Defending your Local Limits

Region 8 Pretreatment Association

R8PA 2016

Greetings from Utah

Statutory Authority

The Federal Water Pollution Control Act of 1948

As amended in 1972, the law became commonly known as the Clean Water Act (CWA)

Statutory Authority

The Federal Water Pollution Control Act

Sec. 307 (d)

Toxic and Pretreatment Effluent Standards

(d) After the effective date of any effluent standard or prohibition or pretreatment standard promulgated under this section, it shall be unlawful for any owner or operator of any source to operate any source in violation of any such effluent standard or prohibition or pretreatment standard.

Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(1)…***Each POTW with an approved pretreatment program*** shall ***continue*** to develop these limits as necessary and effectively enforce such limits.

Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(2) ***All other POTW's*** shall, in cases where pollutants contributed by User(s) result in Interference or Pass-Through, and such violation is likely to recur, ***develop and enforce specific effluent limits*** for Industrial User(s)….

Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(4) POTWs may develop Best Management Practices (BMPs) to implement paragraphs (c)(1) and (c)(2) of this section. Such BMPs shall be considered ***local limits*** and Pretreatment Standards for the purposes of this part and section 307(d) of the Act.

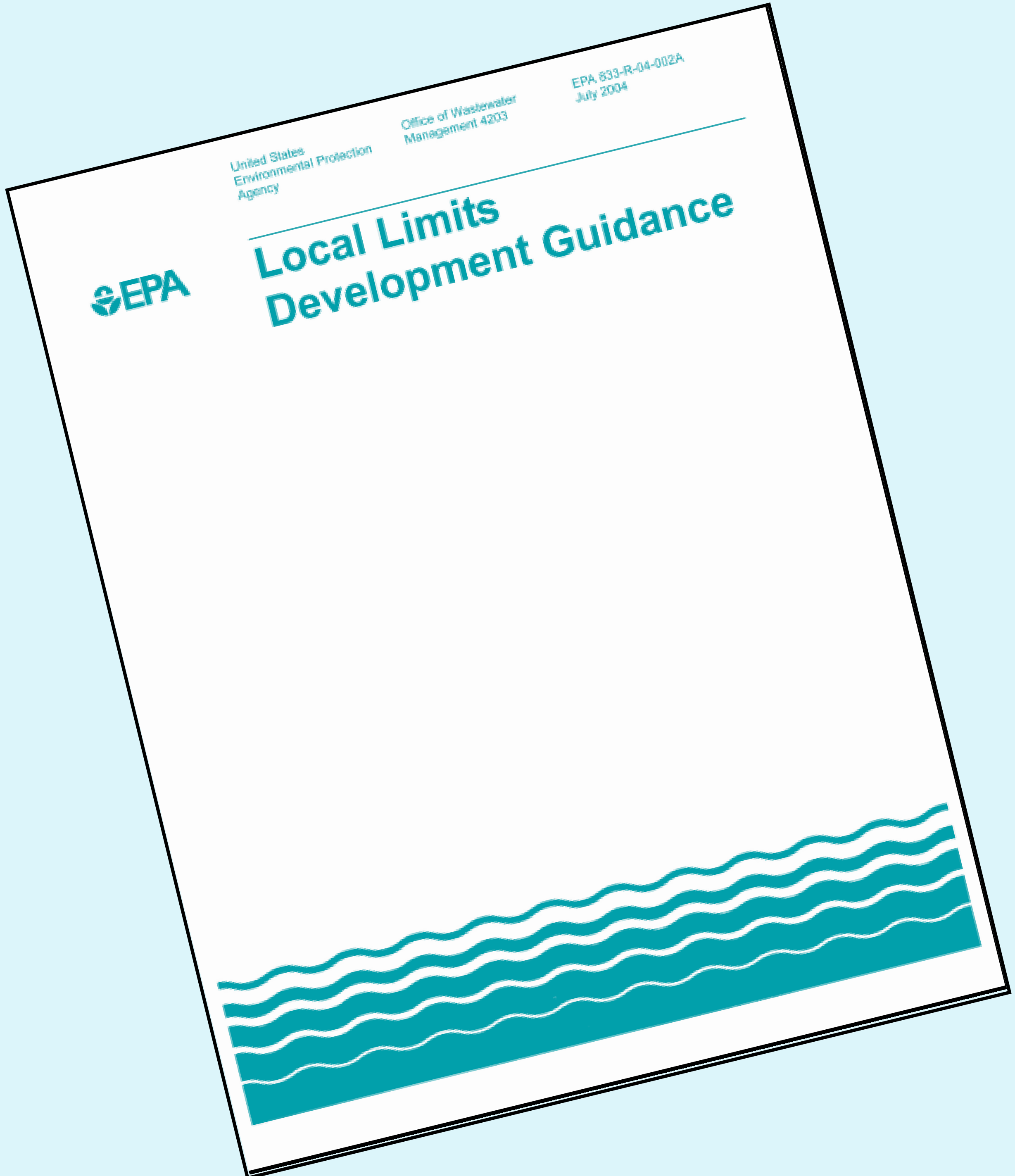
Statutory Authority

40 CFR 403.5 - National pretreatment Standards: Prohibited discharges

(c) When specific limits must be developed by POTW.

(d) ***<u>Local limits.</u>*** Where specific prohibitions or limits on pollutants or pollutant parameters are developed by a POTW in accordance with paragraph (c) above, such limits shall be deemed Pretreatment Standards for the purposes of section 307(d) of the Act.

Guidance


United States Environmental Protection Agency
Office of Wastewater Management 4203
EPA 833-R-04-002A
July 2004

EPA

Local Limits Development Guidance

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Environmental Protection
Agency

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EPA

Local Limits Development Guidance

Guidance Outline

Chapter 1 - Introduction

Chapter 2 - Overview

Chapter 3 - Pollutants of Concern

Chapter 4 - Data Needs

Chapter 5 - Calculating MAHL

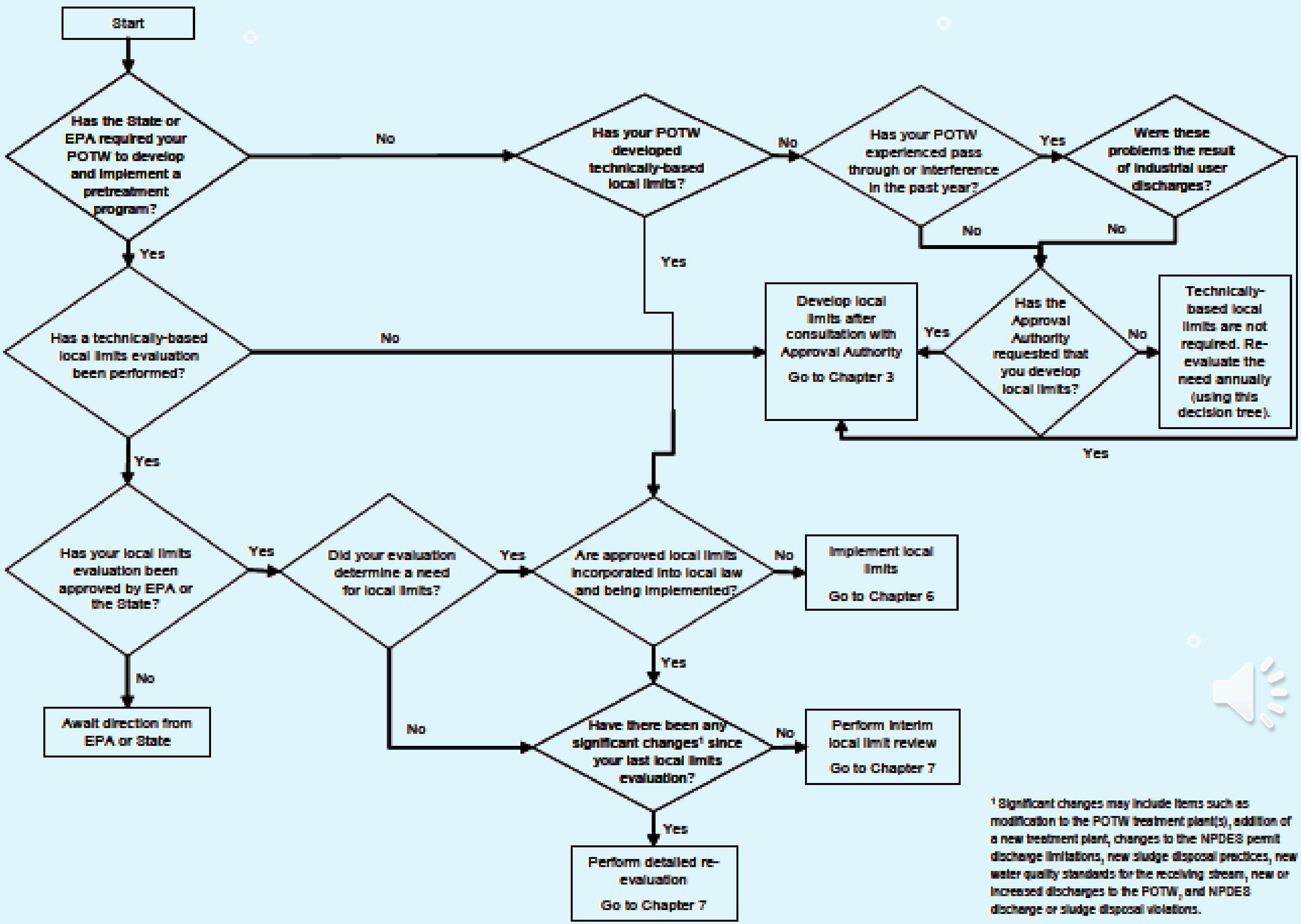
Chapter 6 - Implementation

Chapter 7 - Review / Re-Evaluation

Chapter 8 - Collection Systems

Chapter 9 - Q and A

Figure 2-1: POTW Local Limits Decision Tree



Local Limits Steps

Determining pollutants of concern (POCs)

Collecting and ***analyzing*** data

Calculating maximum allowable headworks loadings (MAHLs) for each POC

Designating and implementing local limits

Performing local limits re-evaluations

Pollutants of Concern

Determine by final disposal

Effluent receiving

Solids disposal

Pollutants of Concern

15 Minimum!

- Ammonia
- Arsenic
- BOD_5
- Cadmium
- Chromium
- Copper
- Cyanide
- Lead
- Mercury
- Molybdenum
- Nickel
- Selenium
- Silver
- TSS
- Zinc

Pollutants of Concern

Any Existing Effluent Limit

Any Existing Local Limit

126 Priority Pollutants

- Organics
- Metals

Any in your Current Waste Load Analysis

Region 8

Saskatchewan
Milk
Missouri–Poplar
Souris
Red
Kootenai–Pend Oreille–Spokane
Missouri–Marias
Missouri–Musselshell
Missouri–Little Missouri
Lower Snake
Lower Yellowstone
Missouri–Oahe
Missouri Headwaters
Upper Yellowstone
James
Minnesota
Powder–Tongue
Cheyenne
Big Horn
Missouri–White
Missouri–Big Sioux
Upper Snake
Niobrara
Great Divide–Upper Green
North Platte
Bear
Missouri–Little Sioux
Great Salt Lake
White–Yampa
South Platte
Republican
Lower Green
Colorado headwaters
Smokey Hill
Escalante Desert–Sevier Lake
Upper Colorado–Dolores
Gunnison
Upper Arkansas
Upper Colorado–Dirty Devil
Rio Grande headwaters
Middle Arkansas
San Juan
Rio Grande–Elephant Butte
Upper Cimarron
Lower Colorado–Lake Mead
Upper Canadian

Exercise 1

Exercise 1

Given the Data in the handout

Identify the major pollutants of concern

Ignore All Organic Data

Exercise 1

Ammonia
Arsenic
BOD_5
Cadmium
Chromium
Copper
Cyanide
Lead
Mercury
Molybdenum

Nickel
Selenium
Silver
TSS
Zinc
Aluminum
Antimony
Boron
Iron
Thallium

Data Needs

- Sample Types
  - Grab
  - Composite
    - Time Weighted
    - Flow Composite

Data Needs

Grab Sampling

Grab samples are individual samples collected over a period of time not exceeding 15 minutes and are representative of conditions at the time the sample is collected.

Data Needs

Grab Sampling

Cyanide

Flashpoint

Oil and Grease

pH

Sulfides

Temperature

Total Petroleum Hydrocarbons

Total Phenols

VOCs

Data Needs

Composite Sampling

A Composite sample should contain a minimum of eight discrete samples taken at equal time intervals over the compositing periods or proportional to the flow rate over the composting period.

Data Needs

Composite Sampling

Data Needs

Composite Sampling

Time Composite Sample

This method requires discrete sample aliquots collected in one container at constant time intervals.

Data Needs

Composite Sampling

Flow-Proportional Composite Sample

One method collects a constant sample volume at varying time intervals proportional to stream

The other method, collect the sample by increasing the volume of each aliquot as the flow increases, while maintaining a constant time interval between the aliquots.

Data Needs

Local limits may be established on an instantaneous, daily, weekly or monthly-average basis.

The sample type used to determine compliance with local limits should be linked to the duration of the pollutant limit being applied.

Data Needs

Compliance with instantaneous limits should be established using individual grab samples. Exceedances identified by composite sampling are also violations.

Data Needs

Compliance with daily, weekly or monthly average limits should be determined using composited sampling data, with the same exceptions noted.

Data Needs

Minimum Sample Days

- Initial Development
- Ongoing / Re-Evaluation

Data Needs

Initial Development

Parameter	**POTW**		
	Influent days to sample	Effluent days to sample	Sludge days to sample
Organic Priority Pollutants	1 - 2	1 - 2	1
National POCs	7 - 14	7 - 14	2
POTW-specific POCs	7 - 14	7 - 14	2
Percent solids, sludge			2
TCLP pollutants			1

Data Needs

Ongoing / Re-Evaluation

Parameter	Location	Less than 5 MGD	5 – 10 MGD	10 – 50 MGD	>50 MGD
Adopted Local Limits	Influent Effluent Sludge	4 / year	4 / year	4 / year	6 / year
MAHLs Calculated	Influent Effluent Sludge	1 / year	2 / year	2 / year	4 / year
Organic Priority Pollutants	Influent	1 / year	1 / year	1 / year	2 / year
TCLP Pollutants	Sludge	1 / year	1 / year	1 / year	1 / year
Sludge Percent Solids	Sludge	2 / year	3 / year	4 / year	6 / year

Pollutants Defined

Conventional – pollutants that treatment plants are typically designed for.

Non-Conventional – all other pollutants or toxic pollutants.

Conservative – pollutant partitions in a recoverable form.

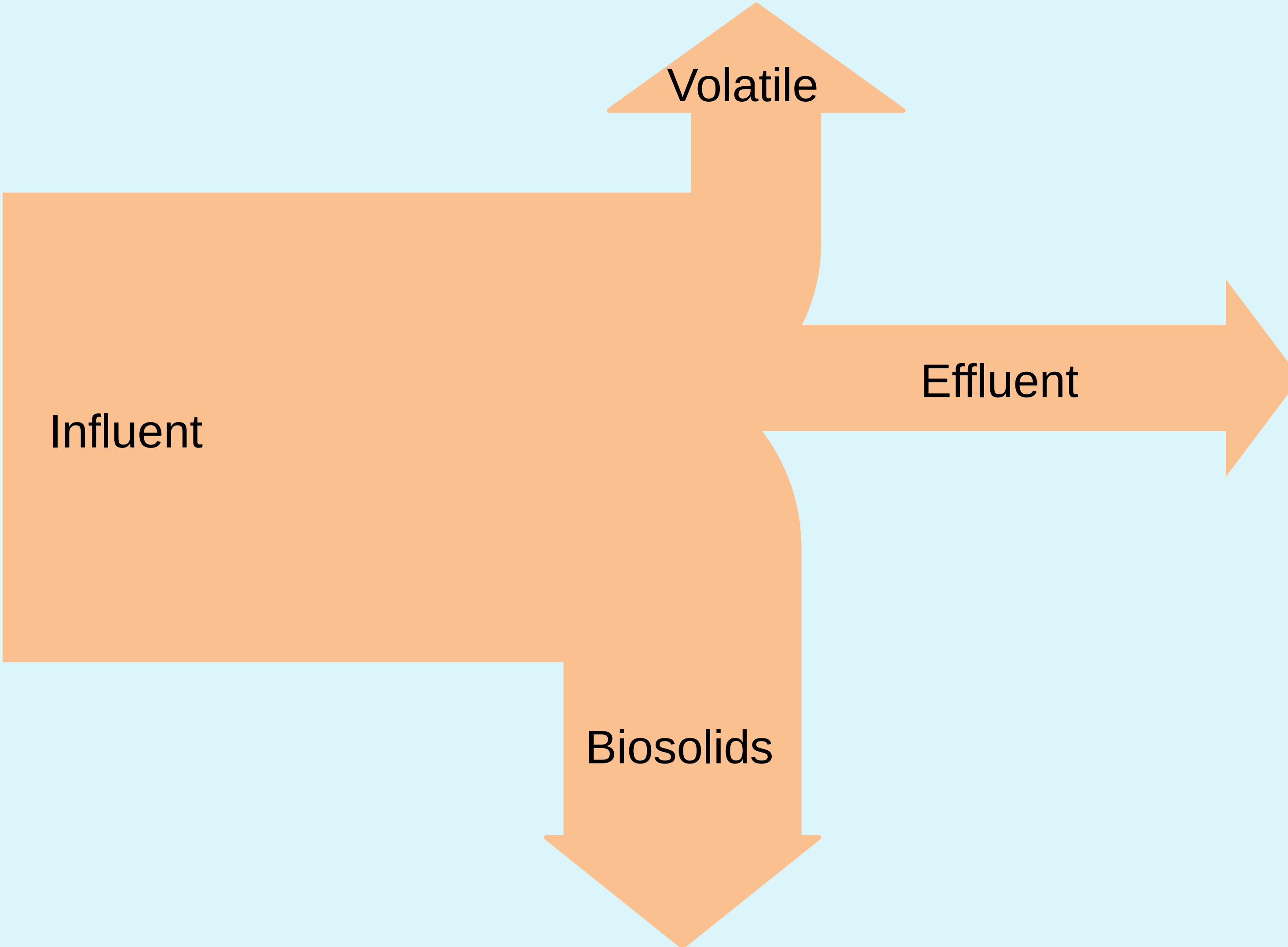
Non-Conservative – pollutant maybe transformed into new compound.

Non - Conservative Pollutants

Incoming Pollutant

Effluent Water | Biosolids | Atmosphere

Pollutant's Fate



Non - Conservative Pollutants

Examples

Conventional

$BOD_5 + O_2 \rightarrow CO_2$

Non-Conventional

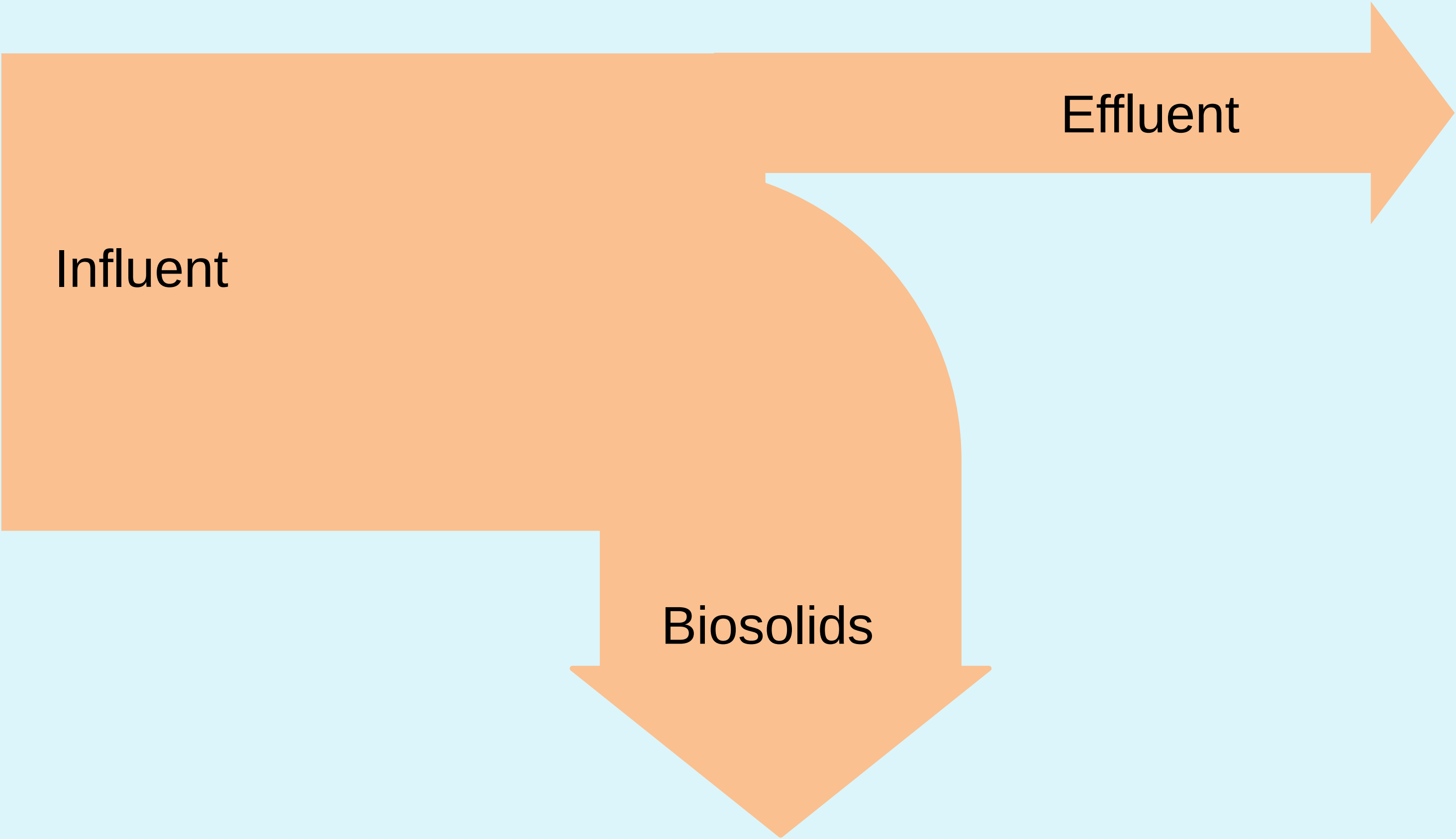
$NH_4 + O_2 \rightarrow NO_3$

Conservative Pollutants

Incoming Pollutant

Effluent Water	Biosolids	Atmosphere
		

Pollutant's Fate



Conservative Pollutants

Arsenic
Cadmium
Chromium
Copper
Lead
Mercury
Molybdenum
Nickel
Selenium
Zinc

Analytical Methods

40 CFR Part 136

40 CFR Part 503

- Anticipated pollutant concentration.
- Potential interferences.
- Total vs. a fraction thereof (e.g., Total vs. dissolved metals, or total vs. amenable cyanide).

Analytical Methods

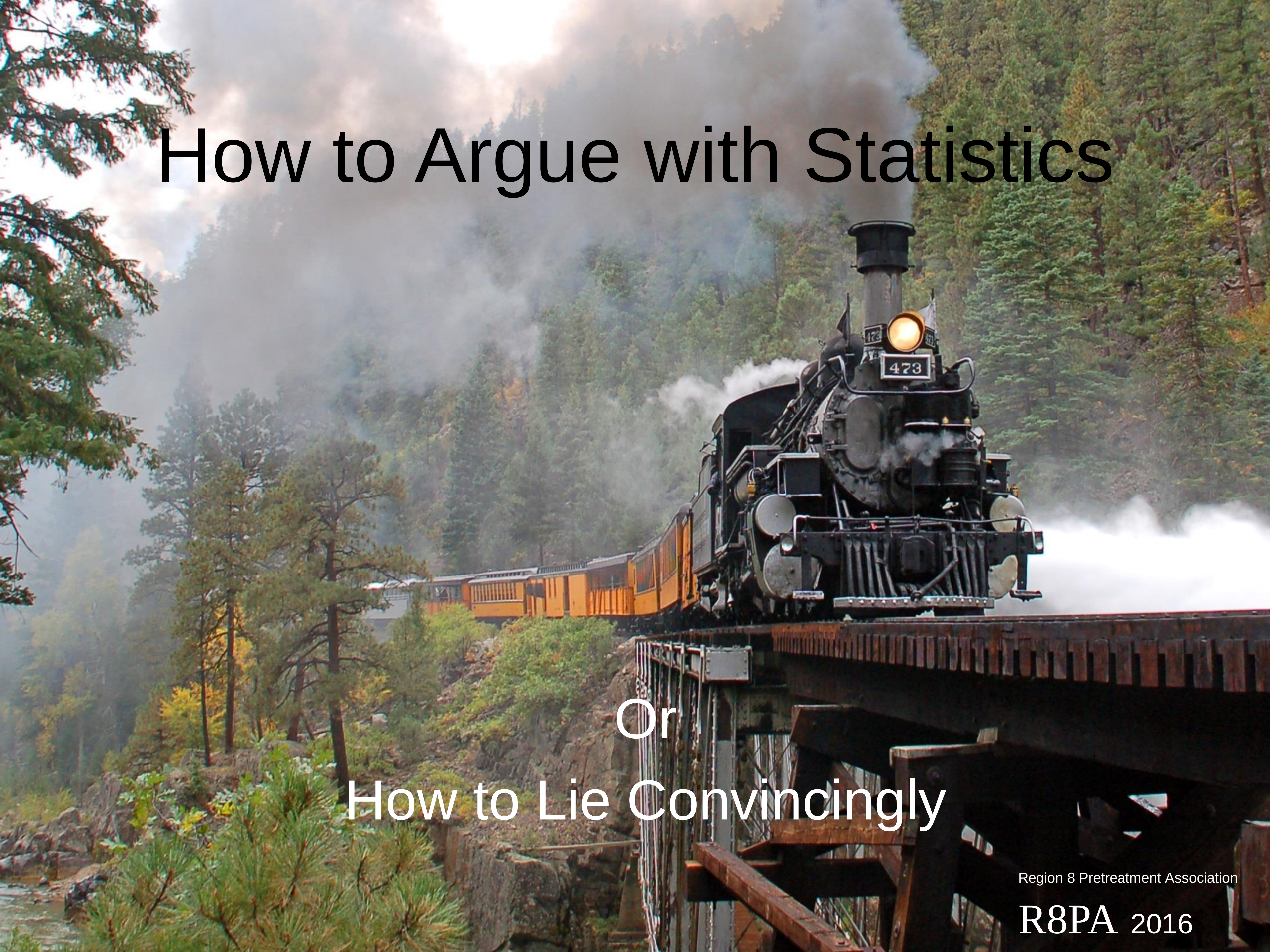
40 CFR Part 136

40 CFR Part 503

The minimum detection level (MDL) of the analytical method to detect the presence of pollutants in trace amounts and the corresponding minimum level (ML) of quantitation (generally 3.18 times the MDL) to determine removal efficiencies.

Data Analysis

How to Argue with Statistics



Or

How to Lie Convincingly

Region 8 Pretreatment Association

R8PA 2016

Introduction to Statistics

Two Types

Descriptive Statistics
    Entire POPULATION

Inferential Statistics
    SAMPLES from a population.

Introduction to Statistics

Descriptive Statistics

Greek notation

μ - mean

N - population size

Σ - sum

Introduction to Statistics

Inferential Statistics

Roman Notation:

X - mean

n - sample size

Σ - sum

Assume the sample size is unbiased

Introduction to Statistics

Univariate Statistics – one variable

- Mean 
- Median 
- Mode 
- Range (min, max) 
- Variance 
- Standard Deviation 

Introduction to Statistics

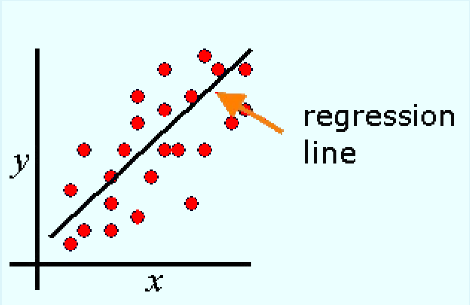
Bivariate Statistics – two variables

- Dependence

- Independence

- Association

- Linear Regression

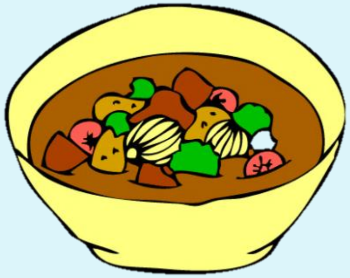


Introduction to Statistics

Multivariate Statistics – multiple variables

Factor Analysis

Multiple Regression



Univariate Statistics

The “mean” is the average score or value, such as flow from an industry.

Mean of a population

$$\mu = \frac{\Sigma X}{N}$$

Inferential mean of a sample

$$X = \frac{\Sigma X}{n}$$

Univariate Statistics

Because the mean average can be sensitive to extreme values, the “median” is sometimes useful and more accurate.

The “median” is simply the middle value among some scores of a variable.
(no standard formula for its computation)

Univariate Statistics

The “mode” is simply the most frequent value for a variable. Multiple modes are possible: bimodal or multimodal.

Univariate Statistics

Measures of dispersion tell us about variability in the data.

Basic question: how much do values differ for a variable from the min to max, and distance among values in between. We use:

Range

Variance

Standard Deviation

Univariate Statistics

The “range” gives us the value between the minimum and maximum values of a variable.

range = maximum – minimum

Univariate Statistics

The “variance” is a measurement of the spread between numbers in a data set.

Variance of a population

$$S^2 = \frac{\Sigma (x - \mu)^2}{N}$$

Variance of a sample

$$S^2 = \frac{\Sigma (x - X)^2}{n-1}$$

Univariate Statistics

The “standard deviation” is a measure that is used to quantify the amount of variation or dispersion of a set of data values.

Standard Deviation of a population

$$\sigma = \sqrt{\frac{\Sigma(x - \mu)^2}{N}}$$

Standard Deviation of a sample

$$\sigma = \sqrt{\frac{\Sigma(x - X)^2}{n-1}}$$

Exercise 2

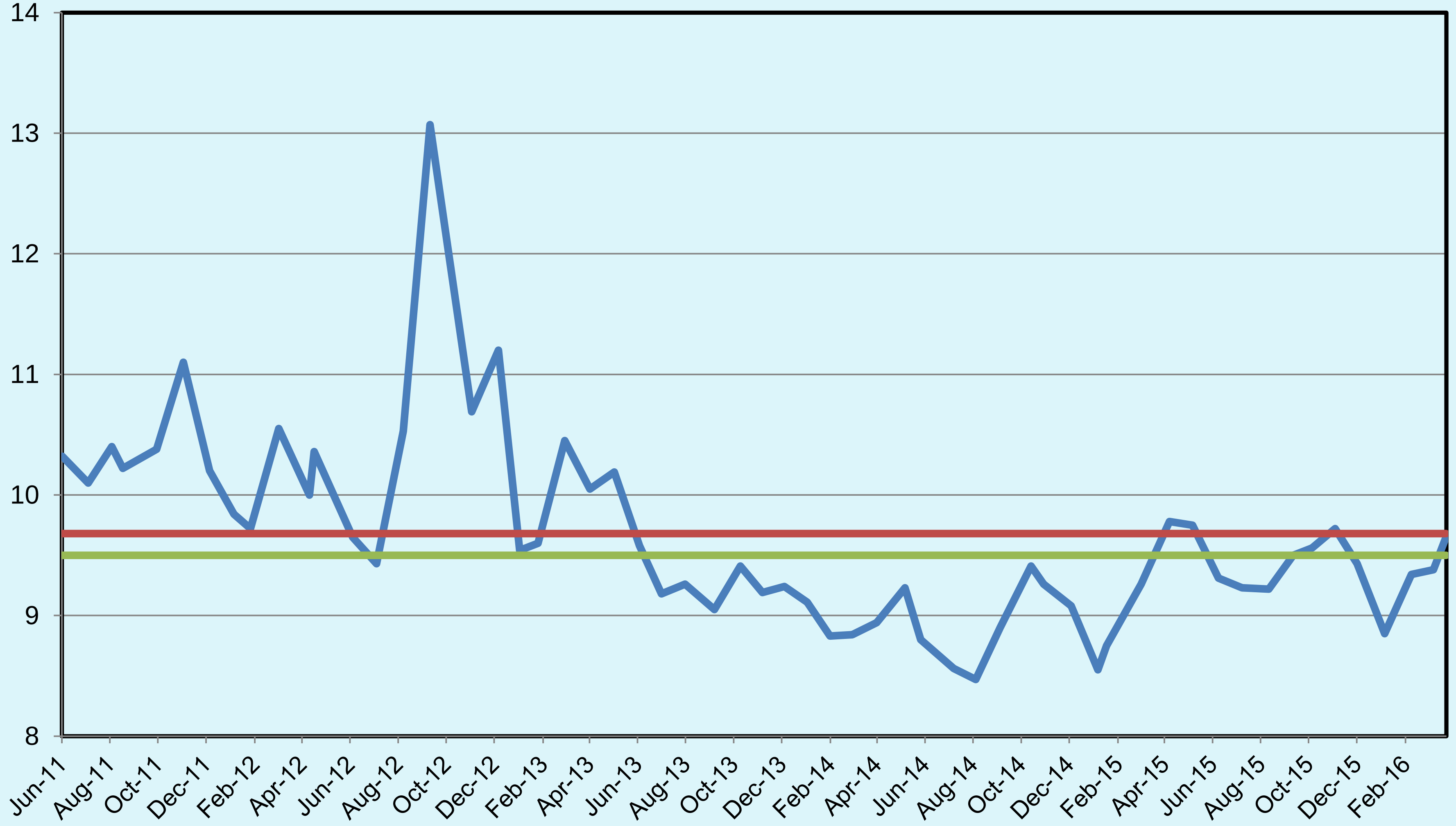
Exercise 2

Given the flow data from the thumb drive

Calculate and plot the

- Mean
- Median
- Mode
- Range
- Variance
- Standard Deviation

Exercise 2



14
13
12
11
10
9
8
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
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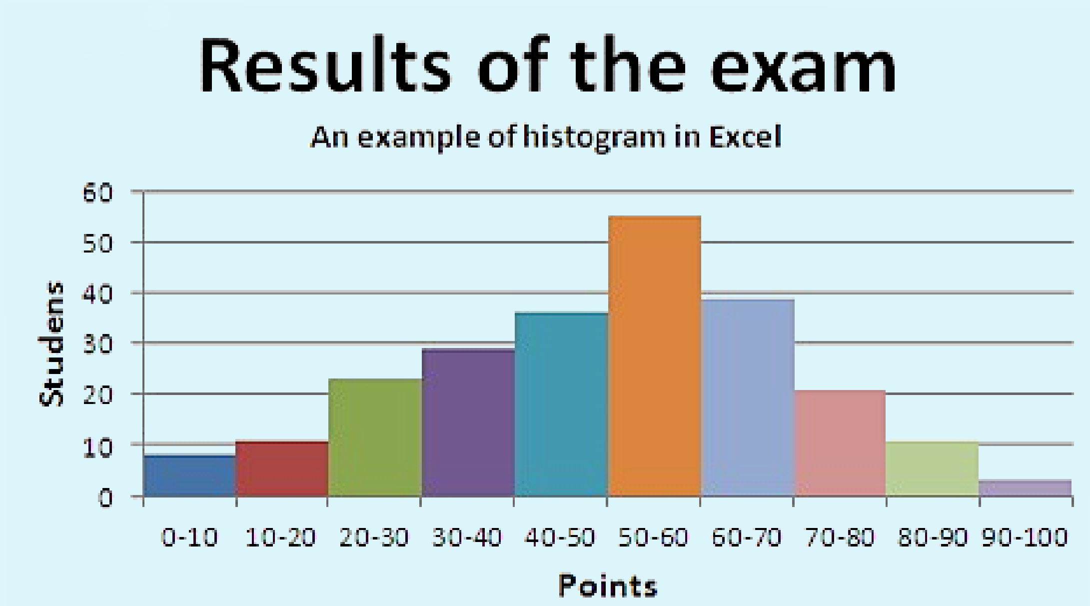
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14
Feb-15
Apr-15
Jun-15
Aug-15
Oct-15
Dec-15
Feb-16

Histogram

A histogram is a graphical representation of the distribution of numerical data.

It is an estimate of the probability distribution of a continuous variable



Histogram

Organize data into groups (bins)

Use between 8 and 16 when dealing with a lot of data.

Adjusted bin width round up the bin width to the higher value

$$\text{Bin size} = \frac{\text{Range}}{\text{Number of Bins}}$$

Exercise 3

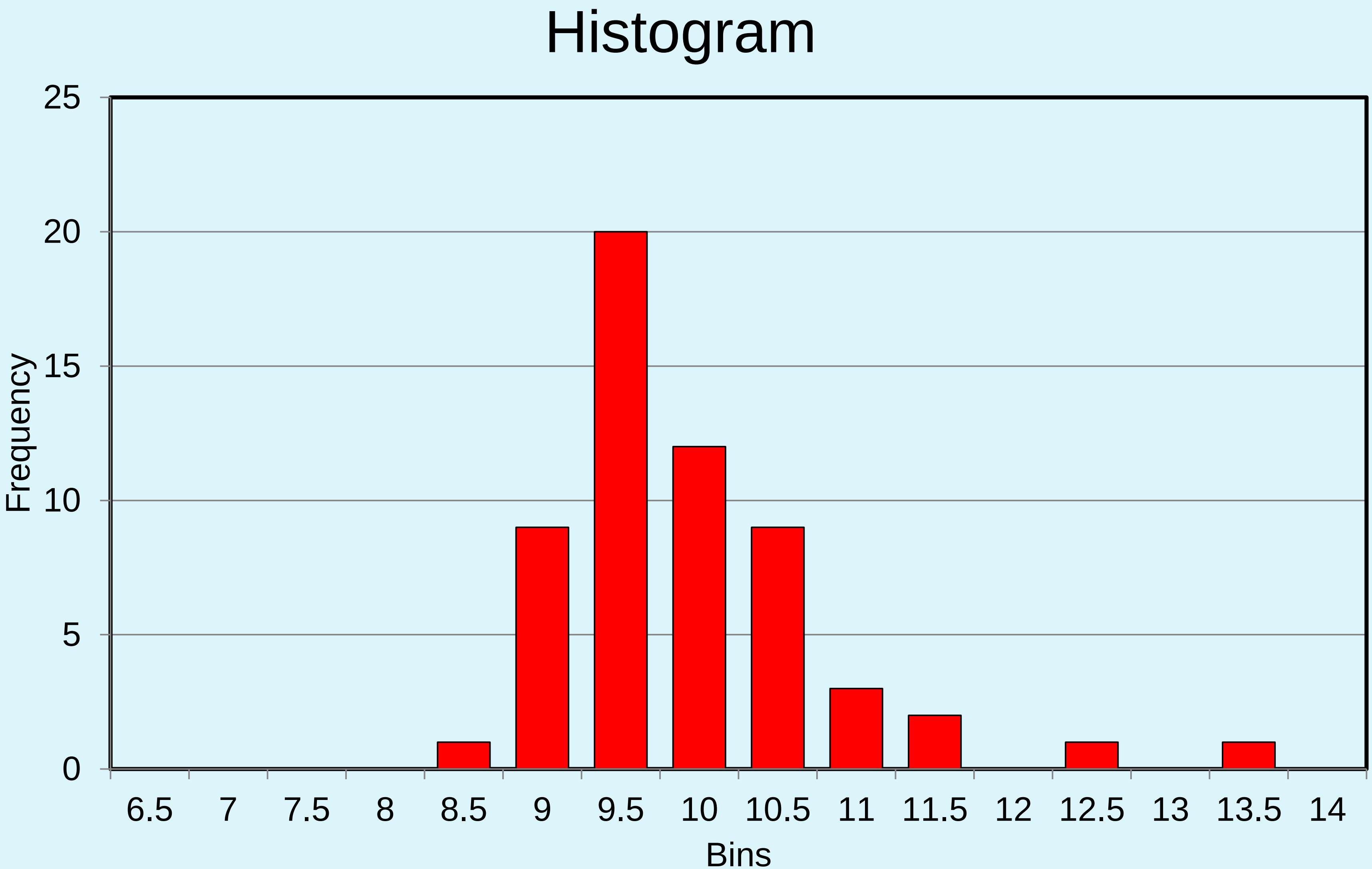
Exercise 3

Given the flow data from the thumb drive

Develop a 16 bin Histogram

Range 6.5 to 14 with step 0.5

Exercise 3



Histogram
25
20
15
10
5
0
Frequency
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
Bins

Normal Distribution

Assuming a normal distribution allows us to take advantage of its properties and make inferences from our sample to the population.

The theoretical *sampling distribution* of various statistics do seem to be normally distributed.

Normal Distribution

The Classic Bell-Shaped curve is symmetric, with mean = median = mode = midpoint

Also known as Gaussian distribution

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}(e)^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Normal Distribution

Curve has a total area or probability = 1

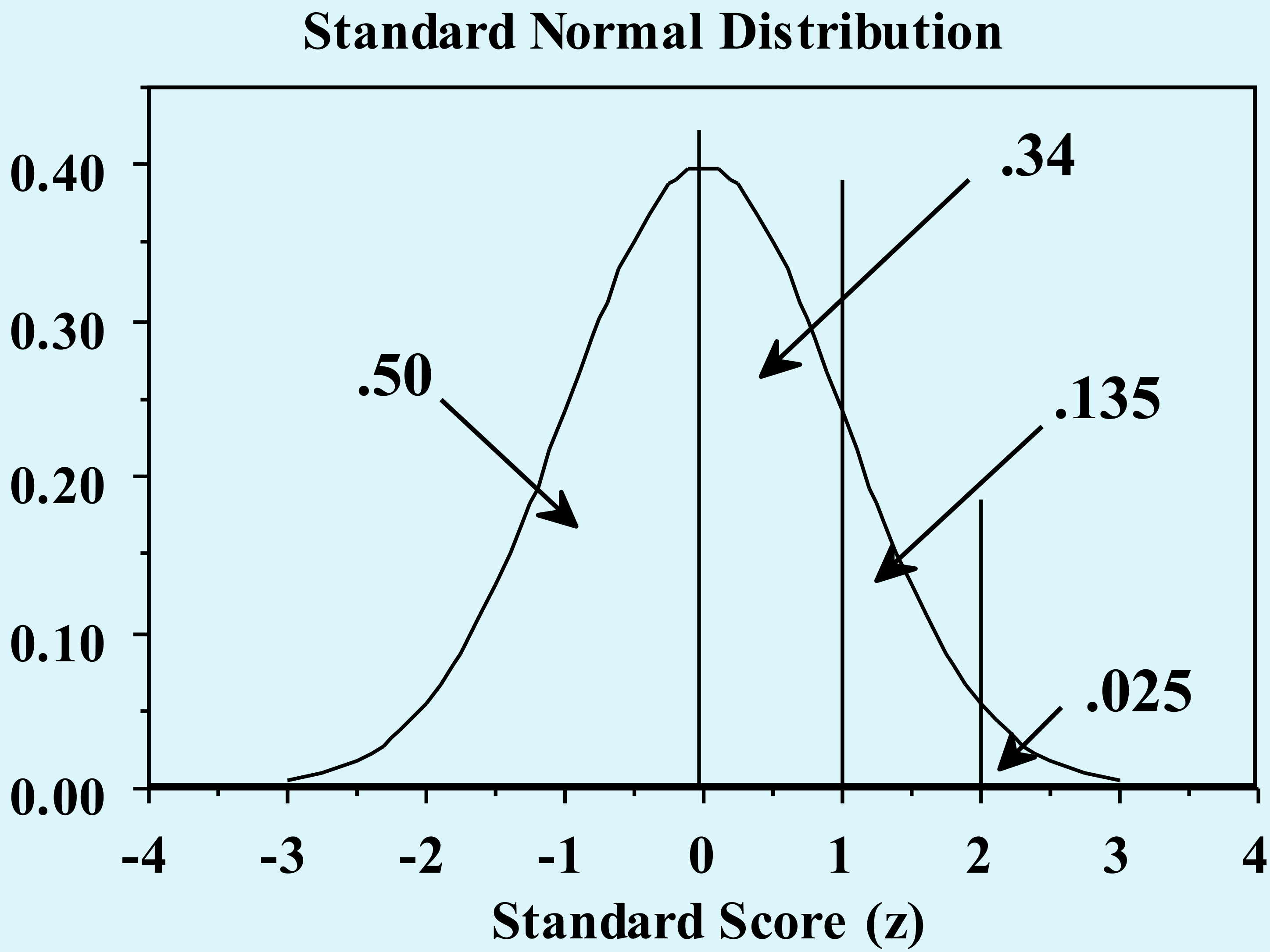
For normal distributions

$\pm$ 1 SD ≈ 68%

$\pm$ 2 SD ≈ 95%

$\pm$ 3 SD ≈ 99.9%

Normal Distribution



Exercise 4

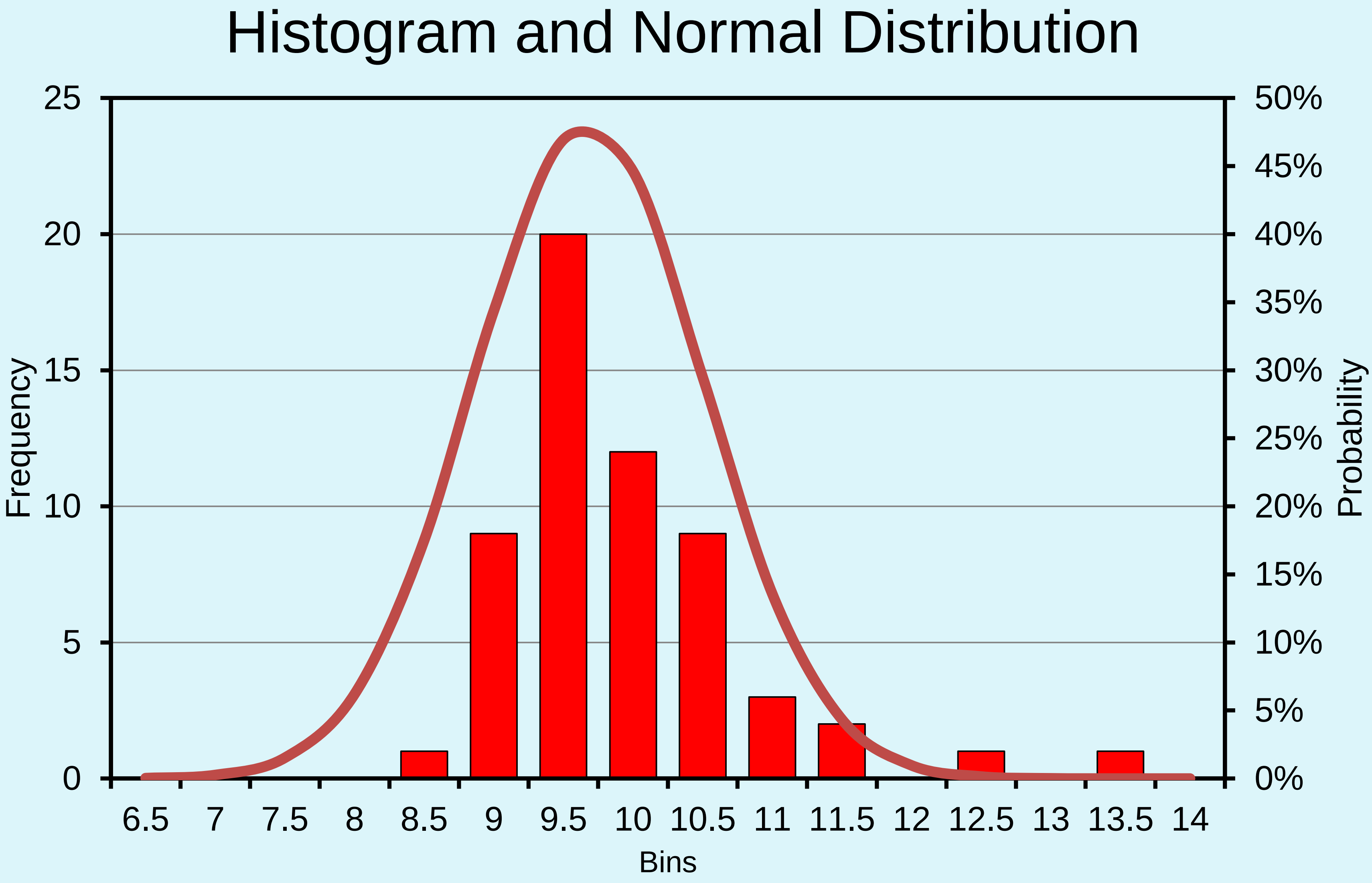
Exercise 4

Given the flow data from the thumb drive

And the 16 bin Histogram developed before

Overlay a Normal distribution plot

Exercise 4



Histogram and Normal Distribution
25
20
15
10
5
0
Frequency
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Probability
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
Bins

Bivariate Statistics

Bivariate Statistics – two variables

- Dependence
- Independence
- Association
- Linear Regression

Bivariate Statistics

The dependent variable is 'dependent' on the independent variable.

An independent variable is the variable that is changed or controlled in a scientific experiment to test the effects on the dependent variable.

Bivariate Statistics

Association between two variables means the values of one variable relate in some way to the values of the other. Association is usually measured by correlation for two continuous variables and by cross tabulation and a Chi-square test for two categorical variables.

Linear Regression

Exercise 5

Exercise 5

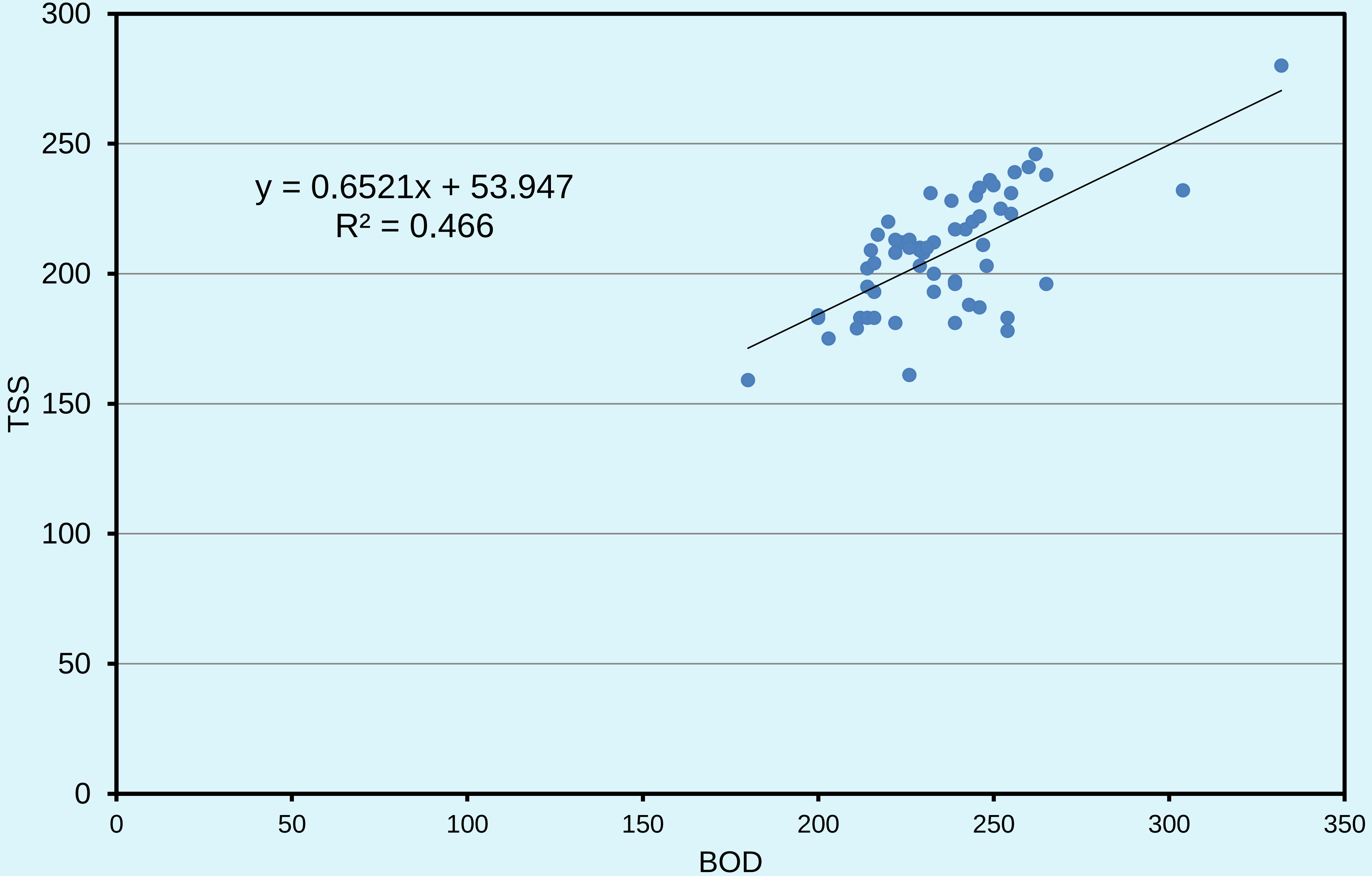
Given the BOD and TSS data from the thumb drive

Plot BOD_5 vs TSS

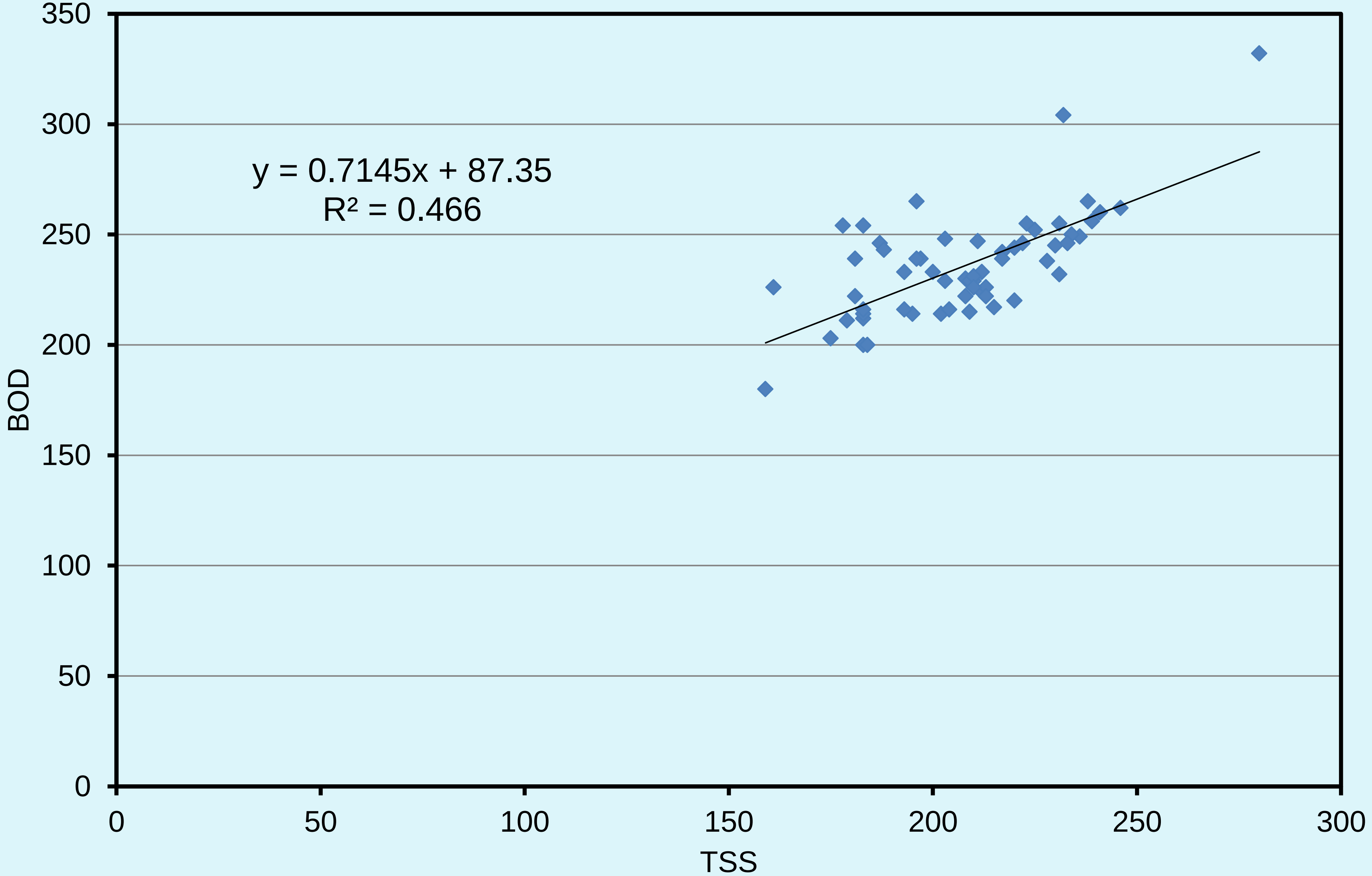
Plot TSS vs BOD_5

Calculate linear curve fit and regression coefficient

Exercise 5


y = 0.6521x + 53.947
R² = 0.466
300
250
200
150
100
50
0
TSS
0
50
100
150
200
250
300
350
BOD

Exercise 5



Calculating MAHL

Calculating MAHL

Calculate POTW removal efficiency for the POC

Calculate allowable headworks loadings (AHLs) for each environmental criterion

Designate as the MAHL the most stringent AHL for the POC

Removal Calculations

Pollutant removal efficiency is defined as the percent change of a pollutant’s mass flow taken before and after treatment:

$$\text{Removal Efficiency} = \frac{\text{Influent Mass} - \text{Effluent Mass}}{\text{Influent Mass}} \times 100\%$$

Removal Calculations

Removal efficiency is the most important Calculation in determining Local Limits.

If they are wrong

Everything else is wrong TOO

Removal Calculations

Sample Decision Tree

Influent → present / absent

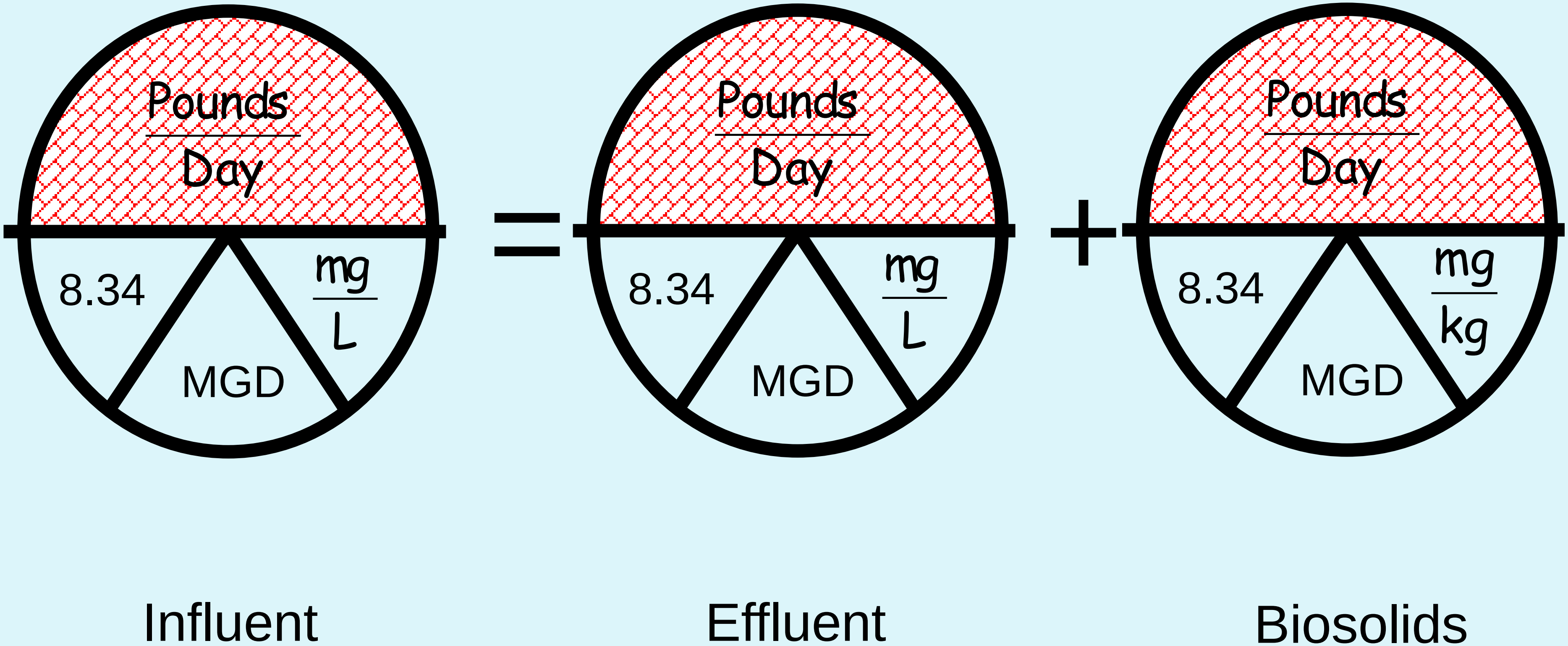
Effluent → present / absent

Biosolids → present / absent

Can you mass balance the pollutant?

Influent = Effluent + Biosolids

Mass Balance



Exercise 6

Exercise 6

Find the influent and effluent data for copper

Enter the data in the removal spreadsheet

Calculate removals

Use effluent 1 only

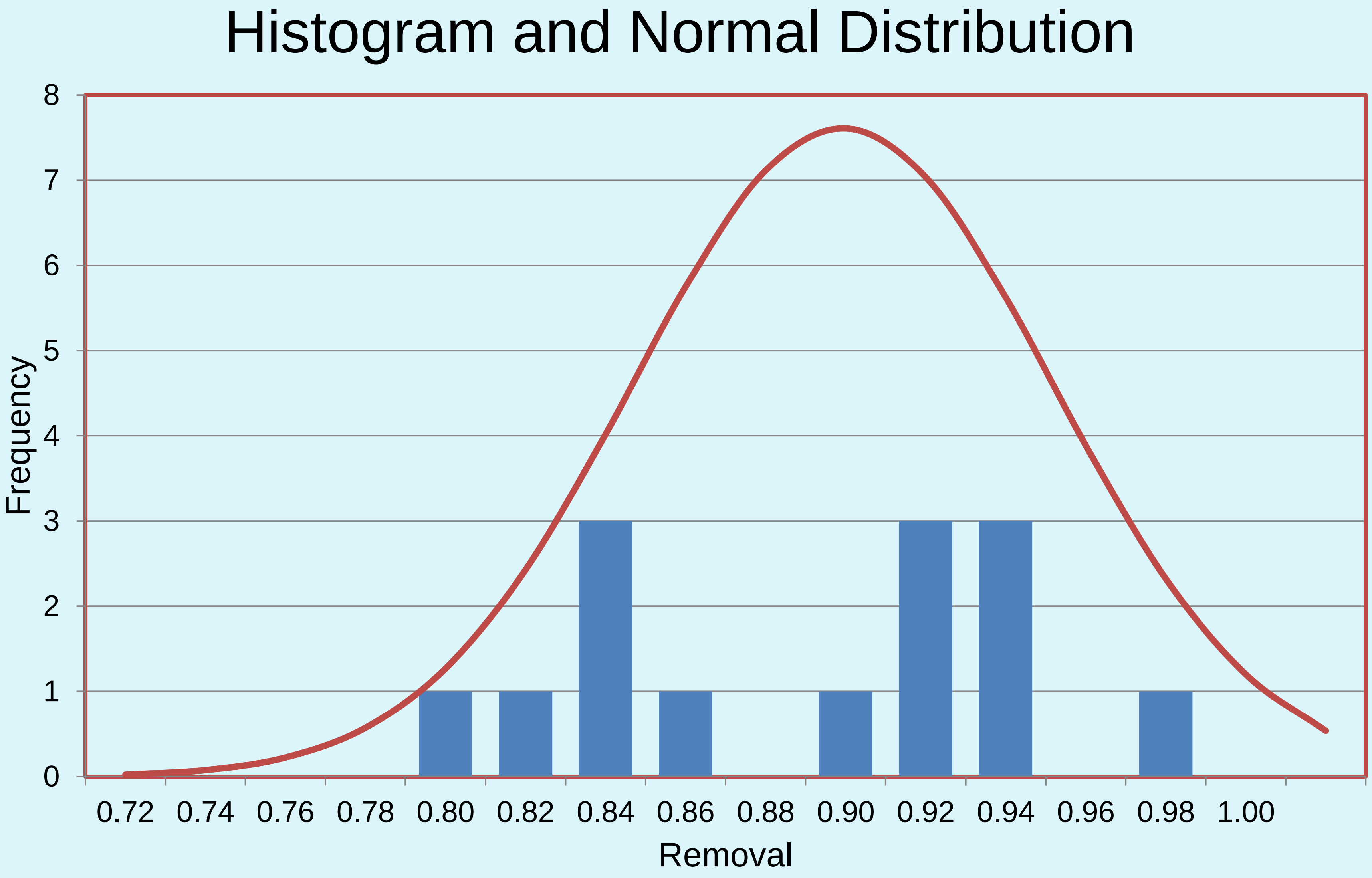
MRL Limits

200.7	0.01000 mg/L
200.8	0.00050 mg/L

Exercise 6

Average	-	0.87925
St Deviation	-	0.05242
Min	-	0.78533
Max	-	0.97259
Range	-	0.18726

Exercise 6


Histogram and Normal Distribution
Frequency
8
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4
3
2
1
0
0.72
0.74
0.76
0.78
0.80
0.82
0.84
0.86
0.88
0.90
0.92
0.94
0.96
0.98
1.00
Removal

Calculating AHL

Calculate the allowable discharge from the Wastewater Analysis

Remember the to look at Chronic Standard

Calculate the allowable discharge from the Sludge disposal

Use the lower of the two loadings

Calculating AHL

Calculate the allowable headworks loading using the following equation

$$AHL_{npdes} = \frac{WLA_{npdes}}{(1 - R_{potw})}$$

AHL_{npdes} - allowable headworks loading (water quality)

WLA_{npdes} - permitted water quality load

R_{potw} - pollutant removal efficiency

Calculating AHL

Calculate the allowable headworks loading using the following equation

$$AHL_{solids} = \frac{8.34 \times Q_{sludge} \times 503_{npdes} \times \text{Solids } \%}{R_{potw}}$$

AHL_{solids}	-	allowable headworks loading (sludge disposal)
Q sludge	-	daily sludge flow (MGD)
503_{solids}	-	maximum sludge concentration (disposal driven)
Solids %	-	percent solids of sludge
R_{potw}	-	pollutant removal efficiency

40 CFR 503

Parameter	Maximum ppm	Maximum lbs-ac	Annual ppm	Annual lbs-ac/yr
Arsenic	75	223	41	11
Cadmium	85	212	39	10
Copper	4,300	8,172	1,500	409
Lead	840	1,634	300	82
Mercury	57	93	17	5
Molybdenum	75			
Nickel	420	229	420	114
Selenium	100	545	100	27
Zinc	7,500	15,254	2,800	76

Exercise 7

Exercise 7

Calculate the allowable headwork loading for copper based upon water quality

Remember the to look at Chronic Standard

Calculate the allowable discharge from the Sludge disposal

Use the lower of the two loadings

Exercise 7

Average Removal	-	0.87925
Permitted effluent	-	9.5 lbs/day
503 limit	-	1500 mg/kg
Sludge flow	-	0.0748 MGD
Solids percentage	-	2.35%
AHL_{NPDES}	-	50.418 lbs/day
AHL_{503}	-	25.010 lbs/day

MAIL

MAHLs estimate the maximum combined loadings that can be received at the POTW’s headworks from all sources.

MAILs developed by the POTW represent the amount of pollutant loadings the POTW can receive from controlled sources (i.e.,industrial users, some commercial sources)

MAIL

Parameter	Comments	Source of Data
IU and SIU flow	Sum of all flows for IU and SIU	POTW local use sampling program, periodic reports from SIUs
Uncontrolled Source Pollutant Concentrations and Flows	Levels of POCs in domestic and commercial discharges that the POTW does not intend to control with local limits	POTW local use sampling program
Hauled Waste Loadings	Based on volume and pollutant concentration data	POTW sampling of waste hauler loads
Safety Factor	Varies depending on quality and amount of data	POTW choice based on data analysis
Growth Allowance	Varies based on the projected growth for the area	POTW choice based on data analysis

MAIL

Calculate the maximum allowable industrial loading using the following equation

$$MAIL = MAHL\ (1-SF) - ((Load_{res/com} + Load_{hauled})\ (1+GF))$$

MAIL	-	maximum available industrial load
MAHL	-	maximum available headworks load
SF	-	safety factor
$Load_{res/com}$	-	load from residential commercial areas
$Load_{hauled}$	-	load from hauled waste
GF	-	growth factor

Growth Factors

Population Growth 2010-2015		
US Rank	State	Percent
1	North Dakota	12.54%
3	Colorado	8.50%
4	Utah	8.40%
12	South Dakota	5.44%
19	Montana	4.40%
23	Wyoming	3.99%

Exercise 8

Exercise 8

Calculate the maximum allowable industrial loading for copper

Exercise 8

$MAHL_{503}$	-	25.010 lbs/day
$cMAHL_{503}$	-	22.509 lbs/day
$aHL_{res/com}$	-	1.659 lbs/day
aHL_{hauled}	-	0.605 lbs/day
aHL_{total}	-	2.265 lbs/day
$acHL_{total}$	-	2.605 lbs/day
$MAIL_{503}$	-	19.904 lbs/day