

## General Instructions

The Local Limit Calculator uses a Microsoft Excel spreadsheet to complete the various calculations needed to develop or update plant protection criteria or local limits.

Below, the “top half” of the sheet calculates the plant protection criteria, seen below as the yellow highlighted numbers, from three areas: pass-through limits (blue headings), inhibition (red headings), and biosolids (brown headings). The RED outlined cells or columns are for data entry and the sheet now used this data to populate many other cells and formulas. The sheets have no hidden or protected cells.

City	Date: Mar-22									
Calculation of Plant Protection Criteria to prevent Pass Through, Inhibition and contamination of Biosolids.										
Plant Protection Limits	Pass through	Act. Sludge								
Parameter	Con. ug/L	% removal	Plant Protection ug/L	Reference	AS at Inhibition	Biosolids Criteria ug/L	503 lbs per Day	Sludge wasted		Avg Flow
	C	D	E		I	K	L	M		O
	C/(1-(D/100))					(M24*S24)/(1000*V24*B.34"/D24/100)				
Pass Through Limits from TDEC date										
Arsenic	51.92	45		EPA LL	Act Sludge	100	16,186,308	41	9038	6.1
Copper	82	82	288.44	EPA LL	Nit @ 50%	265	324.97792	1500	9038	6.1
Chromium III	9.93	84		EPA LL	Nitrification	250				
Chromium VI	80	84	62.06	EPA LL	Nitrification	250				
Nickel	180	47	375.00	EPA LL	Nitrification	250			9038	6.1
Cadmium	5	85	33.33	EPA LL	Act Sludge	1000	158.75517	420	9038	6.1
Lead	33.79	82	187.72	TN Guid	Act Sludge	100	8.151211	39	9038	6.1
Mercury	0.05	91	0.56	EPA LL	Act Sludge	100	64.985585	300	9038	6.1
Zinc	200	73	740.74	EPA LL	Nit @ 50%	250	3.3188222	17	9038	6.1
Molybdenum		41					681.4149	2800	9038	6.1
Selenium		73					32.497792	75	9038	6.1
Silver, daily max.	5	83	29.41	TN Guid	Act Sludge	250	24.336246	100	9038	6.1
Cyanide	4.69	62	12.34	EPA LL	Act Sludge	100				
Toluene	15	93	214.29	EPA LL	Act Sludge	200000				
Benzene	3	77	13.04	EPA LL	Act Sludge	100000				
1,1,1-Trichloroethane	30	88	250.00							
Ethylbenzene	4	90	40.00	EPA LL	Act Sludge	200000				
Carbon Tetrachloride	15	99	1500.00							
Chloroform	85	62	223.68							
Tetrachloroethylene	25	82	138.89							
Trichloroethylene	90	90	100.00							
1,2-Transdichloroethylene	1.5	86	7.50							
Methylene chloride	50	48	96.15							
Phenol	50	89	454.55	EPA LL	Nitrification	4000				
Naphthalene	1	92	12.50	EPA LL	Act Sludge	500000				
Bis(2-ethyl hexyl) phthalate		62	0.00							
Butyl benzyl phthalate		94	0.00							
D-n-butyl phthalate		68	0.00							
Diethyl phthalate		91	0.00							
Total Phthalate	64.5	62	169.74							
* percent removal from SAR's										

Information Cells										
PLANT PROTECTION DATA										
Design Capacity		9	MGD							
Current Average Flow		6.1	MGD							
Biosolids		9038	lbs/day							
Pass Through Limits Date		01/01/10								
Nitrification Required	Yes		Y/N							
Current SUI Flow		4.3	MGD	0.213146						
Current R/C Flow		4.8	MGD	0.786852						
Unused or Available Flow		2.9	MGD							
Full Capacity flow estimate using current flow percentages										
Residential/Commercial SUI Flow		7.861967213	MGD							
		1.91832787	MGD							

\* percent removal from SAR's

PLANT PROTECTION DATA	
Design Capacity	3 MGD
Current Average Flow	6.1 MGD
Biosolids	9038 lbs/day
Pass Through Limits Date	01/01/10
Nitrification Required	Yes Y/N
Current SIU Flow	1.3 MGD
Current R/C Flow	4.8 MGD
Unused or Available Flow	2.9 MGD
Full Capacity flow estimate using current flow percentages	
Residential/Commercial	7.061967213 MGD
SIU Flow	1.918032787 MGD

The “bottom half” begins with plant protection (yellow highlighted cells), calculates the maximum allowable headworks loading (MAHL); and working left to right, allocates the MAHL first to the residential and commercial customers, sets aside a reserve leaving the Maximum Allowable Industrial Load (MAIL) then calculates Local Limits.

	B	D	I	J	K	M	O	R	
Pollutant Loading		Maximum Allowable Headworks Loading MAHL					Maximum Allowable Industrial Loading MAIL		
Parameter	Plant Protection Criteria ug/L B= lowest value of C/(1-(D/100))	Loading lbs/day @ Design Flow B/1000*0.34*S557	Residential/Commercial Background mg/L Flow	Load in lbs T/9.34	Available Loading D-K= lbs	Available Load after Reserve is Removed	Monthly Average Local Limit at Flow 2 MGD	Daily Maximum Mo Avg	1.5
Arsenic	16.1861	1.21492867	0.005	7	0.2919	0.9230287	0.8307258	0.049803705	Arsenic 0.0747056
Copper	265	19.8909	0.076	7	4.43688	15.45402	13.90818	0.03385	Copper 1.250775
Chromium III	187.94	14.186764	0.005	7	0.2919	13.844876	12.43389	0.745407	Chromium III 1.1181105
Chromium VI	62.06	4.6582236	0.005	7	0.2919	4.3663236	3.926912	0.235593	Chromium VI 0.353895
Nickel	250	18.765	0.005	7	0.2919	18.4731	16.62579	0.99675	Nickel 1.455125
Cadmium	0.1512	0.61182907	0.001	7	0.05838	0.5534451	0.4981042	0.02986236	Cadmium 0.0447935
Lead	64.9555	4.87856223	0.00477	7	0.2784726	4.6008996	4.1408007	0.248206275	Lead 0.3723094
Mercury	0.56	0.0420396	0.0001	7	0.005838	0.0361956	0.032676	0.001953	Mercury 0.0020295
Zinc	290	21.7674	1.3655	7	79.71789	-57.95049	-52.15544	-3.126825	Zinc -4.690238
Molybdenum	32.4977	2.4392736	0.004035	7	0.2822673	2.1570101	1.9413091	0.116389435	Molybdenum 0.1745782
Selenium	24.3362	1.82667517	0.005	7	0.2919	1.5367752	1.3812977	0.08291161	Selenium 0.1242174
Silver	29.41	2.2075146	0.0025	7	0.14595	2.0615646	1.8554081	0.1112355	Silver 0.1668533
Cyanide	13.68	1.0268208	0.0025	7	0.14595	0.8808708	0.7927837	0.047529	Cyanide 0.0712935
Toluene	214.29	16.046074	0.001565	7	0.1141329	15.970475	14.373427	0.96171625	Toluene 1.2925744
Benzene	13.04	0.9787824	0.0015	7	0.08757	0.8912124	0.8029912	0.048087	Benzene 0.0721305
1,1,1-Trichloroethane	250	18.765	0.0015	7	0.08757	18.67743	16.809687	1.007775	1,1,1-Trichloroethane 1.5116625
Ethylbenzene	48	3.0024	0.0015	7	0.08757	2.91480	2.623347	0.157275	Ethylbenzene 0.2359125
Carbon Tetrachloride	1500	112.59	0.0015	7	0.08757	112.50243	101.25219	6.070275	Carbon Tetrachloride 9.1054125
Chloroform	223.68	16.7894208	0.0075	7	0.43785	16.351571	14.716414	0.882279	Chloroform 1.3224185
Tetrachloroethylene	138.89	10.425934	0.0015	7	0.08757	10.37513	9.3037621	0.5577795	Tetrachloroethylene 0.8366693
Trichloroethylene	100	7.506	0.0015	7	0.08757	7.41843	6.676587	0.400275	Trichloroethylene 0.6004125
1,2-Transdichloroethylene	7.5	0.58295	0.0015	7	0.08757	0.715325	0.427842	0.02565	1,2-Transdichloroethylene 0.038475
Methylene chloride	56.15	7.2171019	0.0075	7	0.43785	15.979169	6.1032521	0.3657829	Methylene chloride 0.5486738
Phenol	454.55	34.118523	0.1405	7	8.20239	25.916133	23.32452	1.3983525	Phenol 2.0975288
Naphthalene	12.5	0.93825	0.00375	7	0.218925	0.719325	0.6473925	0.0388125	Naphthalene 0.0562188
Bis(2-ethyl hexyl) phthalate			0.01125	7	0.656775	-0.656775	-0.591098		Bis(2-ethyl hexyl) phthalate 0.5486738
Butyl benzyl phthalate			0.01125	7	0.656775	-0.656775	-0.591098		Butyl benzyl phthalate 0.5486738
Di-n-butyl phthalate			0.01125	7	0.656775	-0.656775	-0.591098		Di-n-butyl phthalate 0.5486738
Diethyl phthalate			0.01125	7	0.656775	-0.656775	-0.591098		Diethyl phthalate 0.5486738
Total Phthalate	169.74	12.7406844	0.01125	7	0.656775	12.083909	10.875518	0.6520095	Total Phthalate 0.9780143

Data Needed: Plant design and average flow and flow from SIU's. If your NPDES permit has ammonia limits, nitrification is required, and this impacts the inhibition values.

Pass-through Limits from TDEC for each parameter.

Percent Removal Data: From SAR forms, generally three years' worth, or Book Values. See the reference tab of the spreadsheet for an example of actual SAR percent removal data.

Inhibition Values: Book values from the Tennessee Guidance Manual or EPA Manual. See pages on the Reference Tab of the spreadsheet.

Biosolids Data: If biosolids are land applied, the dry pounds of biosolids removed from the plant daily is needed. This is generally the previous calendar year tonnage adjusted to a daily amount divided by 365.

Test values for the Residential and Commercial "background" sewage are needed. For updates in small plants, one or two tests are adequate. Two from the same location a few weeks apart or two from different locations but on the same day. Note these samples should have no process wastewater from any significant industrial users. This is to determine background levels of the various pollutants contributed by the residential and commercial users. I often compare these to older values if available and sometimes include those older values if similar.

Industrial Flow: The expected average or perhaps expected maximum flow from SIU's.

Note: The calculation of Plant Protection Criteria is generally rather prescribed so there is little room for adjustments or manipulation of the calculation on the top half of the sheet. But on the bottom half of the spreadsheet, where we go from Plant Protection to Local Limits we have a great deal of flexibility. The assumptions and decisions need to be protective of the plant and receiving stream, but there is a lot of room for local adjustments.

### **Step 1, Calculating Plant Protection Criteria**

- a) Enter the City or Utility name ( Cell A2) and the date (Cell E2).
- b) Skip to the right side of the sheet and add several numbers into the red outlined cells. Design hydraulic capacity is in Cell S7, Current Average Flow is in Cell S8, Biosolids removed from the plant in pounds of Total Solids (dry) per day is in Cell S10, the date the Pass-through Limits were calculated by TDEC is in Cell S11, Cell S13 is a simple yes/no if nitrification is required (plant has an ammonia limit), and Cell S17 is the current average SIU flow.
- c) Enter the date TDEC issued Pass-through Limits into Cell C12 and the actual Pass-through Limits into Column C Row 19-46 on the top half of the spreadsheet. Note the units are ug/L, micrograms per liter.
- d) In Column D the updated or book value data for percent removal is entered. I generally like to look at three years of SAR's. See the example on the Reference Tab of the spreadsheet.

These are actual percent removal numbers. For parameters like copper and zinc there are generally 6 values and the average of these is used. In the example Cu, Ni, Hg, and Zn had 5-7 values that made good “representative” averages. For many others there may only be one or two values and often they are the vague >(greater than) numbers. Book values could be used as an alternative or you can just average the number and forget the > sign. In the example, Toluene and Trichlorethylene only had a single value so I averaged it with the book value. Ethylbenzene had two values, 65% and >17%. >17% could be 18% or 100%, we just don’t know. I dropped the >17% and averaged the 65% with the book value. Total Phthalate had two good values, so I averaged them and used that average.

Sometimes there are “outliers” values that are far different from the others. For example, if you have four numbers in the 70-90 range and one that is 4%, I will call it an “outlier” and simply not use it. When making these types of decisions, I often use the book values as a guide. If an “outlier” is close to a book value, I would use it.

- e) The next section is the inhibition values. These are all book values coming from either the Tennessee Guidance Manual or the EPA Local Limit guidance manual. See the Reference Tab of the spreadsheet for copies of the important tables. Note: there are gaps in our knowledge, so we often must work around having little or no knowledge about some parameters. TDEC prefers that the reference book used be included and the bacterial population of importance be noted so, these are noted in Columns G & H. Each of these guidance manuals list inhibition values for Activated Sludge and Nitrification. Because the nitrifying bacteria are often the “wimps” of the system, their value is often lower, but not always. If you look at these Tables, you will see a lot of missing value. We simply do not have a complete list. The copper and zinc inhibition values in each guidance manual gives ranges. If you use the lowest value, that would be highly protective but you will end with extremely low local limits that most industries cannot meet and perhaps even negative local limits. I use, and TDEC allows the use of the average values. So, the commonly seen Copper value at 265 ug/L and Zinc at 290 ug/L are average values in the published inhibition range.
- f) Biosolids Criteria. If you do not land apply biosolids and never foresee doing so this section can be skipped and deleted from the spreadsheet. Entering data into the Current Plant Average Flow- Cell S8 and Biosolids- Cell S10 should auto populate the various cells and formulas in the Biosolids Section.  
If you are land applying Biosolids or may be doing so in the future, this section will need to be completed. This is needed because generally the pollutants that are removed from the effluent are now located within the biosolids.
  - i. Note: The example spreadsheet has three metals listed that are not on TDEC’s pass-through list: Arsenic, Molybdenum, and Selenium. These are added because they are regulated in biosolids land application. Also Note: Column L has the EPA (and TDEC) metals limits for Biosolids. Listed here are the Table 3 values from 40 CFR 502.13. In this example, the Biosolids calculations set the Plant Protection Criteria for 6 of the metals. Sometimes these calculations result in very low Local Limits. If using Table 3 values results in very low Local Limits and your influent tests are

consistently under the current Plant Protection Criteria, TDEC has allowed the use of higher (503) Table 1 biosolids limits.

- ii. Data needed: Mass of biosolids land applied per day. This is Total Solids (SM-2540 B) and is always in dry weight, that is 100% dry and 0.0% moisture.
  - iii. Generally, the annual Biosolids Report has total mass disposed of for the previous year. This should be adequate unless there have been major changes in the plants daily production rate of biosolids. Biosolids Annual Reports use Metric Tons (2205 lbs/T) and this spreadsheet uses U.S. Tons (2000 lbs/T) so conversions may be needed. Use the annual pounds land applied divided by 365 and enter this value in Cell S10.
  - iv. The Biosolids Criteria formula, found in column K, is quite complex. It was taken from the Tennessee Guidance Manual and has been checked and reviewed by numerous TDEC personnel. There is also a printed version of the formula in Row 11 of the example. The actual average plant flow, Column O, is very important.
- g) The next step is to choose Plant Protection Criteria. I like to highlight the cells in Yellow. The lowest values in Columns E, K, and I will be Plant Protection Criteria. I like to highlight these in yellow. This is the level of the various pollutants that will protect the receiving stream from “pass-through,” the plant biomass from “inhibition,” and the biosolids from “contamination.” The values for the volatile and semi-volatile compounds rarely change. Note: There are no pass-through limits for arsenic, molybdenum, and selenium so those cells are empty and there are no biosolids limits for Chromium, so those cells are also empty.
- The next step is to manually enter the Plant Protection Criteria from the top half of the sheet to Column B on the bottom half. If you are an Excel expert, you may want to make a formula for this but I never took the time. Again, I like to highlight these in Yellow.
- h) Chromium Notes. The three Chromium parameters: Total Chromium, Chromium III, and Chromium VI can become confusing because of various pass-through limits, detection levels, the way Chromium III is quantified and the wide differences in inhibition values.
- i. First, Chromium III is a calculated value. The Chromium VI test value is simply subtracted from the Total Chromium test value.
  - ii. Second, the inhibition values range from 250 ug/L to 10,000 ug/L, but there are gaps in the data.
  - iii. The listed inhibition values for Chromium III to the activated sludge (BOD) bacteria is 10,000 ug/L and there is no data for the nitrifying bacteria. Using this value can give extraordinarily high Chromium III local limits which are unreasonable when Total Chromium limits are far lower coupled with the fact that Chromium III is a portion of Total Chromium and thus cannot exceed the Total Chromium value.
  - iv. The listed inhibition value for the nitrification bacteria is listed as 250 ug/L for both Total Chromium and Chromium VI, so this is the value I most often use.
  - v. In the example spreadsheet, there was no Chromium III pass-through limit. The pass-through percent removal value of 62.06 ug/L set the plant protection for Chromium VI. The inhibition value of 250 ug/L set the Total Chromium plant protection value. So the difference of these two set the Chromium III plant

protection value. This mirrors the way the Chromium III test value is determined by subtracting the Chromium VI from the Total Chromium test value.

## Step 2, Calculating Local Limits

- a) The next step is to view the Maximum Allowable Headworks Loading (MAHL) in Column D. The formula in this column converts the Plant Protection values in ug/L to mg/L then using the design flow, from the information section at the top of the sheet, calculates the MAHL in pounds. This the theoretical pounds of each pollutant that the plant can accept each day, at full capacity flow, without violating the Pass-through Limits, inhibiting the treatment bacteria, and not contaminating biosolids.
- b) The next three columns to the right are the Residential and/or Commercial background section. Column I is the mg/L values from the Residential and/or Commercial background testing. This should be at a minimum two sets of tests. They can be two tests in one location on two different dates or two locations on the same day. Large systems will want to do more tests. The test data is entered on the Residential Testing tab (second spreadsheet). In the example Excel sheet there are two columns of actual test values included. Two lift stations were sampled for all the needed test parameters.
  - i. Most of these test reports have list results as BDL(below detection level) or ND (non-detect) In these cases, the detection level is entered in the cell.
  - ii. In the example Arsenic was BDL so the detection level of 0.01 mg/L is used.
  - iii. For Copper there are two detected values, 0.135 mg/L and 0.017 mg/L. I generally change the detected values to **Bold** font.
  - iv. Calculating the values to use must be done on each row. In the example Copper, Zinc and Phenol each had two detected values so the value to use is the simple average.
  - v. Where values are below detection the Value to Use will be half of the detection level. This can be entered in the cell by hand, but I have used the formula that divides each value by 2 and then averages these two numbers.
  - vi. Where there is one BDL value and one detected value, average half of the detection level with the detected value.
  - vii. When the Values to Use are calculated, they can be “copied and pasted” into Column I on the main spreadsheet. Note: when “pasting” paste the “values” not the formulas. The Paste icon is a clipboard with the numbers 123 on it.
- c) Back to the main spreadsheet, Column J is the Residential and/or Commercial flow. It is at this point we can actually begin to make some local decisions or assumptions regarding the allocation of pounds of pollutants that enter the treatment plant. I prefer to scale to full hydraulic capacity, because it simplifies the calculations and builds in reserve. If you use actual flow values, larger reserves are needed to be ready for flow increases. When you do make decisions or assumptions, write them down as part of a rationale statement. You will need them in 5 years when you repeat this process.
  - i. Data needed: Plant design flow, average flow, permitted SIU flow. These all have a RED box in the Information Cells.
  - ii. I generally start with the permitted industrial user flow. What is the current average and what do you expect that flow to be in 5 years? This is a good time to ask

managers or city leaders questions about expected industrial growth. If current flow is 80% commercial and residential and 20% permitted industrial, you can simply scale up to full capacity using these same percentages.

- iii. The GREEN box under the Information Cells does some percentage calculation and flow predictions. The value in Cell S17 is calculated by subtracting current SIU flow from current average flow. Column U calculates the current percent (as decimal) each of these flow sources. Column V is the percent value.
- iv. Within the GREEN box there is also a calculation of predicted flow. Using the current percent values for SIU flow and residential/commercial flow the formulas scale up to full capacity. The current SIU flow is about 21% of the current flow so at full capacity 20% is 1.918 MGD or about 2.0 MGD. We do not need exact numbers; these are all predictions. The current residential/commercial flow is about 78% and 78% of 9 MGD is about 7 MGD.
- v. If the “Full Capacity flow estimates using current flow percentages” located in Cells S23 and S24 is reasonable, enter these numbers into the small BLUE cells under the LOCAL LIMIT DATA Calculation Data heading. I choose 7 MGD as the residential/commercial flow and 2 MGD as the SIU flow.
- vi. Also in the small BLUE cells is the percent industrial reserve. Generally 10% is used. If your plant is fully loaded and no additional flow can be accepted using a zero reserve has been accepted. The daily maximum multiplier is also here. These values follow the pattern from your NPDES permit. Using a 2 gives Daily Maximum values double of the Monthly Average or you can use 1.5 to be more conservative.

d) Now we begin to allocate the Maximum Allowable Headworks Loading, that is pounds, to the various customers or sewer users. After adding the numbers into the BLUE cells all formulas should have automatically populated the remaining formulas across the bottom half of the spreadsheet.

- i. Column K should show the pounds of each pollutant needed for the Residential and Commercial customers at the flow level in Column J.
- ii. Column M is a simple subtraction of the Residential and Commercial pounds from the MAHL to give the pounds available for industrial customers.
- iii. Column O removes the industrial reserve percent that was entered into Cell Y8 in the BLUE box. These values, in Column O, are the Maximum Allowable Industrial Load or MAIL.
- iv. Column R calculated the Monthly Average Local Limits at the specified flow from Cell Y9. If this value is greater than the current industrial flow, you automatically have more industrial reserve for new industries.
- v. Column V calculated the Daily Maximum Local Limit using the specified Daily Maximum multiplier. Some plants receive Pass-through Limits for Silver that are specified as Daily Maximum. All the others are Monthly Averages, so the final calculations of Local Limits are Monthly Averages. So if your Silver pass-through limits specify Daily Maximum, this must be adjusted in Columns R and V.
- vi. Note: Pass-through limits are always Monthly Average values, except some utilities have Silver Pass-through limits that are specified as Daily Maximum. In these cases

the number the sheet calculates in Column R is really a Daily Maximum value and the sheet should be adjusted to reflect this.

- e) Rationale Statement. A rather recent TDEC request is for a Rationale Statement. This is just a simple, step by step explanation of what was done, where data came from, and why decisions and assumptions were made.