Memo

Stantec

To:	Tony Brcic, P.Eng. CRD	From:	Reno Fiorante, P.Eng. Paul Pai, P.Eng.
File:	CRD 149009002	Date:	February 4, 2010

Reference: CRD Core Area Wastewater Management Program – Design Flows and Loads

1.0 Introduction

The Capital Regional District (CRD) is currently in the process of planning for secondary wastewater treatment. The selection of appropriate design flows is an important element of the Core Area Wastewater Treatment Program (CAWTP). The CRD has already completed a comprehensive assessment of existing and future design flows for the CAWTP. The Discussion Paper 033-DP-2, prepared by KWL, CH2MHill, and Associated Engineering in September 2008 and updated in January 2009, outlined the methodology and summarized the design flows for each of the sewerage catchment areas in the program. As the Discussion Paper is very comprehensive and provides all detailed calculations, this memo serves to provide a synopsis of the information detailed in the Discussion Paper 033-DP-2 and also includes BOD and TSS load projections which are the governing factors for sizing of secondary wastewater treatment facilities.

2.0 Existing Design Flows

Under the current plan for wastewater treatment, Option 1A, four treatment facilities are proposed. One facility at Clover Point will be a wet weather treatment facility.

The historical flow information for Clover and Macaulay catchment areas serving the proposed plants for the past four years and is tabulated below:

Table 1 – Measured Historical Flows (in ML/d)

Catchment Area	Year 2006		Year 2007		Year 2008		Year 2009	
	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF	ADWF	PWWF
Clover Point	59	185	55	178	48	132	43	173
Macaulay Point	41	123	40	130	40	85	40	145

The historical flow data for Clover Point include the flows from both Clover and East Saanich catchments, while the Macaulay flow data include the flows from West Shore. Over the last 4 years, ADWF flows have been fairly consistent.

Regulatory Requirements

New treatment facilities must meet the requirements of the Municipal Sewage Regulation and must also satisfy Federal regulations. Secondary treatment must be provided for flows up to 2 times ADWF. Primary treatment must be provided for flows in excess of 2 times ADWF. For CRD we are proposing that flows up to 4 times ADWF be provided with primary treatment. This should cover the majority of peak wet weather flow events currently experienced in the CRD sewerage system.

Appendix 1 to schedule 7 of the MSR specifies redundancy requirements for the various process units within a wastewater treatment plant. For facilities the size of the CRD, multiple process trains must be provided such that the plant can meet operating certificate effluent requirements at all times. For the secondary process units the remaining capacity with the largest unit out of service or train out of service must be capable of treating 75% of the design flow.

3.0 Project Design Populations

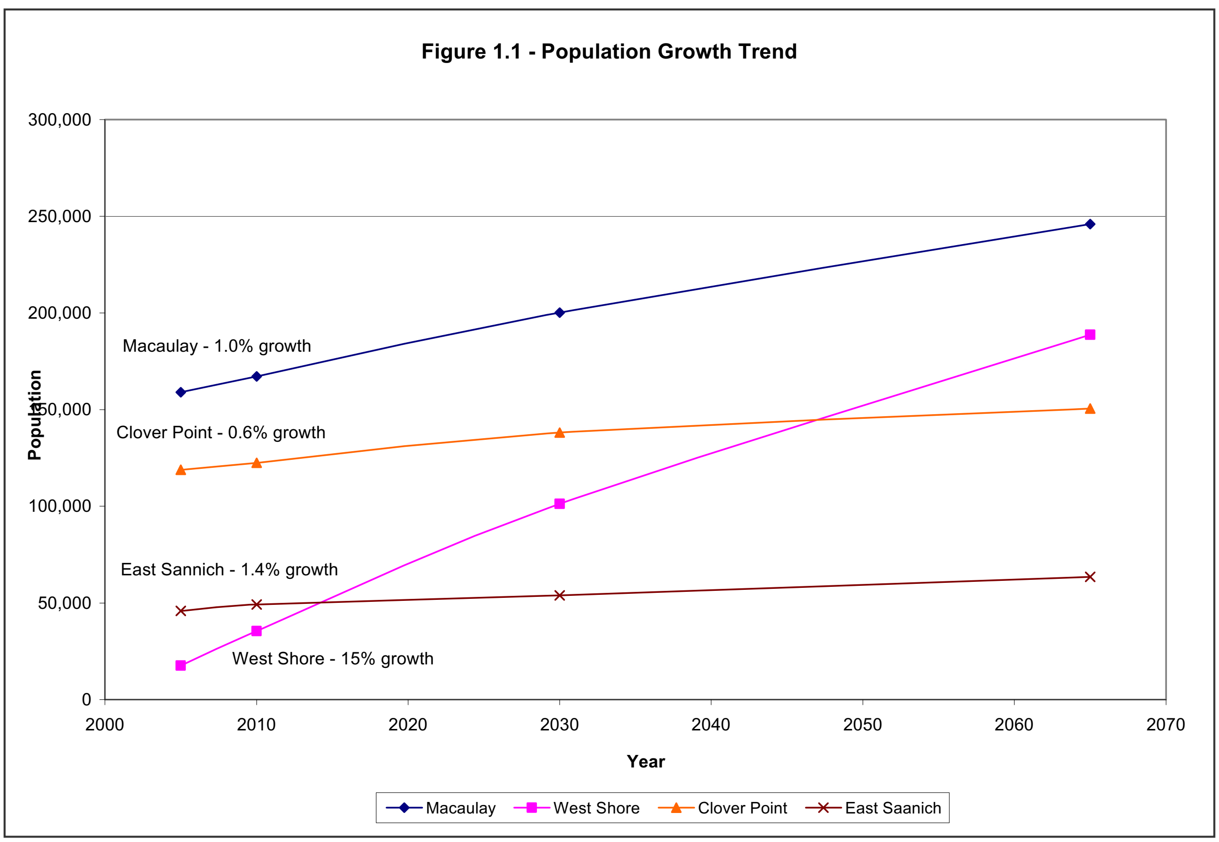
The total population as defined in the Discussion Paper 033-DP-2 is the Total Population Equivalent which is the sum of Residential Population and ICI Population Equivalent (as a number of full time residential population equivalents for industrial, commercial, and institutional activities).

The future populations have been projected in two recent reports prepared by Kerr Wood Leidal Associates Ltd (KWL) in consultation with CRD Planning. The population projections have also been carried out by the Province through BC STATS using PEOPLE software.

The population equivalents for year 2005 and the projected populations for years 2030 and 2065 have been appended in the Discussion Paper 033-DP-2. They are extracted and tabulated in Table 2. In addition, the estimated population equivalents for year 2010 are also included as projected by Stantec Consulting Ltd. based on year 2005 population with an annual population growth rate in each catchment as follows:

Catchment Area	Projected Annual Population Growth Rate
East Saanich	1.4%
Clover Point	0.6%
Macaulay Point	1.0%
West Shore	15.0%

Figure 1.1 illustrates the project population growth in the CRD.



A review of the above data indicated that significant growth is expected on the West Shore but given current economic conditions this growth may take some time to be realized. Options for staging West Shore facilities are discussed in other sections of this memorandum.

Table 2 – Existing and Projected Population Equivalents

Year	Residential PE	ICI PE	Total PE
East Saanich Population Equivalents			
2005	28,178	17,681	45,859
2010	30,206	18,954	49,160
2030	31,746	22,173	53,919
2065	34,424	29,061	63,485
Clover Point Population Equivalents			
2005	85,055	33,844	118,900
2010	87,637	34,873	122,510
2030	94,349	43,744	138,093
2065	103,425	47,155	150,580
Macaulay Point Population Equivalents			
2005	121,755	37,299	159,054
2010	127,966	39,202	167,168
2030	144,299	55,935	200,234
2065	163,480	82,476	245,956
West Shore Population Equivalents			
2005	12,193	5,429	17,622
2010	24,524	10,920	35,444
2030	71,871	29,360	101,231
2065	136,778	51,957	188,735

The total connected **sewered equivalent** population in the Core Area is expected to increase to approximately 493,400 by year 2030, to 650,000 by year 2065. The expected rate of growth in the Macaulay catchment is much greater than that in the Clover catchment. The growth potential in the Clover catchment is through infill and densification while the Macaulay catchment still has more room for expansion.

For West Shore communities, significant development is planned in the District of Langford and City of Colwood in the coming years.

Although the populations in years 2015, 2030, 2045, and 2065 have been projected in the Discussion Paper, only the projected populations for years 2030 and 2065 will be used for design flow projection as the timeframe is considered to be reasonable for staging of construction. The design populations used for developing the wastewater flows for the preliminary design are summarized in the following table:

Table 3 – Design Population Equivalents including ICI

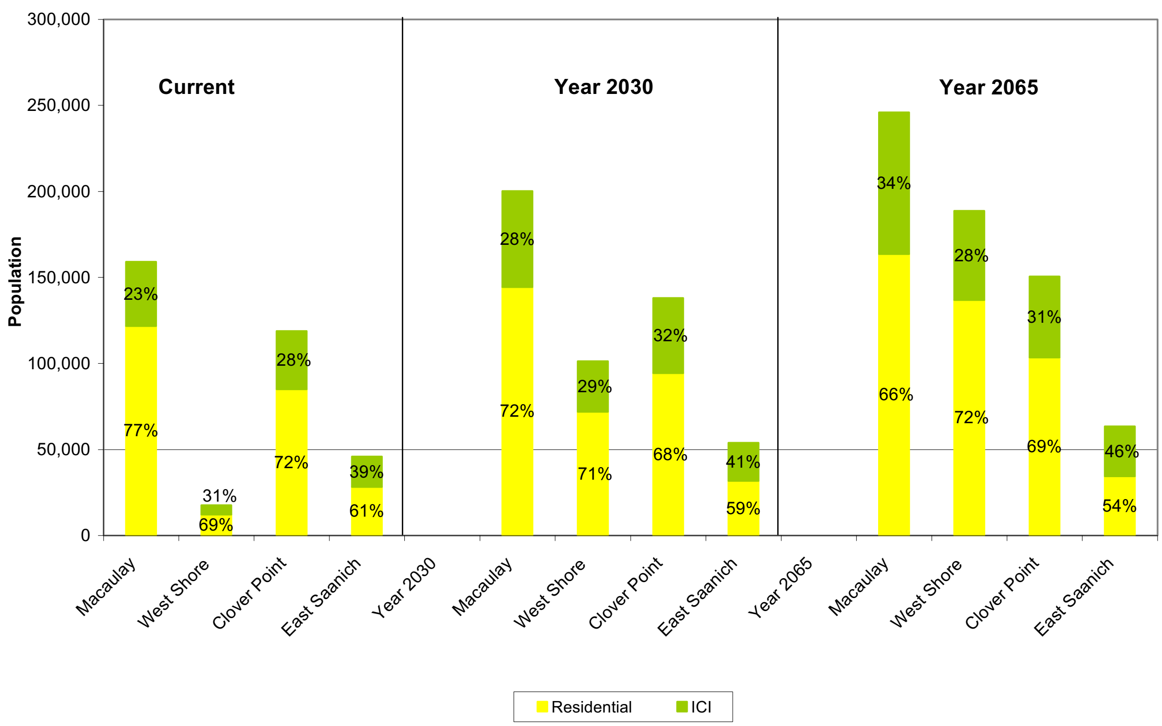
Catchment Area	Year 2030	Year 2065
East Saanich	53,900	63,500
Clover Point	138,100	150,600
Macaulay Point	200,200	246,000
West Shore	101,200	188,800
Total	493,400	648,900

It is noted that the actual population is lower than the numbers outlined in Table 3 because industrial, commercial and institutional users are converted to population equivalents to estimate flows. This is a common practice in the design of sewerage systems.

Figure 1.2 illustrates the breakdown of residential and ICI projections for current, 2030 and 2065 populations.

Reference: CRD Core Area Wastewater Management Program – Design Flows and Loads

Figure 1.2 - Design Population Equivalents including ICI



4.0 Project Design Flows and Loads

The projected flows were developed based on the following approaches assuming that water conservation initiatives are implemented in the future through use of low flow fixtures. CRD has already embarked on this program over the last 5 years and have noticed a reduction in water consumption:

4.1 ADWF (Average Dry Weather Flow)

ADWF consists of two main components: BSF and $GWI_{summer.}$

- BSF (Dry Weather Base Sanitary Flow): The per capita equivalent BSF in the projected areas is currently between 225 and 250 L/d/capita. With water conservation and fixture reduction, the per capita equivalent value could be reduced to 206 L/d/capita in year 2030, and to 184 L/d/capita in year 2065.

- GWI (Ground Water Infiltration): It represents leakage of ground water into the sewer system through cracked pipe or pipe joints. Older sewer systems typically have higher GWI rates than newer sewer systems. GWI_{summer} represents ground water that infiltrates into the collection system during the driest months of the year.

Typically, GWI increases with time as a sewer system deteriorates due to age. A considerable investment would be required for the CRD to reduce the GWI as the core system is getting older.

Table 4 provides a summary of average dry weather flows.

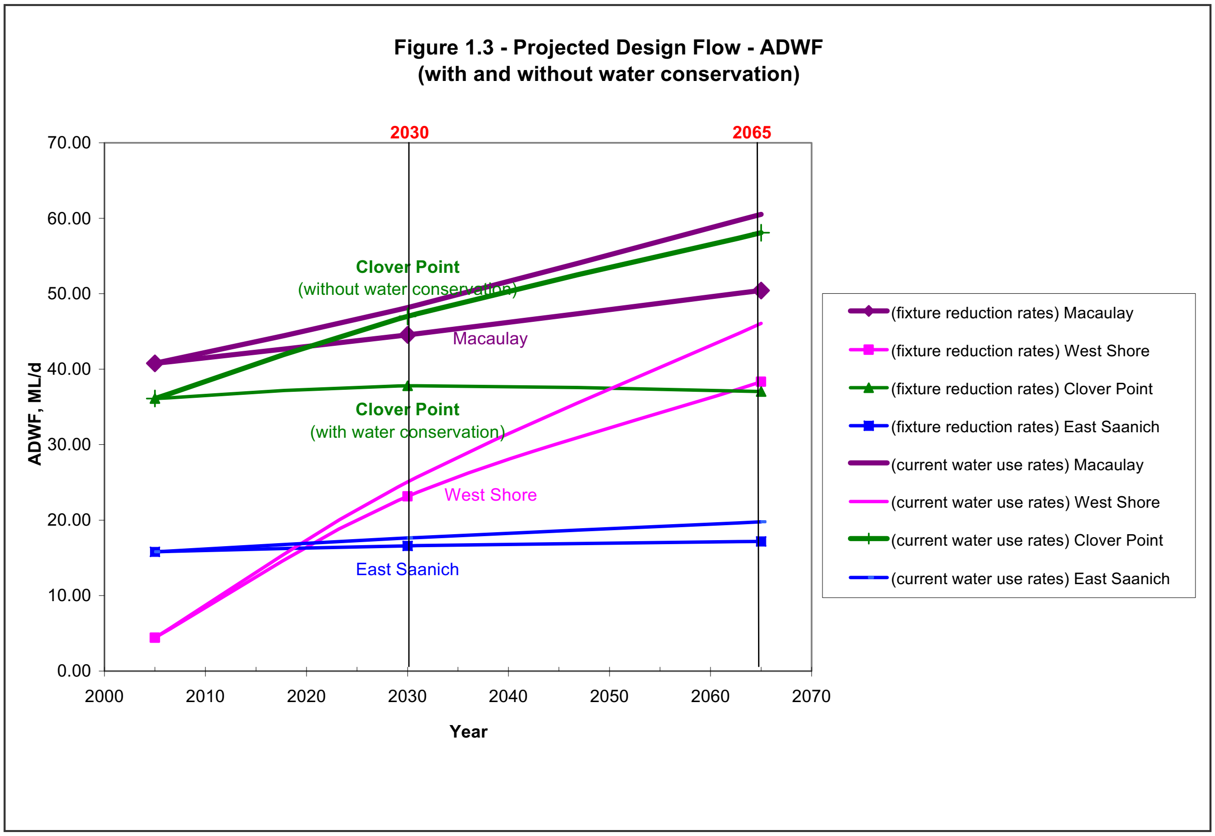
Table 4 – Average Dry Weather Flows (ADWF)

WWTP Site	Ave. of Measured ADWF (ML/d)* 2006-2009	Year 2030		Year 2065	
		Projected ADWF (ML/d)	Plant Design ADWF (ML/d)	Projected ADWF (ML/d)	Plant Design ADWF (ML/d)
East Saanich	51	16.60	16.60	17.18	17.17
Clover Point		37.79	37.79	37.05	37.05
Macaulay Point / McLoughlin Point	40	44.55	46.36	50.43	50.43
West Shore		23.14	24.14	38.34	38.34

* This value does not include upstream overflows.

The above table shows that the design flows for most of the plant sites are the same as the projected flows except the 2030 design flows for Macaulay Point and West Shore sites which are slightly higher than the projected flows. We note that the current measured flows only include the flows measured at the Clover Point and Macaulay Point and do not include overflows. The design flows assume that upstream overflows are eliminated and conveyed to new treatment plants.

Figure 1.3 provides a summary of design flows with and without fixture reduction. Fixture reduction has been assumed in **Table 4** flows.



4.2 PWWF (Peak Wet Weather Flow)

PWWF is estimated as PDWF (Peak Dry Weather Flow) plus I&I (inflow and infiltration).

PDWF is the product of ADWF and PF (peaking factor). Usually, 80% of the calculated value from Harmon equation is applied. The exception is that 100% of the Harmon equation value was used for peak flow estimate along the ECI (East Coast Interceptor) and has been confirmed by flow monitoring results.

I&I (inflow and infiltration) for wet weather flows is the sum of RDI&I (rainfall dependent inflow and infiltration) and $GWI_{winter.}$ Where GWI_{winter} is the ground water infiltrates into the collection system during the wettest months of the year.

Wet weather flows are typically based on storm events. The magnitude of storm events varies based on the frequency of their return periods. The methodology used in the Discussion Paper 033-DP-2 is termed as the "I&I Envelope" which uses a series of flow monitored storm events, including 2, 5, 10, 25, 50 and 100 years, to develop a correlation between the amount of rainfall that occurs and the magnitude of I&I that shows up at a given site. A return period of 5-Year and a 6-Hour rainfall duration were selected for best correlation of return period. The projected flows (ADWF) for the catchments as shown in the Appendices of Discussion Paper 033-DP-2 are summarized and tabulated below for comparison with the design flows used in the cost estimate. The 5 year return period is a regulatory requirement under the MSR.

4.3 Wastewater Design Loads

Secondary wastewater treatment plants are designed to handle the organic and suspended solids loading. The organic loading governs the sizing the of secondary treatment process while hydraulic flows govern the sizing of components such as headworks, primary treatment and outfalls. These loadings are measured as biochemical oxygen demand (BOD_5) and total suspended solids (TSS). For preliminary design, the total quantity of the organic and suspended solids loading for each plant is determined using the design flow (ADWF) with a solids loading factor of 1.3 to account for the load increases during the storm events and maximum month loading conditions. The BOD_5 and TSS concentrations in the storm water are greatly reduced. The solids loading factor could range from 1.1 to 1.4 x ADWF depending on the characteristics of the catchment area and ICI contributions. The increases in flow during the wet weather conditions would mainly affect the hydraulic capacity of the wastewater treatment. The primary and secondary treatment facilities have been designed to handle the wet weather flow hydraulically at 4 x ADWF and 2 x ADWF, respectively.

The following values were used for all catchment areas for calculating the design loads:

- ADWF BOD_5 : 240 mg/L

- ADWF TSS: 195 mg/L
- Primary clarification efficiency for TSS removal: 55%
- Primary clarification efficiency for BOD_5 removal: 30%
- Net yield factor for conversion of primary effluent to secondary solids: 0.8
- Biosolids Loading Factor applied for increase in loads that occur at flows above ADWF conditions: 1.3

The selected design wastewater treatment concentrations are consistent with the results of the wastewater sampling characterization program which has been in process for several years. These design parameters are in fact lower than many communities in British Columbia mainly due to the I&I impacts from older sewers in the Core Area.

The design flows used in the calculations for biosolids loads are ADWF for year 2030 except East Saanich plant. Year 2065 ADWF has been used for East Saanich as it is only 3% higher than the year 2030 ADWF, there would have no facility expansion required in year 2065.

The design loads for all plant sites with secondary treatment were computed and summarized in the table below:

Table 5 – 2030 Design Flows and Loads for Plant Sizing

Plant Site	Design Flow (ML/d)	Design Loads (kg/d)	Action
East Saanich	17.2	5,410	To Clover Point via sanitary sewers
Clover Point (Primary Treatment)	37.8	5,410	No additional loads. Biosolids from East Saanich in sewage up to 2xAWDF is pumped to McLoughlin WWTP
Macaulay / McLoughlin Point	46.4 + 37.8 from Clover Point.	29,430	Off-site Treatment
West Shore	24.1	7,570	On-site Treatment

5.0 Potential Treatment Plant Staging Opportunities

Staging of construction has been considered in the construction of the CRD wastewater treatment plants. The required treatment capacities would be constructed in two stages in years 2030 and 2065. Other than West Shore plant there does not appear significant opportunities for staging at other locations. The following is suggested for staging of each of the plants:

- West Shore Plant – only construct 7 ML/d plant and bring current 7 ML/d from West Shore catchments to the central McLoughlin Plant. Total capacity allocated to West Shore is 14 ML/d. In the future additional capacity can be obtained by expanding the West Shore plant to obtain additional capacity.
- McLoughlin Point Plant - Because of the site constraints, it recommended to build concrete tankage to 2065 flows and loads. There is only a 4 ML/d difference between 2030 and 2065 flows and it is not practical to do a 4 ML/d expansion to the plant in the future.
- Clover Point Plant – Build to 2030 flow and load. The 2065 flow is actually lower than the 2030 flow due to I&I reduction and water conservation initiatives.
- Saanich East Plant - The difference between the 2030 and 2065 flow is only 0.6 ML/d. Tankage should be built to 2065 flows and membranes installed for additional flow in the future.

6.0 Conclusions

Based on the assessments that have been completed with respect to design flows and loads for the CRD Wastewater Treatment Program the following can be concluded:

1. A review of the selected design flows and loads for the various catchments serving the CRD has been completed. With the exception of the West Shore plant, all 2030 design flow and load projections provide little additional capacity over current loading conditions and is in fact considered a very aggressive design with no conservatism. The flows and loads have been calculated assuming fixture reduction continues to be implemented and I&I reduction programs continue. The difference between 2030 and 2065 design loads for all plants is minimal and future capacity will come from the implementation of water conservation efforts and reduction in I&I.
2. Ongoing wastewater characterization completed by the CRD indicates the selected design parameters for BOD and TSS loading used in the planning

work to date are reasonable for the purposes of secondary treatment process sizing.

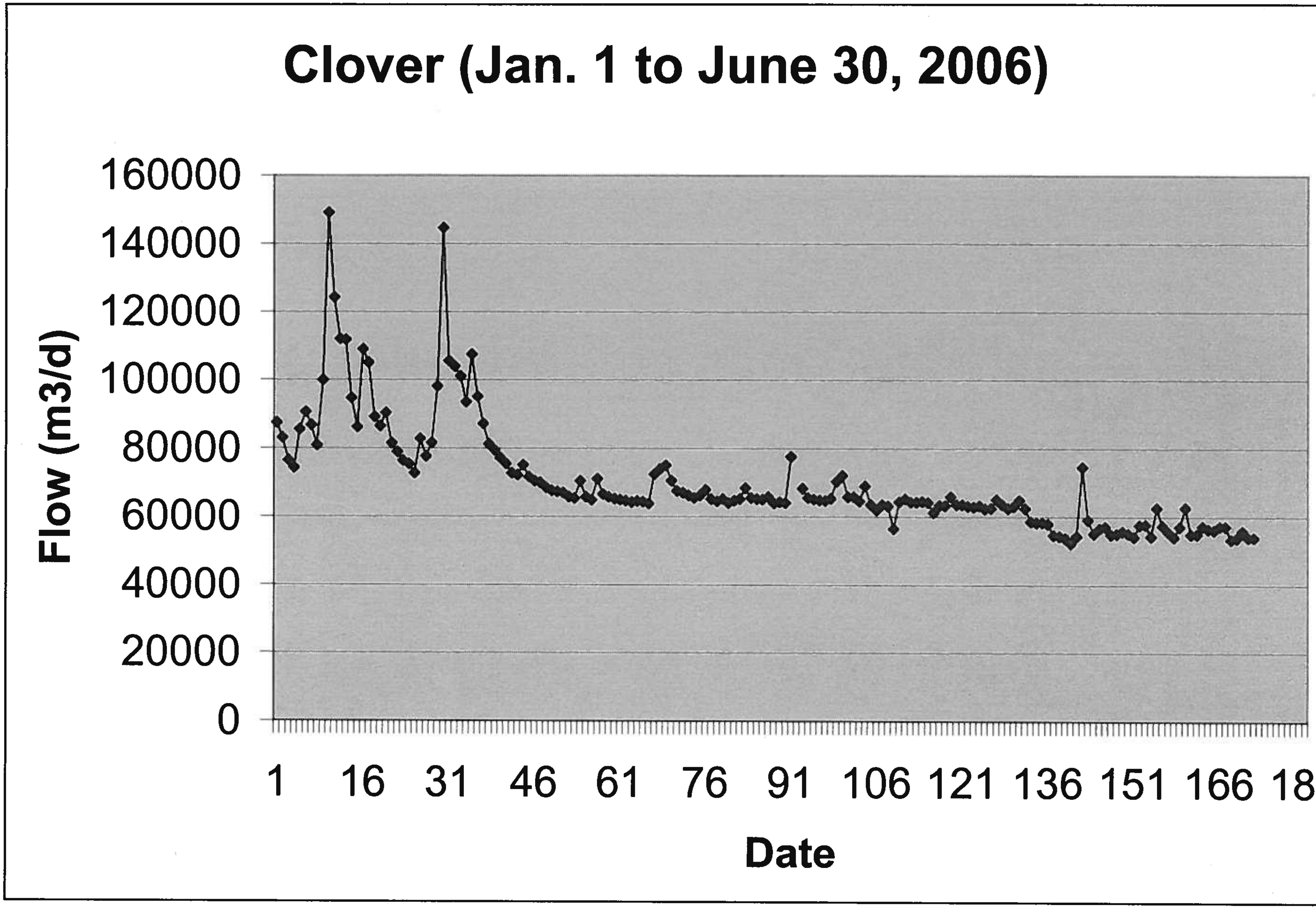
3. In assessing existing flow records for the last 4 years based on measured flows at Clover Point, Macaulay Point and other locations within the Core Area system, the selected design flows are considered aggressive and will require that CRD continue with water conservation and I&I reduction initiatives. CRD is already committed to these initiatives and they are part of the recent Liquid Waste Management Plan Amendment No.7.

4. The only opportunity for phasing is the West Shore plant. Consideration should be given to phasing of West Shore plant and it has been suggested that only 14 ML/d be allocated to this area which allows for growth of an additional 7 ML/d over the next 10 years. Current planning indicates that 7 ML/d capacity will be provided at the Mc Loughlin plant with an additional 7 ML/d provided at a new plant on the West Shore. When additional capacity is needed on the West Shore in the future, it can be provided by decentralized treatment facilities or expansion of the proposed first phase 7 ML/d plant on the West Shore.

Attachment: - Historical Flow Charts for Clover and Macaulay outfalls

- Wastewater Characterization Data

Historical Flow Charts for Clover and Macaulay outfalls



Clover (Jan. 1 to June 30, 2006)
160000
140000
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Flow (m3/d)
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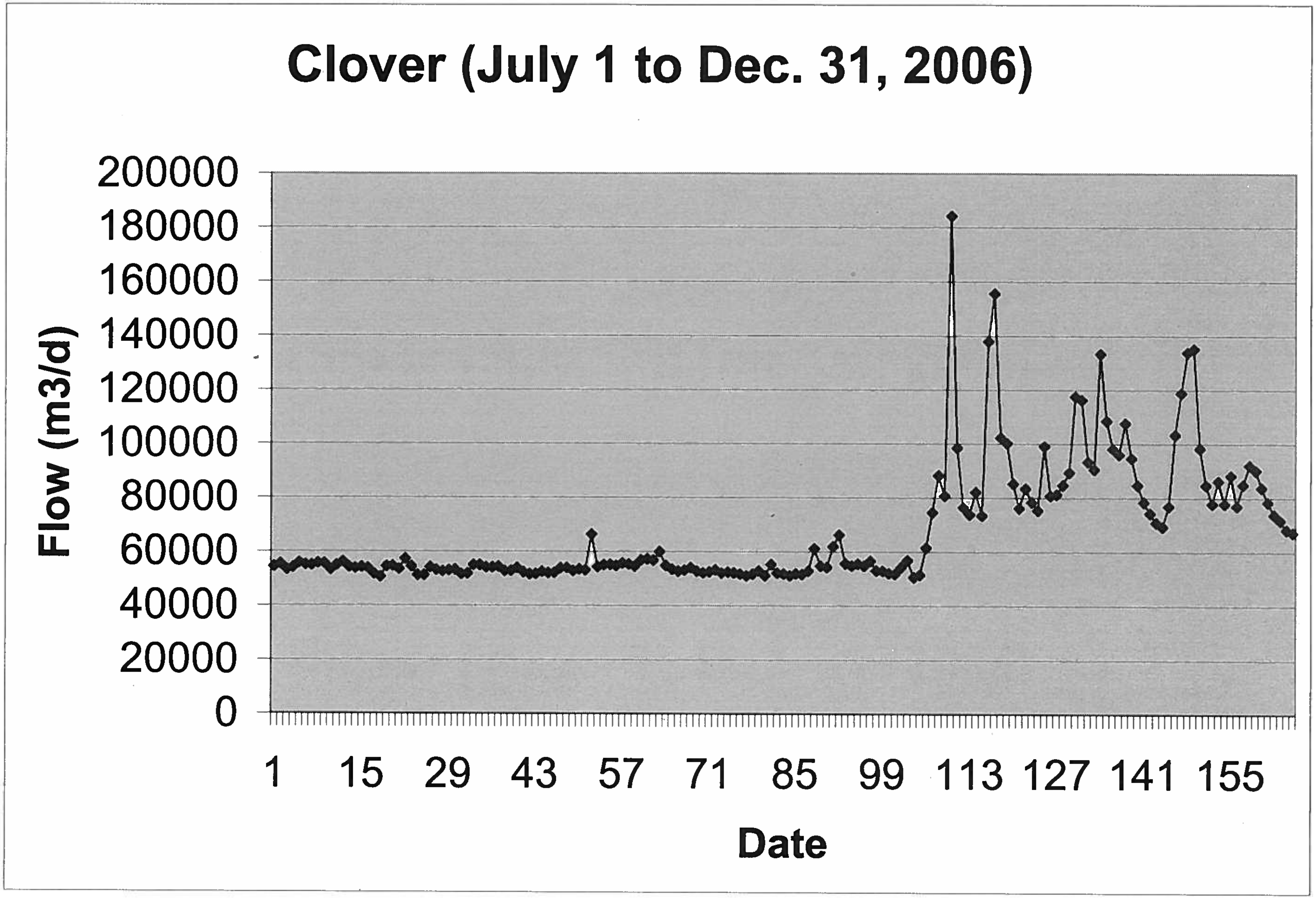
Date


Clover (July 1 to Dec. 31, 2006)
Flow (m3/d)
200000
180000
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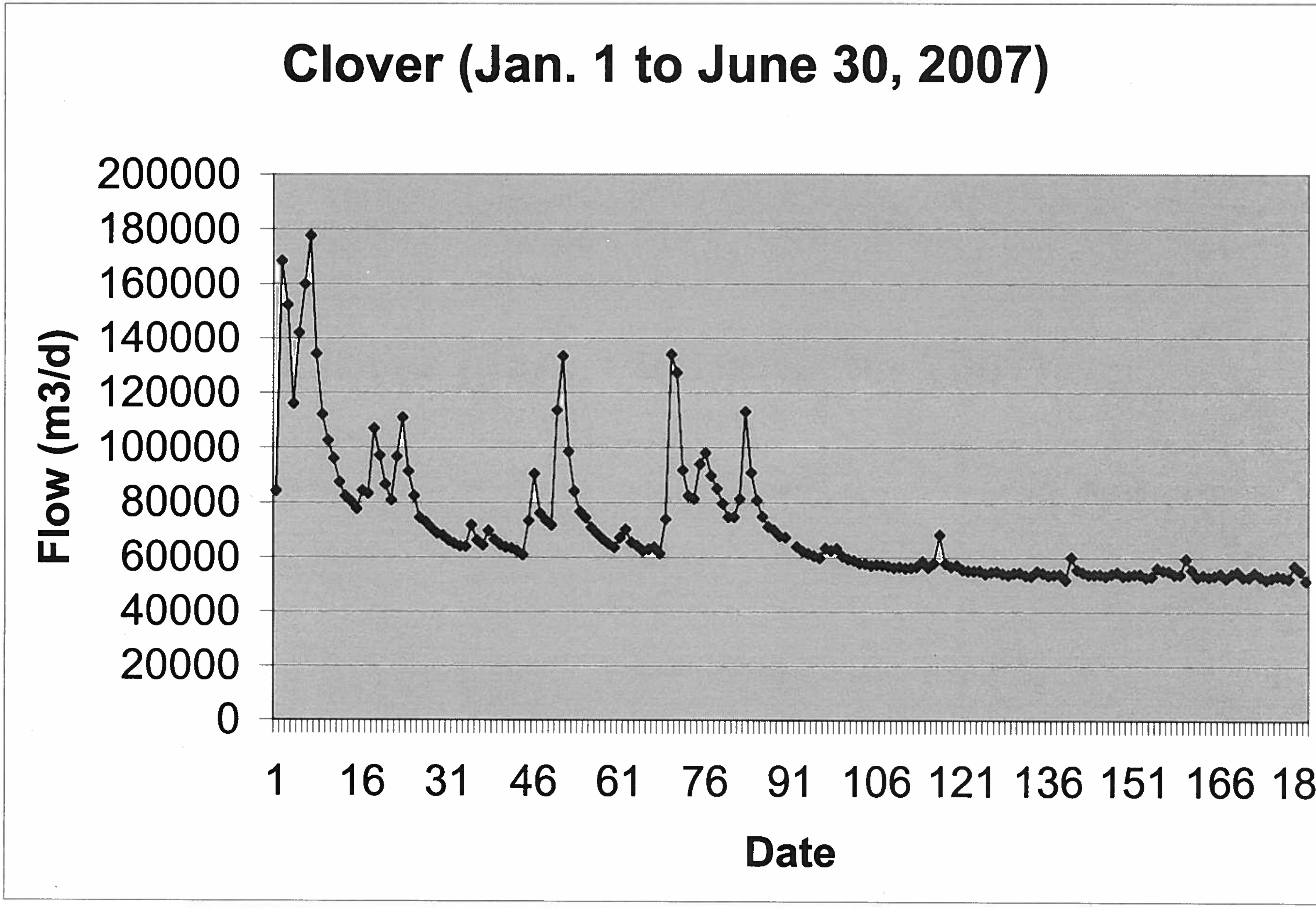

Clover (Jan. 1 to June 30, 2007)
Flow (m3/d)
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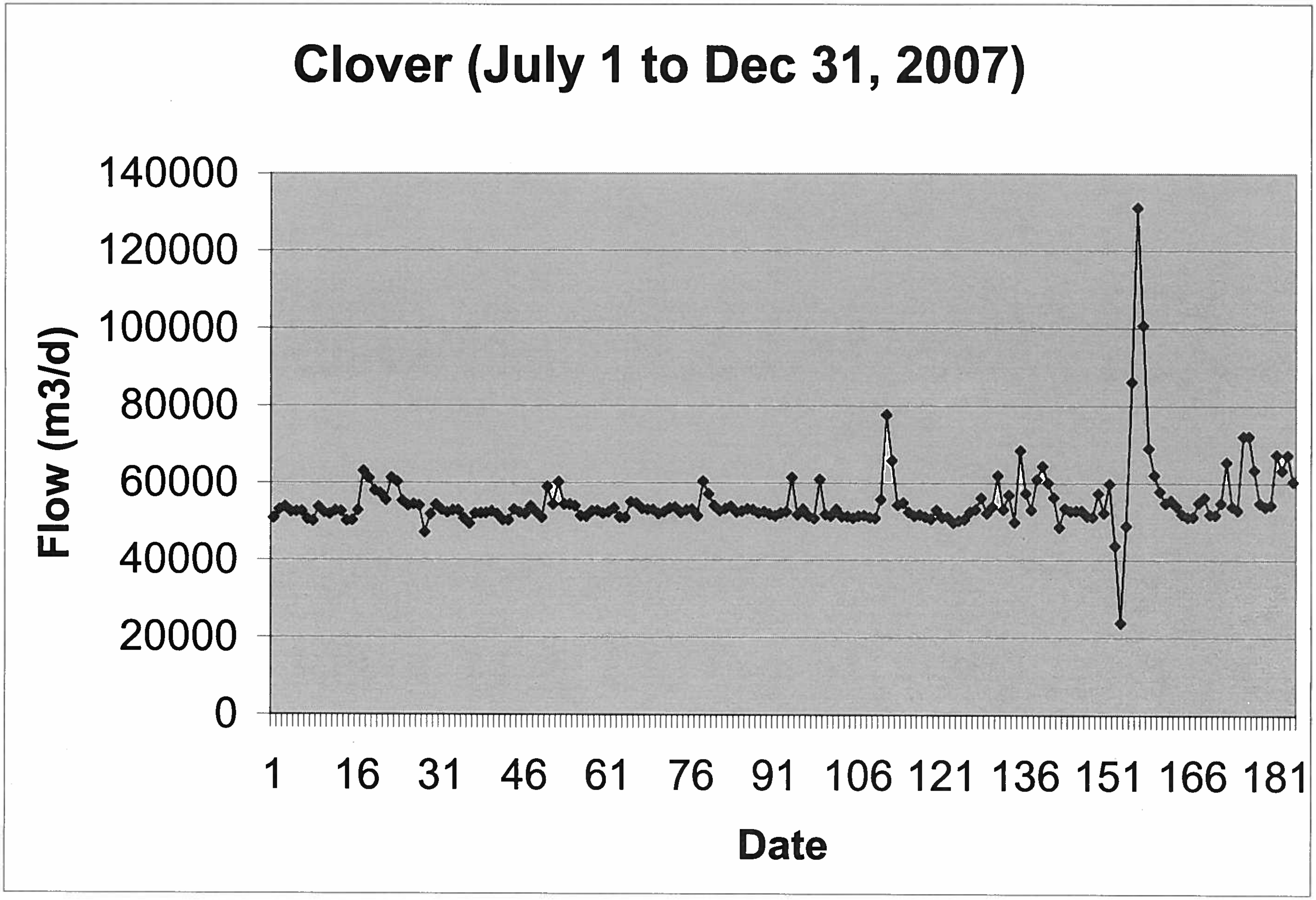

Clover (July 1 to Dec 31, 2007)
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Flow (m3/d)
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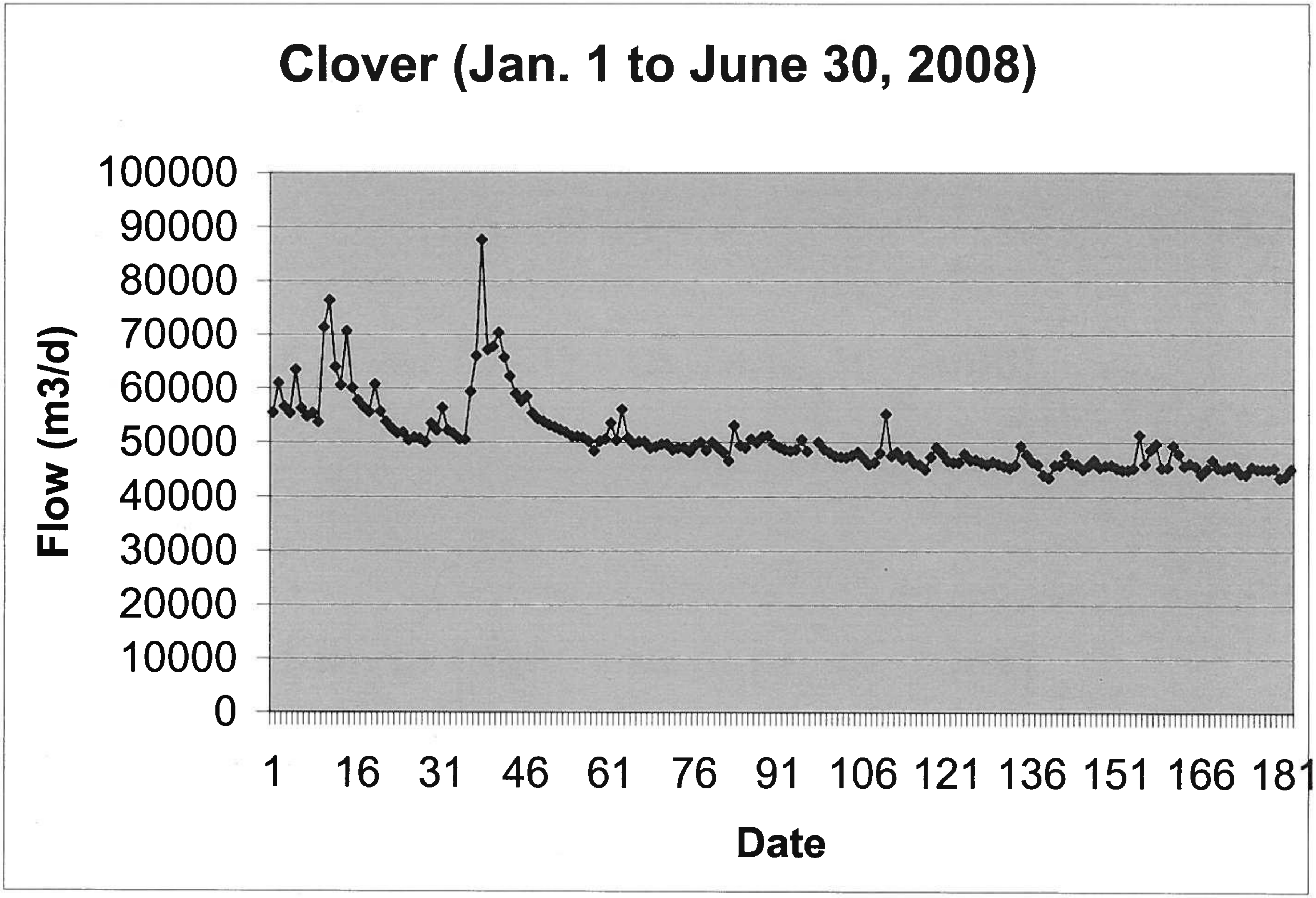

Clover (Jan. 1 to June 30, 2008)
Flow (m3/d)
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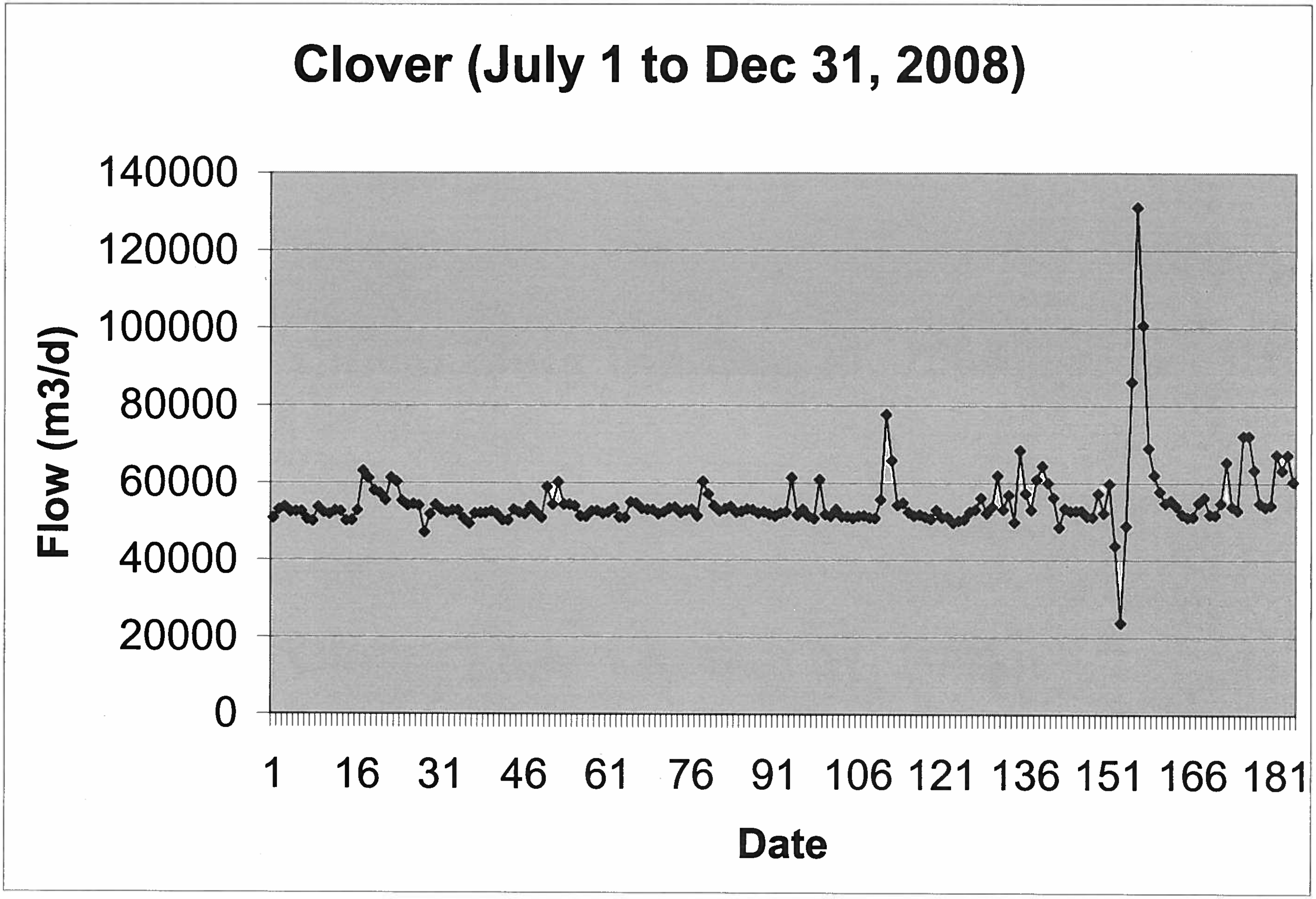

Clover (July 1 to Dec 31, 2008)
Flow (m3/d)
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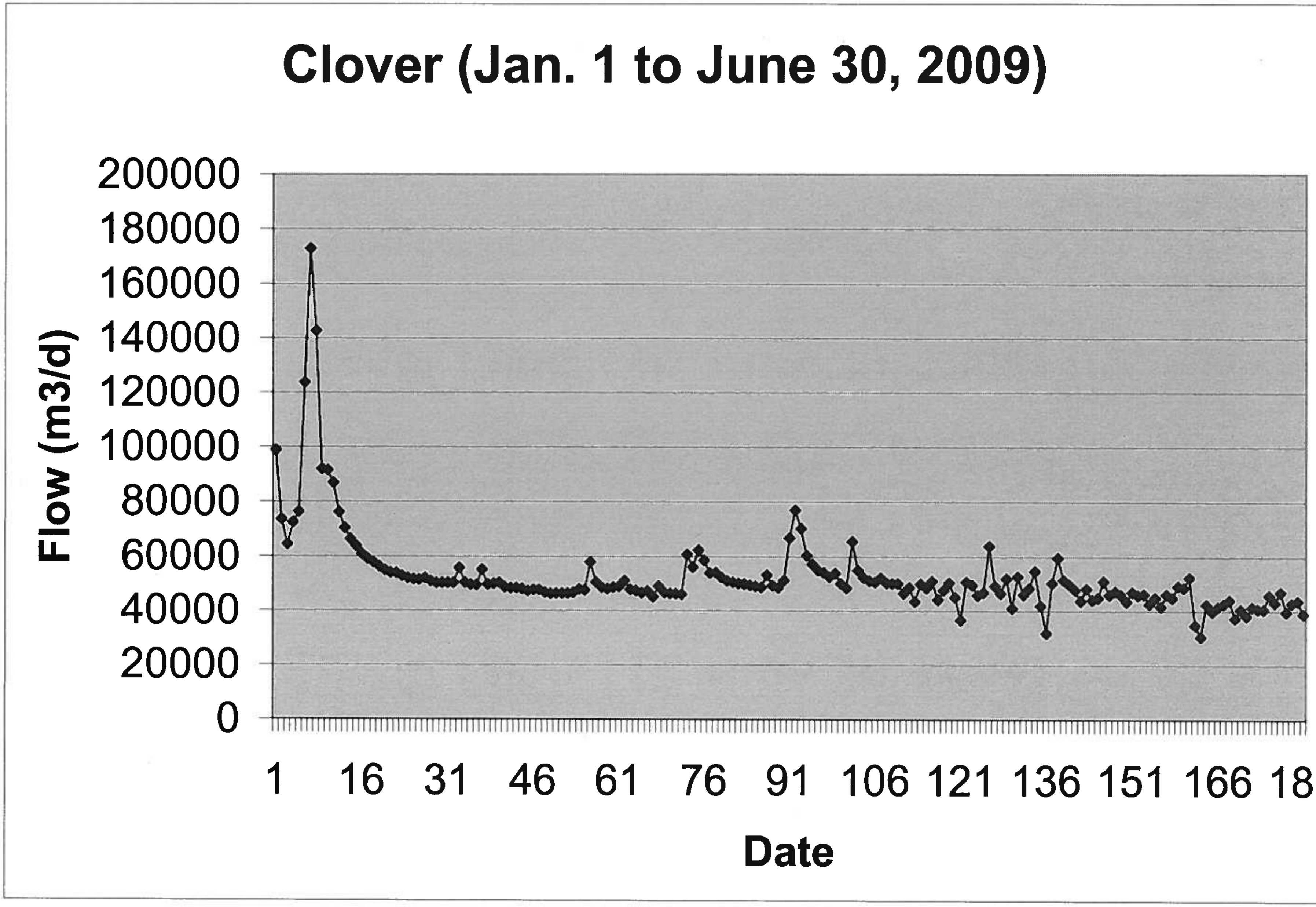

Clover (Jan. 1 to June 30, 2009)
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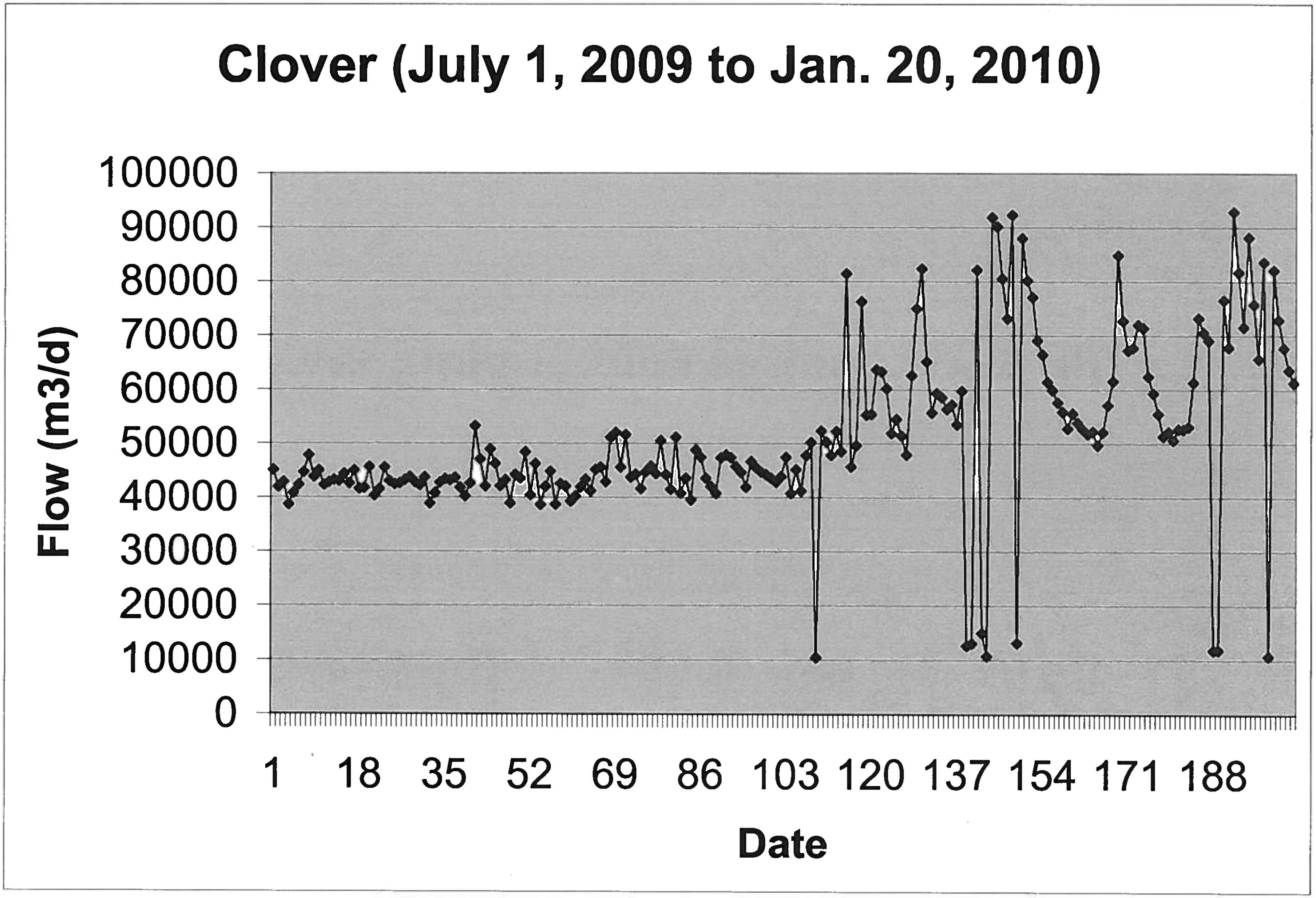

Clover (July 1, 2009 to Jan. 20, 2010)
100000
90000
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Flow (m3/d)
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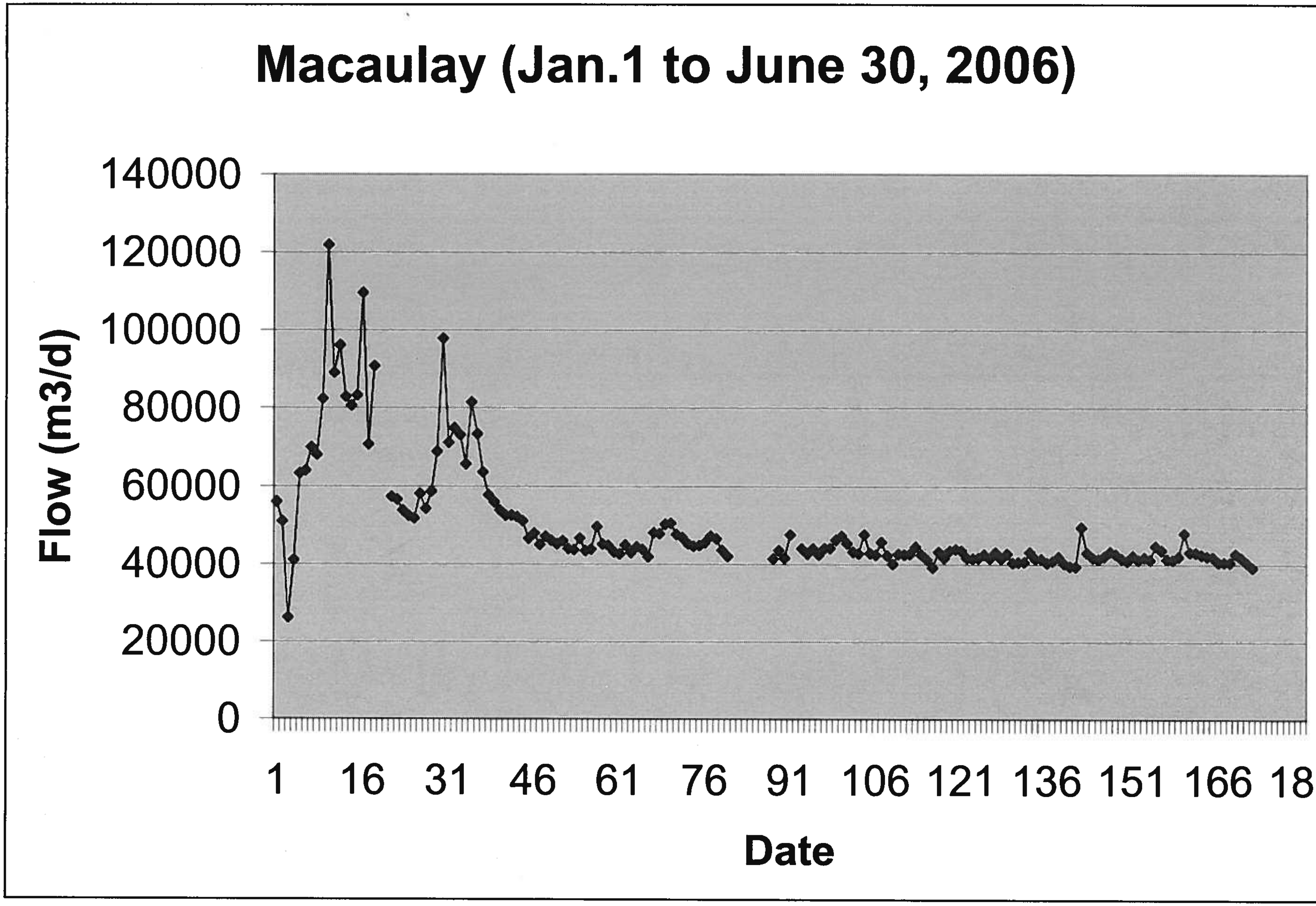
Macaulay (Jan.1 to June 30, 2006)
Flow (m3/d)
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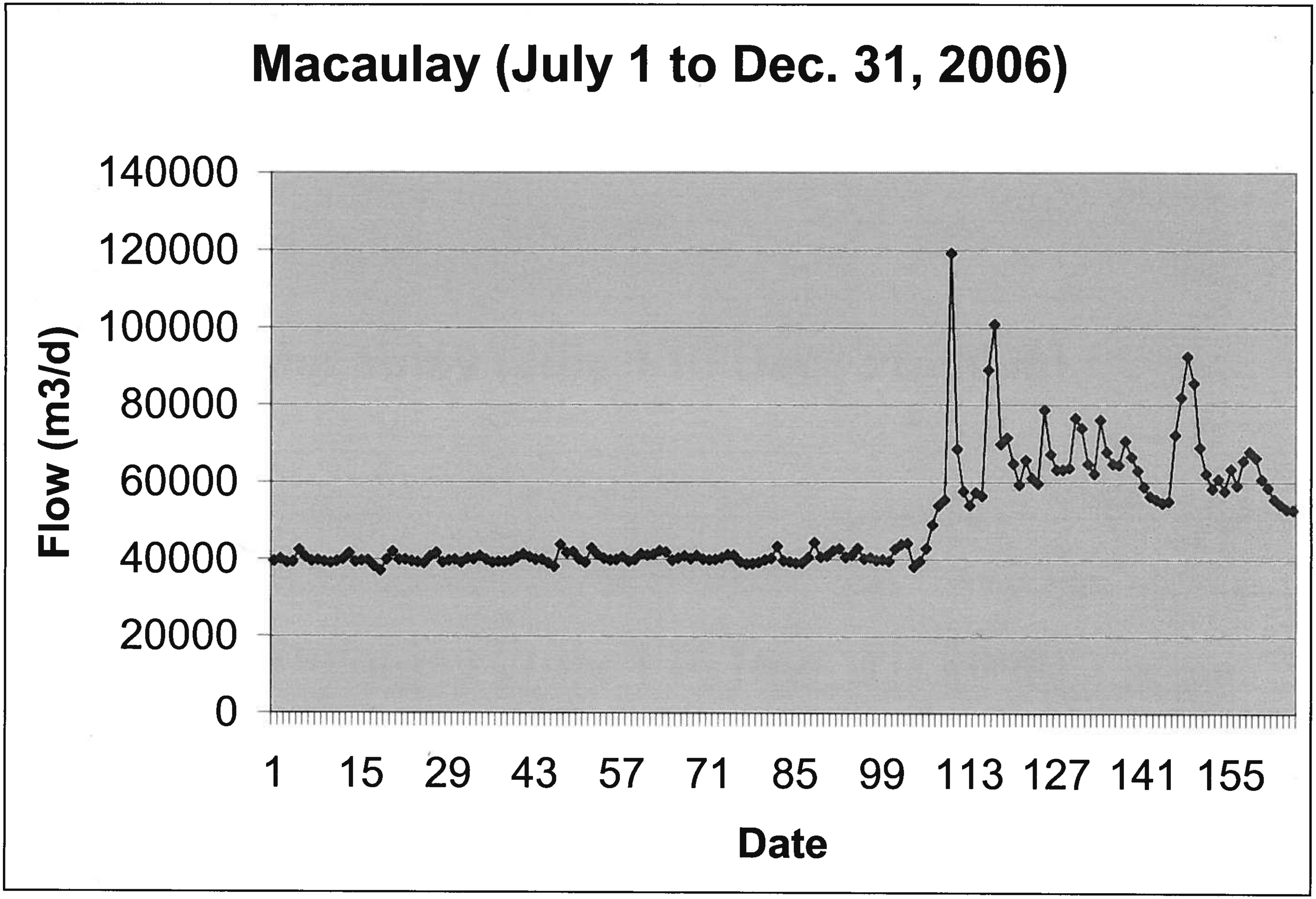

Macaulay (July 1 to Dec. 31, 2006)
Flow (m3/d)
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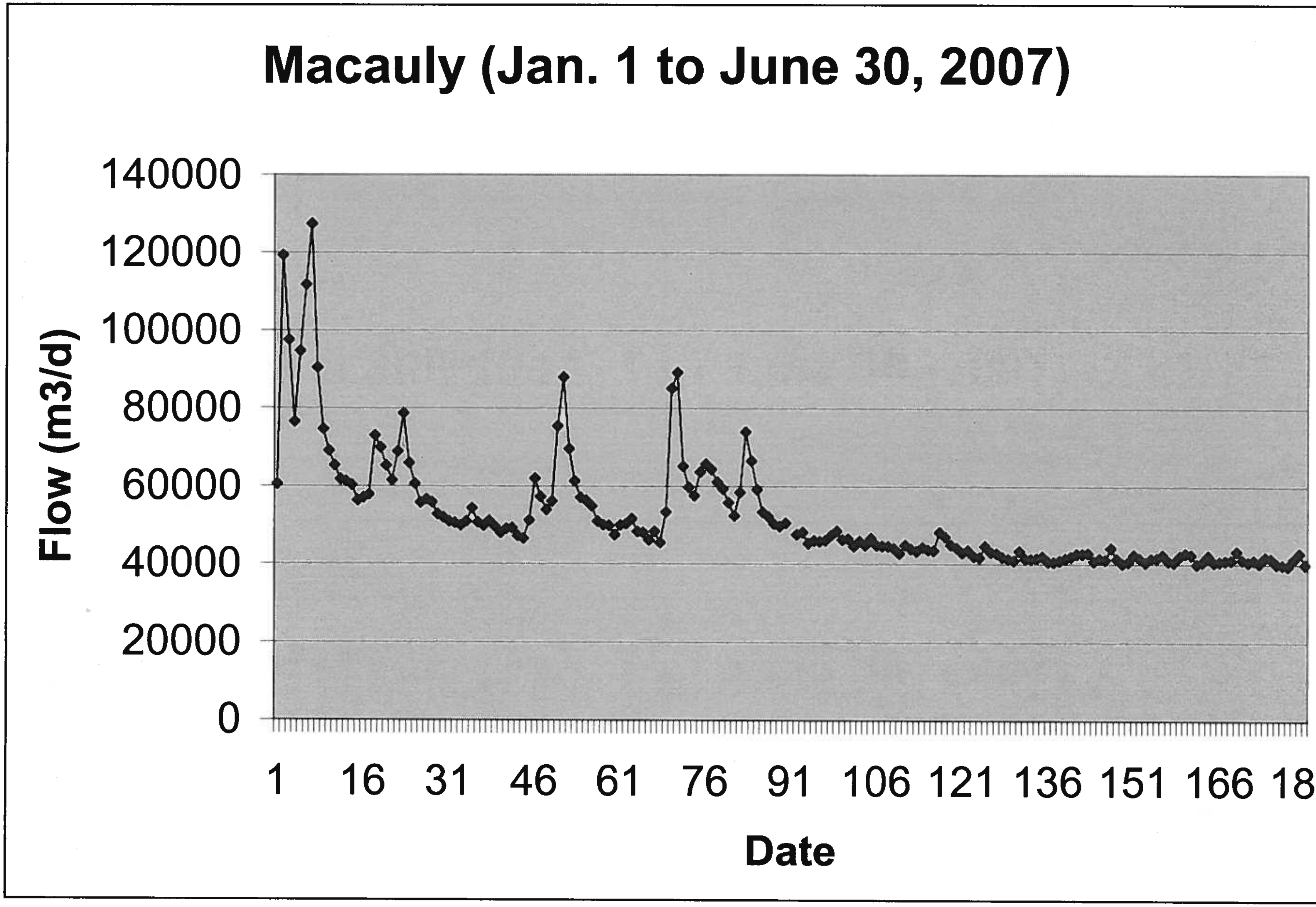

Macauly (Jan. 1 to June 30, 2007)
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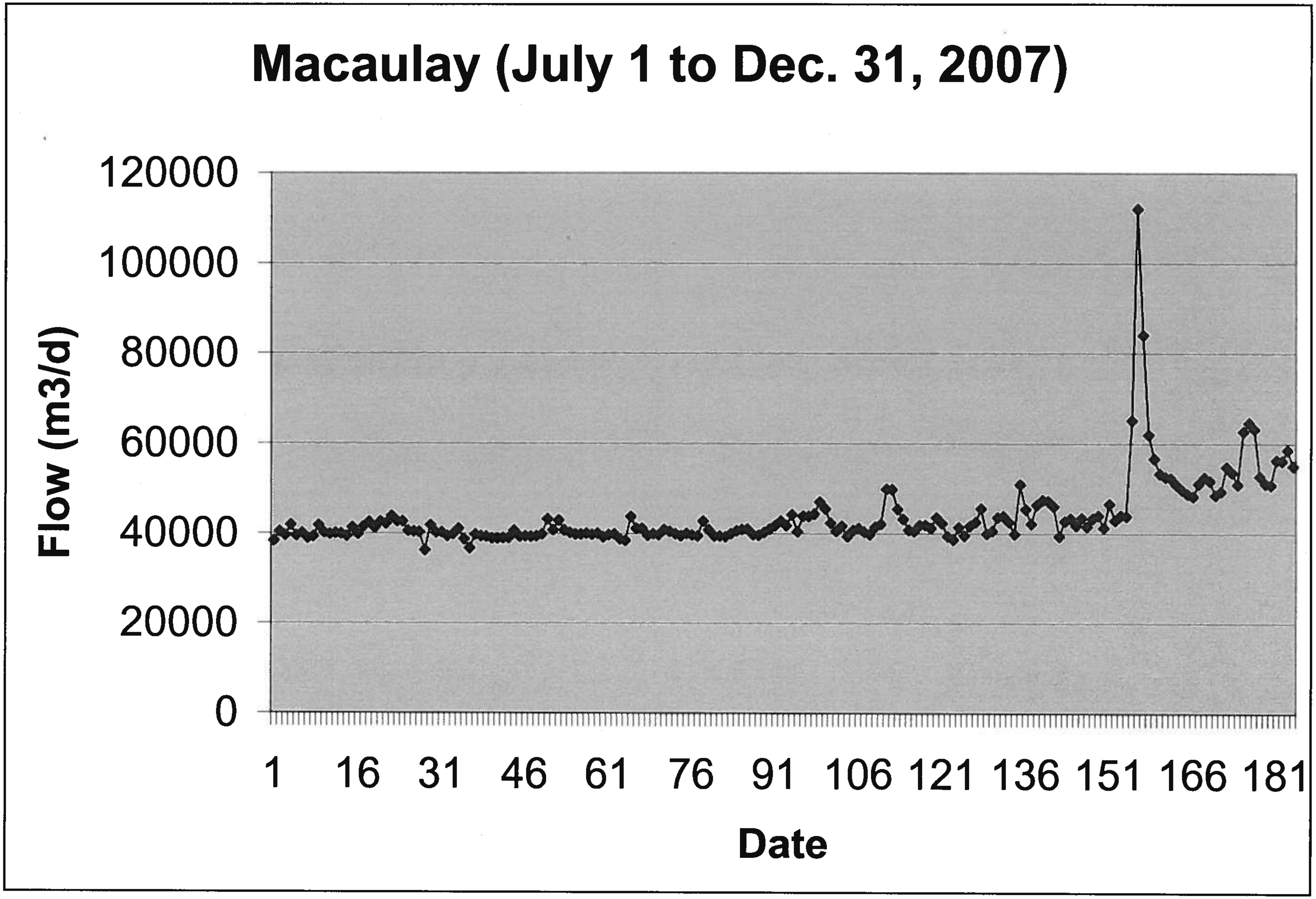
Macaulay (July 1 to Dec. 31, 2007)
Flow (m3/d)
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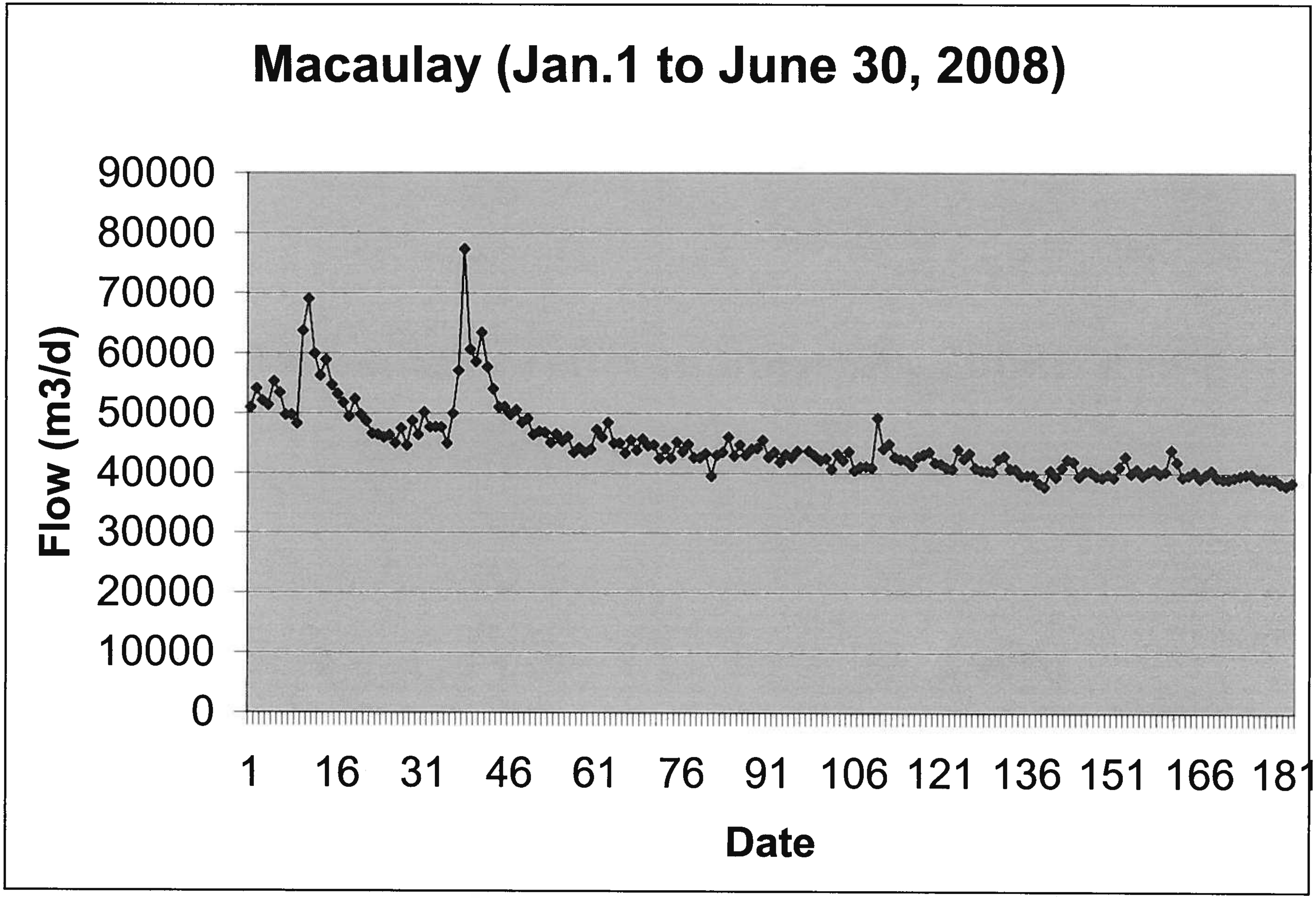

Macaulay (Jan.1 to June 30, 2008)
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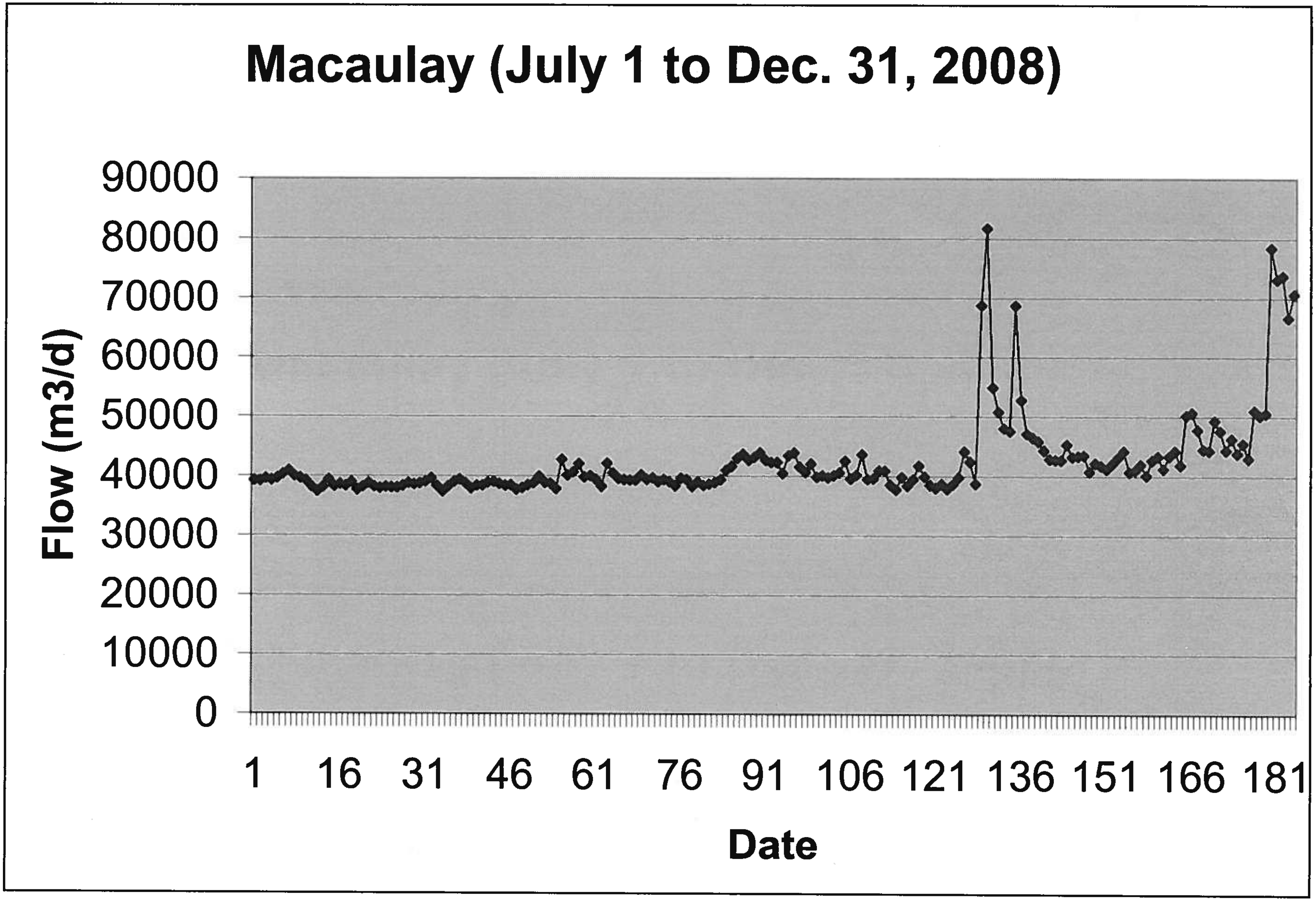
Macaulay (July 1 to Dec. 31, 2008)
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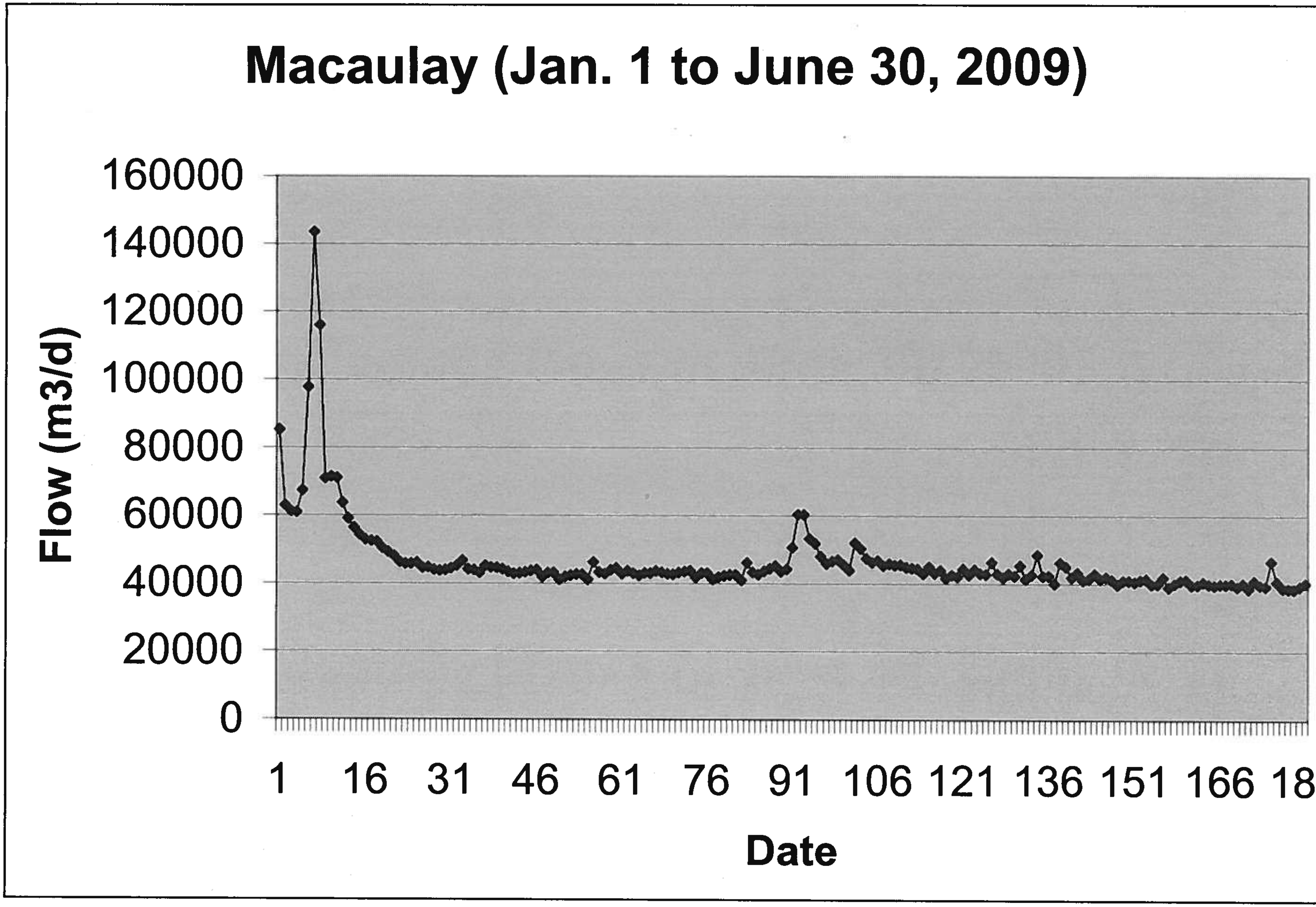
Macaulay (Jan. 1 to June 30, 2009)
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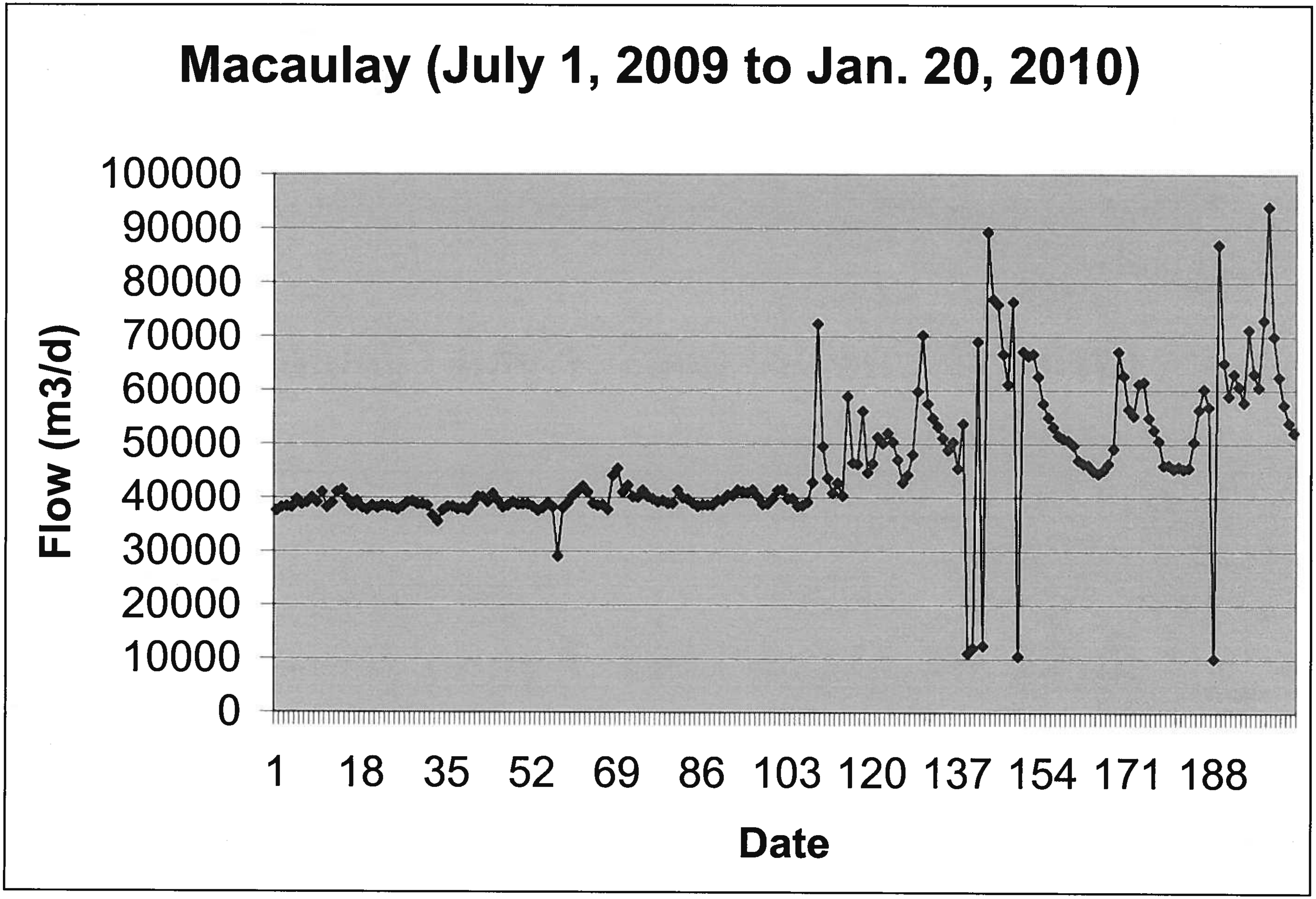
Macaulay (July 1, 2009 to Jan. 20, 2010)
Flow (m3/d)
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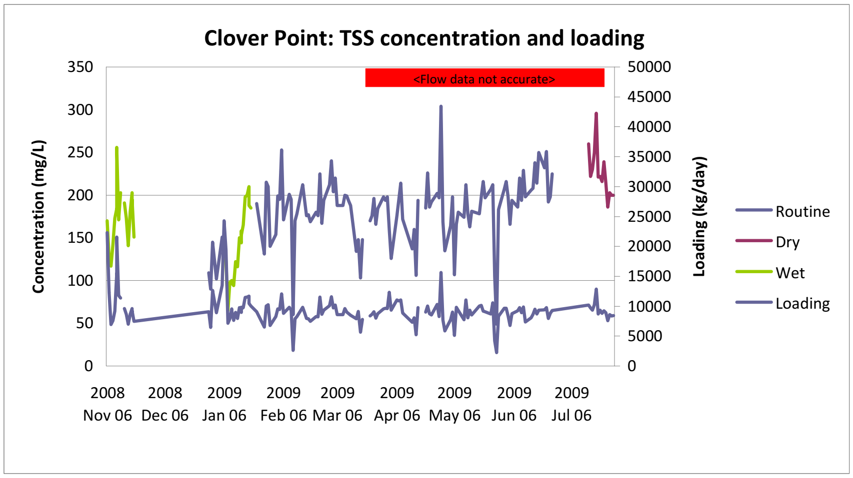
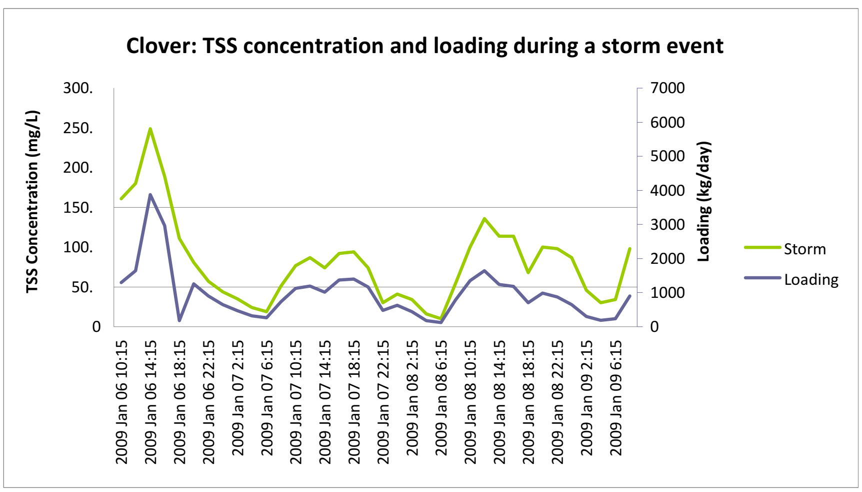
Wastewater Characterization Data



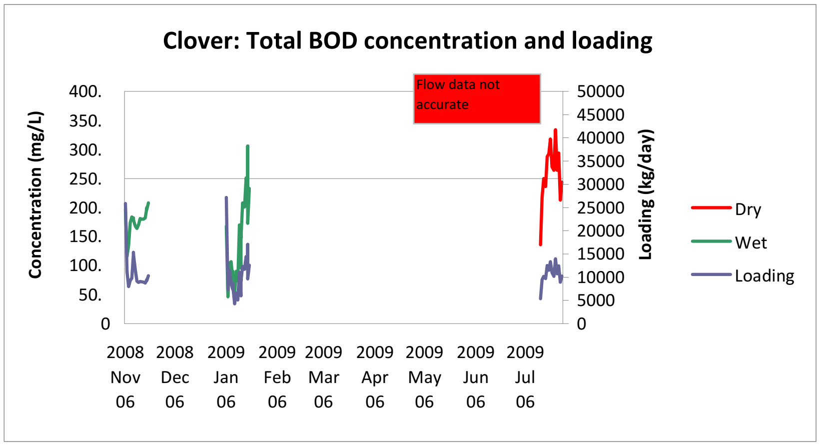
TSS concentration and loading

	Routine	Dry	Wet	Loading
Max	304.	296.	256.	24256
Min	49.	186.	65.	2260
SD	39.19	28.55	40.69	2704.42



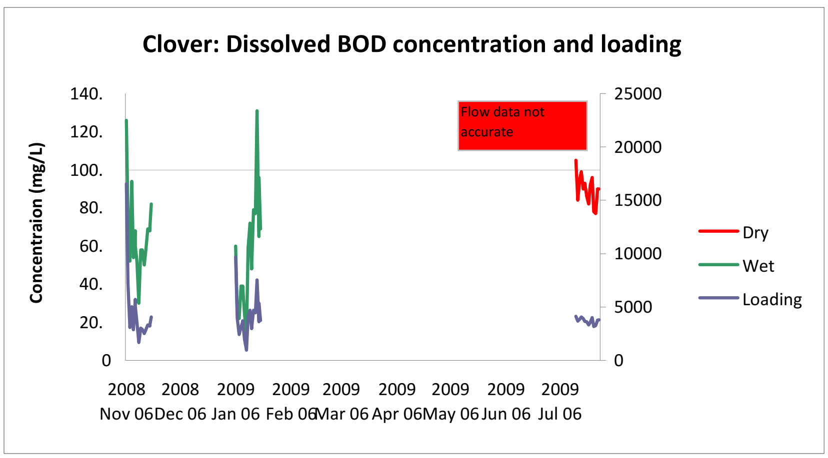
TSS concentration and loading during a storm

	Storm	Loading
Max	249.	3874
Min	10.	122
SD	53.08	755.62



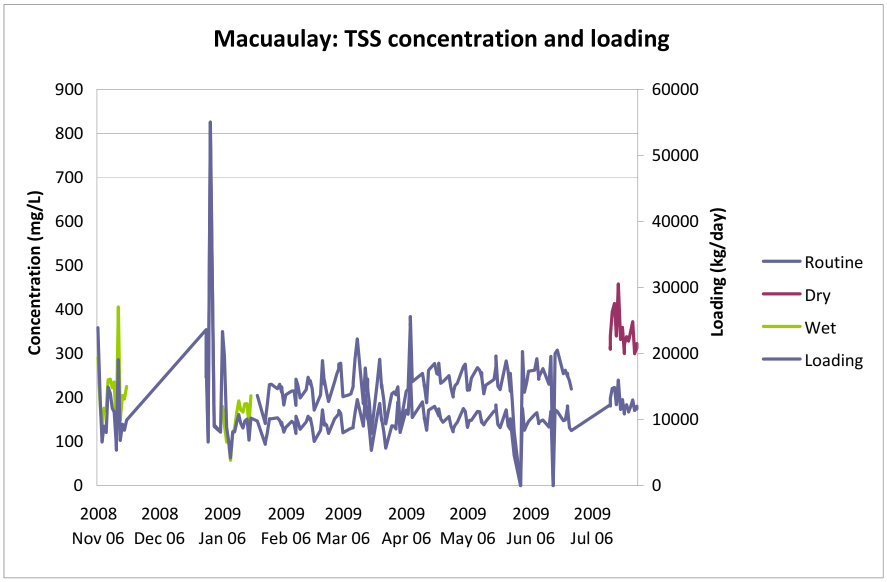
Total BOD concentration and loading

	Dry	Wet	Loading
Max	334.	306.	27167
Min	136.	46.	4233
SD	49.76	56.22	4062.15

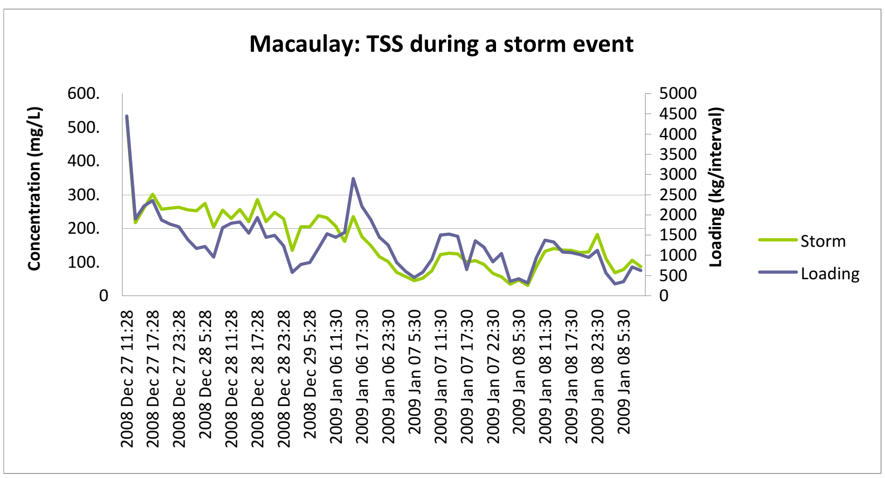


Dissolved BOD concentration and loading

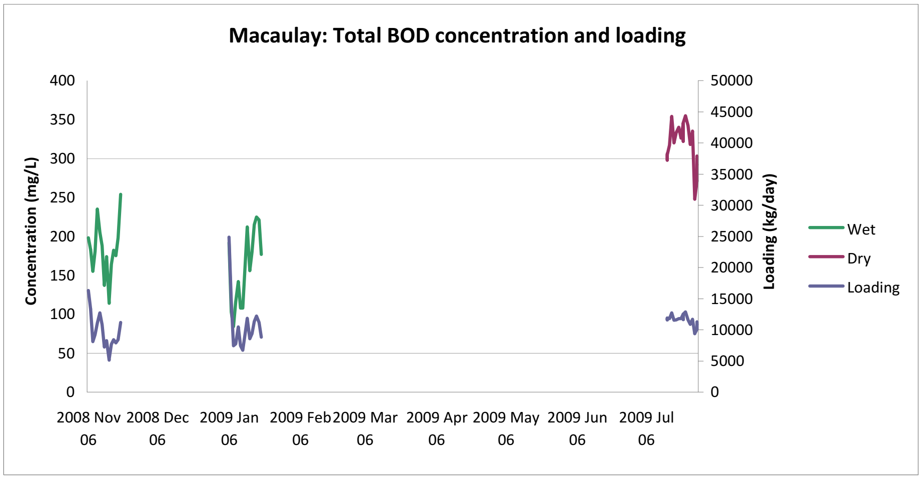
	Dry	Wet	Loading
Max	105.	131.	16525
Min	77.	13.	955
SD	7.89	24.56	2217.75



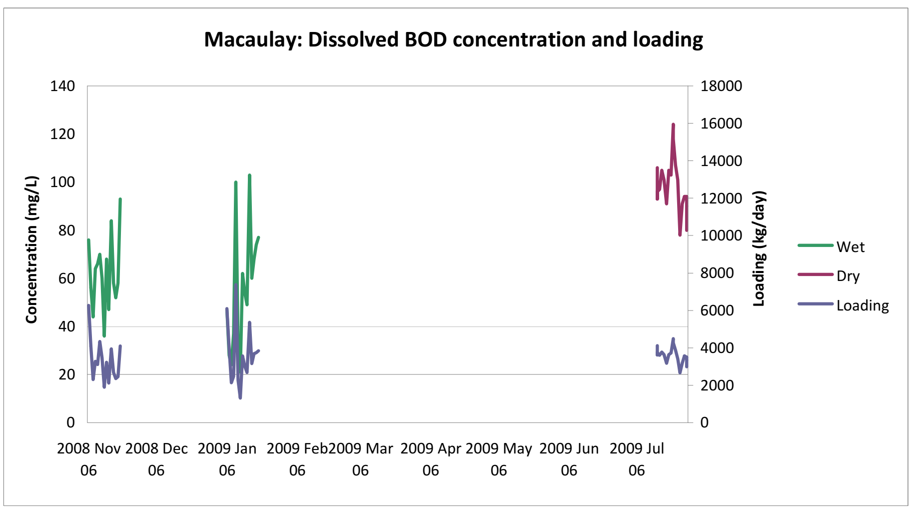
TSS concentration and loading				
	Routine	Dry	Wet	Loading
Maximum	806.	458.	406	55084
Minimum	99.	300.	57.	1908
Standard deviation	63.91	41.39	64.43	4232



TSS during a storm event		
	Storm	Loading
Maximum	530.	4444
Minimum	30.	292
SD	90.83	695.13



Total BOD concentration and loading			
	Wet	Dry	Loading
Maximum	254	355.	24879
Minimum	84.	248.	771
SD	43.54	27.67	3378



Dissolved BOD concentration and loading			
	Wet	Dry	Loading
Maximum	103	124.	7379
Minimum	21.	78.	395
SD	20.28	12.09	1176