Technical Memorandum 2

NSMCSD Collection System Capacity Evaluation/Assurance, Management and Improvement Plan

Subject: **Task 2: Review of 1993 Collection System Master Plan**

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This Technical Memorandum (TM) summarizes the review of the 1993 City of Daly City Collection System Master Plan (1993 Master Plan) for the North San Mateo County Sanitation District (NSMCSD). The purpose of this review is to determine whether the 1993 Master Plan provides sufficient information to meet the intent of the capacity management elements of the San Francisco Bay Regional Water Quality Control Board (RWQCB) and State Water Resources Control Board (SWRCB) Sewer System Management Plan (SSMP) requirements, and/or whether additional flow monitoring and capacity analyses should be conducted to ensure that the SSMP reflects the most up-to-date information about the capacity of the collection system.

This TM is divided into the following sections:

1. SSMP Capacity Management Requirements
2. Task Scope
3. Summary of 1993 Master Plan
4. Assessment of 1993 Master Plan
5. Analysis of Wastewater Treatment Plant Flows
6. Assessment of Lift Station Flows and Capacity
7. Summary and Conclusions
8. Proposed Flow Monitoring Program

1 SSMP Capacity Management Requirements

The requirements with respect to capacity management are summarized below for both the Regional and State SSMPs.

RWQCB requirements for Capacity Management:

- **Capacity Assessment** – establish a process to assess the current and future capacity requirements for the collection system facilities.
- **System Evaluation and Capacity Assurance Plan** – prepare and implement a capital improvement plan (CIP) to provide hydraulic capacity of key sewer system elements under peak flow conditions.

SWRCB requirements for System Evaluation and Capacity Assurance Plan:

- **Evaluation** – identify actions needed to evaluate those portions of the sewer system that are experiencing or contributing to an overflow caused by hydraulic deficiency, including estimates of peak flows, capacity of key system components, hydraulic deficiencies, and the major sources that contribute to the peak flows associated with overflow events.

- **Design Criteria -** establish appropriate design criteria for evaluating capacity.
- **Capacity Enhancement Measures** – identify steps needed to establish short- and long-term CIPs to address identified hydraulic deficiencies, including prioritization, alternatives analysis, implementation schedules, and sources of funding.
- **Schedule** – develop a schedule of completion dates for the above items, which shall be reviewed and updated at least every five years.

Both the Regional and State requirements would normally be satisfied by completion of a collection system master plan that is based on accurate information about current system flows and capacities and realistic projections of future flows, utilizes sound hydraulic evaluation and design criteria, and provides an associated CIP that addresses any identified capacity deficiencies.

2 Task Scope

Task 2 of the NSMCSD Collection System Capacity Evaluation/Assurance, Management and Improvement Plan (Collection System Improvement Plan) project calls for a thorough analysis of the 1993 Master Plan with respect to the capacity management requirements of the SSMP, and development of a Work Plan to fill any identified gaps in information or analyses. The 1993 Master Plan review focuses on:

- **Model Data** – does the system data on which the 1993 Master Plan hydraulic modeling was based accurately reflect the current configuration of the system?
- **Flow Basis** – is the basis for estimating peak design flows in the 1993 Master Plan a valid approach for capacity evaluation with respect to Regional and State requirements or expectations?
- **Land Use** – do the future land uses on which the 1993 Master Plan was based reflect the development that has occurred since that time and the current projections of future development in the NSMCSD service area?

The review also analyzes recent flow data for the NSMCSD Wastewater Treatment Plant (WWTP) to further validate the projected flows in the 1993 Master Plan; and compares the 1993 Master Plan design flows to the current capacities of existing system lift stations.

3 Summary of 1993 Master Plan

The purpose of the 1993 Master Plan was to assess the existing and future capacity needs of the NSMCSD wastewater collection system through the year 2010. The assessment of existing capacity was based on the results of the 1989 Infiltration/Inflow (I/I) Evaluation, which in turn was based on flow monitoring conducted in the system in 1988. The key analyses and results of the 1989 I/I Evaluation and 1993 Master Plan are summarized below.

3.1 Flow Monitoring

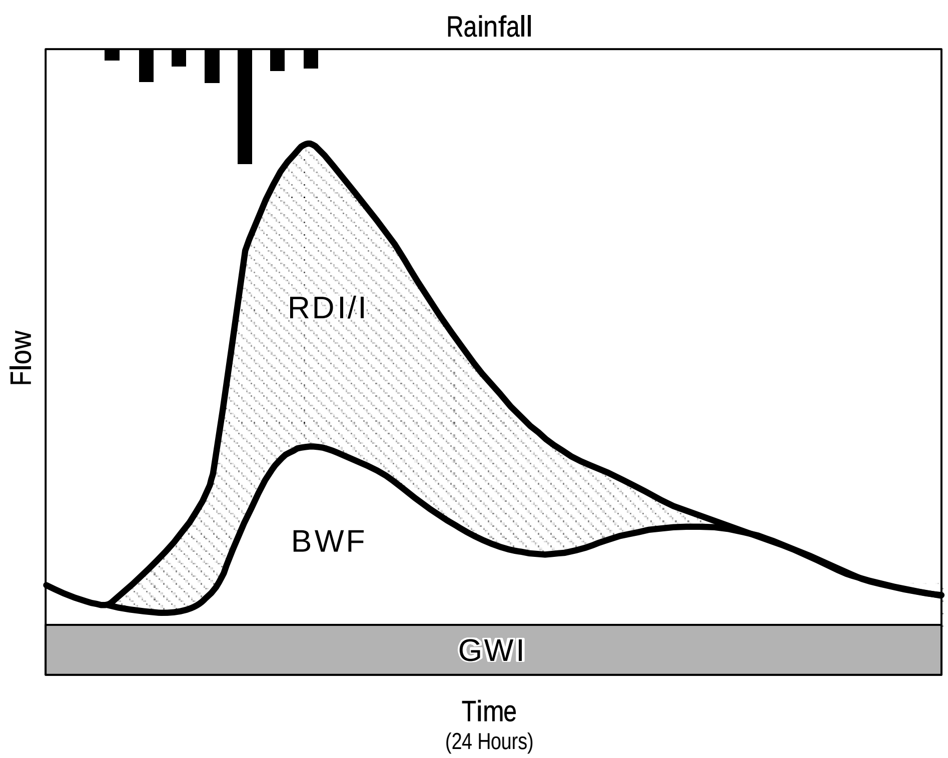
Twenty three flow meters and three rain gauges were placed in the system for a 10-week period from late February through early May 1988. The monitoring included only the portion of the system tributary to the NSMCSD WWTP (the portion of the system in the northeast part of the service area consists of combined sewers that discharge into the City of San Francisco sewer system). One of the meters captured flow from Westborough Water District (WWD), which is served by NSMCSD under contract. Level meters (meters that record depth of flow in the pipe) were utilized in the flow monitoring program , and flow rates were calculated based on a calibration curve developed from weekly measurements of flow velocity taken with a hand-held velocity meter at various times during the monitoring period. The I/I evaluation report noted that 2.4 inches of rain were recorded during the 10-week flow monitoring period.

3.2 Flow Analysis

The 1988 data were analyzed to quantify each of the components of wastewater flow: base wastewater flow (BWF) (called "sanitary flow" in the CH2M Hill reports), groundwater infiltration (GWI), and rainfall-dependent I/I (RDI/I). **Figure 1** provides a conceptual illustration of the wastewater flow components.

These flow components were quantified for each incremental meter tributary area or basin (total of 22 basins including WCD). Where meters were located in series, basin flows were computed by meter subtraction, which was required for 11 of the 22 basins. The methodology used to determine each of the flow components is described below.

Figure 1: Wastewater Flow Components



3.2.1 Base Wastewater Flow

As indicated in the reports, BWF was estimated for each basin based on 90 percent of winter water consumption. The total average BWF was determined to be 7.3 mgd. Peak BWF for each basin was calculated based on a peaking factor curve developed from the flow monitoring data. For most basins, the peaking factors ranged from 1.6 to 1.8. The overall peak BWF was determined to be 12.3 mgd.

3.2.2 Groundwater Infiltration

GWI was estimated as the difference between measured flow on non-rainfall days during the flow monitoring period and the calculated BWF. The estimated GWI flows were scaled up to represent maximum or "saturated soil" conditions based on the ratio of the historical peak seasonal GWI at the WWTP (0.94 mgd) to the total calculated GWI during the flow monitoring period (0.70 mgd).

3.2.3 Rainfall-Dependent I/I

RDI/I represents the flow response in the system that is directly related to rainfall. As such, a common way to quantify RDI/I is as a volume percentage of rainfall falling on an area (ratio of RDI/I volume to rainfall volume), called the "R" value. The R value may vary based on the physical characteristics of the area, condition of the sewers, and degree of saturation of the soil. Maximum saturation typically results in the highest R values.

For NSMCSD, CH2M Hill determined R values for each basin for the 1988 monitored storm events. The overall R value was determined to be 1.4 percent. A more extensive RDI/I analysis was conducted for WWTP flows based on several years of data (1982 to 1988) to determine the maximum RDI/I response (maximum R value) at the WWTP. That value of 3.1 percent, assumed to represent maximum saturated soil conditions, was used to scale up the basin R values determined for the1988 events to "design" R values. Eleven of the Daly City basins, as well as WCD, appeared to have no RDI/I response based on the 1988 data; therefore, design R values of 1 percent were assumed for these basins. For the other basins, the design R values ranged from 1.2 to 16.9 percent.

Peak RDI/I flows are of most concern with respect to sewer system capacity. Peak RDI/I is based on the shape of the RDI/I hydrograph as well as its volume. For NSMCSD, RDI/I hydrograph shapes were determined for each meter by developing a set of synthetic unit hydrograph parameters which, when applied to hourly rainfall, results in a hydrograph that closely matches the observed RDI/I hydrograph. Although the specific details of the synthetic RDI/I hydrograph methodology used for NSMCSD were not described in the CH2M Hill reports, it can be surmised that the methodology used was one that was developed during the 1980s and commonly used for many I/I studies performed in the Bay Area during that time. The synthetic hydrograph parameters are applied to the rainfall for a "design storm" to generate the design RDI/I hydrograph for the design storm event.

The design storm used for NSMCSD was a 4-hour rainfall event with a total rainfall equivalent to a 4-hour duration, 5-year return frequency rainfall of 1.8 inches based on historical rainfall intensity-duration-frequency statistics for the Daly City area. It appears that the event was assumed to have a uniform intensity of 0.45 inches per hour over the entire 4-hour event duration.

By applying the synthetic hydrograph parameters developed through analysis of the 1988 flow monitoring data to the design storm rainfall, design RDI/I hydrographs were generated for each basin. The total 5-year design peak RDI/I for the NSCMSD service area was determined to be 20.3 mgd.

3.2.4 Existing (1988) Design Flows

Peak design flows were defined as the concurrent occurrence of the following three conditions:

- Daily maximum BWF
- Maximum GWI
- Peak RDI/I for 5-year design storm

Because of the conservative assumption of these three flow conditions occurring concurrently, the return frequency of the peak design flows would likely be less frequent than once every five years.

Based on these assumptions, the existing (1988) overall 5-year frequency peak design flow for the NSMCSD WWTP service area was determined to be 33.5 mgd.

3.3 Future Flow Projections

The 1993 Master Plan developed projections of future design flows for the year 2010 based on Daly City's 1987 General Plan (the General Plan planning area also includes the unincorporated areas of Broadmoor and Colma, which are located within the City's Sphere of Influence) and the 1993 Colma BART Station Area Specific Plan (CBSASP). Specifically, future changes to land uses as identified in these documents were quantified to determine the incremental flow from future development or redevelopment. The land use changes identified in the 1987 General Plan had previously been captured in digital mapping created for the City's 1991 Water Master Plan. Those land use changes, which were tabulated by water pressure zones, were allocated to sewer basins by a graphical overlay of sewer basins and pressure zones. The 1993 Master Plan acknowledges that this methodology could underestimate local effects of more concentrated new developments. In addition to the General Plan land use changes, the additional changes identified for the Colma BART Station Area were also quantified. Flow factors developed in the Water Master Plan (adjusted to account for return flows to the wastewater system) were used to quantify the change in BWF due to new development. Unit flow factors equivalent to 1,763 gpd/acre for residential development, 3,150 gpd/acre for commercial/industrial development, and 93 gpd/dwelling unit in the CBSASP area were used.

For WWD, no future land use changes were identified.

The resulting future (2010) average and peak BWF were estimated to be 7.9 mgd and 13.2 mgd, respectively. GWI and RDI/I were assumed to remain the same, resulting in a projected total peak 5-year design flow of 34.4 mgd.

3.4 Hydraulic Modeling

The 1989 I/I Evaluation and 1993 Master Plan utilized a CH2M Hill proprietary model called SAM (System Analysis Model). SAM utilizes a modified kinematic wave routine for open-channel flow conditions, and a surcharge routine based on intersection of energy and hydraulic gradelines for full-pipe conditions. Computations of flow rates, capacity, and sizing of relief (parallel or replacement) pipes are based on Manning's equation for uniform flow applied on a pipe-by-pipe basis.

The SAM model included the 10-inch and larger lines plus some 8-inch sewers in the NSMCSD collection system. Data for the modeled network (pipe diameters, lengths, and slopes, and manhole rim and invert elevations) were taken from District maps; no surveying or field checking was conducted. Total basin flows were allocated to modeled pipe segments based on the ratio of segment length to total modeled pipe length within each basin. The reports state that the model was calibrated and verified using the 1988 flow monitoring data, and "modifications to the model calibration were made as necessary." No explanation of these modifications or presentation of calibration results were included in the reports.

The model results were used to identify predicted capacity deficiencies (flow exceeding full pipe capacity) and develop recommended capacity improvement projects to correct identified capacity deficiencies.

3.5 Capital Improvement Program

The Master Plan recommended a CIP which included 13 pipeline capacity relief projects (Projects A through M) totaling approximately 15,000 feet of parallel and replacement sewers; and one lift station capacity improvement (Project S – El Portal Lift Station backup pump). Additional projects were recommended for the combined portion of the sewer system, which is not addressed in this study. A final Project T consisted of "additional projects" to be identified by District staff to address collection system operational problems. According to the District, all CIP projects from the Master Plan have been addressed.

4 Assessment of 1993 Master Plan

To confirm the current validity of the 1993 Master Plan, RMC conducted a more detailed review of the model data (configuration of the system) and the basis of the flow and land use projections in that document. These assessments are discussed below.

4.1 Model Data

As noted above, the model used in the 1993 Master Plan included the 10-inch and larger sewers plus some 8-inch pipes. Review of the model data consisted of visual comparison of the configuration of the system, as shown on maps in the 1993 Master Plan, to the current system configuration based on the City's GIS mapping and grid maps. Based on discussions with District staff, it is not possible to validate the actual model *data* (e.g, pipe diameters, lengths, slopes, invert elevations, etc.) against current GIS information due to incompatible reference information.

Based on the visual review, there appear to be some areas of the 1993 Master Plan system that differ from the current system configuration shown in GIS and grid maps. Specific areas include the downstream portions of Basins D6, D7, D9, D10, and D11. These differences may be due to construction that has occurred since the 1993 Master Plan or possible inaccuracies in the GIS or grid maps.

Overall, most of the existing 10-inch and larger lines in the system appear to have been included in the 1993 Master Plan model. A few lines (e.g., 10-inch pipe in Serramonte Boulevard west of Gellert) were not in the 1993 model. There is also a new pump station located on Hickey Boulevard east of I-280 with a 10-inch force main connecting to the 18-inch trunk sewer in Gellert Boulevard. According to the District, this area east of I-280 is no longer discharging into the South San Francisco sewer system (as per the 1993 Master Plan) but has been re-routed to the NSMCSD system via this new pump station.

In the 1993 Master Plan, the area south of Verducci Drive and west of Gellert Boulevard is shown as being part of Basin D22, but the area east of Gellert is shown as discharging to the South San Francisco sewer system. In GIS, both areas drain to the intersection of Gellert and King Drive, where the flow appears to go east across I-280 and then into South San Francisco. Comparison of the pipe sizes shown in the list of 1988 meter locations (Table 3-1 of the 1989 I/I Evaluation report) show some differences with the pipe sizes in the current GIS. Again, these differences may be due to construction that has occurred since 1988 or possible inaccuracies in the GIS data.

4.2 Flow Basis

The approach used to develop design flows for the 1993 Master Plan is a standard methodology commonly used for collection system planning. The methodology depends on the analysis of flow monitoring data and, as such, the accuracy of the results is dependent on both the quality of the flow monitoring data and the analyses conducted.

The flow monitoring on which the Master Plan was based was conducted in 1988, almost 20 years ago. As noted previously, the program utilized level meters to measure flow. The accuracy of such meters depends heavily on having uniform flow conditions in the pipes so that a consistent relationship between flow depth (level) and velocity can be developed. It is not known how many field calibration points were obtained and how "good" the calibration was to the field measurements. Furthermore, if any of the meter sites surcharged during the monitoring period, it would not have been possible to determine the actual flows.

Based on the information presented in the reports, the sizes of the monitored storm events in 1988 are not known. If the events were small (as the example shown in Figure 3-2 of the I/I Evaluation report would seem to indicate), a relatively large "extrapolation" would have been necessary in applying the synthetic hydrograph parameters to the much larger 5-year design storm rainfall event. This process could have over-estimated the design RDI/I flows. Also, as noted in the I/I Evaluation report, 11 basins had no apparent RDI/I response (which might indicate either very tight systems and/or very small monitored events), and therefore a 1 percent R value was assumed for those basins

Also as noted previously, meter data subtractions were required to isolate basin flows for half of the basins. Subtracting meter flows, particularly peak flows, induces errors that may lead to inaccurate or unreasonable results. The lack of backup data in the reports makes it difficult to assess the accuracy of these data analyses.

The selection of a 5-year frequency rainfall event as a design storm is a reasonable criteria. A 5-year design event is widely used by many agencies in the San Francisco Bay Area, who consider it to provide a reasonable level of protection against overflows and bypasses of untreated wastewater. Based on precedent sent by other agencies in the San Francisco Bay region, including the Central Marin Sanitation Agency, East Bay Municipal Utility District, and Vallejo Sanitation and Flood Control District, a 5-year event has been generally accepted by regulators as appropriate criteria for evaluation and design of wastewater facilities for wet weather conditions.

A uniform intensity design storm was used in the 1993 Master Plan. Most agencies that utilize a synthetic design rainfall event use one that includes a higher intensity peak hour rainfall (e.g., equivalent to a 1-hour duration, 5-year frequency rainfall intensity), resulting in a more conservative peak flow than a uniform intensity design storm

In summary, while the methodology used in the 1993 Master Plan to develop design flows is basically sound and likely conservative, the lack of backup data in the report makes it difficult to assess the quality or accuracy of the results.

4.3 Land Use Basis

As described previously, existing base flows for the NSMCSD were estimated based on flow monitoring as part of the District's I/I Evaluation. These base flows were updated for the 1993 Master Plan based on projected changes in land use. The approach used to identify land use changes for the Master Plan draws from land use information gathered from the 1987 Daly City General Plan: Housing, Land Use and Circulation Elements, and the 1993 Colma Bay Area Rapid Transit (BART) Station Area Specific Plan/Environmental Impact Report (CBSASP/EIR), with most of the information coming from the 1991 Water Master Plan. The Water Master Plan established land use based on the City's General Plan for pressure zones throughout the drainage area. The pressure zones were overlaid with wastewater collection system basins in order to estimate the land use in each collection system basin. This was an analytical exercise and no land use maps were provided as part of the master plan. While this method is a generalized view of land use in the collection system area, it was considered sufficient for the scale of the project.

The 1993 Master Plan reports that Daly City's 1987 General Plan indicates that the overall distribution of land use had not changed significantly in the 10 to 15 years preceding the report. Several specific redevelopment areas, including the Mission Street corridor and the Daly City Civic Center, were expected to experience growth and were included in the land use evaluation studied in the Master Plan. Additional planning documents provided to RMC by the District, such as the Sullivan Corridor Specific Plan, show future land uses that are different from those shown in the General Plan; therefore, these changes may have impacted the capacity assessment in the 1993 Master Plan, and capacity in these areas may need to be verified.

The Master Plan indicates that there was no projected change in land use for the Westborough Water District during the planning period. However, recent development could have increased base flows from this area. In conversations with a representative of the Westborough Water District, RMC learned that several hundred homes have been constructed in recent years (approximately 280). Development has been centered in two areas: Gellert Blvd, which among other developments is now the site of a retirement community located at 2280 Gellert Blvd, and Carter Drive/Callan Blvd, which has seen approximately 135 condominiums constructed in recent years as part of the Carter Park development (with 150 additional condominiums planned for phase 3 of the project). In addition, 40 single family homes have recently been constructed on Oakmont Drive, near Callan Blvd.

A small portion of the collection system area is also within the Town of Colma. Land use changes in this area are currently being investigated through communication with the Town of Colma Planning Department. Any changes in land use that have take place and were not reflected in the 1993 Master Plan should be evaluated to determine if they could have impacted the Master Plan capacity assessment.

5 Analysis of Wastewater Treatment Plant Flows

WWTP flow data were reviewed to assess flow trends since the 1993 Master Plan and analyze RDI/I response to recent large storm events. The purpose of these analyses was to determine if I/I appears to have changed or increased and if the total system flow projections in the 1993 Master Plan still appear to be valid.

5.1 Dry Weather Flows

Figure 2 shows average daily flows to the NSMCSD WWTP from June 1997 to September 2007, and **Figure 3** shows the average dry weather flow (ADWF) for the months of July through October from 2000 to 2007. Although there are periods of missing data, particularly prior to 2001, the overall trend shows a decrease in average flows over the past 7 years. This trend has also been observed at other northern California wastewater treatment plants. The City's water use data over the past 5 years also shows a decreasing trend. Single-family residential winter water use (mid-January through mid-March period) steadily decreased from any average of about 208 gpd/DU in 2003 to 193 gpd/DU in 2007.

Figure 4 shows a typical dry weather pattern at the WWTP for month of July 2007. The current average dry weather flow (ADWF) is approximately 6.0 mgd, and peak (hour) dry weather flow (PDWF) is approximately 10 mgd. These values are about 18 percent lower than the estimated 1988 BWF and 24 percent lower than the predicted 2010 BWF in the 1993 Master Plan.

Water consumption data for the City indicates that winter water use averages about 6.3 mgd. Assuming that the Daly City portion of dry weather wastewater flows (i.e., without WWD) is about 5.8 mgd, then wastewater flows appear to be about 90 percent of winter water use, which is reasonable.

5.2 Wet Weather Flows

Several large wet weather events have occurred over the past few years in the Daly City area. These include the major storm of February 25, 2004, which caused major flooding in Daly City, as well as other large storms on December 27, 2004, and December 31, 2005. **Figures 5, 6, and 7** show hourly flows to the WWTP for the periods January through March 2004, December 2004 through March 2005, and December 2005 through April 2006. During these periods, the highest flows occurred on February 25, 2004, and December 27, 2004, when flows to the WWTP exceeded 25 mgd. The peak flows for both of

Figure 2
NSMCSD WWTP Daily Flows 1997 to 2007

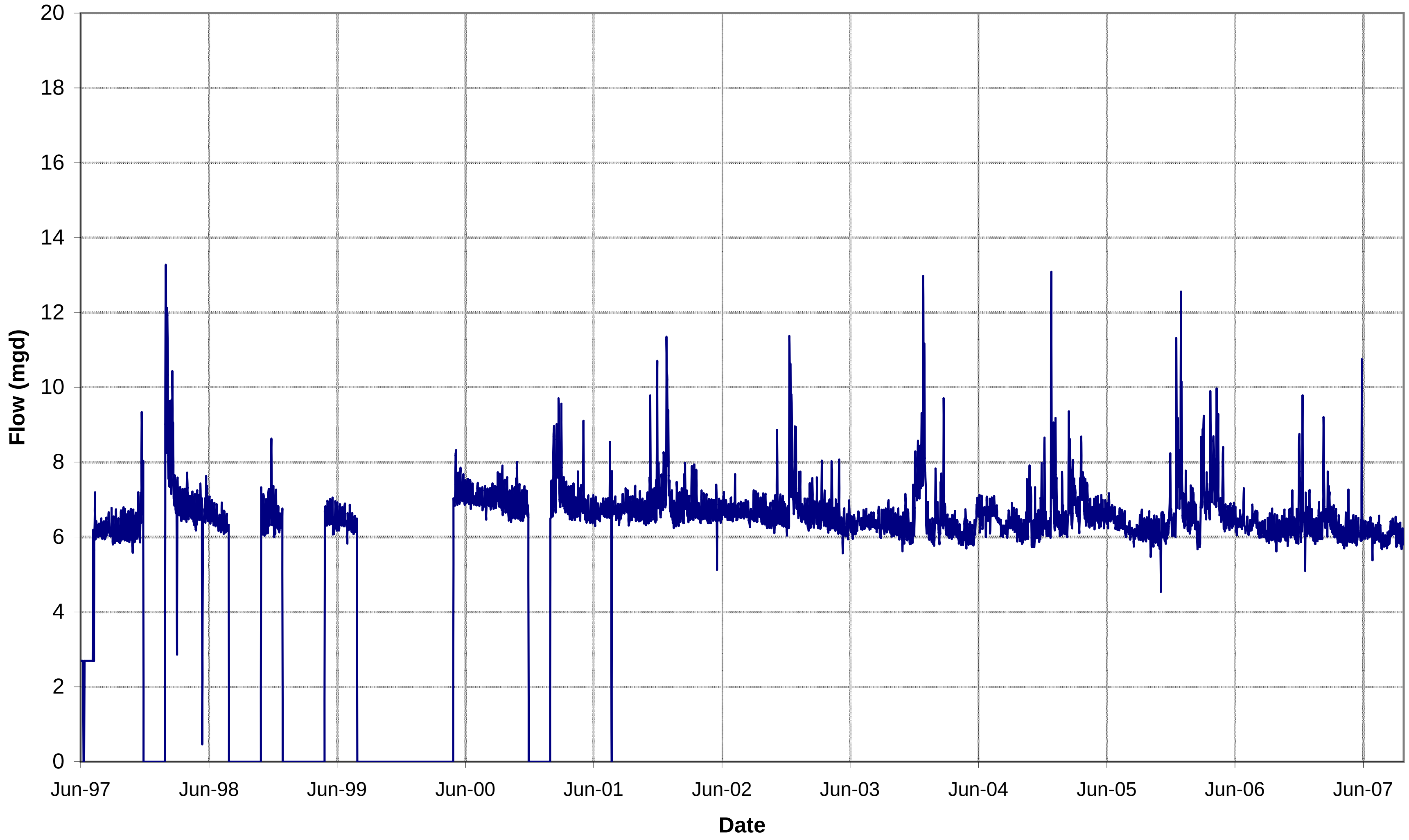


Figure 3
NSMCSD Average Dry Weather Flow (July to October)

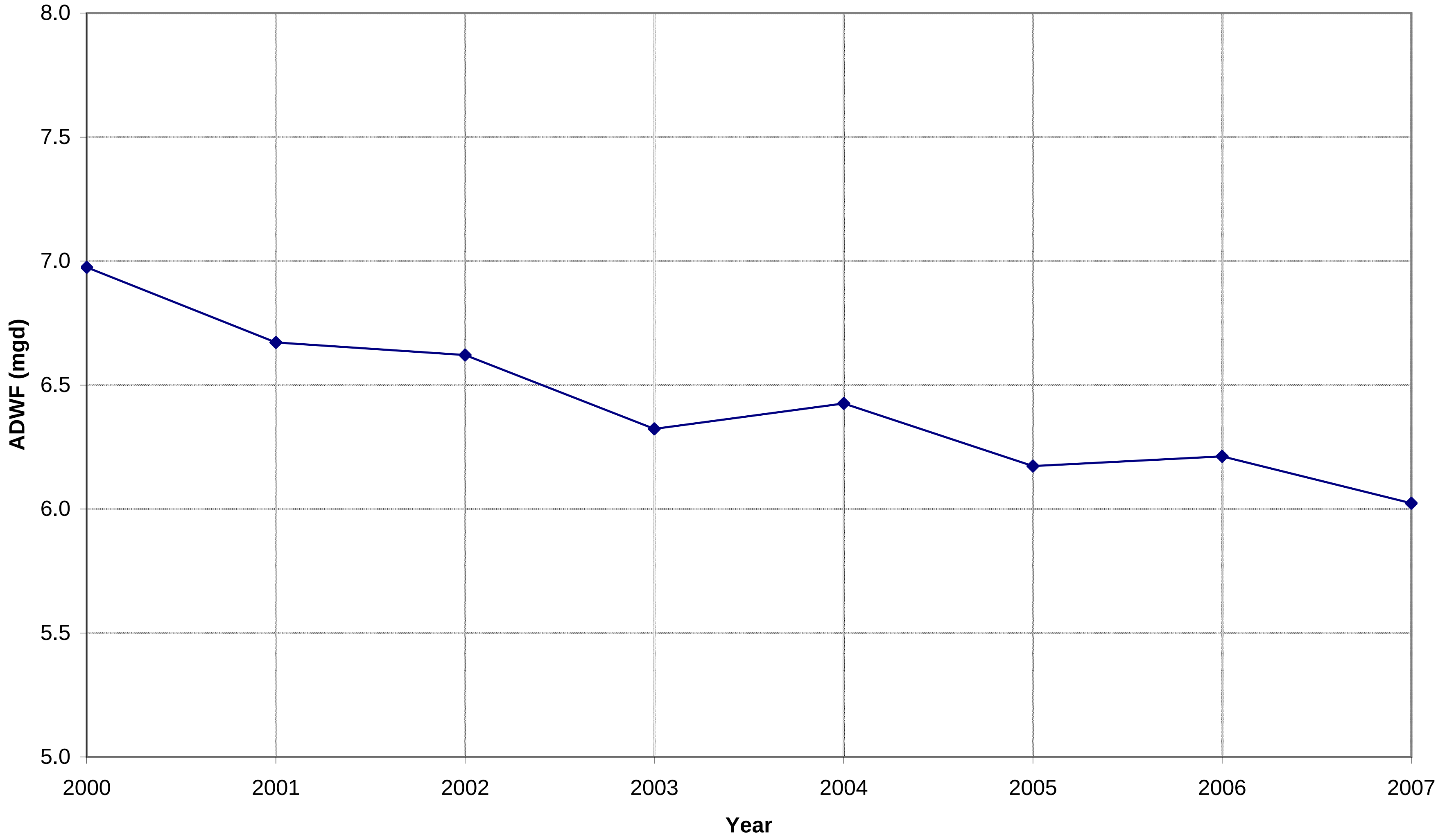


Figure 4
NSMCSD WWTP Hourly Flows July 2007

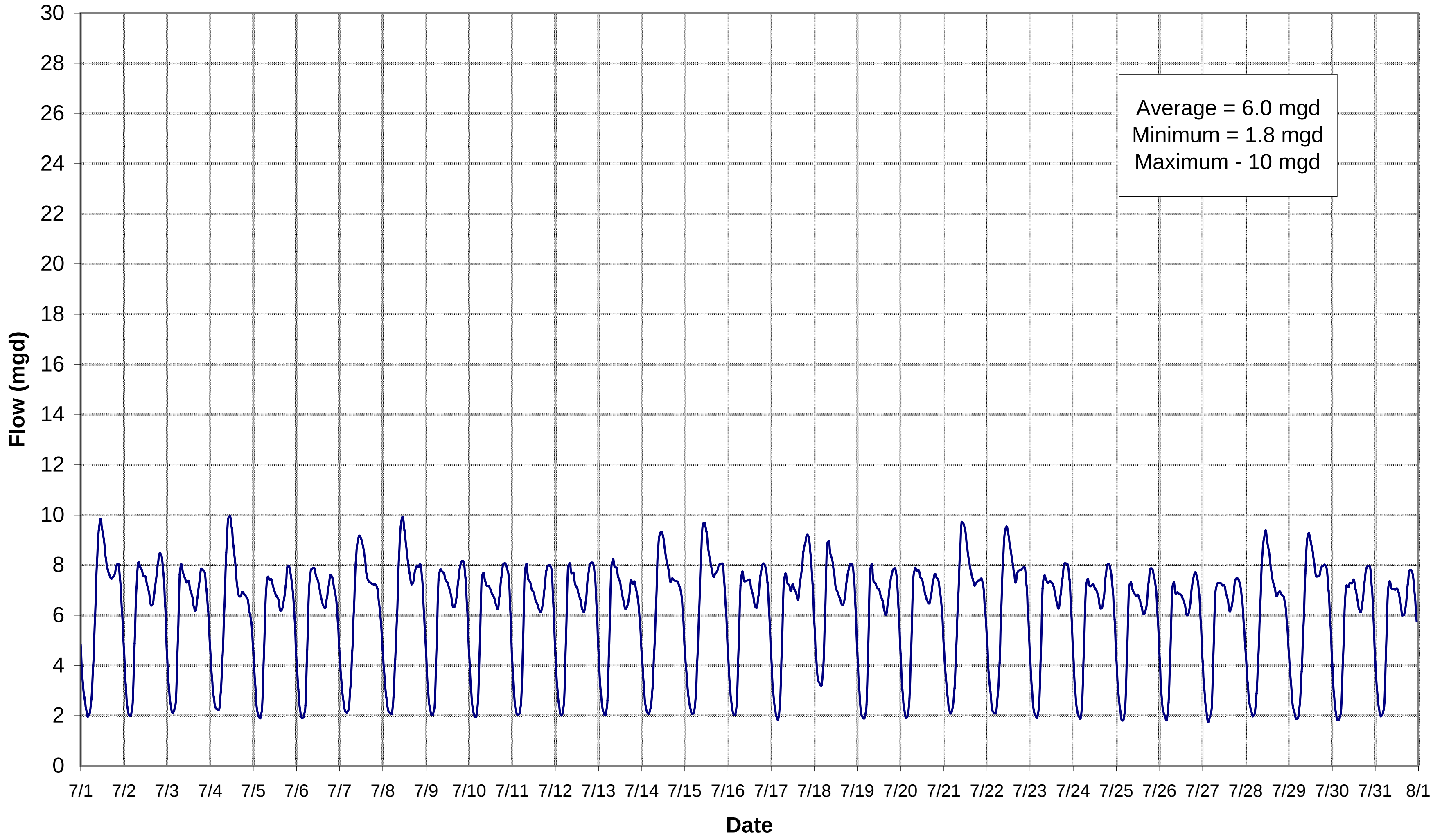


Figure 5
NSMCSD WWTP Hourly Flows 1/1/04 to 3/31/04

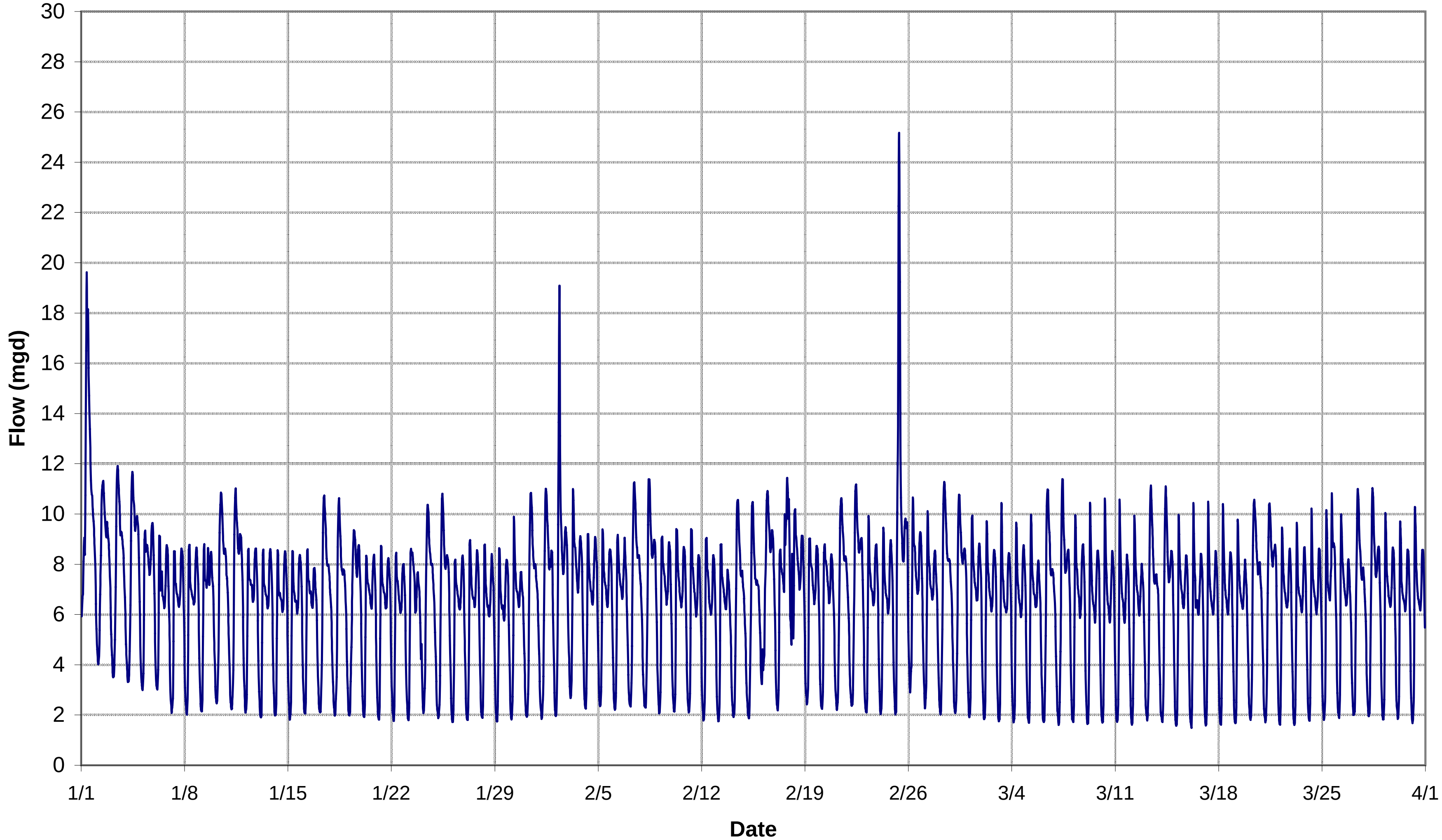


Figure 6
NSMCSD WWTP Hourly Flows 12/1/04 to 3/31/05

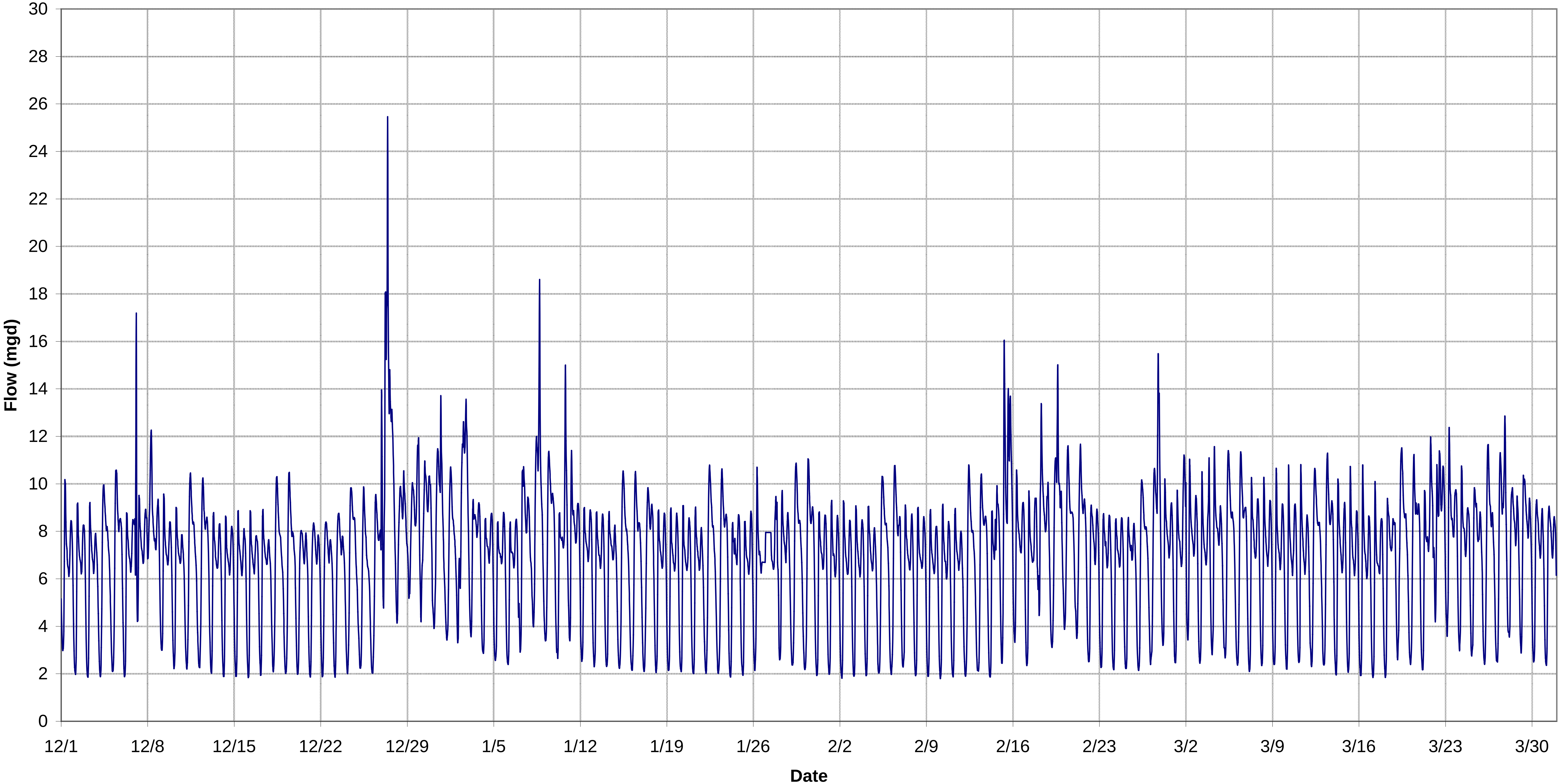
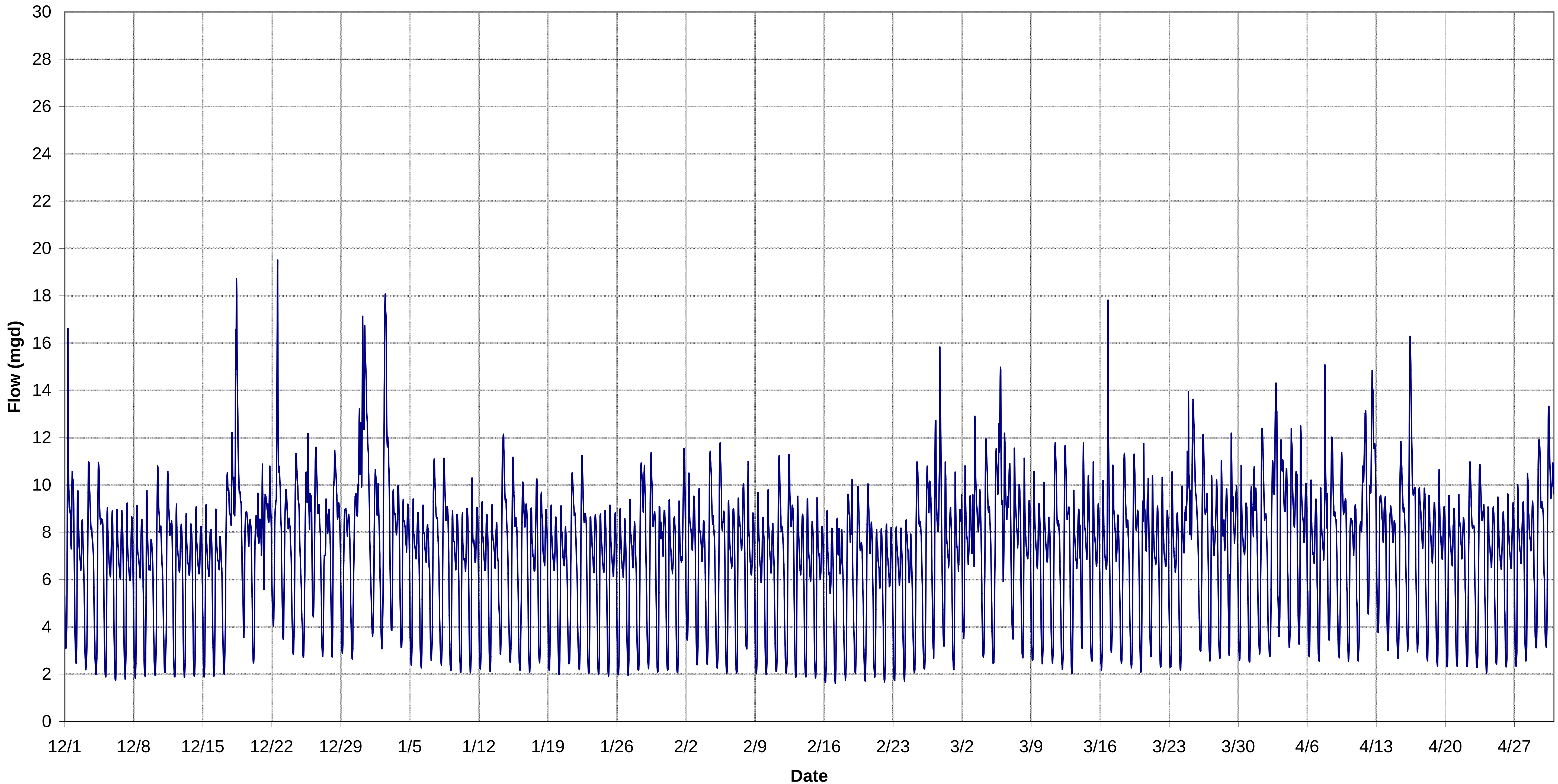


Figure 7
NSMCSD WWTP Hourly Flows 12/1/05 to 4/30/06



these events occurred concurrently with the morning diurnal peak flow. The event of December 31, 2005, had a lower peak flow of 17 mgd at the WWTP but occurred in the early morning hours when the normal diurnal flow was near its lowest level; had the storm occurred at a different time of day, it would have likely resulted in a peak flow more comparable to the other two events.

The major historical storm events were analyzed to isolate the RDI/I portion of the flow and develop synthetic unit hydrograph parameters that could be used to project the flow to a design storm condition. Rainfall data for the storm events were obtained from the City of San Francisco for their rain gauge located at San Francisco State University. The analysis was conducted by "calibrating" a model (for this exercise, the model consisted of a single pipe representing the flow to the WWTP) such that the model-simulated flows generally approximated the observed flows at the WWTP for the historical events. Synthetic unit hydrograph parameters were used to simulate the modeled RDI/I flows, using the methodology illustrated in **Figure 8** below. This methodology is equivalent to the methodology used in the 1989 I/I Evaluation. The calibrations for the February 25 and December 27, 2004, events are shown in **Figure 9.**

Figure 8: RDI/I Unit Hydrograph Components

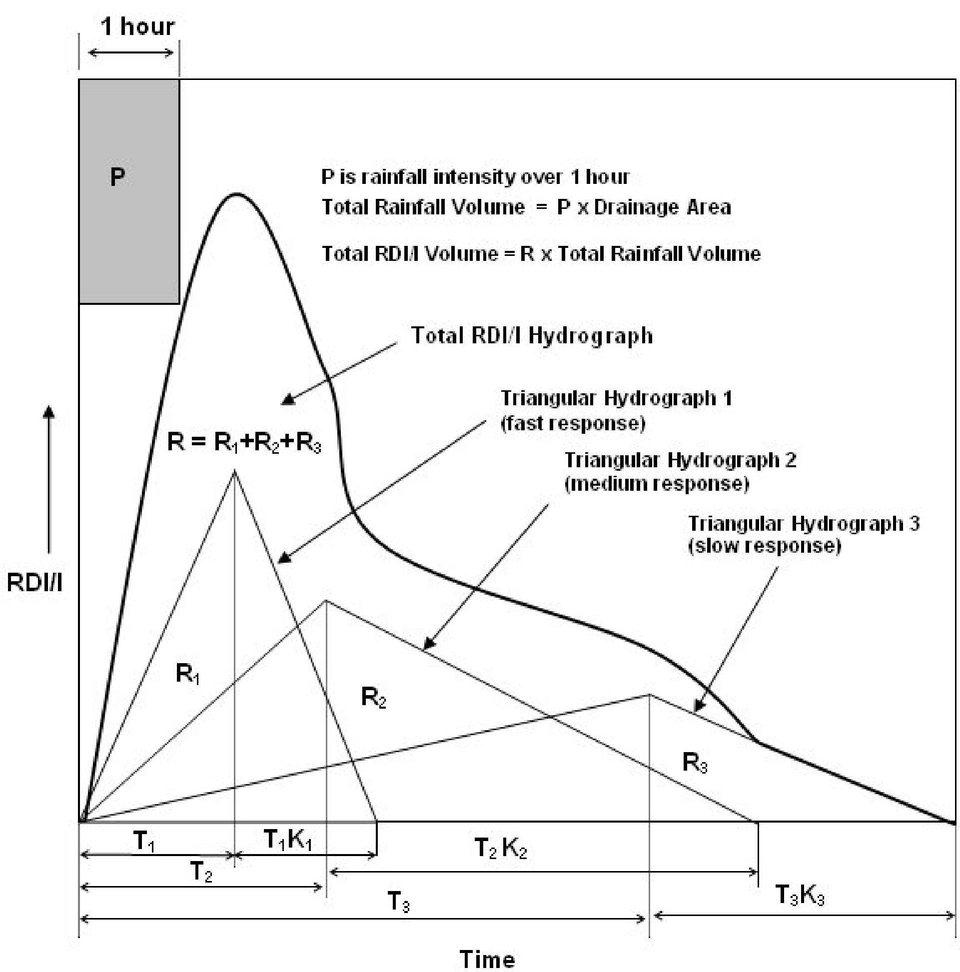
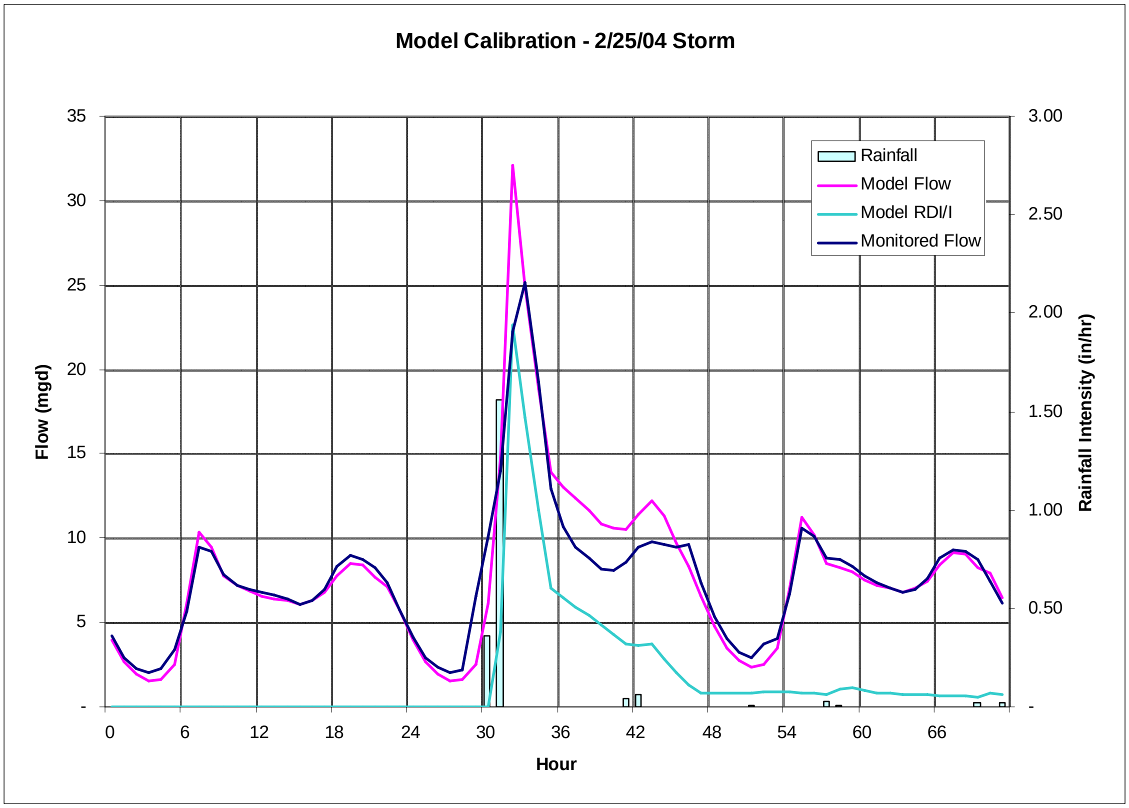


Figure 9
Model RDI/I Calibration for Historical Storm Events



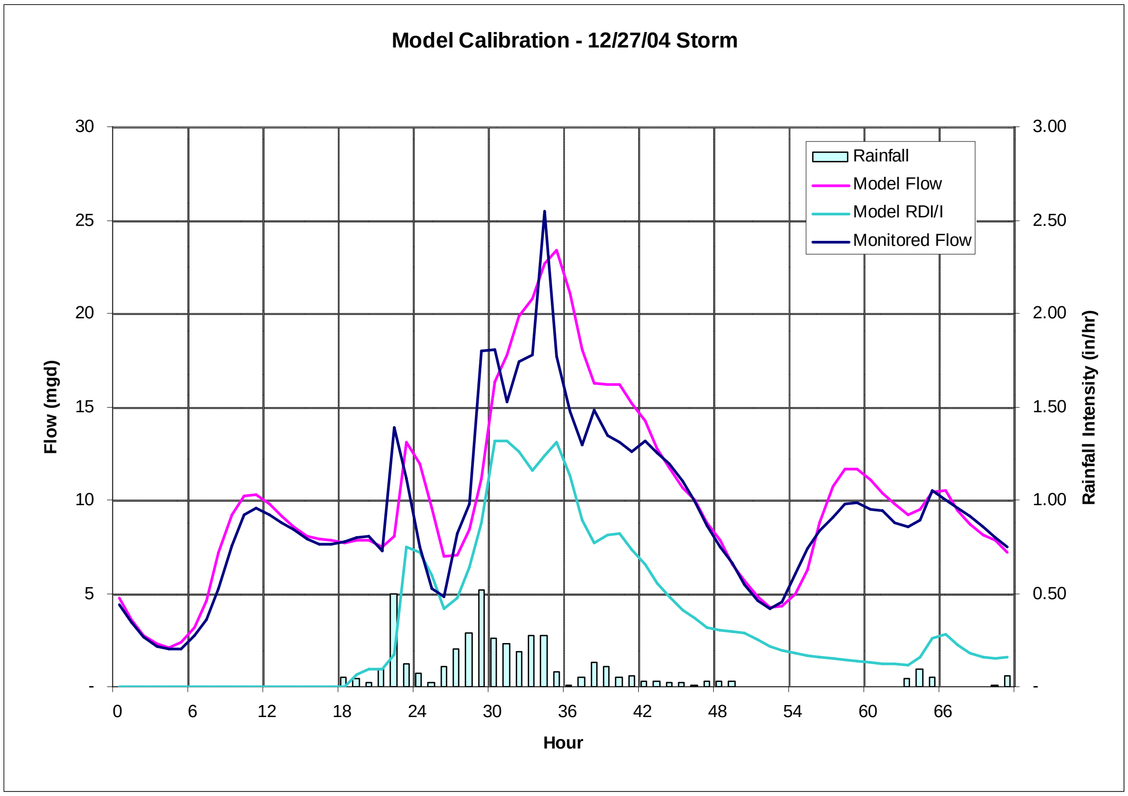
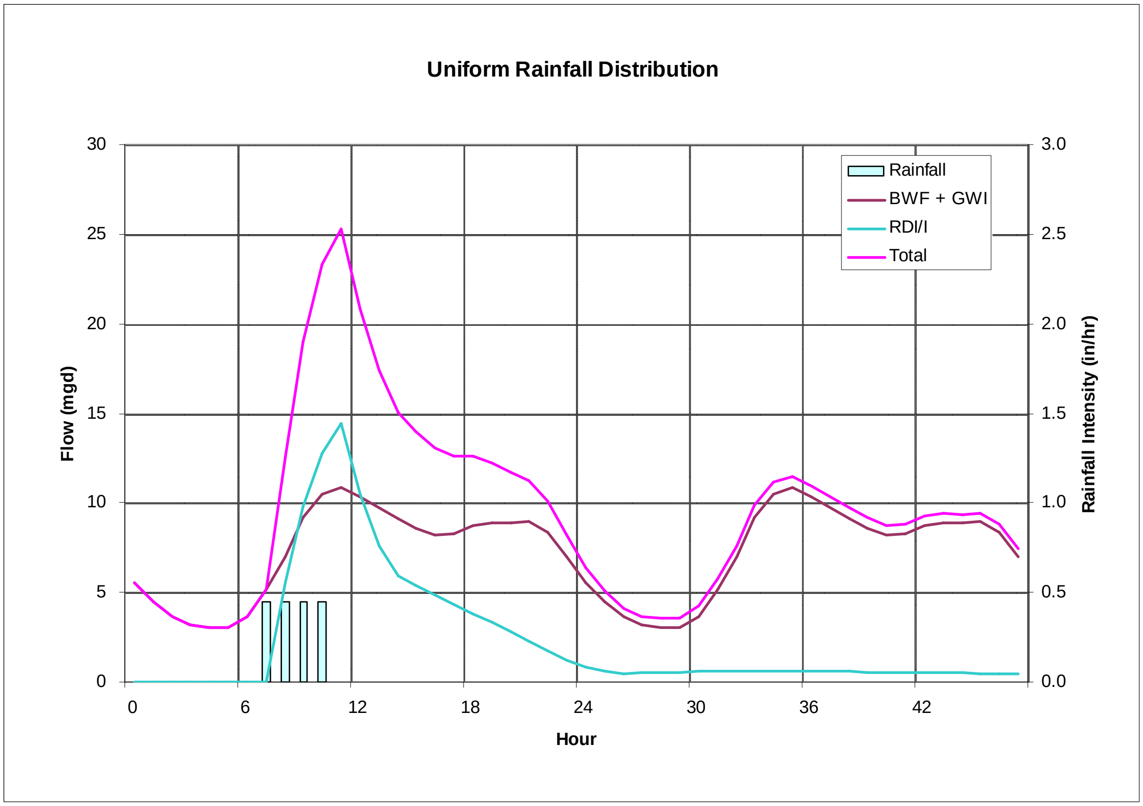
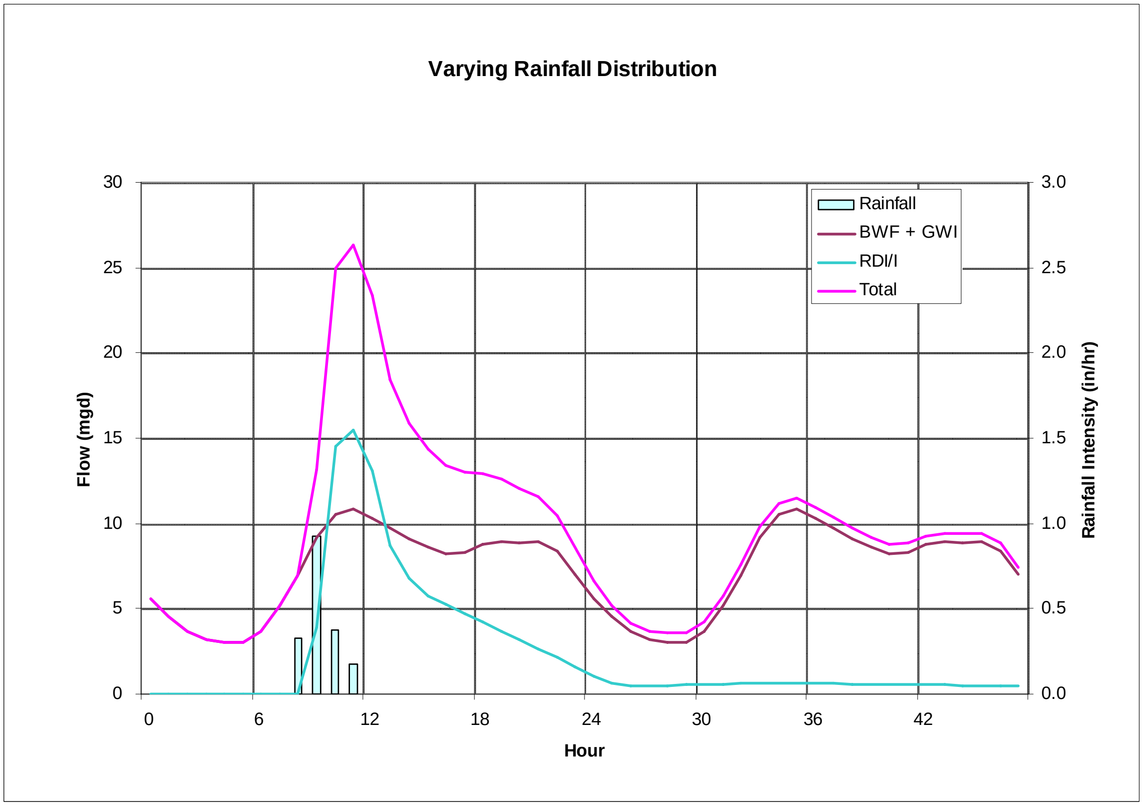


Figure 10
5-year Design Storm Hydrographs





Using the model-calibrated unit hydrograph parameters, a 5-year design storm flow hydrograph was generated for the 4-hour, 5-year design storm rainfall from the 1993 Master Plan. As in the 1993 Master Plan, the peak RDI/I was assumed to coincide with the peak daily flow (in this case, a dry weather weekend flow was used, as peak flows are generally higher on weekends, and a maximum GWI condition was superimposed on the DWF). An alternate hydrograph was also generated using a 4-hour, 5-year storm with a varying rainfall distribution. The rainfall distribution was based on a unit rainfall distribution for Daly City developed by Kennedy/Jenks Engineers for the 1983 Vista Grande Storm Sewer Project Draft Report (see Figure 4-1 of that report). **Figure 10** shows the model-simulated total and RDI/I hydrographs for the both the uniform and varying intensity 4-hour, 5-year design storm events.

Based on these results for the more conservative varying intensity design storm rainfall, the estimated total peak wet weather flow (PWWF) for a 5-year design storm is approximately 26.3 mgd. This flow is about 20 percent lower than design peak flows predicted in the 1993 Master Plan and slightly higher than the recorded peak flows during the February 25 and December 27, 2004, storm events.

6 Assessment of Lift Station Flows and Capacity

There are a total of six wastewater lift stations located within the NSMCSD, with an additional three located outside of the District's boundary in the WWD service area. Those located inside of the NSMCSD boundary include El Portal, Colma, Hickey, Mussel Rock, Belcrest and Skyline. Those located in the WWC area include Rowntree (called "Roundtree" in the 1993 Master Ploan), Westborough and Avalon. The District has provided data regarding the equipment installed at all nine lift stations. This data includes pump curves, pump design data (speed, design flow and head, etc.) and motor data for most stations.

The 1993 Master Plan listed the theoretical capacity for four of these pump stations, as shown in **Table 1**. These capacities were developed as part of the 1989 Infiltration/Inflow Evaluation. The capacities shown assume that one pump at each station is not in use (this is often referred to as the "firm capacity" in planning documents). In addition, the previous evaluations reduced the pump station capacities by an efficiency correction factor depending on the number of pumps in service. RMC has developed the calculated capacity for the remaining 5 pump stations not included in the previous evaluations using the same methodology.

Table 1 – Calculated Lift Station Capacities

Pump Station	Total Number of Pumps	Efficiency Factor[1]	Calculated Capacity (mgd)[2]
El Portal	2	80%	0.46
Colma	3	75%	1.94
Belcrest	4	70%	0.91
Skyline	4	70%	0.91
Mussel Rock[3]	2	80%	unknown
Hickey[3]	2	80%	0.75
Westborough[3]	3	75%	2.38
Avalon[3]	2	80%	0.16
Rowntree[3]	3	75%	2.81

1. Efficiency Factor is estimated in accordance with the 1989 Infiltration/Inflow Evaluation based on the number of active pumps
2. Calculated Capacity is the product of firm capacity (design flow with one pump out of service) and the Efficiency Factor.

3. The capacity of this pump station was estimated using the same methodology presented in the 1989 I/I Evaluation.

The pump data provided to RMC indicates that the pump stations in their current configuration have the same capacity as when they were evaluated in 1989 and 1991. The calculated capacities presented in Table 1 indicate that the same (or similar) pumps are in use at El Portal, Colma, Belcrest and Skyline as were in use when the I/I Evaluation was prepared.

The data provided to RMC includes a pump curve and a single pump performance point, but not a system curve with which to determine where on the pump curve the pumps are likely to operate. The efficiency factor used in the I/I Evaluation is an attempt to correct the single design point to account for inefficiencies in pump operation at an unknown point on the system curve. This is likely to be a conservative estimate, but cannot be confirmed without more in-depth analysis that is beyond the scope of this evaluation. Because the City has accepted the methodology in the past and it has become the basis for pump station planning, this evaluation continues to use the same approach. If the City wishes to determine more exactly the capacity of each station, it is recommended that system curves be developed for each lift station so that they may be combined with the system curve.

While firm capacities were stated for six pump stations, only four were evaluated as part of the previous Master Plan with respect to their ability to convey design flows. These included El Portal, Skyline, Colma and Belcrest. Mussel Rock, Hickey and the three WWD pump station were not evaluated. No modeling has been done as a part of the current evaluation, and it is therefore only possible to evaluate the four stations for which the 1993 Master Plan developed design flows. A comparison of calculated capacity and design flows is presented in **Table 2**.

Table 2 – Comparison of Calculated and Peak Wet Weather Flow

Pump Station	Calculated Capacity (mgd)	Peak Wet Weather Flow (mgd)[1]
El Portal	0.46	0.93
Colma	1.94	1.58
Belcrest	0.91	0.41
Skyline	0.91	0.41
Mussel Rock	unknown	unknown
Hickey	0.75	unknown
Westborough	2.38	unknown
Avalon	0.16	unknown
Rowntree	2.81	unknown

1. From 1993 Collection System Master Plan

The conclusions that can be drawn from Table 2 are consistent with those drawn in the 1993 Master Plan. Of the four pump stations evaluated, only El Portal has a projected capacity deficiency. Improvements to the pump station were included in the recommendations and CIP developed as part of the Master Plan; however the most recent pump station data provided by the City indicates that the pump station has not been improved, as the pump data indicates that the capacity remains as it was in 1993.

This evaluation of pump station capacity has been based on available information for the nine pump stations that are located in or that impact the NSMCSD service area. Of these nine, only four pump stations had sufficient data to assess potential capacity deficiencies, and one of these was found to have the same projected deficiency as was identified in past reports.

The accuracy of design flows and pump station capacities for each lift station can only be confirmed through detailed hydraulic analysis and hydraulic modeling. In particular, five of the pump stations for which NSMCSD provided data have unknown projected design flows, and these include the two largest stations, Rowntree and Westborough. However, since these two stations are owned by WWD and located outside of the NSMCSD boundary, the capacity assessment of these pump stations is not necessarily the responsibility of NSMCSD. The evaluation of pump station capacity will be confirmed and refined as part of the future hydraulic modeling analysis.

7 Summary and Conclusions

Review of the 1993 Master Plan and analysis of recent flow data for the NSMCSD WWTP indicate that the projected design flows in the 1993 Master Plan for the overall system are likely conservative. However, the information presented in the 1993 Master Plan document and the prior 1989 I/I Evaluation is insufficient to validate the results for upstream areas of the system. Although total flows in the system may be lower than predicted by the Master Plan, the flows in some individual basins could be higher due to sewer deterioration, increased development, or changes in system configuration. Furthermore, the use of a uniform intensity design storm, rather than one with a more realistic, varying rainfall distribution, could significantly underestimate flows in small upstream basins that respond quickly to rainfall.

While the City's General Plan has not changed since the 1993 Master Plan, and development in the City has generally followed the planned land uses depicted in the General Plan and in the CBSASP, there have been pockets of intense development that may have impacted flows in local areas within the system. These localized changes may not have been captured in the analyses for the 1993 Master Plan. The 1993 Master Plan also assumed no change in flows in the Westborough WD; yet those flows have likely increased due to development since 1988.

The accuracy of the data used for the hydraulic model and the calibration of the model for the 1993 Master Plan cannot be ascertained, and changes have been made in the system since that time. Also, although the modeling software (hydraulic engine) used in the 1993 Master Plan was representative of the modeling technology available at that time, it is not as accurate as the hydraulic models that are commonly in use today. Finally, the flow monitoring data on which the Master Plan modeling was based is almost 20 years old and was collected using what is now outdated metering technology, i.e., level meters, which can result in significant inaccuracies.

The District has an excellent record of very few SSOs, but with increased attention being paid to sewer issues by regulators, non-governmental organizations, and the public, future SSOs may be more likely to be detected and reported. Should the District experience wet-weather related SSOs in the future, it would be difficult to defend its capacity assurance plan based on a capacity assessment conducted 20 years ago.

For these reasons, it is recommended that NSMCSD conduct further wet weather flow monitoring in the system to confirm the current peak flows. Based on the results of the flow monitoring, the District should re-evaluate whether or not an updated hydraulic modeling effort to update the system capacity assessment is warranted.

8 Proposed Flow Monitoring Program

RMC recommends that the NSMCSD conduct a wet weather flow monitoring program during the winter 2007/08 to confirm peak flows in the system. A program consisting of 11 flow meters and 3 rain gauges installed for a period of two months is proposed. **Table 3** lists the proposed meter sites, locations, pipe diameters, and associated sewer basins captured by each proposed meter. **Figure 11** shows the proposed meter locations. Rain gauges would be installed on suitable public buildings or structures (e.g., WWTP, pump stations, schools or community centers, etc.) and located to provide representative coverage of the entire service area.. Following the completion of monitoring, the collected data would be reviewed to identify the relative magnitude of peak wet weather flows from various areas of the system.

Table 3: Proposed Flow Monitoring Locations

Meter ID	Manhole	Upstream Manhole	Diam. (in.)	Location	Basins
1	MH-C04-119	MH-C04-120	24	John Daly Blvd. at WWTP	D06,09 (a)
2	MH-D03-064	MH-D04-080	18	Mayfair Dr. at S. Mayfair Ave.	D10,11
3	MH-C04-134	MH-C04-133	21	S. Mayfair Ave. betw. Crestwood & Lake Merced Blvd.	D01,03,04
4	MH-C05-154	MH-C05-155	30	w/o Park Plaza Dr. s/o Coronado Ave.	D12,15,16 (a)
5	MH-C05-098	MH-C05-102	18		
11	MH-C05-133	MH-C05-134	24	90th e/o Sullivan Ave.	D14
6	MH-E07-091	MH-E07-092	15	Upstream of F Street Lift Station	D17,18
7	MH-D08-014	MH-D08-025	15	Southgate Ave. at Sullivan Ave.	D02,20
8	MH-D09-007	MH-D09-006	21	Serramonte Center	D19,21,22 (a)
9	MH-D09-034	MH-D09-033	15		
10	MH-E13-053	MH-E13-085	15	Verducci Ct. n/e of Gellert Blvd.	WWD, D22 (a)
(a) Incremental basins.					

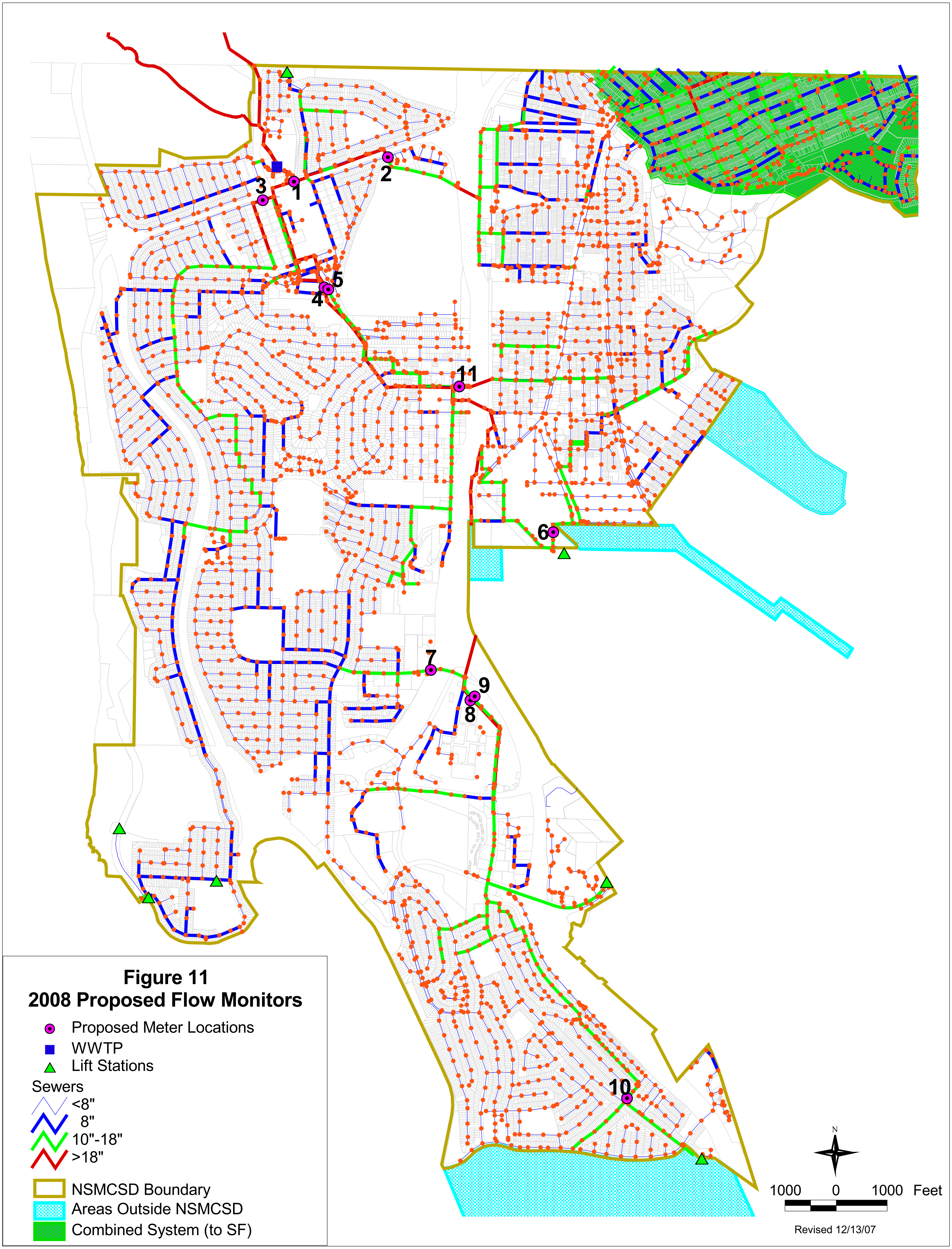


Figure 11
2008 Proposed Flow Monitors

- Proposed Meter Locations
- WWTP
- Lift Stations

Sewers
- <8"
- 8"
- 10"-18"
- >18"

- NSMCSD Boundary
- Areas Outside NSMCSD
- Combined System (to SF)