Problem #1 -- Minnowville

Minnowville's wastewater treatment plant employs two primary clarifiers and two activated sludge basins. Primary and waste activated sludges are stored in an aerated thickening basin and batch treated in an anaerobic digestor that produces a class A biosolids product for public distribution. The plant's outfall discharges to a freshwater river with a hardness estimated to get down to 60 in the summer.

While designed to accept up to 1.5 MGD, the treatment plant presently has a maximum monthly flow of 0.8 MGD in the winter, and a minimum monthly flow of .40 MGD in the summer. About 40,000 gpd (0.04 MGD) is received from their two permitted industries. During the summer time they don't have appreciable I/I. From their permit fact sheet, the estimated mixing zone ratios at the edge of the authorized mixing zones are as follows:

Acute MZ = 4.1:1; Chronic MZ = 12.8:1; Human Health Criteria MZ = 19:1

Records from the plant indicate that digestor flow during this time of year is about 5,000 gallons per day and corresponding dry sludge production is 900 pounds / Day.

Minnowville sampled between January, 2015 and 2016 and has tabulated their eight rounds of sampling data which their laboratory entered into the summary data field of the "Sample Data" spreadsheet (They were able to cut and paste a summary of the data into the spreadsheet). The sampling was from their influent, effluent, primary clarifier, and final sludge. The City Manager wants to know what the local limits computed for existing industrial flow base would be if the pollutant concentrations & removal rates indicated from this initial sampling are typical.

Minnowville's current sewer use ordinance includes Metals limits reflective of 40 CFR part 433's **Daily maximum** criteria for new sources, namely: Cd = .11 mg/L, Cr = 2.77 mg/L, Cu = 3.38 mg/L, Pb = .69 mg/L, Ni = 3.98 mg/L, Ag = .43 mg/L, Zn = 2.61 mg/L, CN = 1.2 mg/L, and TTO's (listed at 40 CFR433) = 2.13 mg/L.

Problem 1A: Using the uniform application allocation scheme, and holding 10% of the maximum allowable headworks loading in reserve. For what pollutants does this initial data point show the pollutant limits might not be adequately stringent (disregarding the TTO limit for the time being)?

Problem 1B: Are any limits (from Problem 1) indicated that would exceed the Washington State's HW Criteria?

Problem 1C: When Ecology reviewed the local limits, they noted that a receiving water study had collected hardness data for the river that showed a lower hardness value should be used. A 90 percentile worst case value (as is Ecology's policy to use for NPDES permit writing), receiving water hardness of 32 mg/L was indicated by the data set. What pollutants would be lower because of this, and what are the local limits indicated?

Data entered into database from sampling for conservative pollutants:

SUMMARY DATA	Antimony	Arsenic (T)	Arsenic(+5)	Beryllium	Cadmium	Chrome(+6)	Chrome (T)	Copper	Cyanide
Ave. Influent Conc.	3.000 ug/L	2.000 ug/L	2.000 ug/L	5.000 ug/L	5.000 ug/L	15.000 ug/L	25.000 ug/L	75.000 ug/L	12.000 ug/L
Ave. Effluent Conc.	2.000 ug/L	1.000 ug/L	1.000 ug/L	3.000 ug/L	1.000 ug/L	11.000 ug/L	15.000 ug/L	6.000 ug/L	2.000 ug/L
Ave. Primary Removal	33.33%	50.00%	50.00%	20.00%	40.00%	13.33%	28.00%	84.00%	16.67%
Ave. Overall Removal	33.33%	50.00%	50.00%	40.00%	80.00%	26.67%	40.00%	92.00%	83.33%
Average Sludge Conc.	2.4 mg/kg	2.1 mg/kg	1.7 mg/kg	3.2 mg/kg	2.9 mg/kg	1.6 mg/kg	5.6 mg/kg	258. mg/kg	11. mg/kg
Ambient Receiving Water Conc	2.100 ug/L	1.300 ug/L	0.900 ug/L	1.200 ug/L	0.300 ug/L	2.600 ug/L	3.800 ug/L	2.600 ug/L	0.300 ug/L
AVE Industrial Conc.	8.0 ug/L	15.0 ug/L	15.0 ug/L	25.0 ug/L	15.0 ug/L	45.0 ug/L	65.0 ug/L	115.0 ug/L	55.0 ug/L

SUMMARY DATA	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Tributyl Tin	Zinc
Ave. Influent Conc.	35.000 ug/L	0.180 ug/L	15.000 ug/L	35.000 ug/L	25.000 ug/L	10.000 ug/L	11.000 ug/L	0.030 ug/L	125.000 ug/L
Ave. Effluent Conc.	4.000 ug/L	0.002 ug/L	12.000 ug/L	15.000 ug/L	12.000 ug/L	2.000 ug/L	5.000 ug/L	0.010 ug/L	25.000 ug/L
Ave. Primary Removal	28.57%	94.44%	6.67%	42.86%	20.00%	40.00%	45.45%	66.67%	56.00%
Ave. Overall Removal	88.57%	98.89%	20.00%	57.14%	52.00%	80.00%	54.55%	66.67%	80.00%
Average Sludge Conc.	46. mg/kg	0.5 mg/kg	4.1 mg/kg	24. mg/kg	12. mg/kg	16. mg/kg	6. mg/kg	0.2 mg/kg	350. mg/kg
Ambient Receiving Water Conc	0.200 ug/L	0.004 ug/L	0.600 ug/L	1.200 ug/L	2.500 ug/L	0.100 ug/L	0.700 ug/L	0.002 ug/L	7.000 ug/L
AVE Industrial Conc.	65.0 ug/L	0.1 ug/L	65.0 ug/L	110.0 ug/L	35.0 ug/L	25.0 ug/L	35.0 ug/L	15.0 ug/L	250.0 ug/L

Solutions to Practical Exercise #1:

Example Minnowville:

Solution to Part 1: Metals for which the indicated local limit is lower than presently:

Cadmium (.29 mg/L v. 1.0 mg/L),
Copper (3.28 mg/L v. 3.38 mg/L)
Cyanide (1.015 mg/L v. 1.2 mg/L)
Nickel (2.12 mg/L v. 3.98 mg/L)
Silver (0.22 mg/L v. 0.43 mg/L)

Solution to Part 2: There is only one pollutant that compliance with Washington State's HW rules drive a lower limit: Chromium, 69.9 mg/L indicated which must be reduced to 5.00 mg/L to meet Chapter 173-303-090 WAC.

Solution to Part 3: After running scenario #1, copy row 76 or 77 to a blank row (for example row 83) using the "copy" and "Paste Values" function. Then change the value for "*Receiving Water Hardness*" on "*Basic Data*" row 19 to "32" instead of "60". The following limits were changed (as shown below):

Cadmium: 0.29 mg/L reduce to 0.10 mg/L
Copper: 3.28 mg/L reduced to 1.25 mg/L
Lead: 1.2 mg/L reduced to 0.28 mg/L
Silver: 0.22 mg/L reduced to 0.02 mg/L

Practical Exercise #2 – Minnowville (Continued)

- Continuing the Minnowville situation, the mayor wants you to allow a new industry that wants to start discharging 30,000 gpd with copper levels of up to 2.0 mg/l. Existing industry (40,000 gpd) has pollutant concentrations listed in "Sample Data" tab.

Part 1: Find at least two options you might employ that would allow taking this wastewater?

Part 2: Which option would you prefer, and why? ____________________________

Part 3: How would you implement your preferred option? ______________________

Part 4: Would growth in domestic wastewater flows help the situation or make it worse, and why?

Exercise #2 SOLUTION:

Analysis:

- Data from the two existing SIU's (see "AVE Industrial Conc." at row 10 on the "Sample Data" sheet) shows average copper concentrations for industries of 0.115 mg/L, or about 8.34*.04*0.115 = 0.04 lb/d for both.
- Row 71 shows that the MAIL is 0.49 lb/d of a MAHL (Row 70) of 0.70 lb/d.
- The requested loading is 0.03MGD * 8.34 lb/g * 1.0ppm = .25 lb/d,
- Loading from all SIU's (0.07 MGD) at 1.0ppm would be over the MAIL (at 0.58 lb/d)

OPTIONS:

1. Limit Minnowville's two existing industries to 0.4MGD at twice their "normal" concentration or .23 mg/L, freeing up .41 lb/d, or 49,000 gpd at 1.0 MGD. **DRAWBACK**: Existing Users may protest.
2. Give all IU's mass based limits, e.g. 0.05 lb/d for existing Users, 0.39 lb/d for the new one. **DRAWBACK**: Maintenance of the limits.
3. Limit SIU's to 49,000 gpd from all SIU's at 1.0 mg/l copper (= the MAIL = 0.49 lb/d total) **DRAWBACK**: Doesn't provide the requested limits.
4. Revisit the data to see if either of the two existing users can qualify as "dilute" for copper, and is so, use the contributing flows method to divide the MAIL over only SIU's with higher than domestic concentrations of copper. (0.02 MGD + 0.03 MGD) = 0.05 MGD, which would result in a limit of 1.02 mg/L with 10% reserve. **DRAWBACK**: Slow & difficult.
5. Explore NPDES permit options to achieve a larger mixing zone ratio or calculating effluent limits based on the hardness of the mixture of effluent and ambient waters (known as "mixed hardness". If effluent hardness is 120, mixed hardness at the acute MZ Boundary = 53.5 **DRAWBACK**: Need data for analysis, this could take time and money.

Part 2: Which is preferred: All solutions have their drawbacks, but how much time there is to make a decision may limit the available solutions. With no "correct" option #4 (evaluating whether one might use contributing flows) is a good choice as it provides "uniform allocation" based limits for everyone with non-domestic strength wastewater.

Part 3: How to implement: Regardless of the option chosen, where the IU's permit limits are being reduced, (and all scenarios were below the current limit at 3.38 mg/L), affected IU's must be advised of the selected allocation method, what it means to them, and how they can provide input into the decision making process.

Part 4: Would growth in domestic wastewater flows help? Yes: In fact, if all other variables remain constant a 10% increase in domestic flow (combined with the .04 MGD new SIU flow) would allow all 0.07 MGD of SIU flows at 1.0 mg/L of copper (absent any safety factor). Adjust "POTW flow" in the "Basic Data" tab to evaluate different scenarios

Exercise #3: Minnowville Explosivity and Vapor Toxicity Concerns:

Problem: One of the City of Minnowville's existing industries (Clown Shoes Inc.) is changing their processes & sent in a new permit renewal application with the following previously unaddressed pollutant characteristics:

Carbon Disulfide = 1.5 mg/L
Trichloroethylene = 2.1 mg/L
Chloroform = .53 mg/L

Part 1: Do these levels meet Explosivity screening levels?

Part 2: Does these levels meet Vapor Toxicity screening levels?

Part 3: What limits would you propose for these pollutants?

Exercise #3 – SOLUTIONS:

RECAP: Clown Shoes Incorporated, one of the City's two industries just submitted a permit update which included the following discharge characteristics:

- Carbon Disulfide = 1.5 mg/L
- Trichloroethylene = 2.1 mg/L
- Chloroform = .53 mg/L

- Part 1: Do these levels meet Explosivity screening levels? **Answer: NO**
  - Carbon Disulfide ("Toxic-Explosive Limits" row 236) = **0.54 mg/L**.
  - Trichloroethylene = 114 mg/L (row 128) **(OK)**
  - Chloroform (not highly explosive) **(OK)**

- Part 2: Do the requested effluent concentrations meet Vapor Toxicity screening levels? **Answer: NO**, below are the vapor toxicity screening levels:

  - Carbon Disulfide = 0.06 mg/L (EPA) **– 0.08 mg/L** (WA-OSHA)
  - Trichloroethylene = **0.71 mg/L (EPA) – 2.85 mg/L** (WA-OSHA STEL)
  - Chloroform = **0.41 mg/L (EPA) - 0.16 mg/L** (WA-OSHA STEL)

- Part 3: What limit is required for each pollutant? Answers below:

  - **Carbon Disulfide = .54 mg/L**
  - **Trichloroethylene = 0.5 mg/L (HW Threshold)**
  - **Chloroform = .41 mg/L**

- NOTE: EPA Methodology promotes the % of exposure limit for several substances should be added to approximate the cumulative toxicity of the mixture. (e.g. if one substance is at 50% of its threshold vapor toxicity concentration, and another at 80%, the total would be at 130% of the permissible limit.)

Exercise #4: Minnowville Compatible Pollutant

BACKGROUND: The City of Minnowville's POTW Nitrifies and is required to meet low Ammonia limits (meaning they need to assure they provide enough oxygen for converting ammonia to nitrate). The POTW is at 51% of their BOD capacity of 1,670 lb/day and has blowers capable of satisfying an Actual Oxygen Requirement (AOR) of 3,000 lb/day. The POTW receives maximum monthly average ammonia loadings of 180 lb/d and MMA flows of 0.4 MGD

Part 1: Can the City accommodate an IU (a Cold storage company using ammonia as refrigerant) which will need to discharge up to 75lb/day of ammonia and still meet permit limits?

Part 2: How does this change the date they run out of capacity if they are growing at 5% per year?

Exercise #4: Solutions

SOLUTION to Part 1: Since flow capacity is not at issue, Check loading capacity:

- Firm Oxygen Transfer Capacity of the POTW: = 3,000 lb/d (design value)
- Present MMA loading of BOD5: = 850 lb/d
- Conversion Factor lb O_2/lb BOD: = 1.25
- Total Oxygen used for BOD5 treatment = 1062.5 lb/d
- Present MMA NH3 = 180lb
- Desired MMA loading of Ammonia (as N) = 180+75 = 255 lb/d
- Conversion Factor lb O_2/lb Ammonia (as N) = 4.6
- Total Oxygen used for Ammonia = 4.6*225lb/d = 1,173 lb/d
- Total Oxygen for BOD and Ammonia = 2,235.5 lb/d
- Percentage of Oxygen Capacity Utilized: = 74.5%
- ANSWER: Additional Loading would Exceed Design Capacity for Air Delivery

Solution to Part 2: Use iterative approach or Engineering Economic Analysis Tables. (Iterative approach is simpler to explain):

Future Loading = Current Loading (1+growth rate %):

- 2016 = 2,235.5 lb/d (Current loading with new User)
- 2017 = 2,235.5 * (1.05) = 2,346.75 lb/d (in 1 year)
- 2018 = 2,346.75 * (1.05) = 2,464.09 lb/d (in 2 years)
- 2019 = 2,464.09 * (1.05) = 2,587.29 lb/d (in 3 years)
- 2020 = 2,587.29 * (1.05) = 2,716.66 lb/d (in 4 years)
- 2021 = 2,716.66 * (1.05) = 2,852.49 lb/d (in 5 years)
- 2022 = **2,995**.11 (~ 3,000 lb/d) AOR in 6 years

Similarly, absent the new User capacity reached in 10 years

- 2016 = **1,890.5 lb/d** (Current loading with new User)
- 2017 = 1,890.5 * (1.05) = **1,985.1 lb/d** (in 1 year)
- 2017 = 1,985.1 * (1.05) = **2,084.2 lb/d** (in 2 year)
- 2018 = 2,084.2 * (1.05) = **2,188.5 lb/d** (in 3 years)
- 2019 = 2,188.5 * (1.05) = **2,297.9 lb/d** (in 4 years)
- 2020 = 2,297.9 * (1.05) = **2,412.8 lb/d** (in 5 years)
- 2021 = 2,412.8 * (1.05) = **2,533.4 lb/d** (in 6 years)
- 2022 = 2,533.4 * (1.05) = **2,660.1 lb/d** (in 7 years)
- 2023 = 2,260.1 * (1.05) = **2,793.1 lb/d** (in 8 years)
- 2024 = 2,793.1 * (1.05) = **2,932.8 lb/d** (in 9 years)
  (Capacity of 3,000 lb/d reached after about 9½ years)
- 2025 = 2,932.8 * (1.05) = **3,079.4 lb/d** (in 10 years)