CSO Data Approaches and Options

Background:

During the phase V model calibration in 2010, Tetra Tech developed the CSO data for all 64 CSOs in the bay watershed for 1985-2009. With the available monitoring CSO data from few CSOs, a single formula was developed to calculate the overflow amount based on rainfall data and CSO service area for 64 CSOs. This same approach, one formula for all CSOs, is also used in phase 6 calibration beta runs and CBP plans to use the Tetra Tech formula for future CSO load estimates.

Issues with Tetra Tech Estimated Data:

1) Rainfall threshold causing overflow was set as 0.01 inches, the lowest rainfall data in dataset, while 0.1 inches is considered as the minimum to form ground surface runoff in the Bay model simulation.

2) Estimates won't match well with observed data of some individual CSOs

Options:

1) Hybrid Approach: real or individually available CSO where available + Tetra Tech estimates for the rest.

2) Tetra Tech estimates for all CSOs.

Tetra Tech developed the CSO flow estimation method

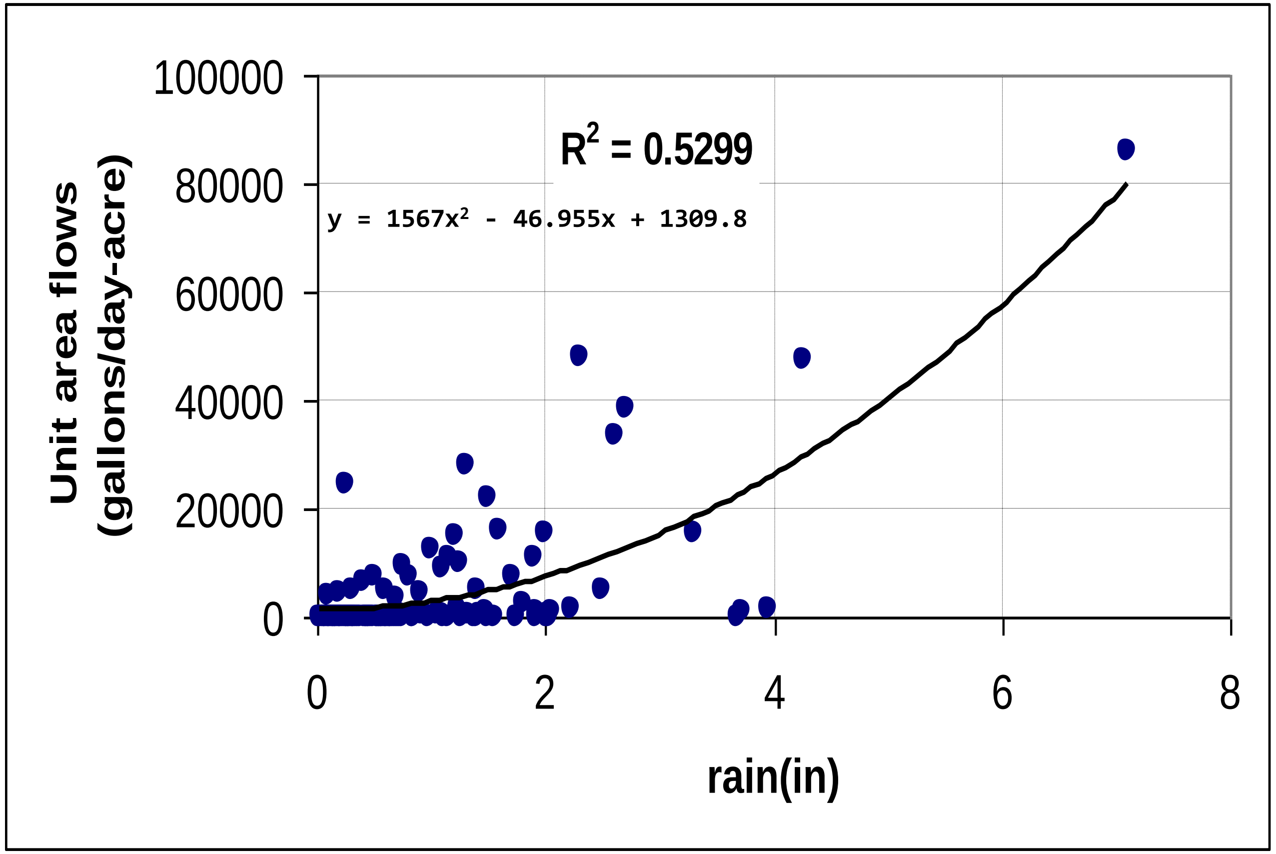


Figure 2. Regression results between 4-community aggregate flows and rainfall.

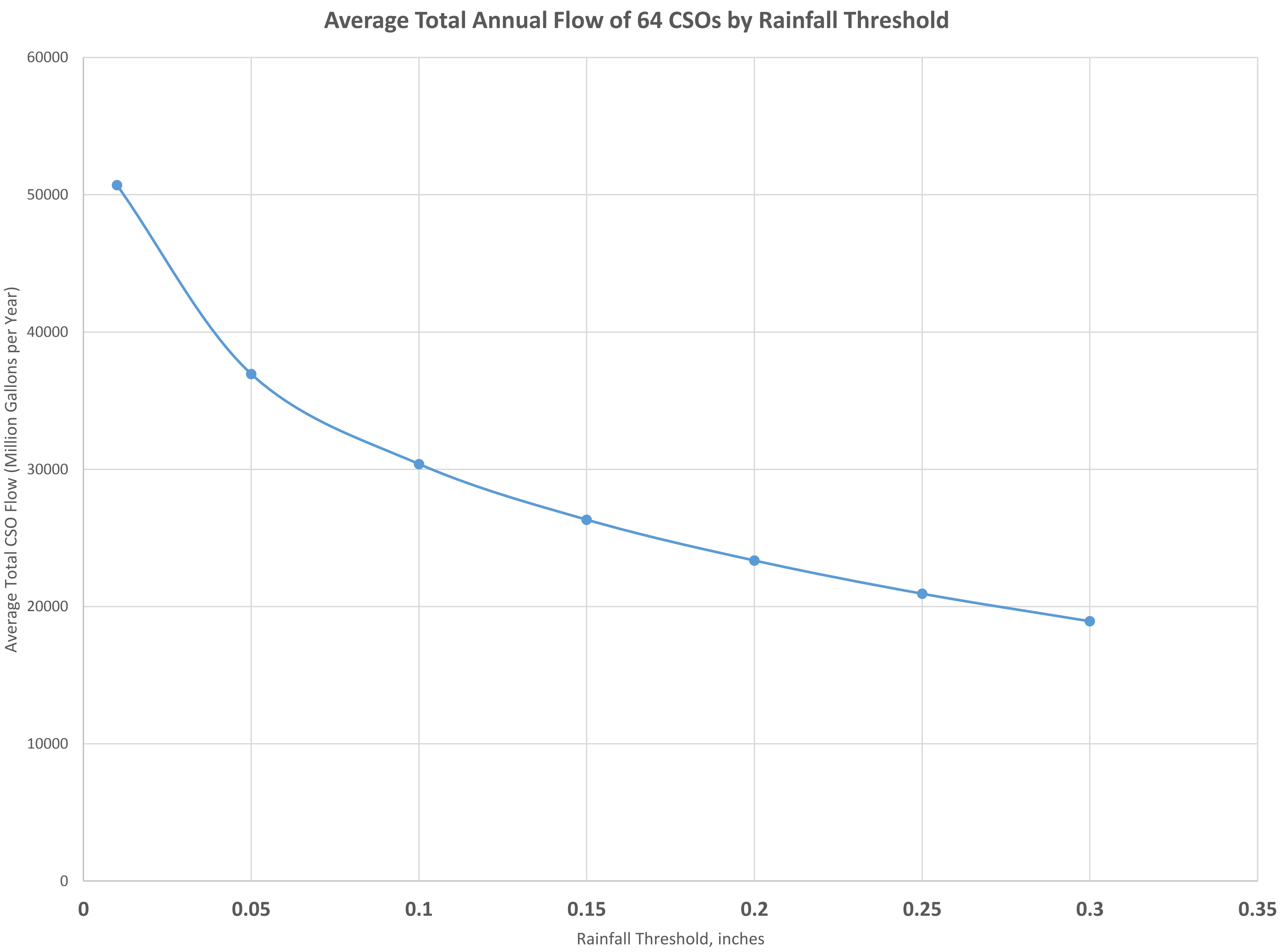
Potentially, an application of the derived regression equation to the selected rainfall data could trigger CSO with small rainfalls as the equations don't discriminate the small rain falls. Therefore, **a cutoff rainfall rate of 0.01" was forced to explicitly eliminate the CSO events for the small rainfalls. The cutoff rainfall rate was determined to be the lowest observed rainfall data generating the observed CSO events for the selected four data sets.** The best fit equation and the cutoff rate was applied to the assigned rainfall data for each CSO community and results were multiplied by the community areas to generate the estimated CSO discharge. CSO offline periods based on information received from communities and shown in Table 2 were incorporated into the CSO overflow estimates.

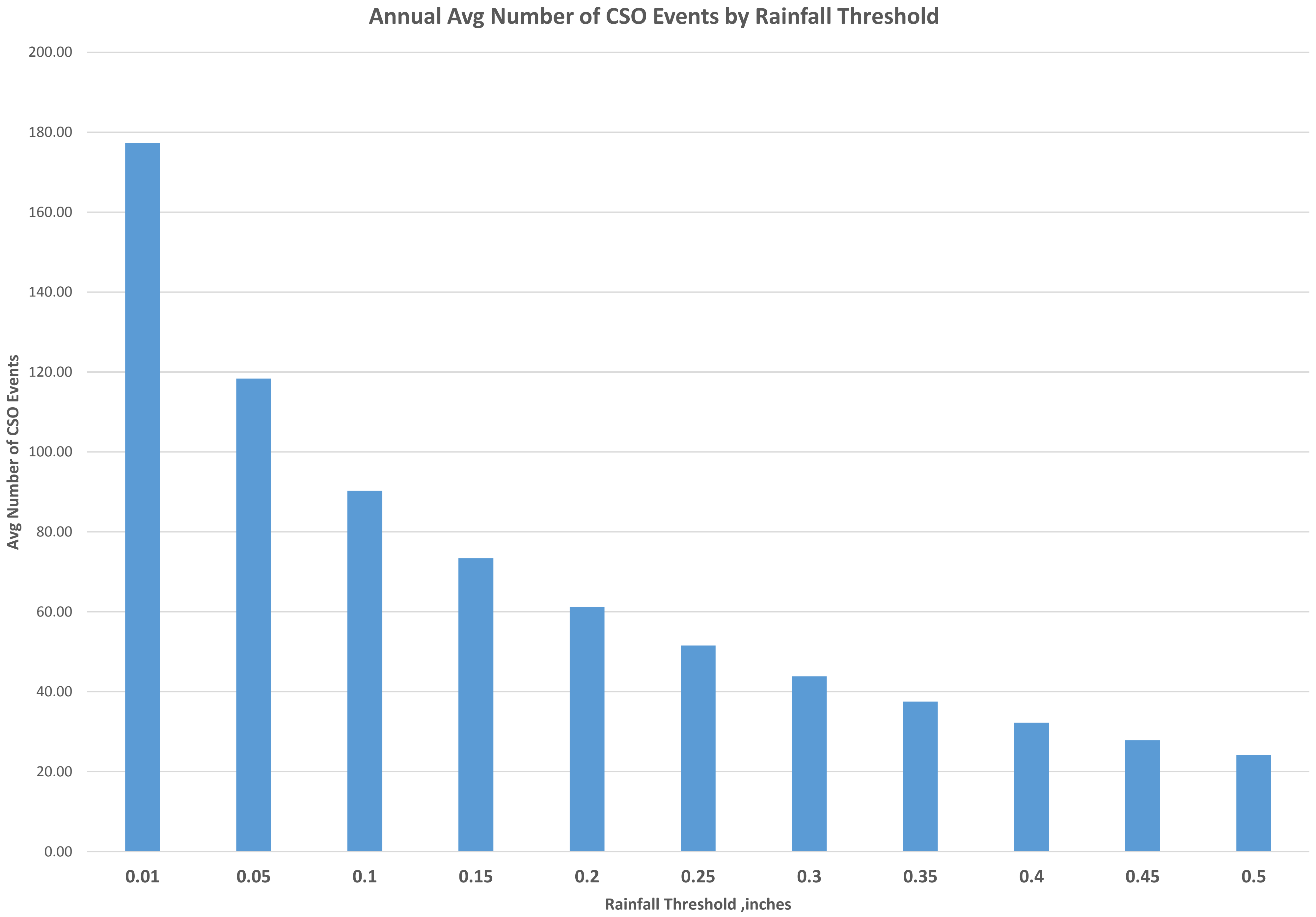
DC CSO Data shows that the lowest minimum rainfall to cause overflow is about 0.1 Inches with a flow weighted average of 0.34 inches

CSO Overflow Predictions for Average Year
Scenario: C2- Inflatable Dams in Service, Pumping Stations Prior to Rehabilitation
Prepared: August 2004

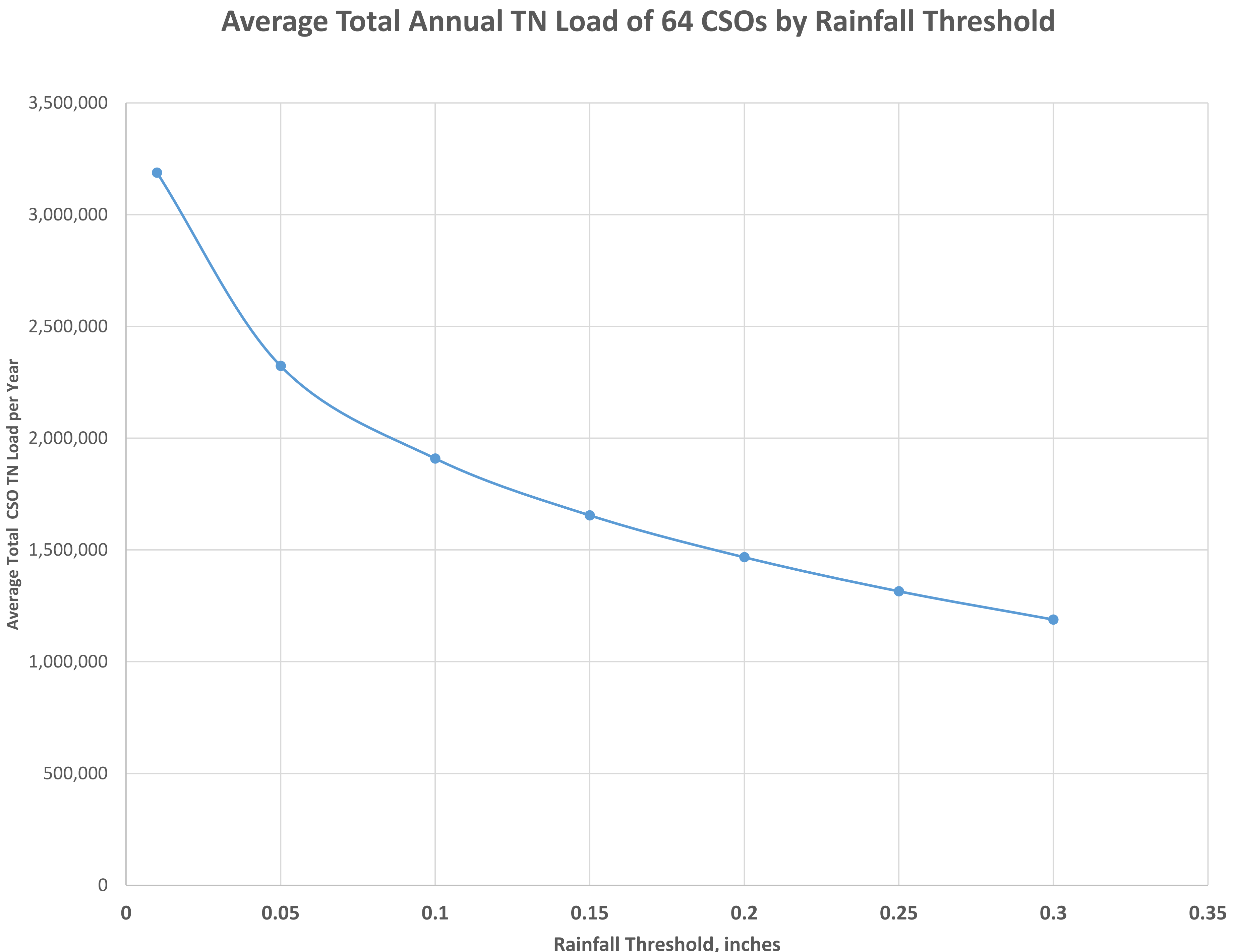
CSO NPDES No.	Description	No. of CSO Overflows	CSO Overflow Volume (million gallons/yr	Approximate Minimum Rainfall to Cause Overflow (in)	Average Overflow Duration (hours)
Anacostia River CSOs					
005	Fort Stanton	73	16.58	0.2	4.0
006	Fort Stanton	5	0.11	1.0	0.5
007	Fort Stanton	64	36.99	0.3	3.7
009	B St./New Jersey Avenue	53	16.92	0.3	3.1
010	B St./New Jersey Avenue	22	442.79	0.4	2.2
011	B St./New Jersey Avenue	0	0.00	No Overflows	No Overflows
011a	B St./New Jersey Avenue	0	0.00	No Overflows	No Overflows
012	Tiber Creek	6	20.99	0.7	0.7
013	Canal Street Sewer	28	10.47	0.4	2.5
014	Navy Yard	50	40.58	0.4	3.4
015	Navy Yard	11	0.74	0.8	0.8
016	Navy Yard	24	13.42	0.5	1.4
017	Navy Yard	32	21.02	0.4	1.6
018	Navy Yard	35	4.93	0.4	1.5
019	Northeast Boundary - Swirl Effluent	36	648.21	0.1	3.2
019	Northeast Boundary - Swirl Bypass	13	211.14	0.4	1.4
	SUBTOTAL		**1,485**		

The annual total CSO flow Bay wide, calculated by the Tetra Tech formula at different rainfall threshold

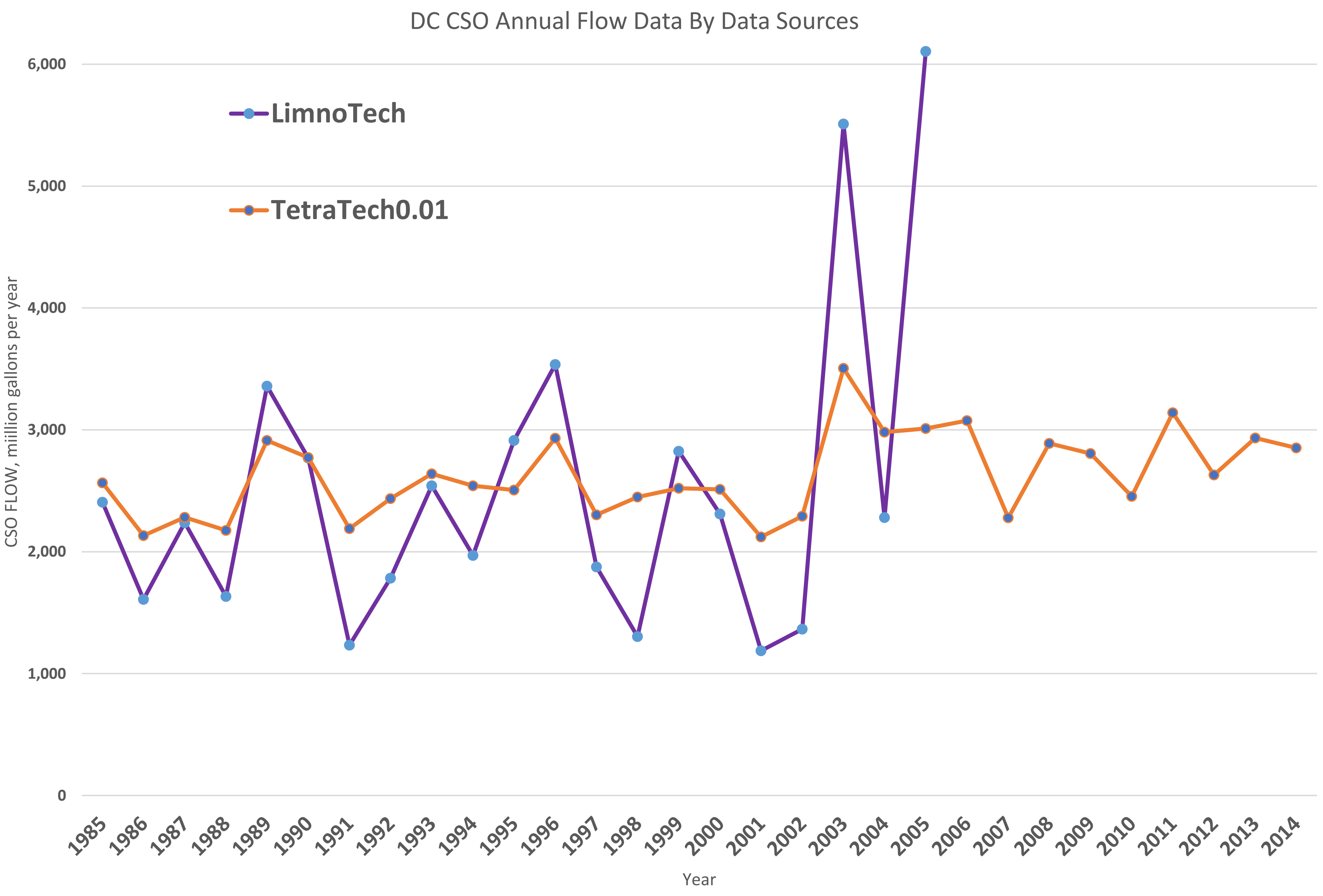




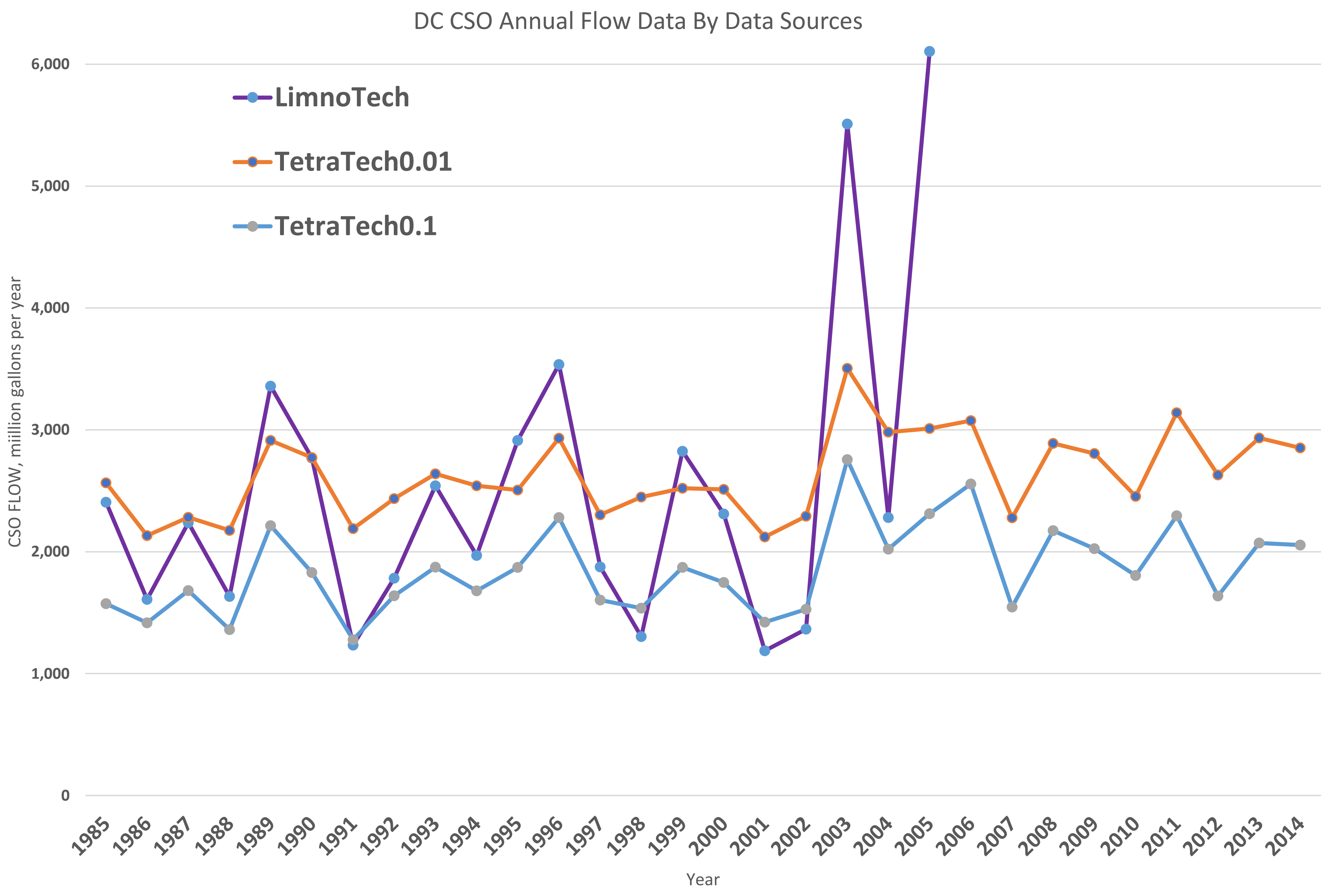
Annual Avg Number of CSO Events by Rainfall Threshold
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Avg Number of CSO Events
0.01
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
Rainfall Threshold ,inches



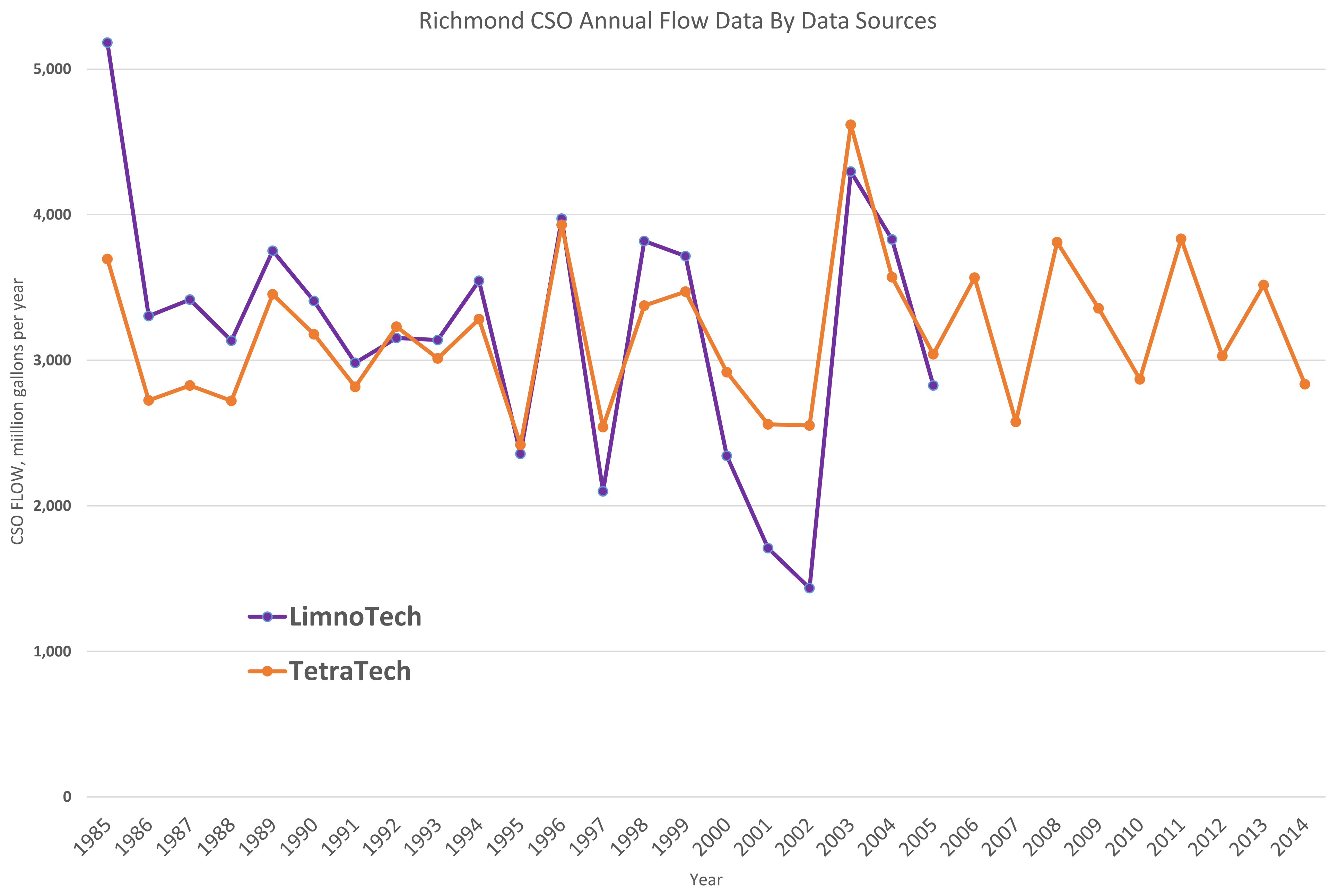
Average Total Annual TN Load of 64 CSOs by Rainfall Threshold
Average Total CSO TN Load per Year
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
Rainfall Threshold, inches



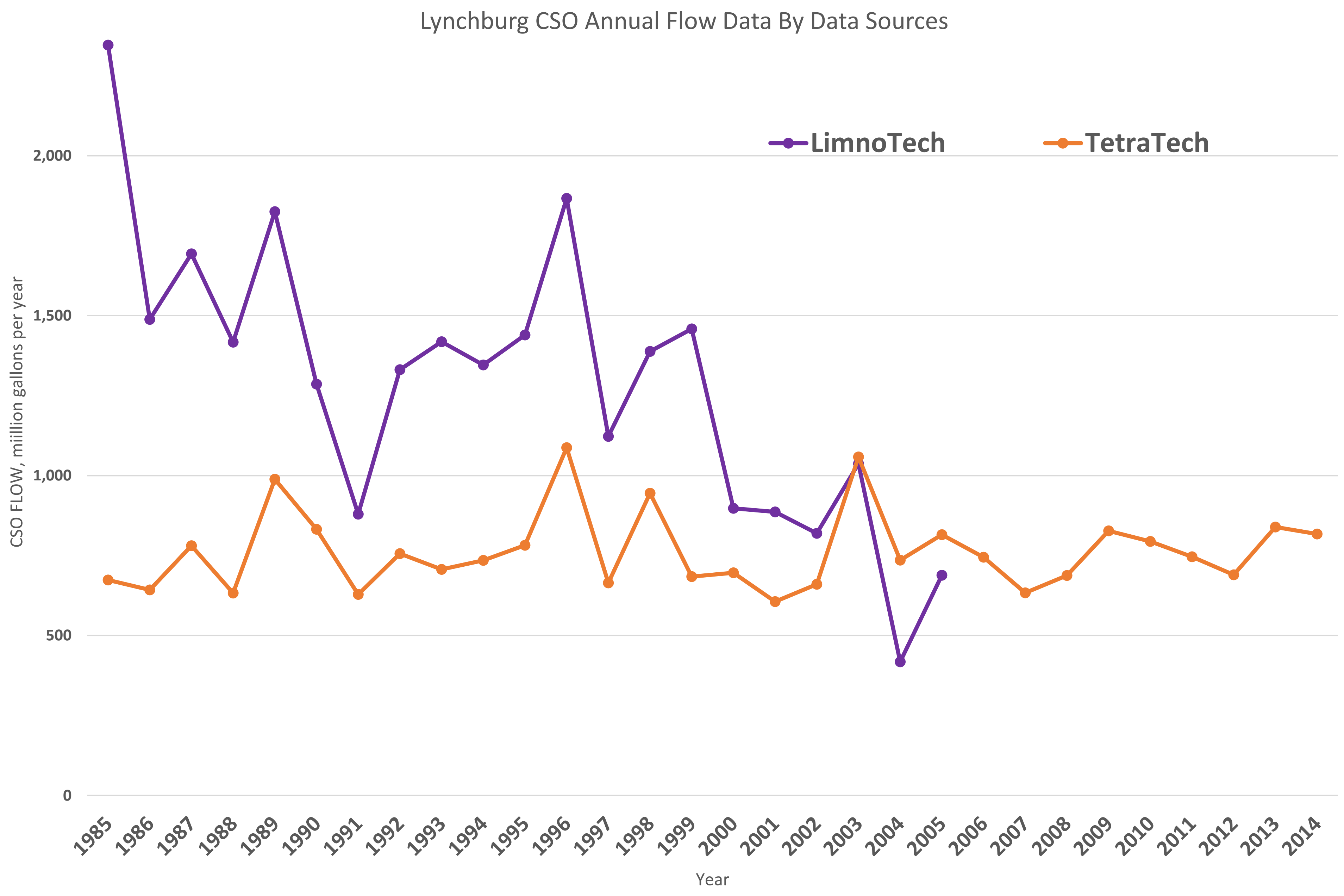
DC CSO Annual Flow Data By Data Sources
LimnoTech
TetraTech0.01
CSO FLOW, million gallons per year
6,000
5,000
4,000
3,000
2,000
1,000
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year



DC CSO Annual Flow Data By Data Sources
LimnoTech
TetraTech0.01
TetraTech0.1
CSO FLOW, miillion gallons per year
6,000
5,000
4,000
3,000
2,000
1,000
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year



Richmond CSO Annual Flow Data By Data Sources
5,000
4,000
3,000
2,000
1,000
0
CSO FLOW, million gallons per year
LimnoTech
TetraTech
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year



Lynchburg CSO Annual Flow Data By Data Sources
LimnoTech
TetraTech
CSO FLOW, million gallons per year
2,000
1,500
1,000
500
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
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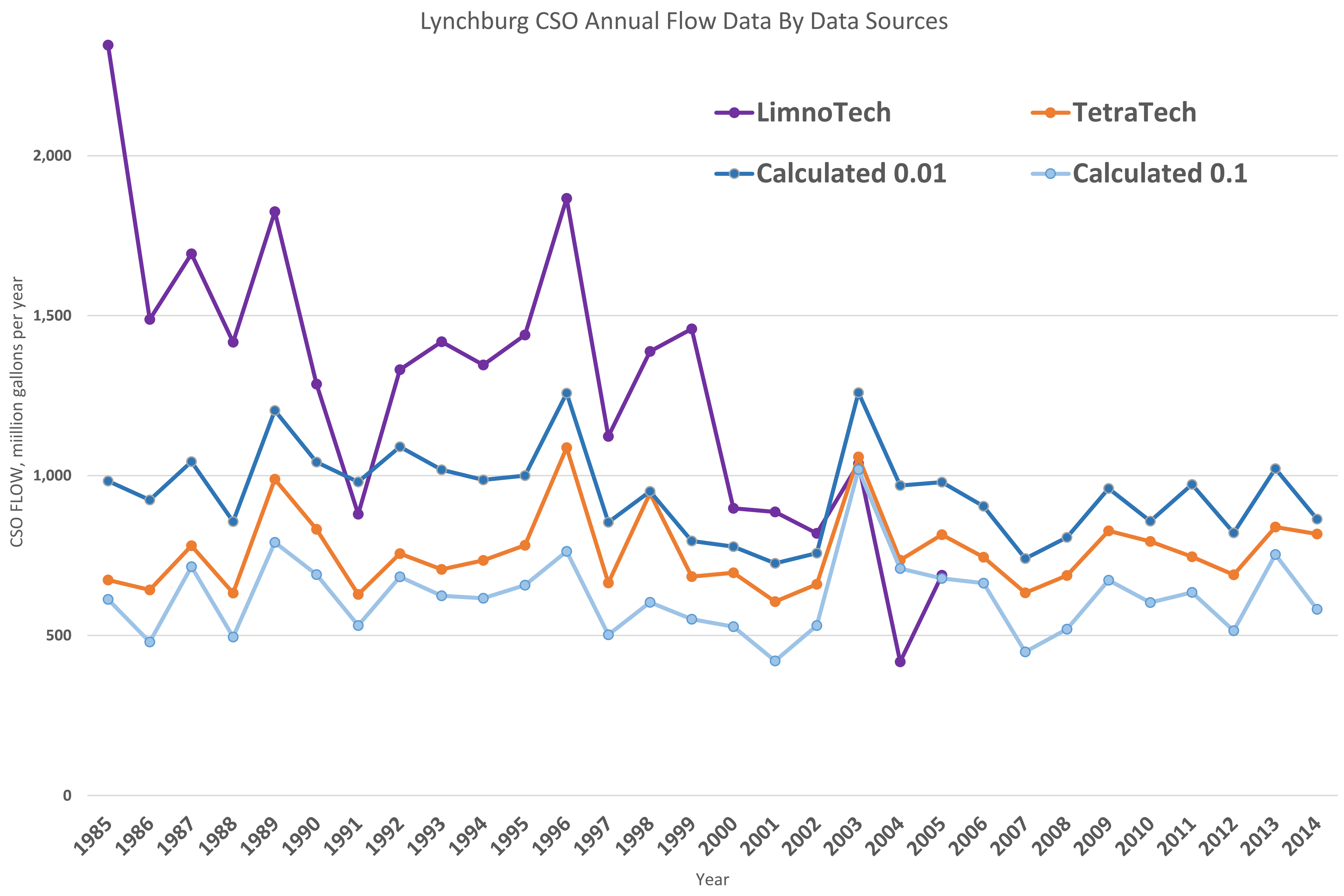
2010
2011
2012
2013
2014
Year



Lynchburg CSO Annual Flow Data By Data Sources
LimnoTech
TetraTech
Calculated 0.01
Calculated 0.1
CSO FLOW, million gallons per year
2,000
1,500
1,000
500
0
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Year

- Tetra Tech method is one formula for all 64 CSOs that is an average approach, but won't match well with observed data of some CSOs.

- Rainfall threshold for overflow at 0.01 inches is basically incorrect in the Tetra Tech method, but applying higher threshold to Tetra Tech formula will generate significantly lower overflow,

  40% lower at 0.1 inches than at 0.01 inches

  60% lower if threshold is set at 0.3 inches

These two points make the Tetra Tech method less defendable.

Alternative Options?

Although not available for all CSOs and all jurisdictions, real or individually predicted CSO data are available for some jurisdictions and some large CSOs.

Options for workgroup consideration:

1) Hybrid Approach: real or individually available CSO data where available + Tetra Tech estimates for the rest.
2) Tetra Tech estimates for all CSOs.

Available CSO Data Source Examples

- **Maryland Reported Sewer Overflow Database**
  http://www.mde.state.md.us/programs/water/overflow/pages/reportedseweroverflow.aspx

- DC Combined Sewer Overflow Model Predictions
  https://www.dcwater.com/wastewater_collection/css/when_do_csos_occur.cfm

- Richmond Combined Sewer Overflow Monthly Reports
  http://www.richmondgov.com/PublicUtilities/projectCombinedSewerOverflow.aspx

- **Maryland Reported Sewer Overflow Database**

Overflow Type	Municipality/Facility	NPDES #	Date Discovered	Duration			Location	Zip Code	Latitude	Longitude	Collection-System	Quantity in Gallons (Estimated)	Net in Gallons (Estimated)	Cause
				Days	Hours	Minutes								
CSO	Allegany County DPW	MD0067407	1/5/2005				002 Braddock Estates	21532	39.3821	78.5555	Cumberland WWTP	27000	27000	Precipitation
CSO	Allegany County DPW	MD0067407	1/5/2005				003 Grahamtown	21532	39.3857	78.5525	Cumberland WWTP	27000	27000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	001/C	21532	37.57912784	81.52842485	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	004/F	21532	37.57913753	81.52840922	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	005/G	21532	37.57913835	81.52841652	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	006/H	21532	37.5791357	81.52842085	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	009/P.1	21532	37.57912886	81.52841316	Cumberland WWTP	20000	20000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	009/P.2	21532	37.57912857	81.52841349	Cumberland WWTP	15000	15000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	010/Q	21532	37.5791275	81.52841273	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	011/R	21532	37.5791267	81.52841199	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/5/2005	1	11	0	012/U	21532	37.57912589	81.5284116	Cumberland WWTP	10000	10000	Precipitation
CSO	La Vale	MD0067547	1/5/2005	15	18	0	001 LA Vale PS	21504	37.57914957	81.52828562	Cumberland WWTP	11460342	11460342	Excessive flow
CSO	Allegany County DPW	MD0067407	1/5/2005				001 Wright's Crossing PS	21532	39.382	78.5557	Cumberland WWTP	18000	18000	Precipitation
CSO	Cumberland, City of	MD0021598	1/5/2005	0	5	0	003 Mill Race PS	21502	39.391	78.491	Cumberland WWTP	1583500	1583500	Precipitation
CSO	Cumberland, City of	MD0021598	1/5/2005	0	3	0	008 Bedford Street	21502	39.391	78.491	Cumberland WWTP	73319	73319	Precipitation
CSO	Cumberland, City of	MD0021598	1/5/2005	0	4	0	011 Franklin Street	21502	39.391	78.491	Cumberland WWTP	48588	48588	Precipitation
CSO	Cumberland, City of	MD0021598	1/5/2005	0	2	0	012 Valley Street	21502	39.391	78.491	Cumberland WWTP	32392	32392	Precipitation
CSO	La Vale	MD0067547	1/5/2005	11	16	0	006 Red Hill	21504	37.57912013	81.52834872	Cumberland WWTP	46218770	46218770	Excessive flow
CSO	Westernport, Town of	MD0067384	1/5/2005	0	14	0	Washington Street	21562	39.2907	79.0241	Cumberland WWTP	10000	10000	Precipitation
CSO	Westernport, Town of	MD0067384	1/5/2005	0	14	0	Waverly Street	21562	39.2922	79.0232	Cumberland WWTP	10000	10000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	001/C	21532	37.57912784	81.52842485	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	004/F	21532	37.57913753	81.52840922	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	005/G	21532	37.57913835	81.52841652	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	006/H	21532	37.5791357	81.52842085	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	010/Q	21532	37.5791275	81.52841273	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	011/R	21532	37.5791267	81.52841199	Cumberland WWTP	4000	4000	Precipitation
CSO	Frostburg, City of	MD0067423	1/8/2005	0	9	30	012/U	21532	37.57912589	81.5284116	Cumberland WWTP	4000	4000	Precipitation
CSO	Cumberland, City of	MD0021598	1/8/2005	0	2	30	003 Mill Race PS	21502	39.391	78.491	Cumberland WWTP	754000	754000	Precipitation
CSO	Cambridge, City of	MD0021636	1/8/2005				Vue de Leau Street, Mills Street, Oakley Street, Maryland Ave., Glenburn Ave and Choptank Ave	21614	38.3431	76.3465	Cambridge WWTP	430000	430000	Precipitation
CSO	Cumberland, City of	MD0021598	1/11/2005	0	4	35	003 Mill Race PS	21502	39.391	78.491	Cumberland WWTP	2470000	2470000	Precipitation
CSO	Frostburg, City of	MD0067423	1/11/2005	0	20	0	001/C	21532	37.57912784	81.52842485	Cumberland WWTP	8000	8000	Precipitation

District of Columbia Water and Sewer Authority

Combined Sewer System Model Results
Period: July, August, September 2015
SCENARIO: Y2015_Q3, produced October 13, 2015

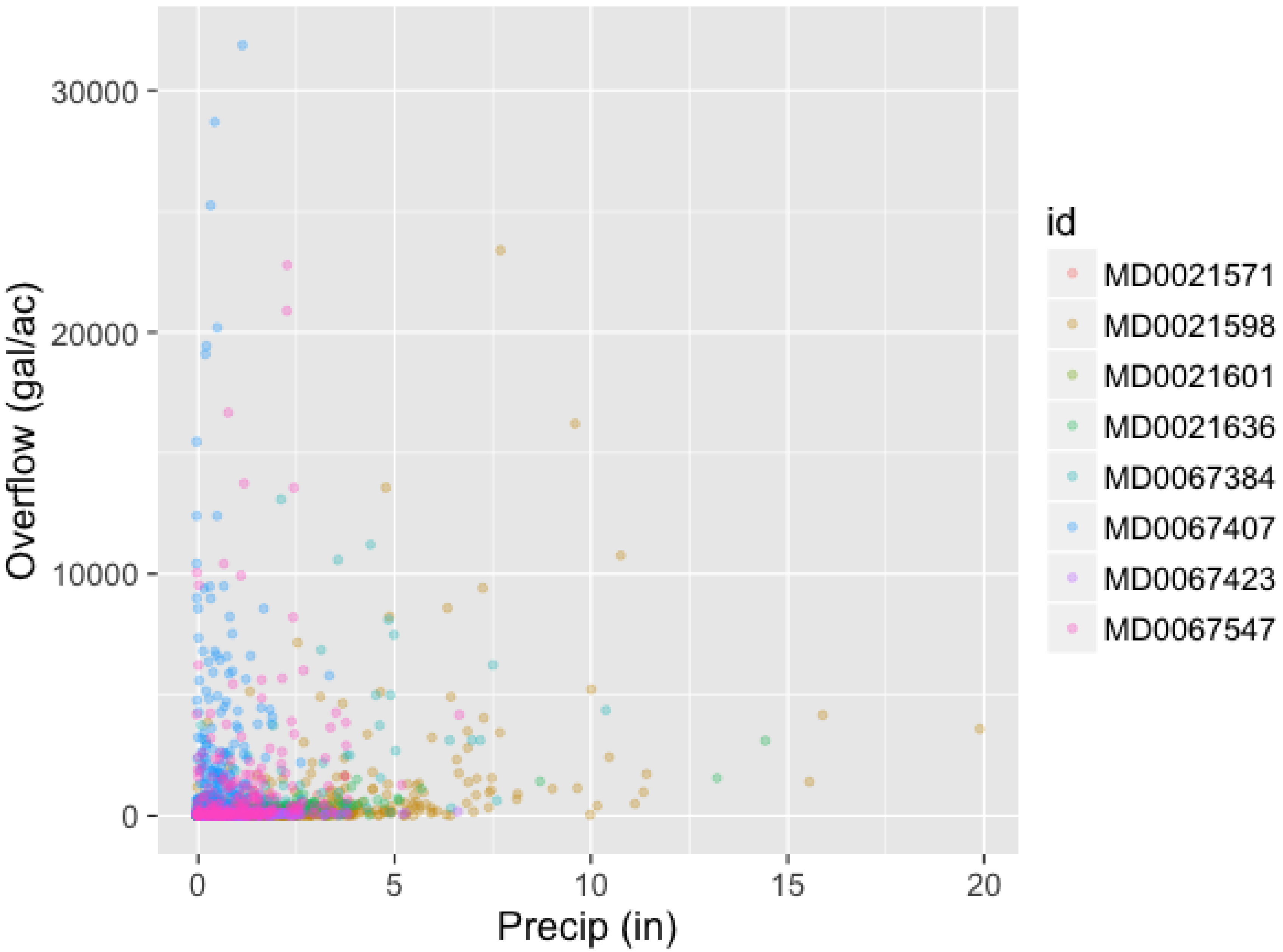
NPDES No.	Description	Number of Overflows (Occurrences)	CSO Overflow Volume (mg)	Total Duration of Overflow (hrs)	Avg Duration of Overflow (hrs)	Maximum Duration of Overflow (hrs)	Minimum Duration of Overflow (hrs)
Anacostia CSOs							
005	Chicago St and Railroad Station SE	13	4.15	23.25	1.79	6.00	0.25
006	Good Hope Road, West of Nichols Ave.,SE	separated					
007	13th Street and Ridge Place,SE	8	4.87	10.00	1.25	5.25	0.25
009	2nd Street, 300 feet North of N Place, SE	7	2.56	9.25	1.32	3.50	0.25
010	O Street SewagePumping Station, SE (pumped Overflow)	6	25.73	5.50	0.92	3.00	0.25
011	South of Main Sewage Pumping Station, SE (pumped overflow)	0	0.00	0.00	0.00	0.00	0.00
011a	South of Main SewagePumping Station, SE (gravity overflow)	0	0.00	0.00	0.00	0.00	0.00
012	North of Main SewagePumping Station, SE (Tiber Creek)	1	12.50	2.50	2.50	2.50	2.50
013	4th and N Streets, SE	7	2.00	10.25	1.46	4.50	0.25
014	6th and M Streets, SE	7	6.05	12.00	1.71	5.00	0.25
015	9th and M Streets, SE	7	1.97	6.75	0.96	3.25	0.25
016	12th and M Streets, SE	6	5.31	8.00	1.33	3.50	0.25
017	14th and M Streets, SE	9	8.72	21.00	2.33	6.25	1.00
018	Barney Circle andPennsylvania Ave, SE	9	5.80	12.00	1.33	4.75	0.25
019	Northeast Boundary - Swirl Effluent	10	100.79	32.75	3.28	6.75	0.75
019	Northeast Bound. - Swirl Bypass	3	55.34	3.50	1.17	2.50	0.25
	SUBTOTAL		**235.79**				
Potomac CSOs							
003	Bolling AFB	1	0.11	1.50	1.50	1.50	1.50

Richmond CSO monthly report

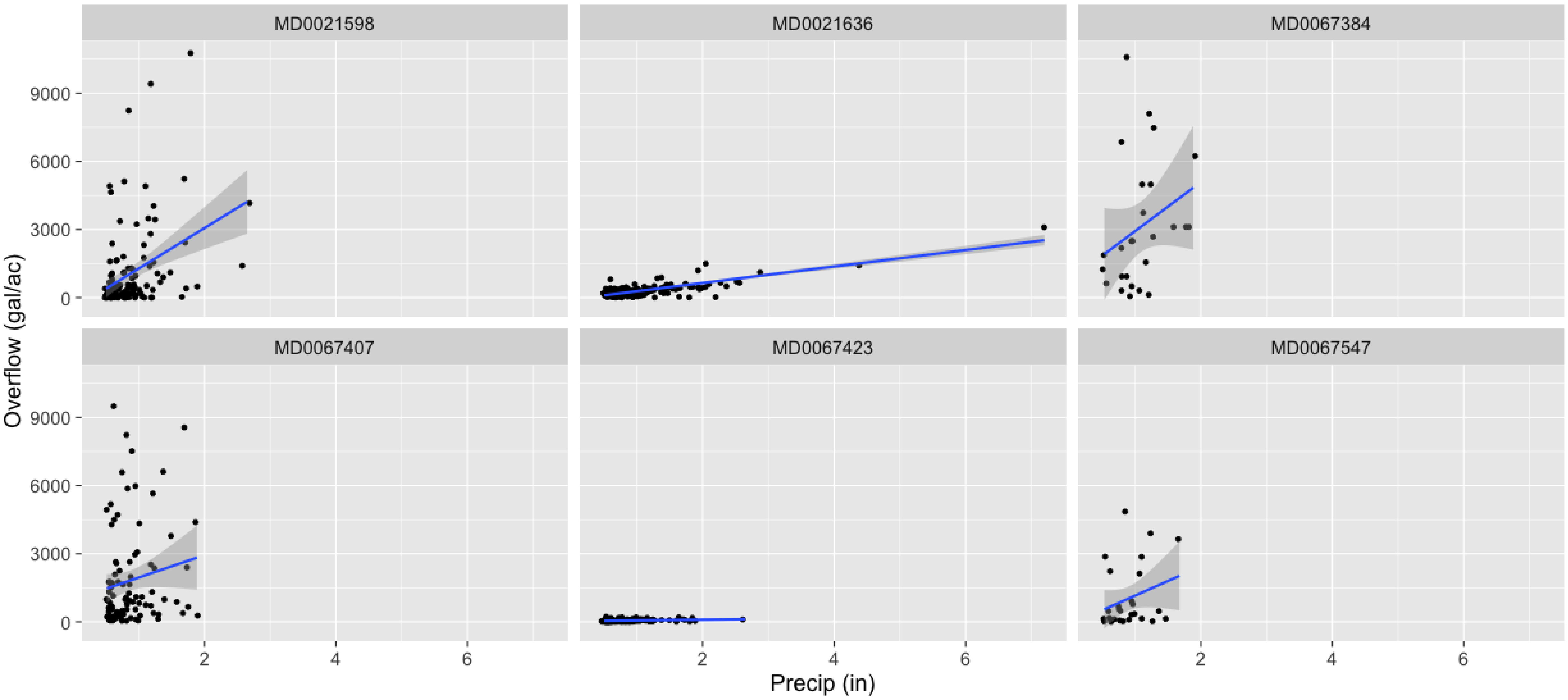
CSO04 - Bloody Run
Rainfall and Overflow Model Summary
Current Month: August 2016

Date	Num of Overflow	Total [(1)] Rain (in)	Hours of Rainfall	Maximum Storm Intensity (in/hr)	Volume of Overflow (MG)	Duration of Overflow (hr)
8/1/16		0.01	0.2			
8/2/16		0.00	0.3			
8/3/16						
8/4/16						
8/5/16						
8/6/16		0.24	1.4	0.36		
8/7/16		0.00	0.1			
8/8/16		0.07	1.0	0.12		
8/9/16	1	0.25	1.2	1.44	0.07	0.67
8/10/16		0.00	0.1			
8/11/16						
8/12/16						
8/13/16						
8/14/16						
8/15/16	1 [(2)]	0.48	1.2	2.04	0.20	1.17
8/16/16		0.20	1.0	0.12	0.06	0.50
8/17/16	1	0.11	0.4	1.32	0.00	0.25
8/18/16		0.00	0.1			
8/19/16						
8/20/16						
8/21/16		0.05	0.4	0.72		
8/22/16						
8/23/16						
8/24/16						
8/25/16						
8/26/16						

Developing new methods based on available data?



Developing new methods based on available data?



Conclusions by the MD CSO data:

CSOs are individually different. There could be relationship between rainfall and overflow, but that relationship varies by site. One relationship for all CSOs is not realistic.

Options for the WWTWG consideration:

1) Hybrid Approach: real or individually available CSO where available + Tetra Tech estimates for the rest.
2) Tetra Tech estimates for all CSOs.