106	885.606	PIPST 72 CMP
2211	107294.232	528884.547	885.662	PIPST 60 CMP ARCH
2212	107293.623	528884.044	890.679	WTS 8-5-11
2213	107306.607	528890.689	893.465	CLT
2215	107320.497	528897.627	885.830	PIPST 60 CMP ARCH
2216	107140.016	528798.576	890.635	STAFF GAUGE @ 3.33 FT
2217	107833.558	529185.843	887.563	CLDT MINERAL
2218	108150.558	529507.509	892.610	XS HUB
2219	108151.355	529510.255	890.608	TOE
2220	108139.960	529520.856	921.649	DIT BOTTOM
2221	108129.715	529514.105	930.239	CLDT
2222	108127.218	529519.732	891.598	DIT BOTTOM
2223	108122.282	529525.099	893.660	TOE
2224	108123.419	529532.214	889.812	TOB
2225	109275.495	533092.864	894.659	CLRD
2226	109244.575	533093.592	884.663	PIPST 7FT X 7FT BOX CULVERT
2228	109234.335	533111.025	887.538	STAFF GAUGE @ 2.44 FT
2229	109293.472	533088.400	884.192	PIPST 7FT X 7FT BOX CULVERT
2230	109247.562	533093.436	884.622	PIPST 7FT X 7FT BOX CULVERT
1002	97290.618	524757.400	932.493	STA HULT MNDT
3000	95486.587	521080.028	897.271	CLRD
3001	95489.126	521036.007	897.501	CLRD
3002	95503.942	520976.947	897.902	CLRD
3003	95568.182	521039.921	894.316	GS
3004	95518.729	521019.955	895.956	GS
3005	95501.395	521018.421	897.654	RDE
3006	95486.549	521016.718	897.292	RDE
3007	95455.001	521030.277	895.311	GS
3008	95322.696	521011.026	894.411	GS
3009	95341.169	521076.540	893.745	GS
3010	95358.110	521142.661	894.597	GS
3011	95367.112	521194.247	895.337	GS
3012	95142.574	520961.981	892.764	CLDT
3013	95145.644	521054.587	892.934	CLDT DEBRIS
3014	95157.244	521149.360	893.725	GS
3015	95149.433	521150.335	893.802	TOB
3016	95145.922	521150.349	892.765	CLDT
3017	95140.752	521150.027	893.501	TOB
3018	95129.061	521149.149	893.845	GS
3019	95147.257	521227.259	893.636	CLDT
3020	95148.220	521325.386	893.293	CLDT
3021	95149.963	521433.162	892.160	CLDT
3022	95151.401	521535.146	892.429	CLDT
3023	95153.456	521630.519	892.620	CLDT
3024	95153.058	521729.909	892.727	CLDT
3025	95116.988	521776.976	892.211	CLDT
3026	95113.603	521779.804	891.362	TOP ICE

ID	Y	X	Z	desc_
3027	95142.039	521801.362	893.915	GS
3028	95134.303	521789.992	893.067	GS
3029	95124.087	521776.620	892.735	TOB
3030	95122.966	521775.042	892.355	TOE
3031	95121.605	521772.792	892.273	CLDT
3032	95120.086	521769.742	892.561	TOE
3033	95116.920	521765.280	893.052	TOB
3034	95110.377	521752.886	892.757	GS
3035	94980.222	520962.704	893.874	GS
3036	94984.595	521118.287	893.755	GS
3037	94973.714	521262.995	894.815	GS
3038	94712.519	521227.650	893.531	GS
3039	94719.246	521086.511	893.604	GS
3040	94727.112	520992.204	896.477	GS UPLAND
3041	94669.478	520742.804	891.945	PIPST 24 RCP
3042	94669.724	520743.165	893.258	SED
3043	94667.993	520760.789	894.071	CLDT
3044	94673.701	520852.522	893.798	CLDT
3045	94674.462	520894.936	893.519	SED
3046	94674.683	520896.405	892.167	PIPST 24 CMP APPROX INV
3047	94675.770	520916.820	893.236	PIPST 24 CMP
3048	94675.915	520917.771	894.092	SED
3049	94708.786	520903.288	898.106	CLRD
3050	94683.276	520905.360	897.137	CLRD
3051	94673.186	520904.581	896.290	CLRD
3052	94630.964	520893.835	895.524	CLRD
3053	94651.053	521073.232	894.185	GS
3054	94677.547	521068.716	893.927	GS
3055	94679.994	521068.279	893.202	TOE
3056	94682.780	521069.014	893.060	CLDT
3057	94684.697	521069.185	893.391	TOE
3058	94686.346	521069.332	893.909	GS
3059	94711.817	521070.738	893.868	GS
3060	94687.872	521259.812	892.024	CLDT
3061	94693.499	521414.082	892.375	CLDT
3062	94695.622	521532.012	891.464	CLDT
3063	94693.567	521537.139	891.462	TOP ICE
3064	94717.170	521535.761	893.257	GS
3065	94701.768	521527.090	892.807	GS
3066	94698.220	521525.184	892.273	TOE
3067	94697.141	521524.819	891.792	CLDT
3068	94696.469	521524.245	892.009	TOE
3069	94695.704	521523.814	893.017	TOB
3070	94689.982	521520.337	893.468	GS
3071	94438.255	520981.429	894.736	GS
3072	94436.806	521076.180	894.490	GS
3073	94442.289	521193.405	894.633	GS
3074	93942.857	521189.386	890.649	PIPST 54 RCP
3075	93944.361	521189.290	891.419	SED
3076	93953.170	521189.018	891.769	WTS 12-29-11
3077	93978.289	521189.411	891.472	CLDT

ID	Y	X	Z	desc_
3078	94091.730	521230.093	891.191	CLDT
3079	93986.576	521094.044	895.602	GS
3080	93973.744	521130.734	896.647	TOE
3081	93968.292	521157.173	900.717	TOB
3082	93964.861	521175.921	896.267	POS
3083	93964.250	521184.366	891.962	TOE
3084	94029.530	521197.968	892.303	TOE
3085	94035.167	521174.177	897.869	TOB
3086	94039.487	521161.454	895.036	TOE
3087	94054.188	521107.980	894.441	GS
3088	94096.042	521192.418	897.087	TOB
3089	94115.145	521203.028	893.753	LOW PT BERM
3090	94141.673	521213.534	896.570	TOB
3091	94112.612	521180.834	893.970	TOE
3092	94102.814	521198.273	894.564	TOE
3093	94088.526	521213.355	894.124	TOE
3094	94112.951	521228.740	893.467	TOE
3095	94127.971	521207.066	894.359	TOE
3096	94142.625	521200.174	893.929	TOE
3097	94201.463	521280.677	892.609	TOE
3098	94226.110	521267.945	893.486	TOE
3099	94230.301	521243.137	893.704	TOE
3100	94221.130	521251.323	895.872	TOB
3101	94232.082	521267.956	893.600	LOW PT BERM
3102	94234.835	521287.759	893.304	TOE
3103	94238.701	521272.442	893.507	TOE
3104	94254.966	521266.086	893.744	TOE
3105	94247.394	521279.478	896.348	TOB
3106	94252.301	521312.517	891.192	CLDT
3107	94307.351	521318.842	893.772	TOE
3108	94325.728	521305.322	893.636	TOE
3109	94324.986	521291.078	893.898	TOE
3110	94316.574	521298.602	895.424	TOB
3111	94334.331	521312.139	893.650	LOW PT BERM
3112	94340.916	521330.309	893.683	TOE
3113	94344.484	521311.783	893.763	TOE
3114	94356.560	521306.706	893.862	TOE
3115	94348.765	521320.475	895.133	TOB
3116	94356.844	521351.464	893.055	TOE
3117	94371.381	521336.671	893.451	TOE
3118	94384.287	521316.626	893.353	TOE
3119	94370.862	521322.950	895.750	TOB
3120	94380.501	521253.516	894.370	GS
3121	94379.739	521337.363	893.487	LOW PT BERM
3122	94372.867	521365.415	892.877	TOE
3123	94381.825	521340.451	893.981	TOE
3124	94387.012	521347.557	895.276	TOB
3125	94398.730	521332.525	893.484	TOE
3126	94429.554	521283.176	893.895	GS
3127	94419.686	521401.679	890.593	CLDT
3128	94454.641	521383.800	893.837	LOW PT BERM

ID	Y	X	Z	desc_
3129	94454.448	521357.682	893.550	TOE
3130	94448.340	521374.050	894.056	TOE
3131	94440.355	521398.975	893.171	TOE
3132	94440.077	521381.048	895.010	TOB
3133	94458.178	521409.257	892.844	TOE
3134	94458.179	521389.762	894.557	TOE
3135	94470.286	521374.259	893.618	TOE
3136	94464.062	521388.318	895.152	TOB
3137	94485.450	521388.146	894.847	TOB
3138	94532.425	521406.031	894.288	TOB
3139	94522.686	521442.919	892.703	POS
3140	94520.772	521446.655	892.028	TOE
3141	94519.116	521449.286	891.297	TOP ICE
3142	94517.910	521451.023	891.345	TOE
3143	94515.227	521456.365	892.317	POS
3144	94512.921	521462.594	893.499	TOB
3145	94505.926	521480.995	893.355	GS
3146	94499.683	521505.158	893.052	GS
3147	94540.105	521400.667	893.252	TOE
3148	94580.466	521306.975	893.226	GS
3149	94582.587	521440.300	893.348	TOB
3150	94597.425	521419.306	893.152	TOE
3151	94576.577	521468.565	892.487	POS
3152	94664.866	521516.833	892.435	POS
3153	94674.938	521494.320	893.942	GS
3154	94663.251	521434.456	893.455	GS
3155	94689.254	521538.121	891.388	TOE
3156	94683.418	521547.523	893.145	TOB
3157	94677.592	521559.603	893.286	GS
3158	94656.888	521604.328	893.839	GS
3159	94633.341	521646.468	894.232	GS
3160	94759.906	521683.057	893.837	GS
3161	94790.461	521625.264	893.639	GS
3162	94799.114	521610.296	893.645	TOB
3163	94805.169	521599.838	891.909	TOE
3164	94806.407	521598.065	891.333	TOP ICE
3165	94808.158	521595.258	891.708	TOE
3166	94813.464	521583.431	893.509	TOB
3167	94821.501	521569.266	893.373	GS
3168	94837.266	521533.101	893.314	GS
3169	94863.632	521449.510	893.759	GS
3170	94885.264	521380.797	894.872	GS
3171	94843.668	521615.932	890.607	CLDT
3172	94926.386	521653.824	891.507	TOE
3173	94929.895	521644.920	893.041	TOB
3174	94941.218	521628.505	893.213	GS
3175	94963.691	521566.384	893.848	GS
3176	94906.854	521649.165	891.276	TOE
3177	94904.190	521654.740	892.192	GS
3178	94897.645	521664.729	894.035	TOB
3179	94886.618	521676.780	893.636	GS

ID	Y	X	Z	desc_
3180	94842.683	521728.709	893.384	GS
3181	94666.475	522050.518	892.896	CLDT
3182	94771.695	521987.880	894.055	GS
3183	94743.254	521968.039	894.024	GS
3184	94734.447	521960.959	893.683	TOB
3185	94731.974	521958.652	893.030	TOE
3186	94730.900	521957.649	892.670	CLDT
3187	94729.264	521956.193	892.894	TOE
3188	94725.846	521952.279	893.927	TOB
3189	94705.832	521930.135	894.017	GS
3190	94675.249	521898.295	893.847	GS
3191	94773.400	521895.475	892.919	CLDT
3192	94845.002	521788.178	892.141	CLDT
3193	94909.851	521693.795	891.627	CLDT
3194	94928.526	521664.540	891.965	CLDT
3195	94937.598	521675.579	892.988	GS
3196	94931.493	521669.557	892.286	GS
3197	94924.276	521663.263	892.134	GS
3198	94937.679	521667.503	891.439	TOE
3199	94933.899	521681.868	893.618	TOB
3200	94929.300	521694.858	893.825	GS
3201	94909.903	521737.008	893.460	GS
3202	95063.433	521590.620	893.138	GS
3203	95035.727	521649.672	893.002	GS
3204	95018.493	521680.802	894.288	TOB
3205	95013.237	521692.900	892.875	POS
3206	95009.481	521699.813	891.314	TOE
3207	95008.840	521700.848	891.241	TOP ICE
3208	95008.024	521701.805	891.312	TOE
3209	95007.211	521703.182	892.354	POS
3210	95001.827	521711.233	893.495	TOB
3211	94988.124	521739.351	893.174	GS
3212	94939.599	521834.438	894.086	GS
3213	95103.427	521760.413	891.242	TOE
3214	95111.302	521755.297	892.723	POS
3215	95113.494	521736.976	893.409	TOB
3216	95112.808	521711.184	893.151	GS
3217	95109.053	521648.869	893.365	GS
3218	95119.028	521789.219	891.265	TOE
3219	95122.166	521789.338	892.584	POS
3220	95130.371	521792.402	893.378	TOB
3221	95157.385	521793.619	894.171	GS
3222	95209.119	521797.256	895.685	GS
3223	95111.566	521819.970	891.357	TOE
3224	95103.835	521819.361	892.935	TOB
3225	95078.403	521823.179	893.432	GS
3226	94987.255	521842.829	893.258	GS
3227	95035.404	521855.377	893.291	GS
3228	95069.766	521853.168	893.422	TOE
3229	95083.105	521852.997	894.625	TOB
3230	95102.612	521854.548	892.984	POS

ID	Y	X	Z	desc_
3231	95110.311	521855.709	891.317	TOE
3232	95112.766	521855.716	891.304	TOP ICE
3233	95116.253	521855.645	891.328	TOE
3234	95121.883	521857.205	892.839	POS
3235	95137.436	521861.180	895.998	TOB
3236	95154.565	521865.358	894.931	TOE
3237	95180.651	521871.243	895.529	GS
3238	95113.751	521945.152	891.441	TOP ICE
3239	95110.540	521945.359	891.403	TOE
3240	95106.256	521945.229	893.278	POS
3241	95083.678	521945.833	895.184	TOB
3242	95071.418	521948.004	893.476	TOE
3243	95044.522	521955.873	893.530	GS
3244	94964.453	521989.378	894.246	GS
3245	95118.335	521963.869	890.685	CLDT
3246	95138.826	522008.007	895.600	TOB
3247	95147.253	521999.400	891.390	TOE
3248	95157.158	521988.481	892.026	TOE
3249	95165.884	521981.196	896.766	TOB
3250	95181.957	522023.528	890.523	CLDT
3251	95167.518	522030.027	891.472	CLDT
3252	95160.577	522138.021	891.709	CLDT/TOP ICE
3253	95157.975	522325.473	891.976	CLDT/TOP ICE
3254	95136.511	522304.208	893.511	GS
3255	95151.776	522303.873	893.153	TOB
3256	95156.978	522304.017	891.848	TOE
3257	95158.821	522304.373	891.704	CLDT
3258	95161.256	522304.526	891.668	TOE
3259	95166.965	522303.689	893.322	TOB
3260	95180.615	522303.098	894.007	RDE
3261	95191.826	522109.225	896.275	CLRD
3262	95251.919	521992.062	898.444	CLRD
3263	95608.601	520958.469	894.419	GS
3264	95596.343	521112.982	894.131	GS
3265	95558.166	521252.618	894.547	GS
3266	95879.511	521296.304	892.699	GS
3267	95901.513	521115.067	892.663	GS
3268	95913.504	520956.498	892.402	GS
3269	96039.722	521075.393	892.808	GS
3270	96072.565	521082.164	893.771	TOB
3271	96082.394	521081.511	891.400	TOE
3272	96091.990	521081.442	891.334	TOP ICE
3273	96099.615	521082.221	891.380	TOE
3274	96114.072	521085.095	893.932	TOB
3275	96121.640	521084.629	892.246	GS
3276	96179.165	521094.949	891.845	GS
3277	96285.095	521107.535	891.793	GS
3278	96094.784	520928.286	891.380	TOP ICE
3279	96088.575	521241.037	891.314	TOP ICE
3280	96085.353	521386.210	891.314	TOP ICE
3281	95946.838	521539.934	891.779	GS

ID	Y	X	Z	desc_
3282	96042.600	521530.474	891.707	GS
3283	96067.878	521523.992	892.270	TOB
3284	96073.381	521523.884	891.572	TOE
3285	96081.965	521524.036	891.294	TOP ICE
3286	96093.943	521525.614	891.563	TOE
3287	96103.443	521528.961	892.128	TOB
3288	96117.955	521537.633	891.664	GS
3289	96212.029	521574.285	891.591	GS
3290	96262.130	521580.901	891.784	GS
3291	96092.281	521758.636	891.289	TOP ICE
3292	96091.253	521763.653	891.353	TOE
3293	96083.093	521774.058	892.717	TOB
3294	96075.750	521782.306	891.867	GS
3295	96042.298	521844.913	891.742	GS
3296	96018.388	521898.059	891.632	GS
3297	96277.648	521763.336	891.274	TOP ICE
3298	96469.488	522109.594	892.147	GS
3299	96431.166	522097.188	891.724	GS
3300	96418.864	522091.292	892.396	TOB
3301	96413.358	522090.764	891.653	TOE
3302	96394.020	522090.063	891.363	TOP ICE
3303	96380.866	522085.588	891.561	TOE
3304	96369.466	522081.870	892.543	TOB
3305	96360.257	522079.011	891.639	TOE
3306	96311.333	522066.660	891.617	GS
3307	96253.743	522050.471	891.457	GS
3308	96395.165	521915.010	891.240	TOP ICE
3309	96394.421	521696.405	891.295	TOP ICE
3310	96404.984	521561.424	891.329	TOP ICE
3311	96535.179	521450.075	891.367	TOP ICE
3312	96505.770	521767.087	891.114	TOP ICE/END LATERAL
3313	96503.072	521766.780	891.520	TOE
3314	96487.318	521766.906	891.727	GS
3315	96450.871	521760.489	891.968	GS
3316	96417.242	521762.669	892.470	TOB
3317	96403.758	521764.996	891.306	TOE
3318	96650.814	521769.532	890.960	TOP ICE
3319	96713.727	521768.992	891.054	CLDT HIGH PT
3320	96853.284	521874.473	891.757	GS SEDGE MEADOW
3321	96851.619	521805.857	891.650	GS
3322	96858.532	521787.179	891.995	TOB
3323	96859.815	521774.004	890.959	TOE
3324	96860.411	521770.540	890.966	TOP ICE
3325	96860.818	521764.681	891.004	TOE
3326	96860.177	521758.697	892.203	TOB
3327	96861.150	521730.781	891.647	GS BLUEJOINT MEADOW
3328	96867.454	521669.130	891.684	GS BLUEJOINT MEADOW
3329	97050.403	521773.500	891.118	CLDT HIGH PT
3330	97065.506	521797.192	891.387	CLDT HIGH PT
3331	97194.727	521774.311	891.083	CLDT
3332	97379.325	521776.447	891.276	CLDT END LATERAL

ID	Y	X	Z	desc_
3333	97062.016	521890.049	891.219	TOP ICE
3334	96963.055	521861.310	891.536	GS
3335	97022.353	521878.602	891.678	GS
3336	97047.863	521890.174	892.693	TOB
3337	97056.596	521890.645	891.231	TOE
3338	97070.169	521889.986	891.099	TOE
3339	97081.981	521891.094	892.405	TOB
3340	97096.639	521891.194	891.828	GS
3341	97159.216	521907.094	891.620	GS BLUEJOINT MEADOW
3342	97056.218	522099.856	891.188	TOP ICE
3343	97046.298	522375.029	891.260	TOP ICE
3344	97039.463	522598.264	891.359	TOP ICE
3345	97038.390	522717.359	891.298	CLDT HIGH PT
3346	97033.933	522773.709	891.438	CLDT?
3347	97033.744	522902.668	891.182	CLDT?
3348	97025.622	522979.595	891.050	TOP ICE
3349	97024.945	523115.871	891.185	CLDT HIGH PT
3350	96934.119	523226.639	891.347	GS BLUEJOINT MEADOW
3351	96974.510	523256.517	891.664	GS BLUEJOINT MEADOW
3352	96996.031	523266.578	892.545	TOB
3353	97012.696	523270.699	890.970	TOE
3354	97018.476	523271.440	890.960	TOP ICE
3355	97028.870	523272.684	890.926	TOE
3356	97043.580	523274.212	892.282	TOB
3357	97061.809	523275.789	891.859	GS BLUEJOINT MEADOW
3358	97128.663	523284.463	891.933	GS BLUEJOINT MEADOW
3359	97016.880	523444.348	890.797	TOP ICE
3360	97005.997	523521.111	890.802	TOP ICE
3361	96881.681	523410.537	890.956	TOP ICE
3362	96985.602	523491.087	890.828	TOE
3363	96990.235	523487.233	892.332	TOB
3364	97001.766	523477.192	892.927	TOB
3365	96995.533	523482.949	891.693	TOE
3366	96980.029	523509.306	890.818	TOE
3367	96976.315	523514.464	892.109	TOB
3368	96961.912	523529.453	892.122	GS
3369	96940.094	523557.154	892.096	GS
3370	96756.885	523400.742	892.867	GS LAWN
3371	96795.497	523365.946	892.773	GS LAWN
3372	96804.119	523357.660	891.916	TOB
3373	96804.655	523357.032	891.047	TOE
3374	96810.102	523350.770	891.072	TOP ICE
3375	96817.803	523341.669	891.140	TOE
3376	96819.285	523340.518	892.007	POS
3377	96830.019	523326.083	892.685	TOB
3378	96837.543	523313.149	891.968	TOE
3379	96852.832	523290.641	892.057	GS
3380	96871.696	523265.716	891.785	GS
3381	96744.727	523281.014	892.574	BRG CR
3382	96751.370	523286.651	892.481	BRG CR
3383	96740.474	523298.033	892.682	BRG CR

ID	Y	X	Z	desc_
3384	96732.845	523293.139	892.935	BRG CR
3385	96745.304	523290.545	891.150	LOW CHORD
3386	96502.448	523186.530	893.037	GS LAWN
3387	96521.648	523137.066	892.427	GS LAWN
3388	96523.023	523134.381	892.666	TOB
3389	96532.398	523119.621	891.356	TOE
3390	96539.374	523112.875	891.339	TOP ICE
3391	96545.081	523106.036	891.302	TOE
3392	96546.339	523104.491	892.044	POS
3393	96553.447	523094.342	892.622	TOB
3394	96560.878	523085.657	891.981	TOE
3395	96577.091	523069.618	891.989	GS
3396	96600.874	523033.002	891.797	GS
3397	96387.627	523000.508	891.290	TOE
3398	96385.388	523002.914	892.187	TOB
3399	96376.155	523012.224	892.756	GS
3400	96367.450	523019.734	892.658	TOE
3401	96359.561	523029.731	894.844	GS
3402	96398.933	522978.976	891.361	TOE
3403	96407.224	522976.889	892.629	TOB
3404	96428.289	522971.166	892.283	TOE
3405	96444.455	522963.343	891.950	GS
3406	96486.647	522952.515	892.207	GS
3407	96458.444	522929.415	892.257	GS
3408	96427.011	522915.691	892.181	TOE
3409	96415.249	522909.704	893.471	TOB
3410	96404.052	522905.448	892.097	POS
3411	96396.485	522903.282	891.245	TOE
3412	96390.563	522902.284	891.267	TOP ICE
3413	96384.734	522901.853	891.246	TOE
3414	96371.281	522894.225	894.348	TOB
3415	96361.758	522888.997	893.615	TOE
3416	96345.978	522852.933	893.005	GS
3417	96336.416	522808.163	892.304	GS
3418	96321.271	522856.793	893.263	GS
3419	96309.896	522869.794	893.770	TOE
3420	96300.706	522882.576	895.508	TOB
3421	96293.697	522891.225	893.601	POS
3422	96289.553	522896.219	891.297	TOE
3423	96316.666	522917.628	891.536	TOE
3424	96334.835	522906.328	895.315	TOB
3425	96343.166	522914.078	893.357	TOE
3426	96347.071	522901.899	893.743	TOE
3427	96335.547	522918.477	893.272	POS
3428	96347.541	522915.918	893.429	LOW PT BERM
3429	96346.826	522925.174	893.093	POS
3430	96356.288	522913.232	893.451	TOE
3431	96355.162	522919.135	894.038	TOB
3432	96370.578	522943.669	894.124	TOB
3433	96367.311	522952.102	892.153	POS
3434	96381.534	522953.119	892.564	POS

ID	Y	X	Z	desc_
3435	96377.456	522927.570	893.312	POS
3436	96251.873	522865.089	891.326	TOE
3437	96256.553	522859.194	892.686	POS
3438	96263.330	522848.961	893.607	TOB
3439	96270.810	522842.004	892.628	TOE
3440	96287.650	522818.986	892.807	GS
3441	96305.284	522782.962	892.164	GS
3442	96240.296	522870.555	891.335	TOE
3443	96226.800	522888.481	894.907	TOB
3444	96219.464	522900.360	894.116	TOE
3445	96193.208	522833.288	891.293	TOE
3446	96183.740	522845.575	892.657	TOB
3447	96169.653	522868.457	892.973	TOE
3448	96154.244	522902.225	893.085	GS
3449	95982.453	522772.876	893.082	GS
3450	95998.348	522744.049	893.085	GS
3451	96013.575	522725.396	893.576	TOB
3452	96028.275	522712.772	892.505	POS
3453	96029.239	522711.629	891.313	TOE
3454	96033.274	522706.993	891.360	TOP ICE
3455	96037.330	522701.943	891.342	TOE
3456	96040.704	522697.426	891.586	POS
3457	96048.891	522686.172	893.067	TOB
3458	96057.519	522674.350	892.422	TOE
3459	96075.138	522642.951	892.211	GS
3460	96102.616	522593.935	892.021	GS
3461	95869.565	522576.441	891.166	TOP ICE
3462	95718.070	522570.293	892.065	GS
3463	95747.511	522530.361	891.683	GS
3464	95758.249	522512.859	891.719	TOE
3465	95764.330	522506.853	892.005	TOB
3466	95766.357	522504.560	891.056	TOE
3467	95769.622	522500.031	891.035	TOP ICE
3468	95772.312	522496.680	891.159	TOE
3469	95780.263	522487.637	891.721	TOB
3470	95788.519	522475.414	891.614	GS
3471	95802.160	522453.226	891.676	GS
3472	95821.463	522425.813	891.679	GS
3473	95640.420	522394.835	891.037	TOP ICE
3474	95482.573	522376.281	892.330	GS
3475	95513.275	522337.555	892.219	TOE
3476	95523.297	522327.325	892.719	TOB
3477	95534.493	522319.816	892.255	POS
3478	95536.181	522317.925	891.211	TOE
3479	95542.852	522310.174	891.108	TOP ICE
3480	95547.923	522305.102	891.133	TOE
3481	95550.668	522300.720	892.399	TOB
3482	95559.832	522294.821	892.031	TOE
3483	95573.300	522280.943	892.102	GS
3484	95599.024	522256.414	892.052	GS
3485	95608.806	522248.067	891.271	TOP ICE POND

ID	Y	X	Z	desc_
3486	95526.513	522239.295	892.620	GS
3487	95507.835	522256.676	892.138	GS
3488	95493.394	522263.952	893.004	GS
3489	95491.557	522273.397	893.044	TOP DITCH PLUG
3490	95482.666	522278.989	892.644	GS
3491	95470.676	522288.164	892.193	GS
3492	95457.222	522298.891	892.276	GS
3493	95446.416	522310.427	892.266	GS
3494	95496.203	522276.341	891.266	TOE DITCH PLUG
3495	95483.016	522261.025	891.429	TOE DITCH PLUG
3496	95454.366	522239.437	891.293	TOE
3497	95456.898	522237.005	891.987	POS
3498	95464.157	522226.559	892.476	TOB
3499	95478.048	522202.350	892.721	GS
3500	95509.603	522164.445	892.837	GS
3501	95294.696	522173.115	892.633	GS
3502	95319.231	522140.742	892.277	TOB
3503	95324.705	522131.592	892.268	POS
3504	95326.262	522129.337	891.379	TOE
3505	95332.283	522119.660	891.345	TOE
3506	95335.842	522117.039	892.566	POS
3507	95342.111	522109.573	892.787	TOB
3508	95348.609	522102.634	892.433	TOE
3509	95366.081	522071.875	892.875	GS
3510	95389.465	522041.090	893.255	GS
3511	97160.812	523655.124	889.988	CLDT
3512	97159.763	523762.543	892.779	GS
3513	97182.376	523729.514	892.211	GS
3514	97192.874	523712.377	892.455	TOB
3515	97204.383	523704.954	891.504	POS
3516	97205.767	523703.502	890.692	TOE
3517	97208.759	523700.687	889.858	CLDT
3518	97215.017	523693.081	890.637	TOE
3519	97215.998	523691.501	891.560	POS
3520	97222.407	523683.177	892.373	TOB
3521	97231.705	523669.771	892.145	GS
3522	97260.444	523631.476	891.852	GS
3523	97287.445	523768.059	889.891	CLDT
1003	97290.617	524757.388	932.421	STA HULT MNDT
3524	99686.316	525015.415	889.262	CLDT
3525	99686.769	525012.641	889.796	TOP ICE
3526	99691.471	525030.184	889.052	CLDT
3527	99691.668	525035.135	889.922	TOE
3528	99687.329	525052.192	894.181	TOB
3529	99681.816	525060.743	893.347	TOE
3530	99669.120	525080.668	893.615	GS
3531	99724.624	525027.658	890.301	TOE
3532	99739.696	525028.423	892.907	TOB
3533	99744.133	525018.538	890.676	TOE
3534	99738.519	525049.371	890.251	TOE
3535	99748.102	525039.883	893.312	GAS

ID	Y	X	Z	desc_
3536	99714.118	525049.373	890.399	GAS
3537	99668.997	525059.052	893.748	GAS
3538	99664.564	525049.108	893.634	TELU
3539	99659.307	525023.898	893.230	FIBER OPTIC
3540	99683.245	525018.203	889.891	FIBER OPTIC
3541	99754.831	524999.479	892.490	FIBER OPTIC
3542	99756.828	525009.616	890.346	CLDT
3543	99778.120	525023.318	894.150	TELU
3544	99786.215	525029.088	894.030	GAS
3545	99759.877	525044.648	893.557	TOB
3546	99744.789	525060.463	890.140	TOE
3547	99741.403	525069.942	889.921	TOP ICE
3548	99727.450	525073.356	890.607	TOE
3549	99725.023	525074.250	891.869	POS
3550	99716.499	525078.649	893.620	TOB
3551	99707.168	525083.828	893.127	TOE
3552	99684.822	525105.130	894.073	GS
3553	99701.091	525156.176	894.273	GS
3554	99731.986	525137.180	894.090	GS
3555	99743.634	525131.291	894.236	TOB
3556	99752.732	525124.802	893.492	POS
3557	99759.706	525120.211	889.997	TOE
3558	99774.460	525112.744	889.768	TOE
3559	99777.334	525111.176	891.650	POS
3560	99789.795	525103.502	893.228	POS
3561	99798.534	525097.560	895.135	TOB
3562	99807.327	525090.533	892.659	TOE
3563	99820.543	525081.774	891.514	GS
3564	99859.002	525048.678	892.359	GS
3565	99857.642	525033.979	893.130	TOE
3566	99854.647	525013.933	894.485	GAS
3567	99855.504	525018.720	894.439	TOB
3568	99851.737	525002.185	893.147	TELU
3569	99850.838	524995.630	891.977	POS
3570	99849.230	524991.459	890.305	TOE
3571	99847.968	524988.899	889.990	CLDT
3572	99845.558	524982.600	890.669	TOE
3573	99844.737	524979.547	892.094	POS
3574	99843.031	524972.952	892.745	FIBER OPTIC
3575	99838.798	524957.939	894.882	GS
3576	99836.959	524950.214	896.303	RDE
3577	99792.277	525092.754	894.093	LOW PT BERM
3578	99799.101	525096.893	895.166	TOB
3579	99789.075	525085.813	895.291	TOB
3580	99841.372	525201.314	889.628	TOP ICE
3581	99787.797	525218.406	889.664	TOP ICE
3582	99745.005	525219.202	889.803	TOP ICE
3583	99679.526	525210.929	889.819	TOP ICE
3584	99666.357	525210.636	890.649	TOP CONC DAM
3585	99669.298	525216.338	890.714	TOP CONC DAM
3586	99670.129	525220.111	889.866	TOP CONC DAM

ID	Y	X	Z	desc_
3587	99660.934	525219.334	889.779	TOP ICE
3588	99784.513	525215.221	889.683	TOE
3589	99784.181	525203.530	892.628	POS
3590	99782.480	525187.397	894.878	TOB
3591	99793.072	525177.117	894.051	POS
3592	99798.975	525171.362	889.753	TOE
3593	99824.820	525196.518	890.096	TOE
3594	99817.583	525207.609	889.795	TOE
3595	99816.406	525197.814	892.105	TOB
3596	99803.415	525191.275	892.591	TOB
3597	99732.831	525166.868	894.757	GS
3598	99848.868	525193.247	889.824	TOE
3599	99851.576	525190.538	892.065	POS
3600	99859.014	525180.856	894.326	POS
3601	99865.470	525168.000	896.089	TOB
3602	99872.619	525158.113	893.607	TOE
3603	99884.240	525147.236	892.445	GS
3604	99921.494	525103.373	892.860	GS
3605	99890.201	525160.850	892.299	TOE
3606	99877.455	525170.808	893.110	TOE
3607	99871.173	525168.742	893.798	TOE
3608	99873.633	525172.485	893.200	LOW PT BERM
3609	99873.928	525182.017	893.327	TOE
3610	99885.528	525177.525	896.297	TOB
3611	99900.585	525169.009	892.687	TOE
3612	99888.098	525194.372	893.801	POS
3613	99885.266	525199.788	892.360	POS
3614	99884.440	525202.631	889.945	TOE
3615	99884.537	525210.215	889.548	TOP ICE
3616	99880.376	525215.649	889.824	TOE
3617	99879.727	525217.610	891.584	POS
3618	99869.893	525227.797	890.618	POS
3619	99864.458	525234.058	891.827	POS
3620	99857.034	525240.813	893.087	TOB
3621	99832.579	525271.348	892.610	GS
3622	99830.890	525233.999	895.160	TOB
3623	99839.056	525220.722	891.823	POS
3624	99824.232	525220.205	891.528	POS
3625	99823.026	525213.880	889.564	TOE
3626	99845.011	525206.917	889.585	TOE
3627	99844.807	525211.651	891.721	POS
3628	99871.960	525315.340	891.439	GS
3629	99889.715	525299.619	893.532	TOB
3630	99899.337	525290.477	892.655	POS
3631	99911.646	525275.405	892.240	POS
3632	99913.955	525273.186	889.689	TOE
3633	99918.847	525270.580	889.554	TOP ICE
3634	99922.283	525268.600	889.600	TOE
3635	99926.398	525265.825	891.075	POS
3636	99939.953	525253.720	891.653	POS
3637	99956.759	525238.476	893.574	TOB

ID	Y	X	Z	desc_
3638	99968.326	525228.109	890.908	TOE
3639	100018.644	525191.899	890.980	GS
3640	99937.192	525409.625	893.408	GS
3641	99975.715	525377.760	892.004	TOE
3642	99987.990	525366.266	892.881	TOB
3643	99996.146	525355.669	890.727	POS
3644	100004.957	525348.121	890.892	POS
3645	100007.623	525346.326	889.865	TOE
3646	100013.353	525340.658	889.486	TOP ICE
3647	100017.590	525337.404	889.477	TOE
3648	100018.922	525336.613	891.150	POS
3649	100030.998	525326.571	892.846	TOB
3650	100045.417	525316.044	890.685	TOE
3651	100094.134	525279.945	890.395	GS
3652	99972.829	525485.977	894.125	GS
3653	100022.294	525447.764	893.084	TOE
3654	100034.199	525438.366	893.772	TOB
3655	100039.775	525435.140	892.614	POS
3656	100043.204	525432.700	889.425	TOE
3657	100047.219	525429.644	889.406	TOP ICE
3658	100050.972	525427.484	889.547	TOE
3659	100052.970	525425.551	890.890	POS
3660	100063.225	525418.973	890.735	POS
3661	100069.732	525414.132	892.450	POS
3662	100088.862	525400.632	894.505	TOB
3663	100096.791	525393.360	891.684	TOE
3664	100121.462	525373.915	890.916	GS
3665	100042.758	525514.605	893.739	GS
3666	100058.181	525503.387	893.959	TOE
3667	100071.169	525488.678	895.725	TOB
3668	100079.075	525480.127	891.266	POS
3669	100083.788	525476.196	890.643	POS
3670	100085.115	525475.056	889.321	TOE
3671	100090.501	525472.332	889.309	TOP ICE
3672	100094.107	525470.502	889.314	TOE
3673	100095.298	525469.660	890.510	POS
3674	100100.247	525465.459	892.789	POS
3675	100116.715	525450.843	895.181	TOB
3676	100126.016	525444.153	894.923	POS
3677	100132.231	525440.010	892.373	TOE
3678	100150.584	525522.735	891.334	TOE
3679	100144.241	525528.680	893.680	TOB
3680	100137.615	525534.649	891.046	POS
3681	100133.857	525537.707	890.384	POS
3682	100132.991	525538.137	889.203	TOE
3683	100129.085	525542.652	889.173	TOP ICE
3684	100123.579	525544.964	889.250	TOE
3685	100118.076	525546.983	893.932	POS
3686	100094.072	525555.961	895.728	TOB
3687	100080.618	525561.504	893.937	TOE
3688	100055.221	525578.269	894.110	GS

ID	Y	X	Z	desc_
3689	100105.240	525602.407	894.689	TOE
3690	100124.540	525595.981	894.365	TOE
3691	100129.256	525584.598	893.701	TOE
3692	100119.929	525587.823	898.339	TOB
3693	100108.428	525584.375	897.908	TOB
3694	100148.785	525774.499	894.622	CLDW
3695	100149.283	525712.784	893.757	CLDW
3696	100149.907	525647.619	893.751	CLDW
3697	100162.013	525584.885	894.640	CLDW
3698	100169.812	525498.700	893.678	CLDW
3699	100167.667	525407.132	893.177	CLDW
3700	100167.277	525292.328	892.265	CLDW
3701	100168.031	525196.246	892.045	CLDW
3702	100171.463	525070.562	892.152	CLDW
3703	100175.396	524938.986	892.172	CLDW
3704	100174.246	524883.124	894.820	CLDW
3705	100154.504	525528.555	892.744	TOE
3706	100144.131	525532.979	893.059	TOB
3707	100139.534	525537.861	890.762	POS
3708	100146.181	525544.549	890.768	POS
3709	100138.663	525547.512	889.302	TOE
3710	100223.578	525581.917	892.022	GS
3711	100200.091	525605.086	891.755	TOB
3712	100189.255	525613.398	889.285	TOE
3713	100176.394	525625.281	890.050	TOE
3714	100171.597	525628.934	892.476	POS
3715	100164.394	525633.813	893.431	TOB
3716	100187.264	525616.828	889.067	TOP ICE
3717	100169.967	525719.544	893.465	GS
3718	100194.593	525697.042	892.275	TOB
3719	100198.476	525694.230	891.526	POS
3720	100200.494	525693.804	889.166	TOE
3721	100209.112	525689.161	888.945	TOP ICE
3722	100214.241	525685.957	888.955	TOE
3723	100216.323	525684.373	890.307	POS
3724	100230.365	525674.165	891.664	TOB
3725	100251.621	525652.186	891.443	GS
3726	100281.774	525622.303	891.018	GS
3727	100228.712	525805.184	894.184	GS NEAR SHED
3728	100339.059	525875.562	891.815	TOB
3729	100343.612	525870.941	890.882	POS
3730	100346.439	525868.153	888.924	TOE
3731	100350.841	525864.441	888.918	TOP ICE
3732	100355.625	525861.388	888.913	TOE
3733	100358.190	525857.690	890.420	POS
3734	100369.774	525847.276	890.611	TOB
3735	100389.959	525829.280	890.348	TOE
3736	100418.726	525796.869	890.274	GS
3737	100444.012	525765.981	890.533	GS
3738	100540.902	525988.288	890.420	TOB
3739	100551.386	525975.868	890.376	TOE

ID	Y	X	Z	desc_
3740	100583.184	525940.763	890.020	GS
3741	100757.786	526172.706	891.971	TOB
3742	100761.234	526168.925	889.552	POS
3743	100765.120	526164.857	889.678	POS
3744	100766.200	526164.197	888.797	TOE
3745	100768.850	526161.731	888.775	TOP ICE
3746	100772.630	526158.758	888.757	TOE
3747	100774.057	526156.970	889.577	POS
3748	100781.481	526148.578	891.495	TOB
3749	100789.863	526136.385	892.237	GS
3750	100809.710	526112.328	891.724	GS
3751	100824.723	526093.594	890.916	GS
3752	100851.143	526072.465	890.226	GS
3753	100953.612	526400.082	890.802	GS
3754	100996.031	526361.523	891.179	GS
3755	101002.979	526351.986	891.485	TOB
3756	101006.591	526347.130	890.851	POS
3757	101007.837	526344.814	888.768	TOE
3758	101011.496	526339.920	888.800	TOP ICE
3759	101015.137	526336.356	888.925	TOE
3760	101017.935	526332.698	889.968	POS
3761	101021.862	526327.352	892.166	TOB
3762	101028.902	526317.745	891.902	GS
3763	101051.472	526286.405	891.820	GS
3764	101076.906	526267.881	892.239	GS
3765	100947.921	526219.766	890.846	GS
3766	100926.832	526241.654	890.564	TOB
3767	100922.281	526247.203	889.899	POS
3768	100916.126	526257.894	889.413	POS
3769	100915.875	526258.491	888.790	TOE
3770	101091.726	526377.800	888.760	TOE
3771	101093.832	526376.321	889.901	POS
3772	101098.732	526370.079	890.916	TOB
3773	101116.031	526346.207	890.757	GS
3774	101151.910	526308.558	890.459	GS
3775	101244.475	526598.521	889.980	GS
3776	101269.352	526557.129	890.179	GS
3777	101275.147	526545.451	889.838	TOB
3778	101278.851	526537.803	889.742	POS
3779	101279.367	526536.564	888.931	TOE
3780	101283.901	526530.458	888.664	TOP ICE
3781	101288.621	526523.530	888.784	TOE
3782	101292.530	526514.666	890.035	POS
3783	101299.701	526502.330	890.851	TOB
3784	101311.005	526485.290	889.591	TOE
3785	101320.035	526470.218	889.176	GS
3786	101336.976	526450.290	889.148	GS
3787	101448.200	526652.014	888.754	TOE
3788	101449.467	526669.849	888.755	TOE
3789	101447.146	526669.695	889.702	POS
3790	101442.387	526653.539	889.842	POS

ID	Y	X	Z	desc_
3791	101432.880	526661.701	890.310	TOB
3792	101411.575	526675.664	889.878	GS
3793	101378.984	526693.360	889.621	GS
3794	101376.135	526717.641	889.507	TOB
3795	101375.116	526725.543	888.640	TOE
3796	101374.095	526735.890	888.663	TOP ICE
3797	101372.559	526745.965	888.678	TOE
3798	101372.701	526755.783	889.723	POS
3799	101370.796	526766.357	890.629	TOB
3800	101367.808	526777.637	889.884	TOE
3801	101361.724	526794.436	889.591	GS
3802	101350.126	526836.922	889.648	GS
3803	101213.871	526732.185	888.633	TOP ICE
3804	101084.463	526732.368	888.645	TOP ICE
3805	100978.469	526728.999	888.651	CLDT HIGH PT
3806	100819.472	526727.843	888.627	TOP ICE
3807	100988.422	526662.301	891.283	GS
3808	100984.690	526702.606	891.396	GS
3809	100982.457	526719.921	890.756	GS
3810	100982.027	526722.952	889.968	POS
3811	100982.117	526724.674	888.805	TOE
3812	100980.840	526735.392	888.685	TOE
3813	100980.676	526739.396	889.970	POS
3814	100979.201	526746.017	890.245	TOB
3815	100977.045	526760.204	890.516	GS
3816	100968.218	526811.152	890.676	GS
3817	101385.101	526796.410	889.271	GS
3818	101414.765	526796.242	889.504	TOE
3819	101424.930	526796.901	891.726	TOB
3820	101436.126	526798.194	889.814	POS
3821	101443.875	526798.649	889.647	POS
3822	101445.309	526799.164	888.777	TOE
3823	101455.682	526798.285	888.646	TOP ICE
3824	101463.968	526798.936	888.569	TOE
3825	101464.489	526799.092	889.372	POS
3826	101477.152	526799.592	889.098	GS
3827	101509.420	526813.986	889.216	GS
3828	101532.141	526826.270	889.227	GS
3829	101456.755	526940.127	888.595	TOP ICE
3830	101454.331	527046.004	888.605	TOP ICE
3831	101459.658	527122.756	888.995	CLDT HIGH PT
3832	101459.289	527132.083	888.687	TOP ICE
3833	101370.859	527047.142	888.654	TOP ICE
3834	101283.935	527049.778	888.998	CLDT HIGH PT
3835	101244.705	527047.259	889.232	CLDT
3836	101468.430	526717.286	888.642	TOE
3837	101481.534	526713.775	892.613	TOB
3838	101495.740	526704.736	891.573	POS
3839	101504.372	526694.867	888.763	TOE
3840	101517.499	526682.926	888.706	TOP ICE
3841	101528.595	526671.704	888.646	TOE

ID	Y	X	Z	desc_
3842	101530.367	526670.190	889.610	POS
3843	101542.876	526657.768	891.487	TOB
3844	101553.599	526647.068	889.631	TOE
3845	101583.081	526615.002	889.573	GS
3846	101604.252	526556.795	888.973	GS
3847	101611.632	526516.845	888.975	GS
3848	101530.076	526607.474	888.663	TOE
3849	101515.515	526612.980	889.862	POS
3850	101505.309	526617.485	890.218	TOB
3851	101498.819	526618.319	888.743	TOE
3852	101494.890	526594.967	888.691	TOE
3853	101504.486	526593.643	890.631	TOB
3854	101519.583	526589.632	888.817	TOE
3855	101508.542	526549.981	888.791	TOE
3856	101497.067	526550.272	888.673	TOE
3857	101501.549	526553.202	890.001	TOB
3858	101513.428	526552.934	888.778	TOP ICE
3859	101517.205	526551.963	888.726	TOE
3860	101525.538	526547.561	889.922	TOB
3861	101539.144	526539.309	889.623	GS
3862	101568.098	526524.842	889.134	GS
3863	101471.438	526533.556	888.766	TOE
3864	101466.497	526533.089	889.395	POS
3865	101455.791	526530.835	890.012	TOB
3866	101430.942	526521.489	889.312	GS
3867	101397.706	526505.370	889.004	GS
3868	101459.999	526505.894	889.439	LOW PT BERM
3869	101459.120	526491.166	890.134	TOB
3870	101469.823	526620.726	888.686	TOE
3871	101459.393	526628.939	888.737	TOE
3872	101462.269	526618.598	890.048	TOB
3873	101437.632	526603.570	890.912	TOB
3874	101415.144	526574.748	890.792	TOB
3875	101472.968	526675.765	888.794	TOE
3876	101557.868	526414.632	889.286	GS
3877	101616.569	526413.873	889.214	GS
3878	101523.357	526413.504	889.635	TOE
3879	101503.078	526415.204	890.894	TOB
3880	101489.469	526413.953	889.547	POS
3881	101486.633	526413.988	888.616	TOE
3882	101479.378	526413.653	888.694	TOP ICE
3883	101468.544	526412.844	888.860	TOE
3884	101466.414	526413.056	889.565	POS
3885	101457.706	526412.798	890.802	TOB
3886	101441.960	526410.779	890.778	POS
3887	101398.796	526403.154	889.352	GS
3888	101597.516	526184.375	889.352	GS
3889	101533.785	526202.168	888.928	GS
3890	101504.686	526210.369	889.648	GS
3891	101490.681	526211.153	890.356	TOB
3892	101485.524	526211.782	889.460	POS

ID	Y	X	Z	desc_
3893	101482.435	526212.199	888.602	TOE
3894	101474.921	526212.322	888.676	TOP ICE
3895	101463.394	526212.004	888.683	TOE
3896	101458.066	526212.190	889.433	POS
3897	101449.964	526211.956	889.973	TOB
3898	101436.070	526210.629	889.675	GS
3899	101416.869	526205.137	889.289	GS
3900	101386.439	526193.972	889.357	GS
3901	101445.502	526161.415	888.920	LOW PT BERM
3902	101447.461	526170.556	890.641	TOB
3903	101446.796	526148.194	890.054	TOB
3904	101580.368	526000.728	889.404	GS
3905	101531.406	525990.702	889.698	GS
3906	101487.885	525987.305	890.298	TOB
3907	101481.420	525986.351	889.761	POS
3908	101478.611	525986.593	888.648	TOE
3909	101470.657	525986.346	888.686	TOP ICE
3910	101461.870	525985.884	888.654	TOE
3911	101458.836	525985.799	889.720	POS
3912	101448.402	525985.142	890.756	TOB
3913	101429.323	525984.453	890.199	GS
3914	101403.170	525982.784	889.499	GS
3915	101358.935	525979.542	890.020	GS
3916	101394.641	525885.771	890.333	GS
3917	101420.477	525890.102	890.171	GS
3918	101443.650	525889.866	890.935	TOE
3919	101457.569	525888.641	892.127	TOB
3920	101462.462	525889.255	890.935	POS
3921	101467.152	525889.534	888.711	TOE
3922	101473.297	525889.736	888.704	TOP ICE
3923	101478.647	525891.044	888.755	TOE
3924	101480.892	525891.110	890.465	POS
3925	101489.556	525891.374	894.508	TOB
3926	101499.114	525892.024	892.713	TOE
3927	101495.851	525907.109	893.002	TOE
3928	101488.799	525910.236	892.696	TOB
3929	101493.645	525881.045	892.609	TOE
3930	101489.828	525879.459	892.569	TOB
3931	101506.490	525884.330	892.967	GS
3932	101522.379	525885.483	892.666	GS
3933	101552.145	525883.737	891.684	GS
3934	101596.649	525873.616	891.381	GS
3935	101505.965	525839.788	893.249	TOB
3936	101470.724	525827.362	888.705	TOE
3937	101467.819	525827.516	890.199	POS
3938	101458.375	525826.684	890.980	TOB
3939	101439.086	525824.995	891.090	GS
3940	101448.390	525873.212	891.178	GS
3941	101455.758	525868.561	891.388	TOB
3942	101462.180	525872.041	891.202	POS
3943	101454.667	525747.217	892.726	TOB

ID	Y	X	Z	desc_
3944	101468.531	525736.697	891.967	POS
3945	101468.708	525719.773	892.227	POS
3946	101469.241	525688.656	891.882	POS
3947	101456.855	525683.228	892.223	TOB
3948	101433.550	525682.459	892.224	GS
3949	101408.852	525681.614	892.010	GS
3950	101427.253	525700.493	892.590	TOE
3951	101425.745	525719.421	892.553	TOE
3952	101432.406	525736.259	892.579	TOE
3953	101444.660	525731.842	898.520	TOB
3954	101444.313	525725.139	900.387	TOB
3955	101442.862	525718.462	900.978	TOB
3956	101442.138	525710.597	899.893	TOB
3957	101475.936	525720.607	888.921	TOE
3958	101483.099	525719.838	888.740	TOP ICE
3959	101490.323	525719.691	888.748	TOE
3960	101492.109	525719.203	890.139	POS
3961	101500.703	525719.602	893.552	TOB
3962	101513.914	525720.025	893.910	TOB
3963	101529.577	525720.958	892.292	TOE
3964	101550.530	525720.503	891.483	GS
3965	101614.320	525719.278	891.488	GS
3966	101564.852	525641.192	891.732	GS
3967	101527.767	525637.614	892.654	TOE
3968	101520.388	525636.928	894.117	TOB
3969	101510.305	525634.661	894.237	TOB
3970	101492.452	525632.641	892.309	POS
3971	101488.121	525632.474	888.613	TOE
3972	101474.762	525628.002	888.894	TOE
3973	101471.791	525628.209	890.881	POS
3974	101461.517	525628.129	893.565	TOB
3975	101452.015	525627.382	893.177	POS
3976	101443.184	525627.255	892.010	TOE
3977	101418.947	525626.557	891.431	GS
3978	101455.291	525657.701	891.878	LOW PT BERM
3979	101479.381	524614.790	889.639	TOP ICE
3980	101567.261	524661.986	890.301	GS
3981	101530.942	524673.426	890.459	TOE
3982	101514.904	524678.765	890.939	POS
3983	101495.866	524682.596	890.871	TOB
3984	101492.678	524683.597	890.357	POS
3985	101490.660	524683.387	889.816	TOE
3986	101484.185	524683.730	889.727	TOP ICE
3987	101476.777	524685.249	889.657	TOE
3988	101469.819	524686.049	889.669	POS
3989	101453.250	524690.484	890.272	TOB
3990	101411.978	524698.966	890.561	GS
3991	101358.098	524704.954	890.092	GS
3992	101467.042	524881.146	889.638	TOE
3993	101452.532	524890.819	889.338	TOE
3994	101452.158	524870.681	890.110	TOB

ID	Y	X	Z	desc_
3995	101439.203	524858.337	890.213	GS
3996	101418.640	524835.271	890.111	GS
3997	101432.414	524906.091	889.236	TOE
3998	101431.635	524923.377	889.779	GS
3999	101428.630	524953.461	890.024	GS
4000	101422.892	524995.025	890.047	GS
4001	101437.682	524957.525	889.683	GS
4002	101460.782	524955.444	889.809	TOB
4003	101472.940	524955.100	889.183	TOE
4004	101479.221	524954.601	889.151	TOP ICE
4005	101484.369	524955.651	889.202	TOE
4006	101486.114	524955.488	889.654	POS
4007	101493.155	524957.091	890.327	TOB
4008	101505.840	524957.611	889.914	GS
4009	101529.092	524958.751	889.679	GS
4010	101571.054	524967.100	889.564	GS
4011	101471.268	524910.810	889.418	TOE
4012	101461.078	524914.712	889.818	GS
4013	101442.494	524926.767	889.929	GS
4014	101490.420	525033.563	888.981	TOE
4015	101480.575	525020.687	889.001	TOE
4016	101510.181	525037.052	889.103	TOE
4017	101509.408	525026.531	889.833	GS
4018	101493.633	525027.252	890.400	GS
4019	101487.305	525018.110	890.285	GS
4020	101528.925	525012.755	889.812	GS
4021	101542.635	525004.574	889.574	GS
4022	101474.116	525038.138	889.085	TOP ICE
4023	101482.309	525065.057	889.016	TOE
4024	101484.260	525049.202	889.123	TOE
4025	101495.815	525046.436	889.109	TOE
4026	101491.898	525054.636	890.139	TOB
4027	101505.820	525072.214	890.302	GS
4028	101533.352	525088.854	890.149	GS
4029	101547.698	525102.046	890.087	GS
4030	101644.994	525040.584	888.936	TOP ICE
4031	101467.181	525052.417	889.130	TOE
4032	101465.800	525071.596	889.230	TOE
4033	101453.747	525070.348	889.015	TOE
4034	101454.279	525058.261	889.881	TOB
4035	101439.012	525041.259	889.803	GS
4036	101412.314	525013.156	890.138	GS
4037	101437.740	525092.808	888.942	TOE
4038	101461.191	525091.305	889.082	TOE
4039	101464.106	525081.031	889.028	TOP ICE
4040	101463.324	525107.951	888.994	TOE
4041	101451.222	525104.689	889.597	TOB
4042	101432.913	525124.735	889.612	GS
4043	101403.744	525164.631	889.981	GS
4044	101372.445	525216.741	890.279	GS
4045	101428.496	525216.357	890.199	GS

ID	Y	X	Z	desc_
4046	101447.528	525216.109	889.970	GS
4047	101467.764	525215.133	889.381	POS
4048	101471.439	525214.289	888.856	TOE
4049	101477.678	525214.356	888.874	TOP ICE
4050	101484.768	525214.993	888.704	TOE
4051	101488.634	525214.974	890.732	POS
4052	101494.750	525215.873	891.269	TOB
4053	101513.092	525218.685	891.100	GS
4054	101533.005	525219.675	890.247	GS
4055	101548.897	525222.952	889.747	GS
4056	101463.147	525365.785	888.813	TOE
4057	101464.502	525379.837	888.814	TOE
4058	101445.965	525381.423	888.806	TOE
4059	101451.605	525366.963	889.322	TOB
4060	101434.996	525351.955	889.621	GS
4061	101399.108	525319.773	889.920	GS
4062	101458.982	525388.382	888.687	TOP ICE
4063	101459.342	525399.023	888.676	TOE
4064	101475.032	525393.037	888.709	TOE
4065	101476.747	525415.509	888.691	TOE
4066	101469.198	525402.096	889.643	POS
4067	101460.869	525409.626	890.858	TOB
4068	101447.210	525423.705	890.692	GS
4069	101432.779	525443.338	889.573	GS
4070	101412.004	525468.070	889.595	GS
4071	101489.031	525456.629	888.606	TOE
4072	101493.840	525457.083	889.277	POS
4073	101501.499	525458.600	890.538	TOB
4074	101511.188	525460.371	891.375	POS
4075	101527.547	525461.934	891.024	POS
4076	101533.326	525462.268	890.061	TOE
4077	101566.931	525461.623	889.906	GS
4078	101623.772	525471.986	890.125	GS
4079	101474.199	525497.064	888.765	TOE
4080	101472.381	525496.795	890.035	POS
4081	101467.037	525496.542	891.175	TOB
4082	101457.750	525496.294	891.372	POS
4083	101436.528	525497.267	889.917	TOE
4084	101402.093	525499.772	889.611	GS
4085	101344.484	525501.271	889.545	GS
4086	101336.978	525460.083	889.511	GS
4087	101337.522	525425.012	889.638	TOE
4088	101336.760	525417.909	890.919	TOB
4089	101336.684	525415.257	890.273	POS
4090	101336.105	525411.466	888.699	TOE
4091	101334.405	525401.357	888.673	TOP ICE
4092	101333.991	525389.651	888.670	TOE
4093	101332.102	525379.828	889.135	TOB
4094	101326.836	525357.758	889.405	GS
4095	101317.653	525321.932	889.788	GS
4096	101075.016	525418.979	888.673	TOP ICE

ID	Y	X	Z	desc_
4097	100929.796	525428.985	888.655	TOP ICE
4098	100876.986	525515.055	889.247	GS
4099	100876.570	525468.044	889.651	TOE
4100	100877.925	525455.830	890.073	POS
4101	100877.283	525450.376	891.790	TOB
4102	100876.976	525446.424	890.542	POS
4103	100876.902	525443.137	888.717	TOE
4104	100875.337	525433.707	888.715	TOP ICE
4105	100871.910	525410.803	888.686	TOE
4106	100872.340	525406.292	889.020	POS
4107	100871.165	525389.012	889.140	GS
4108	100867.658	525364.166	889.469	GS
4109	100695.566	525538.375	890.038	GS
4110	100697.375	525477.765	889.775	TOE
4111	100696.962	525471.785	889.953	POS
4112	100695.598	525463.197	891.781	TOB
4113	100694.819	525459.945	891.165	POS
4114	100694.576	525455.981	888.678	TOE
4115	100693.071	525442.618	888.666	TOP ICE
4116	100691.476	525422.123	888.682	TOE
4117	100689.498	525407.224	889.137	GS
4118	100674.998	525353.098	889.579	GS
4119	100455.588	525462.676	888.665	TOP ICE
4120	100389.930	525467.275	888.817	END LATERAL
4121	100324.175	525376.110	890.655	GS
4122	100318.218	525291.323	890.382	GS
4123	100312.392	525204.054	890.089	GS
4124	100303.937	525159.124	889.810	GS
4125	100302.881	525144.916	888.849	TOE
4126	100302.759	525139.145	888.881	TOP ICE
4127	100239.966	525144.123	889.074	END LATERAL
4128	100237.002	525144.140	890.538	TOB
4129	100228.793	525143.737	890.368	GS
4130	100220.107	525143.641	888.995	TOE
4131	100198.705	525143.305	889.003	TOP ICE
4132	100303.698	525132.521	888.891	TOE
4133	100303.173	525128.853	889.398	POS
4134	100301.355	525115.054	890.094	GS
4135	100289.214	525060.321	890.626	GS
4136	100278.129	524980.741	890.219	GS
4137	100265.743	524920.258	890.491	FIBER OPTIC
4138	100497.245	525176.252	889.639	GS
4139	100491.077	525153.000	889.273	GS
4140	100487.965	525139.366	888.859	TOE
4141	100487.260	525130.279	888.868	TOP ICE
4142	100486.289	525118.347	888.948	TOE
4143	100485.592	525115.764	889.603	GS
4144	100480.294	525075.168	890.648	GS
4145	100479.294	524998.241	890.719	GS
4146	100477.432	524962.384	889.824	GS
4147	100476.465	524954.182	889.121	TOE

ID	Y	X	Z	desc_
4148	100476.224	524948.329	889.127	TOP ICE
4149	100475.007	524943.045	889.175	TOE
4150	100473.826	524935.786	889.859	GS
4151	100471.599	524915.852	890.500	GS/SEDGE MEADOW
4152	100468.892	524874.063	890.557	FIBER OPTIC/SEDGE MEADOW
4153	100437.807	524951.515	889.116	END LATERAL
4154	100422.248	524953.986	889.982	GS
4155	100695.987	524820.922	890.419	FIBER OPTIC/SEDGE MEADOW
4156	100698.546	524877.321	890.325	GS/SEDGE MEADOW
4157	100705.992	524918.399	889.764	GS/SEDGE MEADOW
4158	100705.301	524925.644	889.264	TOE
4159	100705.938	524934.309	889.100	TOP ICE
4160	100705.351	524943.555	889.074	TOE
4161	100705.676	524950.543	889.820	GS
4162	100707.964	524995.394	890.229	GS
4163	100707.713	525054.636	890.120	GS
4164	100707.609	525099.860	889.300	GS
4165	100706.799	525107.969	888.861	TOE
4166	100707.339	525118.061	888.842	TOP ICE
4167	100706.069	525134.917	888.902	TOE
4168	100704.826	525146.557	889.424	GS
4169	100702.305	525174.307	889.782	GS
4170	101038.529	525193.648	889.492	GS
4171	101036.971	525160.146	889.505	GS
4172	101037.117	525125.600	889.485	GS
4173	101037.825	525115.364	888.923	TOE
4174	101037.167	525101.963	888.926	TOP ICE
4175	101038.148	525089.361	888.883	TOE
4176	101037.196	525083.596	889.779	GS
4177	101034.979	525071.163	890.188	GS
4178	101022.603	525011.614	890.884	GS
4179	101018.406	524975.433	890.375	GS
4180	101014.556	524941.429	889.880	GS
4181	101015.355	524929.376	889.187	TOE
4182	101013.987	524919.831	889.171	TOP ICE
4183	101013.404	524911.209	889.217	TOE
4184	101012.128	524897.874	889.679	GS
4185	101005.282	524836.359	890.930	GS
4186	100984.326	524752.023	890.867	FIBER OPTIC
4187	101245.446	524688.844	890.121	FIBER OPTIC
4188	101252.205	524757.758	890.613	GS
4189	101256.310	524841.327	890.248	GS
4190	101253.633	524886.378	889.834	GS
4191	101251.816	524898.539	889.242	TOE
4192	101250.782	524907.153	889.183	TOP ICE
4193	101250.609	524916.035	889.288	TOE
4194	101251.389	524922.390	890.196	GS
4195	101251.972	524975.757	891.174	GS
4196	101247.073	525052.265	890.108	GS
4197	101249.952	525070.220	889.832	GS
4198	101250.623	525074.204	888.914	TOE

ID	Y	X	Z	desc_
4199	101250.539	525090.580	888.957	TOP ICE
4200	101250.106	525104.094	888.890	TOE
4201	101250.004	525110.823	889.521	GS
4202	101248.919	525141.170	889.760	GS
4203	101249.374	525181.889	890.279	GS
4204	101477.980	524639.216	889.659	FIBER OPTIC
4205	101495.012	524565.760	883.924	PIPST INV BOX UNDERWATER
4206	101486.158	524567.061	883.921	PIPST INV BOX UNDERWATER
4207	101617.886	524545.263	890.735	FIBER OPTIC
4208	101672.831	524576.885	891.185	FIBER OPTIC
4209	101568.477	524613.289	890.265	FIBER OPTIC
4210	101754.510	524754.342	890.511	GS
4211	101641.277	524836.952	890.495	GS
4212	101722.517	525021.047	889.975	TOB
4213	101723.141	525024.164	889.116	TOE
4214	101723.144	525034.574	888.977	TOP ICE
4215	101722.481	525046.214	888.816	TOE
4216	101722.665	525047.593	890.070	TOB
4217	101721.968	525052.575	889.984	GS
4218	101724.712	525087.274	889.992	GS
4219	101937.268	525025.946	888.847	TOP ICE
4220	101885.329	525145.995	889.641	GS
4221	101810.267	525309.250	889.255	GS
4222	101734.297	525406.132	889.220	GS
4223	101786.154	525581.663	889.680	GS
4224	101833.386	525753.674	889.864	GS
4225	102002.003	525733.356	890.882	GS
4226	101978.541	525535.364	889.840	GS
4227	102166.614	525436.283	890.189	GS
4228	102214.585	525631.614	889.967	GS
4229	102230.305	525710.274	890.479	GS
4230	102211.359	525806.418	890.897	GS
4231	102248.258	526005.280	891.100	GS
4232	102309.167	526150.579	890.062	GS
4233	102027.775	526152.879	889.674	GS
4234	101894.688	526161.746	889.607	GS
4235	101840.776	526385.059	889.227	GS
4236	102006.951	526399.587	889.000	GS
4237	102178.721	526393.905	889.714	GS
4238	102329.093	526446.406	888.960	GS
4239	102242.146	526626.891	889.313	GS
4240	102224.282	526837.381	888.765	GS
4241	102111.843	526715.517	888.803	GS
4242	101951.046	526626.132	888.745	GS
4243	101768.372	526668.050	888.718	GS
4244	101723.346	526726.187	888.966	GS
4245	101696.505	526757.390	889.369	TOE
4246	101692.779	526763.083	891.341	TOB
4247	101684.707	526771.663	891.800	TOB
4248	101681.437	526775.913	890.005	POS
4249	101673.328	526786.708	889.177	POS

ID	Y	X	Z	desc_
4250	101672.326	526788.311	888.625	TOE
4251	101664.458	526797.479	888.569	TOP ICE
4252	101651.658	526811.838	888.540	TOE
4253	101650.090	526813.909	890.123	POS
4254	101646.351	526818.471	891.588	TOB
4255	101640.408	526826.533	891.743	TOB
4256	101630.400	526827.510	890.732	TOE
4257	101614.477	526847.991	889.162	GS
4258	101600.395	526874.359	889.241	GS
4259	101717.929	526934.988	889.139	GS
4260	101731.389	526916.318	888.941	GS
4261	101736.225	526911.588	889.564	TOE
4262	101741.284	526905.774	890.503	TOB
4263	101749.752	526898.030	890.522	TOB
4264	101754.703	526893.801	889.360	POS
4265	101758.960	526889.557	888.483	TOE
4266	101770.101	526880.066	888.395	TOP ICE
4267	101781.618	526868.228	888.409	TOE
4268	101783.234	526866.306	889.079	POS
4269	101788.548	526860.555	890.164	TOB
4270	101794.245	526853.110	890.202	TOB
4271	101801.558	526844.734	889.900	POS
4272	101804.519	526842.182	888.930	TOE
4273	101844.022	526804.155	888.864	GS
4274	101810.238	527011.727	888.199	LOW PT BERM
4275	101790.346	527026.605	888.801	GS
4276	101815.280	527019.390	890.551	TOB
4277	101809.147	527028.053	888.762	TOE
4278	101826.604	527012.257	889.010	POS
4279	101827.285	527011.301	888.159	TOE
4280	101820.309	526996.301	888.145	TOE
4281	101819.164	526996.785	889.022	POS
4282	101809.126	527000.744	889.504	TOB
4283	101797.182	527004.789	890.138	TOB
4284	101787.376	527007.861	888.914	TOE
4285	101848.146	526993.555	888.178	TOP ICE
4286	101864.402	526984.304	888.184	TOE
4287	101873.391	526978.514	888.596	POS
4288	101876.501	526976.258	889.408	TOB
4289	101885.804	526969.317	889.499	TOB
4290	101889.321	526966.785	888.781	TOE
4291	101943.664	526923.054	888.830	GS
4292	101978.310	526867.355	888.996	GS
4293	101989.239	527177.180	889.127	GS
4294	102002.002	527163.262	889.211	GS
4295	102008.633	527153.252	889.473	GS
4296	102013.443	527147.140	889.480	GS
4297	102016.267	527142.618	889.275	POS
4298	102016.816	527141.556	888.002	TOE
4299	102028.932	527127.213	887.912	TOP ICE
4300	102041.959	527110.134	887.877	TOE

ID	Y	X	Z	desc_
4301	102042.918	527109.287	889.049	POS
4302	102045.999	527102.628	889.061	POS
4303	102050.630	527096.411	890.175	TOB
4304	102059.296	527085.425	890.366	TOB
4305	102062.757	527081.497	888.978	TOE
4306	102093.734	527034.522	888.675	GS
4307	102185.219	527204.838	887.870	TOE
4308	102185.045	527206.769	888.905	LOW PT BERM
4309	102186.085	527209.693	888.269	LOW PT BERM
4310	102188.055	527221.440	888.481	LOW PT BERM
4311	102187.295	527230.830	888.889	GS
4312	102347.295	527276.887	889.036	GS
4313	102355.431	527258.167	888.856	TOE
4314	102358.478	527249.500	890.022	POS
4315	102362.358	527240.450	890.388	TOB
4316	102366.264	527231.827	889.432	POS
4317	102369.429	527223.950	887.807	TOE
4318	102377.725	527206.858	887.776	TOP ICE
4319	102384.625	527190.842	887.752	TOE
4320	102384.864	527189.354	888.886	POS
4321	102386.748	527183.874	889.449	TOB
4322	102392.646	527167.497	889.317	POS
4323	102395.915	527160.528	888.779	TOE
4324	102417.535	527112.767	888.560	GS
4325	102424.923	527052.783	888.724	GS
4326	102437.580	526945.160	889.177	GS
4327	102520.202	526966.980	888.630	LOW SWALE
4328	102516.266	526985.357	888.519	LOW SWALE
4329	102481.359	527005.862	888.349	LOW SWALE
4330	102477.528	527059.174	888.107	LOW SWALE
4331	102515.668	527123.269	888.743	GS
4332	102491.544	527115.581	888.417	GS
4333	102479.137	527112.431	888.058	CLSW
4334	102469.188	527108.996	888.490	GS
4335	102444.050	527109.533	888.533	GS
4336	102469.143	527151.503	887.862	CLSW
4337	102454.298	527190.953	887.872	CLSW
4338	102461.755	527202.839	887.801	CLSW/TOP ICE
4339	102447.573	527221.772	887.840	CLSW/TOP ICE
4340	102456.185	527209.144	887.883	TOE
4341	102460.584	527212.230	887.980	TOE
4342	102451.639	527223.373	887.760	TOE
4343	102452.997	527237.435	887.728	TOE
4344	102433.511	527216.946	888.006	TOE
4345	102434.819	527214.551	889.724	TOB
4346	102437.895	527204.352	889.106	TOB
4347	102441.356	527195.650	888.728	GS
4348	102452.952	527204.517	889.103	TOB
4349	102475.169	527214.050	888.731	GS
4350	102464.798	527221.143	889.217	TOB
4351	102456.892	527228.509	889.263	TOB

ID	Y	X	Z	desc_
4352	102457.301	527236.861	889.242	TOB
4353	102574.284	527458.571	891.201	GS
4354	102580.594	527432.070	890.613	GS
4355	102582.594	527421.861	891.220	TOB
4356	102584.291	527414.882	890.080	POS
4357	102584.933	527410.837	887.689	TOE
4358	102587.932	527394.773	887.752	TOP ICE
4359	102591.598	527378.727	887.777	TOE
4360	102592.519	527376.202	888.784	POS
4361	102594.118	527366.251	889.247	POS
4362	102595.791	527361.073	890.776	TOB
4363	102600.242	527347.815	891.038	TOB
4364	102602.605	527340.258	889.213	TOE
4365	102632.830	527281.797	888.951	GS
4366	102650.341	527227.231	888.929	GS
4367	102687.091	527163.889	888.921	GS
4368	102778.909	527407.556	887.689	TOE
4369	102778.756	527409.647	888.971	POS
4370	102780.567	527417.142	890.662	TOB
4371	102782.179	527428.890	890.448	POS
4372	102784.635	527437.004	889.153	TOE
4373	102788.512	527457.610	889.062	GS
4374	102798.239	527494.274	889.269	GS
4375	102753.633	527423.240	892.844	HIGH PT BERM
4376	102722.073	527419.180	893.396	HIGH PT BERM
4377	102733.519	527405.313	887.760	TOE
4378	102742.162	527377.920	887.733	TOE
4379	102767.452	527375.208	887.784	TOE
4380	102776.021	527369.477	887.833	TOE
4381	102775.992	527348.239	888.221	TOE
4382	102765.497	527349.738	892.349	TOB
4383	102764.308	527364.651	891.424	TOB
4384	102745.544	527358.376	892.835	TOB
4385	102743.414	527345.237	892.494	POS
4386	102742.333	527338.207	890.868	TOE
4387	102737.392	527321.441	889.630	GS
4388	102732.024	527277.607	889.047	GS
4389	102749.006	527276.230	889.110	GS
4390	102755.842	527275.437	890.027	TOB
4391	102771.072	527275.304	889.968	TOB
4392	102777.202	527275.828	889.216	POS
4393	102778.396	527276.139	888.126	TOE
4394	102782.813	527276.304	888.169	TOP ICE
4395	102787.439	527276.513	888.253	TOE
4396	102789.834	527276.583	889.208	POS
4397	102794.242	527276.521	889.826	TOB
4398	102811.067	527274.687	889.844	GS
4399	102848.972	527260.021	890.939	GS
4400	102900.398	527206.077	891.067	GS
4401	102784.897	526929.005	888.555	CLDT HIGH PT
4402	102785.152	526907.129	888.494	TOP ICE

ID	Y	X	Z	desc_
4403	102786.837	526953.662	888.457	CLDT HIGH PT
4404	102784.371	526942.687	888.421	TOP ICE
4405	102784.328	527026.077	888.153	TOP ICE
4406	102731.419	527085.277	888.922	GS
4407	102745.880	527093.811	889.011	GS
4408	102757.719	527097.882	890.081	TOB
4409	102768.115	527100.321	890.309	TOB
4410	102777.474	527101.840	889.227	POS
4411	102780.826	527102.037	888.150	TOE
4412	102784.808	527103.048	888.130	TOP ICE
4413	102788.924	527103.724	888.200	TOE
4414	102790.426	527103.855	889.188	POS
4415	102793.983	527104.188	889.521	TOB
4416	102810.435	527103.654	888.977	GS
4417	102835.784	527101.898	889.568	GS
4418	102783.308	527199.144	888.154	TOP ICE
4419	102782.223	527307.385	888.148	END TOP ICE
4420	102782.225	527310.605	886.857	CLDT/SPRING
4421	102780.750	527311.561	887.847	WTS 12-30-11
4422	102782.877	527362.026	887.267	CLDT
4423	102784.596	527389.533	887.641	TOP ICE
4424	102832.263	527363.060	887.883	TOE
4425	102795.137	527371.146	887.696	TOE
4426	102789.416	527361.457	887.642	TOE
4427	102789.782	527342.098	887.543	TOE
4428	102796.507	527341.733	889.882	TOB
4429	102794.150	527368.318	889.180	TOB
4430	102814.548	527364.275	889.199	POS
4431	102814.557	527350.128	891.668	TOB
4432	103015.356	527418.380	888.820	GS
4433	103014.757	527394.581	888.644	TOE
4434	103015.435	527383.405	889.233	POS
4435	103017.401	527373.084	889.913	TOB
4436	103016.741	527362.360	889.430	TOB
4437	103016.357	527355.876	887.912	TOE
4438	103010.728	527336.803	887.705	TOP ICE
4439	103007.646	527317.499	887.810	TOE
4440	103007.695	527316.216	888.802	POS
4441	103007.820	527312.899	889.055	TOB
4442	103009.176	527299.137	889.683	TOB
4443	103012.125	527291.122	889.056	TOE
4444	103016.750	527276.280	888.974	GS
4445	103030.058	527246.130	889.257	GS
4446	103213.541	527469.445	887.883	LOW PT BERM
4447	103213.026	527482.539	888.268	GS
4448	103207.972	527505.141	888.877	GS
4449	103217.481	527468.274	889.391	TOB
4450	103219.205	527483.240	888.890	TOE
4451	103219.280	527462.680	889.189	POS
4452	103219.555	527460.426	887.780	TOE
4453	103207.581	527459.865	887.807	TOE

ID	Y	X	Z	desc_
4454	103206.930	527461.816	889.085	POS
4455	103205.278	527466.173	889.434	TOB
4456	103202.300	527478.180	888.437	TOE
4457	103193.757	527505.895	888.945	GS
4458	103394.498	527521.457	888.932	GS
4459	103388.733	527489.890	888.651	GS
4460	103387.654	527477.522	888.949	TOE
4461	103387.559	527471.123	889.259	TOB
4462	103387.860	527463.172	888.908	TOB
4463	103387.588	527457.751	888.598	POS
4464	103387.527	527456.871	887.746	TOE
4465	103388.353	527440.586	887.661	TOP ICE
4466	103388.826	527420.918	887.775	TOE
4467	103388.776	527419.512	888.614	POS
4468	103389.169	527410.874	889.041	TOB
4469	103388.829	527400.685	889.621	TOB
4470	103390.348	527394.696	888.512	TOE
4471	103391.882	527374.836	888.701	GS
4472	103402.911	527315.272	888.720	GS
4473	103449.480	527463.180	887.740	TOE
4474	103456.923	527470.943	887.919	TOE
4475	103458.934	527487.544	887.951	TOE
4476	103455.408	527471.157	889.440	TOB
4477	103443.367	527481.187	889.418	TOB
4478	103433.768	527498.240	889.023	GS
4479	103419.559	527520.810	888.643	GS
4480	103466.915	527486.562	887.696	TOE
4481	103462.720	527483.371	887.772	TOP ICE
4482	103461.849	527443.362	887.675	TOP ICE
4483	103470.077	527461.239	887.648	TOE
4484	103488.723	527454.819	887.717	TOE
4485	103470.728	527462.301	888.646	POS
4486	103474.555	527464.613	889.391	TOB
4487	103483.842	527471.813	889.362	TOB
4488	103491.308	527477.059	888.515	TOE
4489	103504.256	527492.820	888.666	GS
4490	103514.885	527513.402	888.684	GS
4491	103463.156	527544.102	887.740	TOP ICE
4492	103417.438	527619.765	888.968	GS
4493	103448.755	527622.496	889.240	GS
4494	103459.752	527624.389	889.271	TOB
4495	103460.981	527624.299	888.458	TOE
4496	103463.302	527624.849	888.195	TOP ICE
4497	103465.556	527625.094	888.597	TOE
4498	103468.388	527625.869	889.203	TOB
4499	103486.625	527628.354	889.081	GS
4500	103528.793	527632.279	888.999	GS
4501	103464.077	527721.680	888.350	TOP ICE
4502	103465.861	527846.266	889.091	CLDT HIGH PT
4503	103465.999	527913.194	889.417	TOP ICE
1004	97290.589	524757.378	932.392	STA HULT MNDT

ID	Y	X	Z	desc_
4504	103572.826	527515.219	888.805	GS
4505	103566.000	527479.297	888.638	GS
4506	103558.780	527446.554	888.766	TOE
4507	103555.529	527441.018	889.185	TOB
4508	103550.388	527430.955	889.244	TOB
4509	103548.576	527428.441	888.536	POS
4510	103546.353	527426.654	887.720	TOE
4511	103533.631	527409.677	887.645	TOP ICE
4512	103520.942	527388.344	888.009	TOE
4513	103520.192	527385.373	888.713	POS
4514	103517.974	527382.069	889.275	TOB
4515	103512.684	527371.745	889.561	TOB
4516	103509.415	527364.548	888.542	TOE
4517	103505.371	527346.794	888.475	GS
4518	103486.761	527303.947	888.943	GS
4519	103468.591	527254.998	889.372	GS
4520	103451.793	527187.628	889.794	GS
4521	103442.161	527122.300	891.779	GS
4522	103645.771	527317.240	887.676	TOP ICE
4523	103722.935	527256.687	888.913	LOW PT BERM
4524	103742.754	527244.291	889.296	TOE
4525	103725.850	527244.031	889.348	TOE
4526	103724.692	527255.531	889.027	TOE
4527	103729.739	527272.079	887.744	TOE
4528	103732.757	527266.901	889.616	TOB
4529	103731.914	527256.970	890.010	TOB
4530	103731.518	527247.518	890.169	TOB
4531	103704.153	527244.971	889.734	TOE
4532	103716.296	527249.662	889.114	TOE
4533	103722.340	527268.817	888.023	TOE
4534	103718.522	527266.709	889.628	TOB
4535	103713.075	527258.754	889.584	TOB
4536	103706.432	527249.729	890.464	TOB
4537	103836.524	527509.232	890.461	GS
4538	103849.052	527448.126	890.262	GS
4539	103859.910	527388.361	889.909	TOE
4540	103861.129	527379.081	890.767	POS
4541	103863.259	527367.734	891.544	TOB
4542	103865.699	527358.084	890.861	POS
4543	103867.401	527350.908	889.356	POS
4544	103867.540	527349.332	887.797	TOE
4545	103871.992	527334.926	887.658	TOP ICE
4546	103877.389	527314.933	887.786	TOE
4547	103877.790	527313.375	889.258	POS
4548	103879.926	527308.598	890.485	TOB
4549	103883.428	527300.228	890.316	GS
4550	103888.639	527281.889	890.274	GS
4551	103901.463	527249.168	891.029	GS
4552	103921.374	527201.476	891.735	GS
4553	103954.747	527127.038	891.981	GS
4554	104010.029	527507.322	893.685	GS

ID	Y	X	Z	desc_
4555	104012.429	527478.354	892.913	GS
4556	104019.607	527426.735	890.247	GS
4557	104025.690	527400.369	890.054	GS
4558	104027.078	527391.302	889.936	TOB
4559	104027.365	527388.078	889.414	POS
4560	104027.309	527386.162	887.655	TOE
4561	104030.658	527369.806	887.625	TOP ICE
4562	104035.672	527349.638	887.741	TOE
4563	104036.027	527345.934	888.650	POS
4564	104037.197	527339.950	889.506	TOB
4565	104041.272	527325.484	890.358	TOB
4566	104042.674	527316.967	889.427	TOE
4567	104056.670	527283.022	889.801	GS
4568	104064.834	527216.496	890.551	GS
4569	104075.893	527152.554	891.032	GS
4570	104201.212	527366.923	887.648	TOP ICE
4571	104289.952	527599.478	890.773	GS
4572	104312.766	527539.867	890.410	GS
4573	104327.354	527500.678	890.229	GS
4574	104338.140	527480.046	890.568	GS
4575	104343.673	527471.729	890.550	TOB
4576	104346.988	527466.350	889.452	POS
4577	104349.300	527462.893	888.156	TOE
4578	104359.505	527447.278	887.664	TOP ICE
4579	104372.279	527431.496	888.011	TOE
4580	104372.659	527430.555	889.321	POS
4581	104374.043	527429.083	889.896	TOB
4582	104379.298	527419.075	890.387	TOB
4583	104386.166	527403.956	889.819	TOE
4584	104391.730	527387.872	889.968	GS
4585	104410.597	527323.629	890.770	GS
4586	104427.953	527246.705	890.851	GS
4587	104477.420	527517.738	887.635	TOP ICE
4588	104556.645	527538.019	887.740	TOE
4589	104551.217	527520.122	890.964	TOB
4590	104564.201	527521.263	890.123	TOB
4591	104575.368	527526.249	890.502	TOB
4592	104589.663	527530.936	892.262	TOB
4593	104558.235	527530.365	889.475	CLDT
4594	104567.396	527517.471	889.251	TOP 18 IN? CMP
4595	104562.550	527525.437	888.960	SED
4596	104562.820	527524.740	889.137	TOP WOOD SUPPORT
4597	104567.716	527516.741	888.633	SED
4598	104572.348	527511.175	889.465	CLDT
4599	104540.541	527445.903	890.441	GS
4600	104560.501	527463.112	890.567	GS
4601	104577.874	527478.821	890.900	GS
4602	104583.902	527483.565	891.189	TOB
4603	104585.576	527484.619	890.146	TOE
4604	104587.332	527485.908	889.585	CLDT
4605	104588.926	527487.842	890.105	TOE

ID	Y	X	Z	desc_
4606	104590.315	527488.922	890.790	TOB
4607	104601.282	527493.923	891.743	GS
4608	104621.256	527503.244	891.448	GS
4609	104642.335	527517.025	892.075	GS
4610	104602.071	527462.749	889.907	CLDT
4611	104611.007	527447.341	890.168	CLDT
4612	104608.708	527404.666	889.806	CLDT
4613	104606.071	527352.793	889.678	CLDT
4614	104602.768	527284.222	889.948	CLDT
4615	104547.561	527213.596	891.187	GS
4616	104579.702	527214.973	890.918	GS
4617	104593.256	527214.363	891.106	TOB
4618	104597.481	527214.536	890.207	TOE
4619	104599.492	527214.644	890.198	CLDT
4620	104601.366	527215.056	890.418	TOE
4621	104605.882	527215.705	891.200	TOB
4622	104610.914	527216.068	891.115	TOE
4623	104623.300	527217.859	890.836	GS
4624	104647.913	527221.996	890.509	GS
4625	104681.410	527223.764	890.680	GS
4626	104595.840	527156.401	890.070	CLDT
4627	104593.694	527065.349	891.517	END LAT
4628	104723.042	527456.454	892.657	GS
4629	104709.658	527507.446	892.301	GS
4630	104687.283	527560.792	892.989	GS
4631	104680.243	527588.256	893.712	POS
4632	104676.068	527597.288	894.448	TOB
4633	104673.808	527601.613	892.421	POS
4634	104670.894	527606.260	889.601	POS
4635	104670.948	527607.960	887.627	TOE
4636	104666.489	527615.898	887.655	TOP ICE
4637	104662.256	527627.136	887.782	TOE
4638	104661.579	527627.943	889.240	POS
4639	104659.750	527631.381	890.853	POS
4640	104656.702	527637.380	894.833	POS
4641	104653.497	527643.175	896.050	TOB
4642	104642.862	527657.567	895.985	GS
4643	104631.719	527676.073	895.366	GS
4644	104588.508	527744.956	895.671	GS
4645	104800.317	527824.625	893.467	GS
4646	104827.841	527790.181	894.081	GS
4647	104842.813	527776.921	894.604	TOE
4648	104846.575	527770.413	894.997	TOB
4649	104857.150	527757.077	895.075	TOB
4650	104859.677	527753.091	893.949	POS
4651	104862.453	527748.565	890.722	POS
4652	104865.841	527745.281	887.700	TOE
4653	104871.669	527737.427	887.667	TOP ICE
4654	104878.724	527726.593	887.830	TOE
4655	104880.519	527724.008	889.336	POS
4656	104884.608	527719.699	892.327	POS

ID	Y	X	Z	desc_
4657	104887.115	527716.164	893.965	TOB
4658	104894.870	527706.732	893.113	TOE
4659	104910.728	527690.108	893.127	GS
4660	104925.609	527676.105	892.599	GS
4661	104919.920	527894.515	895.285	CLRD
4662	104972.538	527852.314	895.864	CLRD
4663	105053.240	527787.830	895.912	CLRD
4664	105138.657	527719.863	895.363	CLRD
4665	105193.662	527912.830	886.706	SPRING
4666	105180.900	527930.397	886.824	SPRING
4667	105727.660	528284.330	888.201	GS
4668	105744.342	528256.608	888.035	GS
4669	105766.843	528235.499	887.754	GS
4670	105776.351	528222.642	887.963	GS
4671	105779.522	528215.582	887.746	TOE
4672	105790.087	528194.547	887.630	TOP ICE
4673	105801.959	528171.334	887.937	TOE
4674	105807.526	528160.722	887.804	GS
4675	105819.440	528126.026	887.675	GS
4676	105840.426	528081.933	887.728	GS
4677	105865.465	528046.812	887.900	GS
4678	105358.645	528047.452	887.732	TOP ICE
4679	105291.185	528032.916	888.935	GS
4680	105307.555	528053.880	889.411	GS
4681	105316.060	528063.773	889.238	TOB
4682	105319.075	528067.682	888.413	POS
4683	105320.502	528070.151	887.915	TOE
4684	105322.668	528073.016	887.855	TOP ICE
4685	105324.285	528076.008	887.883	TOE
4686	105324.568	528076.617	889.094	POS
4687	105325.095	528077.908	889.138	TOB
4688	105329.524	528087.771	888.825	GS
4689	105342.499	528109.162	888.610	GS
4690	105356.292	528161.040	888.518	GS
4691	105245.932	528129.923	888.042	TOP ICE
4692	105151.279	528201.027	888.141	TOP ICE
4693	105046.163	528279.122	888.197	TOP ICE
4694	104952.790	528303.843	888.547	GS
4695	104964.503	528315.398	888.727	GS
4696	104972.896	528322.761	888.641	GS
4697	104975.143	528327.637	888.351	TOE
4698	104976.060	528330.496	888.287	TOP ICE
4699	104978.700	528335.685	888.326	TOE
4700	104979.579	528339.473	888.346	GS
4701	104985.202	528358.215	888.502	GS
4702	104995.063	528395.534	888.468	GS
4703	105003.381	528434.296	888.407	GS
4704	104936.153	528358.965	888.279	TOP ICE
4705	104849.900	528434.242	888.454	TOP ICE
4706	104835.085	531029.123	890.462	SED
4707	104835.361	531027.686	890.023	PIPST 30 CMP

ID	Y	X	Z	desc_
4708	104758.421	531014.989	898.230	CLRD
4709	104799.615	531012.504	896.994	CLRD
4710	104836.970	531009.588	896.456	CLRD
4711	104869.454	531009.560	896.361	CLRD
4712	104912.263	531014.918	896.004	CLRD
4713	104811.580	530969.918	889.612	PIPST 30 CMP
4714	104811.514	530969.163	890.241	SED
4715	104776.631	530890.383	890.192	CLDT
4716	104728.877	530788.740	889.743	CLDT
4717	104766.535	530682.903	891.750	GS
4718	104728.863	530688.333	891.661	GS
4719	104711.190	530693.809	892.324	TOE
4720	104702.819	530695.820	892.277	TOB
4721	104695.025	530697.877	891.603	POS
4722	104689.519	530699.427	889.210	TOE
4723	104686.688	530700.552	888.673	CLDT
4724	104681.286	530702.403	889.502	TOE
4725	104679.112	530703.362	891.034	POS
4726	104675.013	530704.505	892.274	TOB
4727	104666.618	530707.098	892.135	GS
4728	104640.479	530717.745	892.300	GS
4729	104607.965	530728.584	892.558	GS
4730	104639.159	530667.293	891.906	CLT
4731	104656.851	530663.026	892.144	CLT
4732	104663.988	530660.726	891.660	CLT
4733	104673.367	530657.361	892.225	CLT
4734	104705.216	530643.141	891.351	CLT
4735	104670.433	530667.114	888.286	PIPST 12 CMP RUSTED OUT
4736	104669.715	530664.738	889.378	CLDT
4737	104669.528	530662.501	888.513	INV HOLE
4738	104663.086	530651.456	887.850	PIPST 12 CMP RUSTED OUT
4739	104662.978	530650.839	888.420	SED
4740	104663.615	530653.267	888.409	INV HOLE
4741	104660.691	530643.194	889.259	CLDT HIGH PT
4742	104649.125	530621.224	888.606	CLDT
4743	104628.836	530577.667	888.851	TOP ICE
4744	104578.733	530472.529	888.511	TOP ICE
4745	104589.322	530344.284	888.731	GS
4746	104566.864	530351.764	889.046	GS
4747	104548.350	530364.464	889.804	GS
4748	104541.660	530369.729	889.354	TOB
4749	104538.920	530371.035	889.450	POS
4750	104538.205	530371.959	888.617	TOE
4751	104533.543	530374.740	888.715	TOP ICE
4752	104527.672	530378.935	888.892	TOE
4753	104525.401	530380.811	889.201	POS
4754	104517.179	530383.725	890.986	TOB
4755	104509.477	530387.792	890.671	TOE
4756	104499.828	530393.376	889.640	GS
4757	104465.393	530415.383	890.113	GS
4758	104438.148	530430.876	890.227	GS

ID	Y	X	Z	desc_
4759	104483.577	530270.935	888.771	TOP ICE
4760	104444.399	530188.589	888.763	TOP ICE
4761	104461.850	530091.780	888.823	GS
4762	104433.669	530095.577	888.704	GS
4763	104419.025	530101.903	888.718	GS
4764	104410.212	530104.711	888.779	TOP ICE
4765	104402.075	530107.006	888.787	GS
4766	104392.395	530115.441	888.887	GS
4767	104374.096	530122.759	888.732	GS
4768	104350.379	530138.078	888.752	GS
4769	104375.153	530032.255	888.756	TOP ICE
4770	107314.835	528851.483	896.089	TOB
4771	107277.053	528830.056	896.219	TOB
4772	107260.603	528811.153	896.064	TOB
4773	107263.194	528796.958	896.818	BRG CR
4774	107270.044	528800.999	896.591	BRG CR
4775	107278.364	528787.468	896.759	BRG CR
4776	107271.839	528782.997	896.822	BRG CR
4777	107267.059	528788.432	895.068	GS
4778	107276.273	528796.188	895.414	GS
4779	107280.756	528775.613	896.369	GS
4780	107298.358	528754.997	897.492	GS
4781	107294.709	528787.426	893.913	TOP SKIMMER
4782	107296.638	528789.922	892.882	GS
4783	107290.506	528784.151	893.105	PIPST 15 CMP
4784	107266.532	528764.929	892.657	PIPST 15 CMP
4785	107299.748	528742.072	898.415	GS
4786	107279.552	528732.994	893.699	GS
4787	107273.054	528755.465	894.167	GS
4788	107261.916	528761.076	893.035	GS
4789	107262.212	528768.127	894.006	GS
4790	107250.723	528789.875	893.584	GS
4791	107241.163	528809.888	892.931	GS
4792	107257.529	528835.954	893.797	GS
4793	107272.736	528846.112	894.202	GS
4794	107308.239	528865.459	893.155	GS
4795	107295.722	528867.470	890.888	POS
4796	107293.701	528869.593	887.834	TOE
4797	107261.068	528852.489	887.961	TOE
4798	107261.339	528851.214	890.216	POS
4799	107237.502	528840.339	887.946	TOE
4800	107239.267	528836.232	889.855	POS
4801	107164.535	528809.707	888.322	FEN END
4802	107170.866	528813.723	887.796	TOE
4803	107170.749	528810.766	889.597	POS
4804	107172.590	528804.163	891.873	GS
4805	107204.024	528821.074	891.041	FEN
4806	107221.122	528795.139	893.386	GS
4807	107229.861	528815.213	892.287	FEN BEGIN
4808	107244.266	528803.495	893.167	WOOD DUCK BOX
4809	107221.918	528785.027	893.767	GS

ID	Y	X	Z	desc_
4810	107183.763	528776.830	893.412	GS
4811	107218.056	528833.277	887.698	TOE
4812	107223.209	528826.854	889.132	POS
4813	107130.669	528794.617	887.630	TOE
4814	107131.062	528793.202	888.846	POS
4815	107132.807	528788.411	889.951	GS
4816	107137.906	528774.514	890.832	GS
4817	107143.632	528759.972	889.898	GS
4818	107146.893	528751.331	888.002	TOE POND
4819	107152.591	528752.391	889.706	GS
4820	107163.289	528755.263	890.489	GS
4821	107163.628	528768.405	891.376	GS
4822	107168.984	528762.355	893.651	GS
4823	107176.751	528742.014	894.190	GS
4824	107185.871	528718.700	893.436	GS
4825	107206.318	528732.515	893.836	GS
4826	107198.033	528747.898	894.078	GS
4827	107190.140	528766.125	893.697	GS
4828	107223.518	528765.097	893.198	GS
4829	107227.522	528739.203	892.658	GS
4830	107236.420	528708.128	892.102	GS
4831	107244.962	528680.220	891.890	GS
4832	107276.143	528696.785	893.404	GS
4833	107203.989	528773.513	893.651	GS
4834	107122.848	528752.537	890.797	GS
4835	107126.227	528744.391	889.016	GS
4836	107127.871	528740.689	887.842	TOE POND
4837	107102.967	528734.016	887.732	TOE POND
4838	107102.200	528735.429	888.563	GS
4839	107098.748	528740.454	889.653	GS
4840	107094.927	528731.649	887.605	POND RUN OUT
4841	107088.038	528737.318	887.818	POND RUN OUT
4842	107084.415	528744.485	888.197	POND RUN OUT
4843	107081.958	528750.802	887.888	POND RUN OUT
4844	107080.324	528760.671	887.515	POND RUN OUT
4845	107085.049	528733.442	889.424	GS
4846	107089.870	528726.723	889.223	GS
4847	107092.141	528725.004	887.623	TOE POND
4848	107082.153	528716.161	887.823	TOE POND
4849	107079.781	528716.018	888.514	GS
4850	107074.193	528716.179	889.322	GS
4851	107078.849	528694.972	889.428	GS
4852	107084.607	528696.271	889.515	GS
4853	107086.703	528696.339	887.597	TOE POND
4854	107104.039	528663.416	887.849	TOE POND
4855	107103.711	528660.186	889.078	GS
4856	107100.588	528651.130	889.587	GS
4857	107114.309	528683.238	887.692	TOP ICE
4858	107128.165	528659.101	887.904	TOE POND
4859	107128.538	528656.373	888.732	GS
4860	107128.612	528653.487	889.616	GS

ID	Y	X	Z	desc_
4861	107130.273	528646.067	889.931	GS
4862	107165.687	528647.702	890.462	GS
4863	107164.687	528656.940	889.235	GS
4864	107162.921	528662.391	888.214	TOE POND
4865	107180.836	528683.413	888.006	TOE POND
4866	107184.790	528681.097	888.676	GS
4867	107198.808	528671.450	890.509	GS
4868	107172.547	528706.650	888.006	TOE POND
4869	107175.735	528707.525	888.690	GS
4870	107181.206	528710.313	889.402	GS
4871	107187.518	528696.834	889.520	GS
4872	107192.451	528698.511	891.479	GS
4873	107188.195	528712.371	892.790	GS
4874	107172.178	528733.531	890.472	GS
4875	107164.660	528730.393	888.736	GS
4876	107159.172	528728.622	887.884	TOE POND
4877	107165.385	528742.886	889.846	GS
4878	107106.374	528752.577	889.548	GS
4879	107098.202	528767.803	889.716	GS
4880	107096.058	528773.140	888.914	POS
4881	107096.563	528775.754	887.616	TOE
4882	107062.685	528757.733	887.642	TOE
4883	107063.706	528756.291	888.031	POS
4884	107064.151	528753.906	889.236	GS
4885	107069.352	528740.118	889.927	GS
4886	107065.079	528803.838	887.495	TOE
4887	107063.826	528808.396	889.257	GS
4888	107077.550	528808.770	887.632	TOE
4889	107077.427	528809.760	888.927	POS
4890	107076.070	528815.834	890.037	GS
4891	107099.663	528828.625	889.913	GS
4892	107102.040	528823.245	889.926	GS
4893	107103.204	528819.491	887.898	TOE
4894	107123.717	528824.655	887.367	FEN END
4895	107134.493	528830.262	888.094	TOE
4896	107133.592	528831.527	890.545	POS
4897	107131.890	528838.603	891.673	GS
4898	107158.486	528864.732	893.270	GS
4899	107163.752	528851.091	891.823	GS
4900	107165.701	528847.428	889.476	POS
4901	107166.340	528846.587	888.102	TOE/FEN
4902	107201.020	528853.795	887.566	TOE
4903	107200.462	528854.973	888.218	POS
4904	107197.265	528859.904	889.158	POS
4905	107189.852	528861.454	890.332	FEN BEGIN
4906	107195.355	528869.314	892.582	GS
4907	107194.098	528875.134	894.111	GS
4908	107242.545	528892.356	894.553	GS
4909	107244.410	528885.325	893.444	GS
4910	107247.189	528878.756	889.887	POS
4911	107247.345	528878.280	887.860	TOE

ID	Y	X	Z	desc_
4912	107285.275	528891.896	887.492	TOE
4913	107287.256	528895.560	890.541	POS
4914	107286.422	528906.832	893.532	GS
4915	107276.944	528924.210	895.928	TOB
4916	107229.720	528904.662	896.508	TOB
4917	107192.213	528885.039	893.627	TOB
4918	107157.102	528864.949	893.394	TOB
4919	107118.470	528854.351	891.665	GS
4920	107092.147	528840.193	890.439	GS
4921	107066.943	528830.865	889.847	GS
4922	107042.724	528866.316	889.443	GS
4923	107085.200	528887.468	890.921	GS
4924	107090.852	528894.484	892.021	CLT
4925	107122.934	528869.346	892.019	CLT
4926	107160.188	528870.143	892.759	CLT
4927	107210.253	528889.203	894.969	CLT
4928	107273.059	528915.375	894.966	CLT
4929	107255.653	528948.114	891.534	CLDT
4930	107227.184	528933.951	891.473	CLDT END
4931	107222.160	528931.024	894.185	TOP SKIMMER
4932	107217.401	528929.319	893.711	PIPST 15 CMP
4933	107200.085	528975.625	892.747	CLSW
4934	107189.576	528969.426	894.423	POS
4935	107184.390	528966.645	896.039	TOB
4936	107174.656	528962.391	895.774	POS
4937	107164.222	528955.804	890.961	TOE
4938	107202.748	528923.798	895.889	TOB
4939	107194.254	528920.948	893.282	PIPST 15 CMP
4940	107172.278	528913.067	891.285	GS
4941	106596.745	528673.214	887.981	GS
4942	106613.736	528651.360	888.085	GS
4943	106625.059	528629.917	887.697	GS
4944	106633.547	528615.844	888.302	TOB
4945	106635.178	528612.133	888.170	POS
4946	106636.253	528610.881	887.571	TOE
4947	106642.568	528593.882	887.536	TOP ICE
4948	106651.911	528574.998	887.643	TOE
4949	106658.047	528565.873	887.578	GS
4950	106672.705	528543.751	887.930	GS
4951	106697.121	528496.637	887.935	GS
4952	106720.295	528454.357	888.144	GS
4953	107037.574	528964.212	891.905	CLT
4954	107048.881	528974.621	891.157	GS
4955	107059.119	528983.087	890.064	GS
4956	107068.086	528991.393	887.834	POND BOTTOM
4957	107077.809	528999.227	887.260	POND BOTTOM
4958	107093.687	529012.391	889.880	GS
4959	107106.953	529022.161	891.119	TOE
4960	107117.806	529028.037	893.709	GS
4961	107125.545	529032.944	896.091	TOB
4962	107129.911	529037.556	896.138	POS

ID	Y	X	Z	desc_
4963	107139.531	529045.682	893.561	CLSW
4964	107060.088	529116.952	895.913	TOB
4965	107054.139	529113.040	894.985	GS
4966	107043.685	529106.205	892.051	GS
4967	107036.827	529102.012	890.640	TOE
4968	107024.985	529094.909	890.183	POND BOTTOM
4969	107010.438	529083.866	889.350	POND BOTTOM
4970	106996.188	529071.410	890.427	TOE
4971	106985.089	529064.860	890.927	POS
4972	106975.762	529057.076	892.308	POS
4973	106971.903	529054.300	892.490	CLT
4974	107173.214	528884.262	893.070	GS
4975	107161.360	528898.521	891.241	GS
4976	107150.908	528911.755	890.303	TOE
4977	107318.265	528845.117	895.569	POS
4978	107324.428	528835.531	892.855	POS
4979	107331.857	528824.721	890.731	TOE
4980	107335.720	528820.790	890.569	TOP ICE
4981	107307.904	528802.223	891.933	CLDT
4982	107302.294	528810.546	892.489	TOE
4983	107292.981	528823.233	893.665	POS
4984	107288.208	528830.221	896.217	GS
4985	107267.820	528813.263	895.452	GS
4986	107276.587	528809.387	893.882	GS
4987	106765.904	529492.103	895.495	GS
4988	106755.338	529485.490	893.445	GS
4989	106740.288	529475.675	890.552	TOE
4990	106727.131	529466.483	890.302	POND BOTTOM
4991	106717.169	529458.154	889.834	POND BOTTOM
4992	106699.866	529444.329	889.113	POND BOTTOM
4993	106689.725	529436.746	890.422	TOE
4994	106684.394	529430.472	891.166	POS
4995	106677.642	529426.469	891.759	CLT
4996	107573.172	529086.905	899.290	CLRD
4997	107626.804	528999.970	897.733	CLRD
4998	107663.647	528969.492	897.790	CLRD
5002	99685.651	524994.231	892.601	TOP HEADWALL
5003	99685.667	524994.243	892.543	TOP HEADWALL
5004	105140.255	528270.430	888.471	GS
5005	105479.741	528419.115	888.323	GS
5006	105780.758	528605.580	888.458	GS
5007	106103.148	528808.234	888.351	GS
5008	106399.502	528959.107	888.282	GS
5009	106655.799	529083.966	888.423	GS
5010	106558.651	529359.155	888.611	GS
5011	106336.586	529268.382	888.612	GS
5012	106009.458	529127.133	888.462	GS
5013	105753.035	528931.523	888.604	GS
5014	105505.250	528781.941	888.584	GS
5015	105251.047	528637.525	888.774	GS
5016	105011.711	528486.991	888.569	GS

ID	Y	X	Z	desc_
5017	104821.661	528674.295	888.762	GS
5018	105053.155	528907.268	888.738	GS
5019	105321.010	529087.236	888.776	GS
5020	105594.229	529218.720	889.405	GS
5021	105944.881	529254.617	888.685	GS
5022	106257.145	529438.000	889.128	GS
5023	106153.166	529590.514	891.113	CLT
5024	106154.004	529619.188	891.358	CLT
5025	106174.855	529652.661	891.085	CLT
5026	106164.032	529615.933	890.290	PIPST 15 CMP
5027	106144.707	529622.086	889.733	PIPST 15 CMP
5028	106144.286	529622.042	889.795	SED
5029	106029.711	529616.895	888.986	GS
5030	105953.624	529831.844	889.187	GS
5031	105884.779	530118.209	890.019	GS
5032	105672.064	530109.106	890.068	GS
5033	105708.463	529835.951	888.980	GS
5034	105775.870	529575.245	888.891	GS
5035	105542.431	529516.413	889.011	GS
5036	105488.005	529708.134	888.882	GS
5037	105421.075	529966.139	889.068	GS
5038	105252.580	530154.313	888.882	GS
5039	105086.758	530325.309	889.027	GS
5040	105160.178	530023.087	889.052	GS
5041	105225.755	529779.968	888.855	GS
5042	105305.983	529482.556	888.947	GS
5043	105067.535	529379.602	888.966	GS
5044	105004.429	529666.990	888.943	GS
5045	104889.449	529926.728	888.989	GS
5046	104819.461	530162.731	888.941	GS
5047	104787.872	530405.860	889.038	GS
5048	104549.851	530139.049	889.138	GS
5049	104645.223	529910.436	889.001	GS
5050	104727.636	529658.780	888.955	GS
5051	104782.670	529391.252	888.907	GS
5052	104861.192	529139.706	888.750	GS
5053	104659.400	529024.591	888.756	GS
5054	104592.290	529280.481	888.769	GS
5055	104529.806	529504.510	888.820	GS
5056	104482.784	529734.187	888.988	GS
5057	104388.812	529939.608	888.821	GS
5058	104173.000	529598.682	888.744	TOP ICE
5059	104311.215	529555.349	888.785	GS
5060	104349.818	529326.548	888.839	GS
5061	104392.799	529132.841	888.638	GS
5062	104488.302	528916.268	888.784	GS
5063	104644.677	528687.796	888.642	GS
5064	99687.467	524995.333	884.529	PIPST CONC BOX
5065	99695.630	524993.481	884.506	PIPST CONC BOX
5066	99695.822	524993.213	888.671	SED
5067	99687.396	524994.954	888.479	SED

ID	Y	X	Z	desc_
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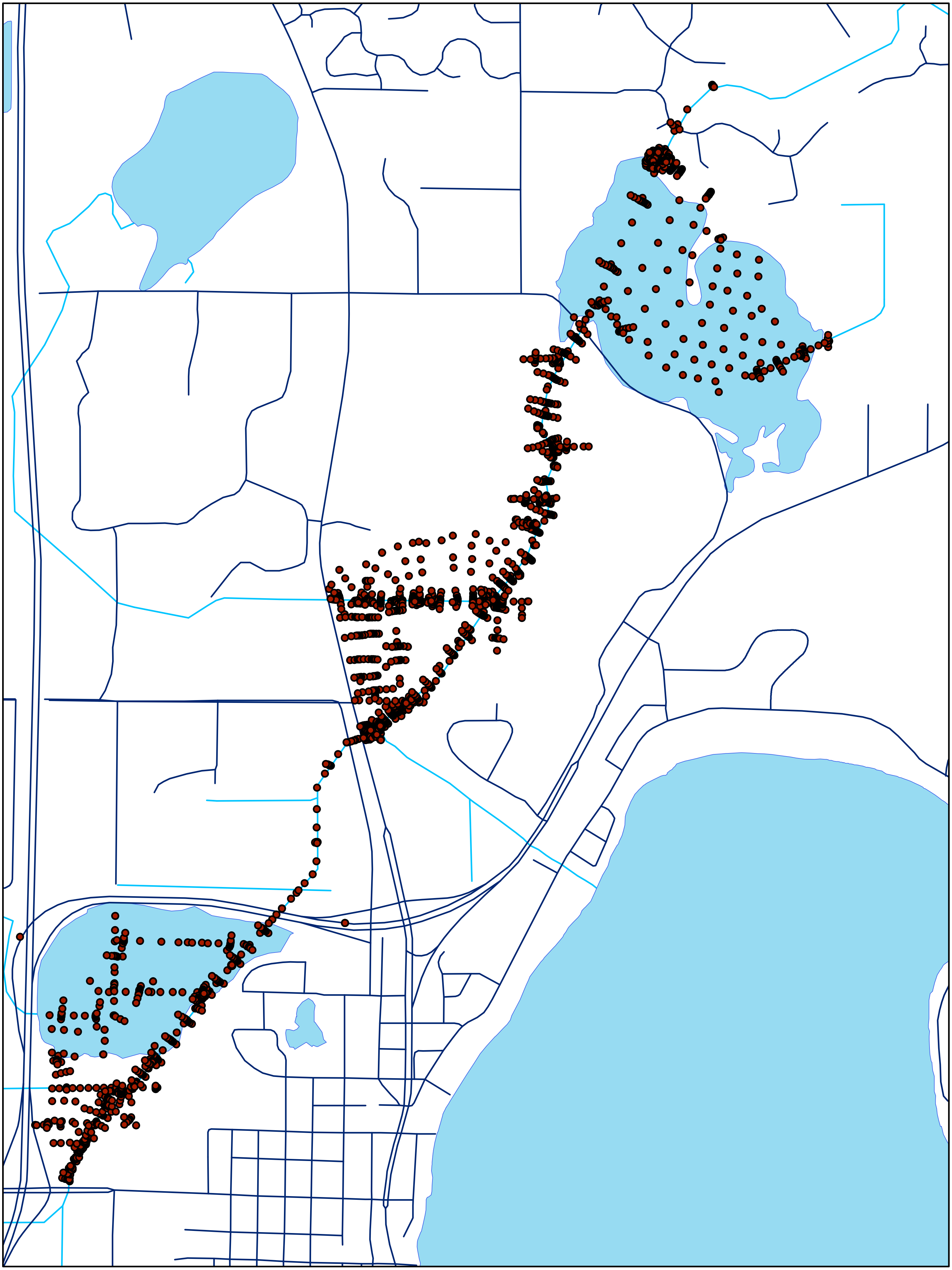
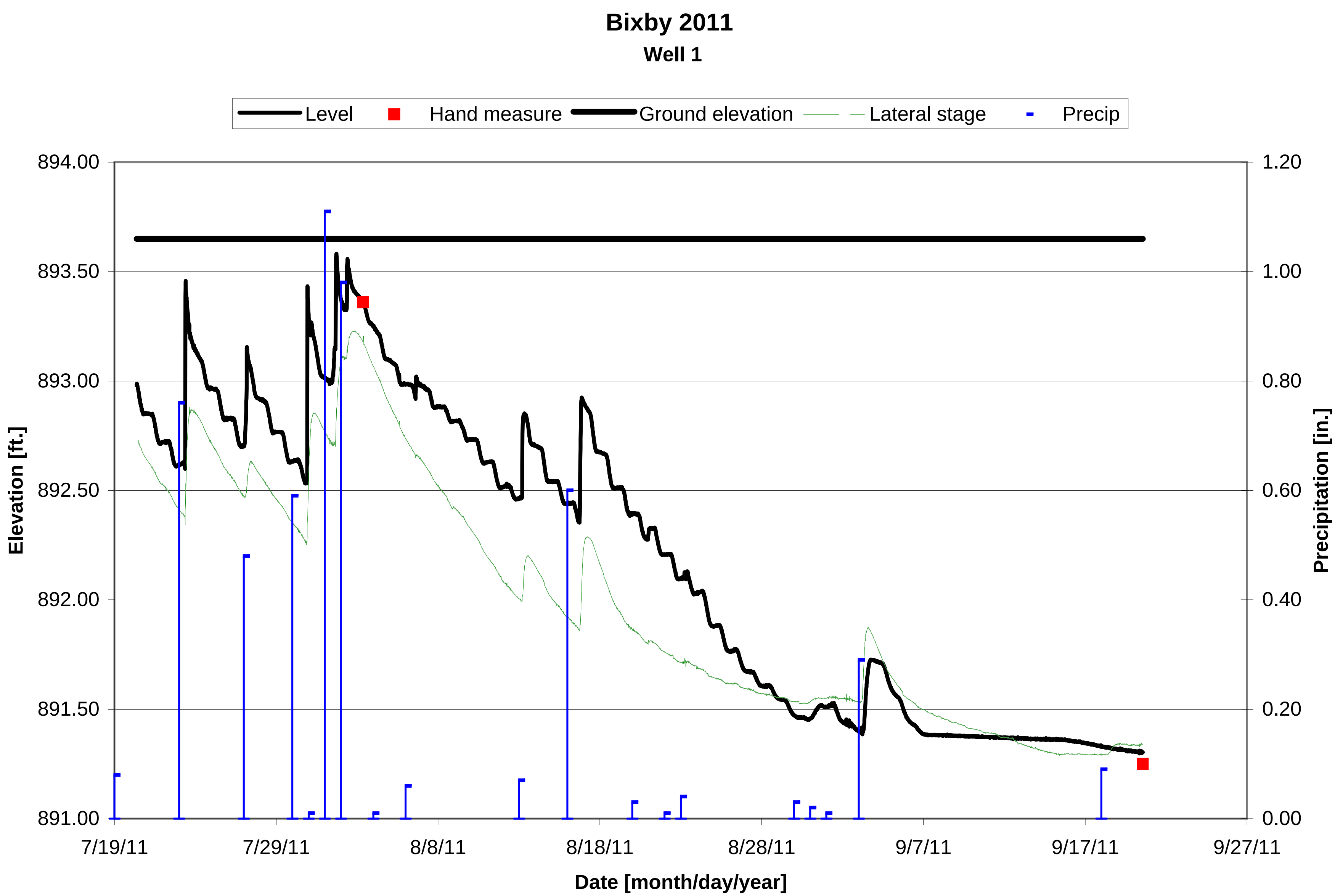
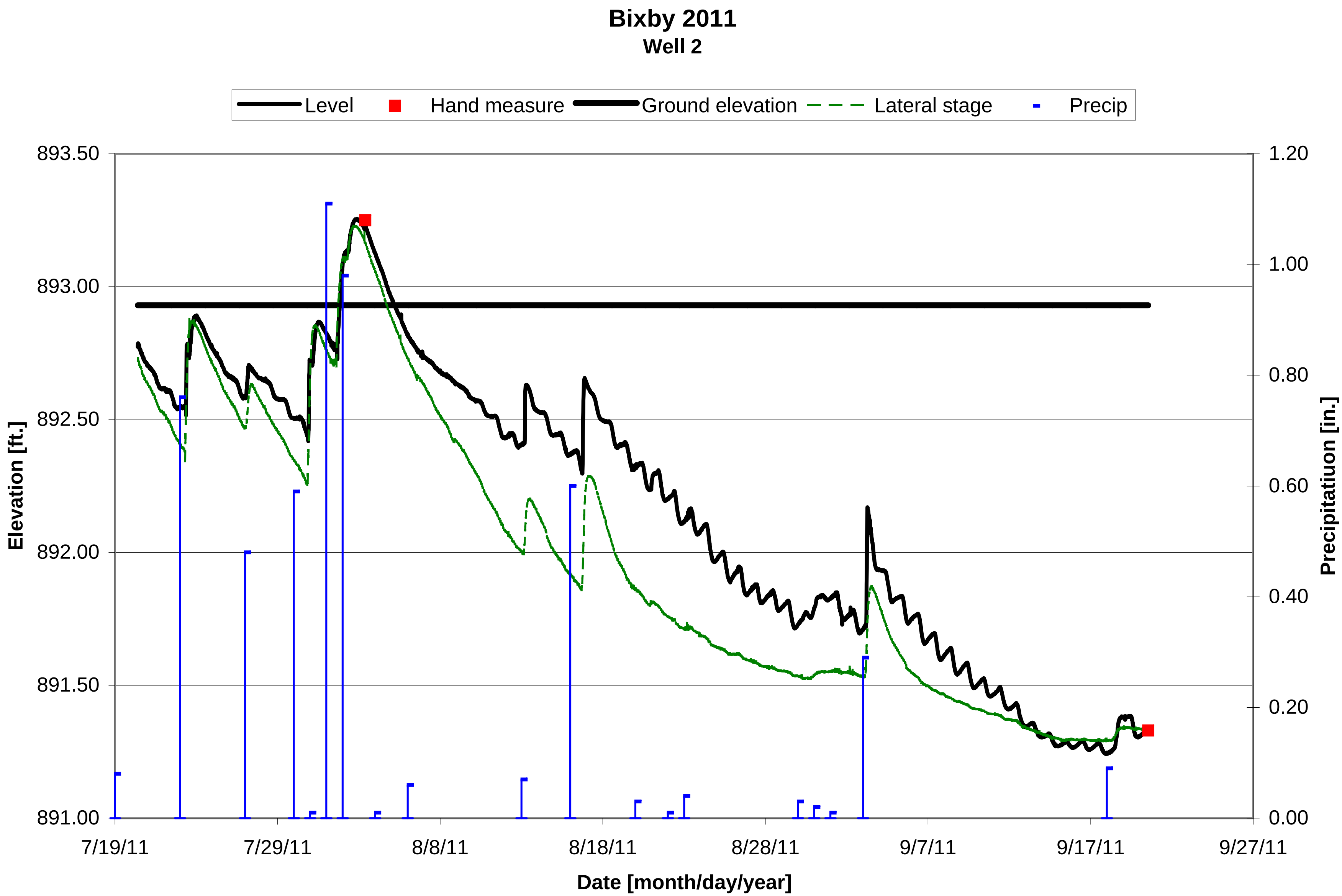


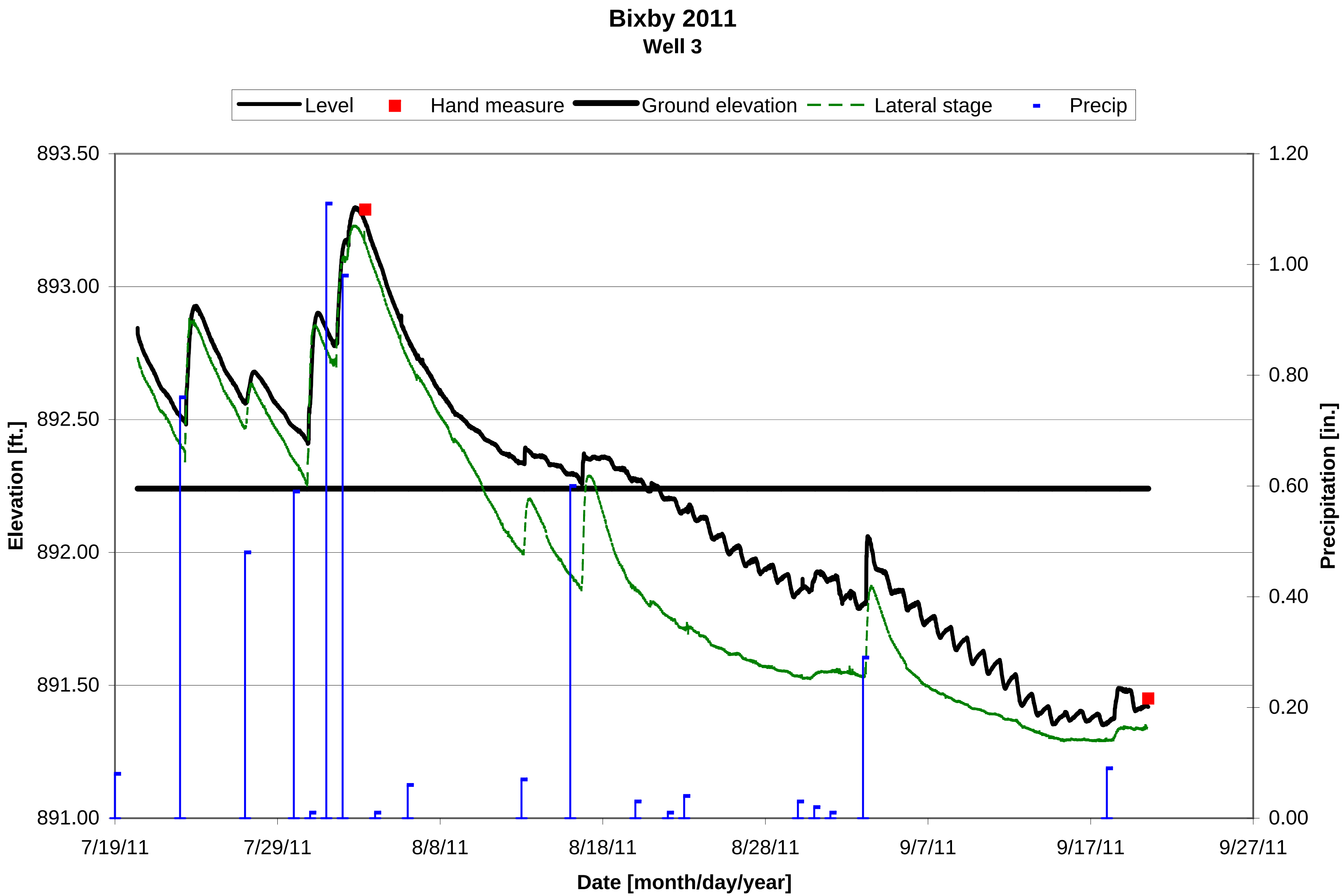
Appendix G. Wetlands Well Data

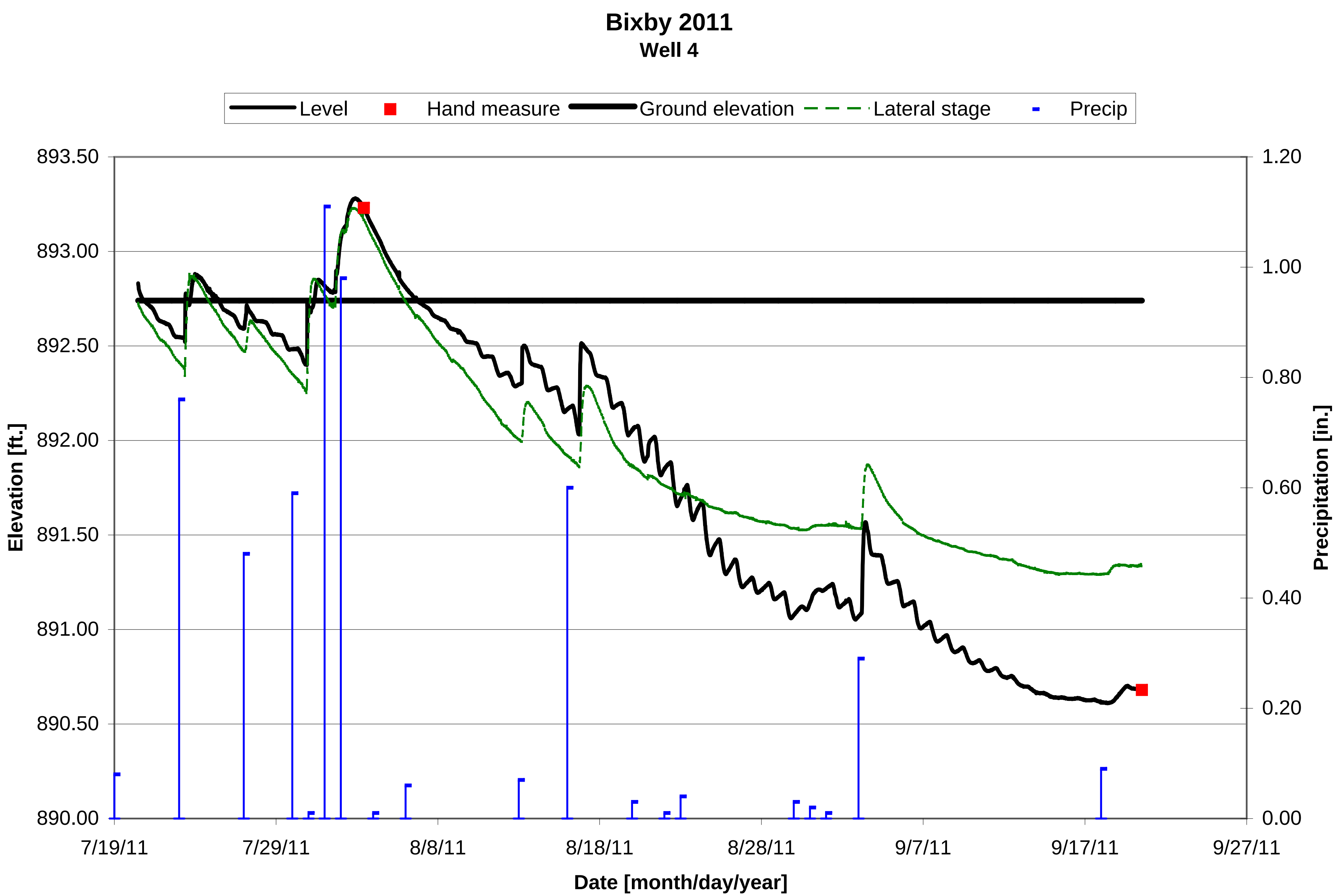


Bixby 2011
Well 1
Level
Hand measure
Ground elevation
Lateral stage
Precip
894.00
893.50
893.00
892.50
892.00
891.50
891.00
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitation [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [month/day/year]

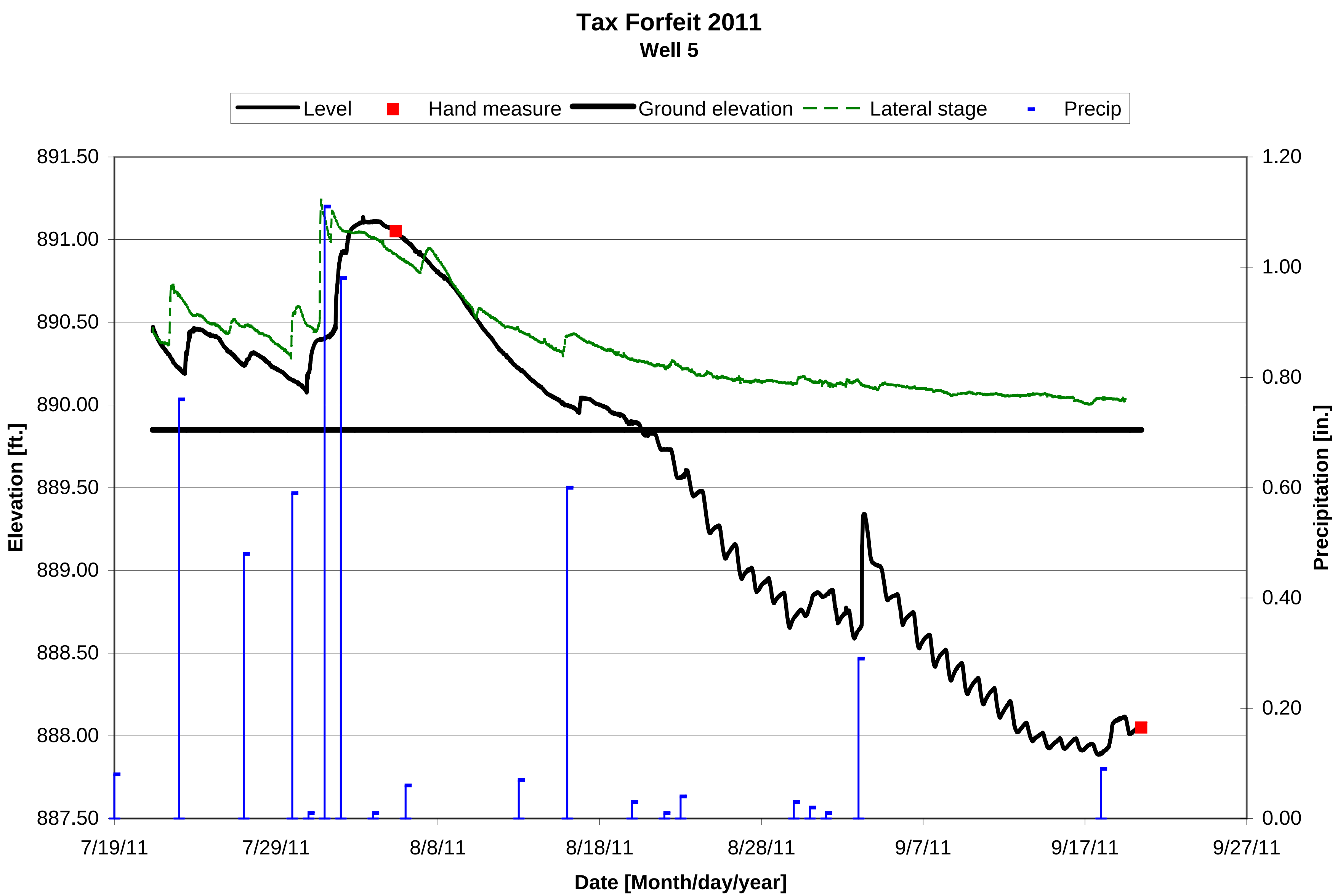


Bixby 2011
Well 2
Level
Hand measure
Ground elevation
Lateral stage
Precip
893.50
893.00
892.50
892.00
891.50
891.00
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitatiuon [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [month/day/year]

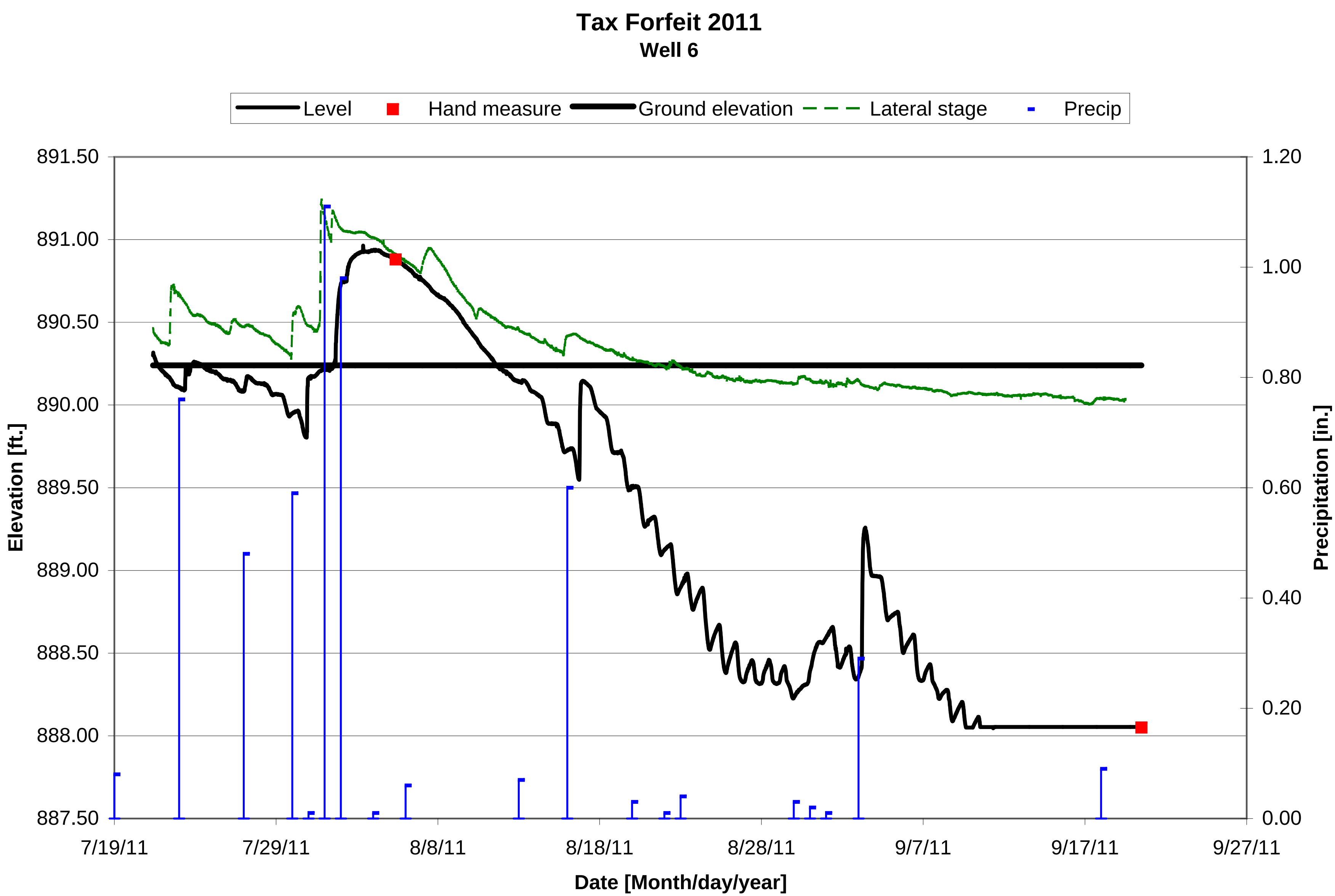

Bixby 2011
Well 3
Level
Hand measure
Ground elevation
Lateral stage
Precip
893.50
893.00
892.50
892.00
891.50
891.00
Elevation [ft.]
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Precipitation [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [month/day/year]



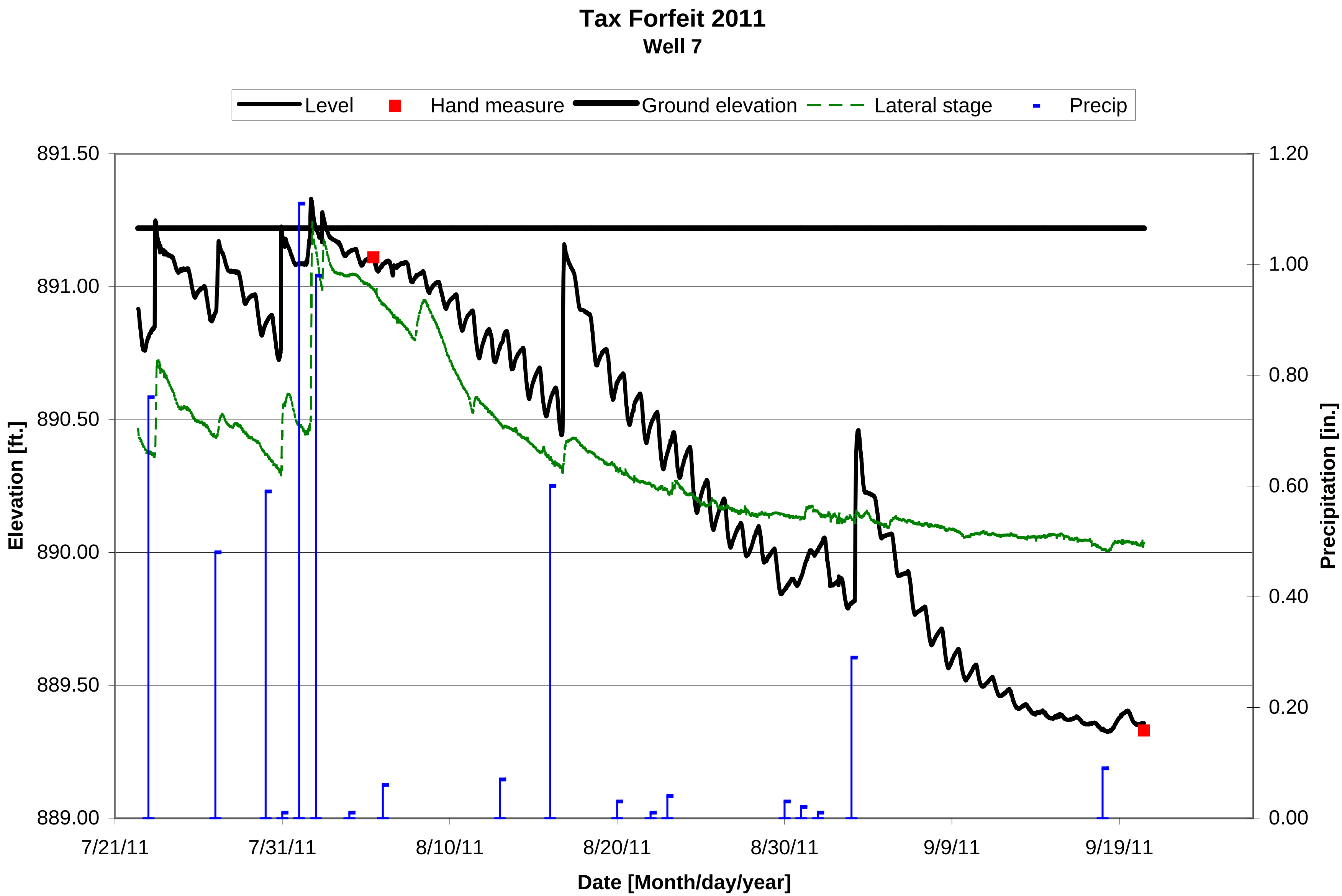
Bixby 2011
Well 4
Level
Hand measure
Ground elevation
Lateral stage
Precip
893.50
893.00
892.50
892.00
891.50
891.00
890.50
890.00
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitation [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [month/day/year]

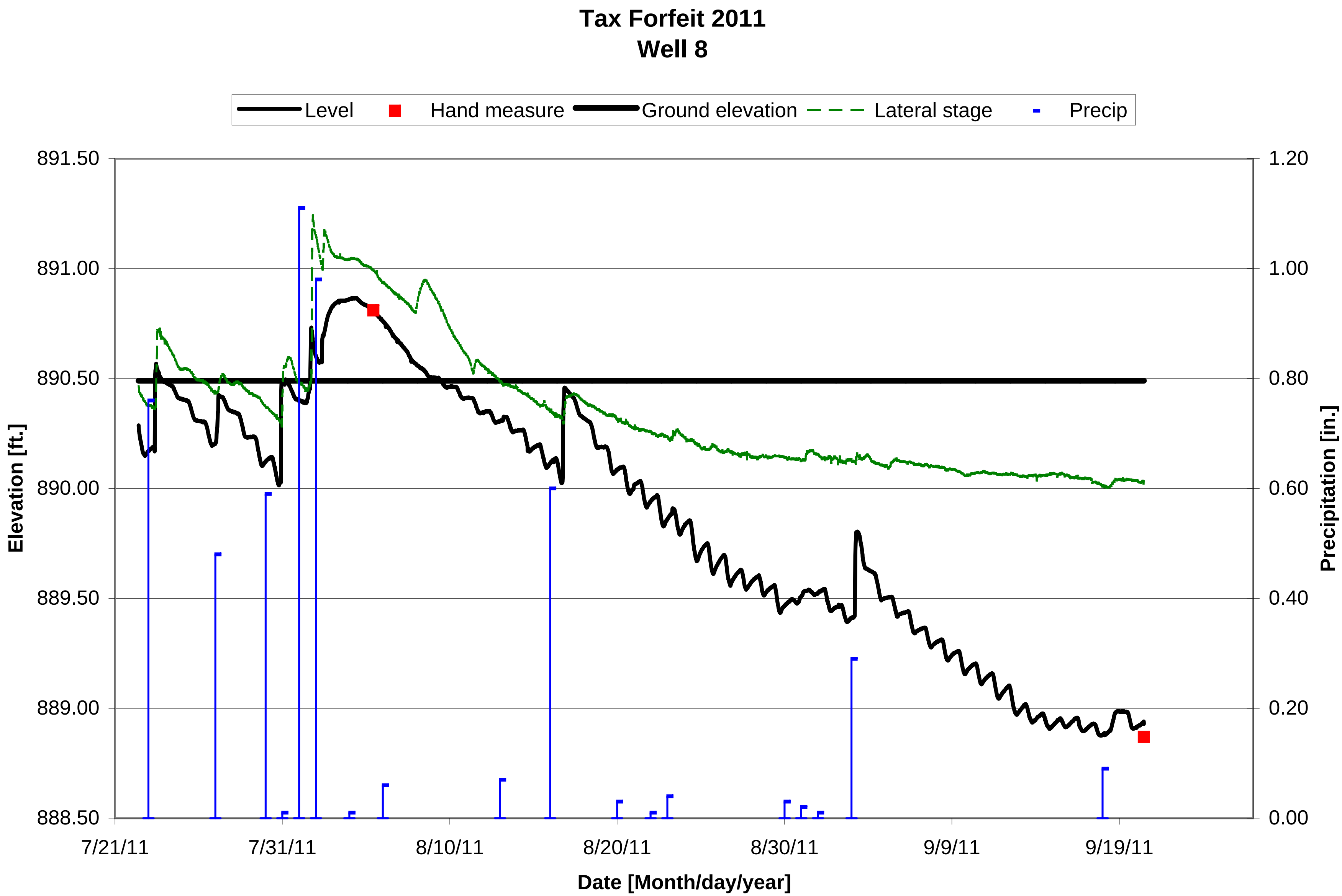


Tax Forfeit 2011
Well 5
Level
Hand measure
Ground elevation
Lateral stage
Precip
891.50
891.00
890.50
890.00
889.50
889.00
888.50
888.00
887.50
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitation [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [Month/day/year]



Tax Forfeit 2011
Well 6
Level
Hand measure
Ground elevation
Lateral stage
Precip
891.50
891.00
890.50
890.00
889.50
889.00
888.50
888.00
887.50
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitation [in.]
7/19/11
7/29/11
8/8/11
8/18/11
8/28/11
9/7/11
9/17/11
9/27/11
Date [Month/day/year]


Tax Forfeit 2011
Well 7
Level
Hand measure
Ground elevation
Lateral stage
Precip
891.50
891.00
890.50
890.00
889.50
889.00
Elevation [ft.]
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Precipitation [in.]
7/21/11
7/31/11
8/10/11
8/20/11
8/30/11
9/9/11
9/19/11
Date [Month/day/year]



Tax Forfeit 2011
Well 8
Level
Hand measure
Ground elevation
Lateral stage
Precip
891.50
891.00
890.50
890.00
889.50
889.00
888.50
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Elevation [ft.]
Precipitation [in.]
7/21/11
7/31/11
8/10/11
8/20/11
8/30/11
9/9/11
9/19/11
Date [Month/day/year]

Appendix H. Wetlands Soils Data

EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-1

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
	Fibric Peat 10YR 2/1 Black				
1					
1.8'					
2	Fibric Peat 10YR 4/3 Brown				
2.4'					
3	Hemic Peat 10YR 2/1 Black				
4					
	4.5' ↓ Hemic approaching Sapric				
5	End of Boring				

No. SB-1	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Barry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 892.44	T.O.C.

EMMONS & OLIVIER RESOURCES

651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-2

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
	Fibric Peat				
1	10YR 4/4 Dark Yellowish Brown				
2					
2.2'	Hemic Peat				
3	10YR 2/1 Black				
4					
5	End of Boring				

No. SB-2	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Berry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 891.15	T.O.C.

EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-3

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
	Fibric Peat				
1					
	10YR 3/4				
2					
	Dark yellowish Brown				
3					
4					
5	End of Boring				

No. SB-3	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Barry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 892.17	T.O.C.

EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-4

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
	Fibric Peat - Dense 10YR 2/1 Black				
1					
2					
2.2'	Hemic Peat - Less Dense 10YR 2/1 Black				
3					
4					
5	End of Boring				

No. SB-4	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Berry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 890.46	T.O.C.

A-1

*Strong flow of wtr @ surface to NW.

EOR EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-5

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
1 2 2.1'	Fibric Peat - dense 10YR 2/1 Black				
2.8'	Mixed Hemic/Sapric Zone 10YR 2/1 → 10YR 4/1				
3 4 5	Sapric Peat 10YR 4/1 Dark Gray				
	End of Boring				

No. SB-5	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Barry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 889.71	T.O.C.

EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-6

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
1	Fibric Peat 10YR 2/1 Black				
2					
2.4'	Hemic Peat 10YR 2/1 Black				
3					
4					
5	End of Boring				

No. SB-6	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Barry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 888.91	T.O.C.

EOR EMMONS & OLIVIER RESOURCES
651 Hale Ave N.
Oakdale, MN
(651) 770-8448
Fax: (651) 770-2552

Project: Sunrise River
Location: Forest Lake
Date: 8-3-11
Boring Number: SB-7

Depth (ft)	Soil Boring Log	Instrument: Units:	Sample no., type, interval	Blow counts	Sample recovery
1	Fibric Peat 10YR 2/1 Black				
2					
2.3'	Hemic Peat 10YR 2/1 Black				
3					
4					
5	End of Boring				

No. SB-7	Sheet 1 of 1	Start	Finish
Driller MJM	Logged by J. Barry	Landowner	File
Drill type Auger	Contractor EOR	Elev.: Surf 889.47	T.O.C.

Appendix I. H/H Model Updates

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
CL05A out	McCullough west	1 inch	CL05A out	CL05A	53	893.3	16.5					893.3	0.0	16.5	-0.1
CL05A out	McCullough west	2 year	CL05A out	CL05A	53	894.6	60.0					894.6	0.0	60.0	0.0
CL05A out	McCullough west	10 year	CL05A out	CL05A	53	895.1	96.6					895.1	0.0	96.6	0.0
CL05A out	McCullough west	100 year	CL05A out	CL05A	53	895.7	141.2					895.7	0.0	141.2	0.0
CL05CULV	under 35 to McCullough	1 inch	CL05 out	CL05	CL05A	894.1	20.2	894.1	0.0	20.1	-0.1	894.1	0.0	20.2	0.0
CL05CULV	under 35 to McCullough	2 year	CL05 out	CL05	CL05A	896.7	64.4	896.8	0.1	64.4	-0.1	896.7	0.0	64.4	0.0
CL05CULV	under 35 to McCullough	10 year				899.0	83.1	898.9	0.0	83.9	0.8	899.0	0.0	83.1	0.0
CL05CULV	under 35 to McCullough	100 year				899.3	82.2	899.2	0.0	86.5	4.3	899.3	0.0	82.0	-0.1
CL05SPILL		1 inch	CL05 out	CL05	CL05A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL05SPILL		2 year	CL05 out	CL05	CL05A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL05SPILL		10 year				0.0	19.1	0.0	0.0	17.5	-1.6	0.0	0.0	19.1	0.0
CL05SPILL		100 year				0.0	65.7	0.0	0.0	60.5	-5.2	0.0	0.0	65.7	0.0
CL12 out		1 inch	CL12 out	CL12	CL12A	893.4	46.9	893.5	0.0	48.1	1.1	893.6	0.2	48.5	1.6
CL12 out		2 year	CL12 out	CL12	CL12A	897.4	151.4	897.4	-0.1	150.5	-1.0	897.4	0.0	151.6	0.2
CL12 out		10 year	CL12 out	CL12	CL12A	898.1	585.5	898.1	0.0	537.5	-48.0	898.1	0.0	586.1	0.6
CL12 out		100 year	CL12 out	CL12	CL12A	898.2	1064.8	898.2	0.0	1013.4	-51.4	898.2	0.0	1071.1	6.3
CL12ACULV	under 35 to Bixby	1 inch	CL12A out	CL12A	CL12B	893.4	42.6	893.4	0.0	47.1	4.5	893.6	0.2	44.3	1.7
CL12ACULV	under 35 to Bixby	2 year	CL12A out	CL12A	CL12B	897.4	66.0	897.4	-0.1	77.5	11.5	897.4	0.0	65.9	0.0
CL12ACULV	under 35 to Bixby	10 year				898.0	67.0	898.0	0.0	81.3	14.3	898.0	0.0	66.9	0.0
CL12ACULV	under 35 to Bixby	100 year				898.0	67.0	898.0	0.0	80.2	13.2	898.0	0.0	67.0	0.0
CL12B out	Bixby ditch west	1 inch	CL12B out	CL12B	Node784	892.4	-36.7	891.7	-0.7	-27.0	9.7	892.4	0.0	-38.4	-1.7
CL12B out	Bixby ditch west	2 year	CL12B out	CL12B	Node784	893.5	-147.4	893.2	-0.3	-77.1	70.2	893.5	0.0	-147.6	-0.2
CL12B out	Bixby ditch west	10 year	CL12B out	CL12B	Node784	894.1	-272.5	893.8	-0.3	-145.1	127.4	894.1	0.0	-272.5	0.0
CL12B out	Bixby ditch west	100 year	CL12B out	CL12B	Node784	894.6	-271.1	894.5	-0.1	-123.4	147.7	894.6	0.0	-271.1	0.0
CL12Bout2	Bixby ditch east of pond	1 inch	CL12Bout2	Node784	51-2	892.4	30.7	891.7	-0.7	-1.2	-31.9	892.4	0.0	31.4	0.7
CL12Bout2	Bixby ditch east of pond	2 year	CL12Bout2	Node784	51-2	893.4	68.7	893.2	-0.3	-6.5	-75.2	893.4	0.0	68.7	0.0
CL12Bout2	Bixby ditch east of pond	10 year	CL12Bout2	Node784	51-2	894.0	80.0	893.8	-0.2	-9.6	-89.7	894.0	0.0	80.1	0.0
CL12Bout2	Bixby ditch east of pond	100 year	CL12Bout2	Node784	51-2	894.6	56.2	894.5	-0.1	-14.3	-70.5	894.6	0.0	56.0	-0.2
CL28 out	Former JD1 under Broadway	1 inch	CL28 out	CL28	54	893.8	33.4	893.7	-0.2	35.2	1.8	893.9	0.1	34.8	1.3
CL28 out	Former JD1 under Broadway	2 year	CL28 out	CL28	54	895.7	79.9	895.6	-0.2	81.8	1.9	895.7	0.0	79.9	0.0
CL28 out	Former JD1 under Broadway	10 year	CL28 out	CL28	54	896.5	94.8	896.3	-0.2	98.5	3.7	896.5	0.0	94.8	0.0
CL28 out	Former JD1 under Broadway	100 year	CL28 out	CL28	54	897.2	105.5	897.0	-0.2	110.4	4.9	897.2	0.0	105.6	0.1
CL30Aout-N	Former JD1 between 8 and 61	1 inch	CL30Aout-N	Node781	CL34	891.5	38.5	889.6	-1.8	9.3	-29.2	891.5	0.0	39.1	0.7
CL30Aout-N	Former JD1 between 8 and 61	2 year	CL30Aout-N	Node781	CL34	893.1	99.6	891.7	-1.5	61.2	-38.4	893.1	0.0	99.6	0.0
CL30Aout-N	Former JD1 between 8 and 61	10 year	CL30Aout-N	Node781	CL34	893.9	-187.1	892.4	-1.5	83.3	270.5	893.9	0.0	-187.5	-0.3
CL30Aout-N	Former JD1 between 8 and 61	100 year	CL30Aout-N	Node781	CL34	894.5	-350.6	893.1	-1.4	-119.6	231.0	894.5	0.0	-351.0	-0.4
CL30Aout-S	Former JD1 between 8 and 61	1 inch	CL30Aout-S	CL30A	Node781	892.1	40.3	890.8	-1.3	8.8	-31.5	892.1	0.0	40.9	0.6
CL30Aout-S	Former JD1 between 8 and 61	2 year	CL30Aout-S	CL30A	Node781	893.3	112.4	892.7	-0.6	75.4	-37.0	893.3	0.0	112.6	0.1
CL30Aout-S	Former JD1 between 8 and 61	10 year	CL30Aout-S	CL30A	Node781	893.9	130.0	893.6	-0.3	109.0	-21.0	893.9	0.0	129.9	0.0
CL30Aout-S	Former JD1 between 8 and 61	100 year	CL30Aout-S	CL30A	Node781	894.5	179.6	894.4	-0.1	108.4	-71.2	894.5	0.0	181.1	1.5
CL30culv	Former JD1 under 8	1 inch	CL30 out	CL30	CL30A	892.1	-27.3	890.8	-1.3	5.6	33.0	892.1	0.0	-27.6	-0.3
CL30culv	Former JD1 under 8	2 year	CL30 out	CL30	CL30A	893.3	-70.4	892.7	-0.7	36.7	107.1	893.3	0.0	-70.4	-0.1
CL30culv	Former JD1 under 8	10 year				894.0	-80.5	893.5	-0.4	66.2	146.7	893.9	0.0	-80.5	0.0
CL30culv	Former JD1 under 8	100 year				894.6	-70.6	894.4	-0.1	106.2	176.8	894.6	0.0	-70.5	0.1
CL30outrd	Former JD1 under 8	1 inch	CL30 out	CL30	CL30A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
CL30outrd	Former JD1 under 8	2 year	CL30 out	CL30	CL30A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL30outrd	Former JD1 under 8	10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL30outrd	Former JD1 under 8	100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL30overrd	Former JD1 under 8	1 inch	CL30 out	CL30	CL30A										
CL30overrd	Former JD1 under 8	2 year	CL30 out	CL30	CL30A										
CL30overrd	Former JD1 under 8	10 year													
CL30overrd	Former JD1 under 8	100 year													
CL34Aculv	Under 61	1 inch	CL34A out	CL34A	CL34B	891.4	-39.2	889.6	-1.8	-20.6	18.6	891.4	0.0	-40.2	-0.9
CL34Aculv	Under 61	2 year	CL34A out	CL34A	CL34B	892.8	-102.8	891.1	-1.7	-108.0	-5.2	892.8	0.0	-102.7	0.1
CL34Aculv	Under 61	10 year				893.5	-109.5	891.8	-1.7	-129.3	-19.8	893.5	0.0	-109.2	0.4
CL34Aculv	Under 61	100 year				894.1	110.2	892.7	-1.5	-130.3	-240.5	894.2	0.0	110.3	0.1
CL34Atrl	Under 61	1 inch	CL34A out	CL34A	CL34B										
CL34Atrl	Under 61	2 year	CL34A out	CL34A	CL34B										
CL34Atrl	Under 61	10 year													
CL34Atrl	Under 61	100 year													
CL34B out	Under 61	1 inch	CL34B out	CL34B	CL34C	891.3	-19.6	889.6	-1.7	-10.2	9.4	891.4	0.0	-20.1	-0.4
CL34B out	Under 61	2 year	CL34B out	CL34B	CL34C	892.6	-51.4	891.0	-1.6	-53.9	-2.5	892.6	0.0	-51.4	0.0
CL34B out	Under 61	10 year	CL34B out	CL34B	CL34C	893.2	-54.8	891.6	-1.6	-64.6	-9.9	893.2	0.0	-54.6	0.2
CL34B out	Under 61	100 year	CL34B out	CL34B	CL34C	893.9	55.1	892.4	-1.5	-65.2	-120.3	893.9	0.0	55.2	0.0
CL34C out	Under 61	1 inch	CL34C out	CL34C	CL35	891.3	39.2	889.6	-1.7	-1.7	-40.9	891.4	0.0	40.0	0.8
CL34C out	Under 61	2 year	CL34C out	CL34C	CL35	892.5	102.8	891.0	-1.6	26.2	-76.6	892.6	0.0	102.8	-0.1
CL34C out	Under 61	10 year	CL34C out	CL34C	CL35	893.2	109.6	891.6	-1.6	69.2	-40.4	893.2	0.0	109.2	-0.4
CL34C out	Under 61	100 year	CL34C out	CL34C	CL35	893.9	-130.8	892.4	-1.4	166.6	297.4	893.9	0.0	-130.9	-0.1
CL34outcul	Under 61	1 inch	CL34 out	CL34	CL34A	891.5	39.2	889.6	-1.8	21.9	-17.3	891.5	0.0	40.1	0.9
CL34outcul	Under 61	2 year	CL34 out	CL34	CL34A	893.1	102.8	891.6	-1.6	109.0	6.3	893.1	0.0	102.7	-0.1
CL34outcul	Under 61	10 year				893.9	109.5	892.4	-1.5	129.3	19.8	893.9	0.0	109.2	-0.4
CL34outcul	Under 61	100 year				894.5	-110.2	893.1	-1.4	130.4	240.6	894.5	0.0	-110.3	-0.1
cl34outrd	Under 61	1 inch	CL34 out	CL34	CL34A										
cl34outrd	Under 61	2 year	CL34 out	CL34	CL34A										
cl34outrd	Under 61	10 year													
cl34outrd	Under 61	100 year													
CL35A out	Sunrise north of Ducharmes	1 inch	CL35A out	CL35A	Node782	890.3	-43.3	889.5	-0.8	-9.5	33.8	890.3	0.0	-43.8	-0.5
CL35A out	Sunrise north of Ducharmes	2 year	CL35A out	CL35A	Node782	891.1	-127.6	890.9	-0.2	-50.9	76.7	891.1	0.0	-127.1	0.5
CL35A out	Sunrise north of Ducharmes	10 year	CL35A out	CL35A	Node782	891.5	-149.5	891.4	-0.1	-83.8	65.7	891.5	0.0	-148.3	1.3
CL35A out	Sunrise north of Ducharmes	100 year	CL35A out	CL35A	Node782	892.1	-164.1	892.1	0.1	-100.3	63.9	892.1	0.0	-163.2	1.0
CL35Aout-N	Sunrise through Ducharmes	1 inch	CL35Aout-N	Node782	CL36	890.1	40.4	889.4	-0.7	15.6	-24.8	890.2	0.1	40.3	-0.1
CL35Aout-N	Sunrise through Ducharmes	2 year	CL35Aout-N	Node782	CL36	891.0	126.5	890.8	-0.2	75.5	-51.0	891.0	0.0	125.6	-0.9
CL35Aout-N	Sunrise through Ducharmes	10 year	CL35Aout-N	Node782	CL36	891.5	138.7	891.3	-0.2	135.8	-2.9	891.5	0.0	137.5	-1.3
CL35Aout-N	Sunrise through Ducharmes	100 year	CL35Aout-N	Node782	CL36	892.1	153.2	892.1	0.1	159.2	6.0	892.1	0.0	152.1	-1.1
CL35outcul	Under Ducharme driveway	1 inch	CL35 out	CL35	CL35A	890.6	44.6	889.5	-1.0	11.4	-33.2	890.6	0.0	45.4	0.8
CL35outcul	Under Ducharme driveway	2 year	CL35 out	CL35	CL35A	892.5	128.5	891.0	-1.5	57.1	-71.4	892.5	0.0	128.4	-0.1
CL35outcul	Under Ducharme driveway	10 year				893.1	156.6	891.6	-1.5	96.9	-59.7	893.1	0.0	156.6	-0.1
CL35outcul	Under Ducharme driveway	100 year				893.8	180.0	892.4	-1.4	123.5	-56.4	893.8	0.0	179.8	-0.2
CL36 out	Sunrise north of CL35A-N	1 inch	CL36 out	CL36	CL36A	889.1	40.9	888.5	-0.6	19.7	-21.2	889.2	0.1	38.5	-2.4
CL36 out	Sunrise north of CL35A-N	2 year	CL36 out	CL36	CL36A	890.8	125.4	890.2	-0.6	91.8	-33.5	890.8	0.1	122.8	-2.6

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
CL36 out	Sunrise north of CL35A-N	10 year	CL36 out	CL36	CL36A	891.4	144.8	891.2	-0.2	157.3	12.5	891.5	0.0	142.9	-1.9
CL36 out	Sunrise north of CL35A-N	100 year	CL36 out	CL36	CL36A	892.1	159.9	892.1	0.1	202.2	42.3	892.1	0.0	158.9	-1.0
CL36A out	Sunrise south of Greenway	1 inch	CL36A out	CL36A	CL37	889.0	-40.6	888.5	-0.5	-19.8	20.8	889.2	0.1	-38.1	2.5
CL36A out	Sunrise south of Greenway	2 year	CL36A out	CL36A	CL37	890.8	-123.0	890.1	-0.6	-87.5	35.4	890.8	0.1	-120.1	2.9
CL36A out	Sunrise south of Greenway	10 year	CL36A out	CL36A	CL37	891.4	-142.2	891.2	-0.2	-144.1	-1.9	891.5	0.0	-140.3	1.8
CL36A out	Sunrise south of Greenway	100 year	CL36A out	CL36A	CL37	892.1	-157.4	892.1	0.1	-180.7	-23.3	892.1	0.0	-156.5	0.8
CL38A out	downstream of 256th	1 inch	CL38A out	CL38A	CL38B	887.4	39.9	887.1	-0.3	28.2	-11.7	887.2	-0.2	32.7	-7.2
CL38A out	downstream of 256th	2 year	CL38A out	CL38A	CL38B	888.7	107.1	888.3	-0.4	85.8	-21.3	888.6	0.0	106.0	-1.0
CL38A out	downstream of 256th	10 year	CL38A out	CL38A	CL38B	889.3	129.1	889.1	-0.2	122.3	-6.8	889.3	0.0	129.2	0.1
CL38A out	downstream of 256th	100 year	CL38A out	CL38A	CL38B	890.5	-186.1	890.4	-0.1	-182.8	3.3	890.4	-0.1	-155.6	30.5
CL38B out	downstream of 256th	1 inch	CL38B out	CL38B	CL38C	887.0	39.8	886.8	-0.3	28.1	-11.7	886.9	-0.1	32.7	-7.2
CL38B out	downstream of 256th	2 year	CL38B out	CL38B	CL38C	888.4	106.9	888.0	-0.4	85.6	-21.3	888.3	0.0	105.9	-1.0
CL38B out	downstream of 256th	10 year	CL38B out	CL38B	CL38C	889.3	-201.4	889.1	-0.2	-207.8	-6.4	889.3	0.0	-213.3	-12.0
CL38B out	downstream of 256th	100 year	CL38B out	CL38B	CL38C	890.6	-366.7	890.4	-0.1	-372.3	-5.6	890.5	-0.1	-374.3	-7.6
CL38C out	downstream of 256th, upstream of W C	1 inch	CL38C out	CL38C	CL39	886.6	39.8	886.4	-0.2	28.1	-11.6	886.5	-0.1	32.6	-7.2
CL38C out	downstream of 256th, upstream of W C	2 year	CL38C out	CL38C	CL39	888.1	-169.0	888.0	-0.2	-169.5	-0.6	888.1	0.0	-170.8	-1.9
CL38C out	downstream of 256th, upstream of W C	10 year	CL38C out	CL38C	CL39	889.3	-329.2	889.1	-0.2	-334.2	-5.0	889.2	-0.1	-337.2	-7.9
CL38C out	downstream of 256th, upstream of W C	100 year	CL38C out	CL38C	CL39	890.6	-541.7	890.5	-0.1	-548.6	-7.0	890.5	-0.1	-551.6	-9.9
CL38culv	256th	1 inch	CL38 out	CL38	CL38A	888.1	39.9	887.7	-0.4	28.2	-11.7	887.9	-0.2	32.7	-7.2
CL38culv	256th	2 year	CL38 out	CL38	CL38A	889.8	107.2	889.3	-0.5	85.8	-21.3	889.8	0.0	106.1	-1.0
CL38culv	256th	10 year				890.4	129.3	890.2	-0.2	122.4	-6.8	890.4	0.0	129.4	0.1
CL38culv	256th	100 year				891.0	145.2	891.0	0.0	148.3	3.1	891.0	0.0	145.8	0.6
CL38overrd	256th	1 inch	CL38 out	CL38	CL38A										
CL38overrd	256th	2 year	CL38 out	CL38	CL38A										
CL38overrd	256th	10 year													
CL38overrd	256th	100 year													
CL39culv	W Comfort Drive (into Comfort Lake)	1 inch	CL39 out	CL39	CL54	886.2	39.7	886.0	-0.3	30.7	-9.0	886.1	-0.1	32.6	-7.2
CL39culv	W Comfort Drive (into Comfort Lake)	2 year	CL39 out	CL39	CL54	888.0	156.1	887.9	-0.1	148.9	-7.2	887.9	-0.1	142.0	-14.1
CL39culv	W Comfort Drive (into Comfort Lake)	10 year				889.3	241.1	889.2	-0.1	233.3	-7.8	889.2	-0.1	237.1	-4.0
CL39culv	W Comfort Drive (into Comfort Lake)	100 year				890.6	344.9	890.5	-0.1	338.0	-7.0	890.5	-0.1	335.3	-9.6
CL39overrd	W Comfort Drive (into Comfort Lake)	1 inch	CL39 out	CL39	CL54										
CL39overrd	W Comfort Drive (into Comfort Lake)	2 year	CL39 out	CL39	CL54										
CL39overrd	W Comfort Drive (into Comfort Lake)	10 year													
CL39overrd	W Comfort Drive (into Comfort Lake)	100 year													
CL40 out	Ditch around Shallow Pond	1 inch	CL40 out	CL40	CL40A	890.1	12.2	890.1	0.0	12.3	0.0	890.1	0.0	13.0	0.7
CL40 out	Ditch around Shallow Pond	2 year	CL40 out	CL40	CL40A	893.6	142.1	892.5	-1.1	144.3	2.2	890.1	-3.4	13.0	-129.2
CL40 out	Ditch around Shallow Pond	10 year	CL40 out	CL40	CL40A	895.0	281.5	893.7	-1.3	289.4	8.0	895.0	0.0	281.4	-0.1
CL40 out	Ditch around Shallow Pond	100 year	CL40 out	CL40	CL40A	895.0	286.3	894.4	-0.6	392.6	106.3	895.0	0.0	286.0	-0.3
CL40A out	Ditch around Shallow Pond	1 inch	CL40A out	CL40A	CL37A	888.7	13.3	888.5	-0.2	14.0	0.7	889.0	0.2	15.0	1.6
CL40A out	Ditch around Shallow Pond	2 year	CL40A out	CL40A	CL37A	891.2	181.7	890.8	-0.4	180.9	-0.8	891.2	0.0	182.1	0.4
CL40A out	Ditch around Shallow Pond	10 year	CL40A out	CL40A	CL37A	892.5	365.7	891.9	-0.5	367.6	1.9	892.5	0.0	365.8	0.1
CL40A out	Ditch around Shallow Pond	100 year	CL40A out	CL40A	CL37A	892.9	441.4	892.7	-0.2	540.0	98.6	892.9	0.0	441.9	0.4
CL41 out	ditch into Shallow Pond	1 inch	CL41 out	CL41	CL40	891.5	10.7	891.5	0.0	10.7	0.0	891.5	0.0	11.5	0.7
CL41 out	ditch into Shallow Pond	2 year	CL41 out	CL41	CL40	894.4	117.4	894.2	-0.3	122.8	5.4	894.4	0.0	117.2	-0.1
CL41 out	ditch into Shallow Pond	10 year	CL41 out	CL41	CL40	895.9	231.0	895.5	-0.4	244.9	13.9	895.9	0.0	230.9	-0.1

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
CL41 out	ditch into Shallow Pond	100 year	CL41 out	CL41	CL40	896.0	274.3	896.0	0.0	326.3	52.0	896.0	0.0	274.2	-0.1
CL44 out		1 inch	CL44 out	CL44	CL45	894.6	1.3	894.6	0.0	1.3	-0.1	894.7	0.0	1.5	0.2
CL44 out		2 year	CL44 out	CL44	CL45	895.3	20.0	895.2	0.0	19.6	-0.3	895.3	0.0	20.0	0.0
CL44 out		10 year	CL44 out	CL44	CL45	895.4	38.6	895.4	0.0	37.9	-0.7	895.4	0.0	38.5	-0.1
CL44 out		100 year	CL44 out	CL44	CL45	896.3	59.7	896.4	0.0	59.0	-0.7	896.3	0.0	59.8	0.1
CL45 out	Under 61 to Tax Forfeit	1 inch	CL45 out	CL45	CL45A	891.4	7.2	891.5	0.1	7.0	-0.2	891.5	0.2	8.5	1.3
CL45 out	Under 61 to Tax Forfeit	2 year	CL45 out	CL45	CL45A	893.8	19.6	893.9	0.1	19.3	-0.3	893.8	0.0	19.6	0.0
CL45 out	Under 61 to Tax Forfeit	10 year	CL45 out	CL45	CL45A	895.3	24.7	895.3	0.0	24.5	-0.2	895.3	0.0	24.7	0.0
CL45 out	Under 61 to Tax Forfeit	100 year	CL45 out	CL45	CL45A	896.3	27.5	896.4	0.0	27.0	-0.5	896.3	0.0	27.4	-0.1
CL45A out	Under 61 to Tax Forfeit	1 inch	CL45A out	CL45A	CL45B	890.1	3.6	891.2	1.1	3.5	-0.1	890.1	0.0	4.2	0.6
CL45A out	Under 61 to Tax Forfeit	2 year	CL45A out	CL45A	CL45B	890.9	9.8	891.5	0.6	9.7	-0.1	890.9	0.0	9.8	0.0
CL45A out	Under 61 to Tax Forfeit	10 year	CL45A out	CL45A	CL45B	891.5	12.4	891.7	0.2	12.3	-0.1	891.5	0.0	12.4	0.0
CL45A out	Under 61 to Tax Forfeit	100 year	CL45A out	CL45A	CL45B	892.1	13.7	892.1	0.1	13.5	-0.2	892.1	0.0	13.7	0.0
CL45B out	through Tax Forfeit	1 inch	CL45B out	CL45B	CL46	890.1	9.5	889.6	-0.5	0.3	-9.2	890.1	0.0	10.8	1.3
CL45B out	through Tax Forfeit	2 year	CL45B out	CL45B	CL46	890.9	52.1	890.9	0.0	12.5	-39.6	890.9	0.0	52.0	-0.1
CL45B out	through Tax Forfeit	10 year	CL45B out	CL45B	CL46	891.5	101.1	891.6	0.1	15.9	-85.2	891.5	0.0	100.3	-0.8
CL45B out	through Tax Forfeit	100 year	CL45B out	CL45B	CL46	892.1	138.1	892.4	0.3	22.5	-115.7	892.1	0.0	136.2	-2.0
CL46 out	through Tax Forfeit/Ducharme	1 inch	CL46 out	CL46	CL36	889.1	9.6	889.4	0.3	-7.8	-17.4	889.2	0.1	11.5	1.9
CL46 out	through Tax Forfeit/Ducharme	2 year	CL46 out	CL46	CL36	890.8	59.1	890.8	0.0	-49.2	-108.3	890.8	0.1	50.7	-8.4
CL46 out	through Tax Forfeit/Ducharme	10 year	CL46 out	CL46	CL36	891.4	82.1	891.3	-0.1	-84.2	-166.3	891.5	0.0	73.1	-8.9
CL46 out	through Tax Forfeit/Ducharme	100 year	CL46 out	CL46	CL36	892.1	64.3	892.1	0.1	-100.2	-164.6	892.1	0.0	65.1	0.8
CL47 out	side ditch just north of 8	1 inch	CL47 out	CL47	CL48	892.1	4.8	890.8	-1.3	8.6	3.8	892.1	0.0	5.2	0.3
CL47 out	side ditch just north of 8	2 year	CL47 out	CL47	CL48	893.3	72.2	892.8	-0.5	65.9	-6.3	893.3	0.0	72.2	0.0
CL47 out	side ditch just north of 8	10 year	CL47 out	CL47	CL48	893.9	137.6	893.8	-0.1	125.4	-12.2	893.9	0.0	137.7	0.1
CL47 out	side ditch just north of 8	100 year	CL47 out	CL47	CL48	894.5	218.9	894.7	0.2	201.6	-17.3	894.5	0.0	219.0	0.1
CL48 out	side ditch just north of 8	1 inch	CL48 out	CL48	CL30A	892.1	8.4	890.8	-1.3	18.9	10.5	892.1	0.0	9.4	1.0
CL48 out	side ditch just north of 8	2 year	CL48 out	CL48	CL30A	893.3	159.8	892.7	-0.5	140.0	-19.8	893.3	0.0	160.0	0.2
CL48 out	side ditch just north of 8	10 year	CL48 out	CL48	CL30A	893.9	310.0	893.7	-0.2	272.5	-37.5	893.9	0.0	310.2	0.1
CL48 out	side ditch just north of 8	100 year	CL48 out	CL48	CL30A	894.5	496.0	894.5	0.0	445.2	-50.8	894.5	0.0	496.3	0.3
CL54 out	out of Comfort Lake	1 inch	CL54 out	CL54	CL54A	886.0	13.2	885.8	-0.1	9.9	-3.3	885.9	0.0	12.5	-0.6
CL54 out	out of Comfort Lake	2 year	CL54 out	CL54	CL54A	887.6	47.8	887.4	-0.3	41.0	-6.9	887.6	0.0	47.0	-0.8
CL54 out	out of Comfort Lake	10 year	CL54 out	CL54	CL54A	888.5	73.8	888.4	-0.2	68.5	-5.3	888.5	0.0	73.6	-0.2
CL54 out	out of Comfort Lake	100 year	CL54 out	CL54	CL54A	889.2	97.0	889.1	0.0	95.2	-1.8	889.2	0.0	97.3	0.2
CL54A out	out of Comfort Lake	1 inch	CL54A out	CL54A	CL54B	885.9	26.3	885.8	-0.1	19.8	-6.6	885.9	0.0	25.0	-1.3
CL54A out	out of Comfort Lake	2 year	CL54A out	CL54A	CL54B	887.6	95.7	887.3	-0.3	81.9	-13.7	887.6	0.0	94.1	-1.6
CL54A out	out of Comfort Lake	10 year	CL54A out	CL54A	CL54B	888.5	147.7	888.3	-0.2	137.1	-10.6	888.5	0.0	147.2	-0.5
CL54A out	out of Comfort Lake	100 year	CL54A out	CL54A	CL54B	889.1	194.0	889.1	0.0	190.3	-3.7	889.1	0.0	194.5	0.5
CL54C out	out of Comfort Lake	1 inch	CL54C out	CL54C	OldOutlet	885.6	13.2	885.3	-0.3	9.9	-3.3	885.5	0.0	12.5	-0.6
CL54C out	out of Comfort Lake	2 year	CL54C out	CL54C	OldOutlet	887.3	47.8	887.0	-0.3	41.0	-6.9	887.3	0.0	47.0	-0.8
CL54C out	out of Comfort Lake	10 year	CL54C out	CL54C	OldOutlet	888.1	73.8	888.0	-0.2	68.5	-5.3	888.1	0.0	73.6	-0.2
CL54C out	out of Comfort Lake	100 year	CL54C out	CL54C	OldOutlet	888.7	97.0	888.7	0.0	95.2	-1.8	888.7	0.0	97.3	0.2
CMFRTWEIR	out of Comfort Lake	1 inch	CL WEIR	CL54B	CL54C	0.0	26.3	0.0	0.0	19.8	-6.6	0.0	0.0	25.0	-1.3
CMFRTWEIR	out of Comfort Lake	2 year	CL WEIR	CL54B	CL54C	0.0	95.7	0.0	0.0	81.9	-13.7	0.0	0.0	94.1	-1.6
CMFRTWEIR	out of Comfort Lake	10 year				0.0	147.7	0.0	0.0	137.1	-10.6	0.0	0.0	147.2	-0.5
CMFRTWEIR	out of Comfort Lake	100 year				0.0	194.0	0.0	0.0	190.3	-3.7	0.0	0.0	194.5	0.5

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
CULVFL81	culvert under 8, east of 61	1 inch	FL81 out	FL81	FL81A	894.6	2.7	894.6	0.0	2.7	0.0	894.6	0.0	2.8	0.1
CULVFL81	culvert under 8, east of 61	2 year	FL81 out	FL81	FL81A	896.2	24.5	896.2	0.0	24.3	-0.2	896.2	0.0	24.6	0.1
CULVFL81	culvert under 8, east of 61	10 year				897.5	37.5	897.5	0.0	37.5	0.0	897.5	0.0	37.5	0.0
CULVFL81	culvert under 8, east of 61	100 year				899.2	48.7	899.3	0.1	44.7	-4.1	899.2	0.0	48.9	0.1
CULVFL82		1 inch	FL82 out	CL62	CL62A	896.4	27.4	896.4	0.0	27.4	0.0	896.4	0.0	27.4	0.0
CULVFL82		2 year	FL82 out	CL62	CL62A	903.1	80.3	903.1	0.0	80.3	0.0	903.1	0.0	80.1	-0.2
CULVFL82		10 year				903.6	88.4	903.6	0.0	88.4	0.0	903.6	0.0	88.4	0.0
CULVFL82		100 year				904.0	90.1	904.0	0.0	90.1	0.0	904.0	0.0	90.1	0.0
FL81A out	side ditch connecting to FL outlet chan	1 inch	FL81A out	FL81A	CL35	892.5	2.7	892.5	0.0	2.7	0.0	892.5	0.0	2.8	0.1
FL81A out	side ditch connecting to FL outlet chan	2 year	FL81A out	FL81A	CL35	893.0	24.3	893.0	0.0	24.2	-0.1	893.0	0.0	24.4	0.1
FL81A out	side ditch connecting to FL outlet chan	10 year	FL81A out	FL81A	CL35	893.2	37.4	893.2	0.0	37.4	0.0	893.2	0.0	37.4	0.0
FL81A out	side ditch connecting to FL outlet chan	100 year	FL81A out	FL81A	CL35	893.8	76.9	893.3	-0.6	44.6	-32.3	893.9	0.0	77.1	0.1
FL82A out	ditch that connects by Ducharme from	1 inch	FL82A out	CL62A	CL36	893.7	14.4	893.7	0.0	14.1	-0.4	893.7	0.0	13.6	-0.8
FL82A out	ditch that connects by Ducharme from	2 year	FL82A out	CL62A	CL36	894.9	79.9	894.9	0.0	79.7	-0.2	894.9	0.0	78.8	-1.1
FL82A out	ditch that connects by Ducharme from	10 year	FL82A out	CL62A	CL36	895.6	149.7	895.6	0.0	149.5	-0.2	895.6	0.0	148.9	-0.8
FL82A out	ditch that connects by Ducharme from	100 year	FL82A out	CL62A	CL36	896.3	240.1	896.3	0.0	240.1	0.0	896.3	0.0	239.4	-0.7
HWY 8 WEIR	Former JD1 under 8	1 inch	CL30 out	CL30	CL30A	0.0	12.2	0.0	0.0	-1.4	-13.7	0.0	0.0	12.4	0.2
HWY 8 WEIR	Former JD1 under 8	2 year	CL30 out	CL30	CL30A	0.0	42.9	0.0	0.0	-24.2	-67.1	0.0	0.0	43.0	0.1
HWY 8 WEIR	Former JD1 under 8	10 year				0.0	57.5	0.0	0.0	-59.1	-116.6	0.0	0.0	57.5	0.0
HWY 8 WEIR	Former JD1 under 8	100 year				0.0	47.0	0.0	0.0	-126.6	-173.7	0.0	0.0	46.9	-0.2
L216	north of Broadway (McCullough) (south	1 inch	L216	54	53	893.4	33.2	892.8	-0.6	35.0	1.8	893.4	0.1	34.6	1.4
L216	north of Broadway (McCullough) (south	2 year	L216	54	53	894.8	79.8	894.5	-0.3	81.7	1.9	894.8	0.0	79.8	0.1
L216	north of Broadway (McCullough) (south	10 year	L216	54	53	895.3	94.6	895.1	-0.3	98.3	3.8	895.3	0.0	94.6	0.0
L216	north of Broadway (McCullough) (south	100 year	L216	54	53	895.9	105.0	895.7	-0.2	110.1	5.1	895.9	0.0	105.2	0.2
L217	"abandoned" ditch east of Bixby pond	1 inch	L217	52	51-2	892.4	18.2	891.7	-0.7	-38.1	-56.4	892.4	0.0	18.6	0.3
L217	"abandoned" ditch east of Bixby pond	2 year	L217	52	51-2	893.4	46.8	893.2	-0.3	-157.3	-204.2	893.5	0.0	46.9	0.0
L217	"abandoned" ditch east of Bixby pond	10 year	L217	52	51-2	894.0	73.0	893.8	-0.2	-242.6	-315.6	894.0	0.0	73.1	0.1
L217	"abandoned" ditch east of Bixby pond	100 year	L217	52	51-2	894.6	78.6	894.5	-0.1	-338.7	-417.3	894.6	0.0	78.5	-0.1
L220	north of Broadway (McCullough) (north	1 inch	L220	53	CL29	893.3	32.5	892.7	-0.6	34.1	1.6	893.3	0.0	33.6	1.0
L220	north of Broadway (McCullough) (north	2 year	L220	53	CL29	894.6	71.0	894.2	-0.4	78.3	7.4	894.6	0.0	71.0	0.0
L220	north of Broadway (McCullough) (north	10 year	L220	53	CL29	895.1	81.6	894.9	-0.3	92.1	10.5	895.1	0.0	81.7	0.1
L220	north of Broadway (McCullough) (north	100 year	L220	53	CL29	895.7	89.4	895.5	-0.2	99.0	9.6	895.7	0.0	89.5	0.1
L220c-culv	under access road south end Bixby	1 inch	L220C	CL29	CL29A	893.2	37.5	892.7	-0.5	25.8	-11.7	893.2	0.0	38.1	0.6
L220c-culv	under access road south end Bixby	2 year	L220C	CL29	CL29A	894.6	72.9	894.1	-0.5	64.9	-8.0	894.6	0.0	72.9	0.0
L220c-culv	under access road south end Bixby	10 year				895.1	84.2	894.9	-0.3	77.6	-6.6	895.1	0.0	84.2	0.0
L220c-culv	under access road south end Bixby	100 year				895.7	92.5	895.5	-0.2	86.9	-5.5	895.7	0.0	92.5	0.0
L221	into Bixby "pond"	1 inch	L221	CL29A	52	892.4	-33.3	891.7	-0.7	-25.7	7.5	892.4	0.0	-33.9	-0.6
L221	into Bixby "pond"	2 year	L221	CL29A	52	893.5	-71.4	893.2	-0.3	-64.4	7.0	893.5	0.0	-71.4	0.0
L221	into Bixby "pond"	10 year	L221	CL29A	52	894.0	-81.6	893.8	-0.1	-77.0	4.6	894.0	0.0	-81.6	0.0
L221	into Bixby "pond"	100 year	L221	CL29A	52	894.6	-89.0	894.5	-0.1	-86.0	3.0	894.6	0.0	-88.9	0.1
L232culv	Greenway	1 inch	L232	CL37	CL37A	888.9	-41.0	888.5	-0.5	-21.1	19.8	889.1	0.2	-38.3	2.6
L232culv	Greenway	2 year	L232	CL37	CL37A	890.7	-122.1	890.0	-0.7	-92.3	29.8	890.8	0.1	-119.1	3.0
L232culv	Greenway	10 year				891.4	-140.7	891.2	-0.2	-149.5	-8.8	891.4	0.0	-138.9	1.8
L232culv	Greenway	100 year				892.0	-156.0	892.1	0.1	-187.4	-31.4	892.1	0.0	-155.2	0.8
L233	Shallow Pond	1 inch	L233	CL37A	N785CL38R	888.7	42.4	888.4	-0.4	25.8	-16.6	889.0	0.2	37.4	-5.1

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
L233	Shallow Pond	2 year	L233	CL37A	N785CL38R	890.3	114.8	889.7	-0.6	173.2	58.4	890.4	0.1	111.5	-3.2
L233	Shallow Pond	10 year	L233	CL37A	N785CL38R	891.0	203.0	890.8	-0.3	340.5	137.6	891.1	0.1	210.7	7.7
L233	Shallow Pond	100 year	L233	CL37A	N785CL38R	891.7	254.0	891.7	0.0	441.7	187.7	891.8	0.0	245.4	-8.6
L271	upstream end of Forest Lake outlet cha	1 inch	L271	N518	N519	899.5	4.0	899.5	0.0	4.0	0.0	899.5	0.0	4.1	0.0
L271	upstream end of Forest Lake outlet cha	2 year	L271	N518	N519	900.1	23.7	900.1	0.0	23.7	0.0	900.1	0.0	23.7	0.0
L271	upstream end of Forest Lake outlet cha	10 year	L271	N518	N519	900.6	44.7	900.6	0.0	44.7	0.0	900.6	0.0	44.6	0.0
L271	upstream end of Forest Lake outlet cha	100 year	L271	N518	N519	901.3	71.8	901.3	0.0	72.0	0.3	901.3	0.0	72.0	0.3
L272	Forest Lake outlet channel	1 inch	L272	N519	N520	898.2	4.0	898.2	0.0	4.0	0.0	898.2	0.0	4.1	0.0
L272	Forest Lake outlet channel	2 year	L272	N519	N520	899.0	23.7	899.0	0.0	23.7	0.0	899.0	0.0	23.7	0.0
L272	Forest Lake outlet channel	10 year	L272	N519	N520	899.6	44.7	899.6	0.0	44.7	0.0	899.6	0.0	44.6	0.0
L272	Forest Lake outlet channel	100 year	L272	N519	N520	900.2	71.8	900.2	0.0	72.0	0.3	900.2	0.0	72.0	0.3
L273	Forest Lake outlet channel	1 inch	L273	N520	N521	897.9	4.0	897.9	0.0	4.0	0.0	897.9	0.0	4.1	0.0
L273	Forest Lake outlet channel	2 year	L273	N520	N521	898.8	23.7	898.8	0.0	23.7	0.0	898.8	0.0	23.7	0.0
L273	Forest Lake outlet channel	10 year	L273	N520	N521	899.4	44.7	899.4	0.0	44.7	0.0	899.4	0.0	44.6	0.0
L273	Forest Lake outlet channel	100 year	L273	N520	N521	900.1	71.8	900.1	0.0	72.0	0.3	900.1	0.0	72.0	0.3
L274	Forest Lake outlet channel - join with d	1 inch	L274	N521	CL35	895.3	4.0	895.3	0.0	4.0	0.0	895.3	0.0	4.1	0.0
L274	Forest Lake outlet channel - join with d	2 year	L274	N521	CL35	895.9	23.7	895.9	0.0	23.7	0.0	895.9	0.0	23.7	0.0
L274	Forest Lake outlet channel - join with d	10 year	L274	N521	CL35	896.3	44.7	896.3	0.0	44.7	0.0	896.3	0.0	44.6	0.0
L274	Forest Lake outlet channel - join with d	100 year	L274	N521	CL35	896.7	71.8	896.7	0.0	72.0	0.3	896.7	0.0	72.0	0.3
L622culv	trail culvert upstream 256th	1 inch	Link622	N785CL38R	Node786	888.3	-39.9	887.8	-0.4	-28.2	11.7	888.0	-0.3	-32.7	7.2
L622culv	trail culvert upstream 256th	2 year	Link622	N785CL38R	Node786	890.3	-107.2	889.7	-0.6	-85.8	21.3	890.2	0.0	-106.1	1.0
L622culv	trail culvert upstream 256th	10 year				891.0	-129.3	890.8	-0.3	-122.4	6.8	891.0	0.0	-129.4	-0.1
L622culv	trail culvert upstream 256th	100 year				891.7	-145.2	891.7	0.0	-148.3	-3.1	891.7	0.0	-145.8	-0.6
L622overrd	trail culvert upstream 256th	1 inch	Link622	N785CL38R	Node786	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L622overrd	trail culvert upstream 256th	2 year	Link622	N785CL38R	Node786	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L622overrd	trail culvert upstream 256th	10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L622overrd	trail culvert upstream 256th	100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Link623	upstream of 256th	1 inch	Link623	Node786	CL38	888.1	39.9	887.7	-0.4	28.2	-11.7	887.9	-0.2	32.7	-7.2
Link623	upstream of 256th	2 year	Link623	Node786	CL38	889.8	107.2	889.3	-0.5	85.8	-21.3	889.8	0.0	106.1	-1.0
Link623	upstream of 256th	10 year	Link623	Node786	CL38	890.4	129.3	890.2	-0.2	122.4	-6.8	890.4	0.0	129.4	0.1
Link623	upstream of 256th	100 year	Link623	Node786	CL38	891.0	145.2	891.0	0.0	148.3	3.1	891.0	0.0	145.8	0.6
LL218	north of Bixby pond, south of Hwy 8	1 inch	LL218	51-2	CL30	892.3	44.9	890.8	-1.6	-3.2	-48.0	892.4	0.0	46.6	1.7
LL218	north of Bixby pond, south of Hwy 8	2 year	LL218	51-2	CL30	893.4	108.6	892.7	-0.7	-21.5	-130.1	893.4	0.0	108.7	0.1
LL218	north of Bixby pond, south of Hwy 8	10 year	LL218	51-2	CL30	894.0	122.2	893.5	-0.4	-33.1	-155.3	894.0	0.0	122.4	0.2
LL218	north of Bixby pond, south of Hwy 8	100 year	LL218	51-2	CL30	894.6	110.7	894.4	-0.1	-35.4	-146.1	894.6	0.0	110.7	0.0
OVERFL51		1 inch	FL81 out	FL81	FL81A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVERFL51		2 year	FL81 out	FL81	FL81A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVERFL51		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVERFL51		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrd		1 inch	L220C	CL29	CL29A										
overrd		2 year	L220C	CL29	CL29A										
overrd		10 year													
overrd		100 year													
over-rd		1 inch	L220C	CL29	CL29A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
over-rd		2 year	L220C	CL29	CL29A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
over-rd		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
over-rd		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrd622		1 inch	Link622	N785CL38R	Node786										
overrd622		2 year	Link622	N785CL38R	Node786										
overrd622		10 year													
overrd622		100 year													
overrdCL34		1 inch	CL34 out	CL34	CL34A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL34		2 year	CL34 out	CL34	CL34A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL34		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL34		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		1 inch	CL35 out	CL35	CL35A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		2 year	CL35 out	CL35	CL35A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		1 inch	CL35 out	CL35	CL35A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		2 year	CL35 out	CL35	CL35A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL35		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL38		1 inch	CL38 out	CL38	CL38A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL38		2 year	CL38 out	CL38	CL38A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL38		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL38		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL39		1 inch	CL39 out	CL39	CL54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL39		2 year	CL39 out	CL39	CL54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL39		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdCL39		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdFL51		1 inch	FL81 out	FL81	FL81A										
overrdFL51		2 year	FL81 out	FL81	FL81A										
overrdFL51		10 year													
overrdFL51		100 year													
overrdL232		1 inch	L232	CL37	CL37A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		2 year	L232	CL37	CL37A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		1 inch	L232	CL37	CL37A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		2 year	L232	CL37	CL37A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
overrdL232		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OVERTOPCL12A	over I35 at Hwy 8 ramps	1 inch	CL12A out	CL12A	CL12B	0.0	0.0	0.0	0.0	0.0	0.0				
OVERTOPCL12A	over I35 at Hwy 8 ramps	2 year	CL12A out	CL12A	CL12B	0.0	86.1	0.0	0.0	73.1	-13.1	0.0	0.0	86.3	0.2
OVERTOPCL12A	over I35 at Hwy 8 ramps	10 year				0.0	212.2	0.0	0.0	212.2	0.0	0.0	0.0	212.2	0.0
OVERTOPCL12A	over I35 at Hwy 8 ramps	100 year				0.0	212.2	0.0	0.0	212.2	0.0	0.0	0.0	212.2	0.0
OVERTOPFL51		1 inch	FL81 out	FL81	FL81A										
OVERTOPFL51		2 year	FL81 out	FL81	FL81A										
OVERTOPFL51		10 year													

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
OVERTOPFL51		100 year													
OVERTOPFL82	over Hwy 8 at side ditch	1 inch	FL82 out	CL62	CL62A	0.0	0.0	0.0	0.0	0.0	0.0				
OVERTOPFL82	over Hwy 8 at side ditch	2 year	FL82 out	CL62	CL62A	0.0	43.4	0.0	0.0	43.4	0.0	0.0	0.0	43.7	0.3
OVERTOPFL82	over Hwy 8 at side ditch	10 year				0.0	123.3	0.0	0.0	123.3	0.0	0.0	0.0	123.3	0.0
OVERTOPFL82	over Hwy 8 at side ditch	100 year				0.0	232.5	0.0	0.0	232.5	0.0	0.0	0.0	232.5	0.0
ovrtrCL34A		1 inch	CL34A out	CL34A	CL34B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ovrtrCL34A		2 year	CL34A out	CL34A	CL34B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ovrtrCL34A		10 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ovrtrCL34A		100 year				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
L217A	Bixby Pond	1 inch				892.4	-13.5	891.7	-0.7	-39.0	-25.5	892.4	0.0	-14.1	-0.6
L217A	Bixby Pond	2 year				893.4	59.0	893.2	-0.3	-140.7	-199.7	893.5	0.0	59.0	0.0
L217A	Bixby Pond	10 year				894.0	179.7	893.8	-0.2	-219.2	-398.8	894.0	0.0	179.7	0.0
L217A	Bixby Pond	100 year				894.6	208.0	894.5	-0.1	-309.4	-517.4	894.6	0.0	207.0	-1.0
Link629	Bixby park channel from west into pond	1 inch	Link629	Node788	CL30			891.7		-35.2					
Link629	Bixby park channel from west into pond	2 year	Link629	Node788	CL30			893.2		-127.6		890.4		106.1	
Link629	Bixby park channel from west into pond	10 year	Link629	Node788	CL30			893.8		-198.6		891.1		129.4	
Link629	Bixby park channel from west into pond	100 year	Link629	Node788	CL30			894.5		-265.5		891.8		145.8	
Link631	Bixby park west channel (running north	1 inch	Link631	Node794	Node792			891.7		31.1		888.9		32.7	
Link631	Bixby park west channel (running north	2 year	Link631	Node794	Node792			893.2		86.6					
Link631	Bixby park west channel (running north	10 year	Link631	Node794	Node792			893.8		131.1					
Link631	Bixby park west channel (running north	100 year	Link631	Node794	Node792			894.5		113.9					
Link632	Bixby park north channel	1 inch	Link632	Node792	CL46			891.7		-35.7					
Link632	Bixby park north channel	2 year	Link632	Node792	CL46			893.2		-139.5					
Link632	Bixby park north channel	10 year	Link632	Node792	CL46			893.8		-237.4					
Link632	Bixby park north channel	100 year	Link632	Node792	CL46			894.5		-365.1					
blockl217.	Bixby berm overflow from south aband	1 inch	Link634	CL45B	Node792										
blockl217.	Bixby berm overflow from south aband	2 year	Link634	CL45B	Node792										
blockl217.	Bixby berm overflow from south aband	10 year	Link634	CL45B	Node792										
blockl217.	Bixby berm overflow from south aband	100 year	Link634	CL45B	Node792										
blockcl12b	Bixby berm overflow from west former	1 inch	Link635	Node791	Node794										
blockcl12b	Bixby berm overflow from west former	2 year	Link635	Node791	Node794										
blockcl12b	Bixby berm overflow from west former	10 year	Link635	Node791	Node794										
blockcl12b	Bixby berm overflow from west former	100 year	Link635	Node791	Node794										
draintile	Bixby outlet - lowest	1 inch						891.7		0.7					
draintile	Bixby outlet - lowest	2 year						893.2		1.3					
draintile	Bixby outlet - lowest	10 year						893.8		1.2					
draintile	Bixby outlet - lowest	100 year						894.5		1.0					
permbix	Bixby outlet - first weir	1 inch													
permbix	Bixby outlet - first weir	2 year													
permbix	Bixby outlet - first weir	10 year													
permbix	Bixby outlet - first weir	100 year													
overbix	Bixby outlet - overflow weir	1 inch						0.0		0.0					
overbix	Bixby outlet - overflow weir	2 year						0.0		10.1					
overbix	Bixby outlet - overflow weir	10 year						0.0		81.3					
overbix	Bixby outlet - overflow weir	100 year						0.0		-137.8					

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
overbrmbx	Bixby outlet - overflow over berm	1 inch						0.0		0.0					
overbrmbx	Bixby outlet - overflow over berm	2 year						0.0		0.0					
overbrmbx	Bixby outlet - overflow over berm	10 year						0.0		0.0					
overbrmbx	Bixby outlet - overflow over berm	100 year						0.0		78.1					
Link637	spreader channel into new Tax Forfeit	1 inch						891.2		6.4					
Link637	spreader channel into new Tax Forfeit	2 year						891.5		19.5					
Link637	spreader channel into new Tax Forfeit	10 year						891.7		24.8					
Link637	spreader channel into new Tax Forfeit	100 year						892.1		26.9					
Link638	new Tax Forfeit outlet	1 inch						891.2		5.1					
Link638	new Tax Forfeit outlet	2 year						891.5		32.8					
Link638	new Tax Forfeit outlet	10 year						891.7		58.8					
Link638	new Tax Forfeit outlet	100 year						892.1		98.4					
inletmc	new McCullough Outlet	1 inch						892.7		13.3					
inletmc	new McCullough Outlet	2 year						894.1		37.8					
inletmc	new McCullough Outlet	10 year						894.9		40.6					
inletmc	new McCullough Outlet	100 year						895.5		38.3					
outletmc	new McCullough Outlet	1 inch						892.7		0.0					
outletmc	new McCullough Outlet	2 year						894.1		16.7					
outletmc	new McCullough Outlet	10 year						894.9		28.4					
outletmc	new McCullough Outlet	100 year						895.5		40.3					
Link640	into new storage south of archies	1 inch						889.6		19.8					
Link640	into new storage south of archies	2 year						891.0		134.1					
Link640	into new storage south of archies	10 year						891.6		190.7					
Link640	into new storage south of archies	100 year						892.4		262.1					
Link641.1	new under Ducharme drive	1 inch						889.6		3.4					
Link641.1	new under Ducharme drive	2 year						891.0		30.7					
Link641.1	new under Ducharme drive	10 year						891.6		44.3					
Link641.1	new under Ducharme drive	100 year						892.4		59.9					
overl641	new under Ducharme drive	1 inch						0.0		0.0					
overl641	new under Ducharme drive	2 year						0.0		0.0					
overl641	new under Ducharme drive	10 year						0.0		0.0					
overl641	new under Ducharme drive	100 year						0.0		0.0					
Link642	new Ducharme east side (south)	1 inch						889.6		7.0					
Link642	new Ducharme east side (south)	2 year						890.9		57.0					
Link642	new Ducharme east side (south)	10 year						891.6		73.0					
Link642	new Ducharme east side (south)	100 year						892.4		89.3					
out643	out archies new storage	1 inch						889.4		2.6					
out643	out archies new storage	2 year						890.9		17.6					
out643	out archies new storage	10 year						891.6		28.3					
out643	out archies new storage	100 year						892.4		34.1					
over643	out archies new storage	1 inch						0.0		0.0					
over643	out archies new storage	2 year						0.0		0.0					
over643	out archies new storage	10 year						0.0		0.0					
over643	out archies new storage	100 year						0.0		23.8					
inflowtf	Banta connection to Sunrise	1 inch						888.7		1.3					

						EXISTING		DESIGNS				Shallow Pond			
Name	Location Description	Storm	Link Name	Upstream Node Name	Downstream Node Name	Peak Upstream Elevation (ft)	Peak Flow (ft)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)	Peak Upstream Elevation (ft)	Change in Peak Elevation (ft)	Peak Flow (ft)	Change in Peak Flow (cfs)
inflowtf	Banta connection to Sunrise	2 year						890.3		24.8					
inflowtf	Banta connection to Sunrise	10 year						891.2		46.8					
inflowtf	Banta connection to Sunrise	100 year						892.1		66.6					
outflowtf	Banta outlet	1 inch						888.7		3.7					
outflowtf	Banta outlet	2 year						890.3		28.7					
outflowtf	Banta outlet	10 year						891.2		35.7					
outflowtf	Banta outlet	100 year						892.1		46.5					
divert1	diversion just east of main channel Hw	1 inch						0.0		1.7					
divert1	diversion just east of main channel Hw	2 year						0.0		-26.1					
divert1	diversion just east of main channel Hw	10 year						0.0		-43.1					
divert1	diversion just east of main channel Hw	100 year						0.0		-61.6					
divert2	diversion just east of main channel Hw	1 inch						0.0		0.0					
divert2	diversion just east of main channel Hw	2 year						0.0		0.0					
divert2	diversion just east of main channel Hw	10 year						0.0		-19.4					
divert2	diversion just east of main channel Hw	100 year						0.0		-73.0					
divert3	diversion just east of main channel Hw	1 inch						0.0		0.0					
divert3	diversion just east of main channel Hw	2 year						0.0		0.0					
divert3	diversion just east of main channel Hw	10 year						0.0		0.0					
divert3	diversion just east of main channel Hw	100 year						0.0		0.0					
Link646	new Ducharme west side (south)	1 inch						889.6		9.9					
Link646	new Ducharme west side (south)	2 year						890.9		89.7					
Link646	new Ducharme west side (south)	10 year						891.6		100.4					
Link646	new Ducharme west side (south)	100 year						892.4		140.1					
Link647	new Ducharme west side (middle)	1 inch						889.6		9.0					
Link647	new Ducharme west side (middle)	2 year						890.9		86.2					
Link647	new Ducharme west side (middle)	10 year						891.6		90.3					
Link647	new Ducharme west side (middle)	100 year						892.4		124.8					
Link648	new Ducharme west side (north)	1 inch						889.6		-3.7					
Link648	new Ducharme west side (north)	2 year						890.9		-38.4					
Link648	new Ducharme west side (north)	10 year						891.6		-44.1					
Link648	new Ducharme west side (north)	100 year						892.4		-60.6					
Link649	new Ducharme east side (north)	1 inch						889.4		-7.0					
Link649	new Ducharme east side (north)	2 year						890.9		-40.2					
Link649	new Ducharme east side (north)	10 year						891.6		-62.6					
Link649	new Ducharme east side (north)	100 year						892.4		-74.1					

Appendix J. Water Quality Model

Evaluation of Potential Shallow Pond Modification using model for:

Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capitol Improvement Plan

		Lake Physical Characteristics				Water Quantity - Existing Conditions: Water Budget Outflow and Inflow Volumes — Outflow Volumes [ac-ft]					Inflow Volumes [ac-ft]					
	Lake Name	Lake Area [acres]	Lake Mean Depth [ft]	Lake Volume [acre-ft]	Shallow or Deep	Evapo-ration from Lake	Discharge through Outlet	Discharge via Groundwater	Regional Ground-water Outflow	Sum of Outflows	Water-shed Runoff	Precip-itation (direct)	Flow from Upstream Lakes via Surface	Flow from Upstream Lakes via Ground Water	Regional Ground-water Inflow	Sum of Inflows
Benchmark Conditions (2004)	Lendt Lake	66	3.0	199	minor	155	38		125	318	200	117	-	-	-	318
	Moody Lake	34	13.8	465	deep	81	470		64	614	498	61	38	16	-	614
	Third Lake	65	3.0	194	minor	155	29		122	306	188	117	-	-	-	306
	Sea Lake	51	3.0	152	minor	121		140		261	169	92	-	-	-	261
										-						
	Bone Lake	204	13.4	2,735	deep	486	1,591		383	2,461	1,431	369	499	162	-	2,461
	Nielsen Lake	32	3.0	95	minor - d	76		184	-	259	202	57	-	-	-	259
	Birch Lake	32	2.8	88	shallow	75	2,335		-	2,411	555	57	1,591	195	12	2,411
	School Lake	50	10.8	532	deep	118	2,838		-	2,956	478	109	2,335	15	19	2,956
	Little Comfort Lake	35	18.4	649	deep	84	3,810		-	3,895	967	78	2,838	2	14	3,898
	Clear Lake	39	3.0	117	minor - d	93		123	-	216	59	71	-	72	15	216
	Twin Lake	21	3.0	63	minor - d	51	243		-	293	117	38	-	130	8	293
	Cranberry Lake	21	3.0	62	minor	49	620		-	669	381	37	243	-	8	669
	Elwell Lake	18	3.0	54	minor - d	43		136	-	179	79	33	-	60	7	179
	Sylvan Lake	84	9.4	792	deep	201		418	-	619	88	152	-	330	33	604
	Shields Lake	27	7.4	203	shallow	65	710		-	776	700	60	-	10	11	781
	Forest Lake East	779	12.6	9,779	deep	1,859	2,564		-	4,423	1,313	1,607	620	656	305	4,502
	Forest Lake Middle	367	11.1	4,089	deep	877	3,416		-	4,294	104	809	3,275	-	144	4,331
	Forest Lake West	1,074	9.9	10,590	deep	2,564	4,957		-	7,521	1,382	2,356	3,416	55	421	7,630
	Heims Lake	90	3.0	269	minor	214	87		-	301	74	192	-	-	35	301
	shallow pond	155	2.5	388	minor	371	8,005		-	8,375	2,925	334	5,045	26	46	8,375
	Comfort Lake	218	19.2	4,182	deep	521	12,175		-	12,696	347	472	11,815	42	85	12,761
	First Lake	51	3.0	154	minor - d	123	-					93			-	
	Second Lake	87	3.0	261	minor - d	208	48					158			-	
	Scandia - Lake West of S	13	3.0	38	minor - d	31	-					23			-	
reference - benchmark	shallow pond	155	1.0	155	minor	371	8,005		-	8,375	2,925	334	5,045	26	46	8,375
	change (proposed - existing)	-	1.5	233	#VALUE! #	-	-	-	-	-	-	-	-	-	-	-

X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\07_Modeling\Water Quality\CLFLWD Watershed and Lake Response Model_edited for Shallow Pond WQ Analysis_1andhalf.xls

Modified CLFLWD Watershed Loading and Lake Response Model (WLLRM)

Evaluation of Potential Shallow Pond Modification using model for:

Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capitol Improvement Plan

			Water Quality - Existing Conditions (1/3)				Water Quality - Existing Conditions (2/3)								
			Phosphorus Budget Outflow				Phosphorus Budget Inflow (1/2)								
							Inflow Phosphorus [lb]								
	Lake Name	Change in Storage [acre-ft]	Lake Outlet Flow	Regional Ground-water	Discharge via Groundwater	Sediment-ation	UAL CF	Runoff (Land use-based)	Landlocked Runoff Removals	Livestock CF	Livestock P Load	Landlocked Livestock P Load Removals	Landlocked Groundwater Load to Lake	P from Upstream Lakes Outlets	P from Upstream Minor Lake Outlets
Benchmark Conditions (2004)	Lendt Lake		15	11.8	-	31	1.00	36	-	1.00	1	0	0	-	
	Moody Lake	-	186	22.1	-	837	1.00	450	(19)	1.00	198	(4)	2	-	15
	Third Lake	-	11.2	9.0	-	20	1.00	-	-	1.00	6	0	0	-	
	Sea Lake	-	23	-	22.9	58	1.00	73	-	1.00	1	0	0	-	
	Bone Lake	-	254	49.1	-	975	1.00	695	(26)	1.00	77	0	25	186	29
	Nielsen Lake	-	35	-	34.9	58	1.00	85	-	1.00	4	0	0	-	
	Birch Lake	-	587.4	-	-	334	1.00	292	(17)	1.00	106	(44)	30	254	23
	School Lake	-	475	-	-	453	1.00	180	(9)	1.00	133	(28)	2	587	
	Little Comfort Lake	4	678	-	-	577	1.00	373	(10)	1.00	24	(1)	0	475	
	Clear Lake	-	17	-	16.8	36	1.00	50	(16)	1.00	0	0	11	-	
	Twin Lake	-	62.1	-	-	81	1.00	116	(13)	1.00	2	(1)	20	-	16
	Cranberry Lake	-	74	-	-	44	1.00	51	-	1.00	0	0	0	-	62
	Elwell Lake	-	19	-	18.7	23	1.00	96	(67)	1.00	0	0	9	-	
	Sylvan Lake	(15)	20	-	19.5	54	1.00	246	(88)	1.00	0	0	50	-	
	Shields Lake	6	321	-	-	786	1.00	202	(15)	1.00	1	0	2	-	
	Forest Lake East	79	245	-	-	1,555	1.00	1,067	(78)	1.00	167	0	100	54	91
	Forest Lake Middle	37	311	-	-	855	1.00	431	-	1.00	1	0	0	*566*	
	Forest Lake West	109	361	-	-	930	1.00	750	(58)	1.00	0	0	8	311	
	Heims Lake	-	15.2	-	-	62	1.00	60	-	1.00	0	0	0	-	
	shallow pond	-	1,101	-	-	841	1.00	1,536	(7)	1.00	5	0	4	361	15
	Comfort Lake	66	1,309	-	-	922	1.00	372	-	1.00	0	0	6	1,779	
	First Lake		-	-	-	688	1.00	440	(16)	1.00	251	(2)	0	-	9
	Second Lake		9	-	-	103	1.00	102	(3)	1.00	1	0	0	-	
	Scandia - Lake West o		-	-	-	130	1.00	124	(6)	1.00	12	(1)	0	-	
reference - benchmark	shallow pond	-	1,335	-	-	607	1.00	1,536	(7)	1.00	5	0	4	361	15
	change (proposed - existing)	- #	(234)	-	-	234	-	-	-	-	-	-	-	-	-

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Modified CLFLWD Watershed Loading and Lake Response Model (WLLRM)

Evaluation of Potential Shallow Pond Modification using model for:

Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capitol Improvement Plan

		Water Quality - Existing Conditions (3/3)														
		Phosphorus Budget Inflow (2/2)														
		Inflow Phosphorus [lb]														
	Lake Name	Watershed Load	Watershed Load Increment	NOTES	Adjusted Watershed Load	Atmospheric	Lakeshore Septic	Regional Groundwater	**Internal Load CF**	Lake Internal Load	Adjusted Internal Load	Internal + Direct Load	Total Lake P Load	Total Load Calibration Increment	Scenario Load Reduction
Benchmark Conditions (2004)	Lendt Lake	37	-		37	9	-	-	**-**	-		9	46	-	
	Moody Lake	642	-		642	4	9	-	**0.75**	490	368	381	1,023	-	
	Third Lake	6	-		6	9	16	-	**-**	-		25	31	-	
	Sea Lake	74	-		74	7	-	-	**-**	-		7	81	-	
													-		
	Bone Lake	986	-		986	27	84	-	**0.80**	165	132	243	1,229	-	
	Nielsen Lake	89	-		89	4	-	-	**-**	-		4	93	-	
	Birch Lake	643	-		643	4	4	2	**1.00**	18	18	28	672	**250**	
	School Lake	865	-		865	7	8	3	**1.00**	46	46	63	928	-	
	Little Comfort Lake	862	**314**		1,176	5	16	2	**1.00**	56	56	79	1,255	-	
	Clear Lake	45	-		45	5	-	2	**-**	-		8	53	-	
	Twin Lake	139	-		139	3	-	1	**-**	-		4	143	-	
	Cranberry Lake	113	-		113	3	-	1	**-**	-		4	117	-	
	Elwell Lake	38	-		38	2	-	1	**-**	-		3	42	-	
	Sylvan Lake	208	-		208	11	72	5	**1.00**	17	17	105	314	**(240)**	
	Shields Lake	189	-		189	4	-	2	**1.00**	76	76	81	270	**837**	
	Forest Lake East	1,400	-		1,400	104	-	46	**1.00**	251	251	401	1,801	-	
	Forest Lake Middle	999	-		999	49	-	22	**1.00**	97	97	168	1,166	-	
	Forest Lake West	1,011	-		1,011	143	-	64	**1.00**	73	73	280	1,291	-	
	Heims Lake	60	-		60	12	-	5	**-**	-		17	77	-	
	shallow pond	1,914	-		1,914	21	-	7	**-**	-		28	1,942	-	
	Comfort Lake	2,157	-		2,157	29	98	13	**0.60**	223	134	274	2,431	**(200)**	
													-		
	First Lake	682	-		682	7	-	-	**-**	-		7	688	-	
	Second Lake	100	-		100	12	-	-	**-**	-		12	112	-	
	Scandia - Lake West o	129	-		129	2	-	-	**-**	-		2	130	-	
reference - benchmark	shallow pond	1,914	-		1,914	21	-	7	**-**	-		28	1,942	-	
	change (proposed - existing)	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Evaluation of Potential Shallow Pond Modification using model for:
Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capitol Improvement Plan

				Lake Response											
				Summer Surface Means										C-B *a* =	C-B *a* =
				TP Concentration			Chlorophyll-*a* Concentration			Secchi Depth				C-B *b* =	C-B *b* =
	Lake Name	NOTES	Adjusted Total Lake P Load	Modeled TP [ug/l]	Estimated TP [ug/L]	Observed Growing Season Average TP [ug/L]	Chl-*a* Calibration Parameter	Modeled Chl-*a* [ug/l]	Observed Growing Season Average Chl-*a* [ug/L]	Secchi Calibration Parameter	Modeled Secchi [m]	Observed Growing Season Average Secchi [m]		Total P Load [kg]	Reference - Total P Load [kg]
Benchmark Conditions (2004)	Lendt Lake		46	41			**1.00**	19		**1.00**	1.4			21	21
	Moody Lake		1,023	152	159		**0.37**	46		**0.88**	0.7			464	464
	Third Lake		31	32.3			**1.00**	13		**1.00**	1.7			14.1	14.1
	Sea Lake		81	72			**1.00**	42		**1.00**	0.9			37	37
			-												
	Bone Lake		1,229	60.3		59.8	**1.00**	32	38	**1.00**	1.0	1.3		557	557
	Nielsen Lake		93	83			**1.00**	52		**1.00**	0.8			42	42
	Birch Lake		922	110	128		**0.35**	27		**2.30**	1.4			418.0	418.0
	School Lake		928	73	73		**1.00**	43		**1.00**	0.9			421	421
	Little Comfort Lake		1,255	78	64		**0.43**	20		**1.30**	1.7			569	569
	Clear Lake		53	60			**1.00**	32		**1.00**	1.0			24	24
	Twin Lake		143	113.0			**1.00**	81		**1.00**	0.6			65.0	65.0
	Cranberry Lake		117	53			**1.00**	26		**1.00**	1.1			53	53
	Elwell Lake		42	61			**1.00**	33		**1.00**	1.0			19	19
	Sylvan Lake		74	20		20	**0.60**	4	3	**1.20**	4.0	5.1		33	33
	Shields Lake		1,107	229		229	**0.20**	45	48	**1.50**	1.3	1.0		502	502
	Forest Lake East		1,801	42.3			**1.00**	19		**1.00**	1.4			817	817
	Forest Lake Middle		1,166	40			**1.00**	18		**1.00**	1.4			529	529
	Forest Lake West		1,291	32.2		32.8	**1.00**	13	10	**1.00**	1.7	1.9		585.4	585.4
	Heims Lake		77	62.2			**1.00**	34		**1.00**	1.0			34.9	34.9
	shallow pond		1,942	49	85		**1.00**	24		**1.00**	1.2			881	881
	Comfort Lake		2,231	39		40	**1.00**	17	17	**1.00**	1.5	1.8		1,012	1,118
			-			30%									
	First Lake		688	341			**1.00**	406		**1.00**	0.2			312	312
	Second Lake		112	86			**1.00**	54		**1.00**	0.8			51	51
	Scandia - Lake West o		130	294			**1.00**	327		**1.00**	0.3			59	59
reference - benchmark	shallow pond		1,942	60	85		**1.00**	32		**1.00**	1.0			881	881
	change (proposed - existing)	-	-	(10)	-	-	-	(8)	-	-	0	-	#	-	-

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Modified CLFLWD Watershed Loading and Lake Response Model (WLLRM)

Evaluation of Potential Shallow Pond Modification using model for:

Watershed and Lake Water Quality Modeling Investigation for the Development of a Watershed Capitol Improvement Plan

	Lake Name	change (proposed - existing) (kg)	CB Calibration Factor	Modeled Summer Mean TP [ug/l]	Ratio of Corrected FWMC / Summer TP [--]	Phosphorus Outflow (Ratio-Adjusted) [kg/yr]	Phosphorus Retention (P Load - Outflow P) [kg/yr]	Phosphorus Outflow (Ratio-Adjusted) [lb/yr]	Phosphorus Retention (P Load - Outflow P) [lb/yr]
		Phosphorus Fate and Transport - - - Canfield & Bachmann Natural Lake Model							
			0.162	**0.114**					
			0.458	**0.589**					
Benchmark Conditions (2004)	Lendt Lake	-	**1.00**	**41.4**	0.84	7.0	13.9	15.5	31
	Moody Lake	-	**1.20**	**152.0**	0.84	84	380	186	837
	Third Lake	-	**1.00**	**32.3**	0.84	5.1	9.1	11.2	20.0
	Sea Lake	-	**1.00**	**71.6**	0.84	10	26	23	58
		-							
	Bone Lake	-	**1.20**	**60.3**	0.78	115	442	254	975
	Nielsen Lake	-	**1.00**	**83.1**	0.84	16	26	35	58
	Birch Lake	-	**1.20**	**109.8**	0.84	266.4	151.6	587.4	334.2
	School Lake	-	**1.10**	**73.1**	0.84	215.5	205.5	475.2	453
	Little Comfort Lake	-	**1.00**	**77.7**	0.84	307	261	678	577
	Clear Lake	-	**1.00**	**60.4**	0.83	8	16	17	36
	Twin Lake	-	**1.00**	**113.0**	0.83	28.2	36.8	62.1	81.2
	Cranberry Lake	-	**1.00**	**52.6**	0.83	33.5	19.8	73.8	44
	Elwell Lake	-	**1.00**	**60.8**	0.83	8	10	19	23
	Sylvan Lake	-	**1.40**	**20.4**	0.84	9	24	20	54
	Shields Lake	-	**1.00**	**228.9**	0.73	146	357	321	786
	Forest Lake East	-	**1.20**	**42.3**	0.83	111	705	245	1,555
	Forest Lake Middle	-	**1.30**	**40.2**	0.83	141.0	388.0	310.9	855
	Forest Lake West	-	**1.00**	**32.2**	0.83	163.8	421.6	361.2	929.6
	Heims Lake	-	**1.00**	**62.2**	1.03	6.9	28.0	15.2	61.7
	shallow pond	-	**3.30**	**49.3**	1.03	499	381	1,101	841
	Comfort Lake	106	**1.20**	**38.5**	1.03	593.8	418.1	1,309.4	922
		-							
	First Lake	-	**1.00**	**341.5**	0.78	-	312	-	688
	Second Lake	-	**1.00**	**86.1**	0.78	4.0	47	8.8	102.9
	Scandia - Lake West o	-	**1.00**	**294.3**	0.78	-	59	-	130
		-							
reference - benchmark	shallow pond	-	**3.30**	**59.7**	1.03	605	275	1,335	607
	change (proposed - existing)	-	-	(10)	-	(106)	106	**(234)**	**234**
		-							

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

File Directory	X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\07_Modeling\Water Quality\
Case Title	Sunrise Project - Designs
Case File	p8_Sunrise_v2.p8c
Particle File	nurp50.p8p
Temperature File	Msp4999.tmp
Storm File	Msp4999.pcp
Precip Scale Factor	1
Watersheds	5
Devices	7
Particles	5
WQ Components	7
Start Date	01/02/49
Keep Date	01/02/49
Stop Date	09/26/99
Storm Count	3602
Total Hours	444600
Wet Hours	42901
Precip (in)	1405
Rain (in)	1219
Snowfall (in)	187
Snowmelt (in)	187
EvapoTran(in)	0
Overall TSS Removal(%)	1
Water Balance Error(%)	0
TSS Mass Balance Error (%)	0

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Case Title	Sunrise Project - Designs
Case Data File	p8_Sunrise_v2.p8c
Path	X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\07_Modeling\Water Quality\
Case Notes:	Proposed project components - without Shallow Pond improvements
Storm Data File	Msp4999.pcp
Particle File	nurp50.p8p
Air Temp File File	Msp4999.tmp

Time Steps Per Hour	4
Minimum Inter-Event Time (hrs)	10
Maximum Continuity Error %	2
Rainfall Breakpoint (inches)	0.8
Precipitation Scale Factor	1
Air Temp Offset (deg-F)	0
Loops Thru Storm File	1
Simulation Dates	
Start	1/1/1949
Keep	1/1/1949
Stop	12/31/1999

Max Snowfall Temperature (deg-f)	32.0
SnowMelt Temperature (deg-f)	32.0
Snowmelt Coef (in/degF-Day)	0.06
Soil Freeze Temp (deg-F)	32.0
Snowmelt Abstraction Factor	1.00
Evapo-Trans. Calibration Factor	1.00
Growing Season Start Month	5
Growing Season End Month	10

5-Day Antecedent Rainfall + Runoff (inches)

P8 Model Results - Project Designs

CN Antecedent Moisture Condition	AMC-II	AMC-III
Growing Season	1.40	2.10
NonGrowing Season	0.50	1.10

Watershed Data							
Watershed Name	McCullough	Bixby	Archies	TaxForfeit	TaxForfeit2		
Runoff to Device	McCullough	Bixby	Archies-pretreat	Tax Forfeit	Tax Forfeit 2		
Infiltration to Device							
Watershed Area	161.9	1123.1	363.6	908.8	143		
SCS Curve Number (Pervious)	61	61	61	61	61		
Scale Factor for Pervious Runoff Load	1	1	1	1	1		
Indirectly Connected Imperv Fraction	0.5	0.4	0.67	0.42	0.55		
UnSwept Impervious Fraction	0.2	0.15	0	0	0		
UnSwept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02		
UnSwept Imperv. Runoff Coefficient	1	1	1	1	1		
UnSwept Scale Factor for Particle Loads	1	1	1	1	1		
Swept Impervious Fraction	0	0	0	0	0		
Swept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02		
Swept Imperv. Runoff Coefficient	1	1	1	1	1		
Swept Scale Factor for Particle Loads	1	1	1	1	1		
Sweeping Frequency	0	0.5	0.5	0.5	0.5		
Sweeping Efficiency	1	1	1	1	1		
Sweeping Start Date (MMDD)	101	101	101	101	101		
Sweeping Stop Date (MMDD)	1231	1231	1231	1231	1231		

Device Data							
Device Name	McCullough	Bixby	Archies-pretreat	Tax Forfeit	Tax Forfeit 2	diversion	Archies
Device Type	POND	POND	POND	POND	POND	SPLITTER	POND
Infiltration Outlet							
Normal Outlet	Bixby	diversion	Archies	Tax Forfeit 2		Archies-pretreat	
Spillway Outlet	Bixby	diversion	Archies	Tax Forfeit 2			
Particle Removal Scale Factor	1	1	1	1	1		1
Bottom Elevation (ft)	891	890	883	888	888		885
Bottom Area (acres)	0.01	6.6	0.01	0.01	0.1		0.01
Permanent Pool Area (acres)	6.3	66	0.97	20.08	0.1		3.52
Permanent Pool Volume (ac-ft)	8.4	72.6	1.77	16.245	0		6.09
Perm Pool Infilt Rate (in/hr)	0	0	0	0	0		0

P8 Model Results - Project Designs

Flood Pool Area (acres)	15.52	98.27	1.33	42.91	24.4		25.67
Flood Pool Volume (ac-ft)	41.3	236.87	4.07	123.24	62.06		68.4
Flood Pool Infilt Rate (in/hr)	0	0	0	0	0		0
Infilt Basin Void Fraction (%)							
Detention Pond Outlet Parameters							
Outlet Type	WEIR	WEIR	WEIR	WEIR	ORIFICE		WEIR
Outlet Orifice Diameter (in)					36		
Orifice Discharge Coef					0.6		
Outlet Weir Length (ft)	38	8	9.43	38			4.71
Weir Discharge Coef	3.1	3.3	3.3	3.3			3.3
Perforated Riser Height (ft)							
Number of Holes in Riser							
Holes Diameter							
Flood Pool Drain Time (hrs)							
Swale Parameters							
Length of Flow Path (ft)							
Slope of Flow Path %							
Bottom Width (ft)							
Side Slope (ft-v/ft-h)							
Maximum Depth of Flow (ft)							
Mannings n Constant							
Hydraulic Model							
Pipe, Splitter, Aquifer Parameter							
Hydraulic Res. Time (hrs)						0	

Particle Data					
Particle File	nurp50.p8p				
Particle Class	P0%	P10%	P30%	P50%	P80%
Filtration Efficiency (%)	90	100	100	100	100
Settling Velocity (ft/hr)	0	0.03	0.3	1.5	15
First Order Decay Rate (1/day)	0	0	0	0	0
2nd Order Decay (1/day-ppm)	0	0	0	0	0
Impervious Runoff Conc (ppm)	1	0	0	0	0
Pervious Runoff Conc (ppm)	1	100	100	100	200
Pervious Conc Exponent	0	1	1	1	1
Accum. Rate (lbs-ac-day)	0	1.75	1.75	1.75	3.5
Particle Removal Rate (1/day)	0	0.25	0.25	0.25	0.25

P8 Model Results - Project Designs

Washoff Coefficient	0	20	20	20	20
Washoff Exponent	0	2	2	2	2
Sweeper Efficiency	0	0	0	5	15

Water Quality Component Data								
Component Name	TSS	TP	TKN	CU	PB	ZN	HC	

Water Quality Criteria (ppm)								
Level 1	5	0.025	2	2	0.02	5	0.1	
Level 2	10	0.05	1	0.0048	0.014	0.0362	0.5	
Level 3	20	0.1	0.5	0.02	0.15	0.38	1	

Content Scale Factor	1	1	1	1	1	1	1	

Particle Composition (mg/kg)								
P0%	0	99000	600000	13600	2000	640000	250000	
P10%	1000000	3850	15000	340	180	1600	22500	
P30%	1000000	3850	15000	340	180	1600	22500	
P50%	1000000	3850	15000	340	180	1600	22500	
P80%	1000000	0	0	340	180	0	22500	

P8-V3.X p8_Sunrise_v2.p8c

Watershed Label	Total Area acres	Outflow Device	Percol Device	Pervious Curve Number	Indirect Imperv Fraction	Pervious Load Factor	Directly Connected UnSwept Areas---> Imperv Fraction	Depress Storage inches	Runoff Coef	Imperv Load Factor	Directly Connected Swept Areas---> Imperv Fraction	Depress Storage inches	Runoff Coef	Imperv Load Factor	Street Sweeping Parameters Start Date MMDD	Stop Date MMDD	Sweep Effic	Sweep Freq 1/week
McCullough	161.9	McCullough		61	0.500	1	0.2	0.02	1	1	0	0.02	1	1	101	1231	1	0
Bixby	1123.1	Bixby		61	0.400	1	0.15	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
Archies	363.6	Archies-pretreat		61	0.670	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
TaxForfeit	908.8	Tax Forfeit		61	0.420	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
TaxForfeit2	143	Tax Forfeit 2		61	0.550	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Devices Listed in Downstream Order

Device:	McCullough	Type:	POND
	Discharges normal outlet to		Bixby
	Discharges spillway to		Bixby
	Runoff from watershed		McCullough
Device:	Bixby	Type:	POND
	Discharges normal outlet to		diversion
	Discharges spillway to		diversion
	Runoff from watershed		Bixby
Device:	Tax Forfeit	Type:	POND
	Discharges normal outlet to		Tax Forfeit 2
	Discharges spillway to		Tax Forfeit 2
	Runoff from watershed		TaxForfeit
Device:	Tax Forfeit 2	Type:	POND
	Runoff from watershed		TaxForfeit2
Device:	diversion	Type:	SPLITTER
	Discharges normal outlet to		Archies-pretreat
Device:	Archies-pretreat	Type:	POND
	Discharges normal outlet to		Archies
	Discharges spillway to		Archies
	Runoff from watershed		Archies
Device:	Archies	Type:	POND

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Device Rating Tables

Device: McCullough, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
891.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
893.66	6.30	8.40	0.00	0.00	0.00	0.00	0.00	1.33	0.00
893.67	6.32	8.46	0.00	0.12	0.00	0.12	0.44	1.34	869.30
894.09	7.35	11.33	0.00	33.16	0.00	33.16	107.43	1.54	4.13
894.51	8.37	14.63	0.00	92.15	0.00	92.15	262.12	1.75	1.92
894.93	9.39	18.35	0.00	168.30	0.00	168.30	426.62	1.95	1.32
895.35	10.41	22.50	0.00	258.35	0.00	258.35	590.62	2.16	1.05
895.77	11.43	27.09	0.00	360.41	0.00	360.41	750.32	2.37	0.91
896.19	12.45	32.10	0.00	473.21	0.00	473.21	904.33	2.58	0.82
896.61	13.48	37.54	0.00	595.81	0.00	595.81	1052.29	2.79	0.76
897.03	14.50	43.40	0.00	727.48	0.00	727.48	1194.29	2.99	0.72
897.45	15.52	49.70	0.00	867.63	0.00	867.63	1330.60	3.20	0.69

Device: Bixby, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
890.00	6.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
892.00	66.00	72.60	0.00	0.00	0.00	0.00	0.00	1.10	0.00
892.01	66.11	73.26	0.00	0.03	0.00	0.03	0.01	1.11	33577.76
892.33	69.69	94.94	0.00	4.99	0.00	4.99	1.70	1.36	230.25
892.65	73.26	117.76	0.00	13.79	0.00	13.79	4.48	1.61	103.32
892.97	76.83	141.73	0.00	25.14	0.00	25.14	7.79	1.84	68.21
893.29	80.40	166.83	0.00	38.56	0.00	38.56	11.41	2.07	52.35
893.61	83.98	193.08	0.00	53.76	0.00	53.76	15.24	2.30	43.46
893.93	87.55	220.46	0.00	70.56	0.00	70.56	19.18	2.52	37.81

894.25	91.12	248.99	0.00	88.82	0.00	88.82	23.20	2.73	33.92
894.56	94.70	278.66	0.00	108.43	0.00	108.43	27.25	2.94	31.10
894.88	98.27	309.47	0.00	129.29	0.00	129.29	31.32	3.15	28.96

Device: Tax Forfeit, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
888.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
889.62	20.08	16.25	0.00	0.00	0.00	0.00	0.00	0.81	0.00
889.63	20.14	16.45	0.00	0.13	0.00	0.13	0.15	0.82	1586.90
890.06	22.67	25.73	0.00	37.06	0.00	37.06	38.91	1.13	8.40
890.49	25.20	36.11	0.00	103.05	0.00	103.05	97.34	1.43	4.24
890.93	27.73	47.58	0.00	188.24	0.00	188.24	161.58	1.72	3.06
891.36	30.26	60.16	0.00	288.98	0.00	288.98	227.31	1.99	2.52
891.80	32.79	73.83	0.00	403.17	0.00	403.17	292.66	2.25	2.22
892.23	35.32	88.60	0.00	529.37	0.00	529.37	356.74	2.51	2.03
892.66	37.85	104.46	0.00	666.53	0.00	666.53	419.15	2.76	1.90
893.10	40.38	121.42	0.00	813.85	0.00	813.85	479.72	3.01	1.81
893.53	42.91	139.49	0.00	970.65	0.00	970.65	538.41	3.25	1.74

Device: Tax Forfeit 2, Type: POND, Outlet Type: ORIFICE

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
888.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
888.01	0.15	0.00	0.00	0.14	0.00	0.14	22.35	0.01	0.11
888.52	2.57	0.69	0.00	7.16	0.00	7.16	66.27	0.27	1.16
889.02	5.00	2.60	0.00	14.19	0.00	14.19	67.57	0.52	2.22
889.53	7.42	5.74	0.00	21.22	0.00	21.22	68.02	0.77	3.28
890.03	9.85	10.11	0.00	28.24	0.00	28.24	68.25	1.03	4.33
890.54	12.27	15.70	0.00	35.27	0.00	35.27	68.39	1.28	5.39
891.04	14.70	22.52	0.00	42.29	0.00	42.29	68.47	1.53	6.44
891.55	17.12	30.57	0.00	48.72	0.00	48.72	67.72	1.79	7.59
892.05	19.55	39.84	0.00	54.40	0.00	54.40	66.23	2.04	8.86
892.56	21.97	50.34	0.00	59.54	0.00	59.54	64.49	2.29	10.23
893.07	24.40	62.06	0.00	64.27	0.00	64.27	62.70	2.54	11.68

Device: diversion, Type: SPLITTER

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs

Device: Archies-pretreat, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
883.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
886.61	0.97	1.77	0.00	0.00	0.00	0.00	0.00	1.82	0.00
886.62	0.97	1.78	0.00	0.03	0.00	0.03	0.76	1.83	692.00
887.01	1.01	2.17	0.00	7.94	0.00	7.94	186.84	2.14	3.31
887.41	1.05	2.57	0.00	22.03	0.00	22.03	498.95	2.45	1.41
887.80	1.09	2.99	0.00	40.21	0.00	40.21	877.55	2.74	0.90
888.19	1.13	3.43	0.00	61.72	0.00	61.72	1299.29	3.03	0.67
888.58	1.17	3.88	0.00	86.09	0.00	86.09	1750.60	3.31	0.55
888.97	1.21	4.35	0.00	113.02	0.00	113.02	2222.56	3.59	0.47
889.37	1.25	4.83	0.00	142.29	0.00	142.29	2708.93	3.86	0.41
889.76	1.29	5.33	0.00	173.73	0.00	173.73	3205.17	4.13	0.37
890.15	1.33	5.84	0.00	207.19	0.00	207.19	3707.88	4.39	0.34

Device: Archies, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
885.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
888.45	3.52	6.09	0.00	0.00	0.00	0.00	0.00	1.73	0.00
888.46	3.57	6.13	0.00	0.02	0.00	0.02	0.10	1.72	4768.56
888.98	6.02	8.62	0.00	5.99	0.00	5.99	23.67	1.43	17.40
889.50	8.48	12.38	0.00	16.70	0.00	16.70	46.89	1.46	8.97
890.02	10.93	17.43	0.00	30.54	0.00	30.54	66.48	1.59	6.90
890.54	13.39	23.75	0.00	46.91	0.00	46.91	83.38	1.77	6.13
891.06	15.85	31.34	0.00	65.47	0.00	65.47	98.33	1.98	5.79
891.58	18.30	40.22	0.00	85.97	0.00	85.97	111.81	2.20	5.66
892.10	20.76	50.37	0.00	108.27	0.00	108.27	124.14	2.43	5.63

892.62	23.21	61.79	0.00	132.21	0.00	132.21	135.55	2.66	5.66
893.14	25.67	74.49	0.00	157.69	0.00	157.69	146.22	2.90	5.72

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Hydraulics

Sedimentation rates assume bulk density of 1 ton per cubic yard of wet sediment.

Variable	Units	McCullough	Bixby	Tax Forfeit	Tax Forfeit 2	diversion	Archies-pretreat	Archies
Total Inflow	ac-ft	6261.32	39039.45	12075.13	14549.80	39038.02	8307.33	8309.89
Total Outflow	ac-ft	6261.23	39038.02	12075.16	14549.87	39038.02	8309.89	8309.89
Mean Inflow	cfs	0.17	1.06	0.33	0.40	1.06	0.23	0.23
Mean Outflow	cfs	0.17	1.06	0.33	0.40	1.06	0.23	0.23
Max Inflow	cfs	432.87	3346.42	2356.96	2734.79	3346.42	972.63	972.63
Max Outflow	cfs	413.42	3346.42	2356.96	2734.79	3346.42	972.63	972.63
Min Elev	ft	893.66	892.00	889.62	888.01	0.00	886.61	888.45
Max Elev	ft	895.97	894.88	893.53	893.07	0.00	890.15	893.14
Max Velocity	ft/sec	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wet Period	%	100.00	100.00	100.00	2.92	0.00	100.00	100.00
WtrBal Error	ac-ft	0.09	0.00	-0.03	-0.06	0.00	-2.56	0.00
WtrBal Error%	%	0.00	0.00	0.00	0.00	0.00	-0.03	0.00
Max Area	acres	11.91	98.27	42.91	24.40	0.00	1.33	25.67
Mean Hyd Load	in/day	0.34	0.26	0.18	0.39	0.00	4.05	0.21
Max Hyd Load	in/hr	36.03	33.77	54.47	111.16	0.00	725.25	37.58
Sed Rate Mass	tons/ac-yr	1.21	0.86	0.46	0.31	0.00	4.58	0.41
Sed Rate Vol	yd3/yr	14.47	84.18	19.62	7.48	0.00	6.10	10.42
Sed Rate Depth	in/yr	0.01	0.01	0.00	0.00	0.00	0.03	0.00
Max Volume	ac-ft	29.44	309.47	139.49	62.06	0.00	5.84	74.49
Direct Watershed	acres	161.90	1123.10	908.80	143.00	0.00	363.60	0.00
Unit Runoff	inches/yr	9.15	6.91	3.14	4.09	0.00	5.41	0.00

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Watershed areas contributing surface runoff to each device

	wtrshd total acres	imperv acres	imperv %	runoff in/yr	perm p area acres	volume ac-ft	depth ft	total p area acres	volume ac-ft	depth ft
McCullough	161.90	32.38	20.00	9.15	6.30	8.40	1.33	15.52	49.70	3.20
Bixby	1123.10	168.47	15.00	8.22	66.00	72.60	1.10	98.27	309.47	3.15
Tax Forfeit	908.80	0.00	0.00	3.14	20.08	16.25	0.81	42.91	139.49	3.25
Tax Forfeit 2	143.00	0.00	0.00	24.07	0.14	0.00	0.01	24.40	62.06	2.54
Archies-pretreat	363.60	0.00	0.00	5.41	0.97	1.77	1.82	1.33	5.84	4.39
Archies	0.00	0.00	0.00		3.52	6.09	1.73	25.67	74.49	2.90
TOTAL	2700.40	200.85	7.44	7.76	97.01	105.11	1.08	208.10	641.05	3.08

Normalized device areas & volumes vs. performance (tss removal)

wi = impervious watershed area draining directly into device (acres)
wt = total watershed area draining directly into device(acres)
ap = permanent pool area (acres)
vp = permanent pool volume (ac-ft)
at = total device area (acres)
vt = total device volume (ac-ft)

device	type	imperv ap/wi %	vp/wi inches	total ap/wt %	vp/wt inches	flood p at/wt %	vt/wt inches	hydraulic load ft/yr	tss removal %
McCullough	POND	19.46	3.11	3.89	0.62	9.59	3.68	7.95	78.99
Bixby	POND	39.18	5.17	5.88	0.78	8.75	3.31	7.83	85.00
Tax Forfeit	POND	0.00	0.00	2.21	0.21	4.72	1.84	5.55	55.83
Tax Forfeit 2	POND	0.00	0.00	0.10	0.00	17.06	5.21	11.76	32.82

P8 Model Results - Project Designs

Archies-pretreat	POND	0.00	0.00	0.27	0.06	0.37	0.19	123.15	24.51
Archies	POND	0.00	0.00	0.00	0.00	0.00	0.00	6.38	55.49
TOTAL	NONE	48.30	6.28	3.59	0.47	7.71	2.85	8.39	78.69

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Mass Balances by Device and Variable

Device: OVERALL Type: NONE Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	61896.65	1.68	18338937.8	361581.5	109.01
06 normal outlet	21740.78	0.59	1032991.1	20367.1	17.48
07 spillway outlet	40157.00	1.09	2874830.4	56681.9	26.34
08 sedimen + decay	0.00	0.00	14431076.6	284531.8	
09 total inflow	61896.65	1.68	18338937.8	361581.5	109.01
10 surface outflow	61897.78	1.68	3907821.4	77048.9	23.23
12 total outflow	61897.78	1.68	3907821.4	77048.9	23.23
13 total trapped	0.00	0.00	14431076.6	284531.8	
14 storage increase	1.43	0.00	39.7	0.8	
15 mass balance check	-2.56	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	78.7	78.7	

Device: OVERALL Type: NONE Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	61896.65	1.68	59018.2	1163.6	0.35
06 normal outlet	21740.78	0.59	9750.0	192.2	0.16
07 spillway outlet	40157.00	1.09	21117.6	416.4	0.19
08 sedimen + decay	0.00	0.00	28121.5	554.5	
09 total inflow	61896.65	1.68	59018.2	1163.6	0.35
10 surface outflow	61897.78	1.68	30867.6	608.6	0.18
12 total outflow	61897.78	1.68	30867.6	608.6	0.18
13 total trapped	0.00	0.00	28121.5	554.5	
14 storage increase	1.43	0.00	28.8	0.6	
15 mass balance check	-2.56	0.00	0.3	0.0	

Reduction (%)	0.00	0.00	47.6	47.6	

Device: McCullough Type: POND Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	6261.32	0.17	1857954.2	36632.5	109.17
06 normal outlet	6261.23	0.17	390417.5	7697.7	22.94
08 sedimen + decay	0.00	0.00	1467529.3	28934.7	
09 total inflow	6261.32	0.17	1857954.2	36632.5	109.17
10 surface outflow	6261.23	0.17	390417.5	7697.7	22.94
12 total outflow	6261.23	0.17	390417.5	7697.7	22.94
13 total trapped	0.00	0.00	1467529.3	28934.7	
14 storage increase	0.00	0.00	7.5	0.1	
15 mass balance check	0.09	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	79.0	79.0	

Device: McCullough Type: POND Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	6261.32	0.17	5976.7	117.8	0.35
06 normal outlet	6261.23	0.17	3083.0	60.8	0.18
08 sedimen + decay	0.00	0.00	2891.3	57.0	
09 total inflow	6261.32	0.17	5976.7	117.8	0.35
10 surface outflow	6261.23	0.17	3083.0	60.8	0.18
12 total outflow	6261.23	0.17	3083.0	60.8	0.18
13 total trapped	0.00	0.00	2891.3	57.0	
14 storage increase	0.00	0.00	2.3	0.0	
15 mass balance check	0.09	0.00	0.1	0.0	
Reduction (%)	0.00	0.00	48.4	48.4	

Device: Bixby Type: POND Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	32778.22	0.89	9655477.5	190373.2	108.38
02 upstream device	6261.23	0.17	390417.5	7697.7	22.94
06 normal outlet	38156.86	1.04	582941.8	11493.6	5.62
07 spillway outlet	881.16	0.02	924110.7	18220.3	385.85

08 sedimen + decay	0.00	0.00	8538810.4	168356.3	
09 total inflow	39039.45	1.06	10045895.0	198070.9	94.68
10 surface outflow	39038.02	1.06	1507052.6	29714.0	14.20
12 total outflow	39038.02	1.06	1507052.6	29714.0	14.20
13 total trapped	0.00	0.00	8538810.4	168356.3	
14 storage increase	1.43	0.00	32.0	0.6	
15 mass balance check	0.00	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	85.0	85.0	

Device: Bixby Type: POND Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	32778.22	0.89	31124.2	613.7	0.35
02 upstream device	6261.23	0.17	3083.0	60.8	0.18
06 normal outlet	38156.86	1.04	12460.6	245.7	0.12
07 spillway outlet	881.16	0.02	3456.9	68.2	1.44
08 sedimen + decay	0.00	0.00	18269.7	360.2	
09 total inflow	39039.45	1.06	34207.2	674.4	0.32
10 surface outflow	39038.02	1.06	15917.5	313.8	0.15
12 total outflow	39038.02	1.06	15917.5	313.8	0.15
13 total trapped	0.00	0.00	18269.7	360.2	
14 storage increase	1.43	0.00	20.0	0.4	
15 mass balance check	0.00	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	53.4	53.4	

Device: Tax Forfeit Type: POND Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	12075.13	0.33	3565361.1	70296.8	108.63
06 normal outlet	11892.99	0.32	1213695.0	23929.9	37.55
07 spillway outlet	182.17	0.00	361021.4	7118.1	729.14
08 sedimen + decay	0.00	0.00	1990644.7	39248.7	
09 total inflow	12075.13	0.33	3565361.1	70296.8	108.63
10 surface outflow	12075.16	0.33	1574716.4	31048.1	47.98
12 total outflow	12075.16	0.33	1574716.4	31048.1	47.98
13 total trapped	0.00	0.00	1990644.7	39248.7	
14 storage increase	0.00	0.00	0.0	0.0	

15 mass balance check	-0.03	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	55.8	55.8	

Device: Tax Forfeit | Type: POND | Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	12075.13	0.33	11485.2	226.4	0.35
06 normal outlet	11892.99	0.32	7516.2	148.2	0.23
07 spillway outlet	182.17	0.00	1221.0	24.1	2.47
08 sedimen + decay	0.00	0.00	2743.5	54.1	
09 total inflow	12075.13	0.33	11485.2	226.4	0.35
10 surface outflow	12075.16	0.33	8737.2	172.3	0.27
12 total outflow	12075.16	0.33	8737.2	172.3	0.27
13 total trapped	0.00	0.00	2743.5	54.1	
14 storage increase	0.00	0.00	4.4	0.1	
15 mass balance check	-0.03	0.00	0.2	0.0	
Reduction (%)	0.00	0.00	23.9	23.9	

Device: Tax Forfeit 2 | Type: POND | Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	2474.65	0.07	737287.9	14536.8	109.62
02 upstream device	12075.16	0.33	1574716.4	31048.1	47.98
06 normal outlet	13606.00	0.37	459208.1	9054.0	12.42
07 spillway outlet	943.86	0.03	1093963.8	21569.2	426.43
08 sedimen + decay	0.00	0.00	758832.4	14961.6	
09 total inflow	14549.80	0.40	2312004.3	45584.9	58.46
10 surface outflow	14549.87	0.40	1553172.0	30623.3	39.27
12 total outflow	14549.87	0.40	1553172.0	30623.3	39.27
13 total trapped	0.00	0.00	758832.4	14961.6	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	-0.06	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	32.8	32.8	

Device: Tax Forfeit 2 | Type: POND | Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm

01 watershed inflows	2474.65	0.07	2369.0	46.7	0.35
02 upstream device	12075.16	0.33	8737.2	172.3	0.27
06 normal outlet	13606.00	0.37	5403.2	106.5	0.15
07 spillway outlet	943.86	0.03	4189.6	82.6	1.63
08 sedimen + decay	0.00	0.00	1513.4	29.8	
09 total inflow	14549.80	0.40	11106.2	219.0	0.28
10 surface outflow	14549.87	0.40	9592.8	189.1	0.24
12 total outflow	14549.87	0.40	9592.8	189.1	0.24
13 total trapped	0.00	0.00	1513.4	29.8	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	-0.06	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	13.6	13.6	

Device: diversion Type: SPLITTER Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
02 upstream device	39038.02	1.06	1507052.6	29714.0	14.20
07 spillway outlet	39038.02	1.06	1507052.6	29714.0	14.20
09 total inflow	39038.02	1.06	1507052.6	29714.0	14.20
10 surface outflow	39038.02	1.06	1507052.6	29714.0	14.20
12 total outflow	39038.02	1.06	1507052.6	29714.0	14.20
Reduction (%)	0.00	0.00	0.0	0.0	

Device: diversion Type: SPLITTER Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
02 upstream device	39038.02	1.06	15917.5	313.8	0.15
07 spillway outlet	39038.02	1.06	15917.5	313.8	0.15
09 total inflow	39038.02	1.06	15917.5	313.8	0.15
10 surface outflow	39038.02	1.06	15917.5	313.8	0.15
12 total outflow	39038.02	1.06	15917.5	313.8	0.15
Reduction (%)	0.00	0.00	0.0	0.0	

Device: Archies-pretreat Type: POND Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	8307.33	0.23	2522857.0	49742.2	111.73

06 normal outlet	7921.60	0.22	1082015.5	21333.7	50.25
07 spillway outlet	388.29	0.01	822479.8	16216.5	779.33
08 sedimen + decay	0.00	0.00	618361.5	12192.0	
09 total inflow	8307.33	0.23	2522857.0	49742.2	111.73
10 surface outflow	8309.89	0.23	1904495.3	37550.2	84.32
12 total outflow	8309.89	0.23	1904495.3	37550.2	84.32
13 total trapped	0.00	0.00	618361.5	12192.0	
14 storage increase	0.00	0.00	0.1	0.0	
15 mass balance check	-2.56	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	24.5	24.5	

Device: Archies-pretreat Type: POND Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	8307.33	0.23	8063.2	159.0	0.36
06 normal outlet	7921.60	0.22	5338.2	105.3	0.25
07 spillway outlet	388.29	0.01	2203.5	43.4	2.09
08 sedimen + decay	0.00	0.00	521.0	10.3	
09 total inflow	8307.33	0.23	8063.2	159.0	0.36
10 surface outflow	8309.89	0.23	7541.6	148.7	0.33
12 total outflow	8309.89	0.23	7541.6	148.7	0.33
13 total trapped	0.00	0.00	521.0	10.3	
14 storage increase	0.00	0.00	0.5	0.0	
15 mass balance check	-2.56	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	6.5	6.5	

Device: Archies Type: POND Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
02 upstream device	8309.89	0.23	1904495.3	37550.2	84.32
06 normal outlet	8134.78	0.22	573782.9	11313.0	25.95
07 spillway outlet	175.12	0.00	273814.0	5398.7	575.28
08 sedimen + decay	0.00	0.00	1056898.3	20838.4	
09 total inflow	8309.89	0.23	1904495.3	37550.2	84.32
10 surface outflow	8309.89	0.23	847596.9	16711.7	37.53
12 total outflow	8309.89	0.23	847596.9	16711.7	37.53
13 total trapped	0.00	0.00	1056898.3	20838.4	

14 storage increase	0.00	0.00	0.1	0.0	
15 mass balance check	0.00	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	55.5	55.5	

Device: Archies | Type: POND | Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
02 upstream device	8309.89	0.23	7541.6	148.7	0.33
06 normal outlet	8134.78	0.22	4346.9	85.7	0.20
07 spillway outlet	175.12	0.00	1010.5	19.9	2.12
08 sedimen + decay	0.00	0.00	2182.6	43.0	
09 total inflow	8309.89	0.23	7541.6	148.7	0.33
10 surface outflow	8309.89	0.23	5357.3	105.6	0.24
12 total outflow	8309.89	0.23	5357.3	105.6	0.24
13 total trapped	0.00	0.00	2182.6	43.0	
14 storage increase	0.00	0.00	1.6	0.0	
15 mass balance check	0.00	0.00	0.0	0.0	
Reduction (%)	0.00	0.00	28.9	28.9	

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Flow-Wtd-Mean Concs (ppm) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.68	61897.8	23.23	0.18
McCullough	POND	0.17	6261.2	22.94	0.18
Bixby	POND	1.06	39038.0	14.20	0.15
Tax Forfeit	POND	0.33	12075.2	47.98	0.27
Tax Forfeit 2	POND	0.40	14549.9	39.27	0.24
diversion	SPLITTER	1.06	39038.0	14.20	0.15
Archies-pretreat	POND	0.23	8309.9	84.32	0.33
Archies	POND	0.23	8309.9	37.53	0.24

Outflow Loads (lbs) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.68	61897.8	3907821.44	30867.60
McCullough	POND	0.17	6261.2	390417.47	3083.03
Bixby	POND	1.06	39038.0	1507052.56	15917.47
Tax Forfeit	POND	0.33	12075.2	1574716.39	8737.16
Tax Forfeit 2	POND	0.40	14549.9	1553171.96	9592.82
diversion	SPLITTER	1.06	39038.0	1507052.56	15917.47
Archies-pretreat	POND	0.23	8309.9	1904495.30	7541.64
Archies	POND	0.23	8309.9	847596.91	5357.32

Removal Efficiency (%)

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.68	61897.8	78.69	47.65
McCullough	POND	0.17	6261.2	78.99	48.38
Bixby	POND	1.06	39038.0	85.00	53.41
Tax Forfeit	POND	0.33	12075.2	55.83	23.89
Tax Forfeit 2	POND	0.40	14549.9	32.82	13.63
diversion	SPLITTER	1.06	39038.0	0.00	0.00

Archies-pretreat	POND	0.23	8309.9	24.51	6.46
Archies	POND	0.23	8309.9	55.49	28.94

Mass Balance Error (%)

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.68	61897.8	0.00	0.00
McCullough	POND	0.17	6261.2	0.00	0.00
Bixby	POND	1.06	39038.0	0.00	0.00
Tax Forfeit	POND	0.33	12075.2	0.00	0.00
Tax Forfeit 2	POND	0.40	14549.9	0.00	0.00
diversion	SPLITTER	1.06	39038.0	0.00	0.00
Archies-pretreat	POND	0.23	8309.9	0.00	0.00
Archies	POND	0.23	8309.9	0.00	0.00

P8 Model Results - Project Designs

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_v2.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Designs	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Concentration Statistics Events with Rainfall + Snowmelt > 0.05 inches

Term: 01 watershed inflows

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	109.008	120.395	0.697	6.355	896.387	100%	99%	93%	5.000	10.000	20.000
OVERALL	TP	2682	0.351	0.377	0.514	0.114	2.170	100%	100%	100%	0.025	0.050	0.100
McCullough	TSS	2682	109.174	121.828	0.675	6.546	790.023	100%	99%	95%	5.000	10.000	20.000
McCullough	TP	2682	0.351	0.380	0.499	0.114	1.924	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	108.377	122.455	0.669	6.546	812.018	100%	99%	95%	5.000	10.000	20.000
Bixby	TP	2682	0.349	0.382	0.496	0.114	1.975	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit	TSS	550	108.633	23.701	2.771	0.001	961.261	54%	38%	24%	5.000	10.000	20.000
Tax Forfeit	TP	550	0.350	0.154	0.987	0.099	2.320	100%	100%	89%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	109.616	25.051	2.641	0.000	987.834	54%	40%	25%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.352	0.157	0.974	0.099	2.381	100%	100%	88%	0.025	0.050	0.100
Archies-pretreat	TSS	966	111.733	28.580	2.408	0.005	1009.617	60%	46%	30%	5.000	10.000	20.000
Archies-pretreat	TP	966	0.357	0.165	0.963	0.099	2.431	100%	100%	91%	0.025	0.050	0.100

Term: 02 upstream device

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
Bixby	TSS	2682	22.941	5.856	2.058	0.011	421.318	43%	16%	2%	5.000	10.000	20.000
Bixby	TP	2682	0.181	0.121	0.354	0.012	1.557	100%	100%	94%	0.025	0.050	0.100
Tax Forfeit 2	TSS	2682	47.980	1.249	10.963	0.000	547.420	3%	2%	1%	5.000	10.000	20.000
Tax Forfeit 2	TP	2682	0.266	0.103	0.464	0.005	1.947	100%	100%	12%	0.025	0.050	0.100
diversion	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
diversion	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Archies	TSS	2682	84.321	5.959	5.668	0.000	901.226	14%	9%	6%	5.000	10.000	20.000
Archies	TP	2682	0.334	0.117	0.793	0.044	2.394	100%	100%	32%	0.025	0.050	0.100

Term: 03 infiltrate

P8 Model Results - Project Designs

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
Term: 04 exfiltrate													
Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
Term: 06 normal outlet													
Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	17.481	1.544	6.244	0.000	303.124	6%	3%	2%	5.000	10.000	20.000
OVERALL	TP	2682	0.165	0.105	0.346	0.013	1.218	100%	100%	29%	0.025	0.050	0.100
McCullough	TSS	2682	22.941	5.856	2.058	0.011	421.318	43%	16%	2%	5.000	10.000	20.000
McCullough	TP	2682	0.181	0.121	0.354	0.012	1.557	100%	100%	94%	0.025	0.050	0.100
Bixby	TSS	2682	5.621	1.791	2.780	0.001	196.276	2%	1%	0%	5.000	10.000	20.000
Bixby	TP	2682	0.120	0.106	0.181	0.008	0.829	100%	100%	83%	0.025	0.050	0.100
Tax Forfeit	TSS	2682	37.546	1.223	10.375	0.000	478.177	3%	2%	1%	5.000	10.000	20.000
Tax Forfeit	TP	2682	0.233	0.103	0.437	0.005	1.749	100%	100%	12%	0.025	0.050	0.100
Tax Forfeit 2	TSS	2682	12.417	1.089	6.524	0.000	228.266	4%	2%	1%	5.000	10.000	20.000
Tax Forfeit 2	TP	2682	0.146	0.106	0.257	0.034	0.950	100%	100%	43%	0.025	0.050	0.100
Archies-pretreat	TSS	2682	50.254	5.674	5.136	0.000	709.278	14%	9%	6%	5.000	10.000	20.000
Archies-pretreat	TP	2682	0.248	0.116	0.711	0.044	1.949	100%	100%	32%	0.025	0.050	0.100
Archies	TSS	2682	25.951	2.118	6.104	0.000	369.771	7%	4%	2%	5.000	10.000	20.000
Archies	TP	2682	0.197	0.107	0.455	0.008	1.456	100%	100%	24%	0.025	0.050	0.100
Term: 07 spillway outlet													
Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	26.339	1.930	5.118	0.001	448.448	2%	1%	0%	5.000	10.000	20.000
OVERALL	TP	2682	0.193	0.106	0.335	0.008	1.684	100%	100%	83%	0.025	0.050	0.100
Bixby	TSS	2	385.851	324.810	0.467	217.443	432.178	100%	100%	100%	5.000	10.000	20.000
Bixby	TP	2	1.443	1.238	0.413	0.876	1.599	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit	TSS	1	729.137	729.137	0.000	729.137	729.137	100%	100%	100%	5.000	10.000	20.000
Tax Forfeit	TP	1	2.466	2.466	0.000	2.466	2.466	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit 2	TSS	5	426.426	194.721	1.096	11.088	529.297	100%	100%	80%	5.000	10.000	20.000
Tax Forfeit 2	TP	5	1.633	0.812	0.937	0.141	1.988	100%	100%	100%	0.025	0.050	0.100
diversion	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000

diversion	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Archies-pretreat	TSS	20	779.330	396.448	0.552	194.814	1010.681	100%	100%	100%	5.000	10.000	20.000
Archies-pretreat	TP	20	2.088	1.152	0.464	0.648	2.647	100%	100%	100%	0.025	0.050	0.100
Archies	TSS	2	575.281	518.907	0.251	426.819	610.996	100%	100%	100%	5.000	10.000	20.000
Archies	TP	2	2.123	1.941	0.217	1.644	2.238	100%	100%	100%	0.025	0.050	0.100

Term: 09 total inflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	109.008	120.395	0.697	6.355	896.387	100%	99%	93%	5.000	10.000	20.000
OVERALL	TP	2682	0.351	0.377	0.514	0.114	2.170	100%	100%	100%	0.025	0.050	0.100
McCullough	TSS	2682	109.174	121.828	0.675	6.546	790.023	100%	99%	95%	5.000	10.000	20.000
McCullough	TP	2682	0.351	0.380	0.499	0.114	1.924	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	94.675	103.402	0.673	5.551	761.137	100%	98%	93%	5.000	10.000	20.000
Bixby	TP	2682	0.322	0.339	0.476	0.112	1.920	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit	TSS	550	108.633	23.701	2.771	0.001	961.261	54%	38%	24%	5.000	10.000	20.000
Tax Forfeit	TP	550	0.350	0.154	0.987	0.099	2.320	100%	100%	89%	0.025	0.050	0.100
Tax Forfeit 2	TSS	2682	58.463	2.722	6.339	0.000	609.174	10%	6%	3%	5.000	10.000	20.000
Tax Forfeit 2	TP	2682	0.281	0.107	0.502	0.035	2.008	100%	100%	25%	0.025	0.050	0.100
diversion	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
diversion	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Archies-pretreat	TSS	966	111.733	28.580	2.408	0.005	1009.617	60%	46%	30%	5.000	10.000	20.000
Archies-pretreat	TP	966	0.357	0.165	0.963	0.099	2.431	100%	100%	91%	0.025	0.050	0.100
Archies	TSS	2682	84.321	5.959	5.668	0.000	901.226	14%	9%	6%	5.000	10.000	20.000
Archies	TP	2682	0.334	0.117	0.793	0.044	2.394	100%	100%	32%	0.025	0.050	0.100

Term: 10 surface outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	23.228	2.202	4.629	0.001	429.024	5%	2%	1%	5.000	10.000	20.000
OVERALL	TP	2682	0.183	0.107	0.346	0.011	1.621	100%	100%	82%	0.025	0.050	0.100
McCullough	TSS	2682	22.941	5.856	2.058	0.011	421.318	43%	16%	2%	5.000	10.000	20.000
McCullough	TP	2682	0.181	0.121	0.354	0.012	1.557	100%	100%	94%	0.025	0.050	0.100
Bixby	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
Bixby	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100

Tax Forfeit	TSS	2682	47.980	1.249	10.963	0.000	547.420	3%	2%	1%	5.000	10.000	20.000
Tax Forfeit	TP	2682	0.266	0.103	0.464	0.005	1.947	100%	100%	12%	0.025	0.050	0.100
Tax Forfeit 2	TSS	2682	39.275	1.221	9.312	0.000	480.103	4%	2%	1%	5.000	10.000	20.000
Tax Forfeit 2	TP	2682	0.243	0.106	0.393	0.034	1.818	100%	100%	43%	0.025	0.050	0.100
diversion	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
diversion	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Archies-pretreat	TSS	2682	84.321	5.959	5.668	0.000	901.226	14%	9%	6%	5.000	10.000	20.000
Archies-pretreat	TP	2682	0.334	0.117	0.793	0.044	2.394	100%	100%	32%	0.025	0.050	0.100
Archies	TSS	2682	37.527	2.178	6.714	0.000	490.472	7%	4%	2%	5.000	10.000	20.000
Archies	TP	2682	0.237	0.107	0.505	0.008	1.847	100%	100%	24%	0.025	0.050	0.100

Term: 11 groundw outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 12 total outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	23.228	2.202	4.629	0.001	429.024	5%	2%	1%	5.000	10.000	20.000
OVERALL	TP	2682	0.183	0.107	0.346	0.011	1.621	100%	100%	82%	0.025	0.050	0.100
McCullough	TSS	2682	22.941	5.856	2.058	0.011	421.318	43%	16%	2%	5.000	10.000	20.000
McCullough	TP	2682	0.181	0.121	0.354	0.012	1.557	100%	100%	94%	0.025	0.050	0.100
Bixby	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
Bixby	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Tax Forfeit	TSS	2682	47.980	1.249	10.963	0.000	547.420	3%	2%	1%	5.000	10.000	20.000
Tax Forfeit	TP	2682	0.266	0.103	0.464	0.005	1.947	100%	100%	12%	0.025	0.050	0.100
Tax Forfeit 2	TSS	2682	39.275	1.221	9.312	0.000	480.103	4%	2%	1%	5.000	10.000	20.000
Tax Forfeit 2	TP	2682	0.243	0.106	0.393	0.034	1.818	100%	100%	43%	0.025	0.050	0.100
diversion	TSS	2682	14.203	1.874	4.334	0.001	369.073	2%	1%	0%	5.000	10.000	20.000
diversion	TP	2682	0.150	0.106	0.275	0.008	1.393	100%	100%	83%	0.025	0.050	0.100
Archies-pretreat	TSS	2682	84.321	5.959	5.668	0.000	901.226	14%	9%	6%	5.000	10.000	20.000
Archies-pretreat	TP	2682	0.334	0.117	0.793	0.044	2.394	100%	100%	32%	0.025	0.050	0.100
Archies	TSS	2682	37.527	2.178	6.714	0.000	490.472	7%	4%	2%	5.000	10.000	20.000
Archies	TP	2682	0.237	0.107	0.505	0.008	1.847	100%	100%	24%	0.025	0.050	0.100

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

File Directory	X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\07_Modeling\Water Quality\
Case Title	Sunrise Project - Existing
Case File	p8_Sunrise_Existing.p8c
Particle File	nurp50.p8p
Temperature File	Msp4999.tmp
Storm File	Msp4999.pcp
Precip Scale Factor	1
Watersheds	5
Devices	4
Particles	5
WQ Components	7
Start Date	01/02/49
Keep Date	01/02/49
Stop Date	09/26/99
Storm Count	3602
Total Hours	444600
Wet Hours	42901
Precip (in)	1405
Rain (in)	1219
Snowfall (in)	187
Snowmelt (in)	187
EvapoTran(in)	0
Overall TSS Removal(%)	0
Water Balance Error(%)	0
TSS Mass Balance Error (%)	0

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Case Title	Sunrise Project - Existing
Case Data File	p8_Sunrise_Existing.p8c
Path	X:\Clients_WD\00376_CLFLWD\0107_Sunrise_River_Water_Quality_Flowage_Project\07_Modeling\Water Quality\
Case Notes:	Existing conditions in areas of proposed project components - without Shallow Pond
Storm Data File	Msp4999.pcp
Particle File	nurp50.p8p
Air Temp File File	Msp4999.tmp

Time Steps Per Hour	4
Minimum Inter-Event Time (hrs)	10
Maximum Continuity Error %	2
Rainfall Breakpoint (inches)	0.8
Precipitation Scale Factor	1
Air Temp Offset (deg-F)	0
Loops Thru Storm File	1
Simulation Dates	
Start	1/1/1949
Keep	1/1/1949
Stop	12/31/1999

Max Snowfall Temperature (deg-f)	32.0
SnowMelt Temperature (deg-f)	32.0
Snowmelt Coef (in/degF-Day)	0.06
Soil Freeze Temp (deg-F)	32.0
Snowmelt Abstraction Factor	1.00
Evapo-Trans. Calibration Factor	1.00
Growing Season Start Month	5
Growing Season End Month	10

5-Day Antecedent Rainfall + Runoff (inches)

P8 Model - Existing Conditions

CN Antecedent Moisture Condition	AMC-II	AMC-III
Growing Season	1.40	2.10
NonGrowing Season	0.50	1.10

Watershed Data

Watershed Name	McCullough	Bixby	Archies	TaxForfeit	TaxForfeit2	
Runoff to Device	McCullough	Bixby	ax Forfeit + Archie	x Forfeit + Archi	Tax Forfeit 2	
Infiltration to Device						
Watershed Area	67.7	1217	34.8	908.8	143	
SCS Curve Number (Pervious)	61	61	61	61	61	
Scale Factor for Pervious Runoff Load	1	1	1	1	1	
Indirectly Connected Imperv Fraction	0.35	0.4	0.58	0.42	0.55	
UnSwept Impervious Fraction	0.2	0.15	0	0	0	
UnSwept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02	
UnSwept Imperv. Runoff Coefficient	1	1	1	1	1	
UnSwept Scale Factor for Particle Loads	1	1	1	1	1	
Swept Impervious Fraction	0	0	0	0	0	
Swept Depression Storage (inches)	0.02	0.02	0.02	0.02	0.02	
Swept Imperv. Runoff Coefficient	1	1	1	1	1	
Swept Scale Factor for Particle Loads	1	1	1	1	1	
Sweeping Frequency	0	0.5	0.5	0.5	0.5	
Sweeping Efficiency	1	1	1	1	1	
Sweeping Start Date (MMDD)	101	101	101	101	101	
Sweeping Stop Date (MMDD)	1231	1231	1231	1231	1231	

Device Data

Device Name	McCullough	Bixby	ax Forfeit + Archie	Tax Forfeit 2		
Device Type	POND	POND	POND	POND		
Infiltration Outlet						
Normal Outlet	Bixby					
Spillway Outlet	Bixby					
Particle Removal Scale Factor	1	1	1	1		
Bottom Elevation (ft)	891	890	888	888		
Bottom Area (acres)	0.01	6.6	3.78	0.1		
Permanent Pool Area (acres)	0.01	6.6	3.78	0.1		
Permanent Pool Volume (ac-ft)	0	0	0	0		
Perm Pool Infilt Rate (in/hr)	0	0	0	0		

P8 Model - Existing Conditions

Flood Pool Area (acres)	15.52	98.27	61.7	24.4		
Flood Pool Volume (ac-ft)	41.3	236.87	104.8	62.06		
Flood Pool Infilt Rate (in/hr)	0	0	0	0		
Infilt Basin Void Fraction (%)						
Detention Pond Outlet Parameters						
Outlet Type	WEIR	WEIR	WEIR	WEIR		
Outlet Orifice Diameter (in)						
Orifice Discharge Coef						
Outlet Weir Length (ft)	200	800	300	400		
Weir Discharge Coef	3.1	3.3	3.3	3.3		
Perforated Riser Height (ft)						
Number of Holes in Riser						
Holes Diameter						
Flood Pool Drain Time (hrs)						
Swale Parameters						
Length of Flow Path (ft)						
Slope of Flow Path %						
Bottom Width (ft)						
Side Slope (ft-v/ft-h)						
Maximum Depth of Flow (ft)						
Mannings n Constant						
Hydraulic Model						
Pipe, Splitter, Aquifer Parameter						
Hydraulic Res. Time (hrs)						

Particle Data					
Particle File	nurp50.p8p				
Particle Class	P0%	P10%	P30%	P50%	P80%
Filtration Efficiency (%)	90	100	100	100	100
Settling Velocity (ft/hr)	0	0.03	0.3	1.5	15
First Order Decay Rate (1/day)	0	0	0	0	0
2nd Order Decay (1/day-ppm)	0	0	0	0	0
Impervious Runoff Conc (ppm)	1	0	0	0	0
Pervious Runoff Conc (ppm)	1	100	100	100	200
Pervious Conc Exponent	0	1	1	1	1
Accum. Rate (lbs-ac-day)	0	1.75	1.75	1.75	3.5
Particle Removal Rate (1/day)	0	0.25	0.25	0.25	0.25

P8 Model - Existing Conditions

Washoff Coefficient	0	20	20	20	20
Washoff Exponent	0	2	2	2	2
Sweeper Efficiency	0	0	0	5	15

Water Quality Component Data							
Component Name	TSS	TP	TKN	CU	PB	ZN	HC

Water Quality Criteria (ppm)							
Level 1	5	0.025	2	2	0.02	5	0.1
Level 2	10	0.05	1	0.0048	0.014	0.0362	0.5
Level 3	20	0.1	0.5	0.02	0.15	0.38	1

Content Scale Factor	1	1	1	1	1	1	1

Particle Composition (mg/kg)							
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500
P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	340	180	0	22500

P8 Model - Existing Conditions

P8-V3.X p8_Sunrise_Existing.p8c

							Directly Connected UnSwept Areas--->				Directly Connected Swept Areas--->				Street Sweeping Parameters			
	Total			Pervious	Indirect	Pervious		Depress		Imperv		Depress		Imperv	Start	Stop		Sweep
Watershed	Area	Outflow	Percol	Curve	Imperv	Load	Imperv	Storage	Runoff	Load	Imperv	Storage	Runoff	Load	Date	Date	Sweep	Freq
Label	acres	Device	Device	Number	Fraction	Factor	Fraction	inches	Coef	Factor	Fraction	inches	Coef	Factor	MMDD	MMDD	Effic	1/week
McCullough	67.7	McCullough		61	0.350	1	0.2	0.02	1	1	0	0.02	1	1	101	1231	1	0
Bixby	1217	Bixby		61	0.400	1	0.15	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
Archies	34.8	Tax Forfeit + Archies		61	0.580	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
TaxForfeit	908.8	Tax Forfeit + Archies		61	0.420	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5
TaxForfeit2	143	Tax Forfeit 2		61	0.550	1	0	0.02	1	1	0	0.02	1	1	101	1231	1	0.5

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Devices Listed in Downstream Order

Device:	McCullough	Type:	POND
	Discharges normal outlet to		Bixby
	Discharges spillway to		Bixby
	Runoff from watershed		McCullough
Device:	Bixby	Type:	POND
	Runoff from watershed		Bixby
Device:	Tax Forfeit + Archies	Type:	POND
	Runoff from watershed		Archies
	Runoff from watershed		TaxForfeit
Device:	Tax Forfeit 2	Type:	POND
	Runoff from watershed		TaxForfeit2

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Particle Data					
Particle File	nurp50.p8p				
Particle Class	P0%	P10%	P30%	P50%	P80%
Filtration Efficiency (%)	90	100	100	100	100
Settling Velocity (ft/hr)	0	0.03	0.3	1.5	15
First Order Decay Rate (1/day)	0	0	0	0	0
2nd Order Decay (1/day-ppm)	0	0	0	0	0
Impervious Runoff Conc (ppm)	1	0	0	0	0
Pervious Runoff Conc (ppm)	1	100	100	100	200
Pervious Conc Exponent	0	1	1	1	1
Accum. Rate (lbs-ac-day)	0	1.75	1.75	1.75	3.5
Particle Removal Rate (1/day)	0	0.25	0.25	0.25	0.25
Washoff Coefficient	0	20	20	20	20
Washoff Exponent	0	2	2	2	2
Sweeper Efficiency	0	0	0	5	15

Water Quality Component Data							
Component Name	TSS	TP	TKN	CU	PB	ZN	HC
Water Quality Criteria (ppm)							
Level 1	5	0.025	2	2	0.02	5	0.1
Level 2	10	0.05	1	0.0048	0.014	0.0362	0.5
Level 3	20	0.1	0.5	0.02	0.15	0.38	1
Content Scale Factor	1	1	1	1	1	1	1
Particle Composition (mg/kg)							
P0%	0	99000	600000	13600	2000	640000	250000
P10%	1000000	3850	15000	340	180	1600	22500
P30%	1000000	3850	15000	340	180	1600	22500

P8 Model - Existing Conditions

P50%	1000000	3850	15000	340	180	1600	22500
P80%	1000000	0	0	340	180	0	22500

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Hydraulics

Sedimentation rates assume bulk density of 1 ton per cubic yard of wet sediment.

Variable	Units	McCullough	Bixby	Forfeit + Archies	Tax Forfeit 2
Total Inflow	ac-ft	2253.00	37757.52	12718.34	2474.65
Total Outflow	ac-ft	2238.79	37631.47	12718.61	2483.28
Mean Inflow	cfs	0.06	1.03	0.35	0.07
Mean Outflow	cfs	0.06	1.02	0.35	0.07
Max Inflow	cfs	177.59	3376.04	2449.23	377.83
Max Outflow	cfs	278.66	3357.29	2403.90	557.98
Min Elev	ft	891.00	890.01	888.01	888.01
Max Elev	ft	891.60	891.16	889.80	888.67
Max Velocity	ft/sec	0.00	0.00	0.00	0.00
Wet Period	%	0.00	0.07	0.12	0.00
WtrBal Error	ac-ft	14.21	126.05	-0.27	-8.64
WtrBal Error%	%	0.63	0.33	0.00	-0.35
Max Area	acres	1.77	30.20	36.41	3.30
Mean Hyd Load	in/day	0.82	0.81	0.23	0.49
Max Hyd Load	in/hr	99.40	110.87	66.72	113.59
Sed Rate Mass	tons/ac-yr	1.33	1.87	0.42	0.58
Sed Rate Vol	yd3/yr	2.35	56.45	15.47	1.91
Sed Rate Depth	in/yr	0.01	0.01	0.00	0.00
Max Volume	ac-ft	0.58	21.91	36.45	1.26
Direct Watershed	acres	67.70	1217.00	943.60	143.00
Unit Runoff	inches/yr	7.87	6.91	3.19	4.09

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Device Rating Tables

Device: McCullough, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
891.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
891.01	0.04	0.00	0.00	0.62	0.00	0.62	376.83	0.01	0.00
891.54	1.59	0.43	0.00	246.62	0.00	246.62	3698.27	0.27	0.02
892.07	3.14	1.69	0.00	687.91	0.00	687.91	5222.21	0.54	0.03
892.60	4.68	3.76	0.00	1257.88	0.00	1257.88	6392.68	0.80	0.04
893.13	6.23	6.66	0.00	1932.10	0.00	1932.10	7379.79	1.07	0.04
893.66	7.78	10.38	0.00	2696.39	0.00	2696.39	8249.62	1.33	0.05
894.20	9.33	14.92	0.00	3541.18	0.00	3541.18	9036.11	1.60	0.05
894.73	10.88	20.28	0.00	4459.40	0.00	4459.40	9759.43	1.86	0.06
895.26	12.42	26.47	0.00	5445.60	0.00	5445.60	10432.71	2.13	0.06
895.79	13.97	33.47	0.00	6495.38	0.00	6495.38	11065.11	2.40	0.06
896.32	15.52	41.30	0.00	7605.09	0.00	7605.09	11663.26	2.66	0.07

Device: Bixby, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
890.00	6.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
890.01	6.80	0.07	0.00	2.64	0.00	2.64	9.24	0.01	0.31
890.46	15.95	5.19	0.00	825.64	0.00	825.64	1232.10	0.33	0.08
890.91	25.10	14.45	0.00	2297.34	0.00	2297.34	2178.82	0.58	0.08
891.36	34.24	27.82	0.00	4197.35	0.00	4197.35	2917.49	0.81	0.08
891.81	43.39	45.31	0.00	6444.46	0.00	6444.46	3535.14	1.04	0.09
892.26	52.54	66.93	0.00	8991.51	0.00	8991.51	4073.60	1.27	0.09
892.71	61.68	92.68	0.00	11806.59	0.00	11806.59	4555.80	1.50	0.09
893.17	70.83	122.54	0.00	14866.27	0.00	14866.27	4995.66	1.73	0.10

893.62	79.98	156.53	0.00	18152.34	0.00	18152.34	5402.28	1.96	0.10
894.07	89.12	194.64	0.00	21650.16	0.00	21650.16	5781.99	2.18	0.11
894.52	98.27	236.87	0.00	25347.62	0.00	25347.62	6139.36	2.41	0.11

Device: Tax Forfeit + Archies, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
888.00	3.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
888.01	3.96	0.04	0.00	0.99	0.00	0.99	5.95	0.01	0.47
888.33	9.73	2.22	0.00	186.91	0.00	186.91	456.98	0.23	0.14
888.65	15.51	6.25	0.00	516.65	0.00	516.65	792.91	0.40	0.15
888.97	21.28	12.12	0.00	941.83	0.00	941.83	1053.30	0.57	0.16
889.29	27.06	19.83	0.00	1444.42	0.00	1444.42	1270.66	0.73	0.17
889.61	32.83	29.39	0.00	2013.94	0.00	2013.94	1460.08	0.90	0.18
889.92	38.60	40.79	0.00	2643.27	0.00	2643.27	1629.72	1.06	0.19
890.24	44.38	54.03	0.00	3327.19	0.00	3327.19	1784.49	1.22	0.20
890.56	50.15	69.11	0.00	4061.65	0.00	4061.65	1927.61	1.38	0.21
890.88	55.93	86.03	0.00	4843.38	0.00	4843.38	2061.30	1.54	0.21
891.20	61.70	104.80	0.00	5669.69	0.00	5669.69	2187.16	1.70	0.22

Device: Tax Forfeit 2, Type: POND, Outlet Type: WEIR

Elev	Area	Volume	Qinflt	Qnorm	Qflood	Qtotal	HydLoad	MnDepth	ResTime
feet	acres	ac-ft	cfs	cfs	cfs	cfs	in/day	ft	hrs
888.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
888.01	0.15	0.00	0.00	1.32	0.00	1.32	212.33	0.01	0.01
888.52	2.57	0.69	0.00	488.72	0.00	488.72	4520.62	0.27	0.02
889.02	5.00	2.60	0.00	1362.25	0.00	1362.25	6486.86	0.52	0.02
889.53	7.42	5.74	0.00	2490.36	0.00	2490.36	7984.67	0.77	0.03
890.03	9.85	10.11	0.00	3824.75	0.00	3824.75	9243.32	1.03	0.03
890.54	12.27	15.70	0.00	5337.37	0.00	5337.37	10350.20	1.28	0.04
891.04	14.70	22.52	0.00	7009.24	0.00	7009.24	11349.71	1.53	0.04
891.55	17.12	30.57	0.00	8826.44	0.00	8826.44	12268.10	1.79	0.04
892.05	19.55	39.84	0.00	10778.14	0.00	10778.14	13122.40	2.04	0.04
892.56	21.97	50.34	0.00	12855.65	0.00	12855.65	13924.39	2.29	0.05
893.07	24.40	62.06	0.00	15051.77	0.00	15051.77	14682.66	2.54	0.05

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Watershed areas contributing surface runoff to each device

	wtrshd total acres	imperv acres	imperv %	runoff in/yr	perm p area acres	volume ac-ft	depth ft	total p area acres	volume ac-ft	depth ft
McCullough	67.70	13.54	20.00	7.87	0.02	0.00	0.00	15.52	41.30	2.66
Bixby	1217.00	182.55	15.00	7.34	6.80	0.07	0.01	98.27	236.87	2.41
Tax Forfeit + Archie	943.60	0.00	0.00	3.19	3.96	0.04	0.01	61.70	104.80	1.70
Tax Forfeit 2	143.00	0.00	0.00	4.09	0.14	0.00	0.01	24.40	62.06	2.54
TOTAL	2371.30	196.09	8.27	5.51	10.92	0.10	0.01	199.89	445.03	2.23

Normalized device areas & volumes vs. performance (tss removal)

wi = impervious watershed area draining directly into device (acres)
wt = total watershed area draining directly into device(acres)
ap = permanent pool area (acres)
vp = permanent pool volume (ac-ft)
at = total device area (acres)
vt = total device volume (ac-ft)

device	type	imperv ap/wi %	vp/wi inches	total ap/wt %	vp/wt inches	flood p at/wt %	vt/wt inches	hydraulic load ft/yr	tss removal %
McCullough	POND	0.16	0.00	0.03	0.00	22.92	7.32	2.86	35.99
Bixby	POND	3.72	0.00	0.56	0.00	8.07	2.34	7.58	52.60
Tax Forfeit + Archie	POND	0.00	0.00	0.42	0.00	6.54	1.33	4.06	41.76
Tax Forfeit 2	POND	0.00	0.00	0.10	0.00	17.06	5.21	2.00	26.30
TOTAL	NONE	5.57	0.01	0.46	0.00	8.43	2.25	5.45	49.47

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Mass Balances by Device and Variable

Device: OVERALL   Type: NONE   Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	52964.72	1.44	15620515.3	307983.4	108.51
06 normal outlet	52833.36	1.44	7887826.1	155521.1	54.93
08 sedimen + decay	0.00	0.00	7727766.4	152365.3	
09 total inflow	52964.72	1.44	15620515.3	307983.4	108.51
10 surface outflow	52833.36	1.44	7887826.1	155521.1	54.93
12 total outflow	52833.36	1.44	7887826.1	155521.1	54.93
13 total trapped	0.00	0.00	7727766.4	152365.3	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	131.36	0.00	4922.8	97.1	
Reduction (%)	0.00	0.00	49.5	49.5	

Device: OVERALL   Type: NONE   Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	52964.72	1.44	50335.2	992.4	0.35
06 normal outlet	52833.36	1.44	40877.8	806.0	0.28
08 sedimen + decay	0.00	0.00	9438.5	186.1	
09 total inflow	52964.72	1.44	50335.2	992.4	0.35
10 surface outflow	52833.36	1.44	40877.8	806.0	0.28
12 total outflow	52833.36	1.44	40877.8	806.0	0.28
13 total trapped	0.00	0.00	9438.5	186.1	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	131.36	0.00	18.9	0.4	
Reduction (%)	0.00	0.00	18.8	18.8	

P8 Model - Existing Conditions

Device: McCullough		Type: POND			Variable: TSS
Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	2253.00	0.06	662785.6	13067.9	108.23
06 normal outlet	2238.79	0.06	424137.5	8362.5	69.70
08 sedimen + decay	0.00	0.00	238516.8	4702.7	
09 total inflow	2253.00	0.06	662785.6	13067.9	108.23
10 surface outflow	2238.79	0.06	424137.5	8362.5	69.70
12 total outflow	2238.79	0.06	424137.5	8362.5	69.70
13 total trapped	0.00	0.00	238516.8	4702.7	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	14.21	0.00	131.3	2.6	
Reduction (%)	0.00	0.00	36.0	36.0	

Device: McCullough		Type: POND			Variable: TP
Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	2253.00	0.06	2137.3	42.1	0.35
06 normal outlet	2238.79	0.06	1961.0	38.7	0.32
08 sedimen + decay	0.00	0.00	175.8	3.5	
09 total inflow	2253.00	0.06	2137.3	42.1	0.35
10 surface outflow	2238.79	0.06	1961.0	38.7	0.32
12 total outflow	2238.79	0.06	1961.0	38.7	0.32
13 total trapped	0.00	0.00	175.8	3.5	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	14.21	0.00	0.5	0.0	
Reduction (%)	0.00	0.00	8.2	8.2	

Device: Bixby		Type: POND			Variable: TSS
Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	35518.74	0.97	10462751.4	206289.9	108.38
02 upstream device	2238.79	0.06	424137.5	8362.5	69.70
06 normal outlet	37631.47	1.02	5156111.8	101661.0	50.41
08 sedimen + decay	0.00	0.00	5726078.9	112898.8	
09 total inflow	37757.52	1.03	10886889.0	214652.4	106.08
10 surface outflow	37631.47	1.02	5156111.8	101661.0	50.41

12 total outflow	37631.47	1.02	5156111.8	101661.0	50.41
13 total trapped	0.00	0.00	5726078.9	112898.8	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	126.05	0.00	4698.3	92.6	
Reduction (%)	0.00	0.00	52.6	52.6	

Device: Bixby | Type: POND | Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	35518.74	0.97	33726.4	665.0	0.35
02 upstream device	2238.79	0.06	1961.0	38.7	0.32
06 normal outlet	37631.47	1.02	27849.6	549.1	0.27
08 sedimen + decay	0.00	0.00	7819.7	154.2	
09 total inflow	37757.52	1.03	35687.4	703.6	0.35
10 surface outflow	37631.47	1.02	27849.6	549.1	0.27
12 total outflow	37631.47	1.02	27849.6	549.1	0.27
13 total trapped	0.00	0.00	7819.7	154.2	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	126.05	0.00	18.0	0.4	
Reduction (%)	0.00	0.00	21.9	21.9	

Device: Tax Forfeit + Archies | Type: POND | Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	12718.34	0.35	3757690.4	74088.9	108.70
06 normal outlet	12718.61	0.35	2188379.2	43147.4	63.30
08 sedimen + decay	0.00	0.00	1569259.4	30940.5	
09 total inflow	12718.34	0.35	3757690.4	74088.9	108.70
10 surface outflow	12718.61	0.35	2188379.2	43147.4	63.30
12 total outflow	12718.61	0.35	2188379.2	43147.4	63.30
13 total trapped	0.00	0.00	1569259.4	30940.5	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	-0.27	0.00	51.8	1.0	
Reduction (%)	0.00	0.00	41.8	41.8	

Device: Tax Forfeit + Archies | Type: POND | Variable: TP

P8 Model - Existing Conditions

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	12718.34	0.35	12102.5	238.6	0.35
06 normal outlet	12718.61	0.35	10758.1	212.1	0.31
08 sedimen + decay	0.00	0.00	1344.3	26.5	
09 total inflow	12718.34	0.35	12102.5	238.6	0.35
10 surface outflow	12718.61	0.35	10758.1	212.1	0.31
12 total outflow	12718.61	0.35	10758.1	212.1	0.31
13 total trapped	0.00	0.00	1344.3	26.5	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	-0.27	0.00	0.2	0.0	
Reduction (%)	0.00	0.00	11.1	11.1	

Device: Tax Forfeit 2 | Type: POND | Variable: TSS

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	2474.65	0.07	737287.9	14536.8	109.62
06 normal outlet	2483.28	0.07	543335.1	10712.7	80.50
08 sedimen + decay	0.00	0.00	193911.4	3823.3	
09 total inflow	2474.65	0.07	737287.9	14536.8	109.62
10 surface outflow	2483.28	0.07	543335.1	10712.7	80.50
12 total outflow	2483.28	0.07	543335.1	10712.7	80.50
13 total trapped	0.00	0.00	193911.4	3823.3	
14 storage increase	0.00	0.00	0.0	0.0	
15 mass balance check	-8.64	0.00	41.5	0.8	
Reduction (%)	0.00	0.00	26.3	26.3	

Device: Tax Forfeit 2 | Type: POND | Variable: TP

Mass Balance Term	Flow_acft	Flow_cfs	Load_lbs	Load_lbs/yr	Conc_ppm
01 watershed inflows	2474.65	0.07	2369.0	46.7	0.35
06 normal outlet	2483.28	0.07	2270.1	44.8	0.34
08 sedimen + decay	0.00	0.00	98.7	1.9	
09 total inflow	2474.65	0.07	2369.0	46.7	0.35
10 surface outflow	2483.28	0.07	2270.1	44.8	0.34
12 total outflow	2483.28	0.07	2270.1	44.8	0.34
13 total trapped	0.00	0.00	98.7	1.9	
14 storage increase	0.00	0.00	0.0	0.0	

15 mass balance check	-8.64	0.00	0.2	0.0
Reduction (%)	0.00	0.00	4.2	4.2

P8 Model - Existing Conditions

P8 Urban Catchment Model, Version 3.4					Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49		Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99		Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602		Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600		TotalYrs	50.72

Flow-Wtd-Mean Concs (ppm) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.44	52833.4	54.93	0.28
McCullough	POND	0.06	2238.8	69.70	0.32
Bixby	POND	1.02	37631.5	50.41	0.27
Tax Forfeit + Archies	POND	0.35	12718.6	63.30	0.31
Tax Forfeit 2	POND	0.07	2483.3	80.50	0.34

Outflow Loads (lbs) Term = 10 surface outflow

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.44	52833.4	7887826.14	40877.81
McCullough	POND	0.06	2238.8	424137.53	1961.01
Bixby	POND	1.02	37631.5	5156111.79	27849.62
Tax Forfeit + Archies	POND	0.35	12718.6	2188379.24	10758.07
Tax Forfeit 2	POND	0.07	2483.3	543335.12	2270.12

Removal Efficiency (%)

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.44	52833.4	49.47	18.75
McCullough	POND	0.06	2238.8	35.99	8.22
Bixby	POND	1.02	37631.5	52.60	21.91
Tax Forfeit + Archies	POND	0.35	12718.6	41.76	11.11
Tax Forfeit 2	POND	0.06758	2483.3	26.30	4.17

Mass Balance Error (%)

Device	Type	QoMeancfs	QVolAcft	TSS	TP
OVERALL	NONE	1.44	52833.4	0.03	0.04
McCullough	POND	0.06	2238.8	0.02	0.02
Bixby	POND	1.02	37631.5	0.04	0.05
Tax Forfeit + Archies	POND	0.35	12718.6	0.00	0.00

Tax Forfeit 2	POND	0.07	2483.3	0.01	0.01

P8 Urban Catchment Model, Version 3.4				Run Date	03/29/12
Case	p8_Sunrise_Existing.p8c	FirstDate	01/02/49	Precip(in)	1405.2
Title	Sunrise Project - Existing	LastDate	09/26/99	Rain(in)	1218.65
PrecFile	Msp4999.pcp	Events	3602	Snow(in)	186.51
PartFile	nurp50.p8p	TotalHrs	444600	TotalYrs	50.72

Concentration Statistics Events with Rainfall + Snowmelt > 0.05 inches

Term: 01 watershed inflows

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	108.507	121.462	0.685	6.546	879.806	100%	99%	93%	5.000	10.000	20.000
OVERALL	TP	2682	0.350	0.380	0.507	0.114	2.131	100%	100%	100%	0.025	0.050	0.100
McCullough	TSS	2682	108.234	123.051	0.659	6.546	753.059	100%	99%	95%	5.000	10.000	20.000
McCullough	TP	2682	0.349	0.383	0.489	0.114	1.839	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	108.377	122.455	0.669	6.546	812.018	100%	99%	95%	5.000	10.000	20.000
Bixby	TP	2682	0.349	0.382	0.496	0.114	1.975	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit + Archies	TSS	801	108.703	18.292	3.050	0.001	962.501	47%	32%	19%	5.000	10.000	20.000
Tax Forfeit + Archies	TP	801	0.350	0.141	0.912	0.099	2.322	100%	100%	88%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	109.616	25.051	2.641	0.000	987.834	54%	40%	25%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.352	0.157	0.974	0.099	2.381	100%	100%	88%	0.025	0.050	0.100

Term: 02 upstream device

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
Bixby	TSS	2682	69.702	70.882	0.769	1.148	544.431	96%	92%	83%	5.000	10.000	20.000
Bixby	TP	2682	0.322	0.340	0.533	0.103	1.686	100%	100%	100%	0.025	0.050	0.100

Term: 03 infiltrate

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 04 exfiltrate

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 06 normal outlet

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	54.929	38.015	0.881	0.237	593.973	89%	81%	65%	5.000	10.000	20.000
OVERALL	TP	2682	0.285	0.242	0.504	0.086	1.961	100%	100%	99%	0.025	0.050	0.100

McCullough	TSS	2682	69.702	70.882	0.769	1.148	544.431	96%	92%	83%	5.000	10.000	20.000
McCullough	TP	2682	0.322	0.340	0.533	0.103	1.686	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	50.411	38.252	0.857	0.237	562.726	90%	82%	66%	5.000	10.000	20.000
Bixby	TP	2682	0.272	0.243	0.492	0.086	1.836	100%	100%	99%	0.025	0.050	0.100
Tax Forfeit + Archies	TSS	797	63.304	8.384	3.993	0.000	615.093	24%	15%	9%	5.000	10.000	20.000
Tax Forfeit + Archies	TP	797	0.311	0.127	0.887	0.062	2.099	100%	100%	57%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	80.499	17.255	2.927	0.000	733.616	40%	29%	18%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.336	0.157	0.958	0.036	2.192	100%	99%	79%	0.025	0.050	0.100

Term: 07 spillway outlet

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 09 total inflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	108.507	121.462	0.685	6.546	879.806	100%	99%	93%	5.000	10.000	20.000
OVERALL	TP	2682	0.350	0.380	0.507	0.114	2.131	100%	100%	100%	0.025	0.050	0.100
McCullough	TSS	2682	108.234	123.051	0.659	6.546	753.059	100%	99%	95%	5.000	10.000	20.000
McCullough	TP	2682	0.349	0.383	0.489	0.114	1.839	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	106.084	118.945	0.673	6.173	797.338	100%	99%	94%	5.000	10.000	20.000
Bixby	TP	2682	0.348	0.379	0.498	0.114	1.959	100%	100%	100%	0.025	0.050	0.100
Tax Forfeit + Archies	TSS	801	108.703	18.292	3.050	0.001	962.501	47%	32%	19%	5.000	10.000	20.000
Tax Forfeit + Archies	TP	801	0.350	0.141	0.912	0.099	2.322	100%	100%	88%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	109.616	25.051	2.641	0.000	987.834	54%	40%	25%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.352	0.157	0.974	0.099	2.381	100%	100%	88%	0.025	0.050	0.100

Term: 10 surface outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	54.929	38.015	0.881	0.237	593.973	89%	81%	65%	5.000	10.000	20.000
OVERALL	TP	2682	0.285	0.242	0.504	0.086	1.961	100%	100%	99%	0.025	0.050	0.100
McCullough	TSS	2682	69.702	70.882	0.769	1.148	544.431	96%	92%	83%	5.000	10.000	20.000
McCullough	TP	2682	0.322	0.340	0.533	0.103	1.686	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	50.411	38.252	0.857	0.237	562.726	90%	82%	66%	5.000	10.000	20.000
Bixby	TP	2682	0.272	0.243	0.492	0.086	1.836	100%	100%	99%	0.025	0.050	0.100

Tax Forfeit + Archies	TSS	797	63.304	8.384	3.993	0.000	615.093	24%	15%	9%	5.000	10.000	20.000
Tax Forfeit + Archies	TP	797	0.311	0.127	0.887	0.062	2.099	100%	100%	57%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	80.499	17.255	2.927	0.000	733.616	40%	29%	18%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.336	0.157	0.958	0.036	2.192	100%	99%	79%	0.025	0.050	0.100

Term: 11 groundw outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm

Term: 12 total outflow

Device	Variable	Count	FWM	Mean	CV	Min	Max	Freq>A	Freq>B	Freq>C	A ppm	B ppm	C ppm
OVERALL	TSS	2682	54.929	38.015	0.881	0.237	593.973	89%	81%	65%	5.000	10.000	20.000
OVERALL	TP	2682	0.285	0.242	0.504	0.086	1.961	100%	100%	99%	0.025	0.050	0.100
McCullough	TSS	2682	69.702	70.882	0.769	1.148	544.431	96%	92%	83%	5.000	10.000	20.000
McCullough	TP	2682	0.322	0.340	0.533	0.103	1.686	100%	100%	100%	0.025	0.050	0.100
Bixby	TSS	2682	50.411	38.252	0.857	0.237	562.726	90%	82%	66%	5.000	10.000	20.000
Bixby	TP	2682	0.272	0.243	0.492	0.086	1.836	100%	100%	99%	0.025	0.050	0.100
Tax Forfeit + Archies	TSS	797	63.304	8.384	3.993	0.000	615.093	24%	15%	9%	5.000	10.000	20.000
Tax Forfeit + Archies	TP	797	0.311	0.127	0.887	0.062	2.099	100%	100%	57%	0.025	0.050	0.100
Tax Forfeit 2	TSS	752	80.499	17.255	2.927	0.000	733.616	40%	29%	18%	5.000	10.000	20.000
Tax Forfeit 2	TP	752	0.336	0.157	0.958	0.036	2.192	100%	99%	79%	0.025	0.050	0.100